ANNUAL GROUNDWATER REPORT

2018 - 2019

US GYPSUM, IMPERIAL COUNTY

September 2019

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

In 1999, US Gypsum (USG) began an expansion and modernization project for the Plaster City Plant. This included construction of a new high-speed gypsum wallboard manufacturing facility to replace the unreliable, slow production line built in 1956. An environmental impact report and study (EIR/EIS) was approved in 2008 for the expansion of the Plaster City Plant. The EIR/EIS showed that groundwater levels in the basin used for supply (the Coyote Wells Valley Basin, **Figure 1**) had been declining prior to the expansion of the Plaster City Plant and predicted that groundwater levels would decline at a greater rate after the expansion was complete. The mitigation plan from the EIR/EIS included implementation of a Groundwater Monitoring Program, which was developed for USG in 2015 (Todd, 2015). Further work with the Sierra Club led to a Settlement Agreement in 2018 that added information and clarification to the Groundwater Monitoring Program.

This Annual Report documents conditions and changes that occurred from Spring 2018 through Spring 2019. Water levels are monitored by the United States Geological Survey (USGS) each spring. The Annual Report is submitted to the County by the first business day of October.

New groundwater level and quality data are documented and discussed below. Overall, the conditions in the Coyote Wells Valley Basin have remained similar to conditions reported in 2018, although some wells show a slight decline in groundwater elevation. Water level elevations were measured by the USGS at 22 wells and water quality was sampled at 15 wells across the basin. USG measured water levels in an additional three wells and specific conductance in one additional well.

2. PHYSICAL SETTING

2.1. DESCRIPTION OF GROUNDWATER BASIN

Groundwater for the Plaster City Plant, community of Ocotillo, and local domestic wells is pumped from the Coyote Wells Valley Groundwater Basin (No. 7-29), as defined by the California Department of Water Resources (DWR, 2003)[1]. DWR generally defines groundwater basins based on the extent of alluvial deposits. As depicted in **Figure 1,** the Basin encompasses 64,000 acres (100 square miles) in the Yuha desert west of Imperial Valley, California. It is located mostly in Imperial County, with the western edge extending into San Diego County. A full description of the basin and the regional hydrogeology can be found in **Appendix A**.

2.2. HYDROLOGY

The Coyote Wells Valley Basin receives very limited precipitation and natural recharge. The closest active precipitation station is in El Centro (Western Regional Climate Center, 2019). Over the period of record 1934-2019, the average annual rainfall for a Spring to Spring

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[1] The EIR/EIS refers to the area as the Ocotillo/Coyote Wells Groundwater Basin as defined by USGS.

water year is 2.56 inches. From April 2018 to March 2019, annual precipitation was 2.68 inches, above average. Rainfall has ranged from 0.07 inches in 2006 to 7.3 inches in 1982. **Figure 2** shows the annual spring to spring precipitation for the El Centro station.

2.3. GROUNDWATER PUMPING

The main use of groundwater pumping within the basin is industrial usage by the Plaster City plant. This groundwater is pumped from three US Gypsum production wells (USG- 4, 5, and 6) located in the center of the Basin as shown on **Figure 3**. **Figure 3** also shows wells in the monitoring program. **Figure 4** provides a close-up view of well locations around Ocotillo.

As documented in **Table 1**, groundwater pumping by USG in calendar year 2018 amounted to 374 AFY, similar to last year's total (362 AFY). **Figure 5** depicts the long-term pumping amounts with annual pumping data from 1970 to the present.

As this Annual Report covers the period Spring 2018 through Spring 2019, the pumping over this time was 370 AFY. **Table 2** shows the pumping on a quarterly basis. Pumping volumes have been consistent in each quarter reflecting steady pumping throughout the year, averaging about 93 AF per quarter.

Other groundwater pumping from the basin occurs for residential and industrial uses. Wells of two mutual water companies and individual domestic wells have been estimated to produce 127 AFY as of 2004 (Todd, 2007).

3. MONITORING PROGRAM

Table 3 identifies all actively monitored wells within and just east of the groundwater basin. Water levels are monitored by the US Geological Survey (USGS) and US Gypsum, and water quality is monitored by USGS. In Spring 2019, the USGS monitored 22 wells for water levels and 15 wells for water quality. The USGS provides water level and water quality data on a semi-annual basis that is made available on the National Water Information System (NWIS) https://waterdata.usgs.gov/.

USG has probes in 5 wells monitoring both water levels and water quality. Three of the logs produced reliable daily water level data for 2018-2019 (USG-4, USG-6, and East well). USG-4 and USG-6 are pumping wells and water levels fluctuate based on pumping from the well and may not reflect regional water levels. When a well is pumped, groundwater levels decline in the well, and the resultant drawdown varies based on type of pump, efficiency of well, and other variables. Water levels are expected to return to static water levels shortly after the pump is turned off. In USG-4, pumping levels are 12 feet below static levels, in USG-6 water levels only fluctuate 1.1 feet. Hydrographs for these wells can be found in **Appendix B**.

Table 3 also lists that wells that were recently monitored but not included in the 2019 dataset, along with the monitoring entity (USGS or USG) and reason for interruption of monitoring.

Locations of monitored wells across and beyond the basin are shown on **Figure 3** and the wells in the Ocotillo area are shown on **Figure 4;** blue indicates wells that have both level and quality data from 2019, yellow indicates wells with water level data only and green indicates water quality data only. Currently inactive wells also are shown, indicated in white.

4. GROUNDWATER ELEVATIONS

4.1. WATER LEVELS

All hydrographs are provided in **Appendix B.** Hydrographs are presented in two sets: one set contains hydrographs with the same scale for all active wells and the other set shows the water levels on a focused scale with a range of 25 feet to highlight small changes. Overall, the hydrographs show that groundwater levels have small changes over time.

Figure 6 shows the location of key wells with hydrographs of groundwater levels. Key wells were selected on the basis of relatively complete water level histories and representative locations that show trends across the groundwater basin.

Pumping in USG wells impacts groundwater levels in the local area. Monitoring wells 31B1 and 36D2, located near the USG production wells, show similar trends (decrease from 1990s to 2008, slight increase from 2008 to 2015 and a slight decrease from 2015 to 2019). As with previous years, water levels decreased slightly due to pumping in the USG wells but can be expected to recover during periods of lower pumping such as the mid 2008-2015. These short-term changes are not visible in wells located farther from the plant, for example, wells 24D1 or 16J1. These wells continue a steady trend (decreasing and increasing respectively) although USG pumping was reduced to half from 2009 to 2015. Wells along the eastern edge of the basin, 42L1 and to a much lesser extent 32R1, continue to reflect seasonal variation, showing sharp increases shortly after peak precipitation events (1993 and 1997).

Of the 17 wells monitored by the USGS in both 2018 and 2019, four showed increasing water levels, seven showed stable water levels, 6 showed decreasing water levels, and the three USG wells show daily variation due to pumping; however, these wells do not reflect static conditions. Wells with decreasing trends were located across the basin with the largest water level decline occurring near the USG monitoring wells (36A1 and 36A2), both the shallow and deeper wells declining by over one foot (1.3 feet in the shallower well and 1.4 feet in the deep well). This decline could reflect a change in USG pumping, as the portion of pumping increased in USG-4 (from 26 percent in 2017 to 41 percent in 2018) which is located closer to the monitoring wells than USG-6, which decreased in volume. One third of wells showing decreasing levels were located on the far eastern edge of the basin, not likely to be affected by short term USG pumping changes. However, these wells should continue to be monitored for long term changes in groundwater flow.

From Spring 2018 to Spring 2019, water levels in the basin showed steady or slightly decreasing groundwater levels. Groundwater levels typically range from about 200 feet above mean sea level in the southeast part of the groundwater basin to about 290 feet in the western portion of the basin. No substantial changes have been seen in the current water levels from 2018-2019 as compared to previous data presented in the monitoring plan.

Figure 7 shows groundwater contours and flow direction in the vicinity of Ocotillo. Groundwater generally flows from west to east. A pumping depression is shown around one well on the west; this depression is most likely due to recent pumping in one or more private, non-USG wells.

4.2. ASSESSMENT OF GROUNDWATER LEVEL DECLINES

Groundwater level declines in the Coyote Wells Valley Basin can reflect two basic causes. First, groundwater levels in a well can be affected by the drawdown effects of nearby pumping, for example, from USG wells. This is a localized and short-term phenomenon. Second, groundwater levels in the Coyote Wells Valley Basin are characterized by long-term regional decline; additional pumping could cause a declining trend that is more widespread or greater than the predicted rate.

Operation of production wells involves alternating periods when well pumps are off and on. When well pumps are operating, groundwater levels decline in and around the pumped well; when this short-term, localized drawdown affects a nearby well, such well interference can have adverse effects on well yield. To increase the effectiveness of the monitoring program, a performance standard was created to assess such potential impacts:

> *Well interference is defined as the combined pumping from all USG pumping wells so as* ***not to exceed 5 feet of drawdown at the nearest water-supply well.***

No private wells have yet reported well interference issues due to USG pumping. As shown in the hydrographs for USG-4, USG-5, and USG-6, water levels vary greatly when the well is pumping but water levels recover quickly within days when wells are not pumping.

To assess potential impacts of USG pumping on long-term regional decline in groundwater levels, the performance standard is designed to act as an early warning system; it is stated as follows:

> *Water level decline is defined as four consecutive* ***annual*** *groundwater measurements (****spring only****) declining at a rate that is greater* ***than 0.1875 feet per year****, occurring at more than* ***10 percent of wells*** *in the regional monitoring program.*

In the wells where water levels have been monitored in 2019, none have showed a declining trend greater than the predicted rate for four consecutive sampling events. This indicates no additional steady groundwater decline attributable to USG pumping. **Table 4** summarizes the calculated rate of decline by well for the period of record (2010-2019); declines greater than 0.1875 feet per year are highlighted To reduce any seasonal effects, only spring measurements are used to calculate the rate of decline.

Well 42L1 has had three consecutive spring water levels showing a decline greater than 0.1875 feet. This well is located on the far eastern side of the basin, and as shown in Figure 6, water levels are highly variable, significantly influenced by wet year recharge, followed by groundwater level recession; above average rainfall this year may result in a small increase in groundwater elevation next year. While this is only one well and its groundwater level decline does not trigger any early warning, monitoring of this well next year is needed to discern a trend; if the decreasing trend continues, additional information should be gathered about local conditionsaround the well.

5. WATER QUALITY

5.1. GROUNDWATER QUALITY

The EIR/EIS indicated that the primary causes of potential groundwater quality degradation from increased groundwater production would include:

- lateral migration of saline water from Tertiary marine sediments that crop out in the Ocotillo and No Mirage area and areas to the east of Coyote Wells, or
- vertical migration of saline water from the Tertiary marine sediments present at depth below the alluvial aquifer.

The monitoring program is designed to detect changes in TDS concentrations due to increased pumping by USG. Use of TDS as an indicator for general mineral groundwater quality is a simplified, but widely accepted method to detect changes in general water quality.

5.2. POTENTIAL WATER QUALITY DEGRADATION

Water quality data generally show stable trends for the key constituents. Because of these stable trends, it is unlikely that high TDS concentrations in the east are migrating west.

The following performance standard is used as an early warning of changing conditions from USG pumping and its potential effect on water quality:

> *A significant increasing trend in **total dissolved solids** (TDS) concentrations is defined as TDS concentrations in groundwater from any well in the groundwater basin whereby **four consecutive annual samples (collected each spring)** show a cumulative increase greater than **20 percent of the long-term average** for that well.*

TDS concentrations for the active USGS monitoring wells are shown in **Table 5**, and other constituents are presented in **Appendix C**. TDS concentrations are steady, as defined by the updated 2018 USG performance standard. Twelve of the eighteen active monitoring wells with both 2018 and 2019 measurements showed stable or a change of less than five percent of the mean concentrations. Six wells showed an increase in TDS concentration from six to thirteen percent of the mean (11H3, 24D1, 25M2, 26F1, 34B1, and 36A2). While this increase is below the threshold and for only one measurement rather than the required four, the wells should continue to be monitored. The well locations are not concentrated in any one area of the basin and all but 25M2 showed a decrease in TDS concentrations in the past 2 years, not a continued upward trend. The well 25M2 began monitoring TDS in March 2018.

Figures 8a and **8b** shows TDS concentrations by well for each spring monitoring event. **Figure 8a** shows all of the wells with a scale of 0 to 1,600 mg/L and **Figure 8b** shows only the wells with an increasing concentration above 5 percent of the well's mean TDS concentration. All wells in the monitoring network met the performance standard for TDS. However, these six wells should continue to be monitored in the event concentrations continue to rise.

Figure 9 shows maximum TDS concentrations within the groundwater basin for Spring 2019; data are provided in Appendix C. As documented in Table 5, one well with previously high TDS concentrations (42A8) showed a decline from a high of 1,240 mg/L in April 2011 to 575 mg/L in March 2019. Well 24B1 has a high TDS concentration of 1,310 mg/L but concentrations have remained stable or decreasing since 2015.

6. SUSTAINABLE GROUNDWATER MANAGEMENT ACT (SGMA)

Pursuant to California Water Code Section 10723.8 of the Sustainable Groundwater Management Act (SGMA), which became effective on January 1, 2015, Imperial County gave notice to DWR of its election to assume the role of Groundwater Sustainability Agency (GSA) and to undertake sustainable groundwater management within County boundaries for all groundwater basins and sub-basins within the county. The County has since been deemed the exclusive GSA for the Coyote Wells Valley Basin.

We understand that the County will continue to work cooperatively with local agencies, water providers and other interested stakeholders within the basin. Should the County choose to prepare a Groundwater Sustainability Plan (GSP) for the Basin, the County will consider the interests of all beneficial uses and users of groundwater, as directed by California Water Code section 10723.2. The GSP process should continue to be followed by USG. Groundwater management may change how groundwater is monitored, reported, or allocated in the basin.

As of August 2019, there is no initial notification for a GSP of Coyote Wells Valley Basin and there are no other indications that the county is moving ahead in the process.

7. CONCLUSIONS

The current monitoring program meets the objectives set forth in EIR/EIS, noting the importance of continued USGS data collection. The water level data collected are sufficient to identify increases in the rate of water-level decline and the water quality data provide an early warning of potential degradation. In summary, none of the performance standards have been exceeded, and no significant adverse trends have been identified.

US Gypsum will prepare the next Annual Report due to the County of Imperial by the first business day in October 2020.

8. REFERENCES

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TABLES

Table 1. Annual USG Pumping by Well (AFY)

Calendar Year Pumping	Well #4	Well #5	Well #6	Total
2005	226	199	149	575
2006	199	188	162	549
2007	192	174	135	501
2008	140	136	125	400
2009	75	84	78	237
2010	78	82	79	239
2011	81	83	82	247
2012	69	109	70	248
2013	106	66	78	250
2014	98	59	82	239
2015	87	93	91	271
2016	115	118	106	339
2017	93	148	121	362
2018	154	127	92	374

Table 2. Quarterly USG Pumping by Well (AF per quarter)

Year	Quarter	#4	#5	#6	TOTAL	Annual Distribution
2018	**Q1**	36	33	21	91	--
2018	**Q2**	46	28	12	86	23%
2018	**Q3**	40	38	29	107	29%
2018	**Q4**	33	28	30	90	24%
2019	**Q1**	30	29	29	88	24%

Table 3. List of Actively Monitored Wells and Available Data for 2019

Well Name	Short Name	Active WL Network	Active WQ Network	First WL Measurement	First WQ Measurement	Agency	Key Well
17S11E22E2	22E2	Y		1975	1975	USGS	
17S10E11B1	11B1	Y		1975	--	USGS	
17S10E11G4	11G4	Y		1978	--	USGS	
17S10E11H3	11H3	Y	Y	1987	1987	USGS	
17S11E16J1	16J1	Y		1970	1972	USGS	y
16S11E23B1	23B1	Y		1974	1964	USGS	
16S09E24B1	24B1	Y	Y	1976	1977	USGS	
16S09E24D1	24D1	Y	Y	1976	1977	USGS	y
16S09E25K2	25K2	--	Y	1972	1972	USGS	
16S09E25M2	25M2	--	Y	1991	1971	USGS	
16S09E26F1	26F1	Y	Y	1998	2013	USGS	
16S11E27F1	27F1	Y		1975	--	USGS	
16S10E27R1	27R1	Y		1975	1975	USGS	
16S10E28D1	28D1	--		1974	1948	USGS	
16S10E29H1	29H1	Y		1975	1975	USGS	
16S10E30R1	30R1		Y	--	1959	USGS	
16S10E31B1	31B1	Y	Y	1993	2013	USGS	y
16S10E32P1	32P1/32P2	Y		1992	--	USGS	
15S11E32R1	32R1	Y		1974	1964	USGS	y
16S09E34B1	34B1	Y	Y	1998	1997	USGS	
16S09E35M1	35M1	Y		1962	1962	USGS	
16S09E36A1	36A1 /MW-2B	Y	Y	2012	2013	USGS	
16S09E36A2	36A2 /MW-2A	Y	Y	2012	2013	USGS	
16S09E36C2	36C2		Y	1975	1961	USGS	
16S09E36D2	36D2	Y		1975	1975	USGS	y
16S09E36G3	36G3 / USG-4	Y	Y	2011	1963	USGS / USG	
16S09E36H2	36H2 / USG-5	Y	Y	2015	2015	US Gypsum	
16S09E36B1	36B1 / USG-6	Y	Y	2015	2015	USGS / USG	
16S10E42A8	42A8		Y	--	1994	USGS	
16S11E42L1	42L1	Y		1975	1975	USGS	y
17S10E11G1	11G1	Y		1967	--	USGS	

Wells Not Monitored in 2019 that were recently active

Well Name	Short Name	Agency	Reason
16S09E25M2	25M2	USGS	No reason given by USGS, WL not monitored since 2017. WQ was monitored
16S09E25K2	25K2	USGS	No reason given by USGS, Last monitored 2018. WQ was monitored
16S10E28D1	28D1	USGS	No reason given by USGS, Last monitored 2018

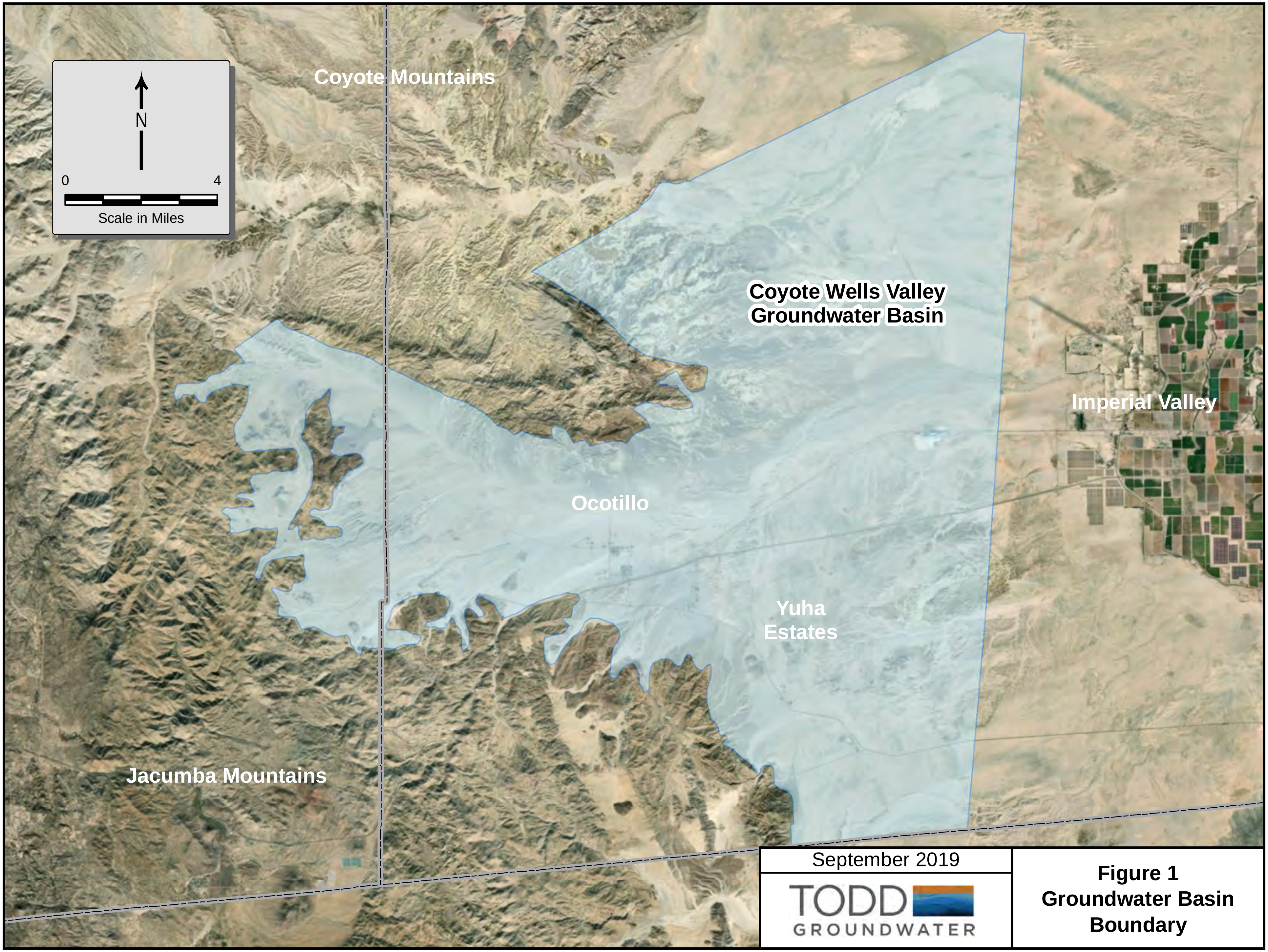
Table 4: Water Level Trends

Well_Short	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Maximum consecutive years of declines greater than 0.1875 ft/year
11B1	0.60	0.52	0.56	0.44	0.37	0.60	0.62	0.43	0.42	0.37	
11G1		0.83	-0.18	0.84	0.64	-0.39	1.46	-0.89			
11G4	0.62	0.29	0.30	0.60	0.55	0.42	0.62	-0.48	1.70	0.28	
11H3			-1.09	2.05	0.29	0.84	0.66	-0.05	0.79	0.24	
16J1	0.38	0.46	0.12	0.27	0.13	0.03	0.20	0.08	0.27	0.06	
22E2	0.38	0.41	0.16	0.24	0.46	-0.27	0.20	0.71	-0.34	0.03	
23B1	-0.30	0.26	-0.45	-0.06	-0.63	0.55	-0.10	3.74	-3.80	0.05	
24B1	-0.07	-0.23	-0.16	-0.09	-0.21	-0.14	-0.09	-0.10	-0.13	-0.13	
24D1	-0.08	-0.18	-0.11	-0.14	-0.19	-0.51	0.30	-0.04	-0.13	-0.11	
25K2								-0.20	-0.12		
25M2		-0.88	1.17	-0.33	0.29	-0.80	0.69	-0.94			
26F1	-0.07	-0.05	-0.11	-0.07	-0.10	-0.06	-0.09	-1.21			
27F1	-0.10	-0.25	-0.28	0.13	-0.10	-0.15	0.05	-0.08	0.13	-0.02	
27R1	-0.12	0.01	-0.09	0.01	0.41	0.05	0.13	-0.13	0.22	0.30	
28D1	-0.38	-0.20	-0.28	-0.15	-0.18	-0.20	-0.15				
29H1	0.35	-0.31	-0.09	-0.01	0.01	0.00	-0.02	-0.08	0.08	0.03	
29L1											
31B1	0.35	0.27	0.18	0.03	-0.02	-1.04	-2.11	2.73	-0.35	-0.20	2
32P1	-0.08	-0.35	-0.18	-0.43	-0.38	-0.10	-0.33	-0.10	-0.17		
32R1	0.01	0.02	-0.09	0.22	0.12	-0.07	-0.01			-0.26	1
34B1										-0.10	
35M1		4.30	0.00	2.83	1.10	-0.07	-0.26	-0.10	-0.05	0.05	
36A1(MW-2B)					0.17	-0.83	-0.31	-1.22	-0.01	-1.26	1
36A2 (MW-2A)					-0.13	3.51	-0.50	-1.03	-0.13	-1.41	1
36D2	0.48	0.36	0.17	0.11	-0.03	0.03	-0.17	-0.25	-0.15	-0.23	1
36H2							-0.08				
42L1	-0.97	-1.01	-0.29	3.03	0.19	-0.05	0.01	-0.43	-0.40	-0.40	3
USG-4				-3.98	4.82	2.52	-1.64				pumping
USG-5	2.99	0.93						-5.48			pumping
USG-6				-0.67	0.25	3.45	-0.16	-1.10			pumping

Table 5: Total Dissolved Solids Concentrations (mg/L)

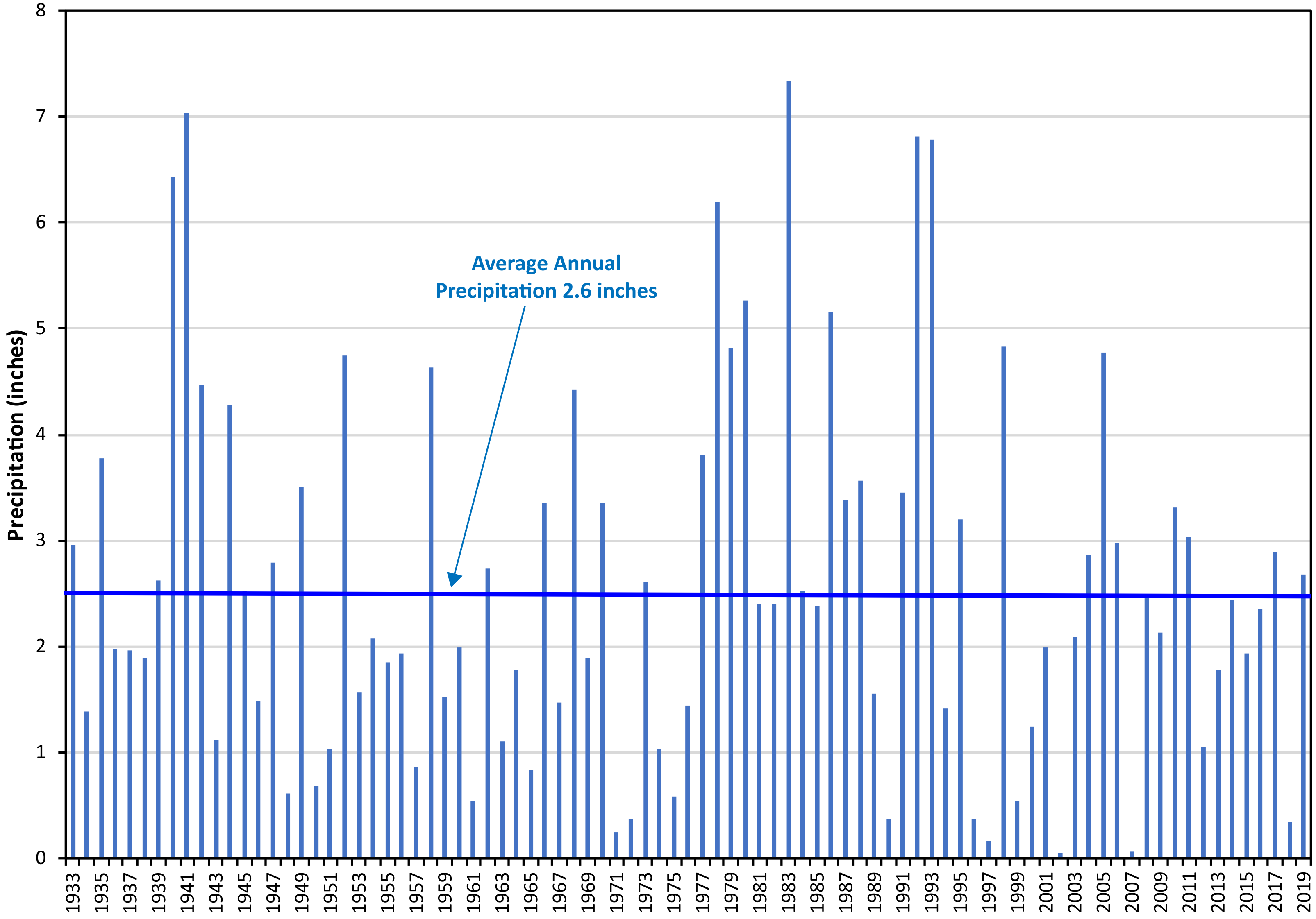
Date	Chem	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1 (MW-2B)	36A2 (MW-2A)	36C2	36D3	36H1/36H2	42A8	USG-4	USG-5	USG-6
Mar-09	Total Dissolved Soilds	287	1210		335			517				302			359	365	305	910			
Mar-10	Total Dissolved Soilds	307	1200		306			498				300			349	346	304	1100			
Apr-11	Total Dissolved Soilds	280	1220		325			525				298			485	359	306	1220			
Mar-12	Total Dissolved Soilds	315	1210	486				511				303			359		320	886			
Feb-13	Total Dissolved Soilds	284	1220	497	302			530	299			306						739			
Apr-14	Total Dissolved Soilds	292	1290	499	309			543	284			314			360		327	728			
Mar-15	Total Dissolved Soilds	297	1350	492					298			315									
Mar-16	Total Dissolved Soilds	280	1350	484	291		356	559	271			303	298	399	362			654	362	334	309
May-17	Total Dissolved Soilds	298	1350	495	323		353	567	283			300	303	412	357			594		328	314
Mar-18	Total Dissolved Soilds	288	1310	439	304	352	342	565	274	469	612	305	291	396	350		323	564	343		
Mar-19	Total Dissolved Soilds	322	1310	503	309	373	365	583	273	477	621	322	307	423	368		331	575	361		317
	Average	295	1,275	487	312	363	354	540	283	473	617	306	300	408	372	357	317	797	355	331	313
	Change from 2018-2019	34	-	64	5	21	23	18	(1)	8	9	17	16	27	18	-	8	11	18	-	
	20 percent of average	59	255	97	62		71	108	57			61	60	82	74	71	63	159	71	66	63

FIGURES



September 2019

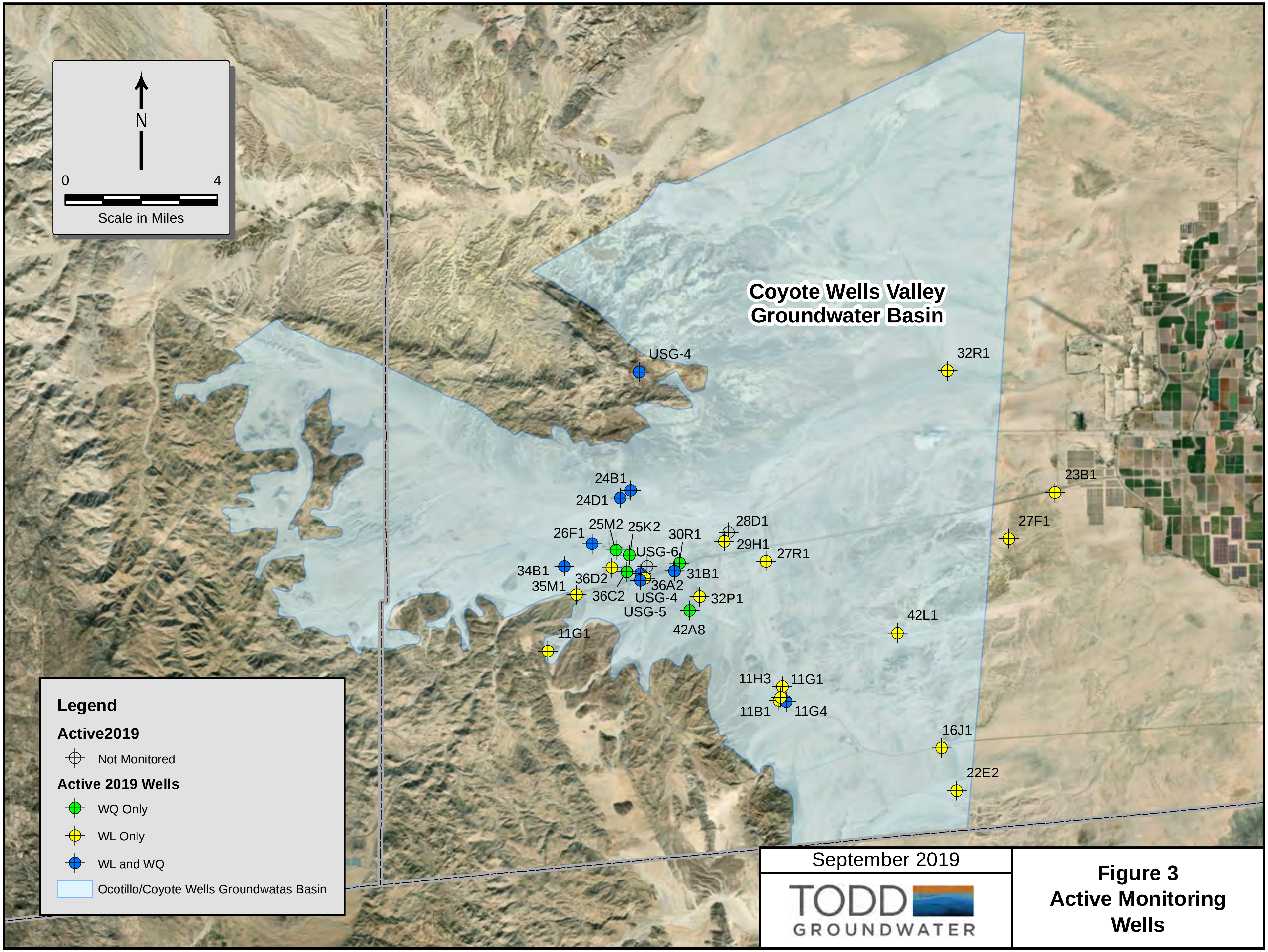
Figure 1
Groundwater Basin Boundary



September 2019

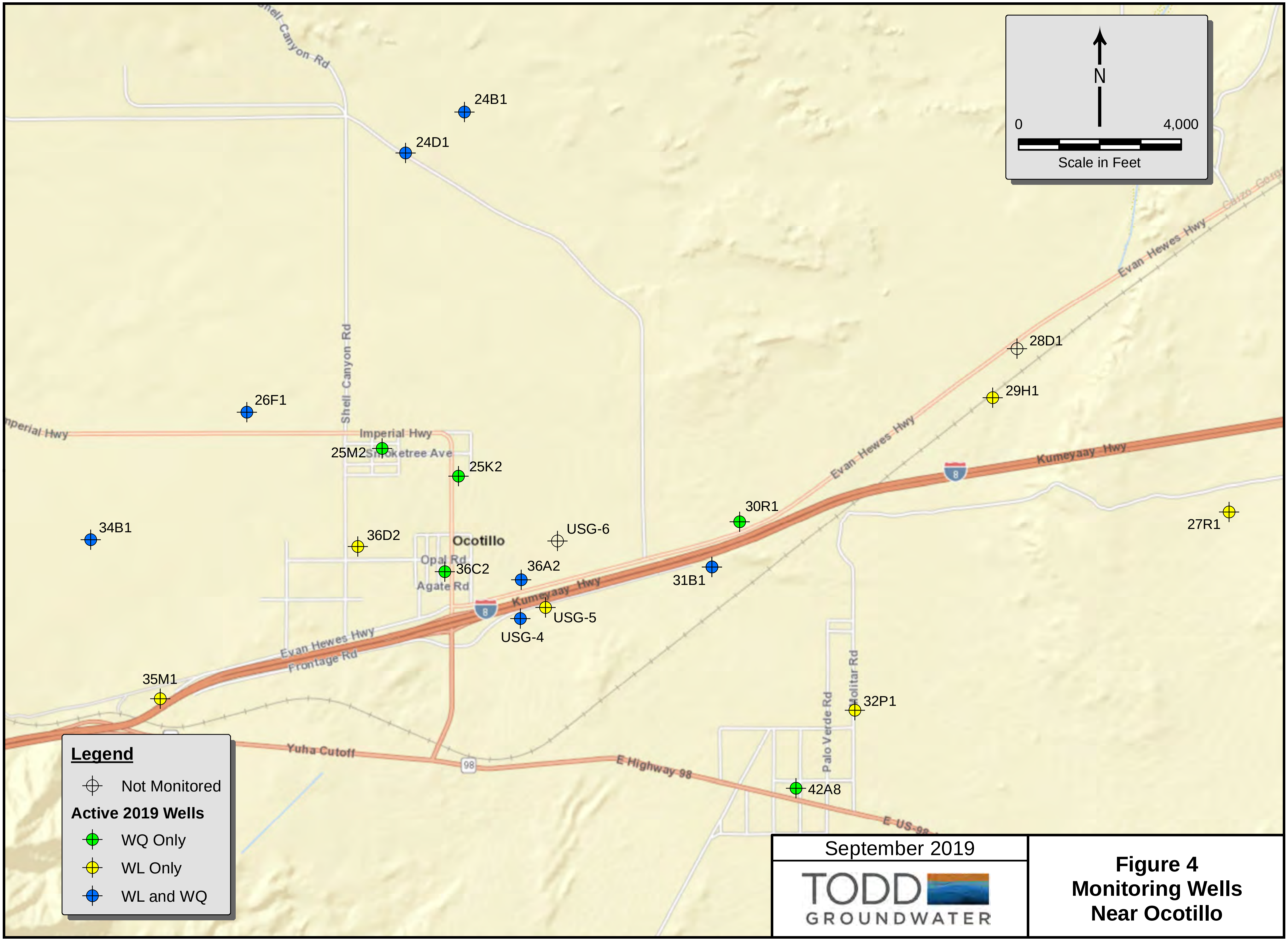
TODD GROUNDWATER

Figure 2
Spring to Spring Precipitation
El Centro Station



September 2019

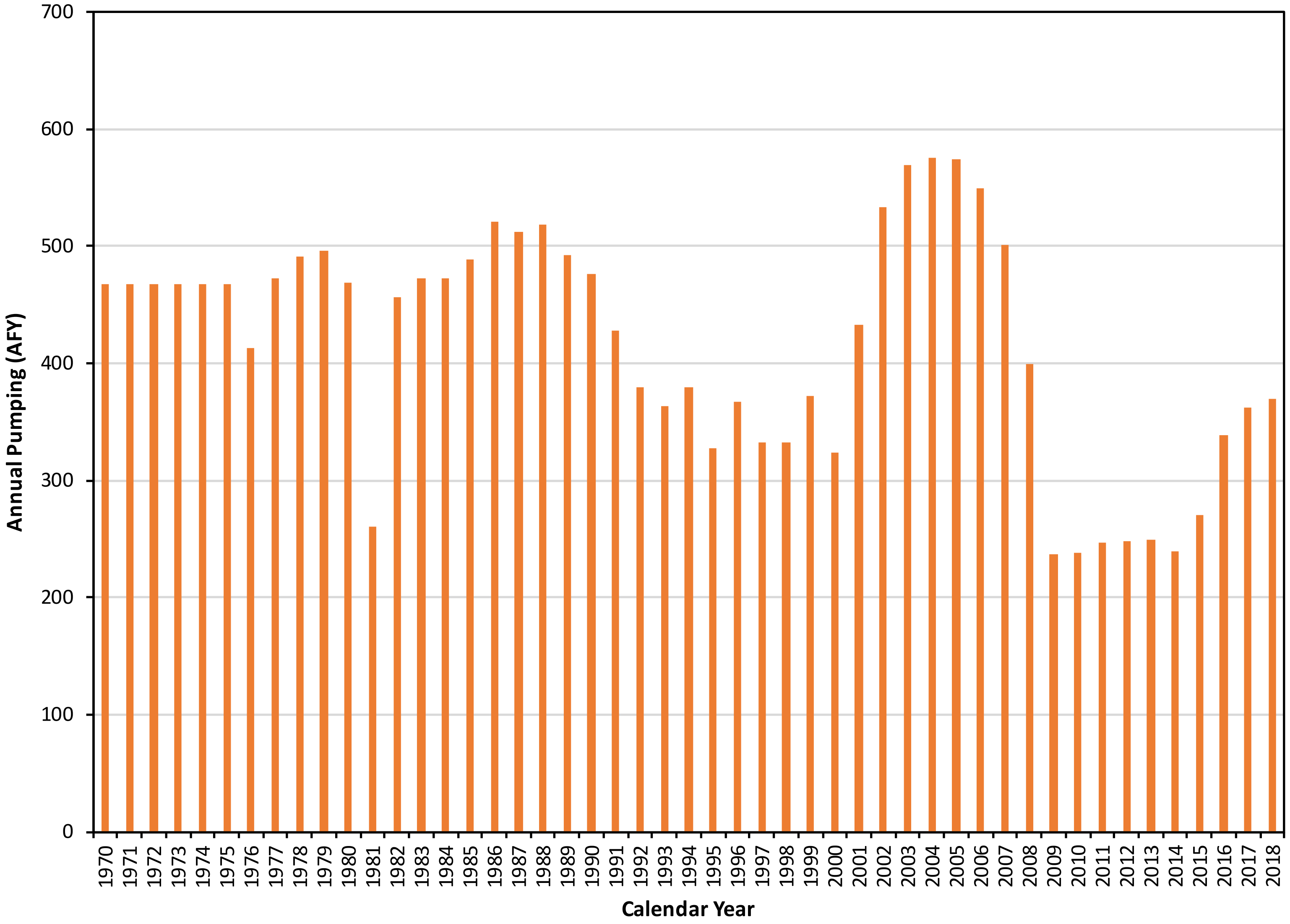
Figure 3
Active Monitoring Wells



September 2019

TODD GROUNDWATER

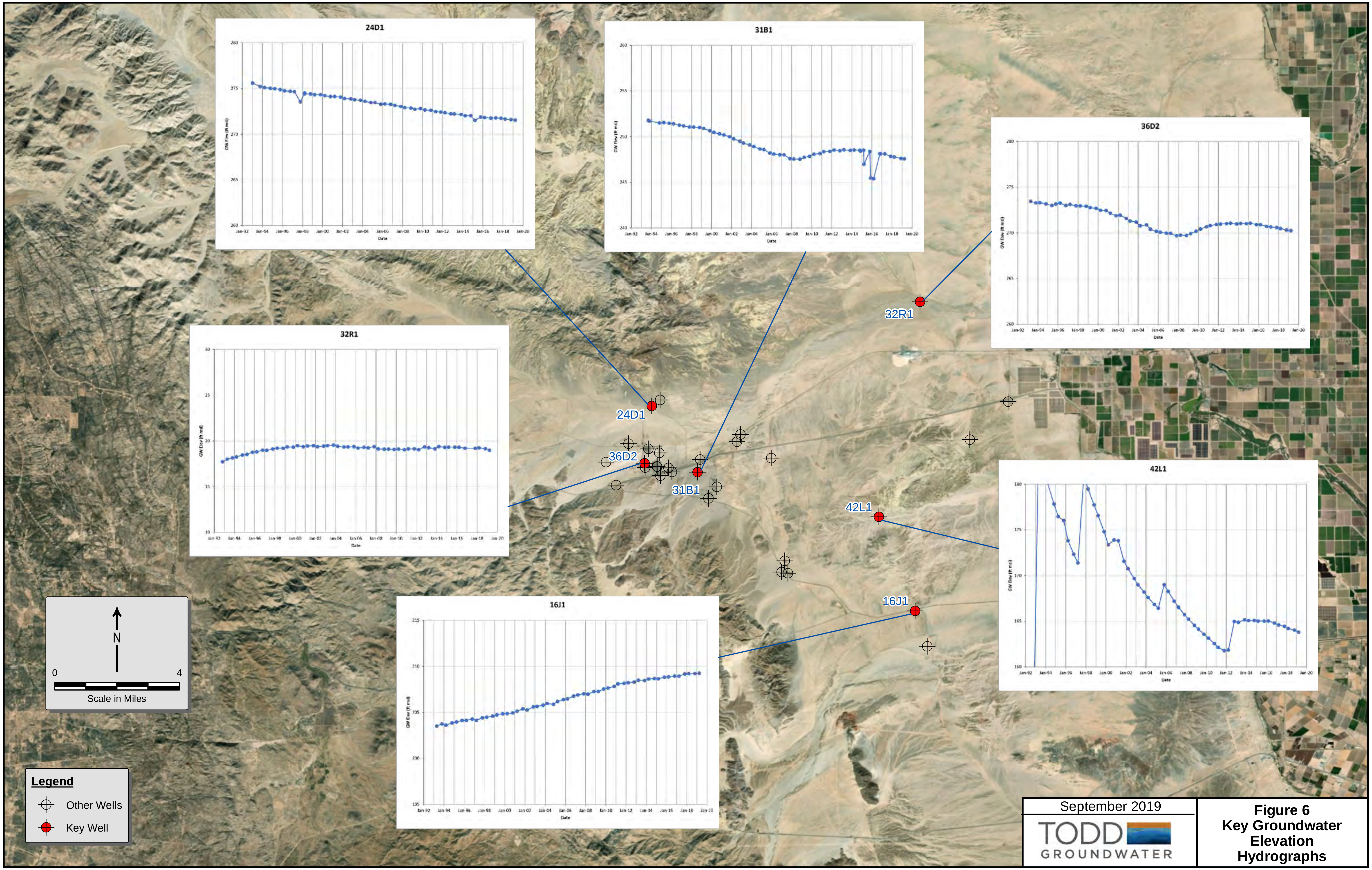
Figure 4
Monitoring Wells
Near Ocotillo



September 2019

TODD GROUNDWATER

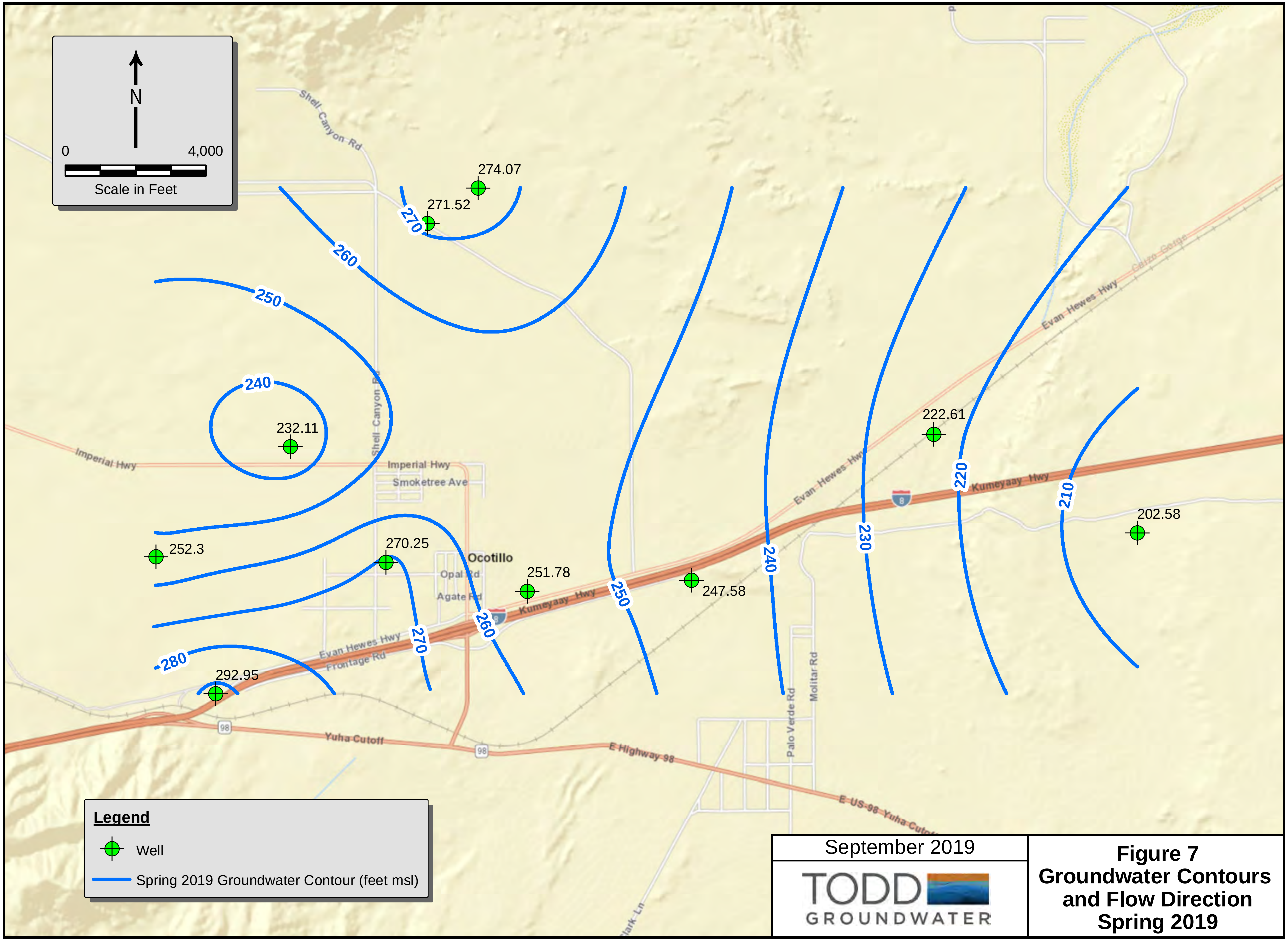
Figure 5
USG
Annual Pumping



September 2019

TODD GROUNDWATER

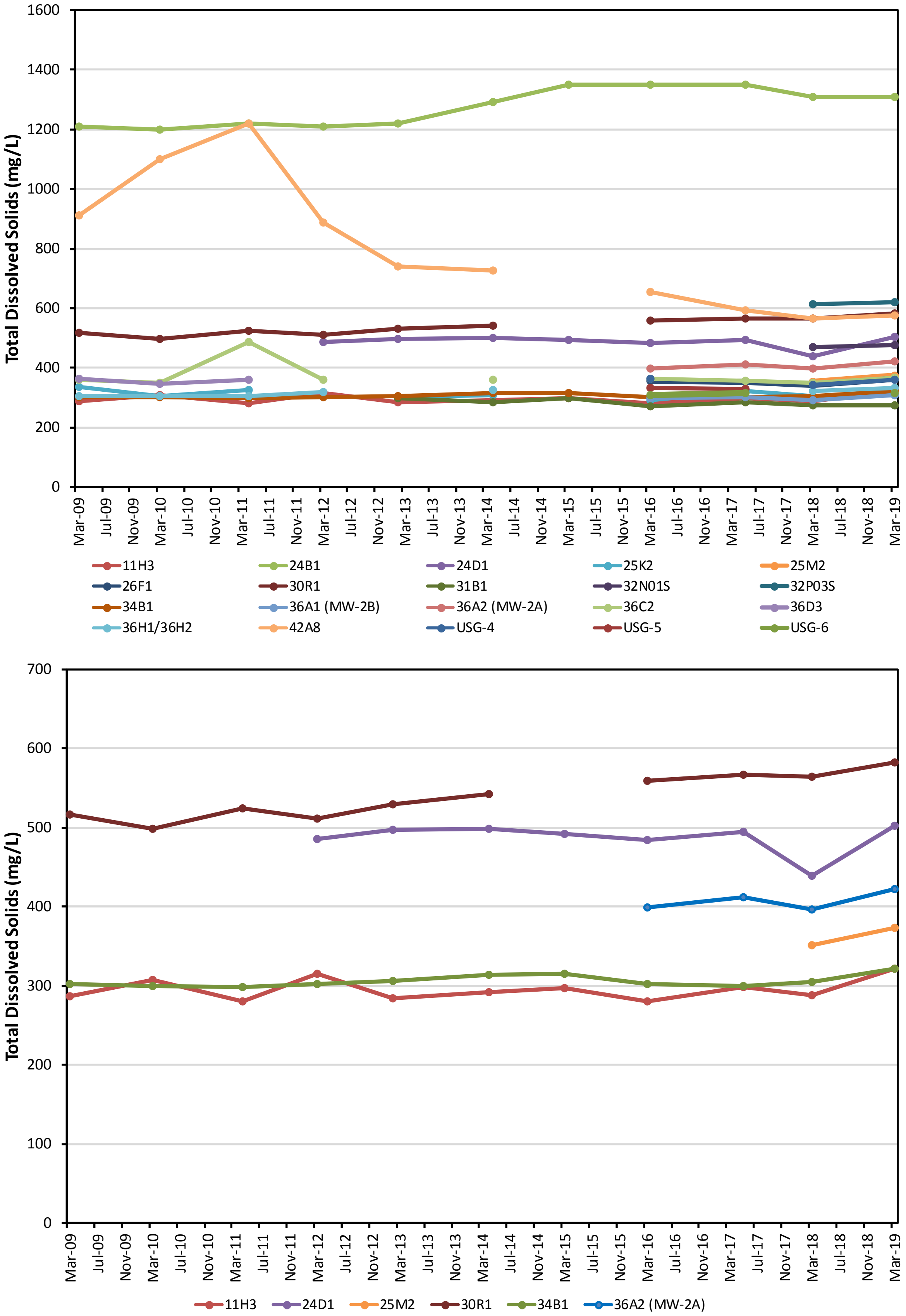
Figure 6
Key Groundwater Elevation Hydrographs



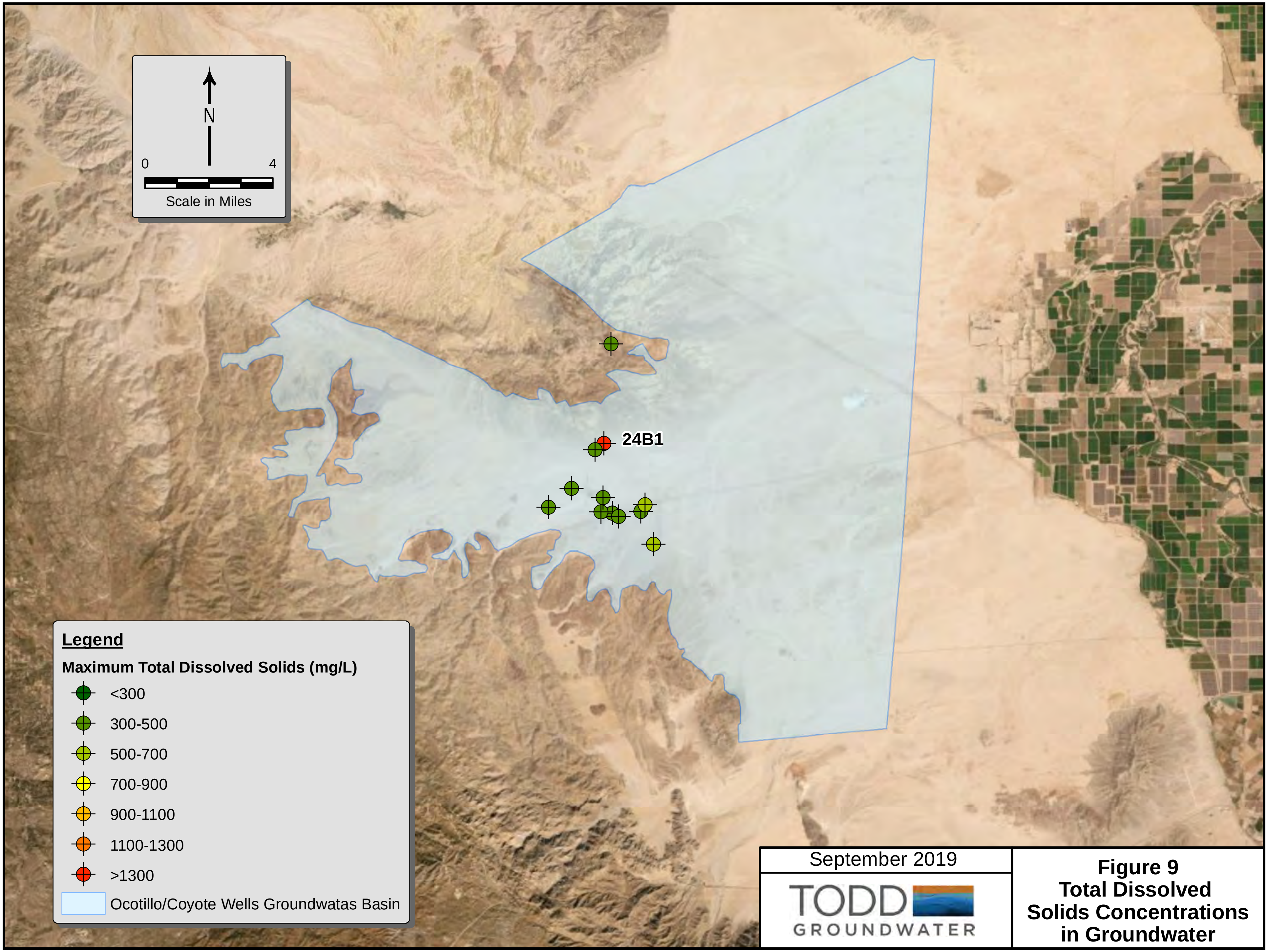
September 2019

TODD GROUNDWATER

Figure 7
Groundwater Contours and Flow Direction
Spring 2019



September 2019	**Figure 8** **TDS** **Concentrations** **Over Time**
TODD GROUNDWATER	



September 2019

TODD GROUNDWATER

Figure 9
Total Dissolved Solids Concentrations in Groundwater

APPENDIX A

BASIN DESCRIPTION AND HYDROGEOLOGY

Groundwater for the Plaster City Plant, community of Ocotillo, and local domestic wells is pumped from the Coyote Wells Valley Groundwater Basin (No. 7-29), as defined by the California Department of Water Resources (DWR, 2003)[2]. DWR generally defines groundwater basins based on the extent of alluvial deposits. As depicted in **Figure A-1,** the Basin encompasses 64,000 acres (100 square miles) in the Yuha desert west of Imperial Valley, California. It is located mostly in Imperial County, with the western edge extending into San Diego County. The Basin is bounded by the Coyote Mountains to the north and the Jacumba Mountains to the west and southwest. These boundaries correspond to the geologic contacts between alluvium and less permeable geologic formations as mapped by DWR. The southern basin boundary is the United States-Mexico border and the eastern boundary is a roughly north-south line from Superstition Mountain on the north to the international border. Part of the northeastern boundary is a surface drainage divide connecting the Coyote Mountains with Superstition Mountain.

A.1. HYDROGEOLOGY

Figure A-2 shows the surficial geology within the Coyote Wells Valley Groundwater Basin, as mapped by the USGS (Loeltz, 1975). The groundwater basin boundaries on the north, west, and southwest generally coincide with the low-permeability formations of the mountain ranges; some discrepancies reflect the scale and interpretation of geologic mapping. The main water-bearing units of the basin are the Quaternary alluvial deposits forming the basin floor. In many areas, alluvium and lake deposits overlie older Quaternary/Tertiary formations including the Palm Springs and Imperial formations. As shown in **Figure A-2**, these crop out to the west and east.

Figure A-3 is a general cross-section illustrating the major formations in the basin (see **Figure A-1** for location). This cross-section is reproduced from the Final EIR/EIS and shows two layers defined for groundwater flow modeling. The upper layer (Layer 1) consists of alluvial deposits (Qa/Qof) and the lower layer (Layer 2) is composed of the Palm Springs and Imperial formations (QTp/QTi), which have been uplifted in the area east of Ocotillo and are relatively near the ground surface. The water-bearing alluvial deposits (Layer 1) are primarily restricted to the center of the basin, with thickness of 550 feet or greater in the Ocotillo area. As shown, the alluvium was previously indicated to be 650 feet thick; however, monitoring wells recently drilled near the US Gypsum pumping encountered alluvium to a depth of 800 feet. The alluvial deposits thin toward the margins of the basin where they become unsaturated. Along the basin margins, the saturated zones occur in the Palm Springs and Imperial formations.

In brief, the alluvial Layer 1 aquifer near Ocotillo is generally characterized by relatively high permeability, good water quality, and rapid recovery from pumping. The less permeable Layer 2 (Palm Springs/Imperial formations) east of Ocotillo and in the Yuha Estates area is characterized by relatively poor water quality and greater, more persistent impacts from pumping. In the Ocotillo area, groundwater levels in Layer 1 have been indicated to be higher than those in Layer 2. However, continued groundwater level declines in Layer 1—at more rapid rates than those in Layer 2—present the potential for significant change in that

---

[2] The EIR/EIS refers to the area as the Ocotillo/Coyote Wells Groundwater Basin as defined by USGS.

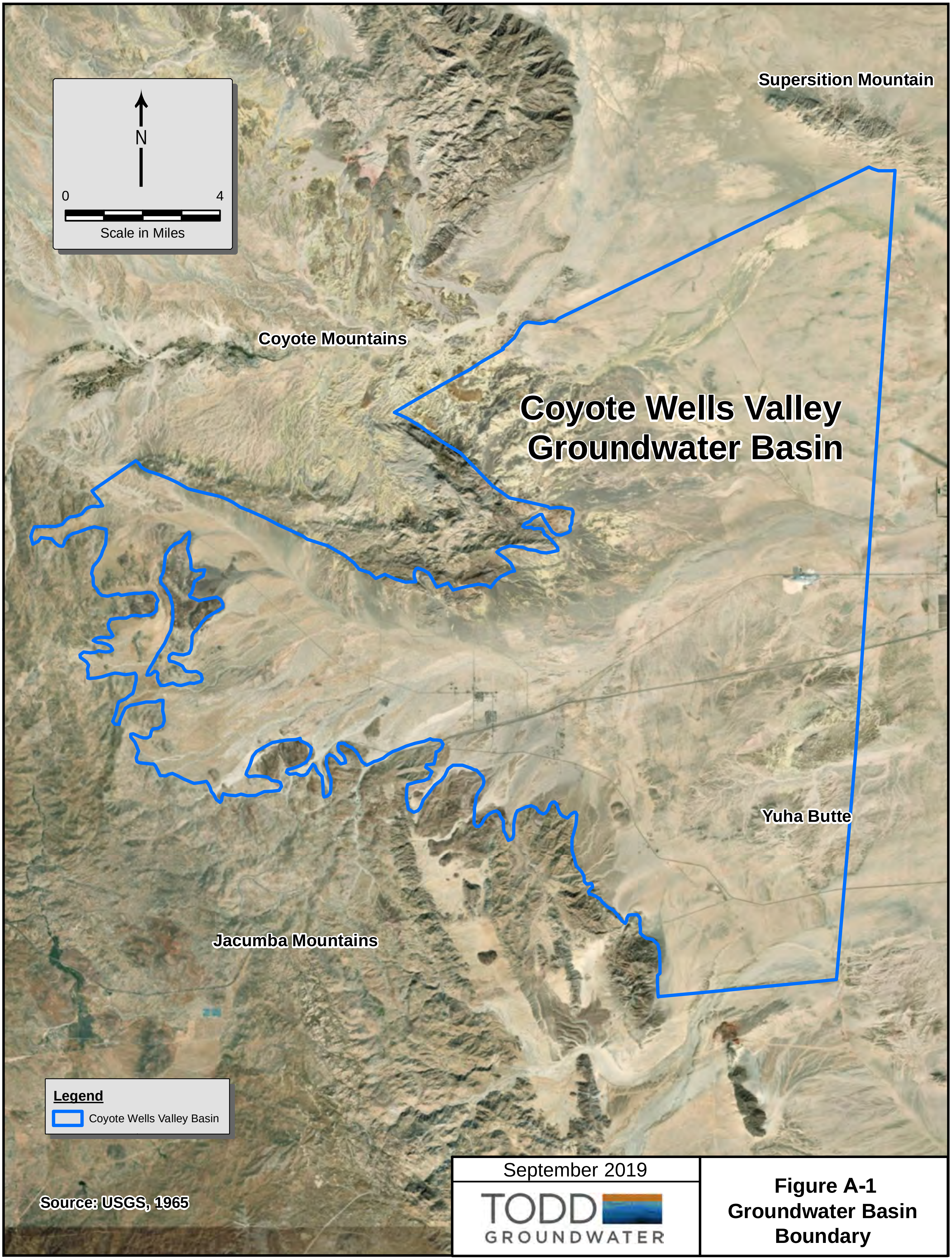
vertical gradient. In that case, relatively poor groundwater from Layer 2 could migrate into Layer 1, resulting in water quality deterioration in Layer 1.

Geologic units in the Ocotillo/Coyote Wells Groundwater Basin can be grouped as follows:

- Quaternary Alluvium (Layer 1), composed of poorly consolidated older alluvial fan deposits and sand, underlies much of the basin floor and extends locally into large canyons of the surrounding mountains. Lake deposits also are mapped by USGS. Most wells drilled in the Ocotillo area are completed within the alluvium. The alluvial wells are noted for high yields and relatively good water quality.
- The Palm Springs Formation (in Layer 2) is composed of fluvial and deltaic sand, silt, and clay deposits deposited by the ancestral Colorado River during the early Pleistocene. Thicknesses can range up to several thousand feet. No pumping test data were found for the Palm Springs Formation, but the aquifer properties (e.g., transmissivity and specific yield) are likely similar to those of the Imperial Formation.
- The Late Miocene to Pliocene Imperial Formation (in Layer 2) is generally described as interbedded claystone and sandstone of dominantly marine origin. The Imperial Formation has an exposed thickness of over 1,500 feet in the Yuha area. Wells drilled into the Imperial Formation typically have low yields and produce poor quality water.

Significant differences have been noted in the hydrogeologic properties, water levels, and water quality between the area around the community of Ocotillo and areas to the east. Near Ocotillo, transmissivities (aquifer properties describing the ease with which groundwater flows through the aquifer) have been noted as significantly higher than those to the east. Transmissivities have been measured in the range of 5,800 to 6,700 ft^2/day near Ocotillo, whereas transmissivities of 34 to 957 ft^2/day have been noted in the eastern areas. These variations are reflected in groundwater gradients: shallower (flatter) hydraulic gradients have been mapped in the Ocotillo area and steeper hydrologic gradients have been mapped in the area east of Ocotillo.

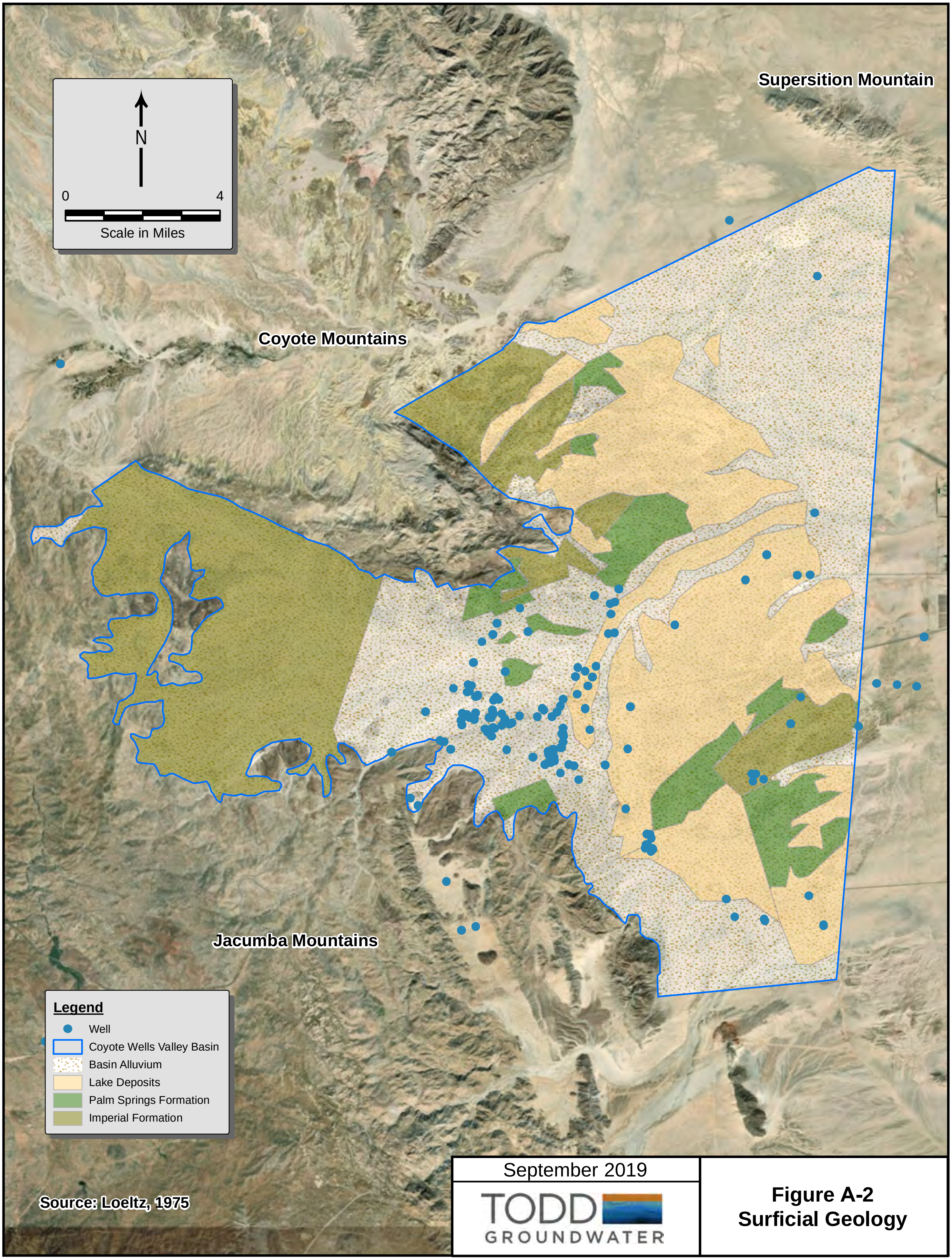
While there is an occurrence of unconfined groundwater in other parts of the basin, water quality these areas are generally poor, with existing wells drilled in confined groundwater showing improved water quality. Groundwater generally flows southeast through the basin, with the principal recharge derived from percolation from precipitation and ephemeral runoff from the surrounding mountains (Skrivan, 1977).



September 2019

TODD GROUNDWATER

Figure A-1
Groundwater Basin Boundary

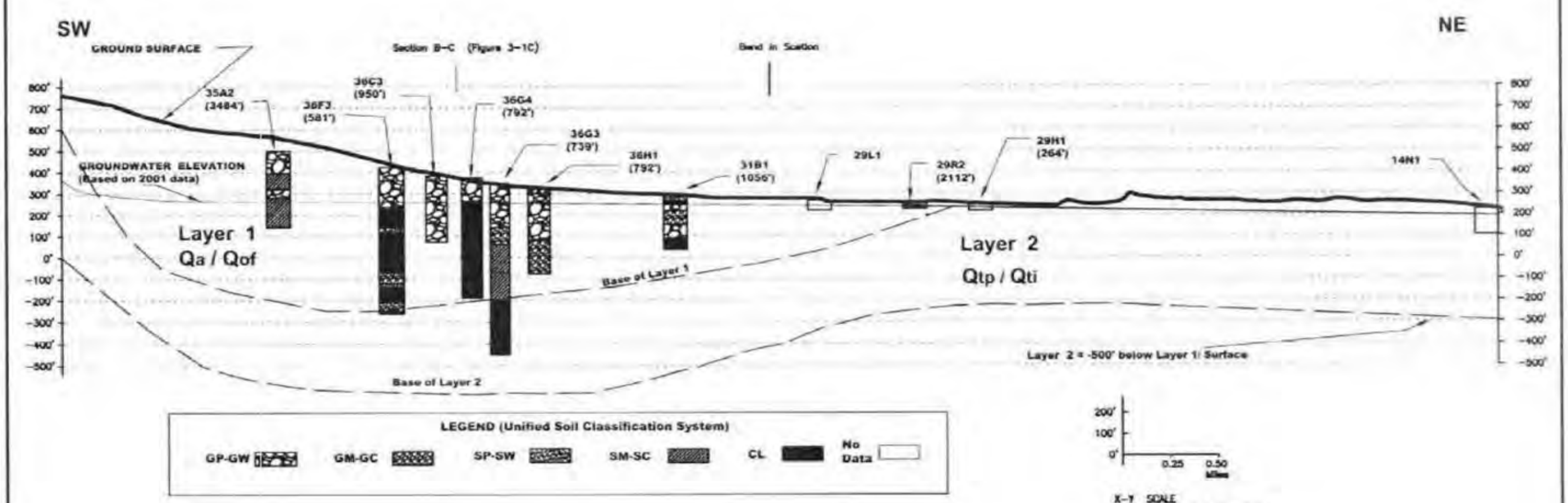


Source: Loeltz, 1975

September 2019

TODD GROUNDWATER

Figure A-2
Surficial Geology



X-Y SCALE
VERTICAL EXAGERATION = 5.9x

NOTES:

Well diameters are not to scale.
All wells except wells 29L1 and 14N1 are projected.
Well projections are shown by ( ) and
are measured in feet.
Distance between C-E equals 7.50 miles.

Bookman-Edmonston
A Division of GEI Consultants, Inc.

Ocotillo/Coyote Wells Groundwater Study
Geologic Cross-Section (Ocotillo-Transverse)
U.S. Gypsum Company

9/24/03

FIGURE 3-1E

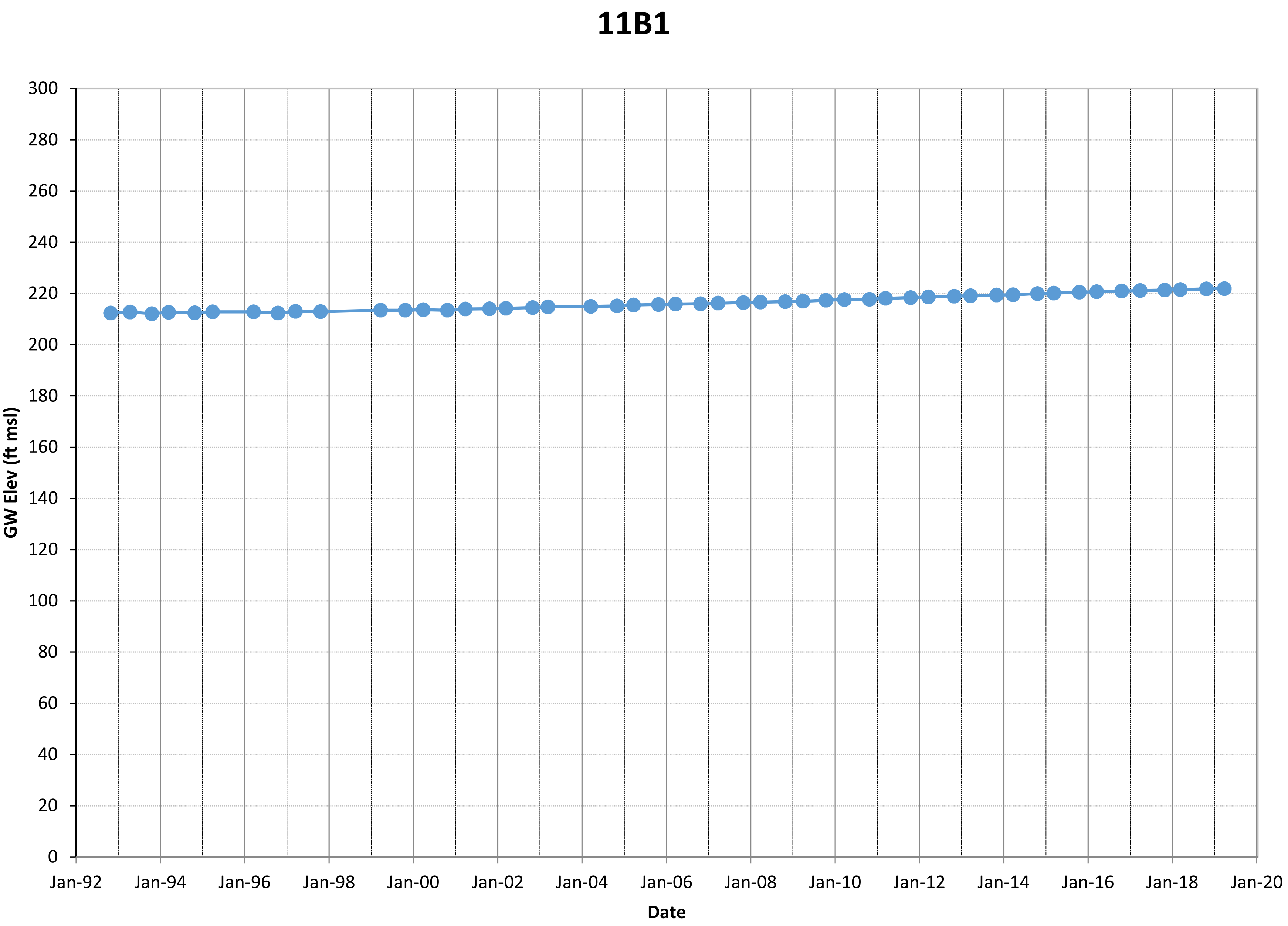
September 2019

TODD GROUNDWATER

Figure A-3
Geologic Cross Section

APPENDIX B

GROUNDWATER ELEVATION HYDROGRAPHS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GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
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Jan-08
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Jan-12
Jan-14
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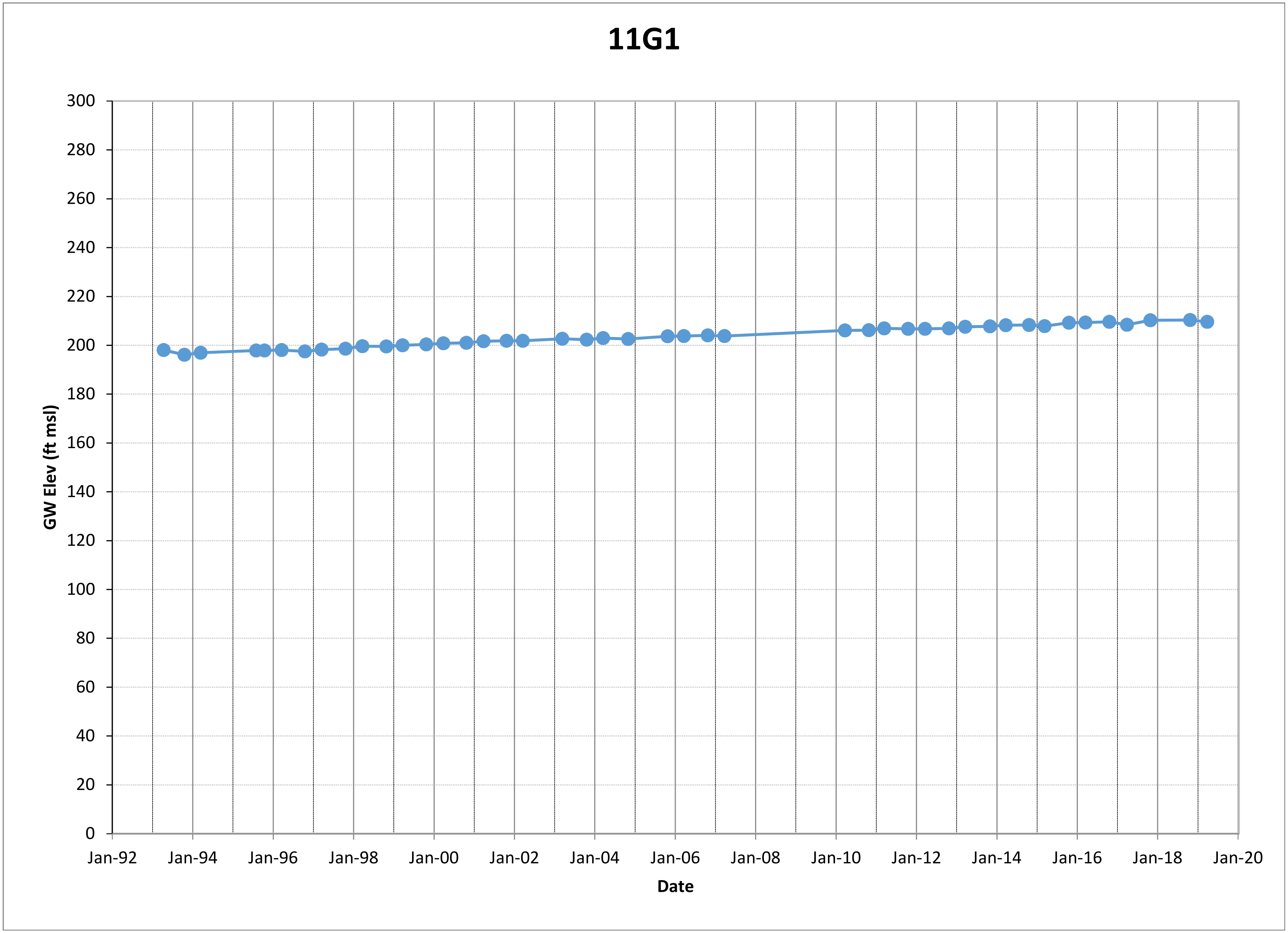
Jan-18
Jan-20
Date



11G1
GW Elev (ft msl)
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Jan-92
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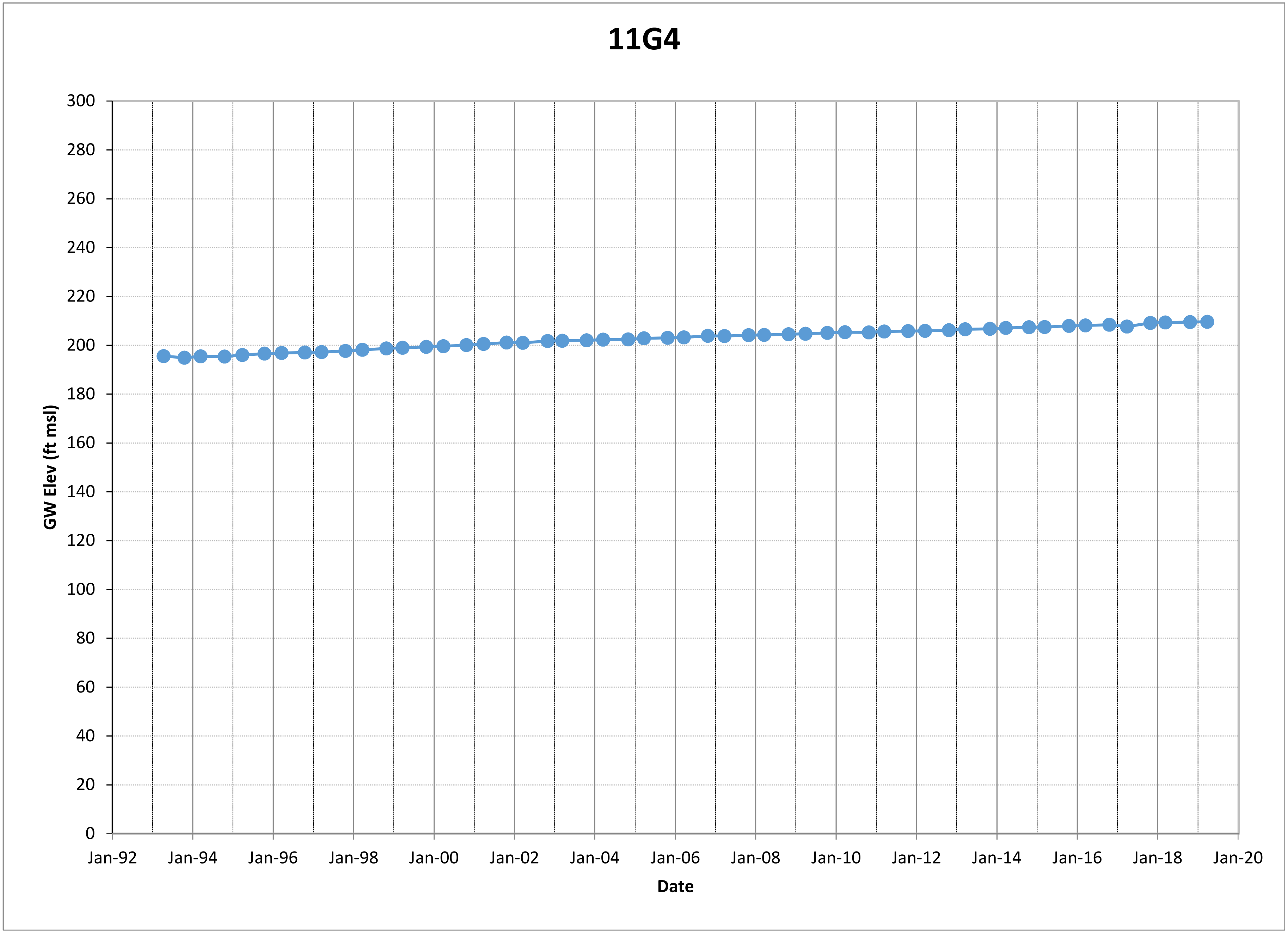
Date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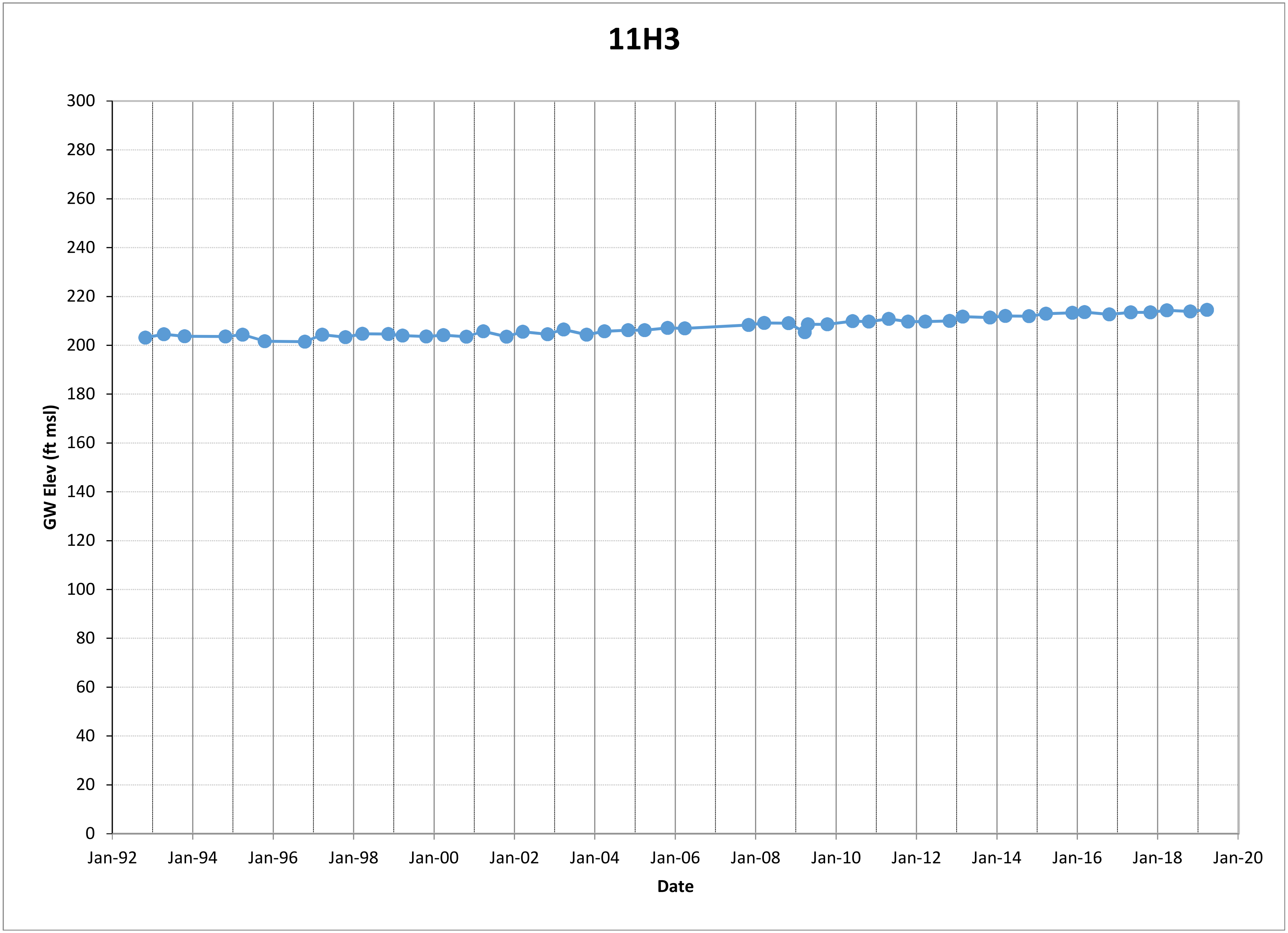
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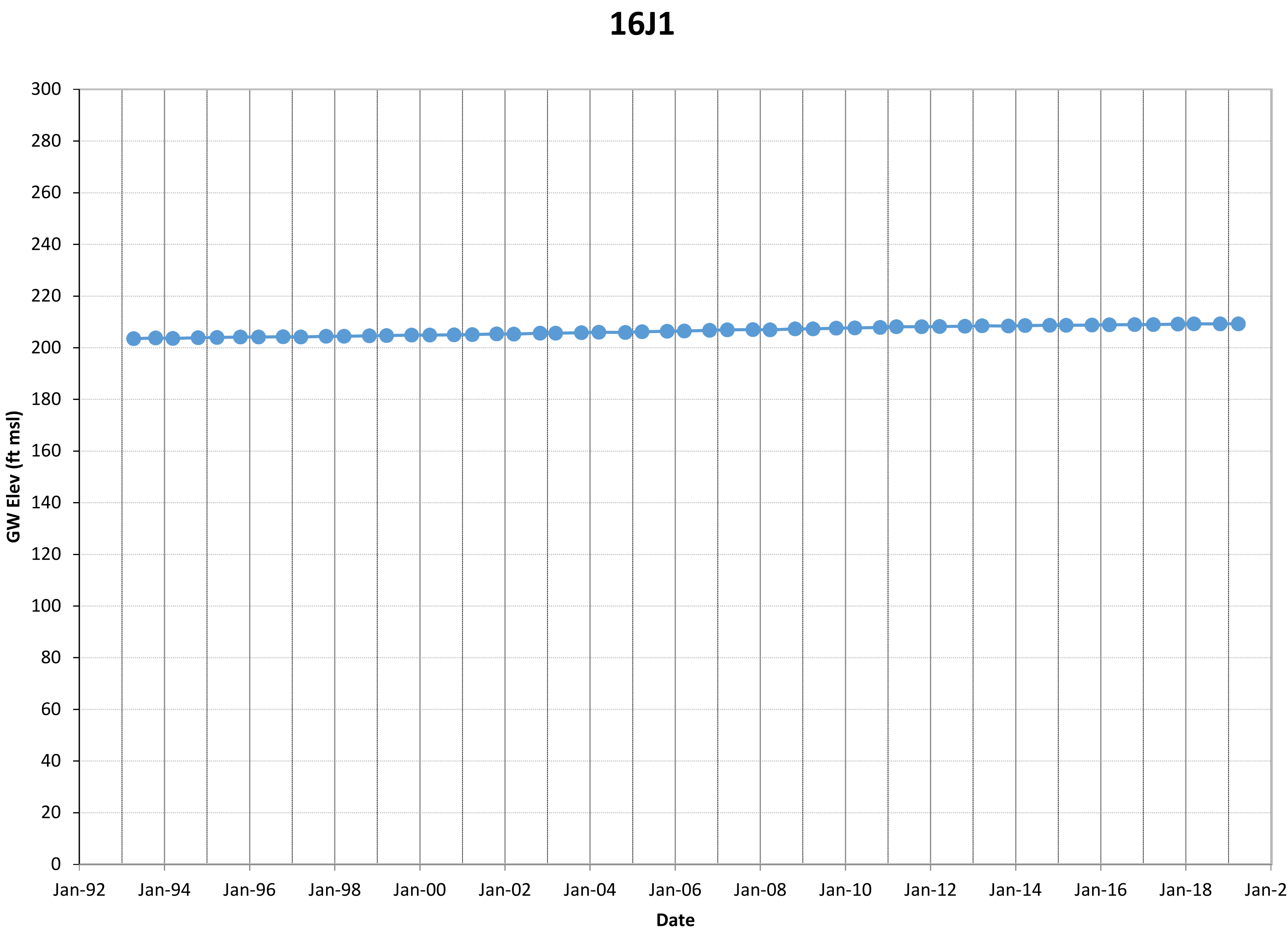
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GW Elev (ft msl)
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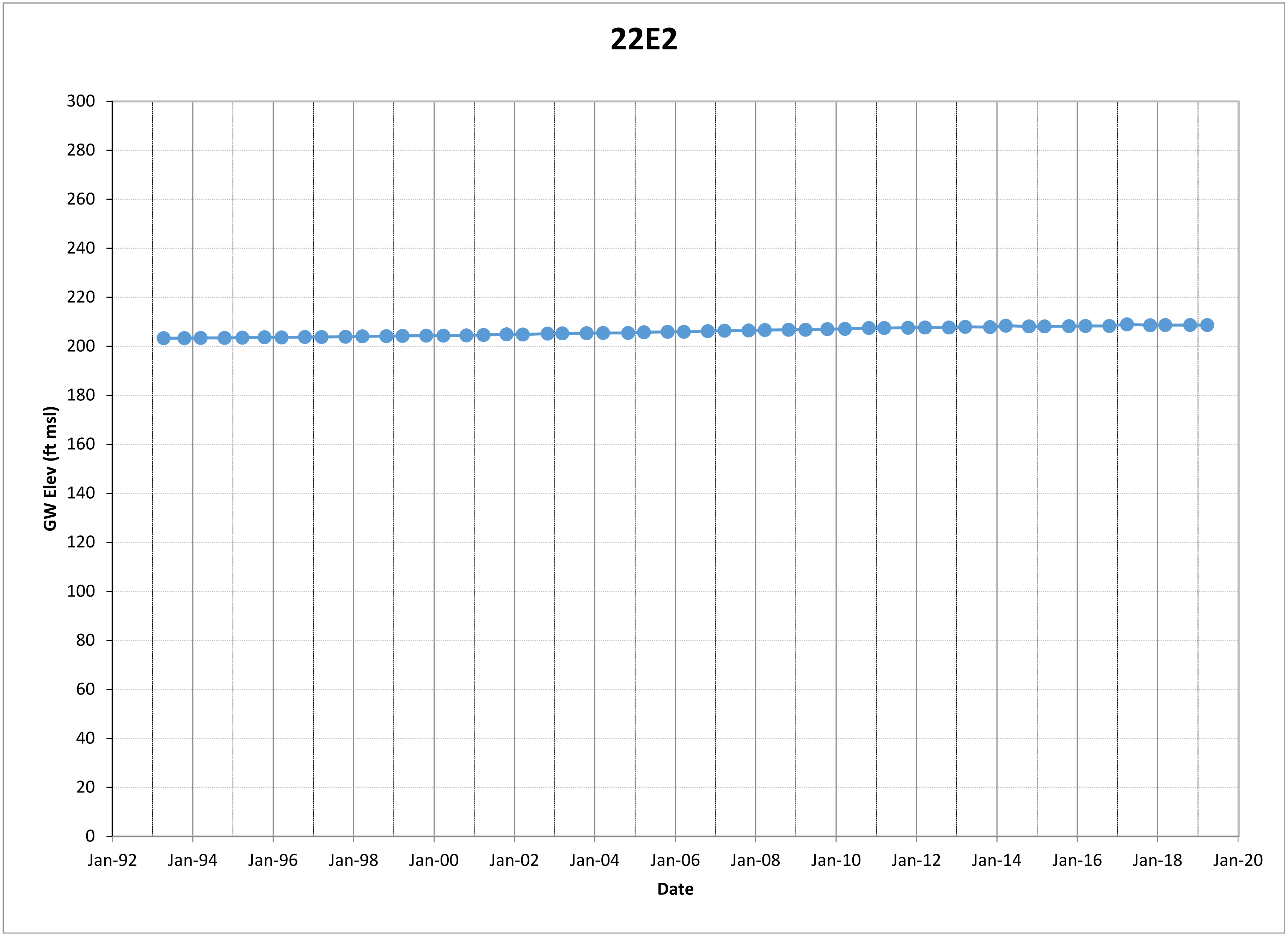
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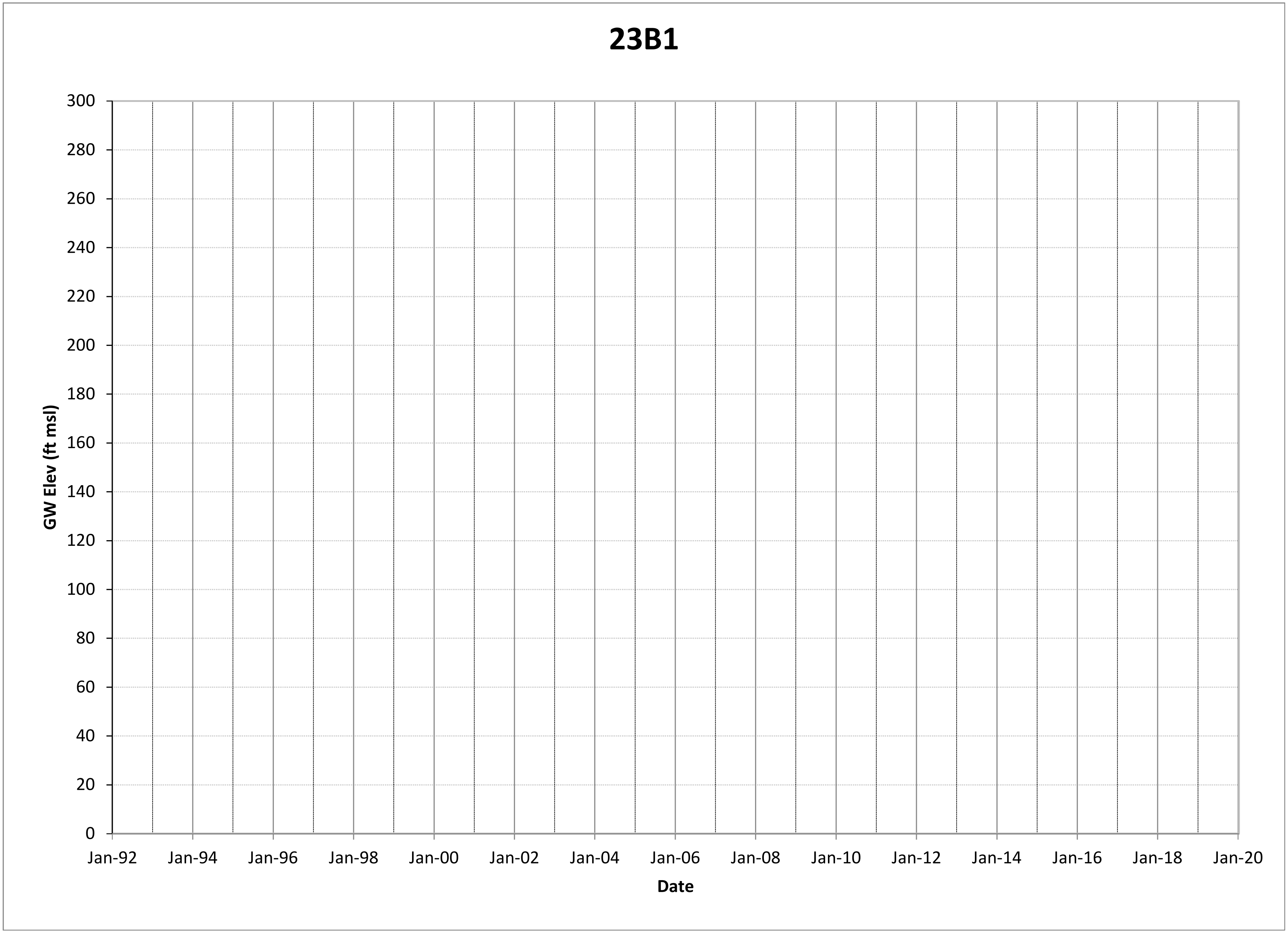
Date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GW Elev (ft msl)
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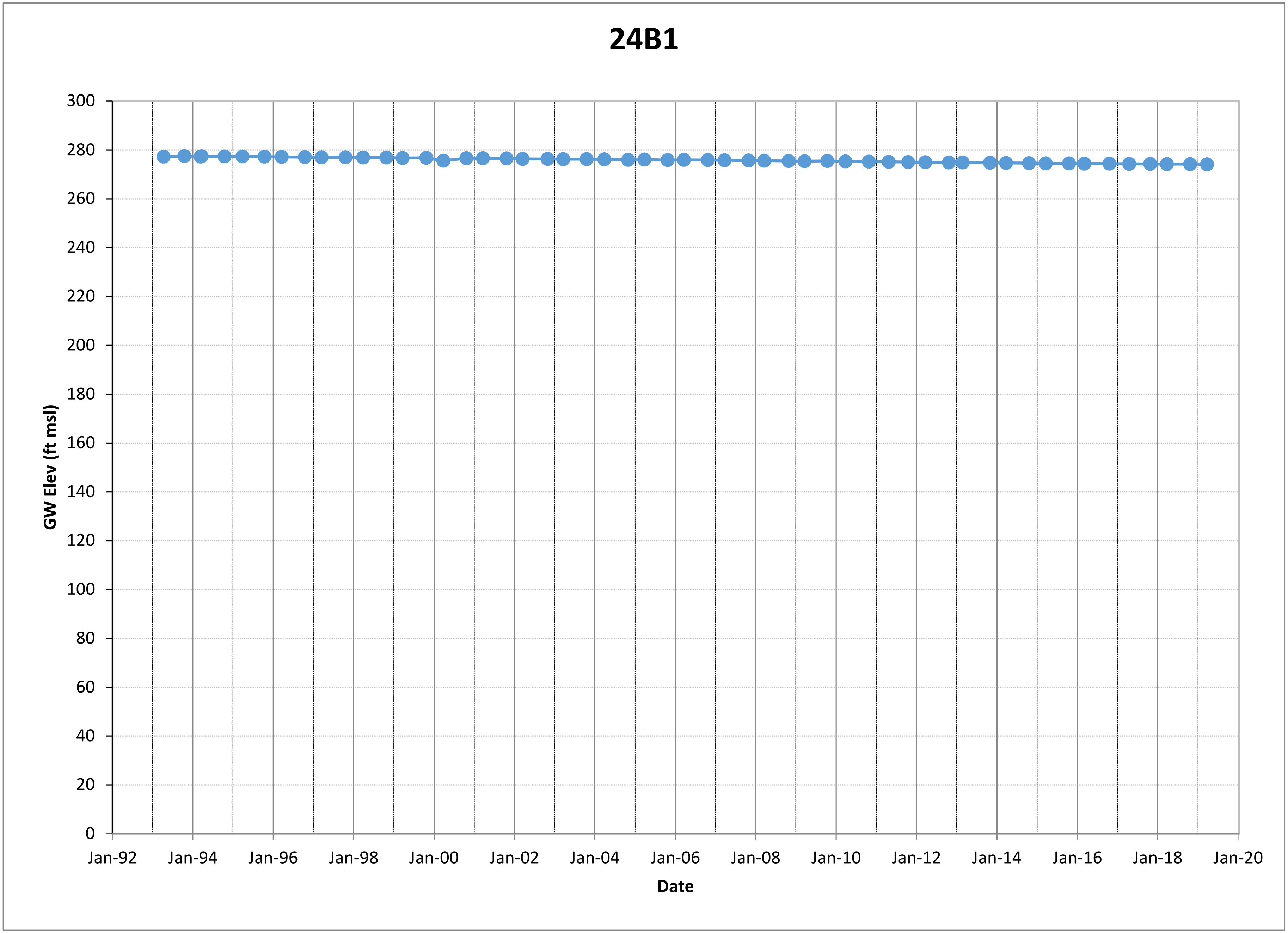
Date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GW Elev (ft msl)
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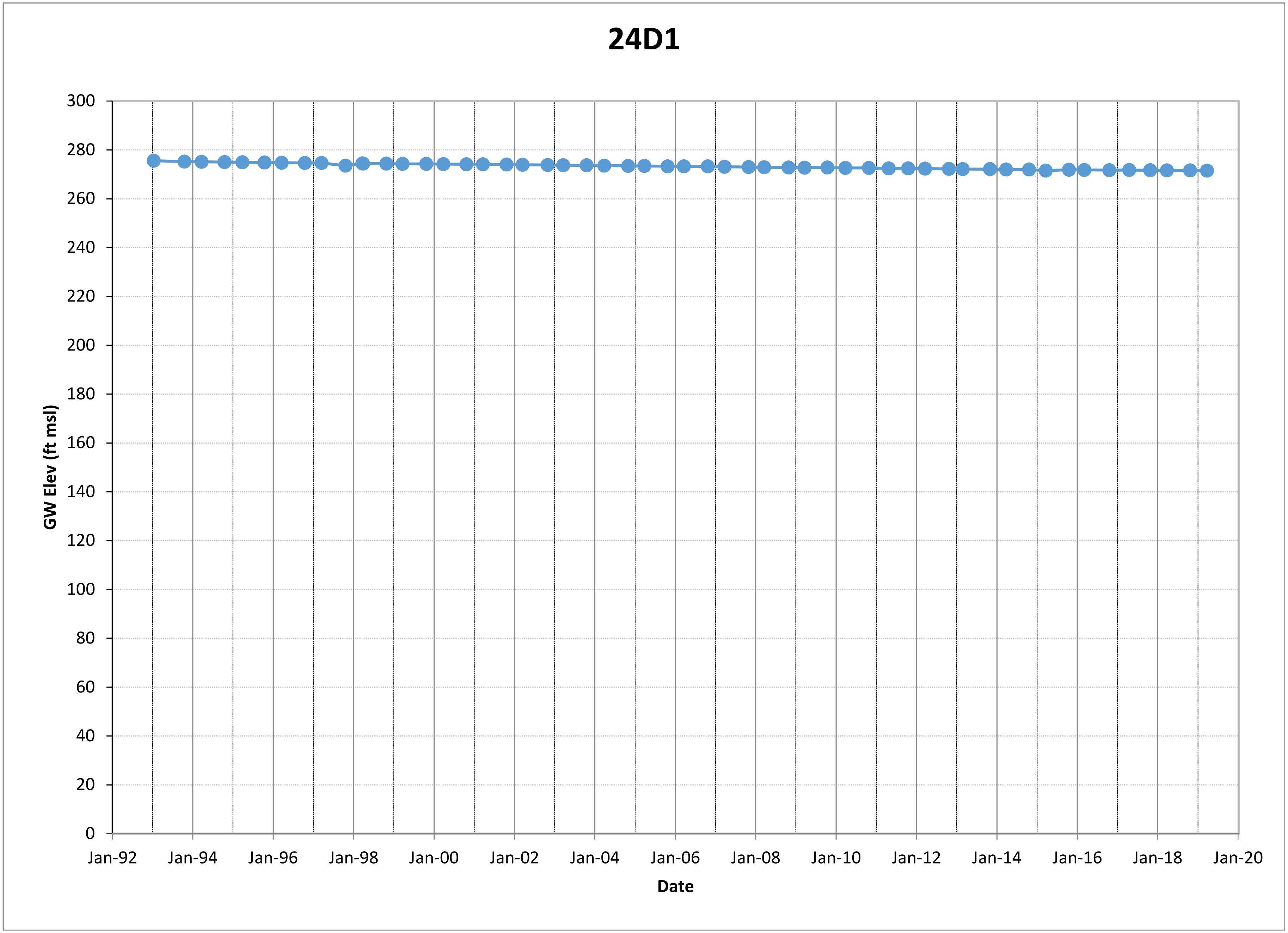
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GW Elev (ft msl)
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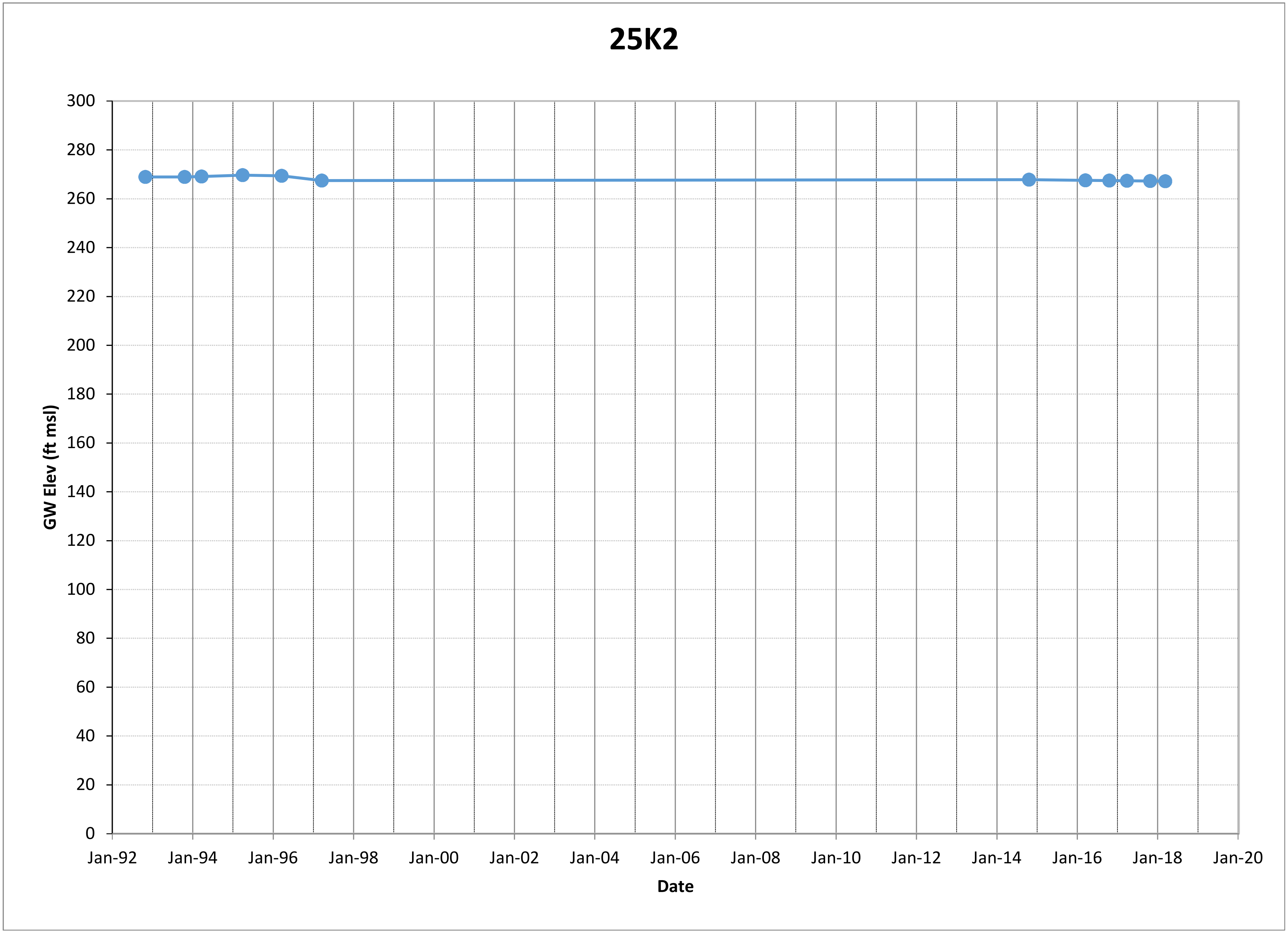
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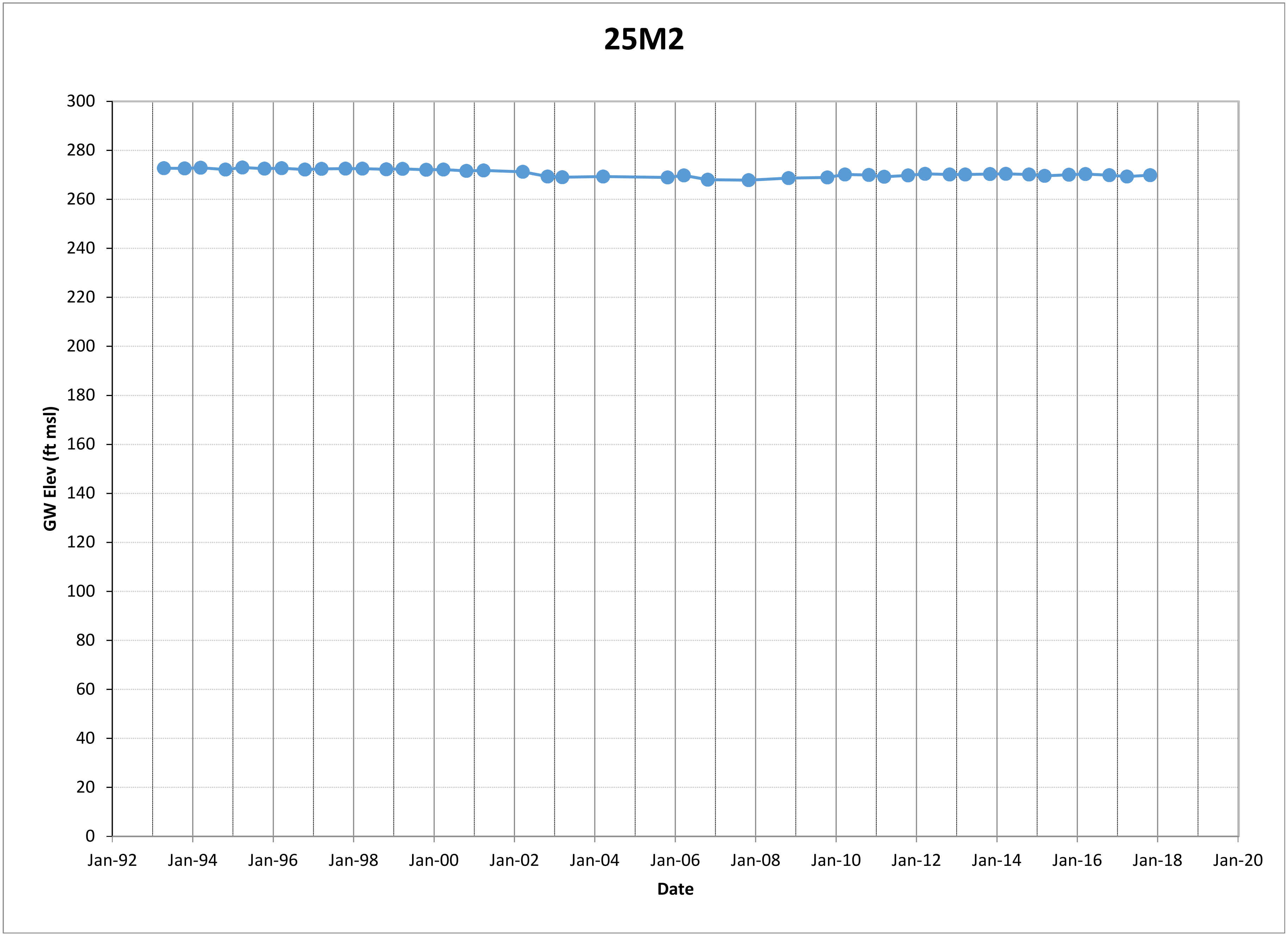
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GW Elev (ft msl)
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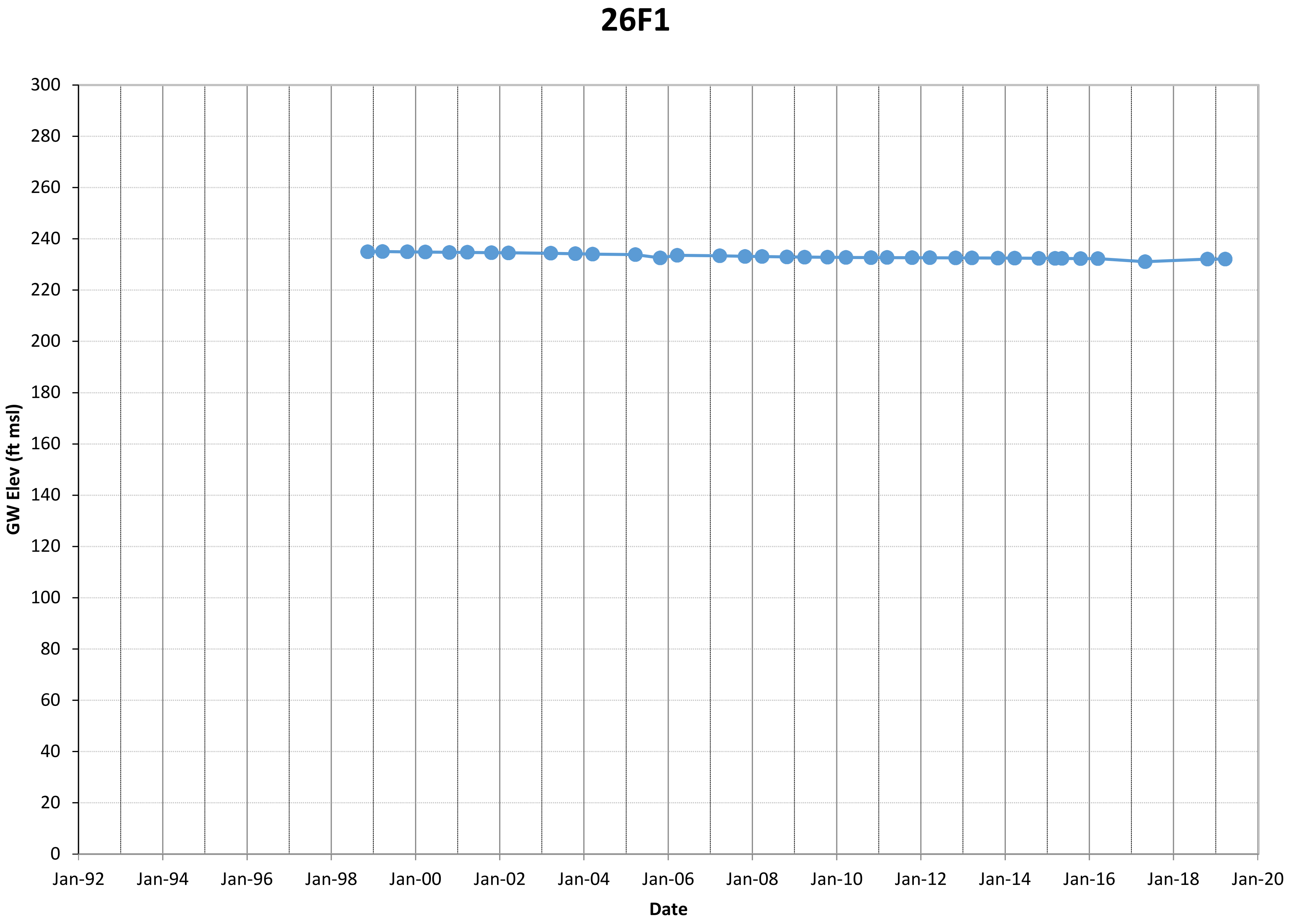
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GW Elev (ft msl)
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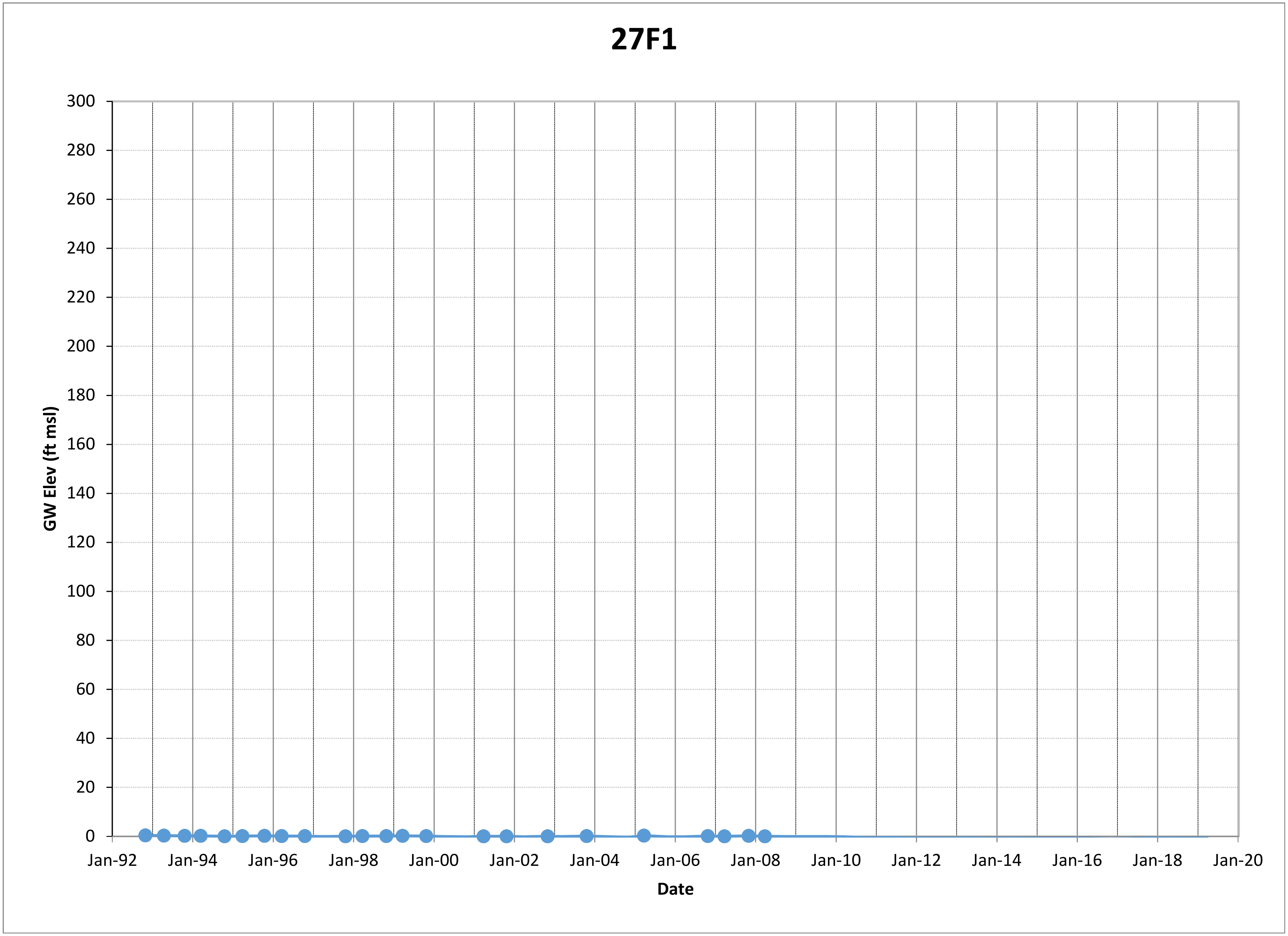
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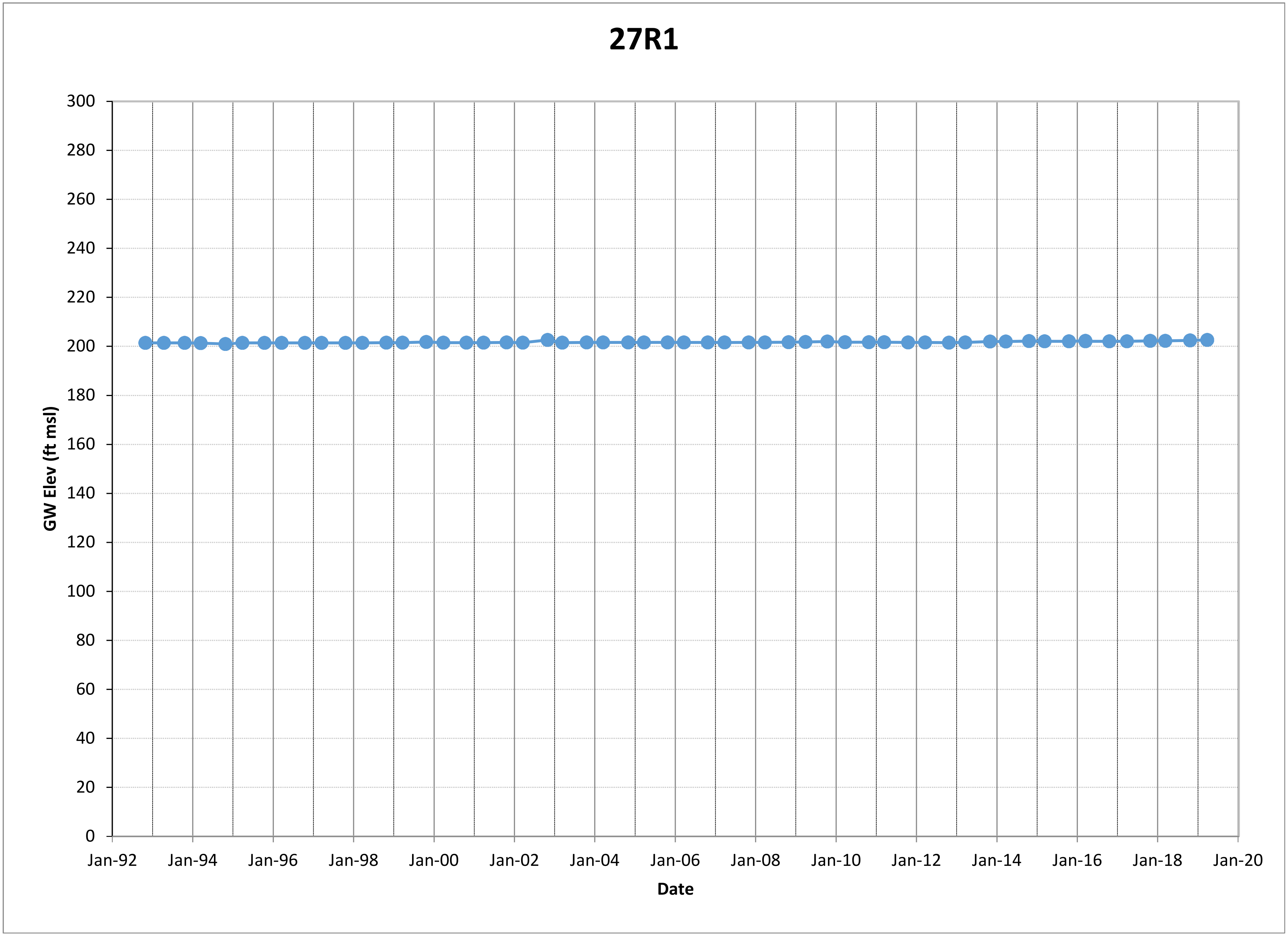
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GW Elev (ft msl)
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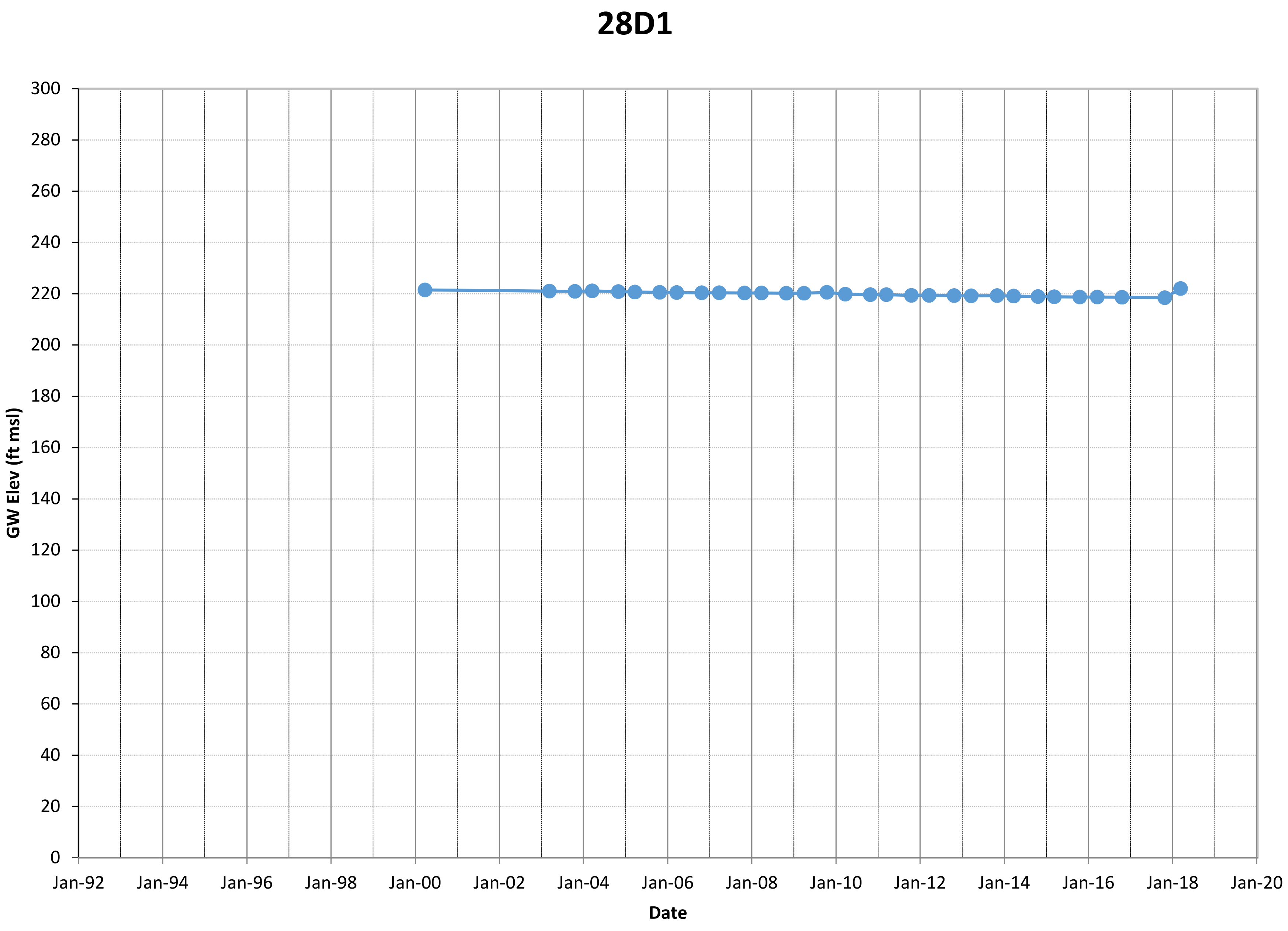
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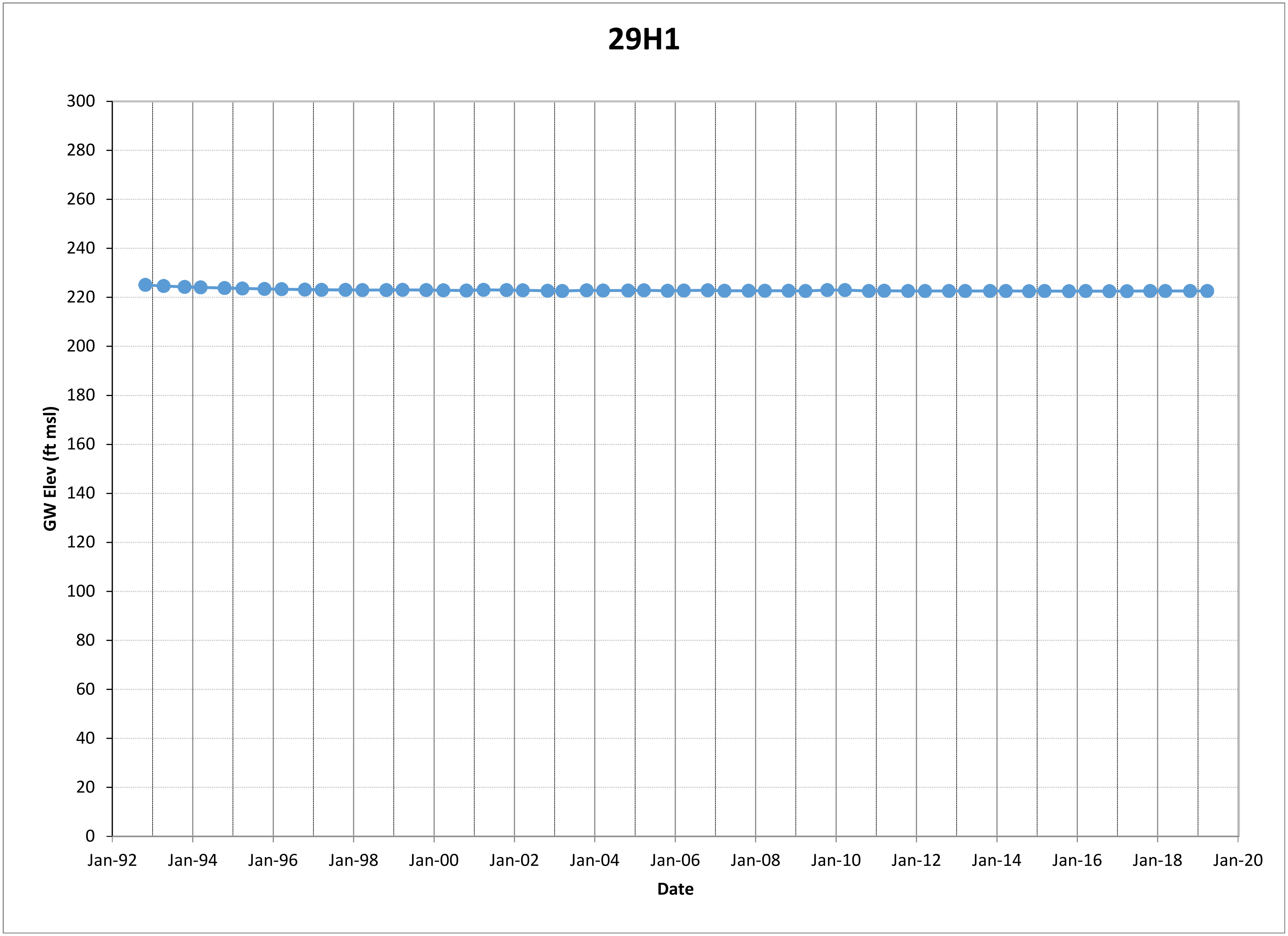
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GW Elev (ft msl)
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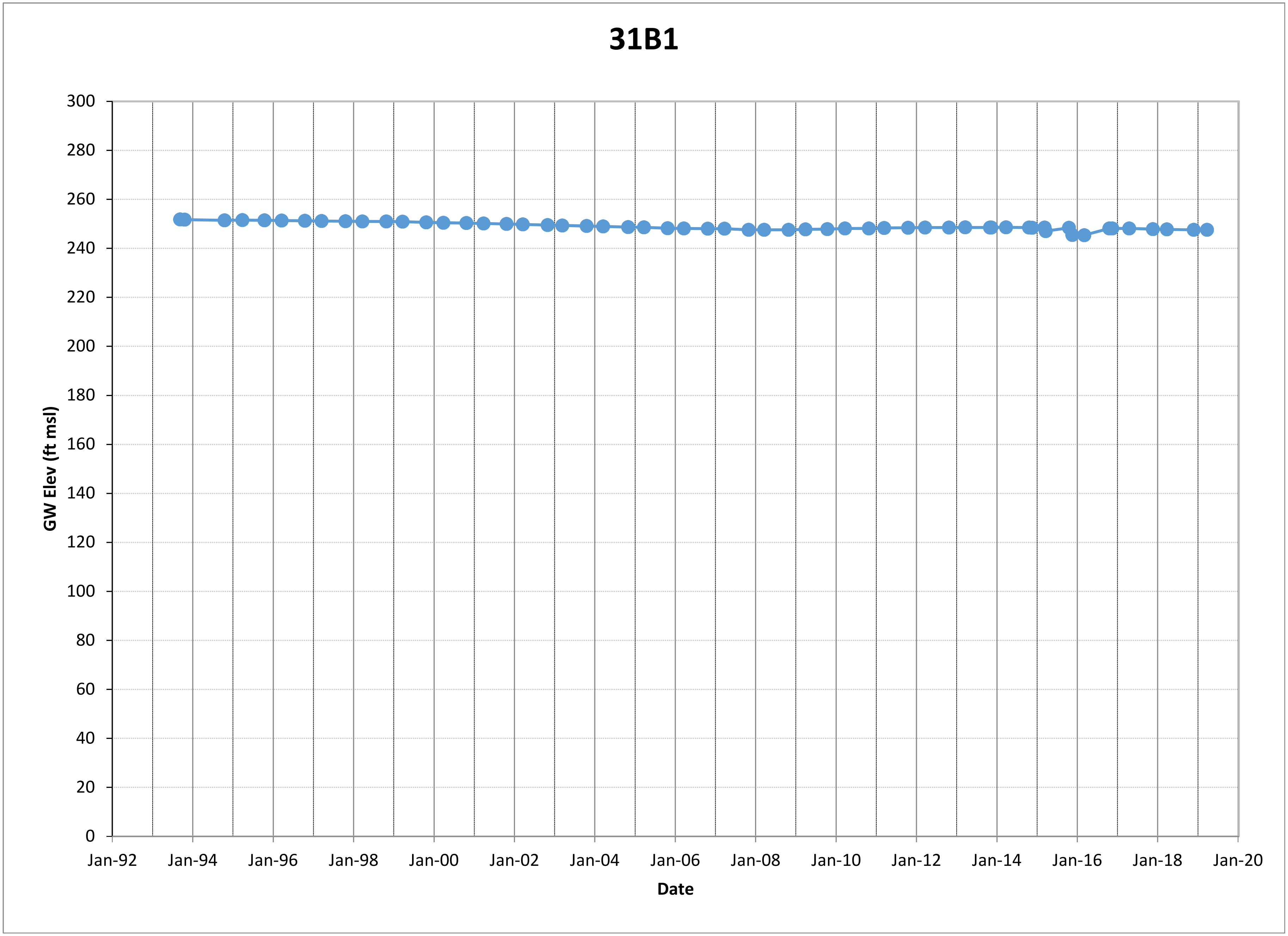

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GW Elev (ft msl)
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Jan-92
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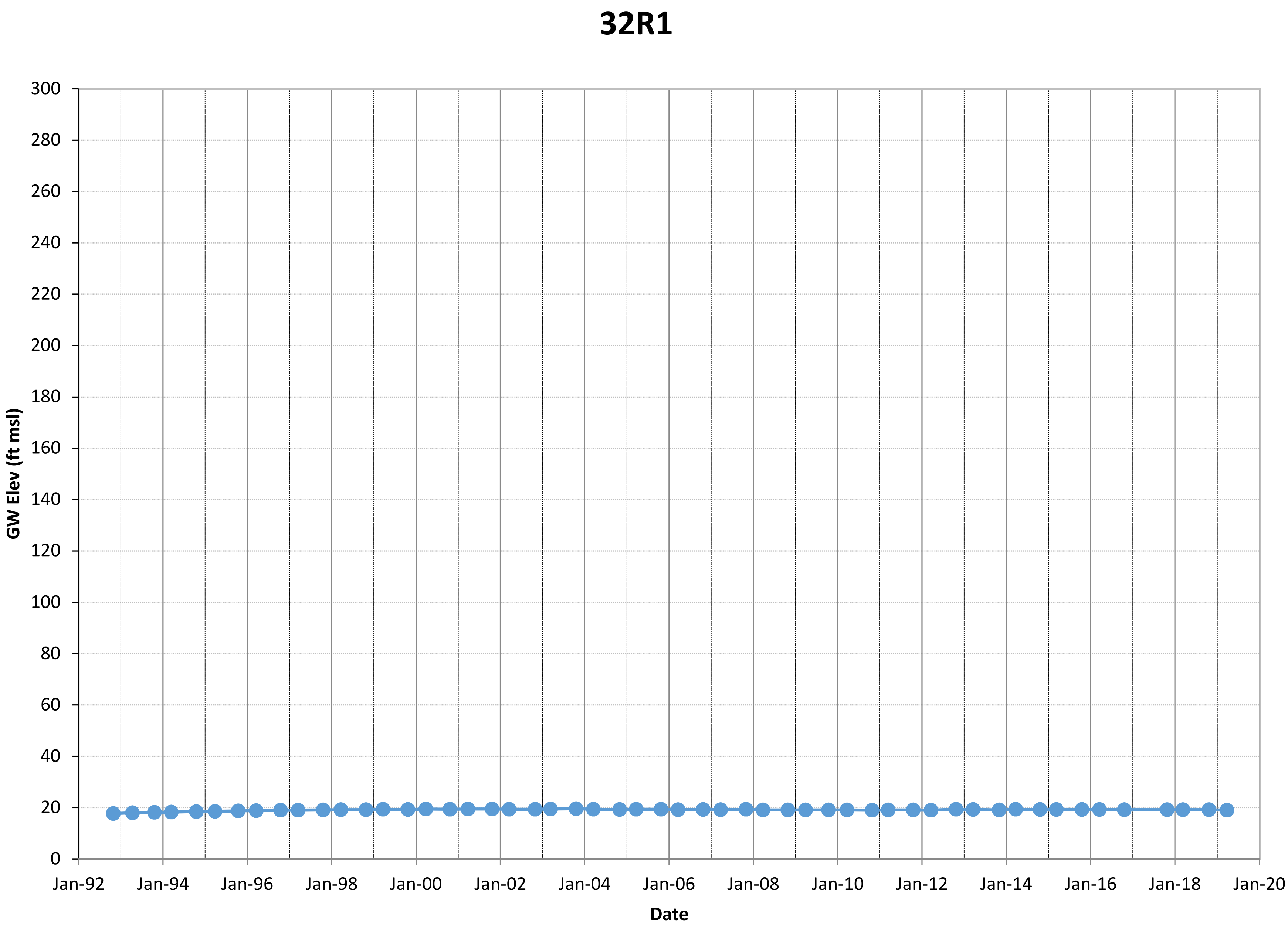
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Jan-92
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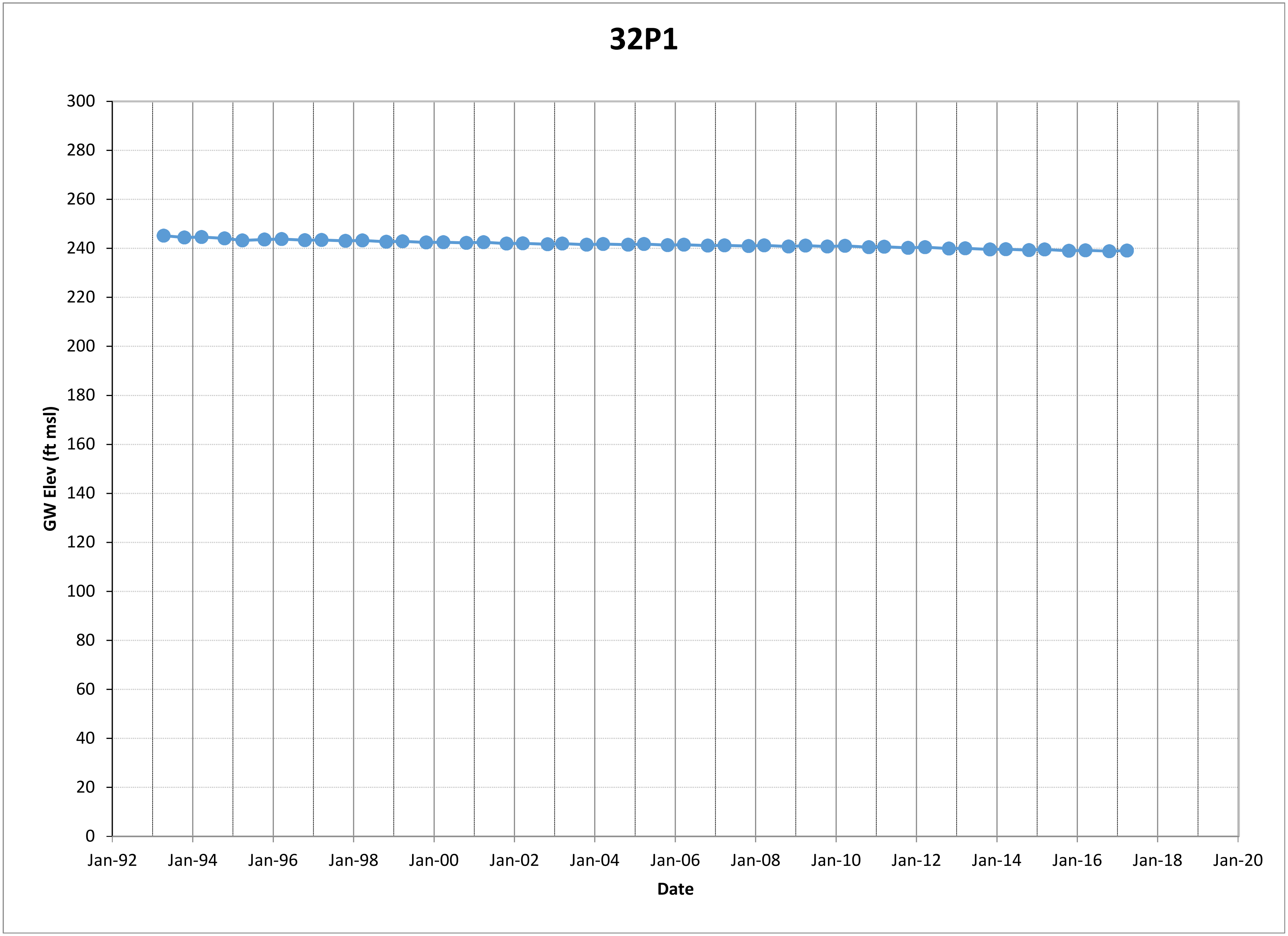

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GW Elev (ft msl)
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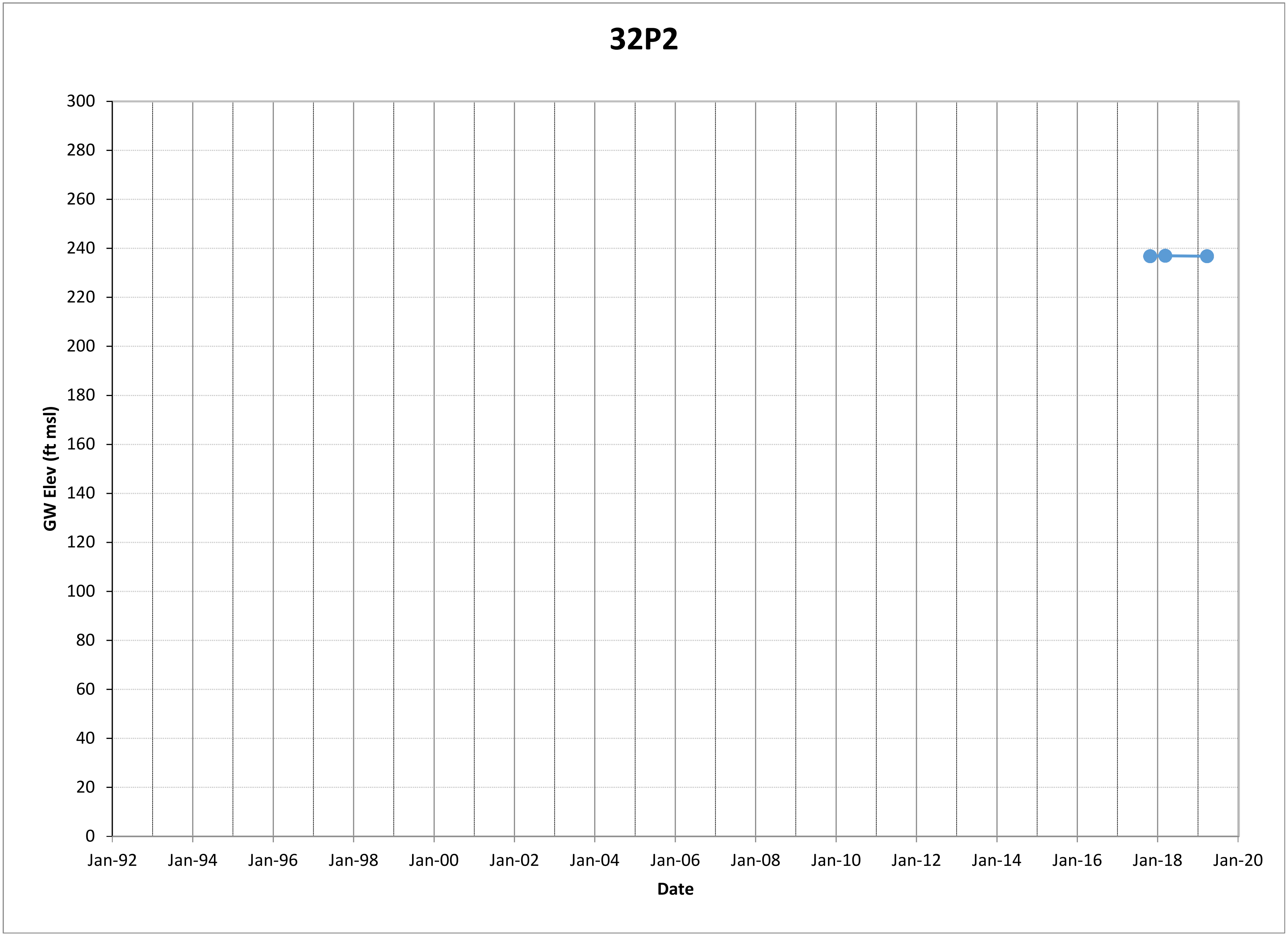
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Jan-92
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Jan-96
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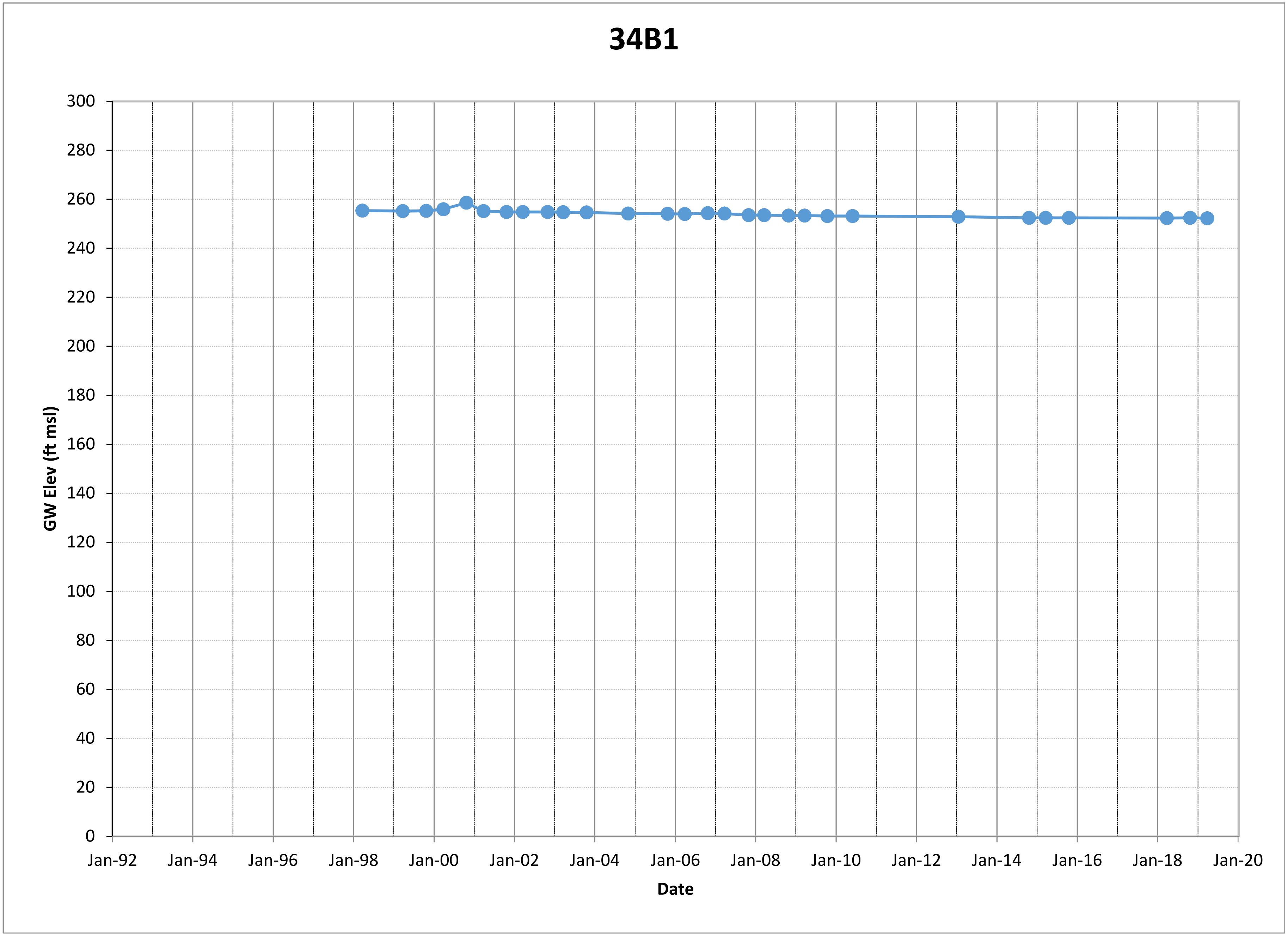
Jan-18
Jan-20
Date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Jan-94
Jan-96
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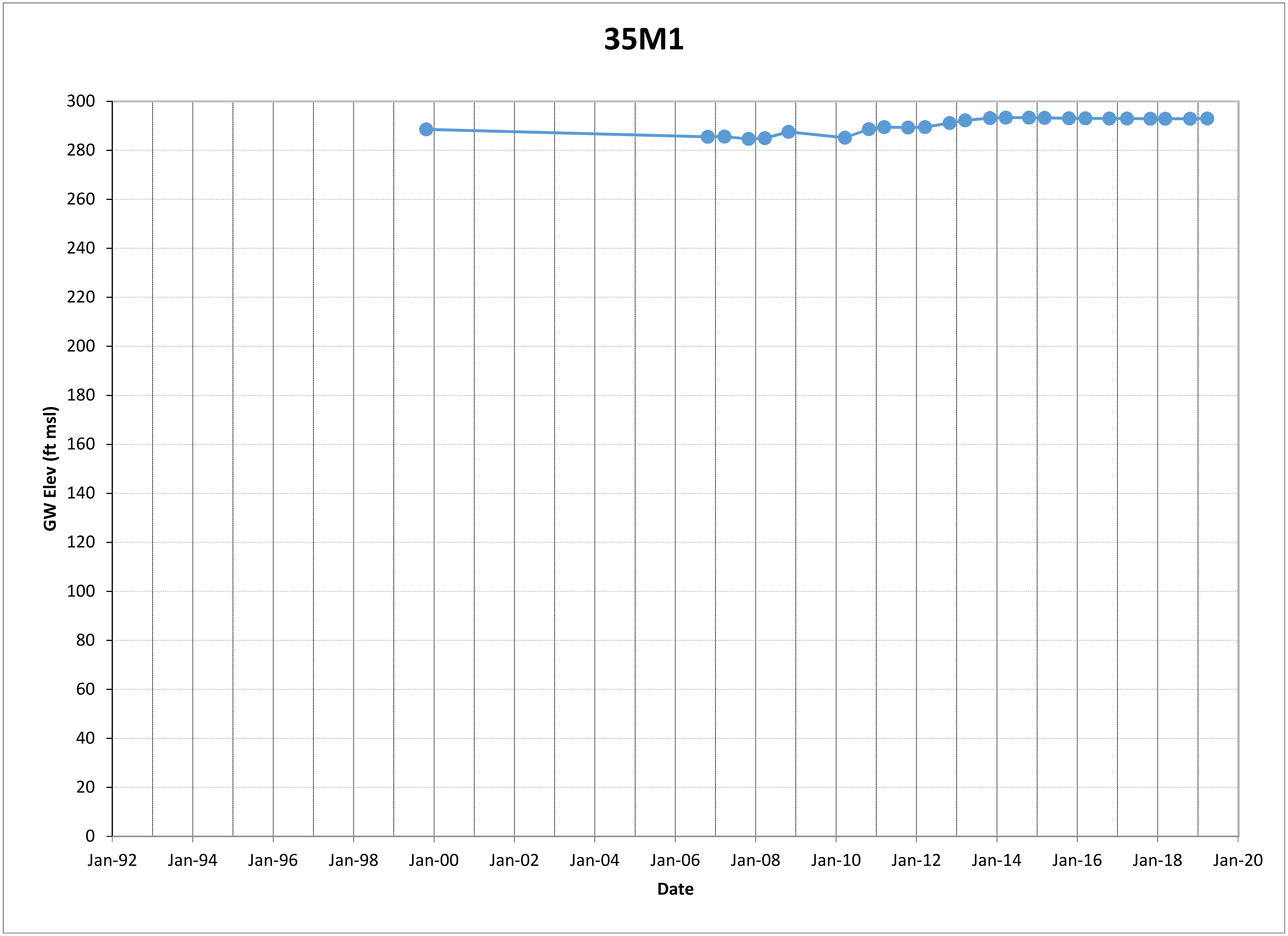
Jan-18
Jan-20
Date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GW Elev (ft msl)
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Jan-92
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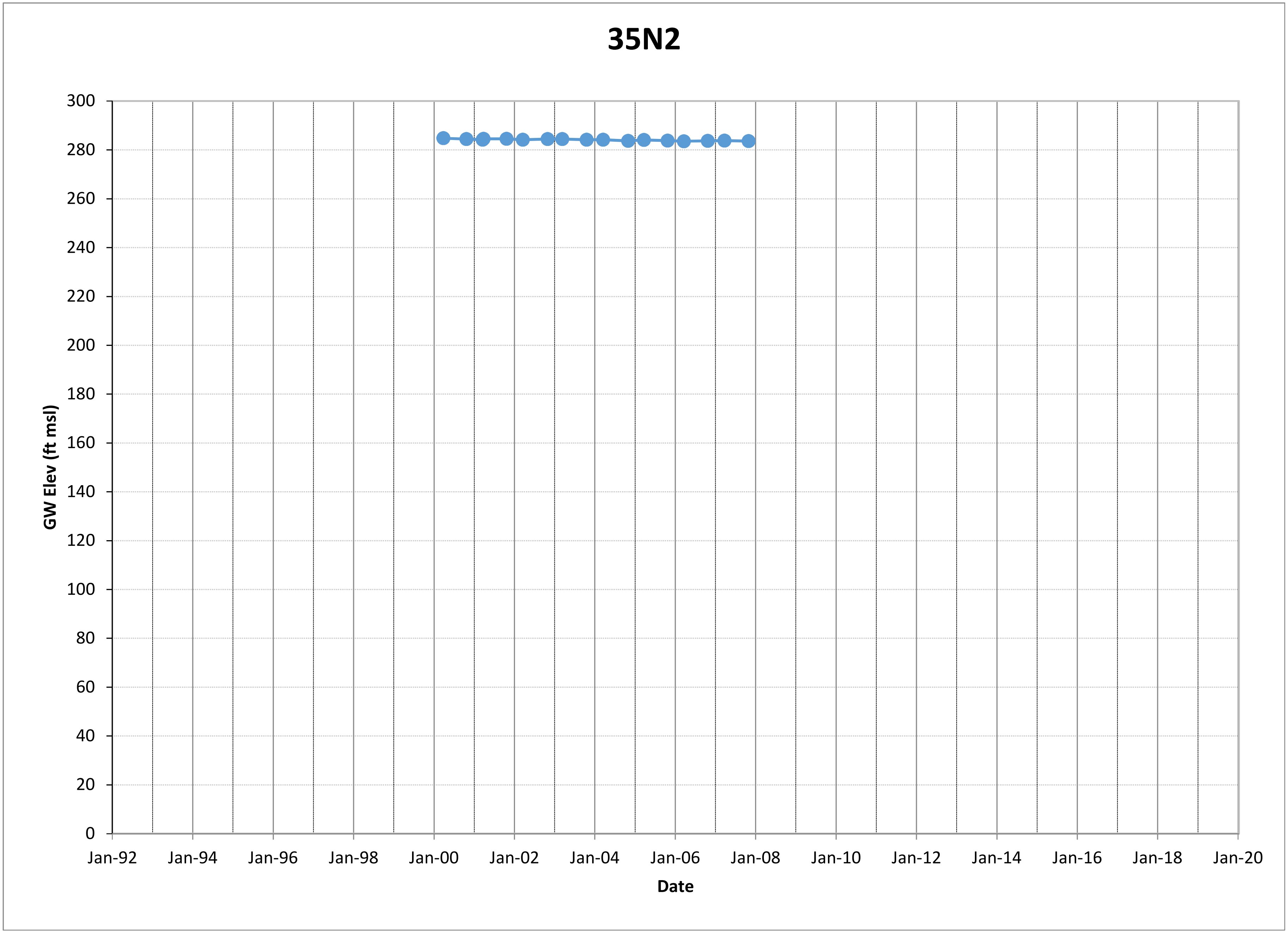
Date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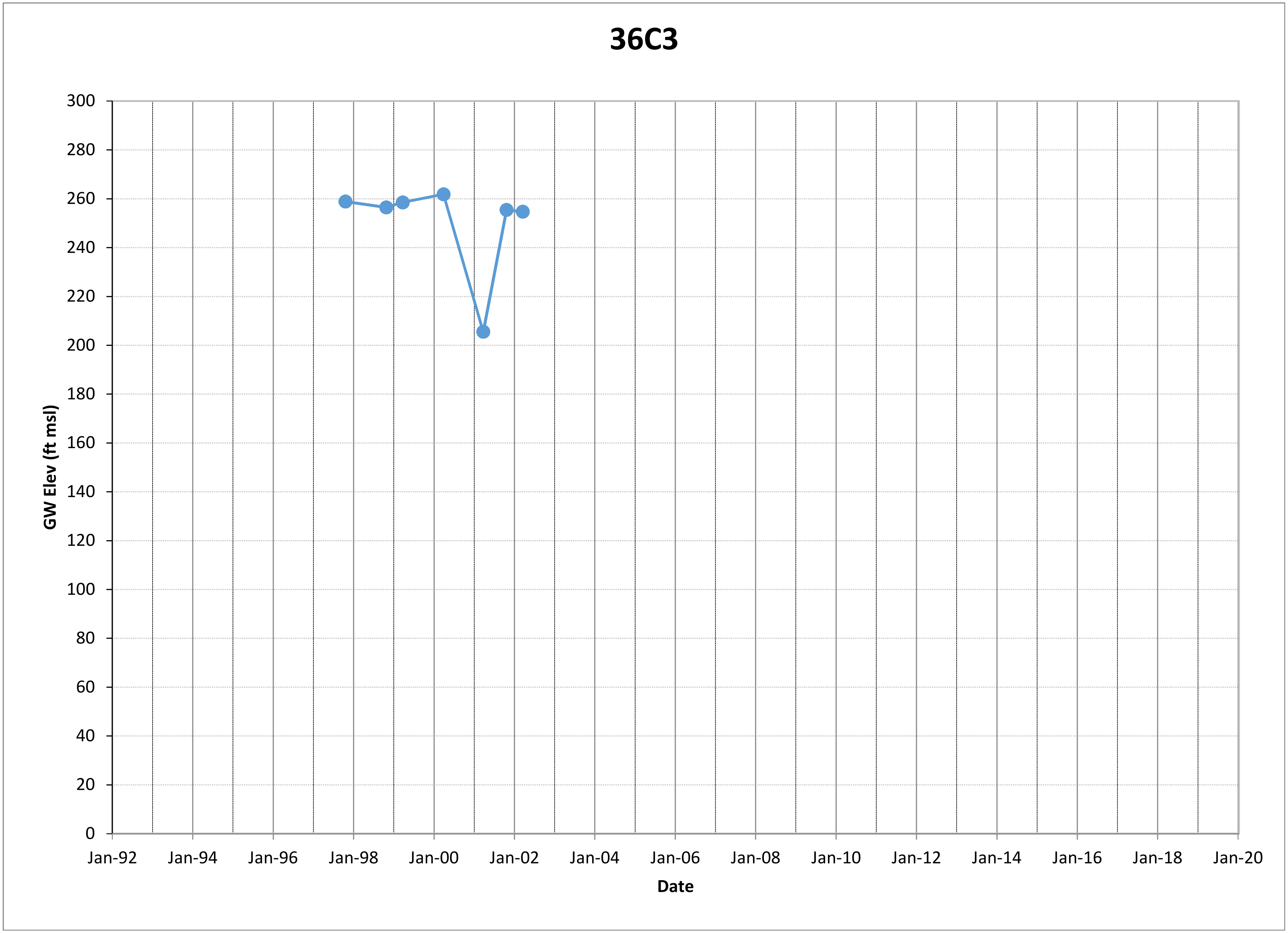
Jan-20
Date


36C3
GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
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Jan-14
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Jan-18
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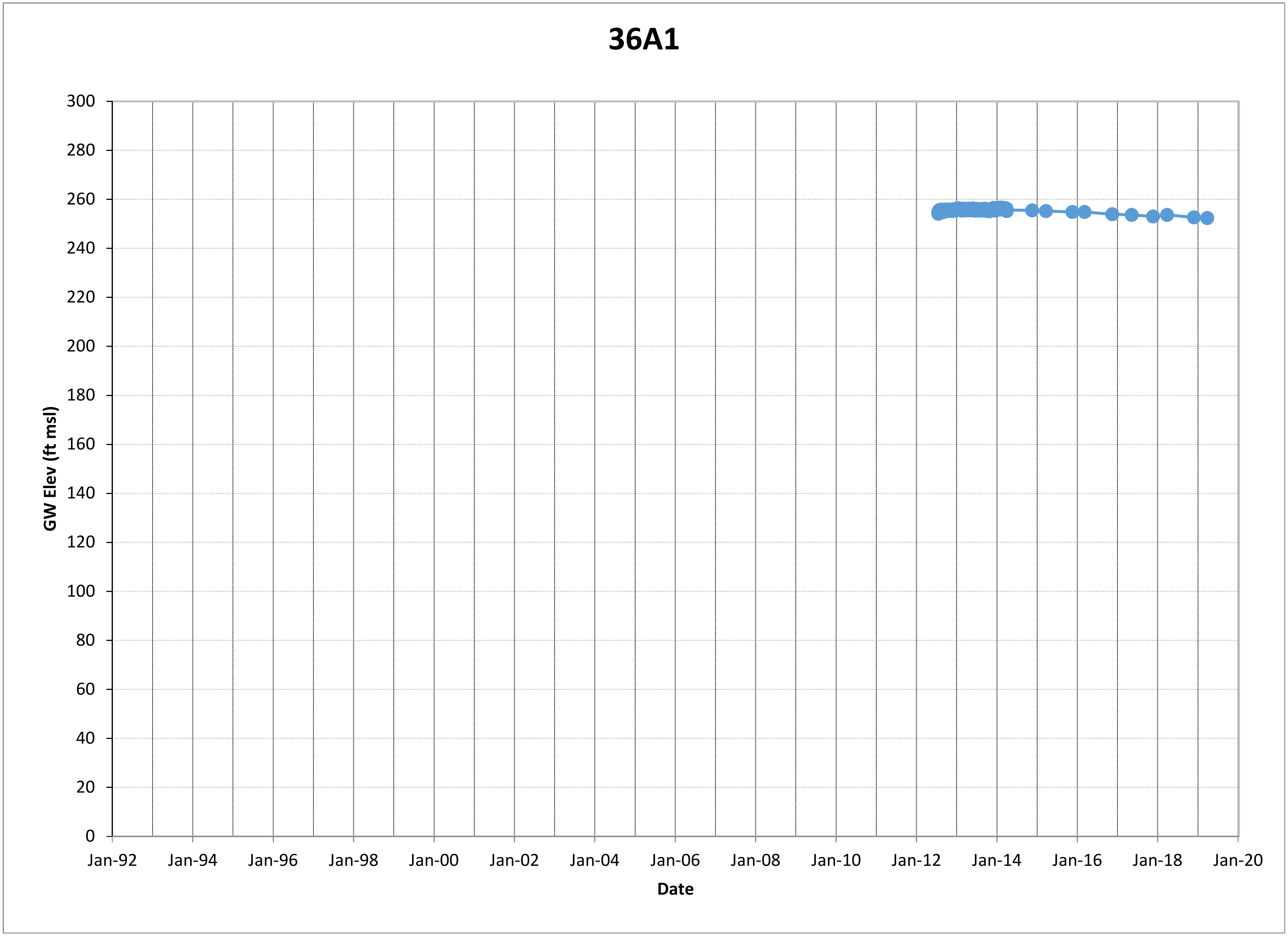36A1
GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
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Jan-14
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Jan-18
Jan-20
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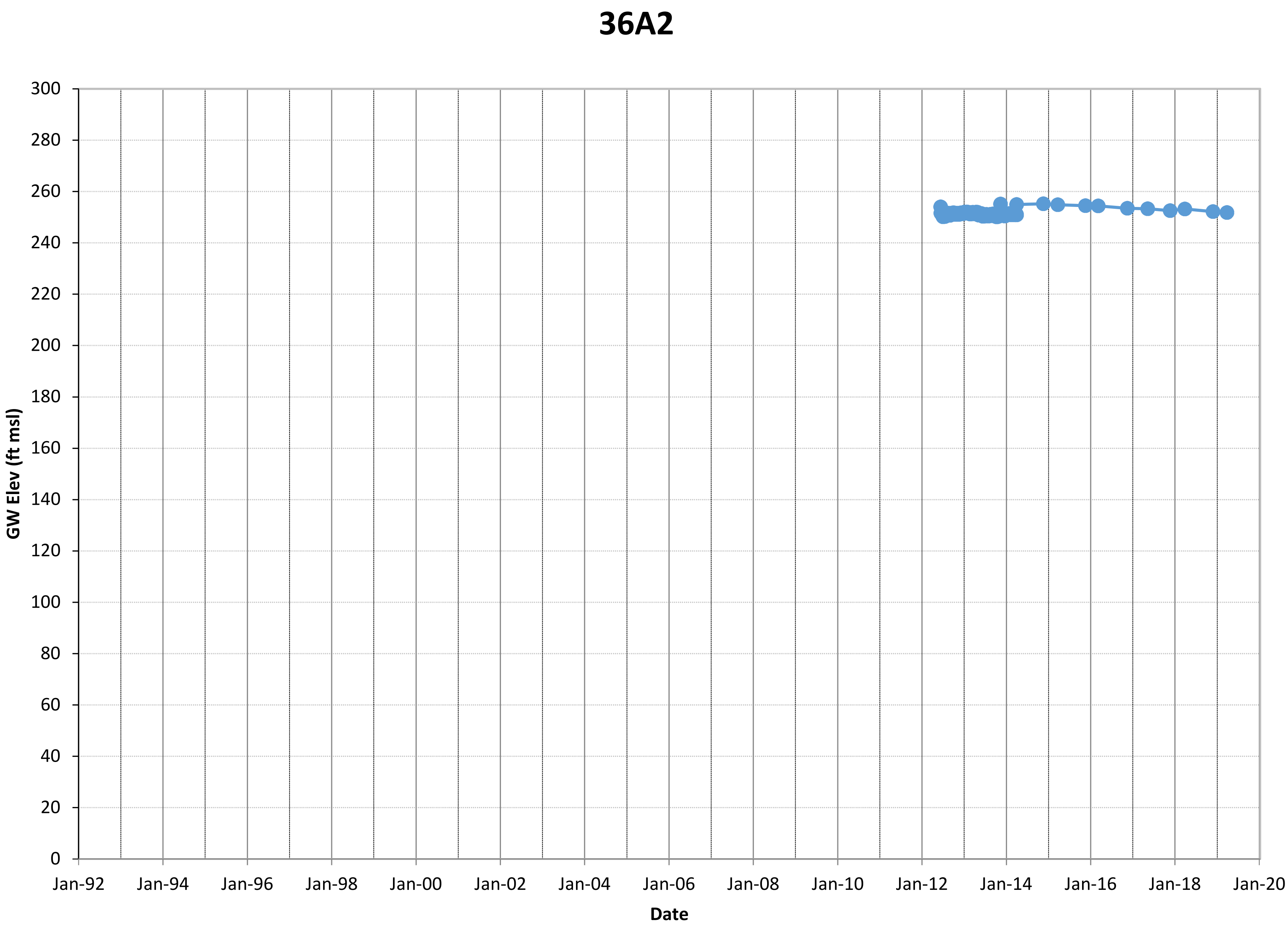
36A2
GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
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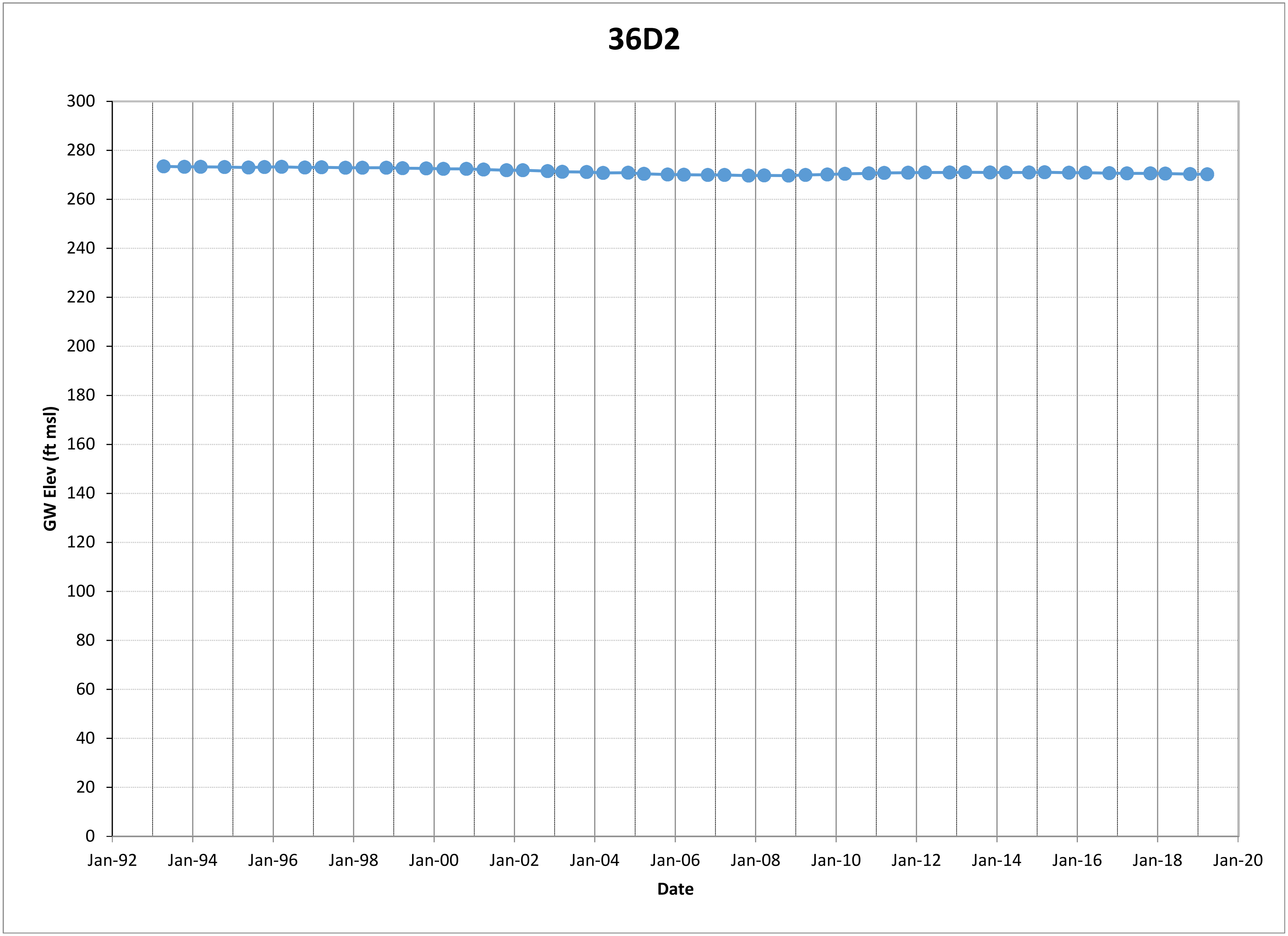
36D2
GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
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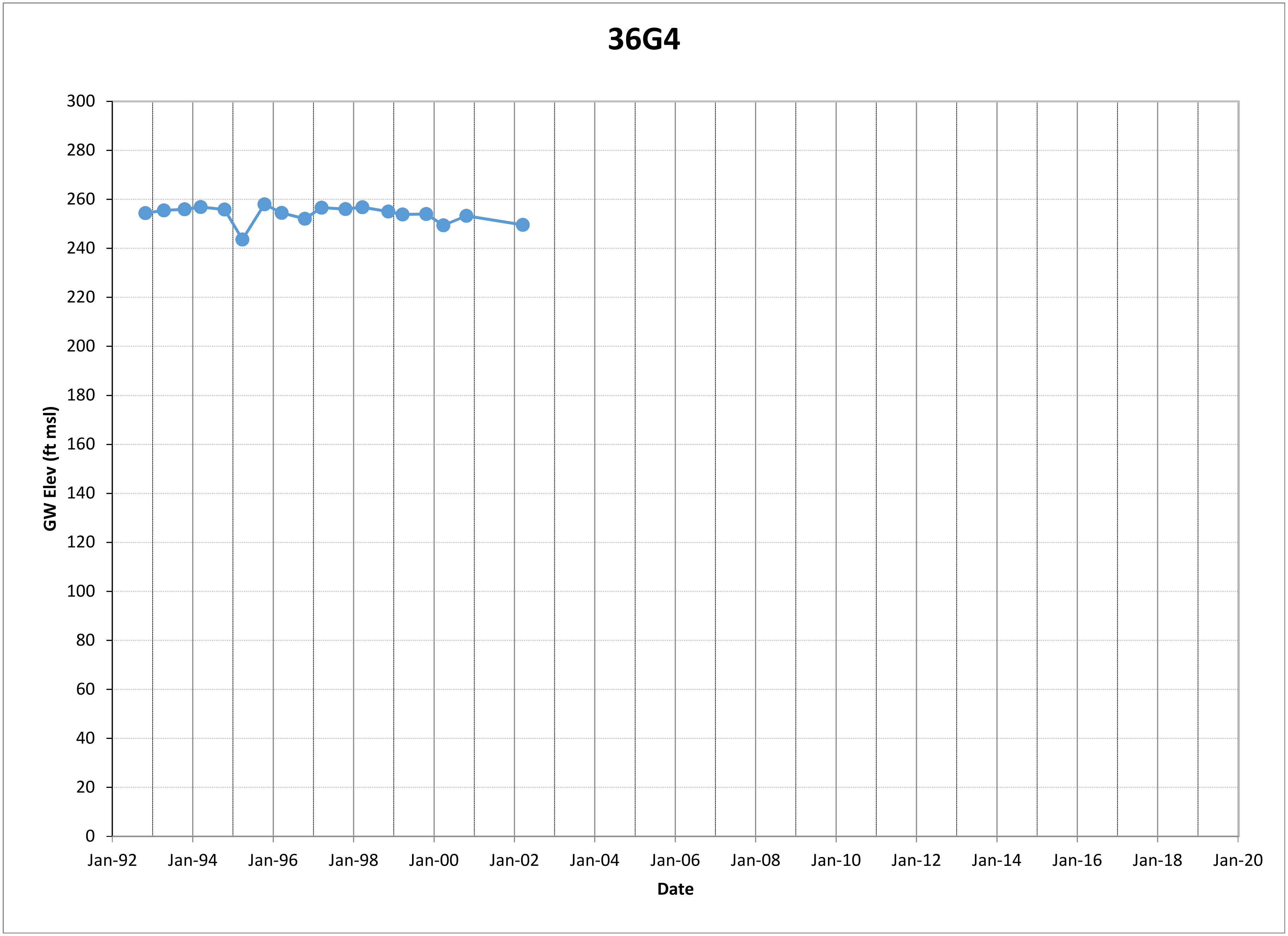
36G4
GW Elev (ft msl)
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280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
Jan-98
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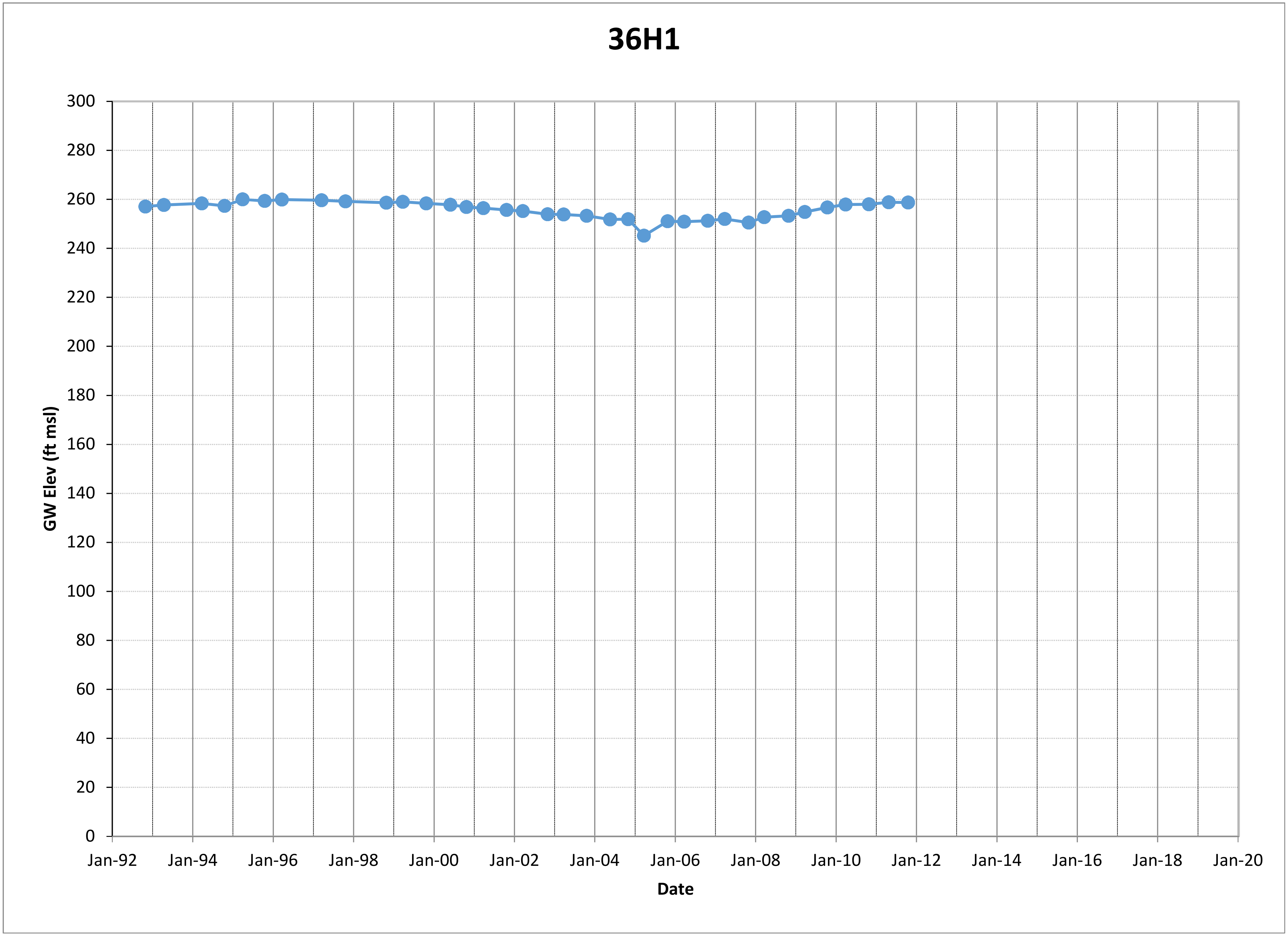
Date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GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
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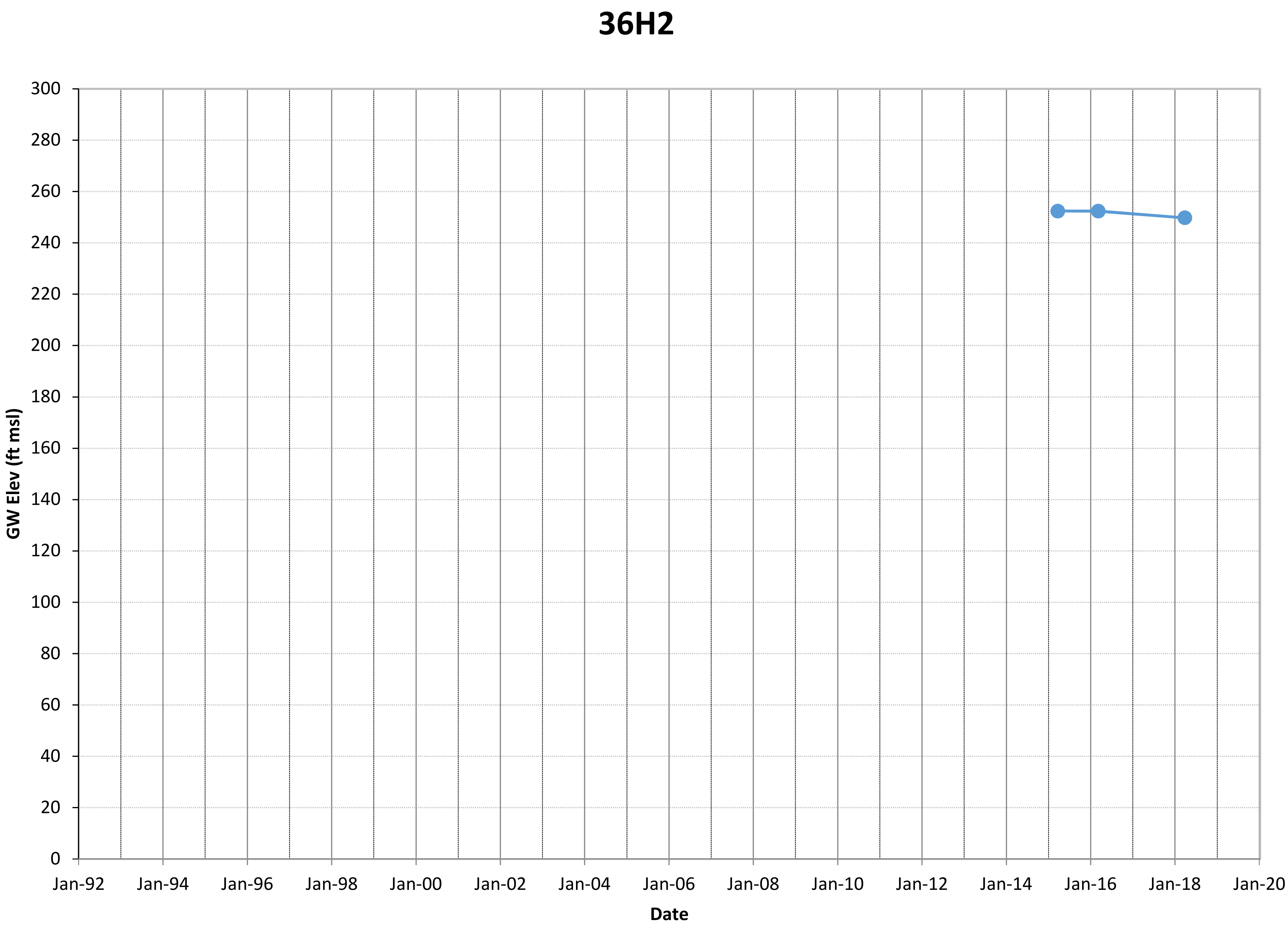
36H2
GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
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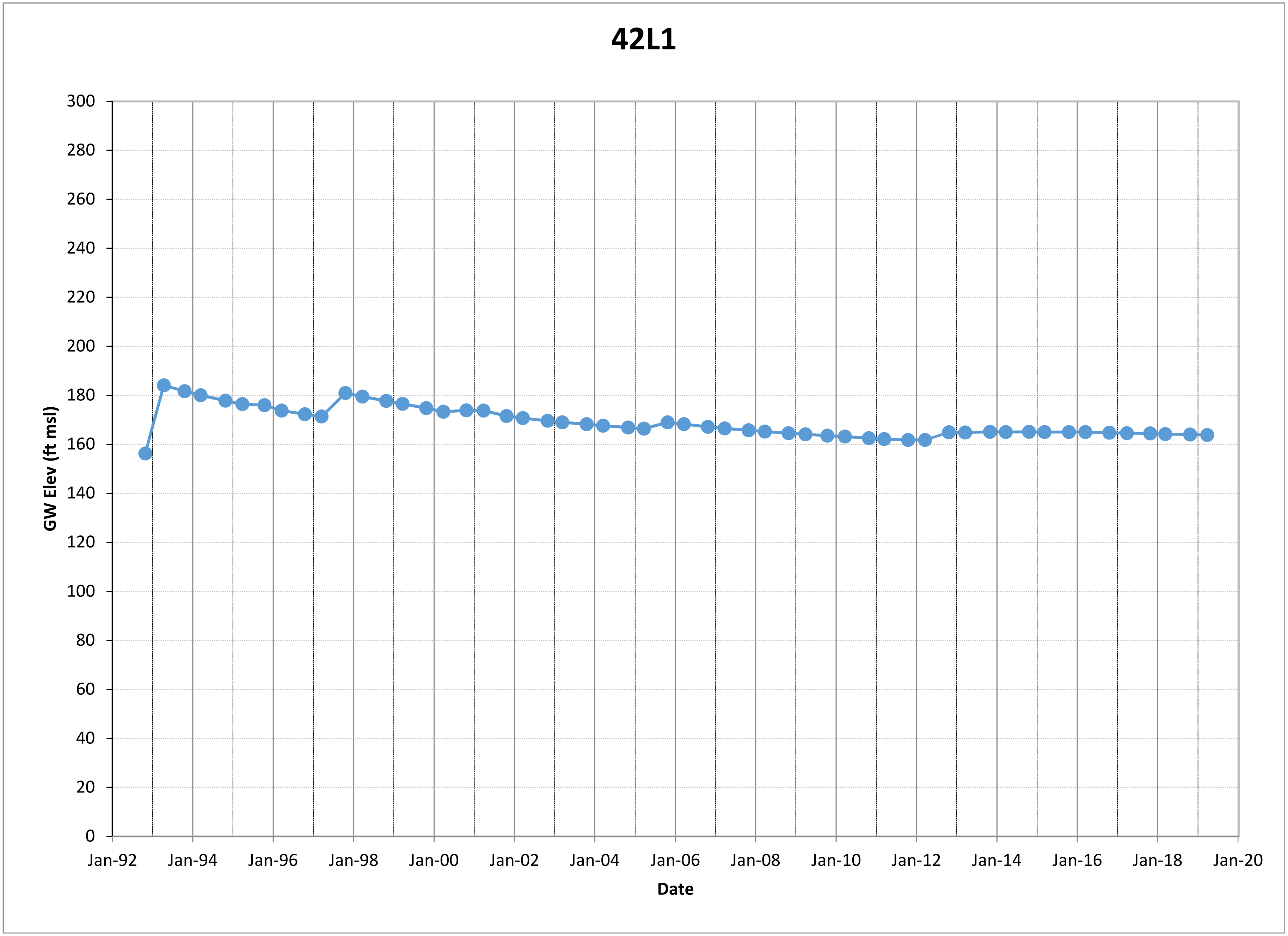

42L1
GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
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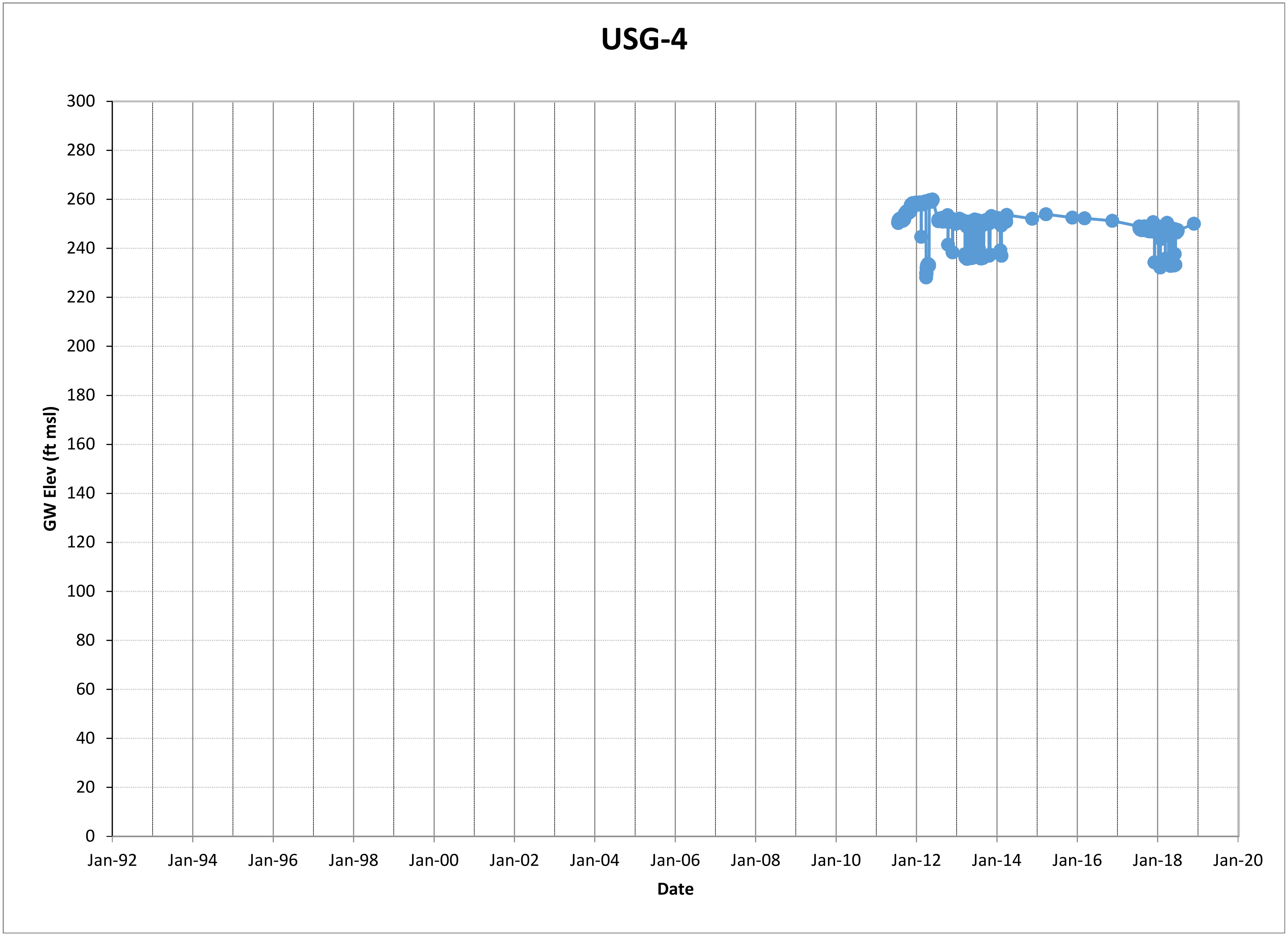
Date


USG-4
GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
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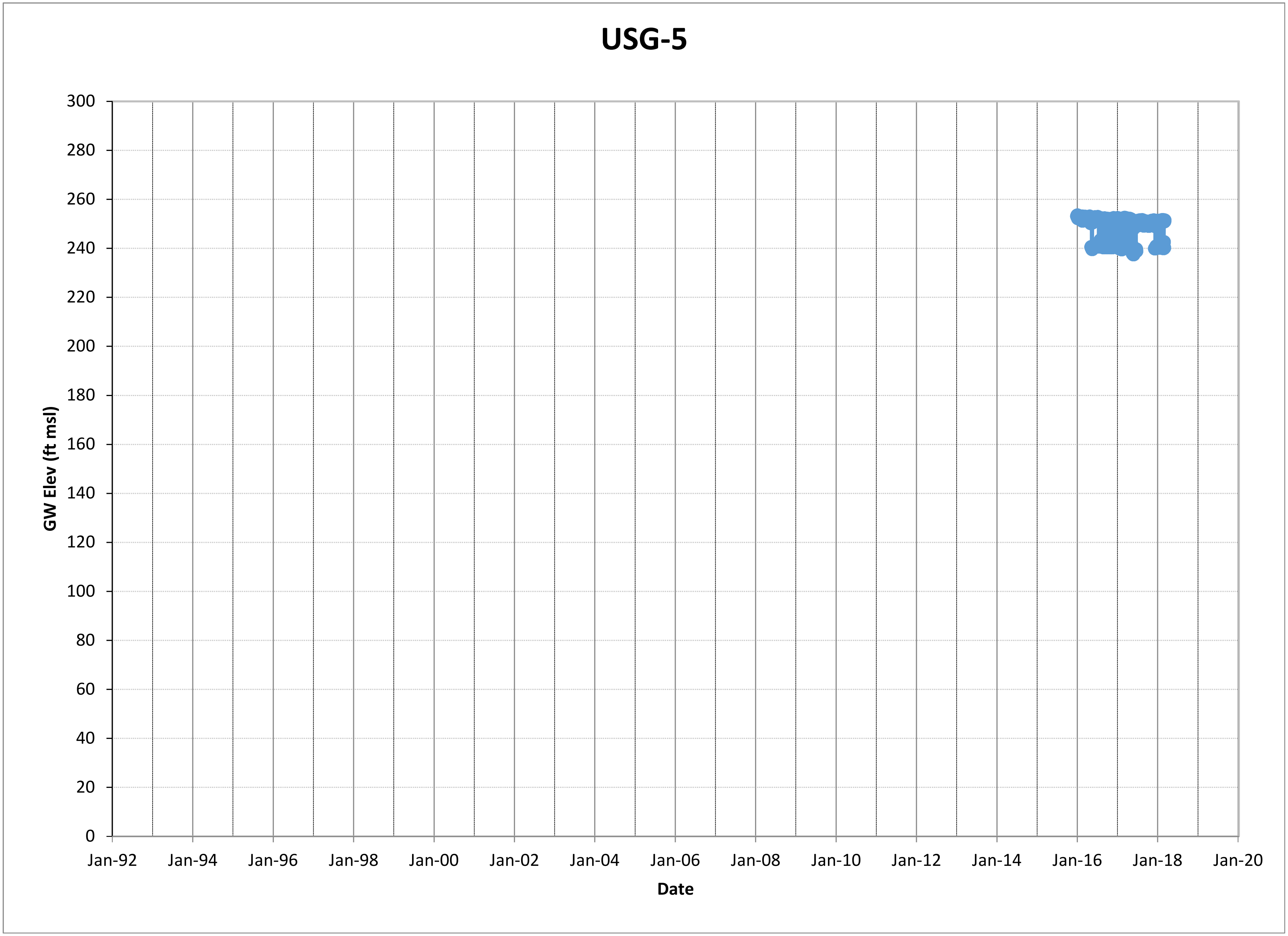
Jan-18
Jan-20
Date


USG-5
GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
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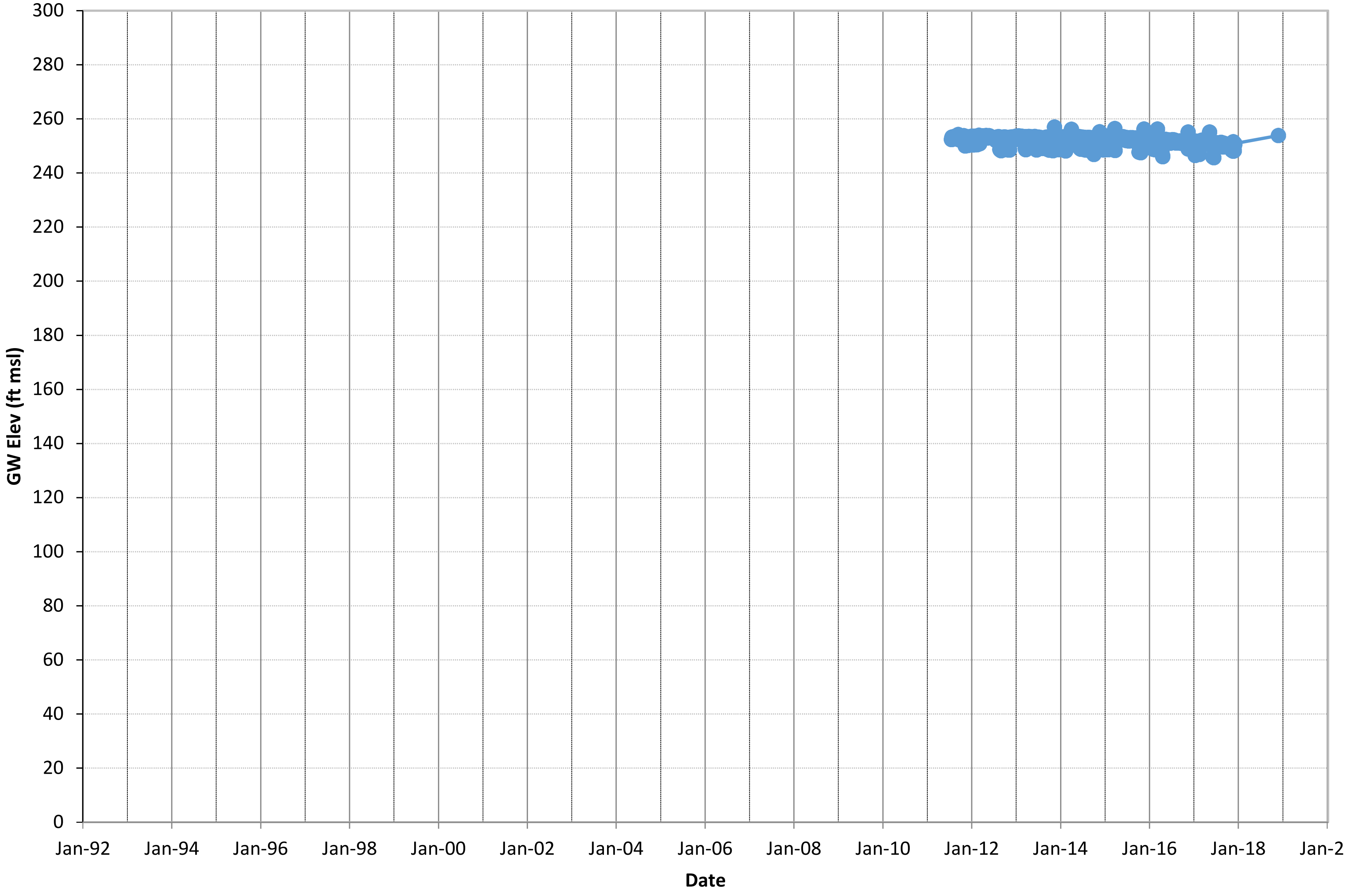
Jan-18
Jan-20
Date

USG-6



GW Elev (ft msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Jan-92
Jan-94
Jan-96
Jan-98
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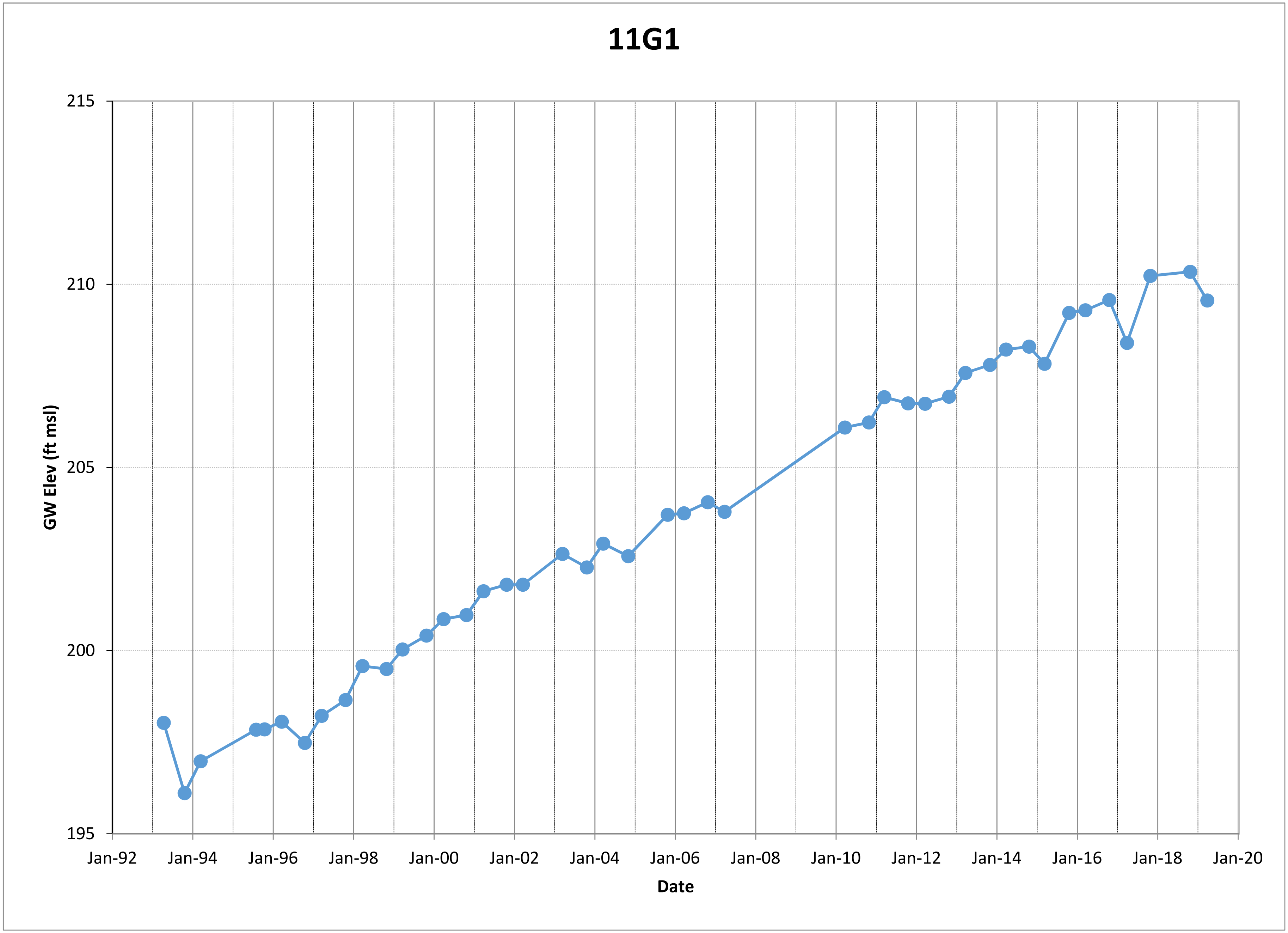
Jan-18
Jan-20
Date


11G1
GW Elev (ft msl)
215
210
205
200
195
Jan-92
Jan-94
Jan-96
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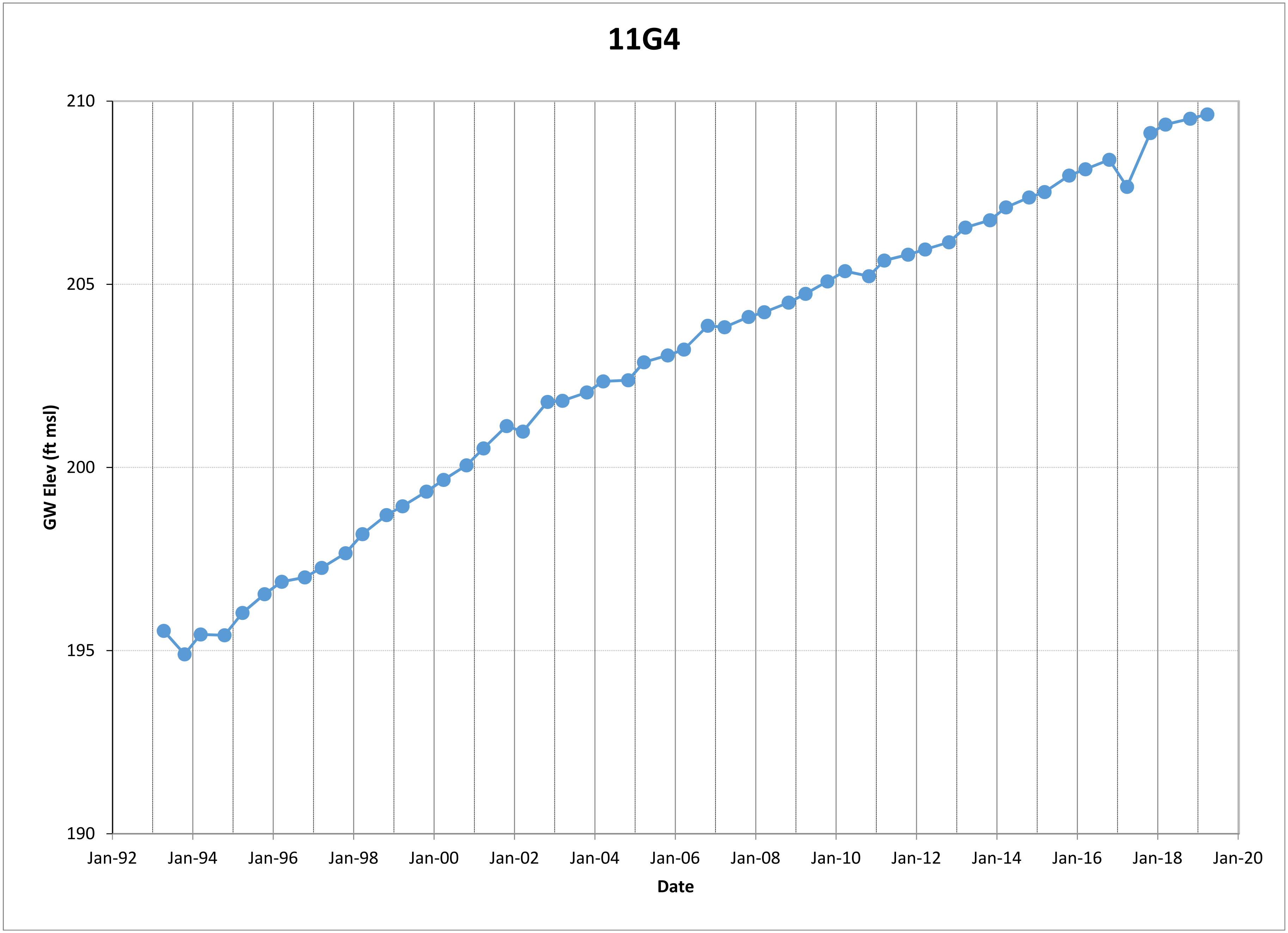
Date


11G4
GW Elev (ft msl)
210
205
200
195
190
Jan-92
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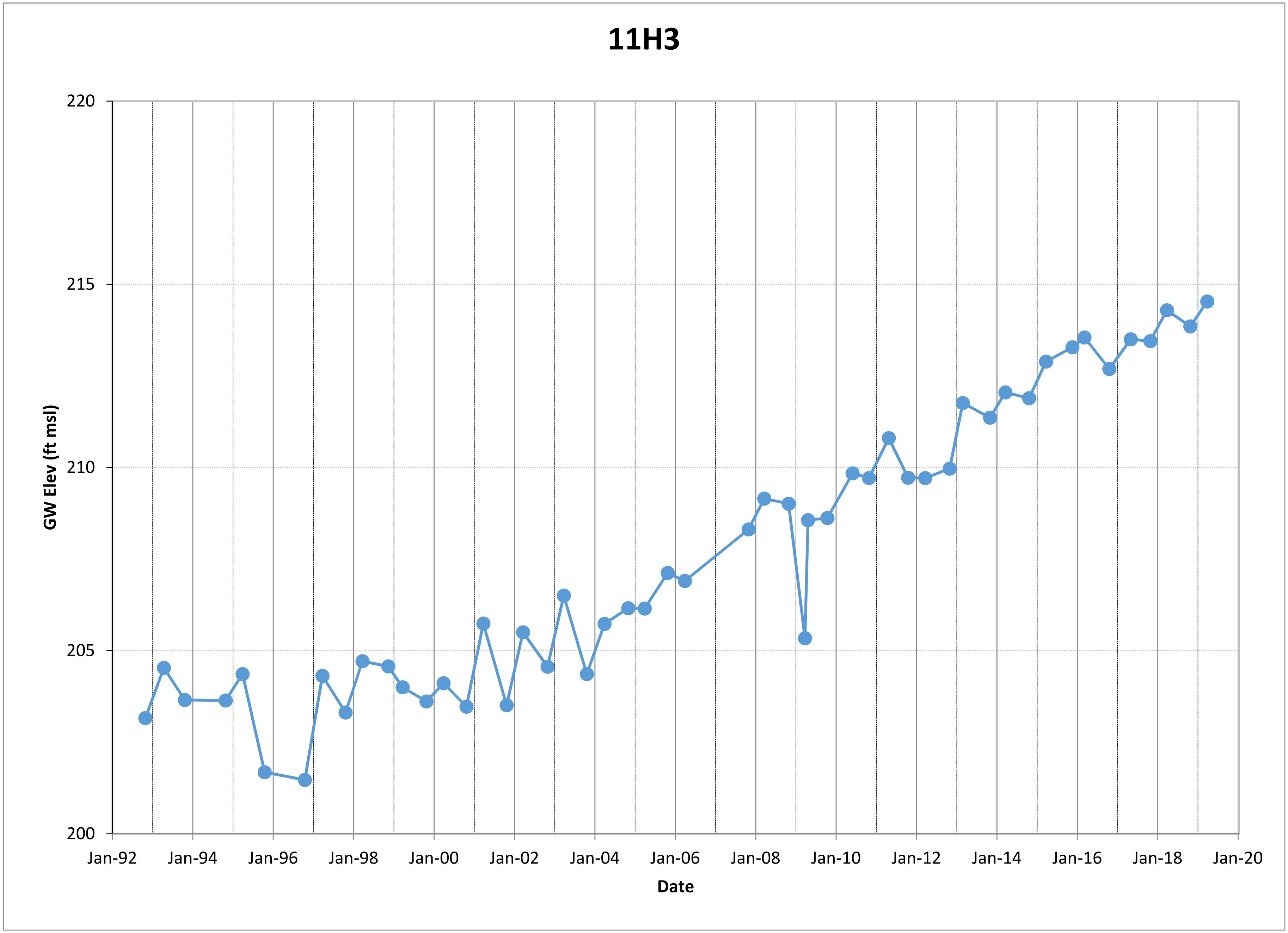
Jan-20
Date


11H3
GW Elev (ft msl)
220
215
210
205
200
Jan-92
Jan-94
Jan-96
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Jan-06
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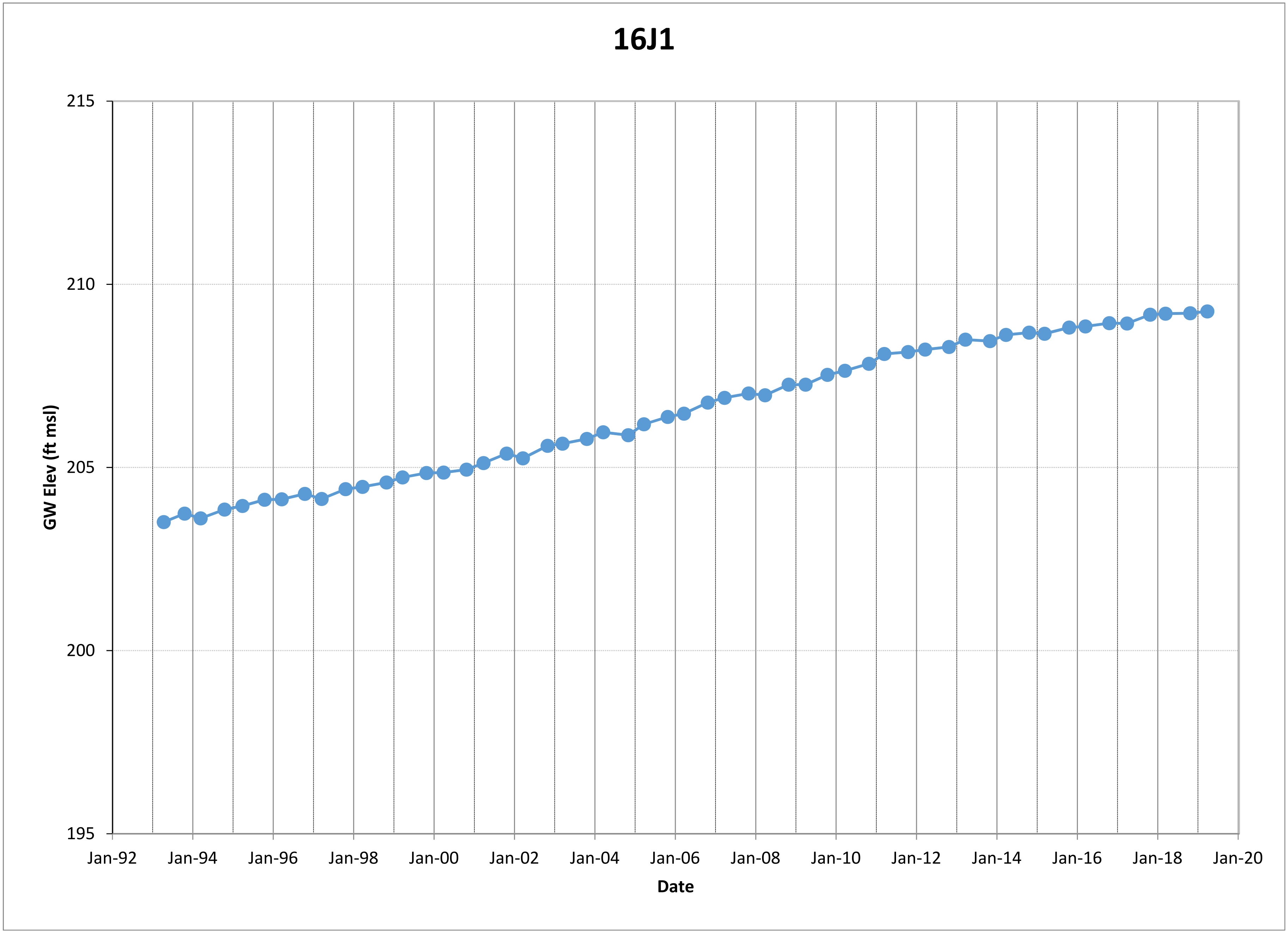
Jan-20
Date


16J1
GW Elev (ft msl)
215
210
205
200
195
Jan-92
Jan-94
Jan-96
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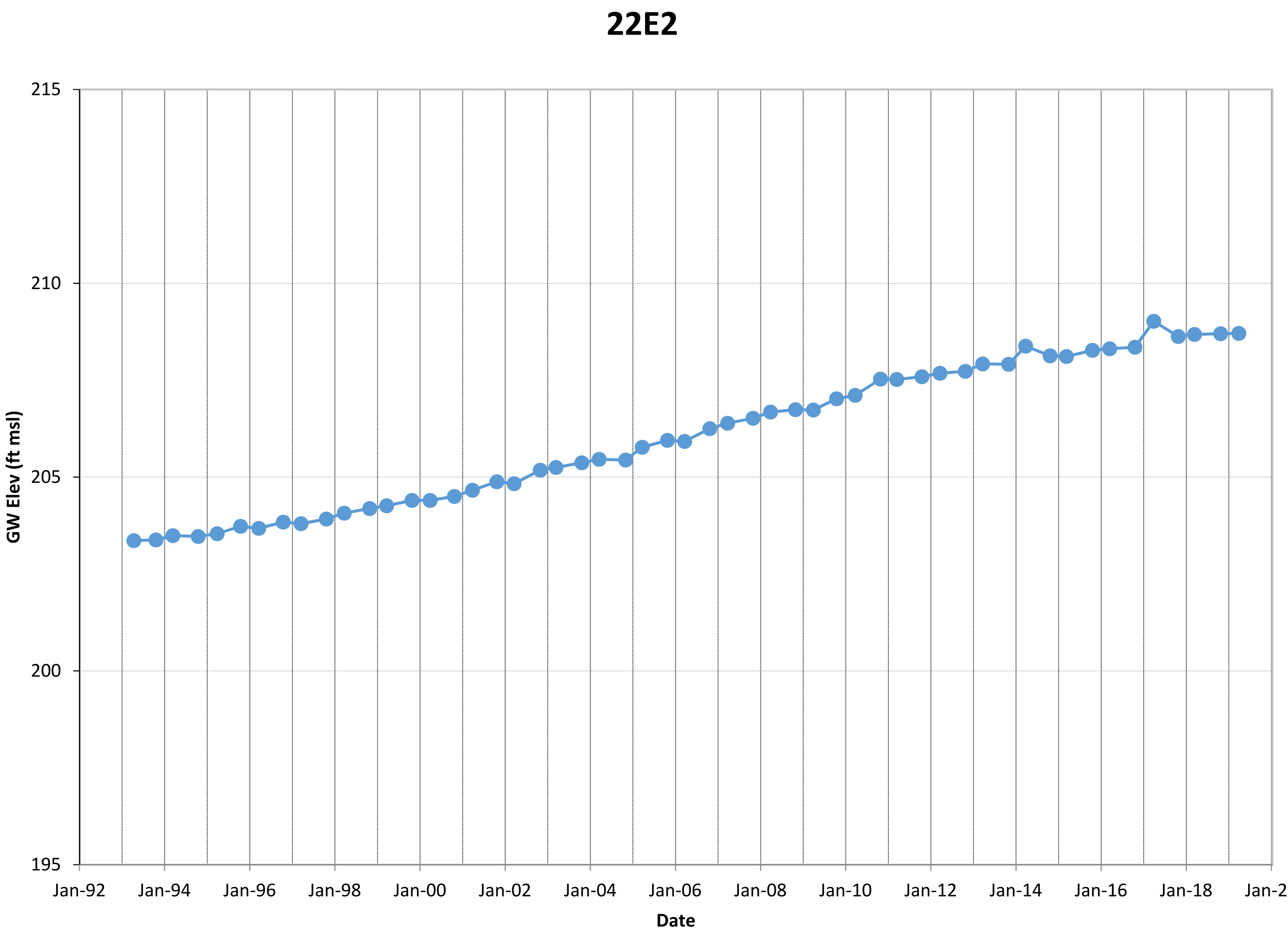
Jan-18
Jan-20
Date


22E2
GW Elev (ft msl)
215
210
205
200
195
Jan-92
Jan-94
Jan-96
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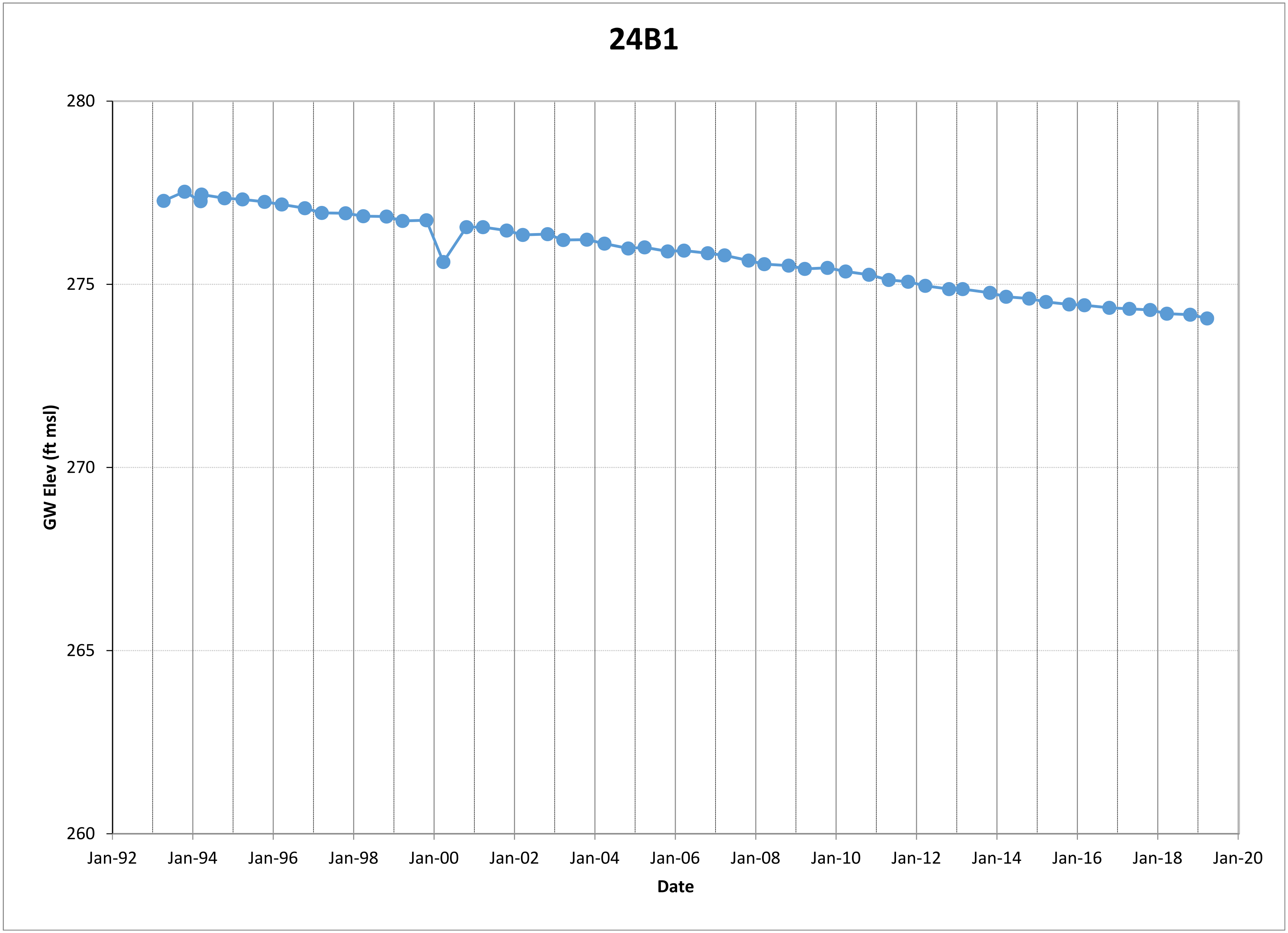
Jan-18
Jan-20
Date



24B1
GW Elev (ft msl)
280
275
270
265
260
Jan-92
Jan-94
Jan-96
Jan-98
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Jan-02
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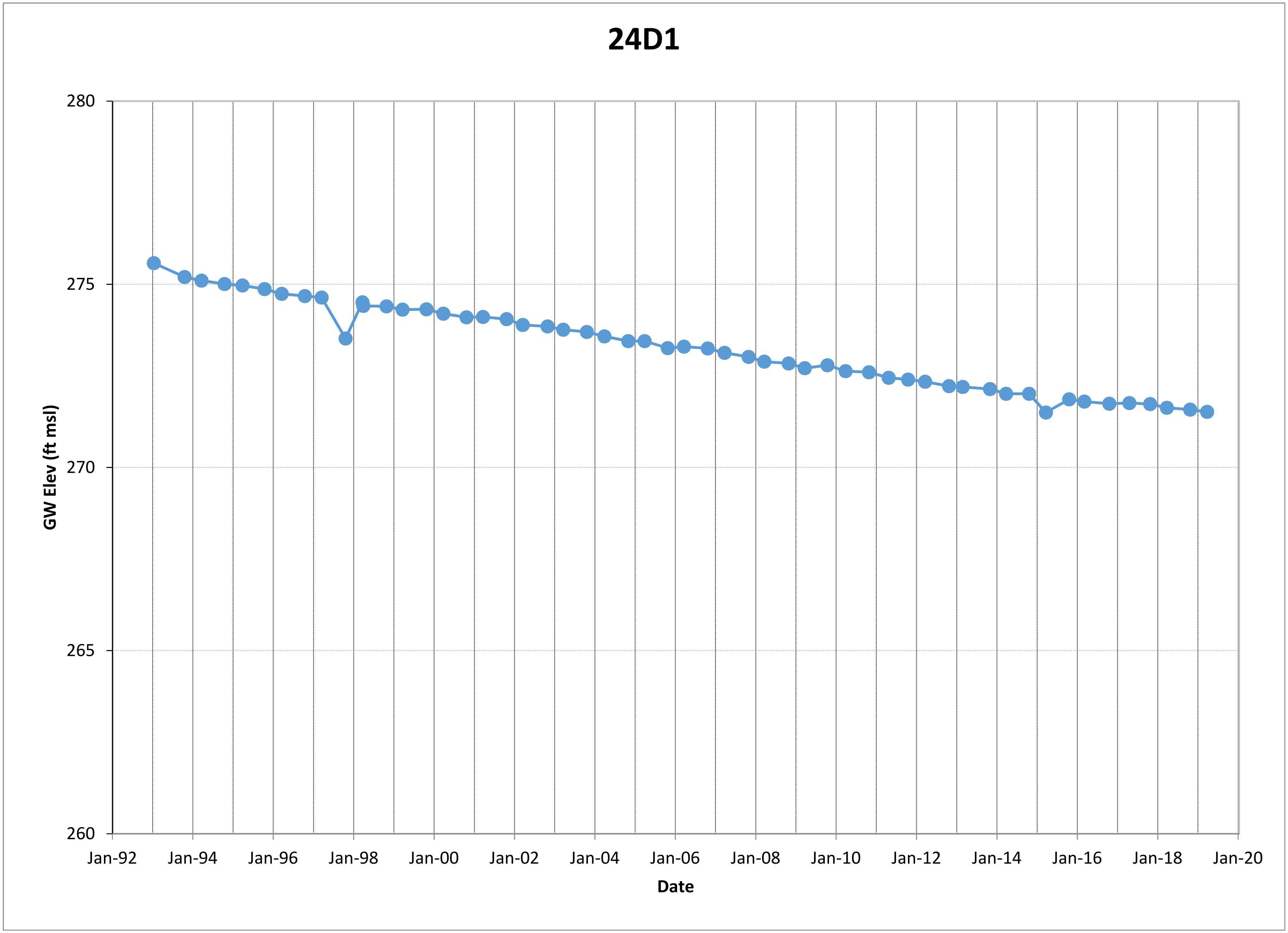
Jan-18
Jan-20
Date



24D1
280
275
270
265
260
GW Elev (ft msl)
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
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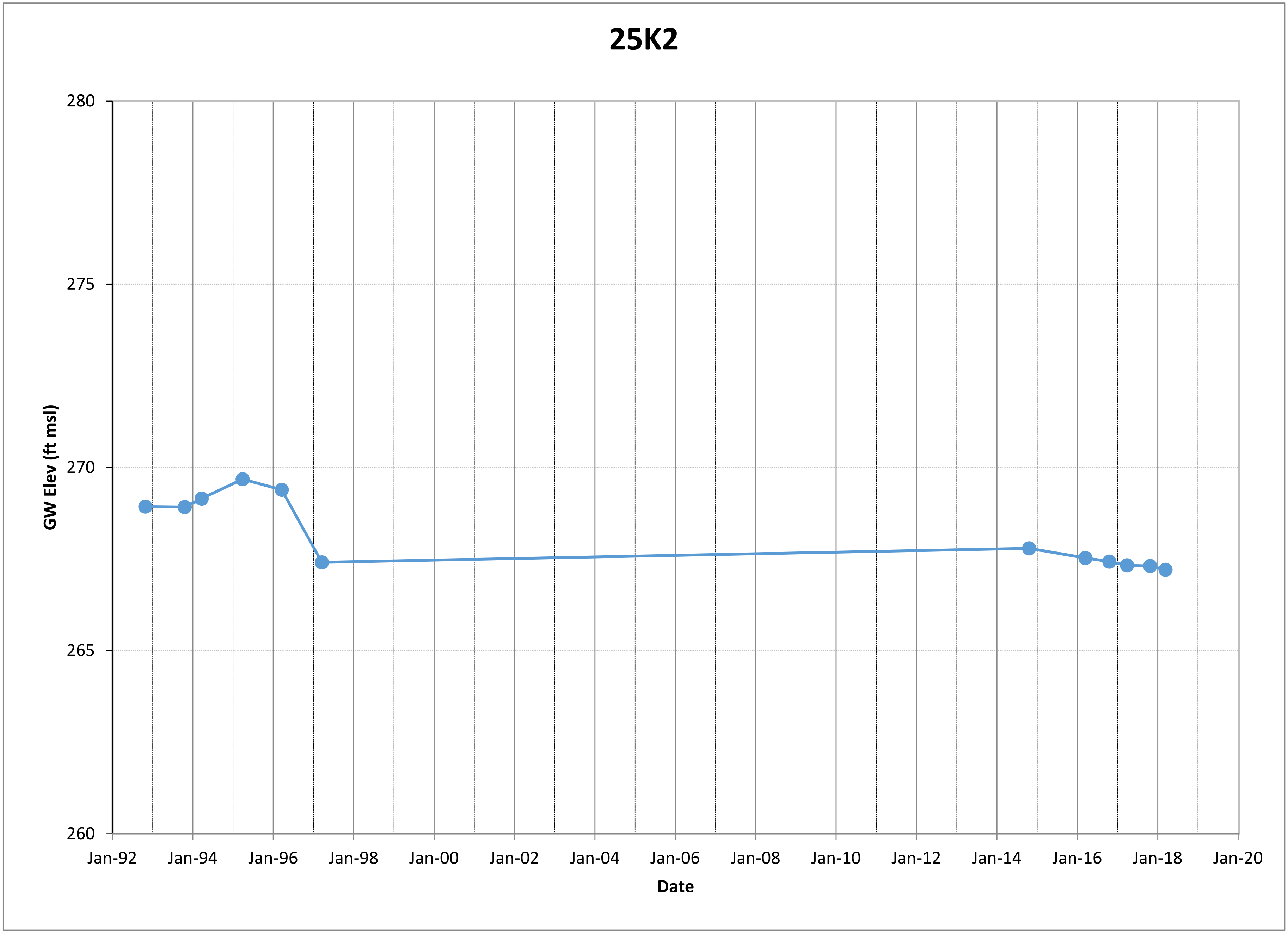
Jan-20
Date


25K2
GW Elev (ft msl)
280
275
270
265
260
Jan-92
Jan-94
Jan-96
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Jan-02
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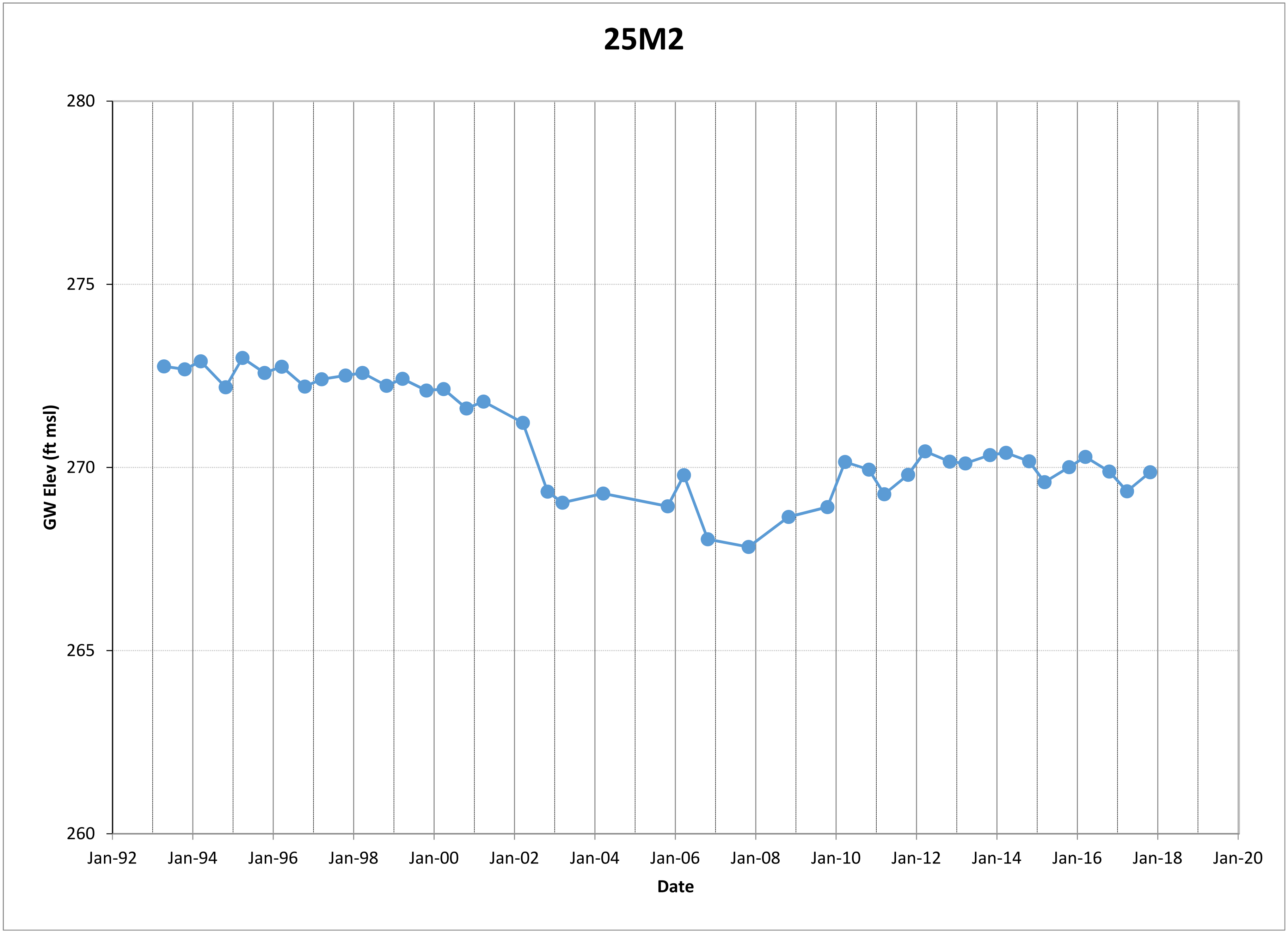
Date


25M2
GW Elev (ft msl)
280
275
270
265
260
Jan-92
Jan-94
Jan-96
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Jan-00
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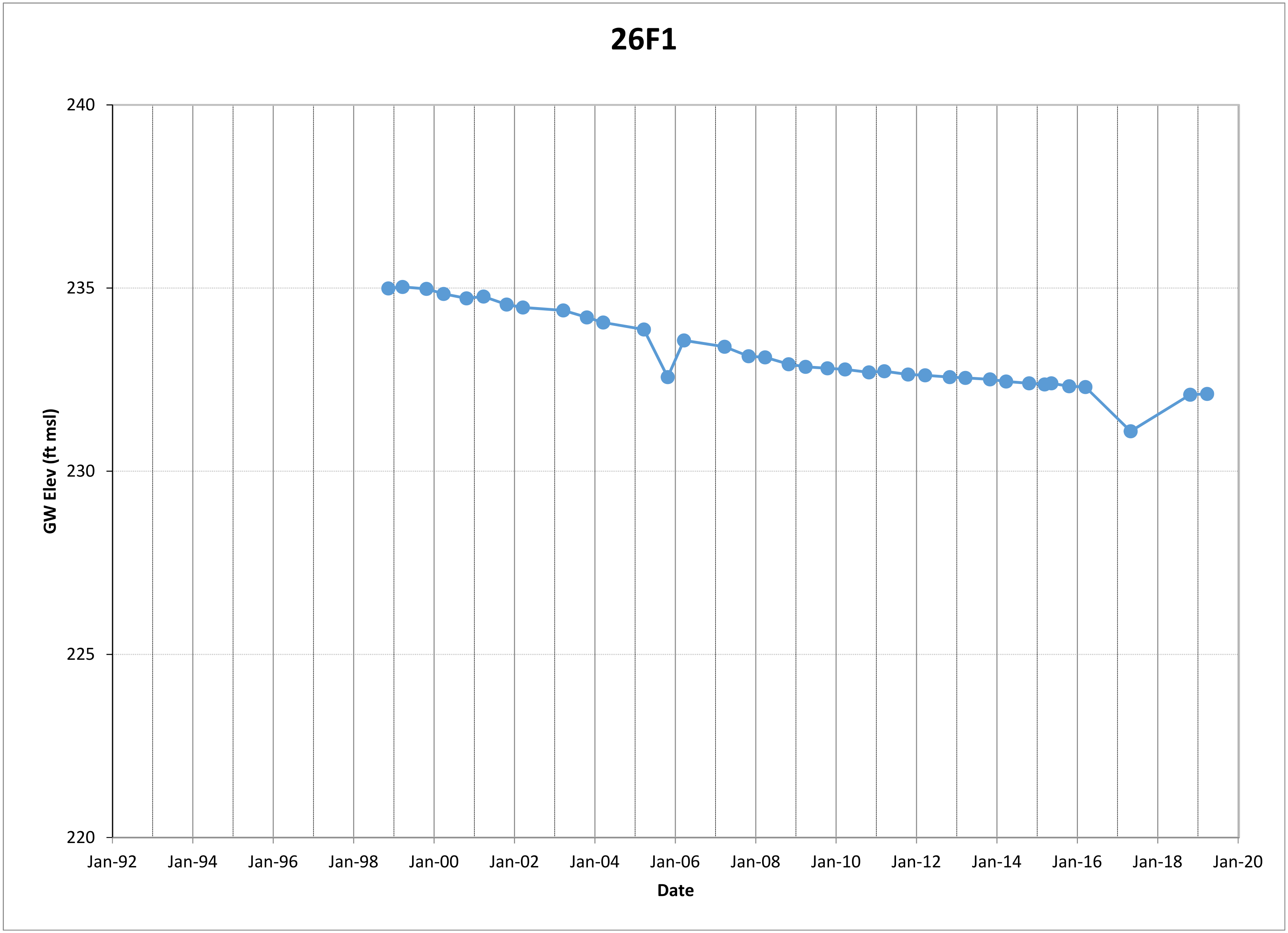
Date


26F1
GW Elev (ft msl)
240
235
230
225
220
Jan-92
Jan-94
Jan-96
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Jan-00
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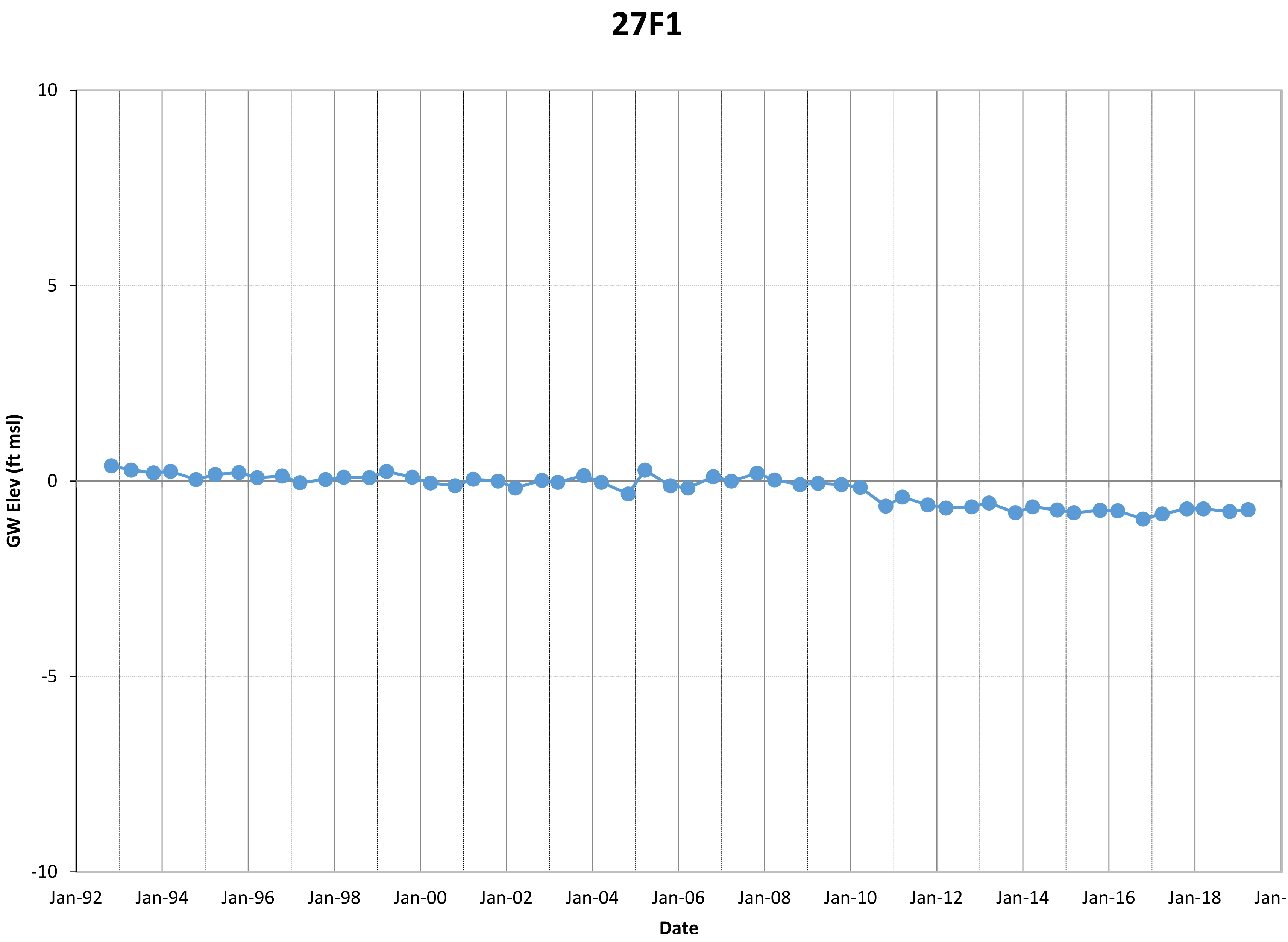

27F1
10
5
0
-5
-10
GW Elev (ft msl)
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
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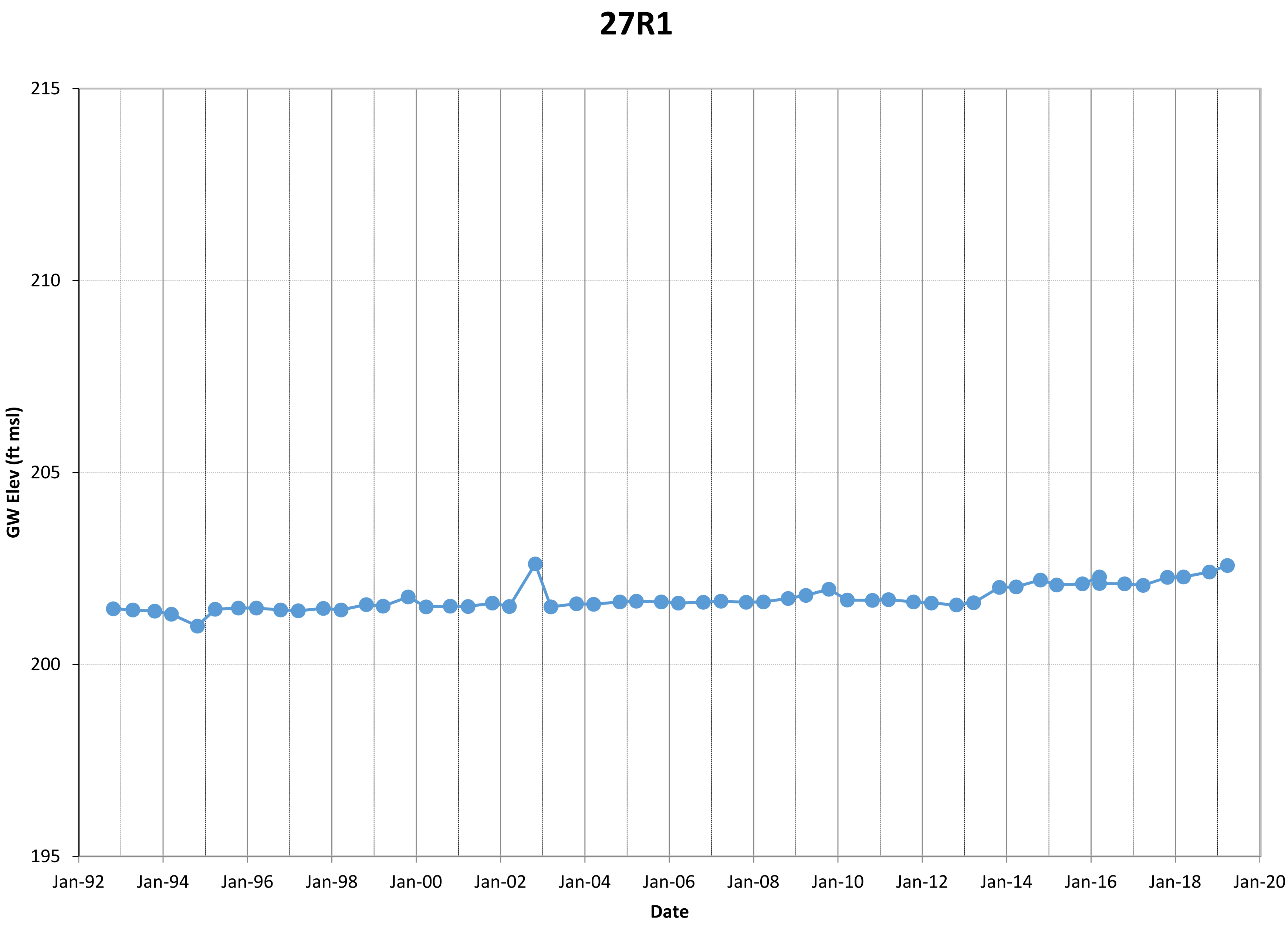
27R1
GW Elev (ft msl)
215
210
205
200
195
Jan-92
Jan-94
Jan-96
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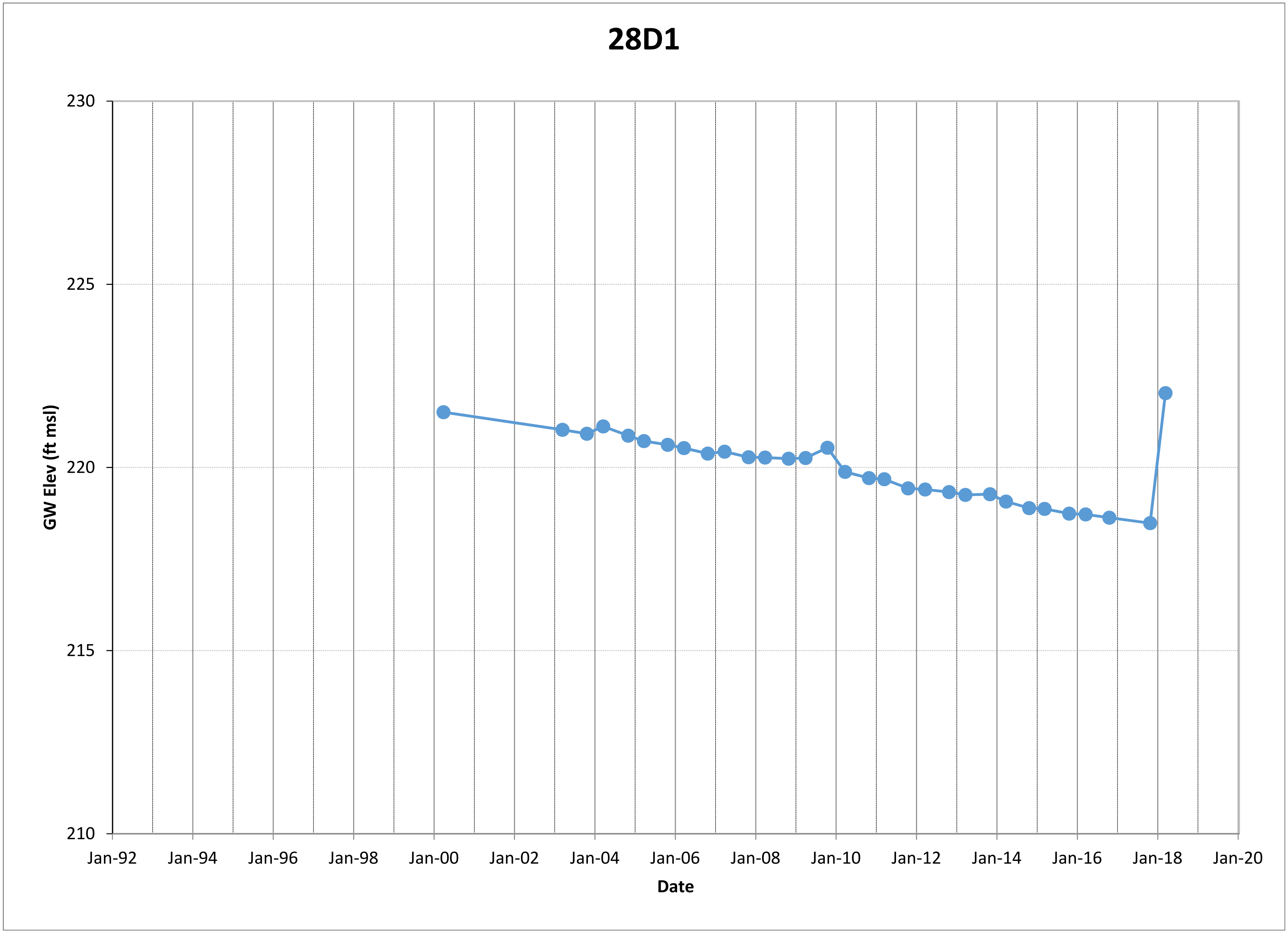
28D1
GW Elev (ft msl)
230
225
220
215
210
Jan-92
Jan-94
Jan-96
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Jan-00
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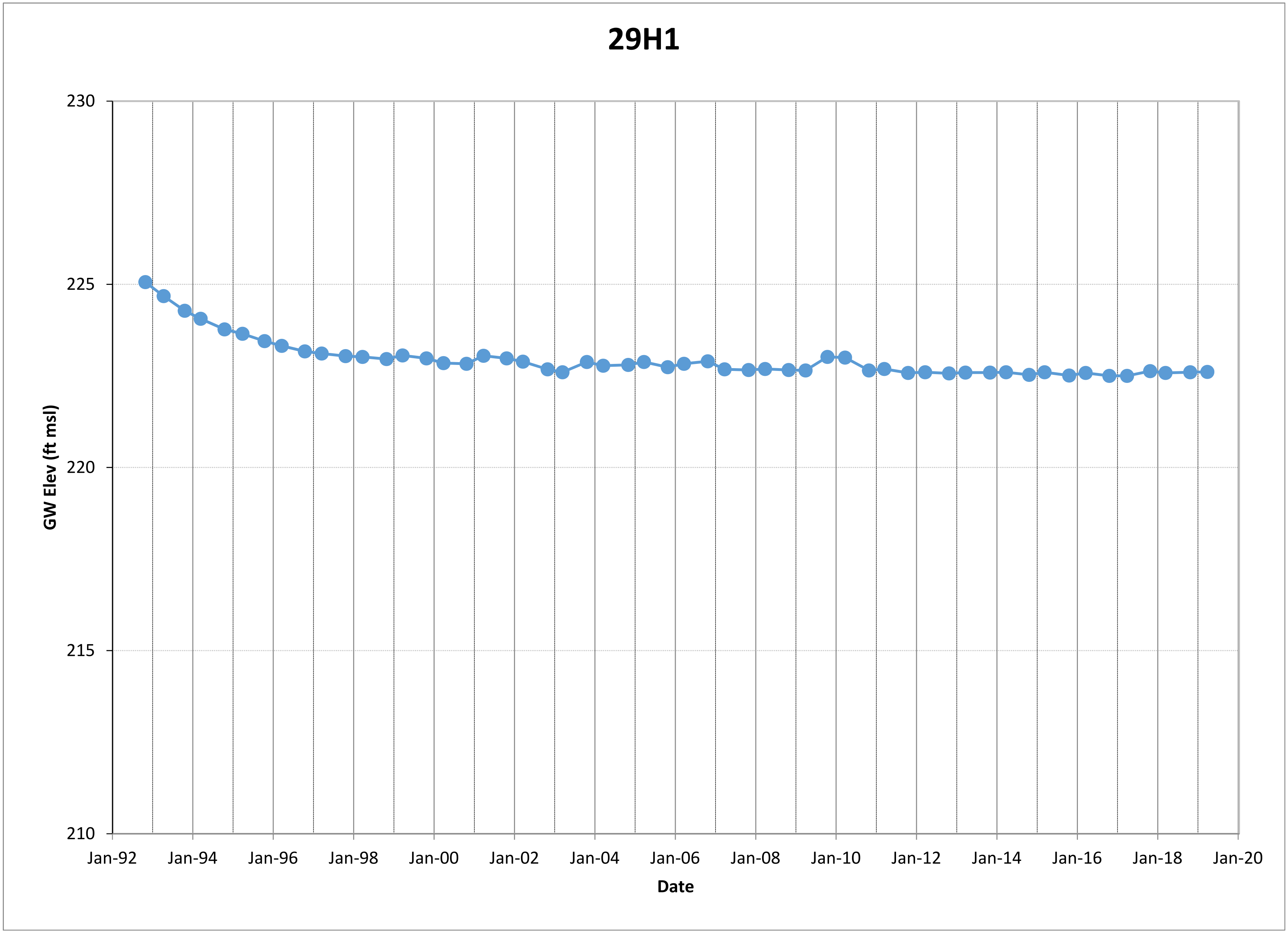
Date


29H1
GW Elev (ft msl)
230
225
220
215
210
Jan-92
Jan-94
Jan-96
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Jan-00
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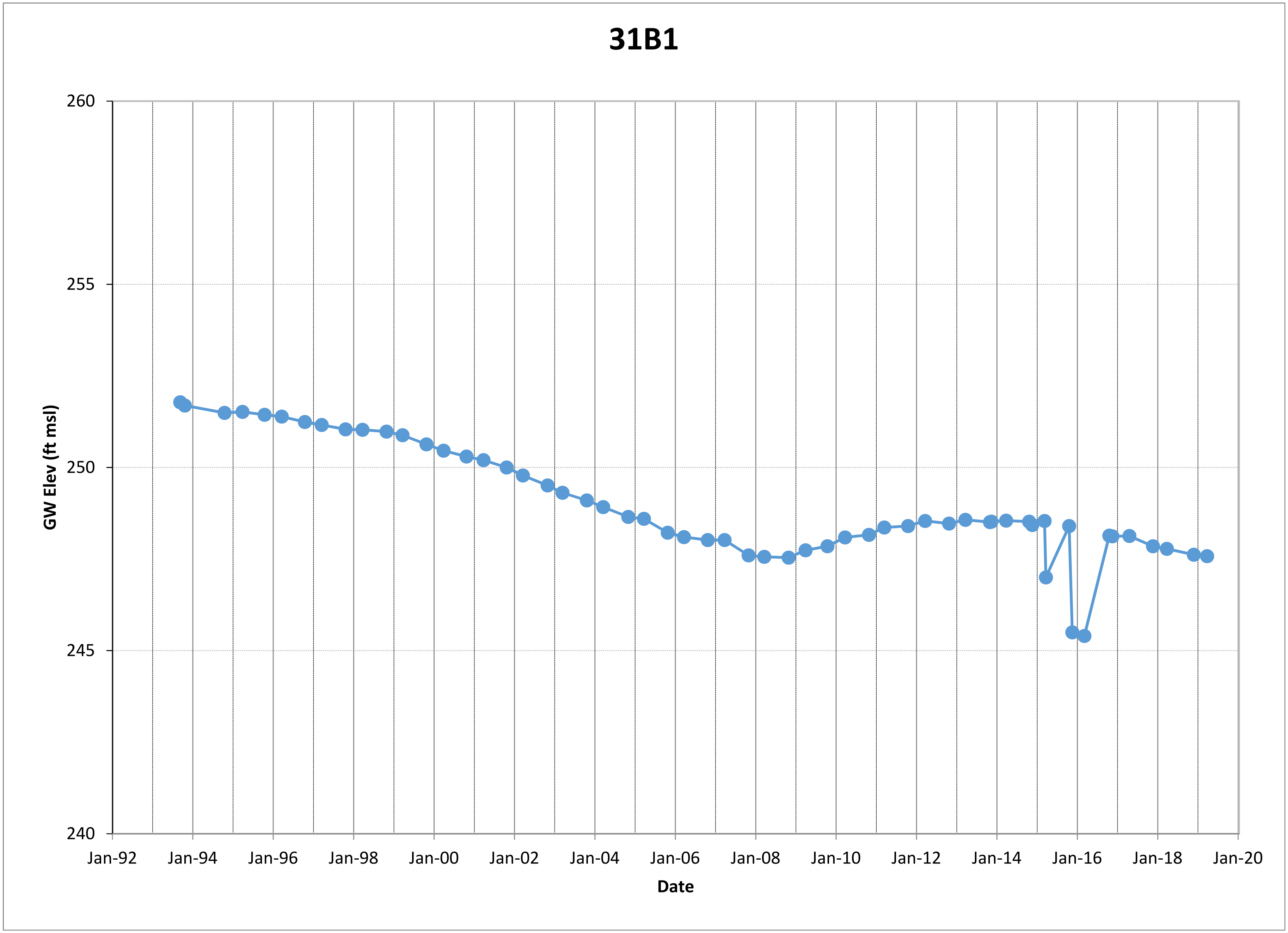
31B1
GW Elev (ft msl)
260
255
250
245
240
Jan-92
Jan-94
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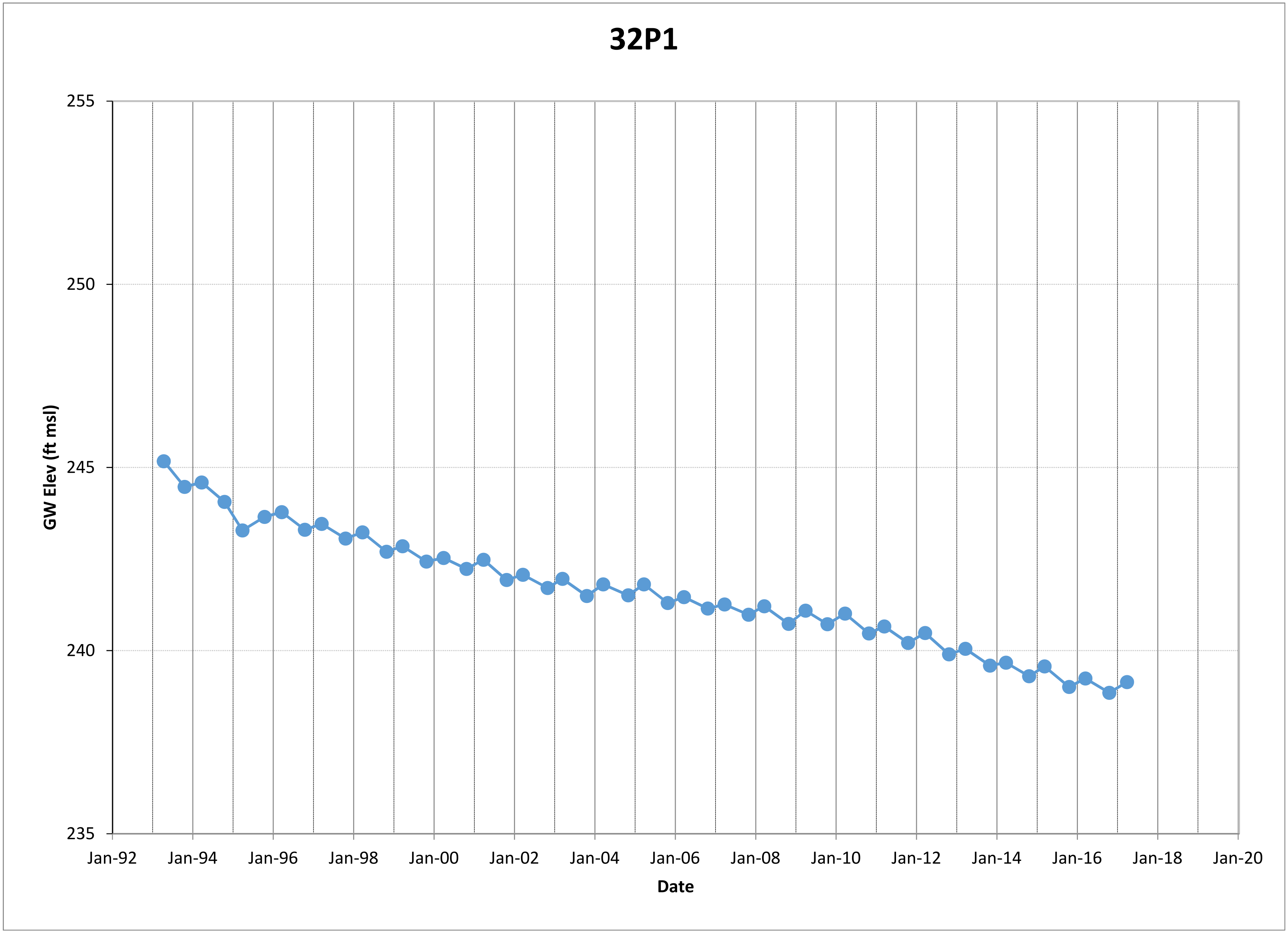
32P1
255
250
245
240
235
GW Elev (ft msl)
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
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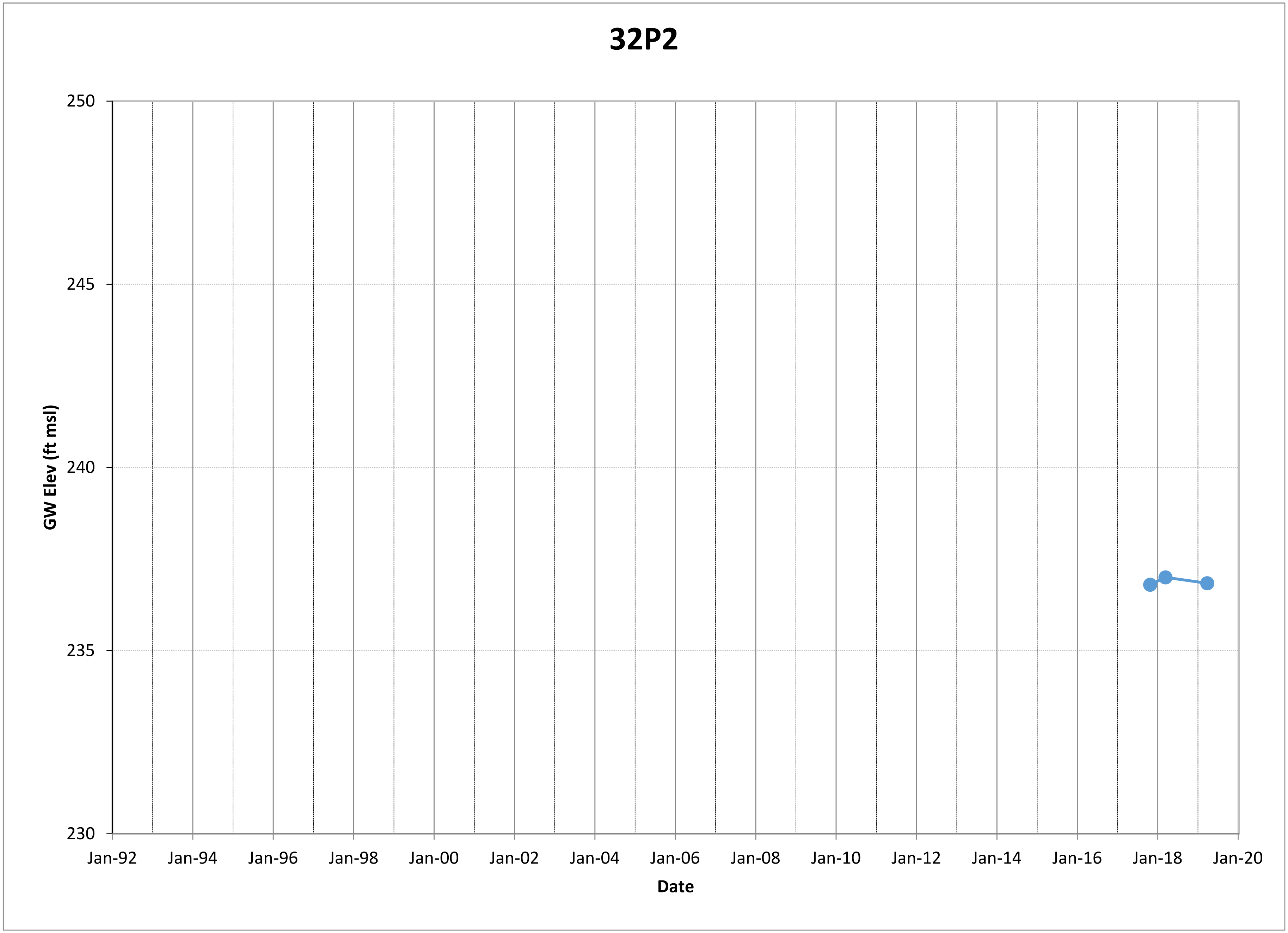
Date


32P2
GW Elev (ft msl)
250
245
240
235
230
Jan-92
Jan-94
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Jan-98
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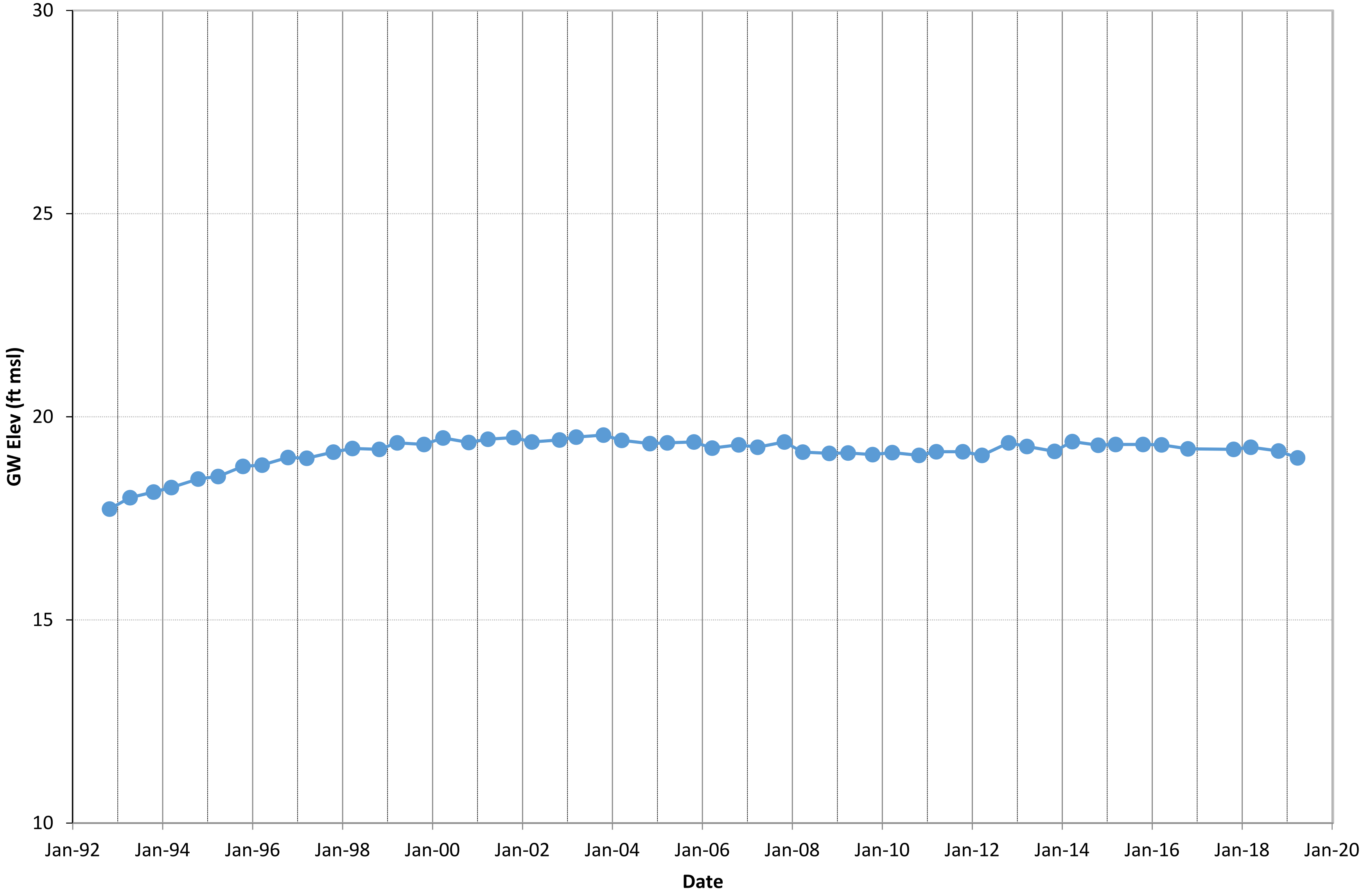
Jan-18
Jan-20
Date

32R1



GW Elev (ft msl)
30
25
20
15
10
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
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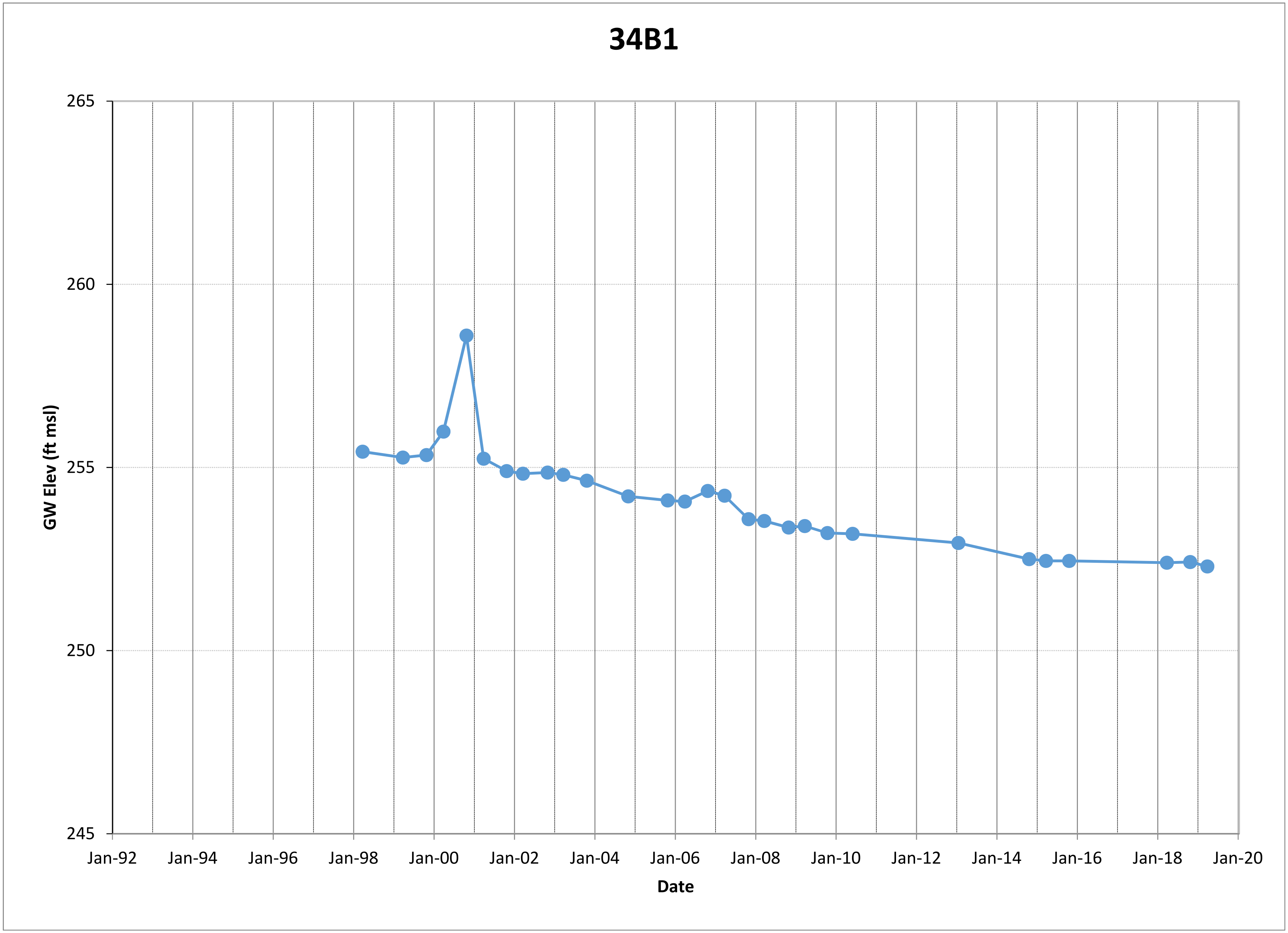
34B1
GW Elev (ft msl)
265
260
255
250
245
Jan-92
Jan-94
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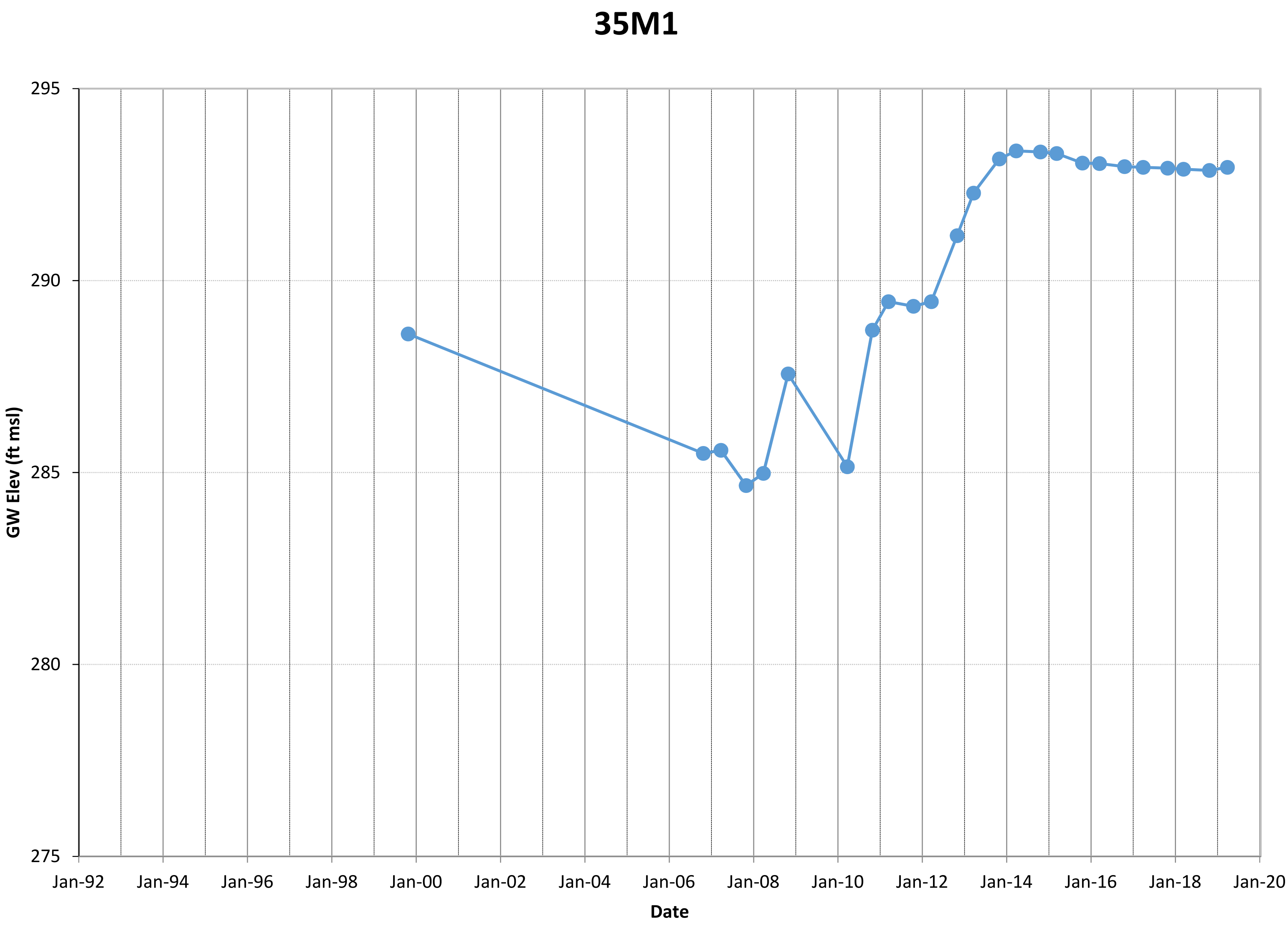
35M1
GW Elev (ft msl)
295
290
285
280
275
Jan-92
Jan-94
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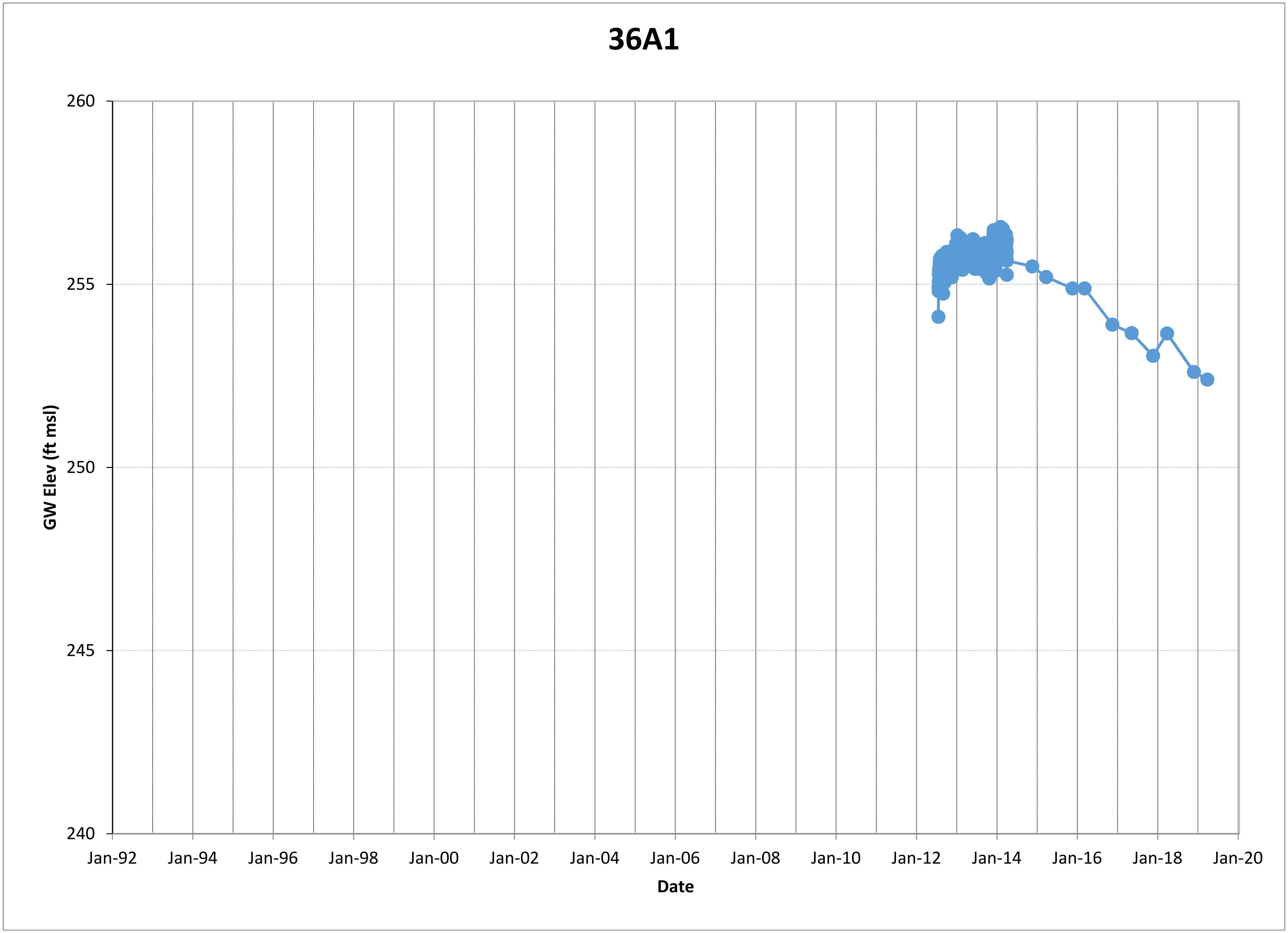
Date


36A1
GW Elev (ft msl)
260
255
250
245
240
Jan-92
Jan-94
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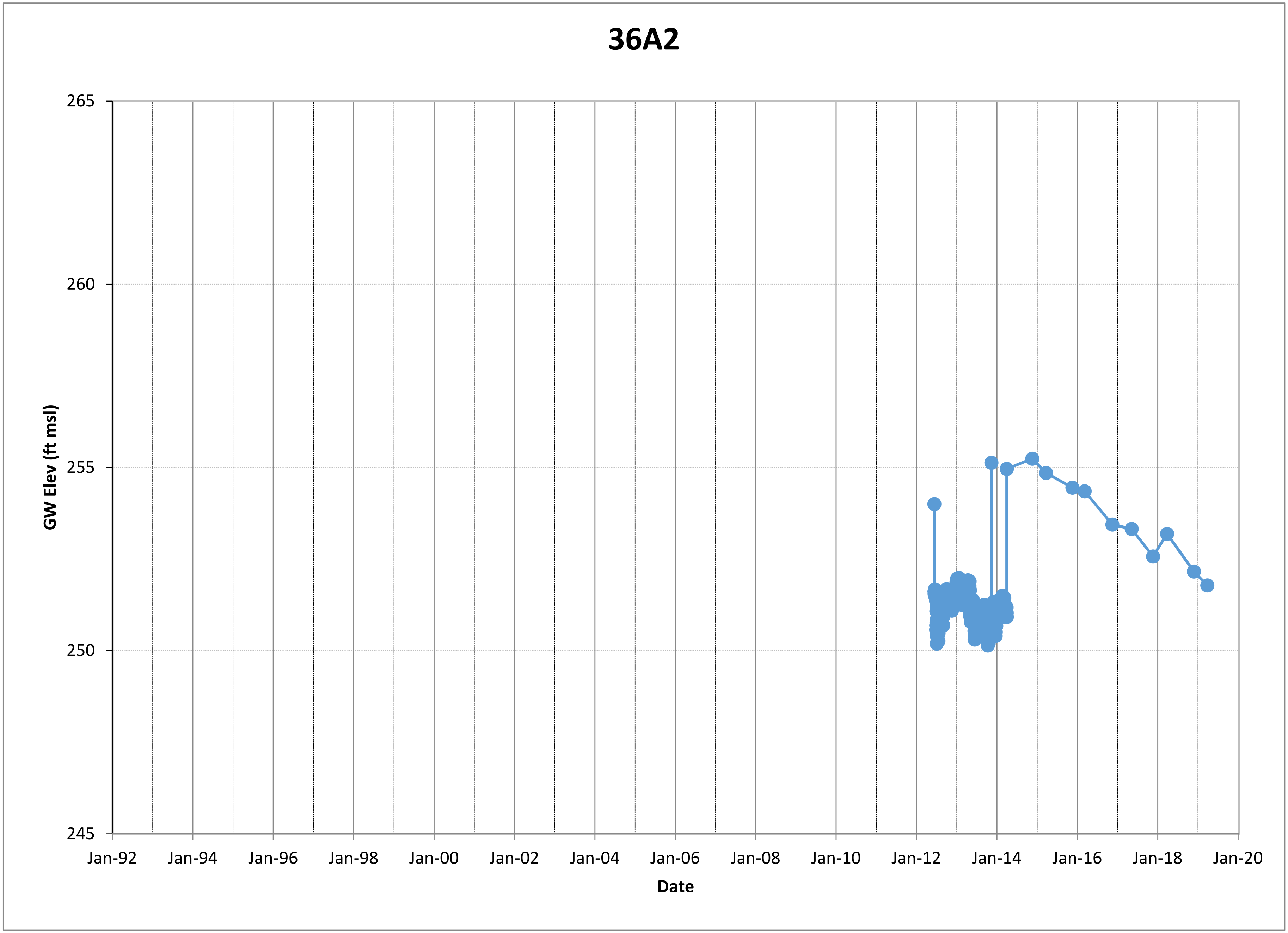
36A2
GW Elev (ft msl)
265
260
255
250
245
Jan-92
Jan-94
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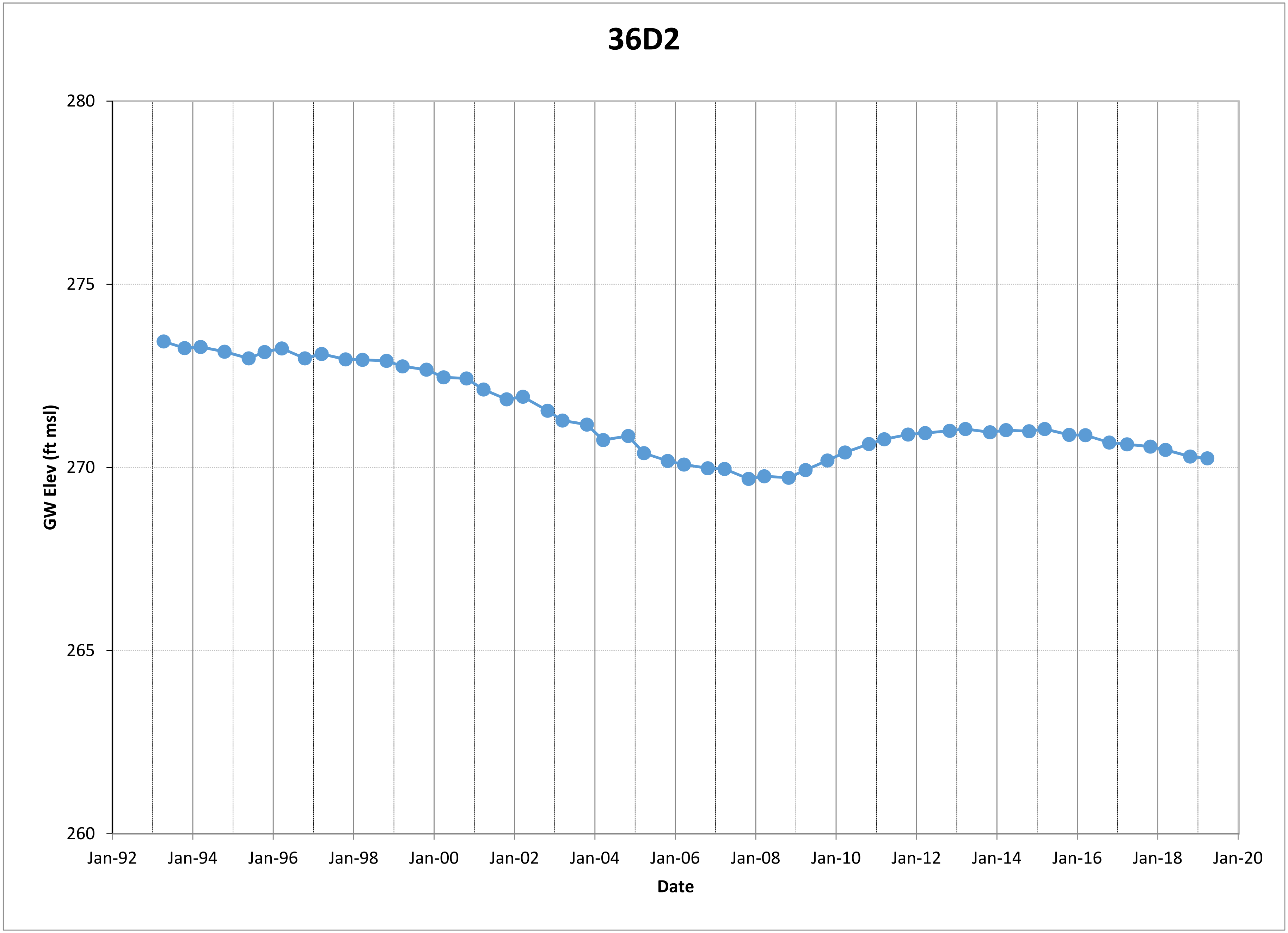
36D2
GW Elev (ft msl)
280
275
270
265
260
Jan-92
Jan-94
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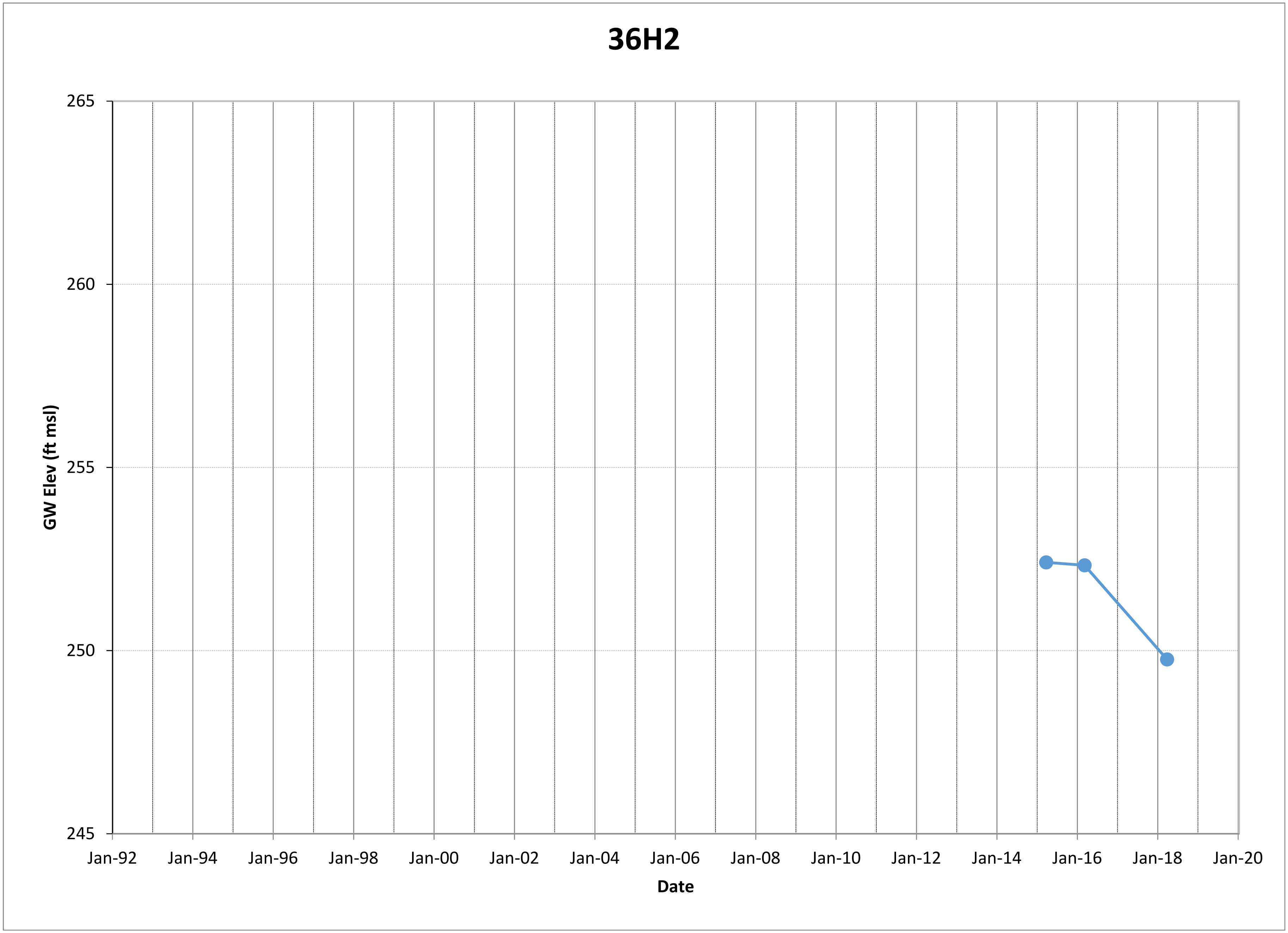
36H2
GW Elev (ft msl)
265
260
255
250
245
Jan-92
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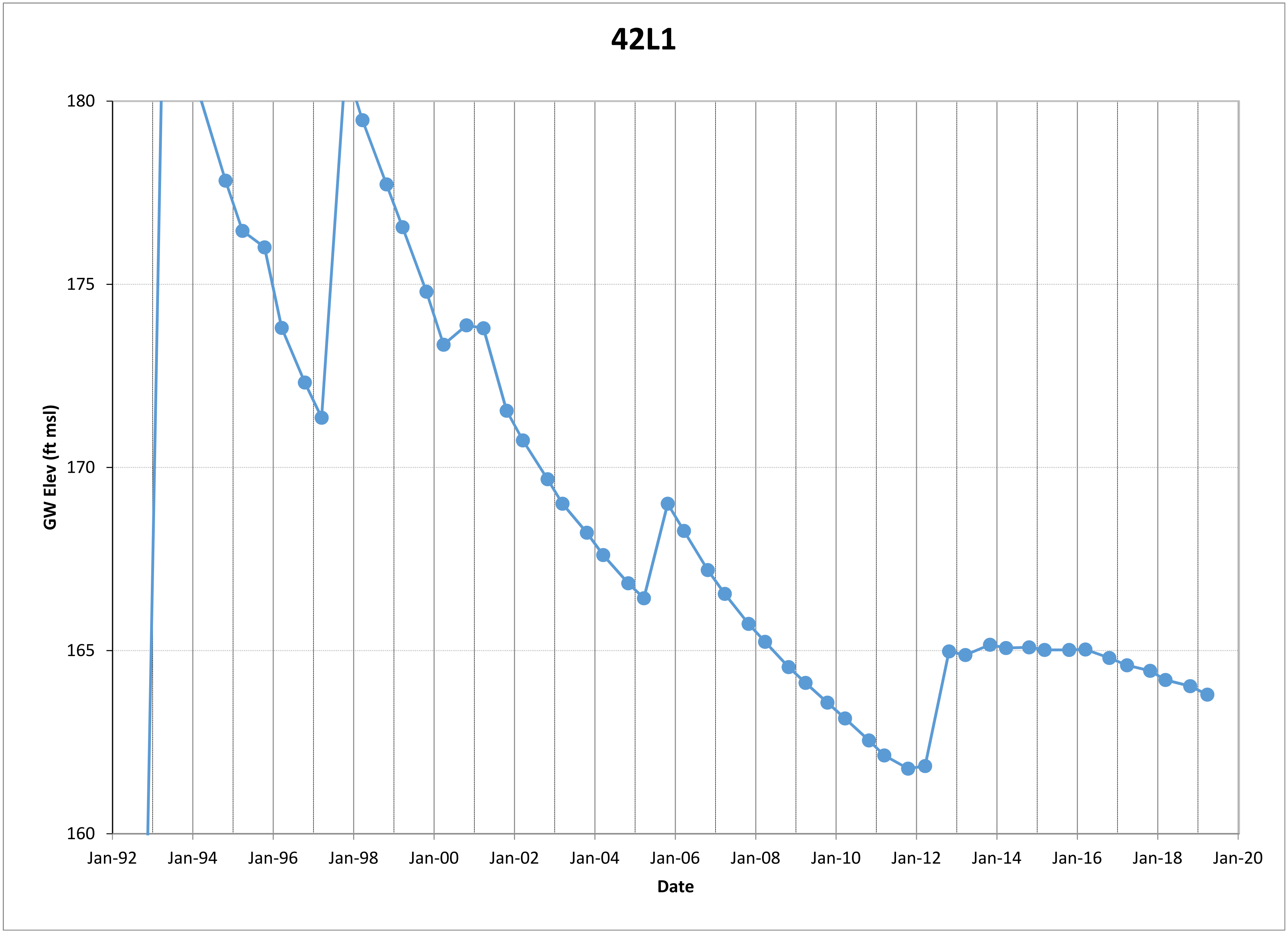
Jan-20
Date


42L1
GW Elev (ft msl)
180
175
170
165
160
Jan-92
Jan-94
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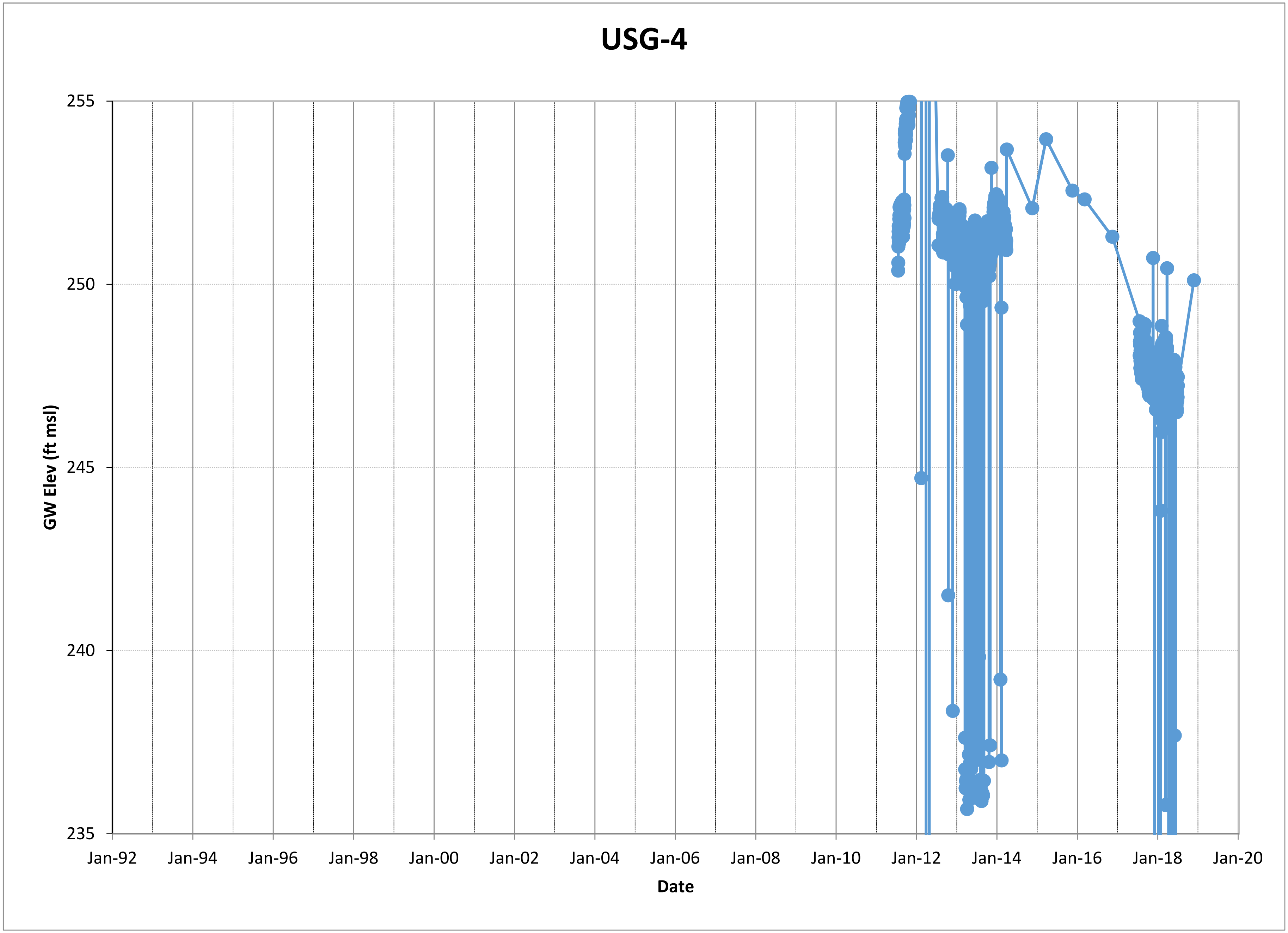
Date


USG-4
GW Elev (ft msl)
255
250
245
240
235
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
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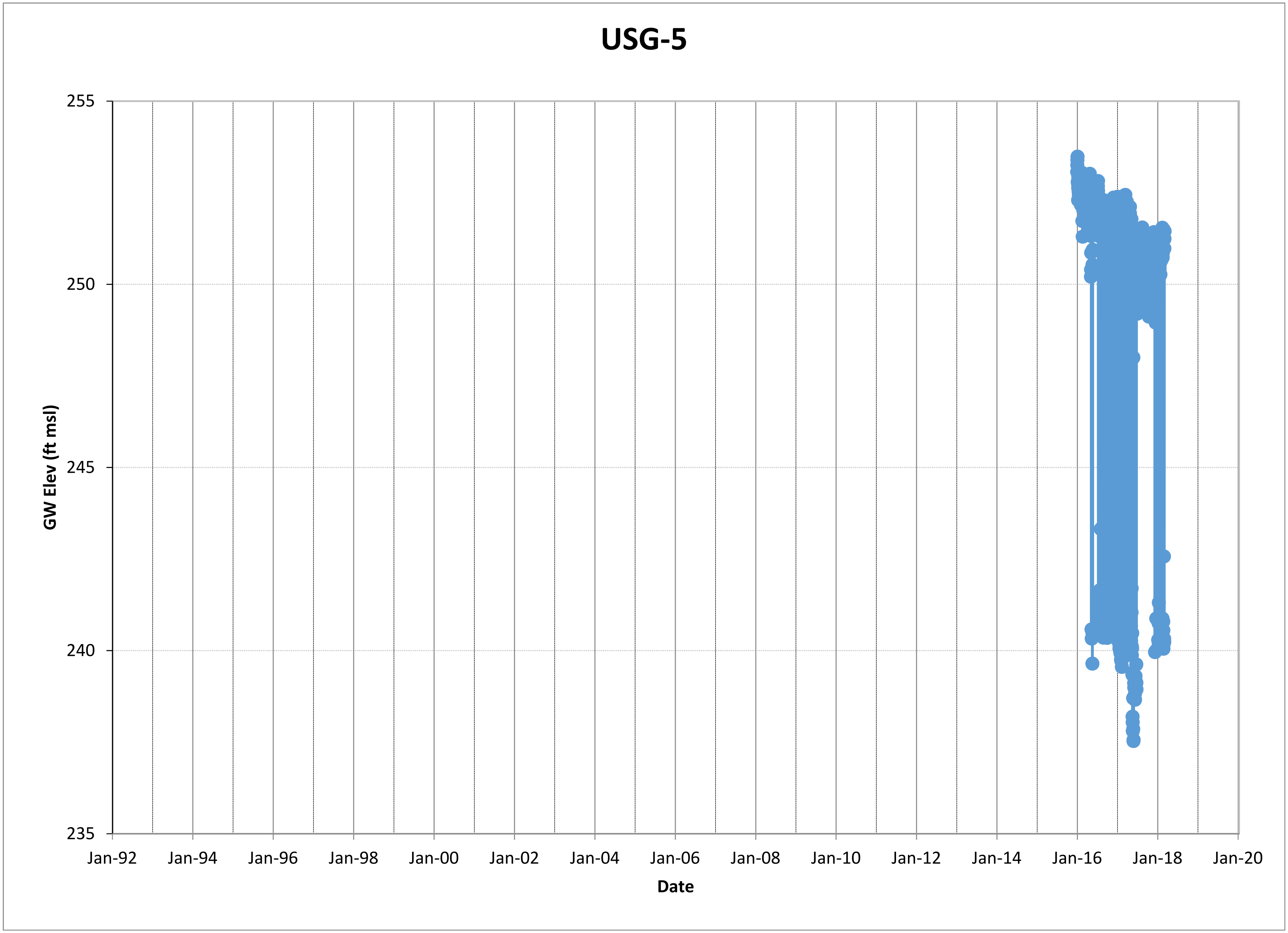
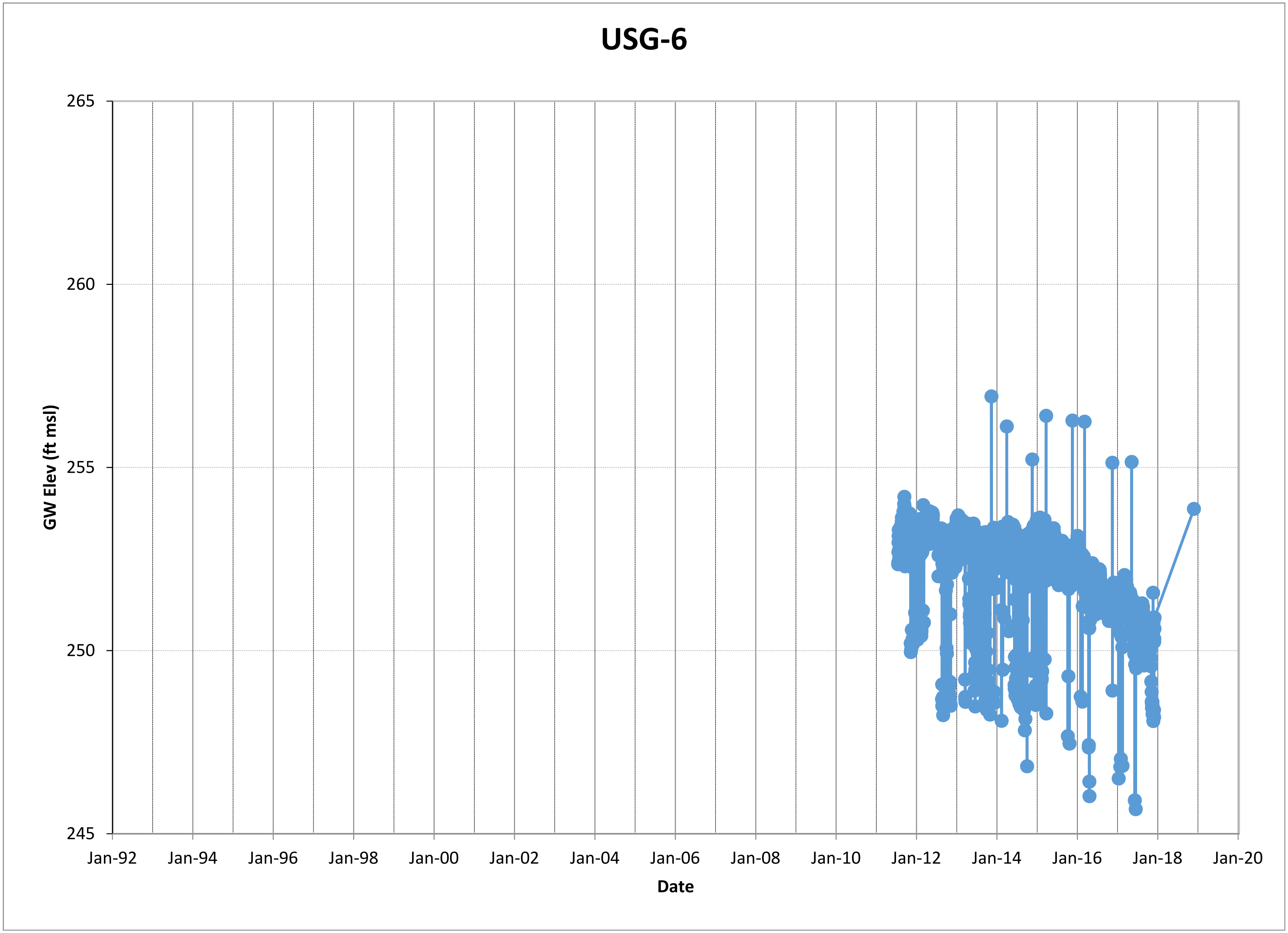
Jan-10
Jan-12
Jan-14
Jan-16
Jan-18
Jan-20
Date


USG-5
GW Elev (ft msl)
255
250
245
240
235
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16
Jan-18
Jan-20
Date


USG-6
GW Elev (ft msl)
265
260
255
250
245
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Jan-16
Jan-18
Jan-20
Date

APPENDIX C

WATER QUALITY RESULTS AND STATISTICAL ANALYSES

Table C-1. Alkalinity results and upper confidence interval test (mg/L)

Date	Chem	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Alkalinity	122	173	101	126			131				109			131	157	107		218		
spring-10	Alkalinity	112	177	98.1	118			114				108			128	148	102		217		
spring-11	Alkalinity	124	177	98.9	121			114				107			128	150	102		234		
spring-12	Alkalinity	113	184	97.7				113				106			128		103		219		
spring-13	Alkalinity	126					127												208		
spring-14	Alkalinity	124	180	98.6	121		126	113	108			105	98.3	116	128		99.6		210	123	109
spring-15	Alkalinity	122	203	98	117		126	111	108			103	98.2	118	127			99	206	132	109
spring-16	Alkalinity	124	201	99	120		126	112	109			105	98.6	120	128			102	205	123	112
spring-17	Alkalinity	121	193	97	117		130	115	115			103	98.4	121	127			103	194		110
spring-18	Alkalinity	123	192	89	119	127	124	111	108	132	172	103	97.9	121	128			104	192	119	
spring-19	Alkalinity	115	191	97.8	118	126	126	110	107	131	176	103	97.1	121	127			104	193	119	109
	Mean	120.5	187.1	97.5	119.7	126.5	126.4	114.4	109.2	131.5	174.0	105.2	98.1	119.5	128.0	151.7	102.7	102.4	208.7	123.2	109.8

Table C-2. Bicarbonate results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Bicarbonate	146	178	108	147			142				127			152	174	120		254		
spring-10	Bicarbonate	128	188	113	139			136				127			152	170	120		262		
spring-11	Bicarbonate	141	181	112	144			128				122			144	172	115		270		
spring-12	Bicarbonate	132	192	113				132				123			150		121		262		
spring-13	Bicarbonate	148					145												241		
spring-14	Bicarbonate	145	180	110	142		147	127	126			120	105	136	147		116		243	144	126
spring-15	Bicarbonate	136	226	108	136		151	128	124			120	111	139	153			116	234	155	128
spring-16	Bicarbonate	145	214	113	136		144	129	123			121	107	140	151			118	232	140	131
spring-17	Bicarbonate	144	206	107	127		148	129	115			122	104	139	149			121	230		128
spring-18	Bicarbonate	140	200	102	139	147	150	131	124	157	201	120	104	142	150			125	220	137	
spring-19	Bicarbonate	134	226	112	138	150	147	132	120	155	207	120	102	146	149			125	227	141	133
	Mean	139.9	199.1	109.8	138.7	148.5	147.4	131.4	122.0	156.0	204.0	122.2	105.5	140.3	149.7	172.0	118.4	121.0	243.2	143.4	129.2

Table C-3. Boron results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Boron	158	727	471	202			372				238			485	764	204		1360		
spring-10	Boron	176	766	430	208			374				256			358	475	191		1500		
spring-11	Boron	167	718	422	203			362				247			504	729	197		1610		
spring-12	Boron	166	761	421				347				262			499		192		1270		
spring-13	Boron	146					254												1010		
spring-14	Boron	166	763	423	204		276	378	231			266	188	234	501		200		1030	491	220
spring-15	Boron	176	818	402	240		286	342	229			258	210	282	454			229	864	500	249
spring-16	Boron	172	840	420	200		279	373	236			257	195	243	508			209	938	470	220
spring-17	Boron	176	865	428	211		284	396	231			279	200	261	519			219	864		236
spring-18	Boron	179	834	381	219	253	287	405	233	545	780	284	198	254	517			221	843	459	
spring-19	Boron	178	855	446	214	241	280	396	231	535	768	265	193	257	535			212	864	459	232
	Mean	169.1	794.7	424.4	211.2	247.0	278.0	374.5	231.8	540.0	774.0	261.2	197.3	255.2	488.0	656.0	196.8	218.0	1104.8	475.8	231.4

Table C-4. Calcium results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Calcium	18.7	3.62	12	23.3			36.1				8			18	7.36	18.4		36.3		
spring-10	Calcium	18.9	2.96	11.5	21.3			34.7				7.91			16.9	6.66	18.2		55.8		
spring-11	Calcium	19.4	2.87	11.6	22.1			37				7.2			17.7	7.12	19.4		60.7		
spring-12	Calcium	19.7	3.73	11.6				36.3				8.15			17.9		20.6		34.1		
spring-13	Calcium	18.7					19.9												22.7		
spring-14	Calcium	19.5	3.01	11.2	20.7		20.1	39.9	18.1			8.39	6.99	30.5	17.4		21.1		21.2	19.1	20.5
spring-15	Calcium	20.7	5.27	12.2	22.4		20.7	41.3	21.6			8.56	8.08	34.4	19.1			23.2	19.8	22.4	22.1
spring-16	Calcium	21.4	4.11	12.1	21		21.7	42.5	19.2			8.03	6.76	34.5	18.4			24.5	18.6	19.4	22.4
spring-17	Calcium	20.4	3.66	11.9	20.9		20.5	43.2	12.4			8.39	6.25	33.5	18			23.1	14.7		22.1
spring-18	Calcium	18.6	3.36	10.1	19.6	26.1	19.9	42.7	16.9	19.9	23.2	8.62	5.99	30.9	17.5			21.6	13.1	17.2	
spring-19	Calcium	19.9	3.97	11.3	19.9	27.7	21.2	44.6	14.8	20.5	23.9	8.61	5.48	33.1	17.9			22.2	13.5	17.9	22.4
	Mean	19.6	3.7	11.6	21.2	26.9	20.6	39.8	17.2	20.2	23.6	8.2	6.6	32.8	17.9	7.0	19.5	22.9	28.2	19.2	21.9

Table C-5. Carbonate results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Carbonate		11	3																	
spring-10	Carbonate	1.2	8.9	1.7	0.9			0.6				0.8			1.3	2.1	1.2		0.8		
spring-11	Carbonate	0.7	7.6	1.1	0.7			0.6				1.1			0.9	0.7	0.7		0.9		
spring-12	Carbonate	0.9	10.7	1.8								0.8			1		0.8		0.8		
spring-13	Carbonate	1					0.6												1.4		
spring-14	Carbonate	1	13.9	2.5	1		0.9	0.6	1.3			1.3	5.7	0.9	1.1		0.9		1.2	1.1	1
spring-15	Carbonate	0.9	7.2	1.7	0.8		0.8	0.6	0.6			0.9	3.1	0.5	1			0.6	1.2	0.8	0.7
spring-16	Carbonate	0.9	10.9	1.4	0.7		0.8	0.6	0.8			1	4	0.5	1.2			0.6	1.6	0.9	0.7
spring-17	Carbonate	0.8	7	1.6	0.5		0.6	0.5	4			0.7	5.1	0.6	0.9			0.7	1.4		0.8
spring-18	Carbonate	0.7	11	1.7	0.9	0.9	0.6	0.6	1.6	1.4	1.1	0.6	4.8	0.7	1.1			0.9	1.9	1.2	
spring-19	Carbonate	1.1	7.9	1.9	1.1	0.8	0.7	0.5	2.1	0.9	1.3	0.6	6.5	0.8	0.9			1	1.9	1.1	1.1
	Mean	0.9	9.6	1.8	0.8	0.9	0.7	0.6	1.7	1.2	1.2	0.9	4.9	0.7	1.0	1.4	0.9	0.8	1.3	1.0	0.9

Table C-6. Chloride results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Chloride	42.8	382	92.8	69.2			170				66.3			83.8	79.2	64.2		268		
spring-10	Chloride	60.9	393	96.6	62.5			179				68.5			84.6	82.9	66.9		393		
spring-11	Chloride	41.7	388	96.1	67			188				69.3			96.3	81.1	67.7		417		
spring-12	Chloride	60.6	392	95.9				181				69.1			85.4		71.8		262		
spring-13	Chloride	41.7					70.6												196		
spring-14	Chloride	43.7	403	93.6	58.2		70.3	191	56.2			70.8	57.8	115	82		76.6		183	85	66
spring-15	Chloride	46.9	398	92	58.1		71.7	189	63.6			72.2	59.9	109	83.4			86.7	149	97.8	68.2
spring-16	Chloride	44.1	394	92.7	58.3		71.7	198	58.2			71.5	59.5	108	82.5			82.3	152	83	68.2
spring-17	Chloride	47.8	408	94.8	56.9		70.7	206	57.4			70.7	58.5	118	81.7			76.9	130		67.3
spring-18	Chloride	44.7	410	84	57.2	81.3	71.1	202	56.4	116	168	71.9	58.4	115	82.1			74.7	116	78.8	
spring-19	Chloride	57.4	404	93.4	57.3	85.3	73.7	178	57.2	115	169	72.3	58.3	117	82.7			74.4	107	78.8	66.3
	Mean	48.4	397.2	93.2	60.5	83.3	71.4	188.2	58.2	115.5	168.5	70.3	58.7	113.7	84.5	81.1	69.4	79.0	215.7	84.7	67.2

Table C-7. Specific conductance results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Specific conductance	491.5	2120	840	624			920.5				518.5			613.5	608.5	505.5		1575		
spring-10	Specific conductance	537	2110	828	520.5			894.5				510.5			598.5	597.5	501.5		1960		
spring-11	Specific conductance	475.5	2090	833.5	553			890.5				491.5			603	596	493.5		2110		
spring-12	Specific conductance	537	2135	825				887.5				504			604		526.5		1480		
spring-13	Specific conductance	504.5					590												1290		
spring-14	Specific conductance	474	2210	819.5	501.5		589.5	937	462			502.5	477.5	689	597.5		530		1190	621.5	519.5
spring-15	Specific conductance	494.5	2350	841.5	510		595	969.5	493			519	485	697	600			571.5	1150	682.5	515.5
spring-16	Specific conductance	483.5	2330	836.5	508		593.5	979.5	472.5			510	488	710.5	604.5			569	1105	603	521
spring-17	Specific conductance	542.5	2275	828.5	508		594.5	999.5	470			519.5	488.5	717.5	602.5			560.5	979		524.5
spring-18	Specific conductance	499.5	2200	718.5	494	599.5	596	1015	465.5	771	1045	519.5	482.5	699.5	604.5			542	944	585	
spring-19	Specific conductance	514	2265	842	505.5	634	609	1025	462.5	782	1055	526.5	488.5	718.5	611			550.5	949.5	591	517.5
	Mean	504.9	2208.5	821.3	524.9	616.8	595.4	951.9	470.9	776.5	1050.0	512.2	485.0	705.3	603.9	600.7	511.4	558.7	1339.3	616.6	519.6

Table C-8. Fluoride results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Fluoride	0.49	1.56	0.93	0.75			0.87				1.72			1.61	2.77	0.63		1.52		
spring-10	Fluoride	0.56	1.69	0.98	0.82			0.85				1.78			1.69	2.93	0.67		1.53		
spring-11	Fluoride	0.52	1.59	0.98	0.79			0.83				1.69			1.61	2.81	0.67		1.43		
spring-12	Fluoride	0.52	1.59	0.98				0.81				1.71			1.61		0.65		1.67		
spring-13	Fluoride	0.45					0.85												1.8		
spring-14	Fluoride	0.53	1.61	1.02	0.78		0.91	0.87	0.77			1.89	0.75	0.68	1.7		0.64		2.28	1.3	0.74
spring-15	Fluoride	0.48	1.48	0.94	0.72		0.9	0.76	0.73			2	0.69	0.6	1.77			0.63	1.91	1.27	0.7
spring-16	Fluoride	0.52	1.48	0.97	0.74		0.89	0.78	0.76			1.88	0.73	0.6	1.79			0.66	2.25	1.29	0.74
spring-17	Fluoride	0.47	1.51	0.97	0.72		0.85	0.77	0.67			1.8	0.69	0.61	1.71			0.62	2.36		0.71
spring-18	Fluoride	0.46	1.54	0.87	0.71	0.69	0.83	0.72	0.7	0.7	1.64	1.78	0.72	0.6	1.7			0.6	2.34	1.23	
spring-19	Fluoride	0.48	1.57	0.98	0.74	0.69	0.86	0.61	0.7	0.82	1.71	1.7	0.72	0.63	1.66			0.64	2.17	1.26	0.74
	Mean	0.5	1.6	1.0	0.8	0.7	0.9	0.8	0.7	0.8	1.7	1.8	0.7	0.6	1.7	2.8	0.7	0.6	1.9	1.3	0.7

Table C-9. Iron results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Iron	2.8	130	4.4	13.1			26.6				14.2			34.4	3.4	7.7		27.3		
spring-10	Iron	<6	<6	<6	17.3			79.1				27.6			4.5	<6	4		73.9		
spring-11	Iron	<3.2	14.7	<3.2	<3.2			49				101			8.3	<3.2	<3.2		119		
spring-12	Iron	<3.2	<6.4	<3.2				61.1				16.4			5.7		13.5		57.7		
spring-13	Iron	6.9					14.5												96.6		
spring-14	Iron	<4	<8	<4	9.8		13.3	57.8	31.1			24.4	<4	6.9	8.5		6.6		83.1	5.3	4.9
spring-15	Iron	42.3	9	<4	14.8		7.5	31.5	10.3			12.9	5.7	13.2	10.2			32.7	43.2	4.4	10
spring-16	Iron	6.2	<8	<4	15.9		<8	66.5	12.3			53.7	<4	190	<8			5	22	<4	<4
spring-17	Iron	6.6	12.2	<5	17		<5	42.2	71.7			11.6	<5	5	<5			17.4	65		5.3
spring-18	Iron	<5	<10	<5	21.5	<5	<5	73	75	118	14.3	23.4	<5	<5	<5			12.4	87.1	<5	
spring-19	Iron	<10	<20	<10	12.1	<10	<10	48.4	176	18.2	<10	19.5	<10	10.8	<10			<10	61.5	<10	<10
	Mean	13.0	41.5	4.4	15.2	#DIV/0!	11.8	53.5	62.7	68.1	14.3	30.5	5.7	45.2	11.9	3.4	8.0	16.9	66.9	4.9	6.7

Table C-10. Magnesium results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Magnesium	4.16	1.59	3.84	5.58			11				1.51			3.17	4.41	3.98		13.4		
spring-10	Magnesium	3.67	1.31	3.36	4.56			11.2				1.51			2.76	1.24	3.5		21		
spring-11	Magnesium	4.2	1.28	3.7	5			12				1.46			3.07	1.39	3.98		22.8		
spring-12	Magnesium	4.27	1.57	3.72				11.7				1.65			3.16		4.27		12.3		
spring-13	Magnesium	4.27					3.85												8.63		
spring-14	Magnesium	4.31	1.38	3.69	4.7		4.19	12.8	4.84			1.66	0.621	7.65	3.12		4.39		7.6	3.46	3.95
spring-15	Magnesium	4.55	2.04	3.8	5.16		4.17	13	5.25			1.68	0.797	8.2	3.7			4.61	7.03	4.06	4.15
spring-16	Magnesium	4.38	1.78	3.65	4.92		4.2	13	4.99			1.61	0.575	8.01	3.15			4.57	6.26	3.28	4.17
spring-17	Magnesium	4.2	1.7	3.53	4.66		4.05	13.2	3.55			1.64	0.506	7.79	2.97			4.28	5.01		3.91
spring-18	Magnesium	4.05	1.77	3.13	4.54	5.17	3.81	14.6	4.55	5.1	7.21	1.66	0.46	7.9	2.98			4.3	4.82	3.07	
spring-19	Magnesium	3.92	1.9	3.52	4.37	5.29	4.13	14.3	4.21	4.86	6.96	1.66	0.408	7.77	2.9			4.24	4.54	3.07	4.1
	Mean	4.2	1.6	3.6	4.8	5.2	4.1	12.7	4.6	5.0	7.1	1.6	0.6	7.9	3.1	2.3	4.0	4.4	10.3	3.4	4.1

Table C-11. pH results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	pH	8	8.8	8.3	7.8			7.7				8.1			8	8.1	8		7.7		
spring-10	pH	8.1	8.8	8.3	8			7.8				8			8.1	8.2	8.2		7.6		
spring-11	pH	7.9	8.8	8.3	7.9			7.8				8.2			8	8.1	8		7.6		
spring-12	pH	8	8.8	8.4				7.9				8			8		8		7.6		
spring-13	pH	8					7.9												7.9		
spring-14	pH	8.1	9	8.6	8.1		8	7.9	8.3			8.2	9	8	8.1		8.1		7.9	8.1	8.1
spring-15	pH	8	8.6	8.4	8		7.9	7.8	7.9			7.9	8.6	7.7	8			7.9	7.8	7.9	7.9
spring-16	pH	8.1	8.8	8.5	8.2		7.8	7.8	8.2			8.3	8.7	7.8	8			8	7.9	8	8
spring-17	pH	8	8.6	8.4	7.8		7.8	7.8	8.7			8	9	7.9	8			8.1	8		8.1
spring-18	pH	7.9	8.8	8.4	8	8	7.8	7.8	8.3	8.2	7.9	7.9	8.8	8	8.1			8	8.1	8.1	
spring-19	pH	8.1	8.7	8.4	8.2	7.9	7.9	7.8	8.4	8	7.8	8	8.9	7.8	8.2			8.1	8.1	8.1	8.2
	Mean	8.0	8.8	8.4	8.0	8.0	7.9	7.8	8.3	8.1	7.9	8.1	8.8	7.9	8.1	8.1	8.1	8.0	7.8	8.0	8.1

Table C-12. Potassium results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Potassium	3.97	2.7	4.02	4.87			4.87				3.28			4.18	2.53	4.44		4.58		
spring-10	Potassium	3.98	2.63	3.85	4.67			4.77				3.38			3.98	2.36	4.21		5.28		
spring-11	Potassium	3.74	2.74	3.68	4.48			5.07				3.22			3.92	2.42	4.17		5.49		
spring-12	Potassium	3.96	2.44	3.59				4.89				3.16			3.97		4.35		4.2		
spring-13	Potassium	3.9					4.59												3.47		
spring-14	Potassium	3.96	2.68	3.76	4.51		4.58	5.06	4.06			3.29	2.05	5.82	3.91		4.46		3.46	3.92	4.44
spring-15	Potassium	4.08	3.11	3.81	4.73		4.82	5.26	4.27			3.62	2.19	6.16	4.14			4.7	3.56	4.37	4.78
spring-16	Potassium	4.22	3.19	3.89	4.82		5.07	5.52	4.25			3.58	1.89	6.06	4.19			4.72	3.51	4.01	4.81
spring-17	Potassium	3.92	2.87	3.72	4.48		4.82	5.27	3.85			3.41	1.67	5.82	3.97			4.32	3.12		4.57
spring-18	Potassium	4.03	3.5	3.39	4.57	5.26	4.62	5.53	4.19	4.07	3.87	3.61	1.69	5.94	4.08			4.46	3.24	4.09	
spring-19	Potassium	3.78	2.76	3.68	4.51	5.28	4.83	5.29	3.91	3.9	3.62	3.45	1.55	5.83	3.95			4.31	2.92	3.83	4.79
	Mean	4.0	2.9	3.7	4.6	5.3	4.8	5.2	4.1	4.0	3.7	3.4	1.8	5.9	4.0	2.4	4.3	4.5	3.9	4.0	4.7

Table C-13. Sodium results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Sodium	75	434	153	80.5			122				88.5			99.5	119	75.7		265		
spring-10	Sodium	77	408	136	68.4			106				83.9			90.4	104	73.2		276		
spring-11	Sodium	72.3	438	151	80.4			124				90			99.9	118	73.9		335		
spring-12	Sodium	84.9	426	142				118				89.5			99.5		79.7		247		
spring-13	Sodium	71.3					94.2												218		
spring-14	Sodium	75.5	448	152	77.2		93.9	130	67.5			97	95.1	90.9	102		78.1		221	100	73.7
spring-15	Sodium	79.9	498	155	83.5		94.8	131	69.8			96.3	99.4	103	110			88.3	227	114	81.1
spring-16	Sodium	83.4	474	156	77.9		102	130	70.8			95	96.2	98.1	104			88	210	102	78.9
spring-17	Sodium	73.8	444	144	71.1		94.4	130	74.9			93.6	91.7	94.4	98.6			79.1	183		74.2
spring-18	Sodium	76.2	470	135	74.9	87.3	94.2	133	72.6	133	187	96.6	95.3	94	104			81.8	182	97.7	
spring-19	Sodium	80.9	453	148	74.4	87.8	93.9	131	70.9	126	180	94.1	92.3	94.4	101			79.2	178	96.6	78.8
	Mean	77.3	449.3	147.2	76.5	87.6	95.3	125.5	71.1	129.5	183.5	92.5	95.0	95.8	100.9	113.7	76.1	83.3	231.1	102.1	77.3

Table C-14. Sulfate results and upper confidence interval test (mg/L)

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	Sulfate	49.8	261	149	40.5			47.4				21.9			32.9	20.8	34.3		144		
spring-10	Sulfate	58.5	273	154	38.7			44.8				21.4			33.3	20.4	34.3		171		
spring-11	Sulfate	48.6	266	151	37.6			44.2				20.5			151	19.8	34		189		
spring-12	Sulfate	55.4	260	147				42.8				20.3			31.6		33.5		146		
spring-13	Sulfate	49.5					49.1												120		
spring-14	Sulfate	51.5	306	154	35.1		50.1	46.9	30.4			21.7	35.8	43.9	34.5		36.3		119	40.2	30
spring-15	Sulfate	52.5	306	146	41.2		50	45.2	31.8			21.4	36.2	42.4	34.5			36.1	100	42.2	29.9
spring-16	Sulfate	52	300	147	39.4		50.1	47.2	30.2			21	36.5	40.3	34.6			37.1	108	38	29.8
spring-17	Sulfate	52.6	301	150	39.6		48.7	48.1	24.6			20.9	35.5	44.6	33.8			37.1	96.7		29.5
spring-18	Sulfate	51.8	297	133	37.5	33.8	49.1	46.2	28.4	64.3	80.6	21.1	35.8	44.1	34.2			37	89.5	36.3	
spring-19	Sulfate	58.1	293	148	38.7	34.5	50.2	39.9	27.3	64.8	83.1	21.4	35.6	43.9	34.5			37	86	36.2	29.6
	Mean	52.8	286.3	147.9	38.7	34.2	49.6	45.3	28.8	64.6	81.9	21.2	35.9	43.2	45.5	20.3	34.5	36.9	124.5	38.6	29.8

Table C-15. Total Dissolved Solids (mg/L)

#VALUE!

Season-Yr	Simple_Name	11H3	24B1	24D1	25K2	25M2	26F1	30R1	31B1	32N01S	32P03S	34B1	36A1	36A2	36C2	36D3	36H1	36H2	42A8	USG-4	USG-6
spring-09	TDS	287	1230	508	338			523				310			359	364	307		943		
spring-10	TDS	322	1260	492	322			516				310			363	349	299		1170		
spring-11	TDS	278	1240	490	325			506				284			350	357	289		1240		
spring-12	TDS	320	1260	484				502				295			355		309		891		
spring-13	TDS	276					375												747		
spring-14	TDS	285	1320	502	310		361	552	284			321	312	409	363		338		731	388	318
spring-15	TDS	283	1390	489	303		342	553	291			308	296	409	359			334	674	406	302
spring-16	TDS	280	1350	484	291		356	559	271			303	298	399	362			334	654	362	309
spring-17	TDS	298	1350	495	323		347.5	567	283			300	303	412	357			328	594		314
spring-18	TDS	288	1310	439	304	352	342	565	274	469	612	305	291	396	350			323	564	343	
spring-19	TDS	322	1310	503	309	373	365	583	273	477	621	322	307	423	368			331	575	361	317
	Mean	294.5	1302.0	488.6	313.9	362.5	355.5	542.6	279.3	473.0	616.5	305.8	301.2	408.0	358.6	356.7	308.4	330.0	798.5	372.0	312.0
	20% of mean	58.9	260.4	97.7	62.8	72.5	71.1	108.5	55.9	94.6	123.3	61.2	60.2	81.6	71.7	71.3	61.7	66.0	159.7	74.4	62.4
	years exceeding mean +20%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
																			353.3		
		-27.5	-8.0	-14.4	4.9	-10.5	-9.5	-40.4	6.3	-4.0	-4.5	-16.2	-5.8	-15.0	-9.4	356.7	308.4	-1.0	223.5	11.0	-5.0
		-9%	-1%	-3%	2%	-3%	-3%	-7%	2%	-1%	-1%	-5%	-2%	-4%	-3%	100%	100%	0%	28%	3%	-2%