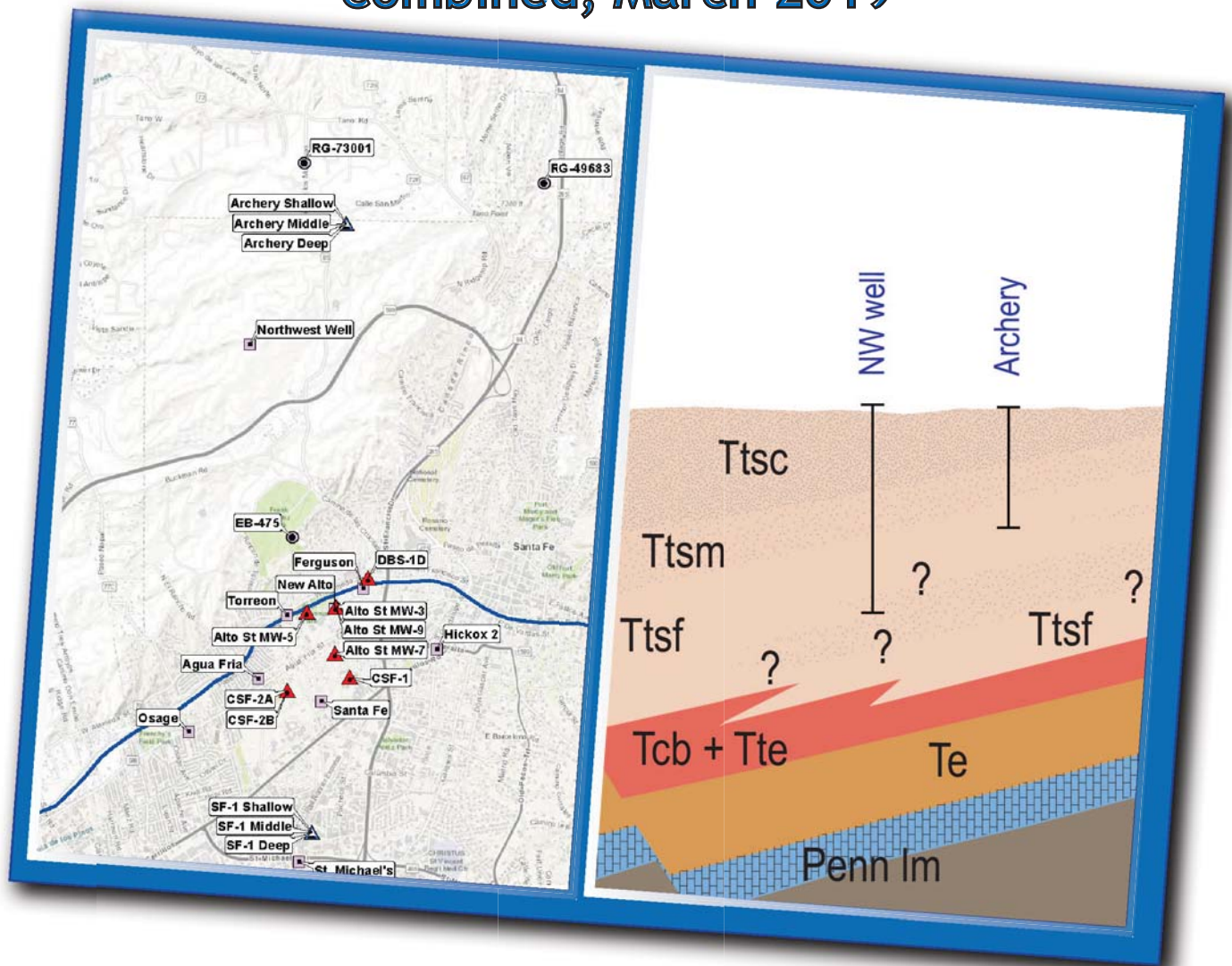


NORTHWEST WELL AND CITY WELL FIELD

GROUNDWATER MONITORING REPORT

RG-68302, RG-81092, and RG-1113 thru RG-1118
Combined, March 2019



prepared by



JOHN SHOMAKER & ASSOCIATES, INC.

prepared for



City of Santa Fe
Water Division

and



NMOSE
District VI Office

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MARCH 2019**

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District VI Office

Santa Fe, New Mexico

March 29, 2019



**NORTHWEST WELL AND CITY WELL FIELD GROUNDWATER MONITORING REPORT
RG-68302, RG-81092, AND RG-1113 THRU RG-1118 COMBINED
MARCH 2019**

EXECUTIVE SUMMARY

The Northwest Well and City Well Field monitoring program document titled *Exhibit 1: Northwest Well and City Well Field Groundwater Monitoring and Reporting Plan*, was adopted by all parties in 2018, as part of New Mexico Office of the State Engineer (NMOSE) Permit RG-68302, RG-81092, and RG-1113 thru RG-1118 Combined issued in 2018. The monitoring report includes the following:

1. Data tables and hydrographs (Appendices A through E) for wells within the monitoring program (Fig. 1), and monthly pumping data for the City of Santa Fe wells within the City.
2. An updated version of the potentiometric surface map of the monitoring program area representing 2014 conditions (Fig. 2), addressing comments provided by the parties.
3. A potentiometric surface map representing current conditions (Fig. 3) and a map showing changes in the potentiometric surface between 2014 and present (Fig. 4).
4. Summary of data provided in the tables, hydrographs, and maps, any trends that may be related to pumping
5. The City's compliance with its permit conditions for the Northwest Well.

Data collection efforts were performed by the City of Santa Fe Water Division (Source of Supply), USGS, and John Shomaker & Associates, Inc. (JSAI). Data compilation and QA/QC was performed by JSAI. There are three periods of data collection: 1) data collected prior to Northwest Well (dating back to 1968), 2) data collected during the Northwest Well temporary permit and prior to the monitoring program (2000 to 2018), and 3) data collected as part of the monitoring program (2018 to current).

The groundwater-elevation contours representative of the regional aquifer in 2018 (current conditions) were prepared based on available data, and according to the Monitoring Plan (Fig. 3). No cone of depression is observed at the Northwest Well given the 50-ft contour intervals, reduced pumping, and regional area contoured. The 6,600-ft contour interval defines the remaining cone-of-depression caused by pumping the City Well Field.

Water-level decline rates in the Northwest Well area range from insignificant (RG-49683; Fig. A3) to 2 ft/yr at the Archery piezometers (Fig. D1). Equipping of the additional "Group A" wells is in progress, so that water-level trends in the Northwest Well area can be better evaluated.

This monitoring report fulfills the requirement in Section 5 of the Monitoring Plan that the first monitoring report be prepared no later than March 2019, and has been prepared according to the requirements set forth in Section 6 of the Monitoring Plan, including data tables, hydrographs, maps, and narrative.

Pumping in 2018 under the Northwest Well and City Well Field permit was within the limits specified in the permit conditions (Table 3).

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NORTHWEST WELL AND CITY WELL FIELD GROUNDWATER MONITORING REPORT RG-68302, RG-81092, AND RG-1113 THRU RG-1118 COMBINED MARCH 2019

1.0 INTRODUCTION

The Northwest Well and City Well Field monitoring program document titled *Exhibit 1: Northwest Well and City Well Field Groundwater Monitoring and Reporting Plan*, was adopted by all parties in 2018, as part of New Mexico Office of the State Engineer (NMOSE) Permit RG-68302, RG-81092, and RG-1113 thru RG-1118 Combined. The monitoring report includes the following:

1. Data tables and hydrographs for wells within the monitoring program, and monthly pumping data for the City of Santa Fe wells within the City.
2. An updated version of the potentiometric surface map of the monitoring program area representing 2014 conditions, addressing comments provided by the parties.
3. A potentiometric surface map representing current conditions and a map showing changes in the potentiometric surface between 2014 and present.
4. Summary of data provided in the tables, hydrographs, and maps, any trends that may be related to pumping.
5. The City's compliance with its permit conditions for the Northwest Well.

This monitoring report is available on the City of Santa Fe Water Division's web site, https://www.santafenm.gov/northwest_well_water_level_monitoring_program

1.1 Background

The Northwest Well was drilled and constructed in 1998 to offset the loss of water supply from the Santa Fe Well (impacted in 1988 by volatile organic compounds at the Santa Fe Generating site). The Northwest Well water right application was protested by neighborhoods that rely on domestic wells, such as Tano Road Association. Emergency authorization to pump the Northwest Well was granted in 2000. The NMOSE granted a temporary 10-year permit in 2002. In 2011, before the temporary permit expired, the City of Santa Fe filed an application to permanently combine the Northwest Well (RG-68302) with the City Well Field (RG-1113 thru RG-1118) and the groundwater remediation well at the Santa Fe Generating site (RG-81092). The 2011 application was protested, but settled through mediation with Protestants. The NMOSE issued the Northwest Well-City Well Field permit in 2018 with conditions limiting pumping and requiring water-level monitoring.

1.2 Monitoring Program Requirements

To manage well field operations and to comply with previous permit requirements, water-level data have been collected in the region for about 70 years. The water-level monitoring program was expanded under the RG-81092, RG-68302, and RG-1113 through 1118 Combined permit in 2018. The current monitoring program area covers about 24.5 square miles as shown in Figure 1. The monitoring program requires water-level monitoring at specified wells in and around the monitoring area at varying frequencies. Northwest Well and City Well Field monitoring program wells are listed in Table 1 and locations are shown on Figure 1.

The document titled *Exhibit 1: Northwest Well and City Well Field Groundwater Monitoring and Reporting Plan* identifies five domestic wells in the Tano Road neighborhood as candidates for inclusion in the Monitoring Plan. However, only three well owners have signed well access agreements, and the Tano Road Association has indicated its satisfaction with proceeding with these three wells, RG-49683, RG-73001, and RG-78218, and has indicated that the Association will not be soliciting any additional well owners in the neighborhood for inclusion of additional wells in the Monitoring Plan.

1.3 Well Field Monitoring Report Requirements

- Data tables and hydrographs with water-level monitoring data for wells within the monitoring program.
- Monthly pumping data for the City of Santa Fe wells within the City (New Alto, Hickox No. 2, Torreon, Ferguson, Santa Fe, Agua Fria, Northwest, Osage, St. Michael's, and any additional City wells that are drilled in the future).
- Potentiometric surface map of the monitoring program area representing 2014 conditions.
- Potentiometric surface map of monitoring program area representing current conditions.
- Map showing changes in the potentiometric surface between 2014 and present.
- Narrative discussion summarizing the data provided in the tables, hydrographs, and maps.
- Summarize water-level trends in monitored wells that may be related to pumping.
- If graphical and spatial analysis of water-level trends is not conclusive, a more detailed analysis such as groundwater-flow modeling may need to be performed to assess whether the pumping allowed in the Settlement by the Northwest Well or the City Wells is causing water-level declines.
- Documentation of the City's compliance with its permit conditions for the Northwest Well.
- Post report, maps, water-level database, and links to U.S. Geological Survey (USGS) well data on-line for public access.

Table 1. Northwest Well and City Well Field Monitoring Program requirements

monitoring group	NMOSE ID	other ID (NMBGMR/ USGS, if any)	name	monitoring frequency	comments and status
A		EB-475	Ortiz 1	hourly	
A	RG-49683	EB-080	RG-49683	hourly	not yet equipped; “east” well
A	RG-73001		RG-73001	hourly	not yet equipped; “north, intermediate, well;” replaces RG-74921
A	RG-78218	EB-275	RG-78218	hourly	not yet equipped, “north, distant, well”
B	RG-1118		Agua Fria	quarterly*	
B	RG-1116		Ferguson	quarterly*	
B	RG-1114	EB-123	Hickox No. 2	quarterly*	
B	RG-1113	EB-276	New Alto	quarterly*	
B	RG-304-S		Osage	quarterly*	
B	RG-1117		Santa Fe	quarterly*	
B	RG-304		St. Michael's	quarterly*	
B	RG-1115		Torreon	quarterly*	
C		EB-279	Alto St MW-3	semi-annual	
C			Alto St MW-5	semi-annual	
C			Alto St MW-7	semi-annual	
C			Alto St MW-9	semi-annual	
C			CSF-1	semi-annual	
C			CSF-2(A)	semi-annual	
C			CSF-2(B)	semi-annual	
C			DBS-1D	semi-annual	
permit well	RG-68302		Northwest Well	quarterly*	
Section 6.b		354321105573701	Archery Deep piez	daily**	
Section 6.b		354321105573702	Archery Middle piez	daily**	
Section 6.b		354321105573703	Archery Shallow piez	daily**	
Section 6.b		353945105574501	SF-1 Deep piez	daily**	
Section 6.b		353945105574502	SF-1 Middle piez	daily**	
Section 6.b		353945105574503	SF-1 Shallow piez	daily**	

* quarterly manual measurements required; wells equipped with transducers recording hourly measurements

USGS - U.S. Geological Survey

**daily measurements available from U.S. Geological Survey database

NMBGMR - New Mexico Bureau of Geology and Mineral Resources

NMOSE - New Mexico Office of the State Engineer

piez. - piezometer

2.0 DATA COLLECTION

Data collection efforts were performed by the City of Santa Fe Water Division (Source of Supply), USGS, and JSAI. Data compilation and QA/QC were performed by JSAI. There are three periods of data collection: 1) data collected prior to Northwest Well, 2) data collected during the Northwest Well temporary permit and prior to the monitoring program (2002 to 2018), and 3) data collected as part of the monitoring program (2018 to current).

2.1 Northwest Well and City Well Field Diversions

All City of Santa Fe municipal wells are equipped with calibrated meters connected to a SCADA system. The metered diversions for each well are recorded monthly. Pumping from St. Michael's and Osage Wells are under separate water right permits, but included as part of the pumping for the monitoring area.

A summary of Northwest Well and City Well Field annual diversions between 1995 and present is presented in Table 2. Figures B1 through B10 in Appendix B present graphs showing historical City Well Field and Northwest Well monthly diversions and water levels. Between 1995 and 2018, total diversions from the City Well Field plus Northwest Well ranged from 582 to 3,968 acre-feet per year (ac-ft/yr; Table 2). In 2018, total diversion from the City Well Field plus Northwest Well was 1,783 ac-ft/yr, the highest diversion from this group of wells since 2011, due to drought conditions. A summary of 2018 pumping and compliance with permitted pumping limits is presented as Table 3.

2.2 Water-Level Data

Ortiz 1 (EB-475, Group A well) has been equipped with a transducer and monitored by JSAI. All remaining Group A wells are scheduled to be equipped with sounding tubes and transducers during April and May of 2019 by JSAI and the subcontracted pump service company. All JSAI water-level monitoring is performed and verified using established Standard Operating Procedures (SOP). The City of Santa Fe Water Division Staff performs monthly water-level measurements in all City supply wells using a Heron water-level indicator. JSAI has installed a transducer in the Northwest Well, and is assisting the City with installing transducers connected to the SCADA system for all other City wells. The USGS maintains transducers in Section 6.b wells and has performed water-level monitoring and data QA/QC for those wells.

Table 2. Summary of City Well Field and Northwest Well diversions between 1995 and present

year	RG-304 St. Michael's	RG-304-S Osage	RG-1113 New Alto	RG-1114 Hickox	RG-1115 Torreon	RG-1116 Ferguson	RG-1117 Santa Fe	RG-1118 Agua Fria	City Well Field (RG-1113 thru RG-1118) Total	RG-68302 Northwest	RG-81092 SFGS Remediation Well	total for all wells in monitoring area
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
1995	102	15	0	0	0	407	0	1,298	1,705	0	0	1,822
1996	677	25	0	0	0	348	42	1,301	1,691	0	0	2,393
1997	218	25	0	0	0	293	0	705	998	0	0	1,241
1998	197	22	0	0	510	244	87	1,211	2,052	0	0	2,271
1999	252	25	122	0	670	118	380	1,234	2,524	0	0	2,801
2000	264	25	337	0	628	329	336	1,233	2,863	675	0	3,827
2001	111	25	309	0	565	317	331	1,208	2,730	123	0	2,989
2002	266	79	297	0	649	319	301	1,155	2,721	902	0	3,968
2003	239	19	240	0	557	254	286	858	2,195	679	0	3,132
2004	320	31	92	0	446	121	289	320	1,268	168	1.39	1,788
2005	446	71	31	0	141	0	295	436	903	240	1.94	1,662
2006	457	0	128	0	449	132	277	949	1,935	434	1.56	2,828
2007	55	0	57	0	260	19	303	482	1,121	90	1.63	1,268
2008	32	0	41	0	267	31	307	254	900	466	1.43	1,399
2009	61	0	34	0	164	50	207	271	726	350	0.89	1,138
2010	157	26	129	0	194	168	219	388	1,098	778	1.16	2,060
2011	262	24	183	0	150	169	334	386	1,222	411	1.37	1,920
2012	124	0	77	0	229	77	347	159	889	142	1.58	1,157
2013	110	11	97	0	182	101	205	69	654	480	0.23	1,255
2014	167	0	109	0	193	89	0	35	426	395	0	988
2015	163	0	34	0	37	30	0	22	123	360	0	646
2016	175	23	3	0	161	16	0	94	274	387	0	859
2017	143	2	4	0	138	18	0	25	185	252	0	582
2018	321	0	98	0	196	159	0	556	1,009	453	0	1,783

ac-ft - acre-feet

Table 3. Summary of 2018 pumping and pumping limits specified in RG-81092, RG-68302, and RG-1113 through 1118 Combined

year	City Well Field (ac-ft)	Northwest Well (ac-ft)	NW/CWF combined (ac-ft)	percent of annual permit limit NW/CWF combined ¹	percent of annual permit limit Northwest Well ²
2018	1,009	453	1,462	30%	50%
2019					
2020					
2021					
2022					
2023					
2024					
2025					
2026					
2027					
10-yr total		453	1,462		
10-yr permit limit ³		6,000	35,072		

¹ maximum annual pumping limit for NW and CWF combined is 4,865 ac-ft

² maximum annual pumping limit for Northwest Well is 900 ac-ft

³ based on any consecutive 10-year pumping period after permit issued in 2018
 NW/CWF - Northwest Well and City Well Field

3.0 ANALYSIS OF WATER-LEVEL DATA

3.1 Groundwater-Elevation Contours

Groundwater-elevation (also referred to as potentiometric surface) contours representative of the regional aquifer beneath the monitoring area were prepared for years 2014 (Fig. 2) and present (Fig. 3). Water-level data used for contouring are presented in Appendix E.

Direction of regional groundwater flow in the monitoring area has generally been eastward away from the Sangre de Cristo mountain front and toward the Rio Grande. The observed differences between the 2014 and present flow fields reflect a decline in non-pumping water levels in the Northwest Well, and a smaller drawdown cone between St. Michael’s Well and Santa Fe Well (Fig. 4).

3.1.1 Groundwater-Elevation Contours Representative of 2014 Conditions

The groundwater-elevation contours representative of the regional aquifer in 2014 were prepared based on available data, and according to the Monitoring Plan (Fig. 2). Comments on the draft 2014 groundwater-elevation contour map were provided in Tano Road Association memo dated January 24, 2019 (Bandeem, 2019); these comments were considered, and are addressed in the discussion below. Water levels for the Northwest Well and City Well Field have been included in previous efforts to contour groundwater elevations for the regional aquifer in the Tesuque Formation (e.g., NMBGMR, 2009). Because well depths vary (see Table 3), and vertical groundwater gradients have been documented within the Tesuque Formation, preparing representative groundwater-elevation contours involves reconciliation of a relatively sparse dataset for a complex hydraulic system. The pattern of groundwater-elevation contours is also based on integration of the most up-to-date geologic mapping and geophysical surveys, which have identified thicknesses and dips of geologic units, and locations of faults (Grauch et al., 2009; Hudson and Grauch, 2013; Koning and Read, 2010).

Throughout the groundwater-flow model analysis for the water right permitting process, the Northwest Well was considered to produce from the same aquifer zone (i.e., same model layer) as the City Well Field (with the exception of 10 percent of production from Torreon Well coming from a deeper layer) in the regional aquifer in the Tesuque Formation; and water levels for these wells should necessarily be integrated into the groundwater-elevation contouring scheme representative of the regional aquifer.

Groundwater elevation at the Northwest Well of 6,694 ft above mean sea level (ft amsl) represents the average non-pumping water level in 2014 (see Fig. B9). The pattern of groundwater-elevation contours in the vicinity of the Northwest Well indicates flatter hydraulic gradient than areas to the north, east, and west, reflective of a higher-transmissivity aquifer zone or flattening of the hydraulic gradient from pumping between fault zones. The pattern of groundwater-elevation contours west of the Northwest Well is based on previous efforts to contour groundwater elevations for the regional aquifer (NMBGMR, 2009) and integration of geologic mapping and geophysical surveys, which have identified locations of faults (Grauch et al., 2009; Hudson and Grauch, 2013; Koning and Read, 2010).

Note that even if the Northwest Well was removed from the contouring scheme due to the fact that it is completed deeper in the regional aquifer than wells of other ownership to the north, the flatter hydraulic gradient in the vicinity of the Northwest Well would remain, and the pattern of the contours should be such that they are relatively evenly distributed across the zone with flatter hydraulic gradient east of the low-permeability fault zone, in the absence of additional data.

As mentioned above, vertical groundwater gradients have been documented within the Tesuque Formation and developing representative groundwater-elevation contours involves reconciliation of these data. However, it should be noted that the difference in head between Archery Deep piezometer (1,100 ft deep) and Archery Shallow piezometer (665 ft deep) is about 20 ft or less (see Fig. D1), and the contour interval is 50 ft.

3.1.2 Groundwater-Elevation Contours Representative of Current Conditions

The groundwater-elevation contours representative of the regional aquifer in 2018 (current conditions) were prepared based on available data, and according to the Monitoring Plan (Fig. 3). No cone of depression is observed at the Northwest Well given the 50-ft contour intervals, reduced pumping, and regional area contoured. The 6,600-ft contour interval defines the remaining cone-of-depression caused by pumping the City Well Field. Vertical head difference between the Archery Shallow and Archery Deep piezometer wells is 17 ft, which is less than the 20 ft observed in 2014.

3.2 Monitoring Network Water-Level Trends

3.2.1 Group A Wells

Available water-level data for Group A wells are presented on the hydrographs in Appendix A. Some historical water-level data exist for Ortiz 1 (Fig. A1) and RG-49683 (Fig. A3) for when the Northwest Well was pumping. No significant drawdown trends are observed from the limited historical data for Group A wells. Water levels in Ortiz 1 have declined by about 6 ft since 2004, which is an average decline rate of 0.4 ft/yr.

Only one of the Group A wells has been equipped with a transducer recording water levels on an hourly basis: Ortiz 1 was equipped with a transducer in September 2018 (Figs. A1 and A2). Water levels at Ortiz 1 showed short-term fluctuations of less than 1 ft.

3.2.2 Group B Wells

Historical water levels at Group B supply wells of the City Well Field have varying long-term trends primarily influenced by pumping at each well, regional pumping by others, and recharge from the Living River flows:

- Non-pumping water levels at Agua Fria declined by over 100 ft between 1959 and 2007, and have recovered somewhat due to lower pumping since then (Fig. B1). Non-pumping water levels at Agua Fria remained relatively stable between 2014 and present (see Appendix E).
- Non-pumping water levels at Ferguson have declined by about 120 ft overall since 1970 (Fig. B2). Non-pumping water levels at Ferguson rose by almost 5 ft between 2014 and present (see Appendix E).
- Non-pumping water levels at Hickox 2 have declined by about 90 ft since 1999 (Fig. B3). The well has not been pumping and water-level declines are thought to be related to downward flow from the shallower aquifer zone through low permeability layer to a more permeable deeper zone. Non-pumping water levels at Hickox 2 declined by almost 7 ft between 2014 and present (see Appendix E).
- Non-pumping water levels at New Alto declined by 90 ft between 1969 and 1999 and have recovered somewhat due to lower pumping since then (Fig. B4). Non-pumping water levels at New Alto rose by 12.5 ft between 2014 and present (see Appendix E).
- Non-pumping water levels at Osage declined by about 50 ft between 1972 and 2003 and have stabilized since then due to the fact that the well has been pumped very little since 2006 (Fig. B5). Non-pumping water levels at Osage rose by almost 5 ft between 2014 and present (see Appendix E).
- Non-pumping water levels at Santa Fe Well have declined by over 100 ft since 1959 and appear to have stabilized since the well was turned off in 2013 (Fig. B6). Non-pumping water levels at Santa Fe Well rose by about 4 ft between 2014 and present (see Appendix E).
- Non-pumping water levels at St. Michael's declined by about 30 ft between 1983 and 2009, and have stabilized since then due to lower pumping (maximum monthly pumping of about 40 ac-ft, and annual pumping typically below 200 ac-ft; Fig. B7). Non-pumping water levels at St. Michael's rose by about 5 ft between 2014 and present (see Appendix E).
- Non-pumping water levels at Torreon rose by about 100 ft between 1998 and present as pumping decreased to maximum monthly pumping of about 50 ac-ft, and annual pumping below 200 ac-ft (Fig. B8). Non-pumping water levels at Torreon rose by almost 45 ft between 2014 and present (see Appendix E).

3.2.3 Group C Wells

Water levels at Group C monitoring wells have varying long-term trends primarily influenced by pumping at nearby wells:

- The shallowest of the Alto Street monitoring wells MW-9 has been dry (water column less than 0.4 ft), whereas MW-5, slightly deeper than MW-9, has had relatively stable water levels (Fig. C1). Water levels at Alto MW-3 and MW-7 declined by about 80 ft between 1998 and 2002 due to high pumping in the City Well Field, and have recovered somewhat since then.
- Water levels in CSF-2(A) and CSF-2(B) declined between 1998 and 2002 due to high pumping in the City Well Field, and have stabilized since then (Fig. C2). Well CSF-1 went dry during the Santa Fe Well remediation pumping (2000 to 2013); however, the aquifer has recently recovered enough for water-level measurements at CSF-1.
- Water levels in DBS-1D rose by about 30 ft between 2002 and present due to lower pumping in the City Well Field (Fig. C3) and recharge from Living River flows. Water levels in DBS-1D rose by about 15 ft between 2014 and present (see Appendix E).

3.2.4 Northwest Well

Non-pumping water levels at the Northwest Well generally rose between 2001 and 2015, and have declined since 2015 (Fig. B9). This sudden drop in non-pumping water levels may not be explained simply by pumping at the well, because the pumping rate slightly decreased between 2013 and 2017 (Table 1). It is suspected that the sudden drop in non-pumping water levels between 2015 and 2016 is due to a change in water-measurement instruments (stretched Powers wireline sounder to Heron cable sounder). Hourly transducer data indicate that non-pumping water-levels rose by about 6 ft between January and March 2019 (Fig. B10) likely as a result of reduced pumping.

A decline in non-pumping water level of 46 ft was observed at the Northwest Well between 2014 and present (see Appendix E). As mentioned above, sudden drop in non-pumping water levels at the Northwest Well may be a result of instrument error. Water-level measurement SOPs have been employed with the implementation of this water-level monitoring program to ensure reliable measurements and allow for QA/QC evaluations.

3.2.5 Section 6.b Wells

Water levels at USGS-monitored Archery piezometers declined by about 30 ft between 2003 and present due to pumping at the Northwest Well located about a mile to the southwest, and pumping of domestic wells in the Tano Road area (Fig. D1). A 2009 study found 264 wells and well permits (primarily domestic wells) in the Tano Road area (JSAI, 2009), and it is likely that additional wells have been completed in the area since that time. The Archery Middle and Deep piezometers show short-term fluctuations in water levels in response to pumping at the Northwest Well. A slight upward head gradient is apparent during periods of water-level recovery. Between 2014 and present, water-levels declined at Archery piezometers by 7 to 10 ft (see Appendix E). Collecting hourly water-level data from the Northwest Well transducer and from equipped Group A wells will help with the analysis of water-level trends observed at the Archery piezometers.

Water levels at USGS-monitored SF-1 piezometers have shown short- and long-term trends influenced by pumping at nearby St. Michael's and Santa Fe Wells (Fig. D2). SF-1 Shallow and Middle piezometers have shown short- and long-term fluctuations in water levels due to pumping at St. Michael's Well, located about one-quarter mile to the south. Water levels at SF-1 Deep piezometer have declined by 75 ft between 1997 and present due to City Well Field pumping. Unlike shallower monitoring wells in the area, water levels have not stabilized or recovered at SF-1 Deep piezometer due to lower pumping since the mid-2000s.

SF-1 piezometers showed a variety of water-level changes between 2014 and present, depending on piezometer depth (see Appendix E). SF-1 Shallow piezometer showed a water-level rise of 13 ft representative of continued recovery due to lower pumping in the City Well Field. Water levels remained stable at SF-1 Middle piezometer, and declined by 12 ft at SF-1 Deep piezometer. Water levels remained stable during this period at NMOSE Fairgrounds piezometers, installed to depths ranging from 540 to 1,700 ft and located southwest of SF-1 and St. Michael's Well (see Appendix E).

3.3 Interpretation of Water-Level Trends

Since the installation of the Northwest Well, water-level trends for the Northwest Well area have been different than those observed at the City Well Field area due to differences in pumping quantities, proximity to recharge from the Santa Fe River, geologic conditions, and distribution of regional pumping.

3.3.1 Northwest Well Area

No significant cone-of depression is observed in the Northwest Well area (Figs 2 and 3). Interpretation of Northwest Well non-pumping water levels would indicate a water-level decline of 15 ft since the well was constructed in 1998, or average decline rate of about 0.8 ft/yr (Fig. B9). The Archery piezometers have shown steady declines of about 2 ft/yr since the early 2000s. Unfortunately, the Archery piezometers were installed after the Northwest Well, so there are no background data for evaluating water-level trends in this area prior to installation of the Northwest Well. In contrast, RG-49683, located approximately 2.3 miles northeast of the Northwest Well, has not shown any significant water-level decline in the sparse historical dataset (Fig. A3). Varying rates of decline in the vicinity of the Northwest Well are likely influenced by varying well depth (see Table 4). Ortiz 1 monitoring well is located between the City Well Field and the Northwest Well, about 0.5 mile north of the City Well Field and about 1.5 miles south of the Northwest Well (see Fig. 1). Ortiz 1 has had a relatively slow rate of water-level decline less than 0.5 ft/yr since 2004 likely in response to pumping of all supply wells in the monitoring area (Fig. A1).

3.3.2 City Well Field Area

Water levels at the City Well Field have varying long-term trends (see Appendix B). Many of these wells showed water-level declines of 50 to 100 ft due to higher pumping prior to the mid-2000s, and water levels have stabilized or recovered since then. Amount of recovery depends on proximity to the Santa Fe River.

Water levels at Group C monitoring wells help define the cone-of depression caused by pumping the City Well Field (Figs. 2 and 3). The City Well Field cone of depressions appear to be shrinking due to reduced pumping since 2011 (Table 2) and increased recharge from Living River flows.

Group C monitoring wells installed to depths less than 250 ft have been less affected by City Well Field pumping (see Table 4 and Fig. C1).

Table 4. Summary of elevation, total depth, and depth to top and bottom of screen for Northwest Well and City Well Field Monitoring Program wells

monitoring group	well	land surface elevation, ft amsl	total well depth, ft bgl	screen interval(s), ft bgl
A	Ortiz 1	6,999.03	460	350 to 460
A	RG-49683	7,178.50	600	400 to 600
A	RG-73001	7,160.00	805	665 to 685; 705 to 725; 745 to 765; 785 to 805
A	RG-78218	6,810.00	1,000	720 to 740; 780 to 800; 840 to 860; 900 to 920; 960 to 980
B	Agua Fria	6,797.65	740	201 to 740
B	Ferguson	6,877.00	750	175 to 746
B	Hickox No. 2	6,965.00	860	400 to 840
B	New Alto	6,861.40	725	226 to 720
B	Osage	6,750.00	770	210 to 760
B	Santa Fe	6,871.60	725	200 to 723
B	St. Michael's	6,853.45	795	380 to 780
B	Torreón	6,828.00	1,230	365 to 1,230
C	Alto MW-3	6,873.90	415	395 to 415
C	Alto MW-5	6,842.80	235	195 to 235
C	Alto MW-7	6,892.70	520	500 to 520
C	Alto MW-9	6,873.90	160	100 to 160
C	CSF-1	6,913.00	284	259 to 284
C	CSF-2(A)	6,858.00	554	534 to 554
C	CSF-2(B)	6,858.00	668	648 to 658
C	DBS-1D	6,885.73	282	267 to 282
permit well	Northwest Well	7,124.00	2,000	500 to 960; 1,000 to 1,980
Section 6.b	Archery Deep piez	7,223.00	1,100	
Section 6.b	Archery Middle piez	7,223.00	920	
Section 6.b	Archery Shallow piez	7,223.00	655	
Section 6.b	SF-1 Deep piez	6,880.00	1,952	
Section 6.b	SF-1 Middle piez	6,880.00	1,060	
Section 6.b	SF-1 Shallow piez	6,880.00	780	

ft amsl - feet above mean sea level

ft bgl - feet below ground level

italics - inferred total depth

4.0 COMPLIANCE WITH NORTHWEST WELL PERMIT

The City of Santa Fe has taken timely actions to maintain compliance under the Northwest Well water right permit. Water-level monitoring is proceeding according to Sections 3 and 4 of the Monitoring Plan with the exception of the three Group A wells in the Tano Road neighborhood that were not yet equipped at the time of this monitoring report. The well owners signed access agreements in late 2018. These access agreements have now been signed by the City Manager, and funding has been secured for installation of sounding tubes and water meters. The transducers have already been purchased. The pump contractor has been selected, and the work is currently being scheduled, to be completed within the next 2 months based on contractor availability. Once sounding tubes are installed, water-level monitoring will commence at these three wells.

This monitoring report fulfills the requirement in Section 5 of the Monitoring Plan that the first monitoring report be prepared no later than March 2019, and has been prepared according to the requirements set forth in Section 6 of the Monitoring Plan, including data tables, hydrographs, maps, and narrative.

Pumping in 2018 under the Northwest Well and City Well Field permit was within the limits specified in the permit conditions (Table 3).

The groundwater-elevation contour map representative of the regional aquifer in 2014 has been prepared based on available data, and according to the Monitoring Plan.

An evaluation of streamflow depletions and offsets associated with the Northwest Well permit has been submitted to NMOSE to fulfill the requirements of the Permit Conditions of Approval 5, 6, and 7.

5.0 RECOMMENDATIONS

Once the three domestic Group A wells in the Tano Road area have been equipped with transducers and a significant water-level dataset has been collected, it is recommended that an addendum be prepared for this report. The addendum would present data tables, hydrographs, and maps incorporating the newly-collected data, and a narrative describing water-level trends and changes for these additional three Group A wells.

6.0 REFERENCES

- Bandeen, R., 2019, OSE File No. RG-81092, RG-68302, and RG-1113 thru 1118 Combined; Comments regarding City of Santa Fe North West Well monitoring program: memo from Reid Bandeen, P.G., for Tano Road Association, to Ramona Martinez, Northern Rio Grande Basin Manager, Water Rights Division, NMOSE, January 24, 2019, 3 p.
- Grauch, V.J.S., Phillips, J. D., Koning, D. J., Johnson, P. S., and Bankey, V., 2009, Geophysical Interpretations of the Southern Española Basin, New Mexico, That Contribute to Understanding its Hydrogeologic Framework: U.S. Geological Survey Professional Paper 1761, 88 p.
- Hudson, M.R., and Grauch, V.J.S., 2013, Introduction: New Perspectives on Rio Grande Rift Basins: From Tectonics to Groundwater: Geological Society of America Special Papers vol. 494.
- [JSAI] John Shomaker & Associates, Inc., 2009, Buckman Monitoring Program well and well permit survey: consultant's letter report to Claudia Borchert, City of Santa Fe Water Division, March 13, 2009, 4 p. plus map and CD containing well and well permit survey, database letter report, and index maps.
- Koning, D.J., and Read, A.S., 2010, Preliminary Draft, Geologic map of the Southern Española Basin, Santa Fe County, New Mexico: New Mexico Bureau of Geology and Mineral Resources Open-File Report 531.
- [NMBGMR] New Mexico Bureau of Geology and Mineral Resources, 2009, Water-level contours and ground water flow conditions (2000 to 2005) for the Santa Fe area, southern Espanola Basin, New Mexico: New Mexico Bureau of Geology and Mineral Resources Open-File Report OFR-520.

ILLUSTRATIONS

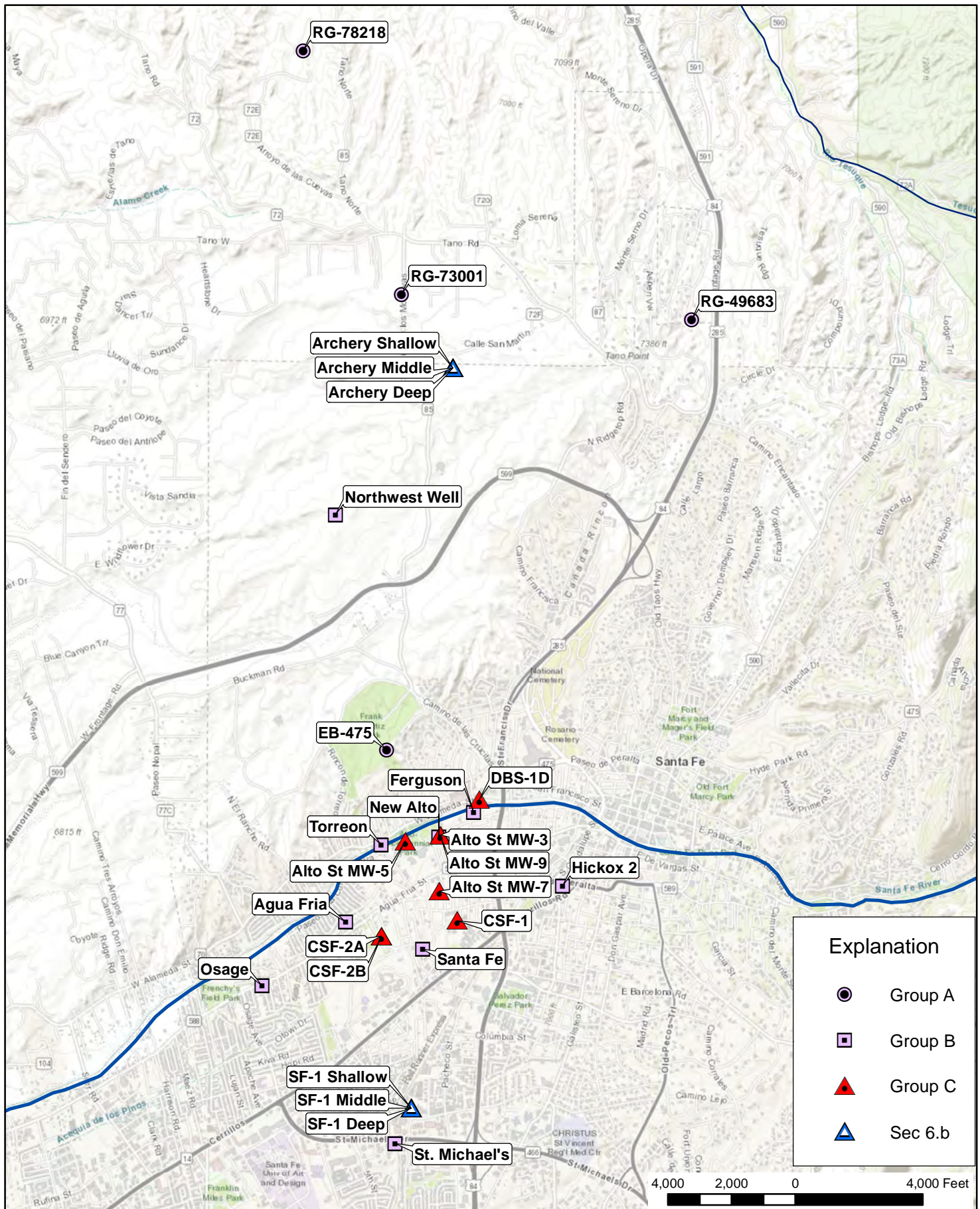


Figure 1. Map showing Northwest Well and City Well Field area water level monitoring network, Santa Fe, New Mexico.

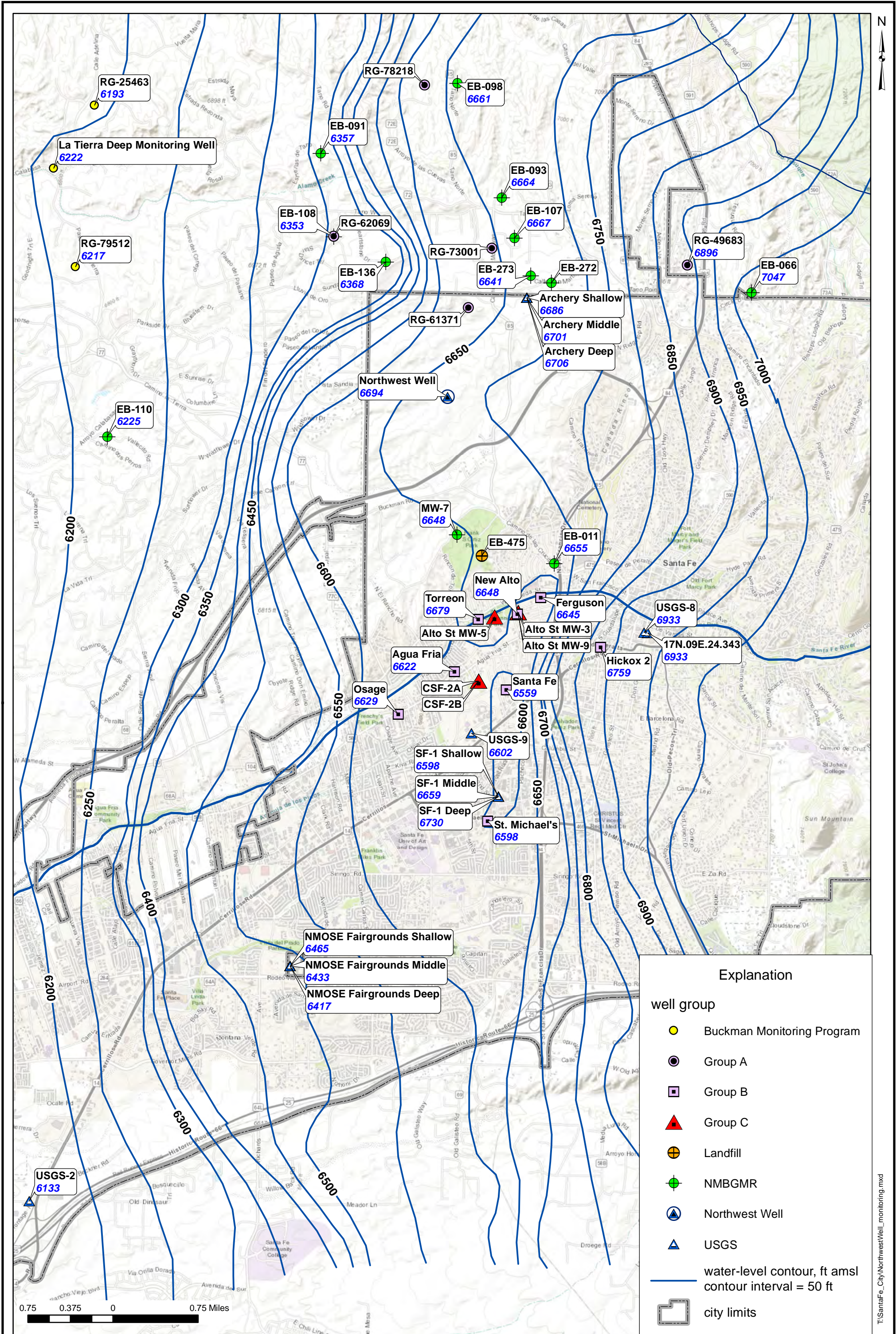


Figure 2. Map showing 2014 water-level elevation contours for Northwest Well and City Well Field area, Santa Fe, New Mexico.

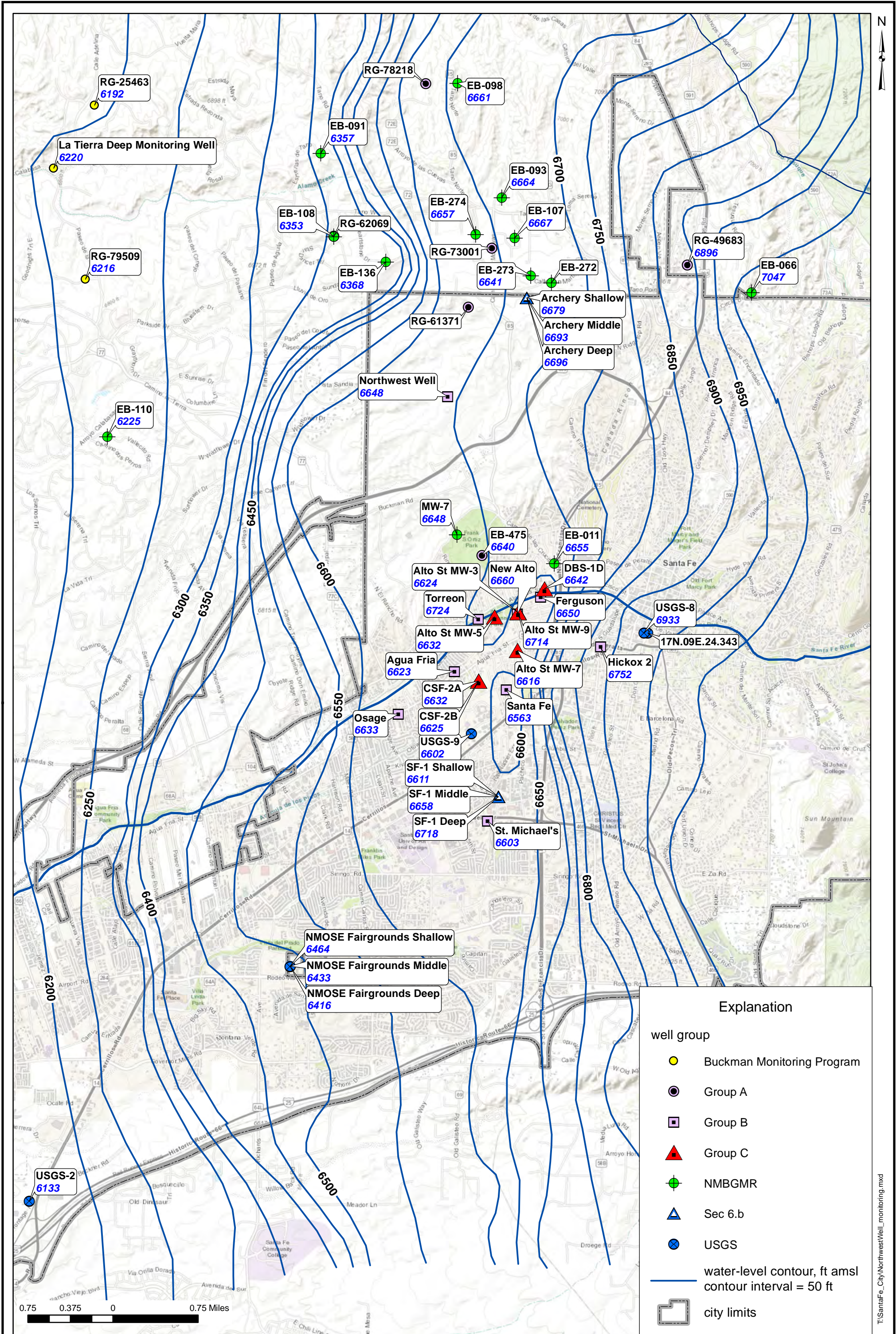


Figure 3. Map showing water-level elevation contours for Northwest Well and City Well Field area representing current conditions, Santa Fe, New Mexico.

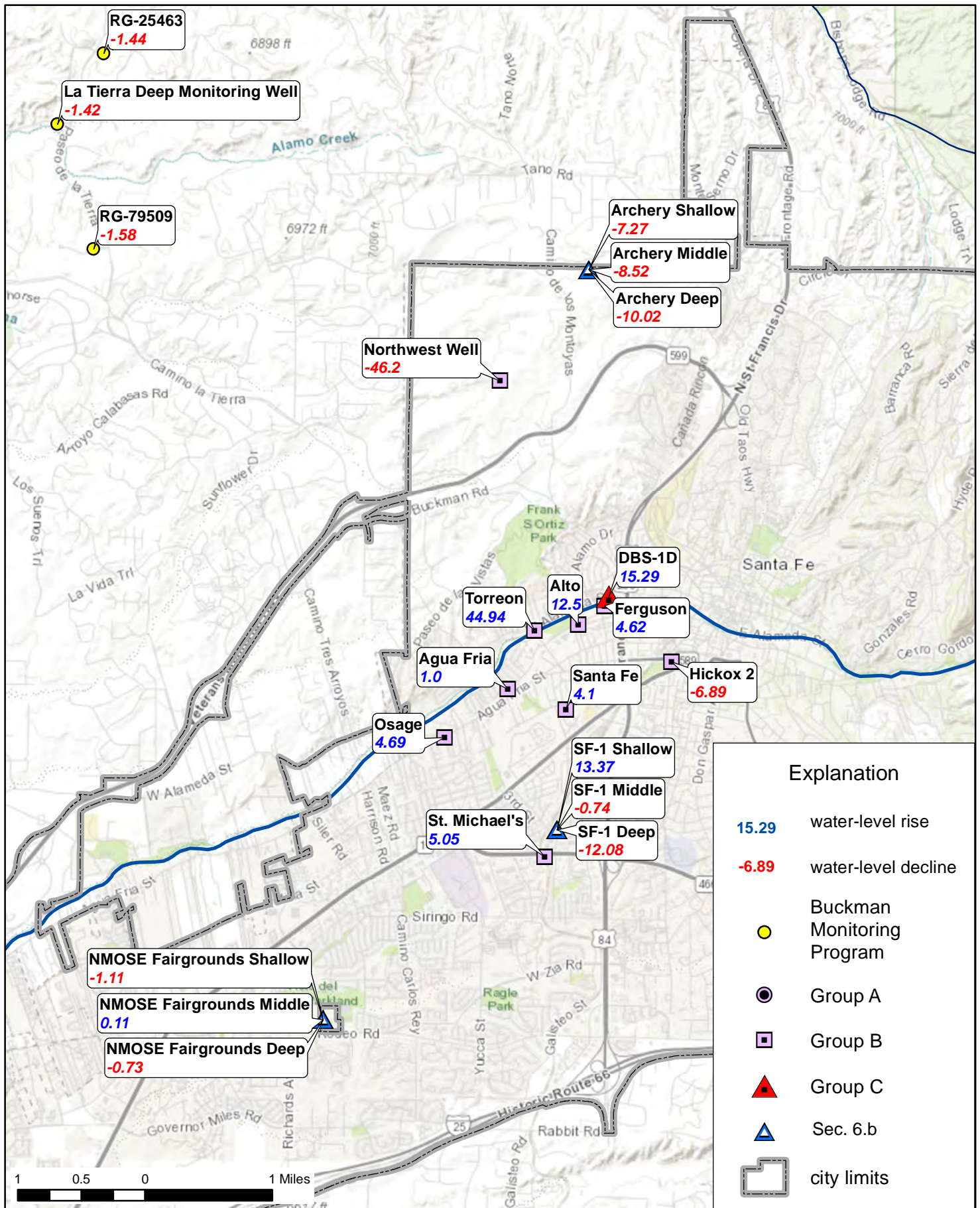


Figure 4. Map showing water-level changes between 2014 and present, Northwest Well and City Well Field area, Santa Fe, New Mexico.

APPENDICES

Appendix A.

**Graphs showing water levels in Group A wells of the Northwest Well and
City Well Field Monitoring Program**

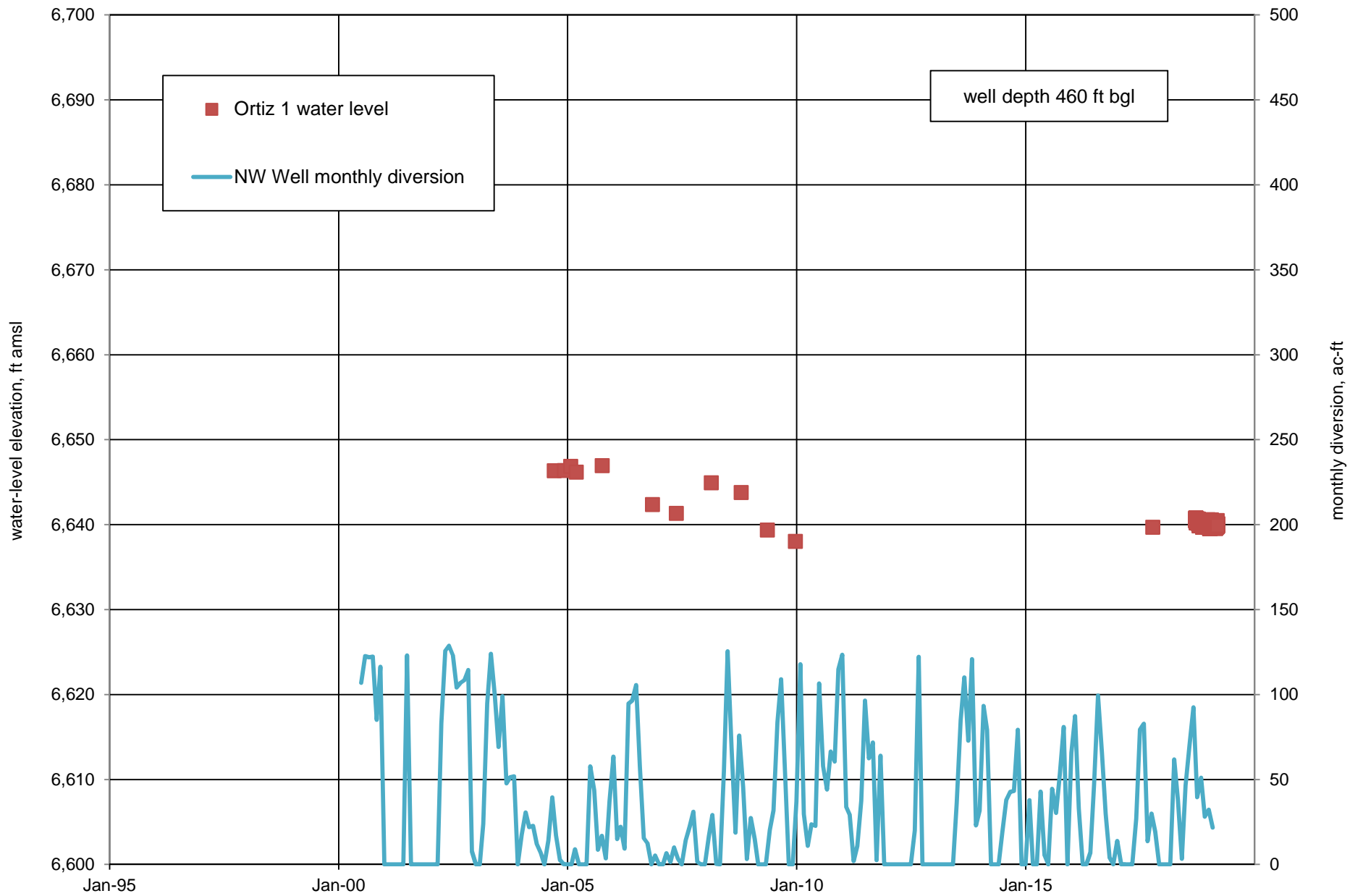


Figure A1. Water-level elevations for Group A well Ortiz 1, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

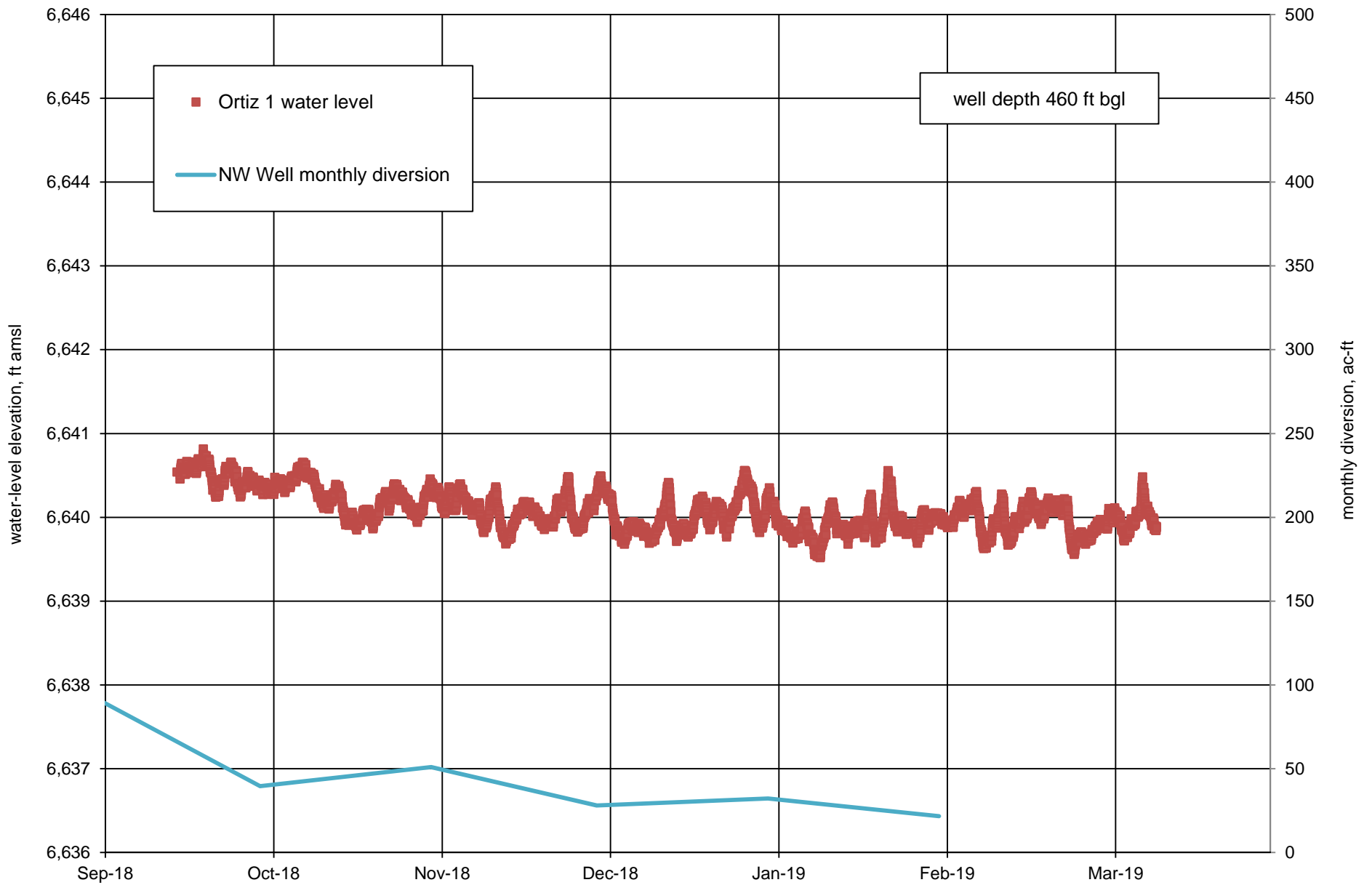


Figure A2. Water-level elevations measured hourly by transducer, Group A well Ortiz 1, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

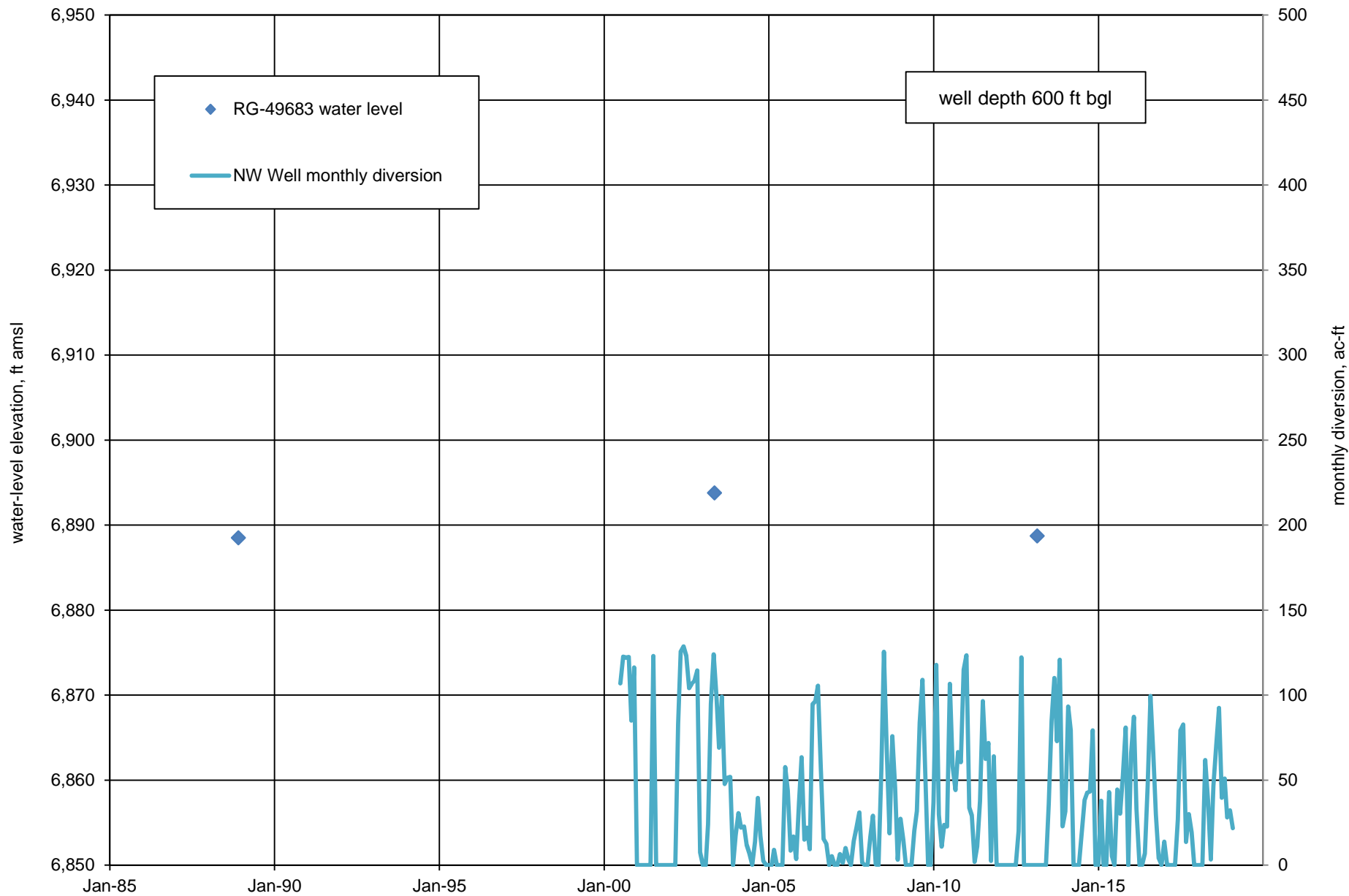


Figure A3. Water-level elevations for Group A well RG-49683, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

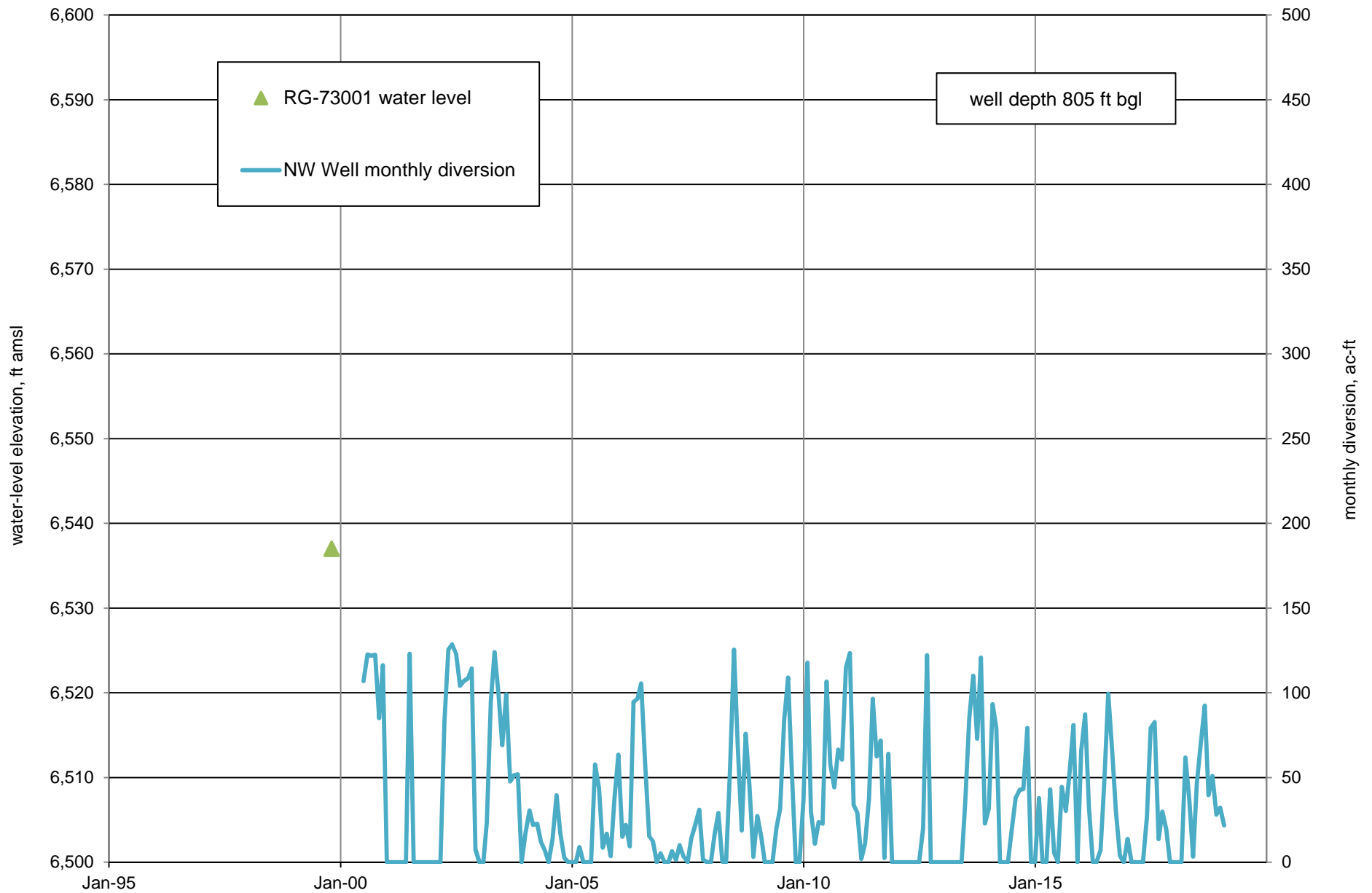


Figure A4. Water-level elevations for Group A well RG-73001, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

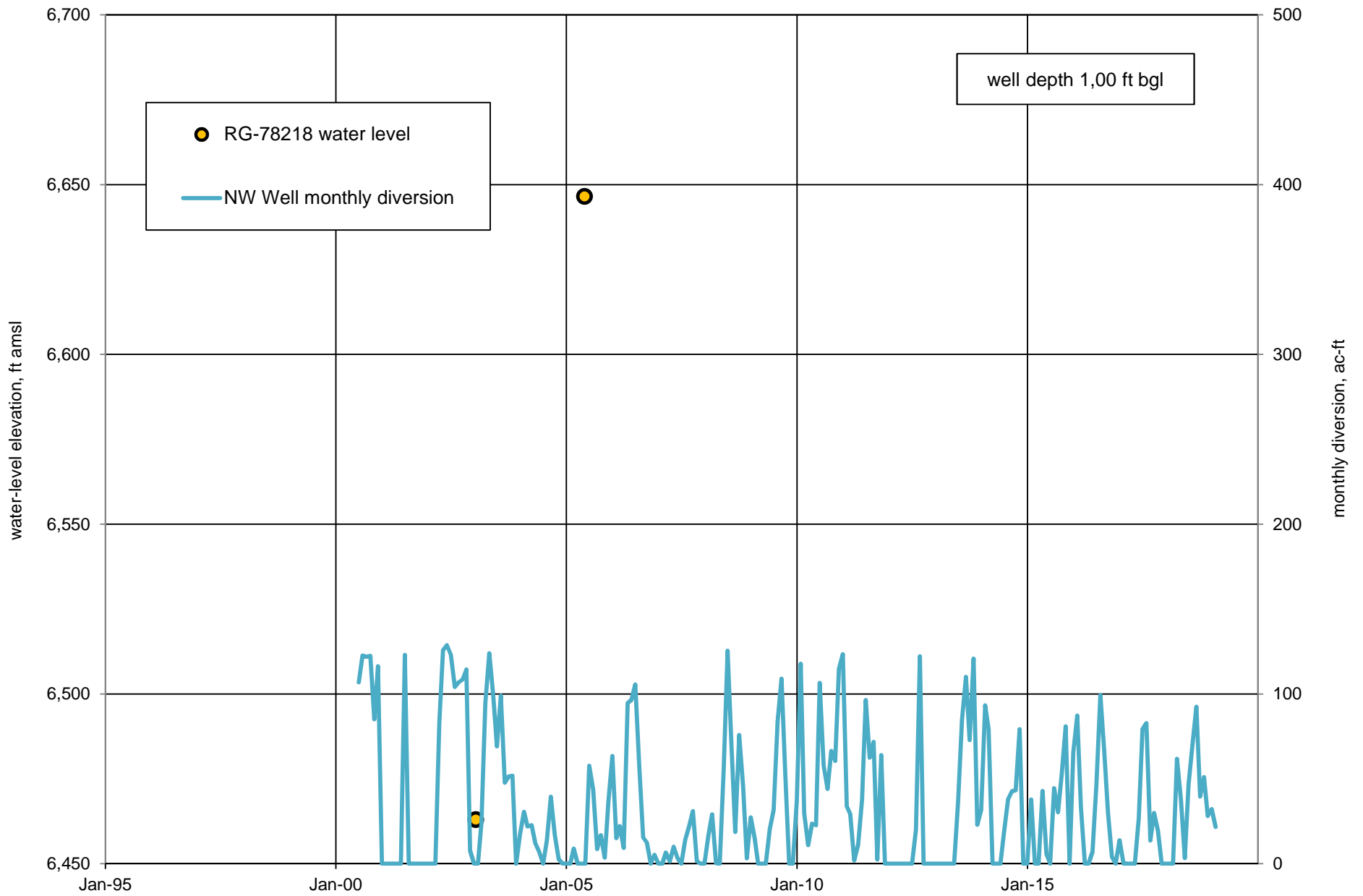


Figure A5. Water-level elevations for Group A well RG-78218, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

Appendix B.

**Graphs showing water levels and monthly pumping for Group B wells of the
Northwest Well and City Well Field Monitoring Program**

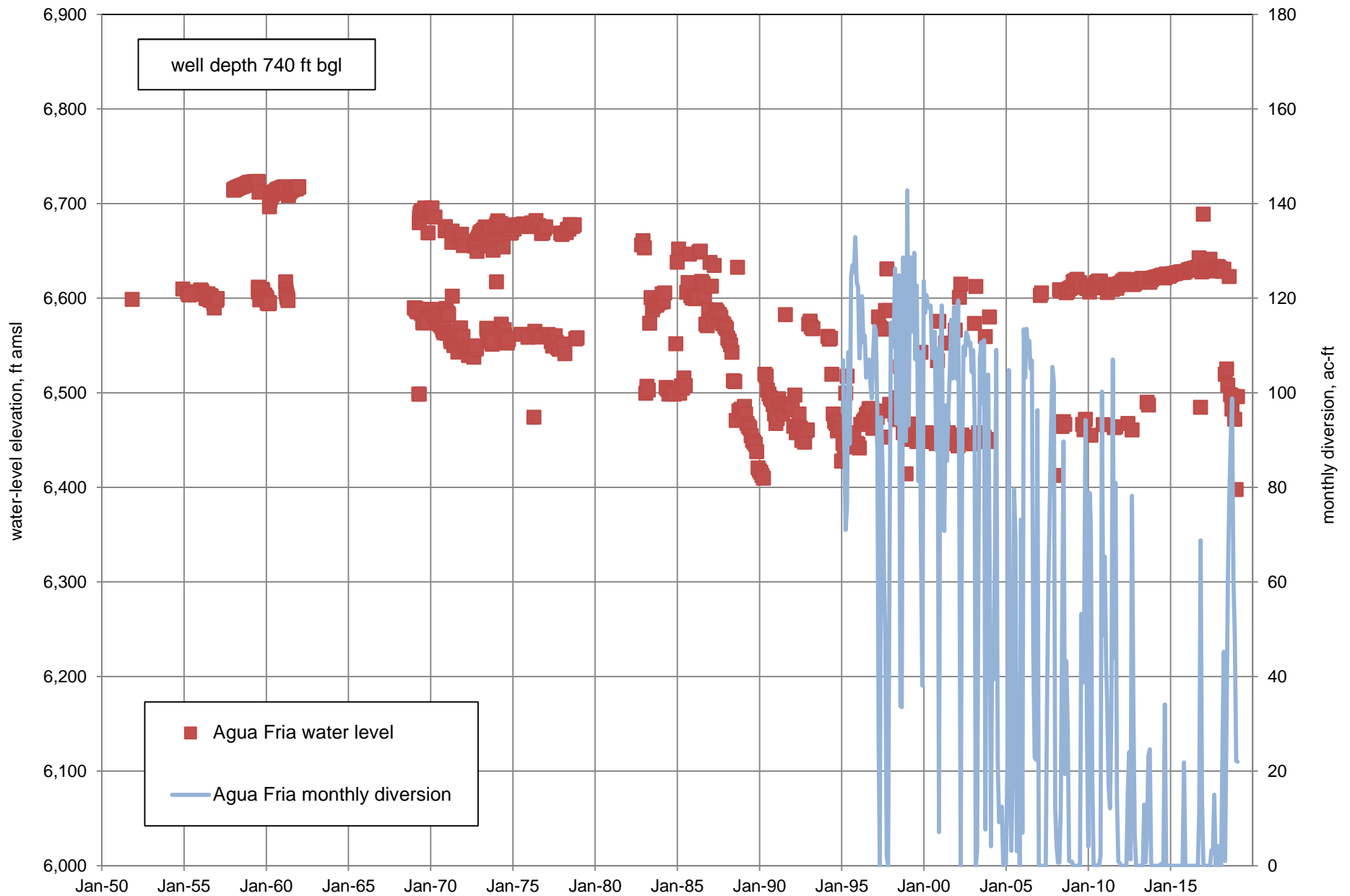


Figure B1. Water-level elevations for Group B well Agua Fria, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

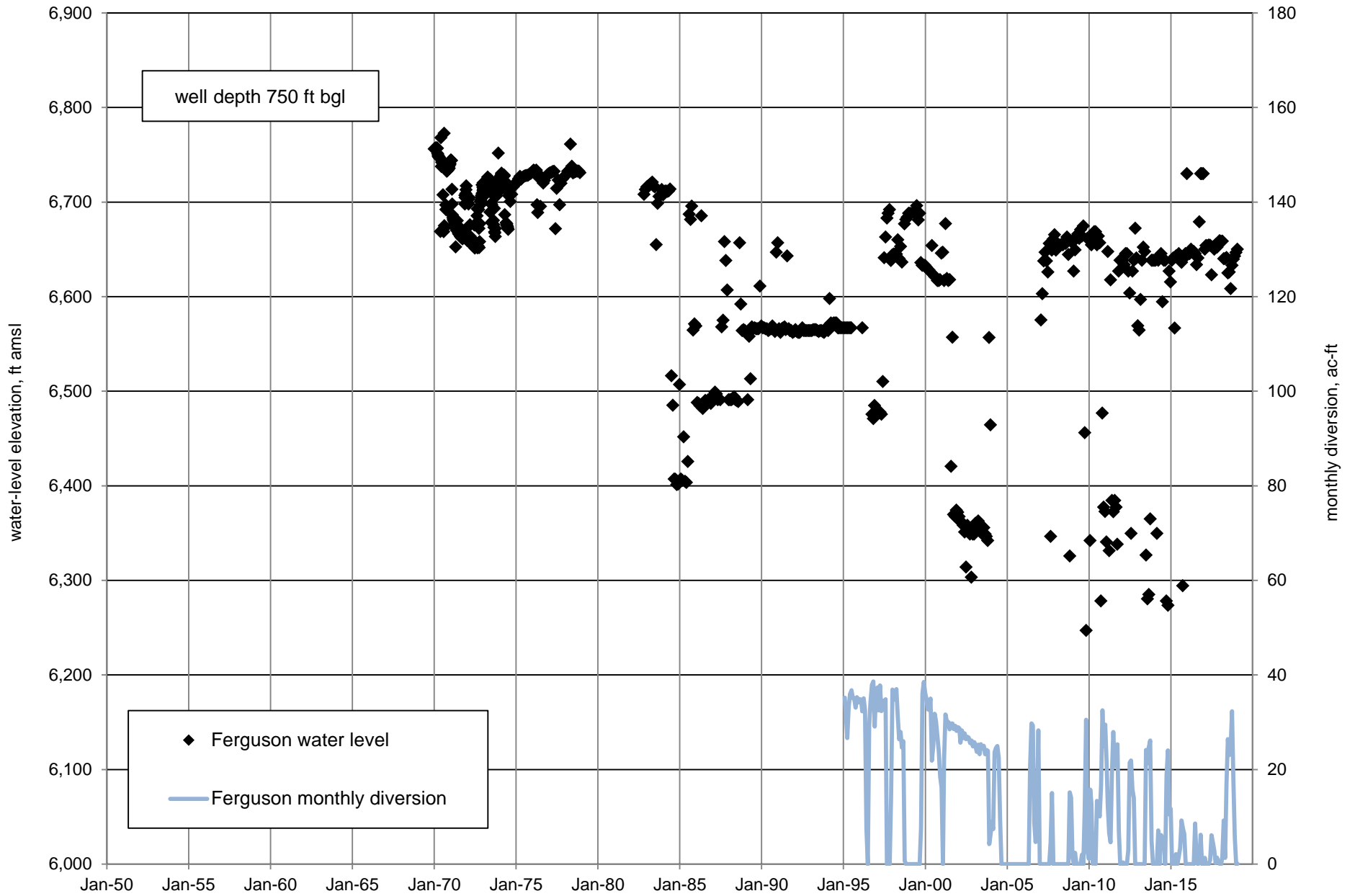


Figure B2. Water-level elevations for Group B well Ferguson, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

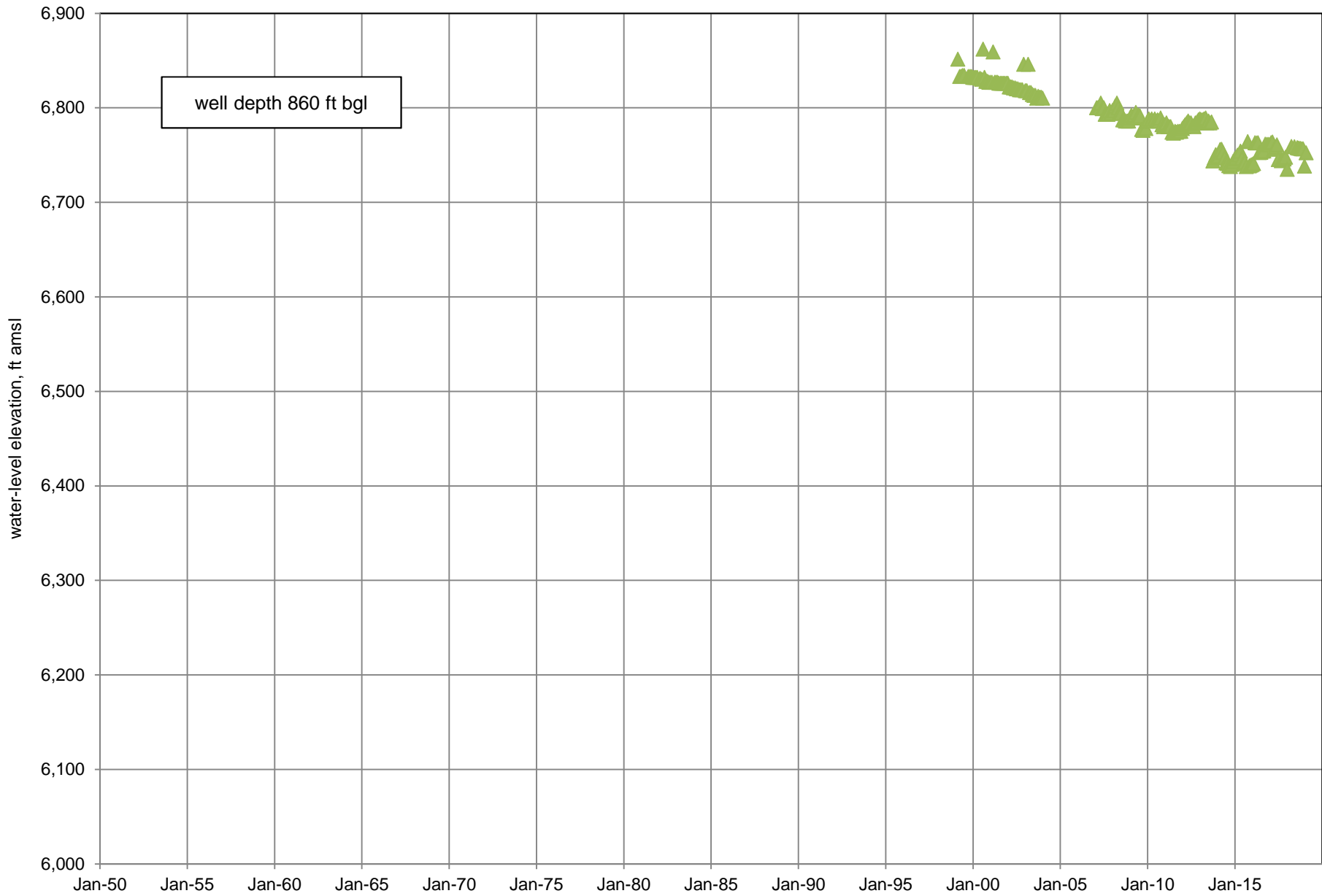


Figure B3. Water-level elevations for Group B well Hickox No. 2, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

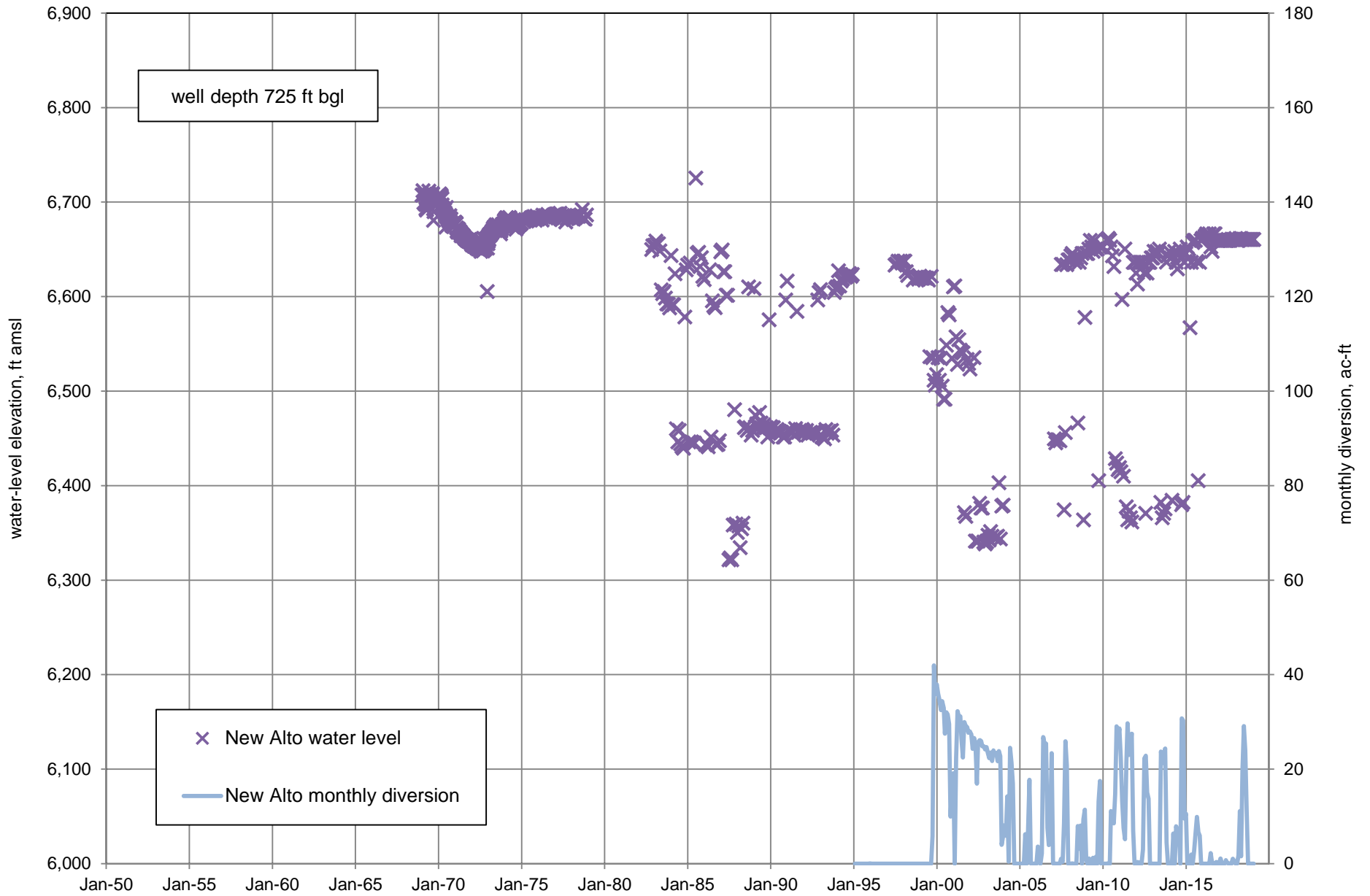


Figure B4. Water-level elevations for Group B well New Alto, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

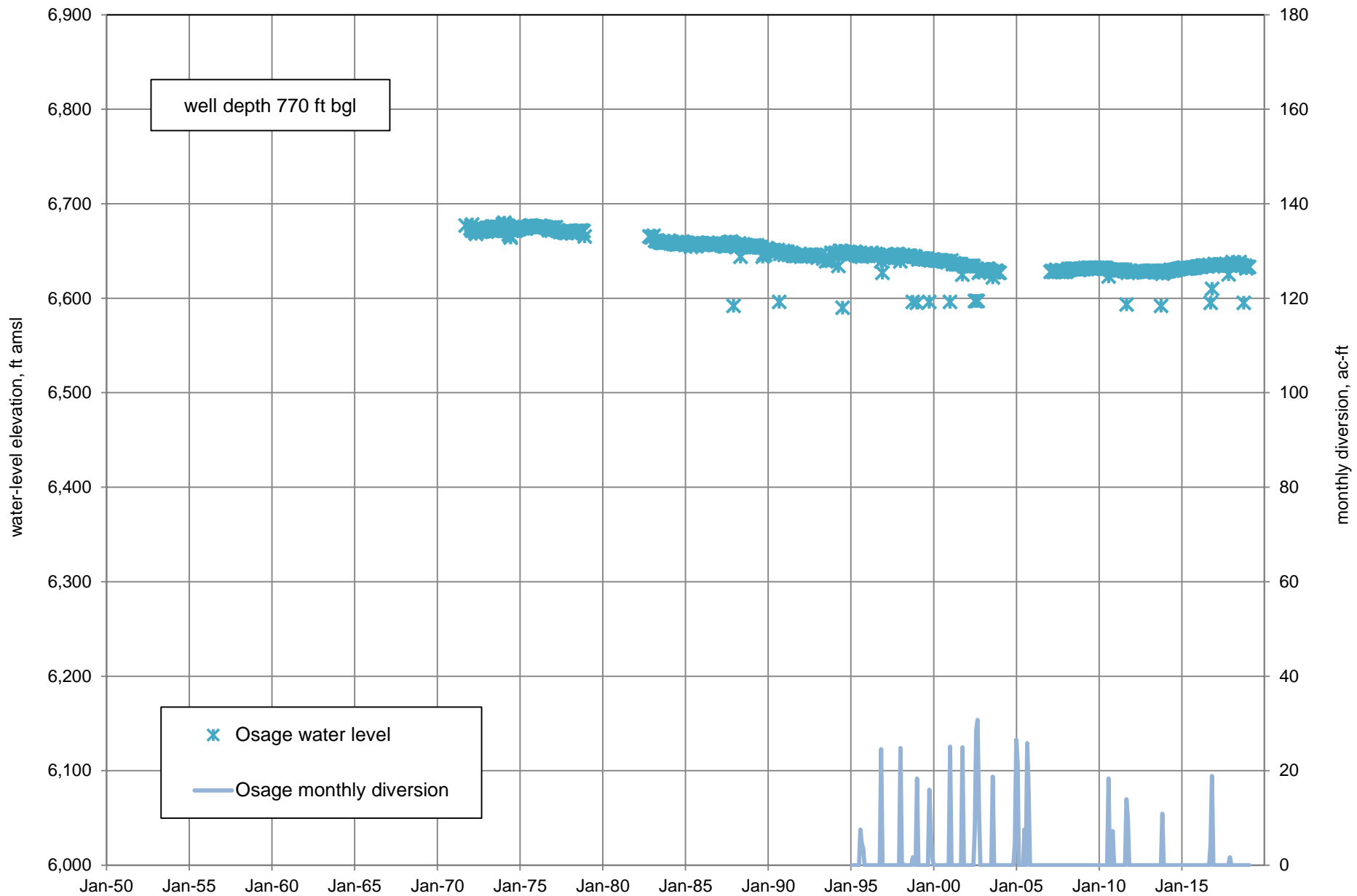


Figure B5. Water-level elevations for Group B well Osage, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

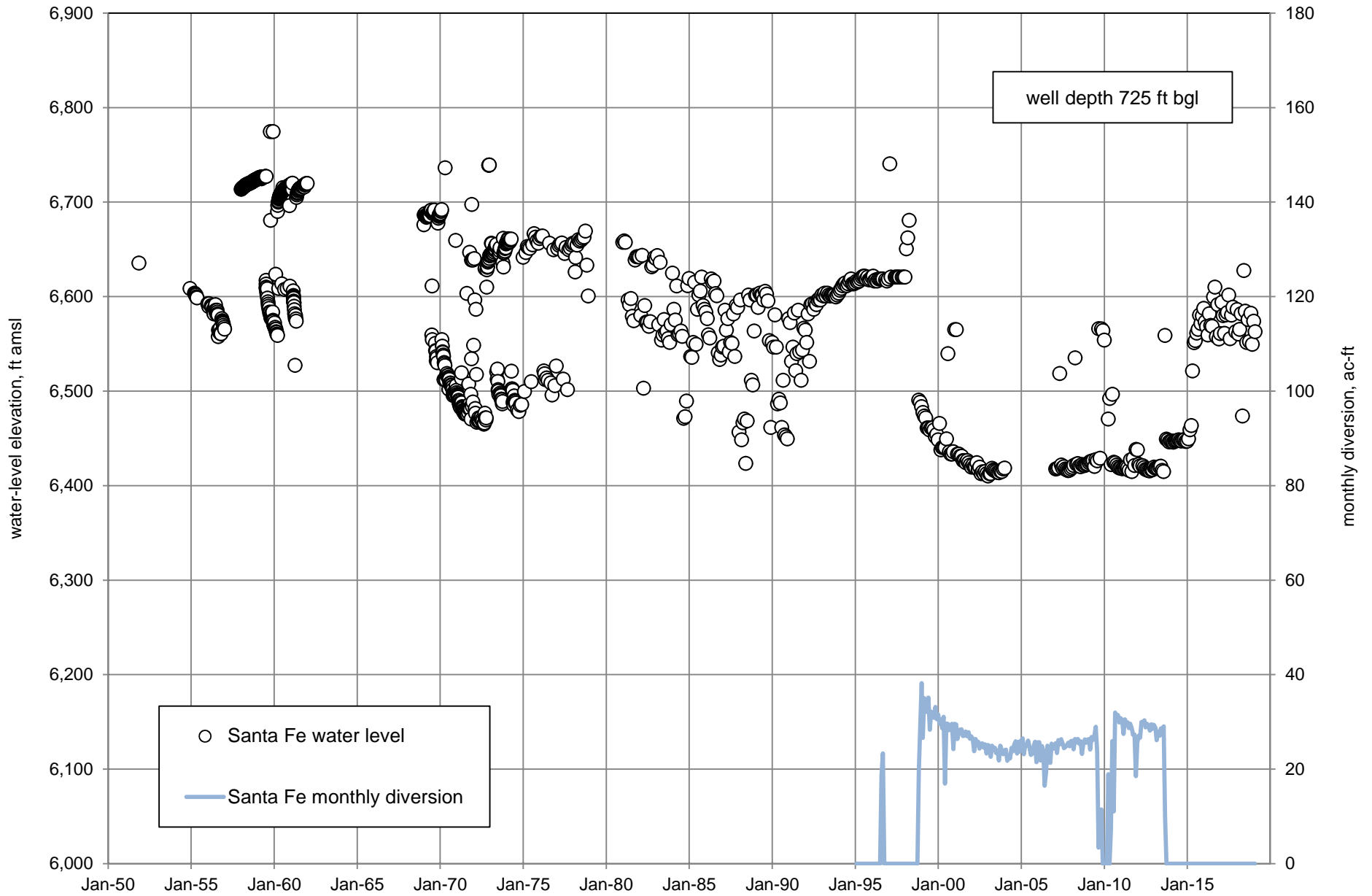


Figure B6. Water-level elevations for Group B well Santa Fe, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

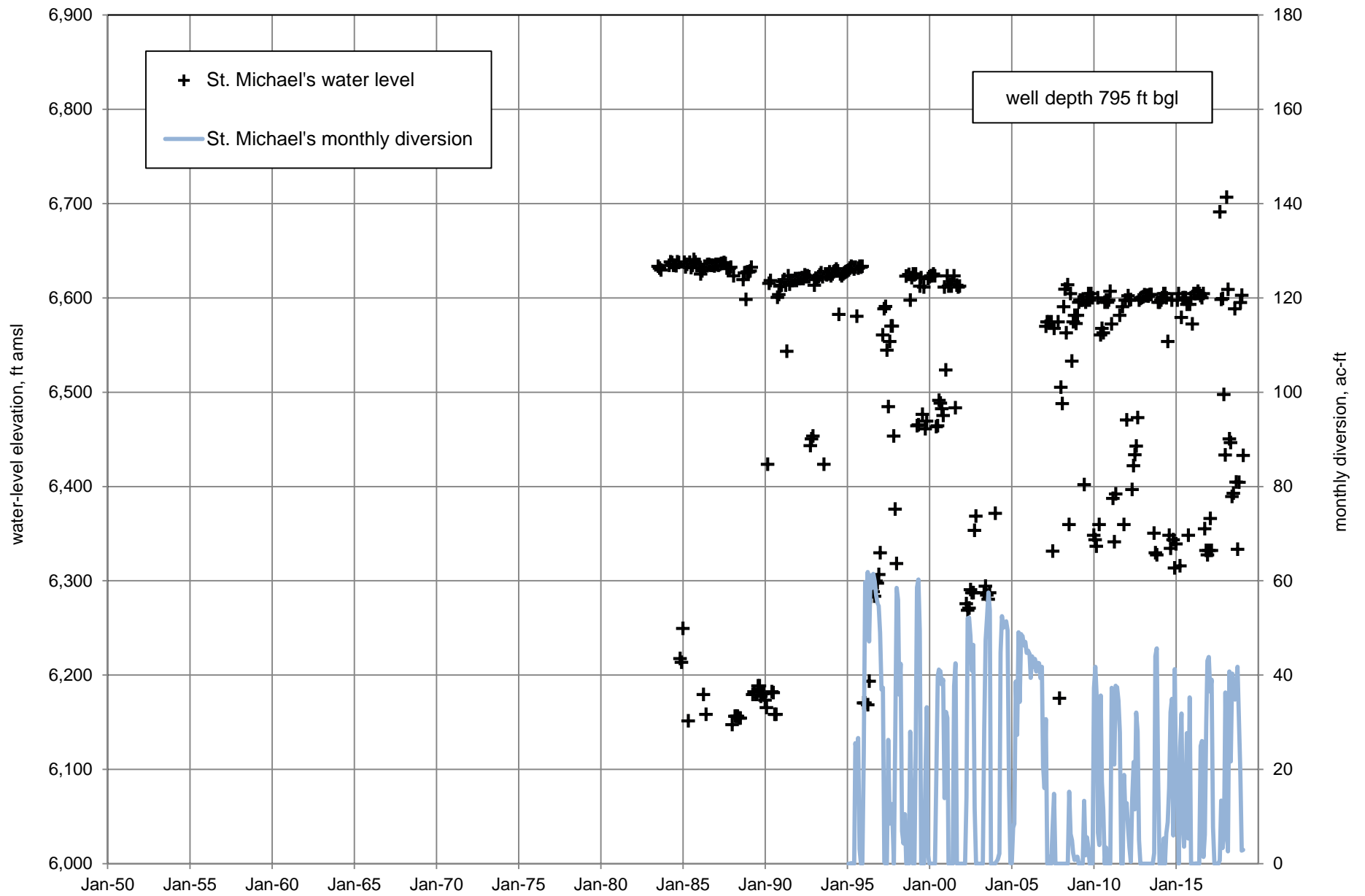


Figure B7. Water-level elevations for Group B well St. Michael's, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

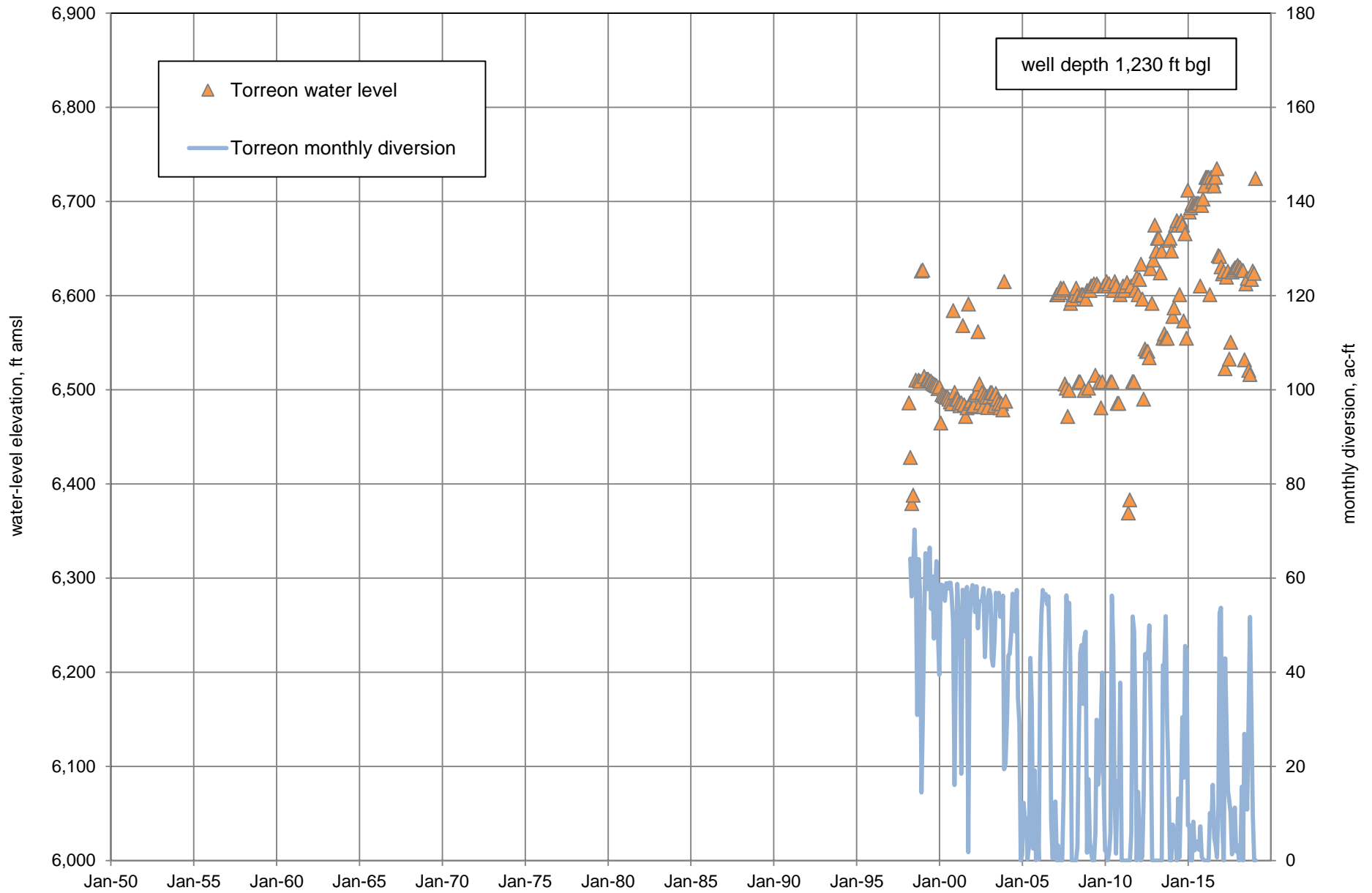


Figure B8. Water-level elevations for Group B well Torreon, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

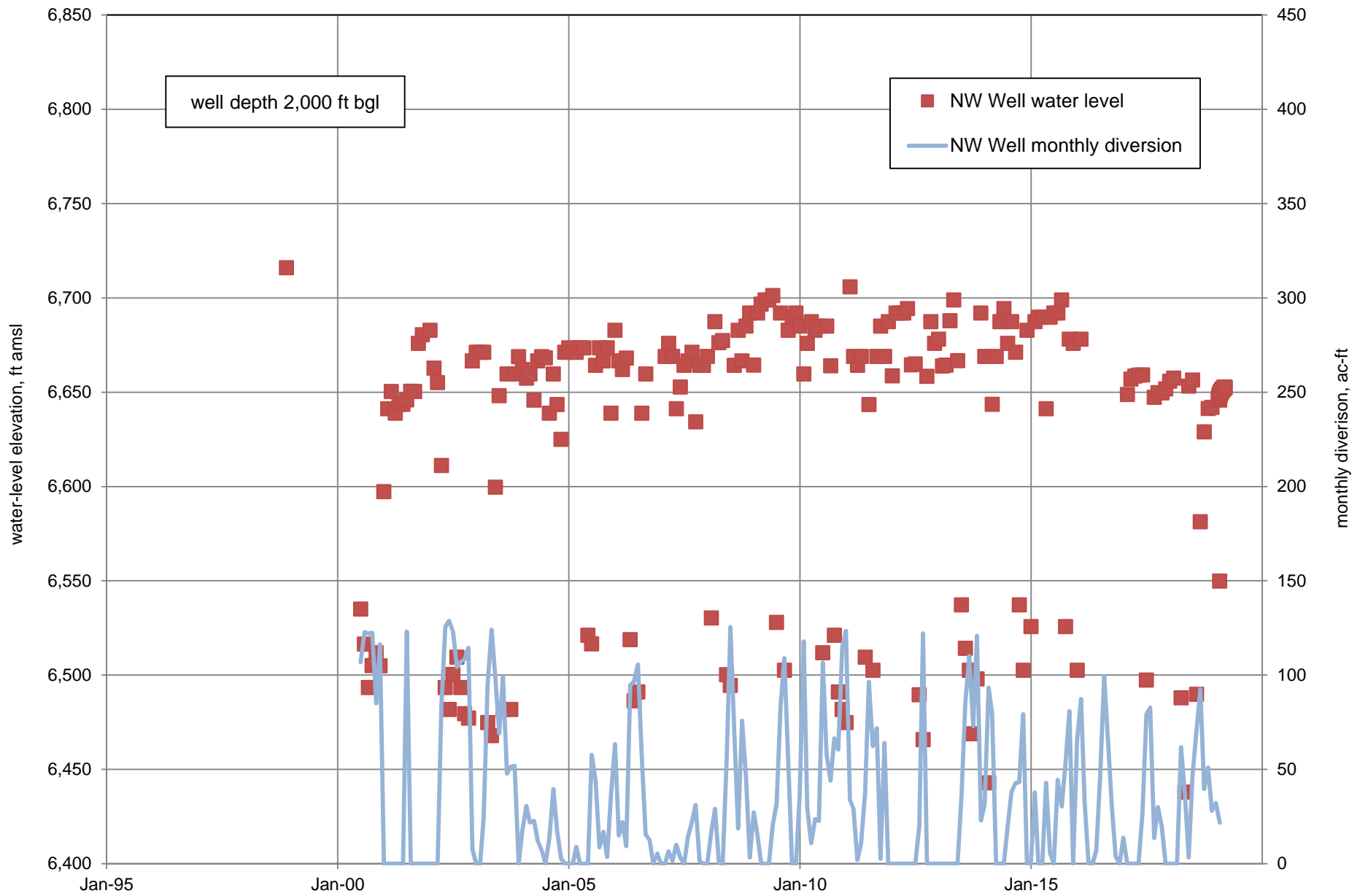


Figure B9. Water-level elevations for Northwest Well, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

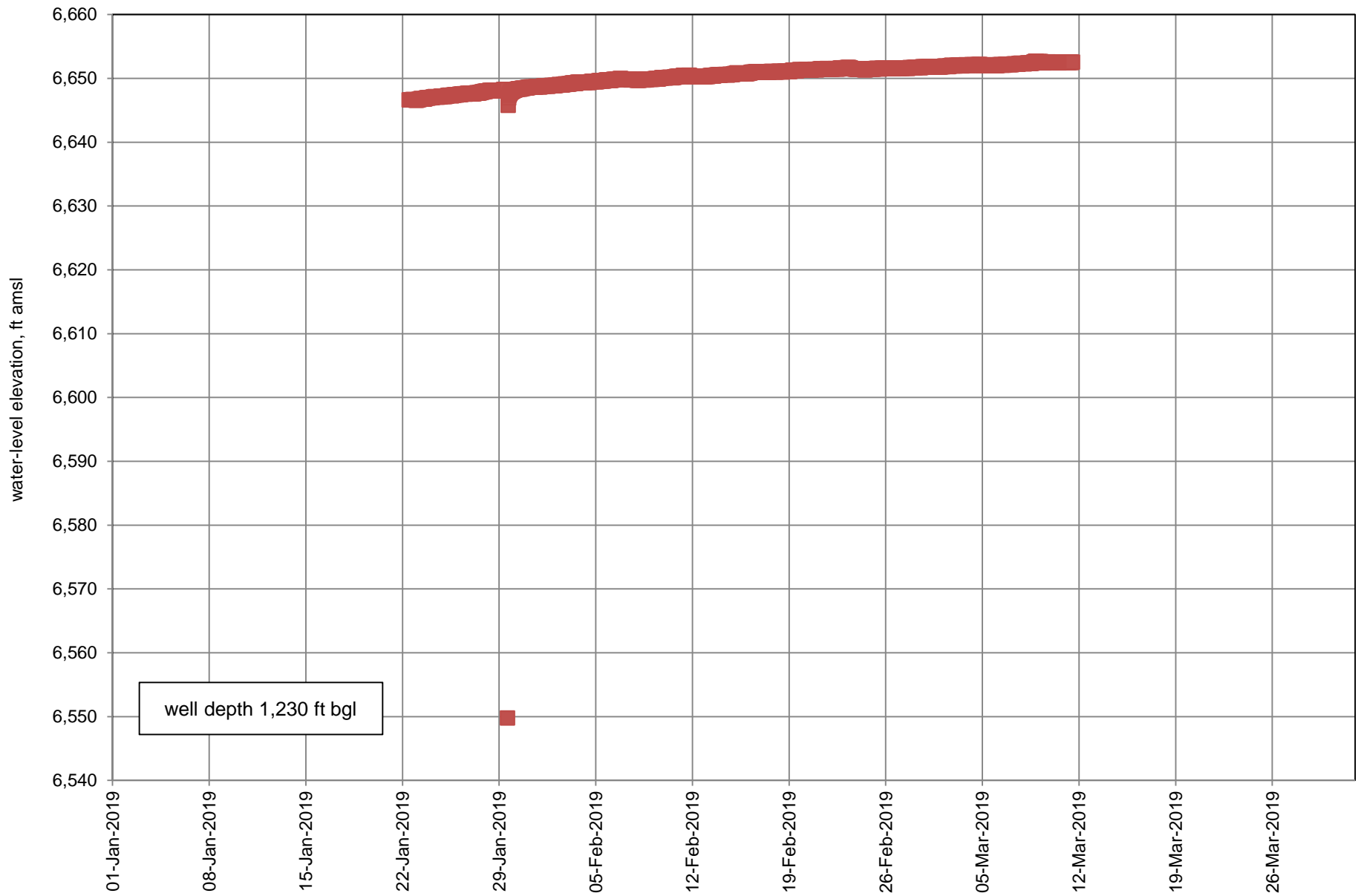


Figure B10. Water-level elevations measured hourly by transducer, Northwest Well, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

Appendix C.

**Graphs showing water levels in Group C wells of the Northwest Well and
City Well Field Monitoring Program**

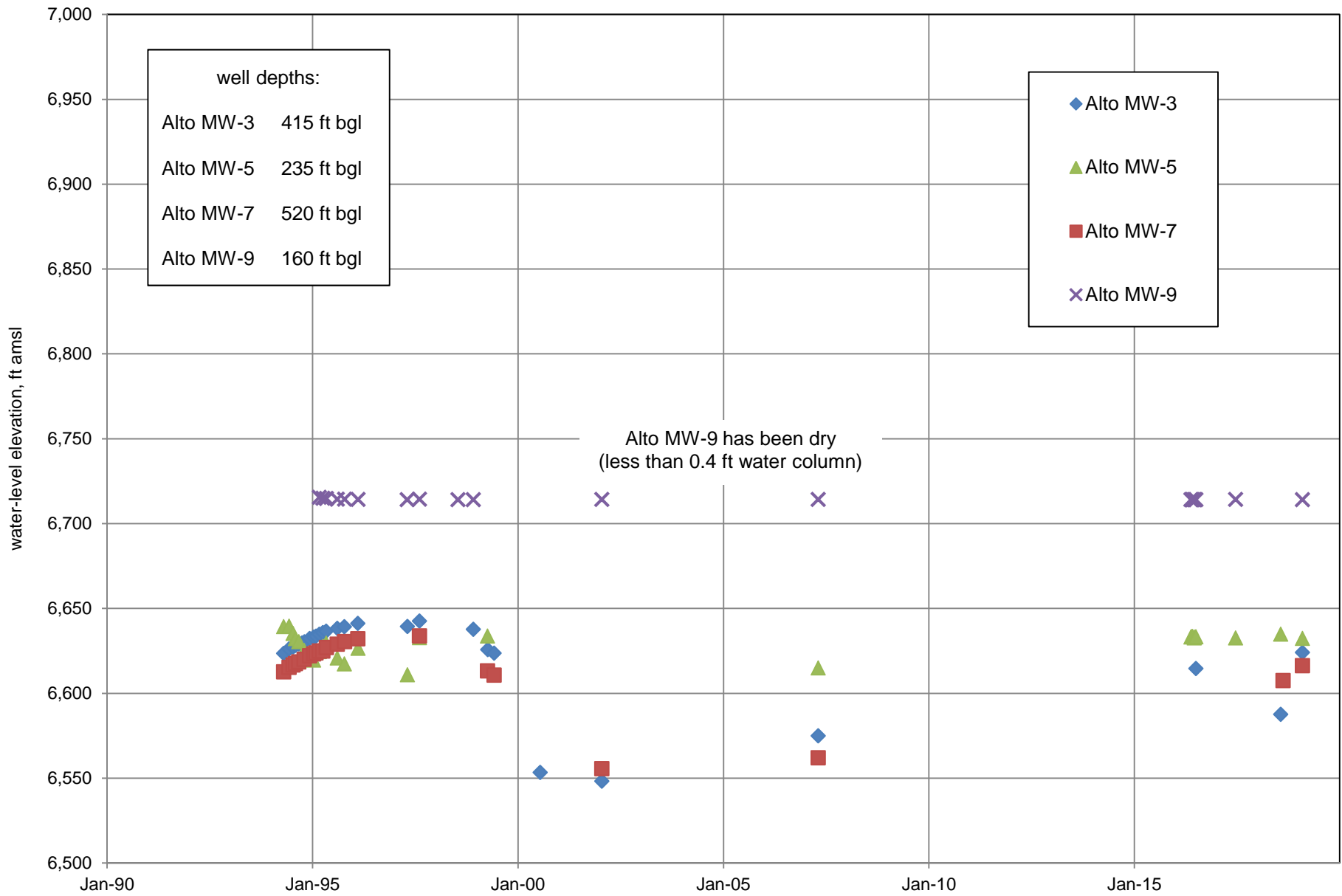


Figure C1. Water-level elevations for Group C wells Alto Street MW-3, MW-5, and MW-9, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

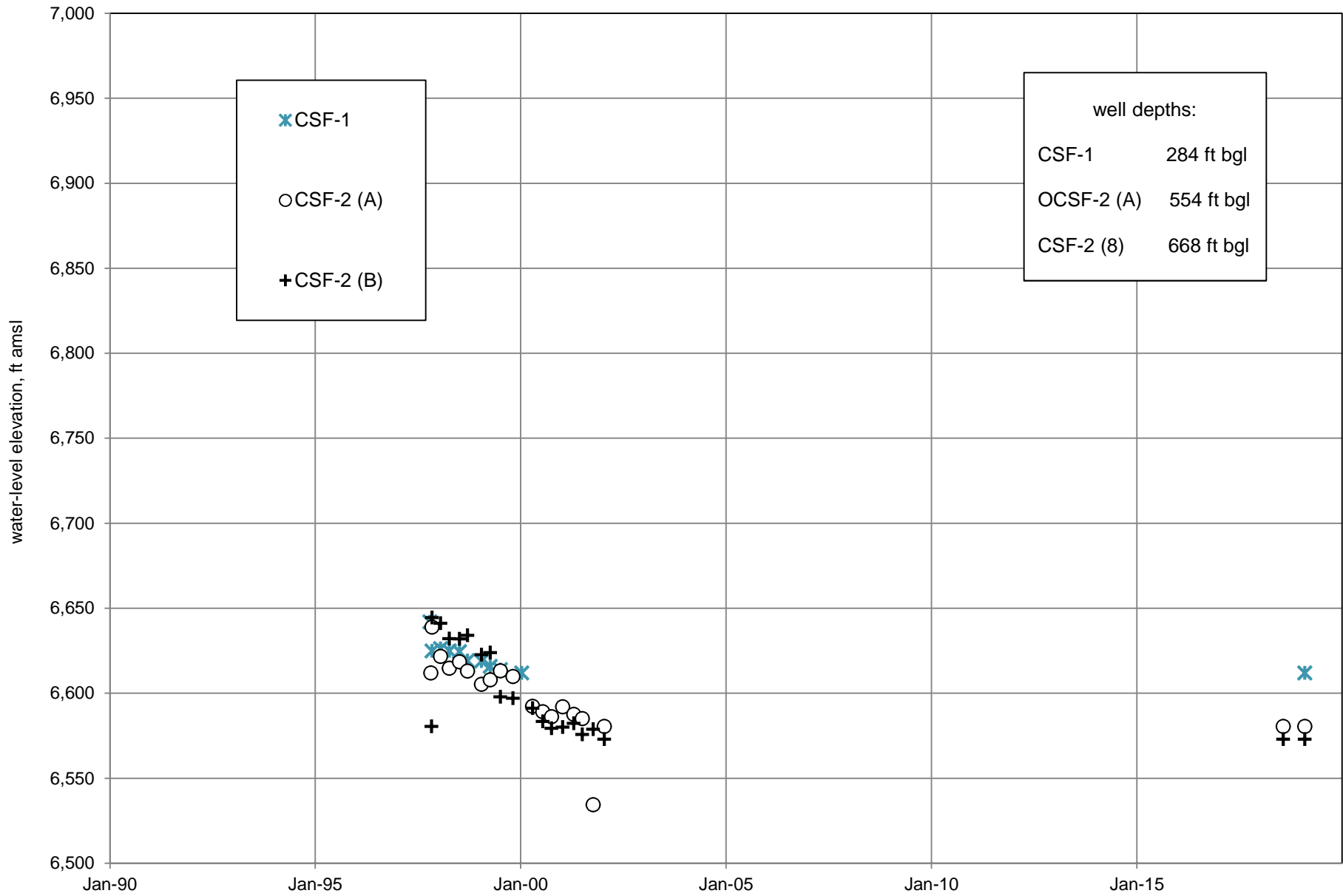


Figure C2. Water-level elevations for Group C wells CSF-1, CSF-2 (A), and CSF-2 (B), Northwest Well Monitoring Plan, Santa Fe, New Mexico.

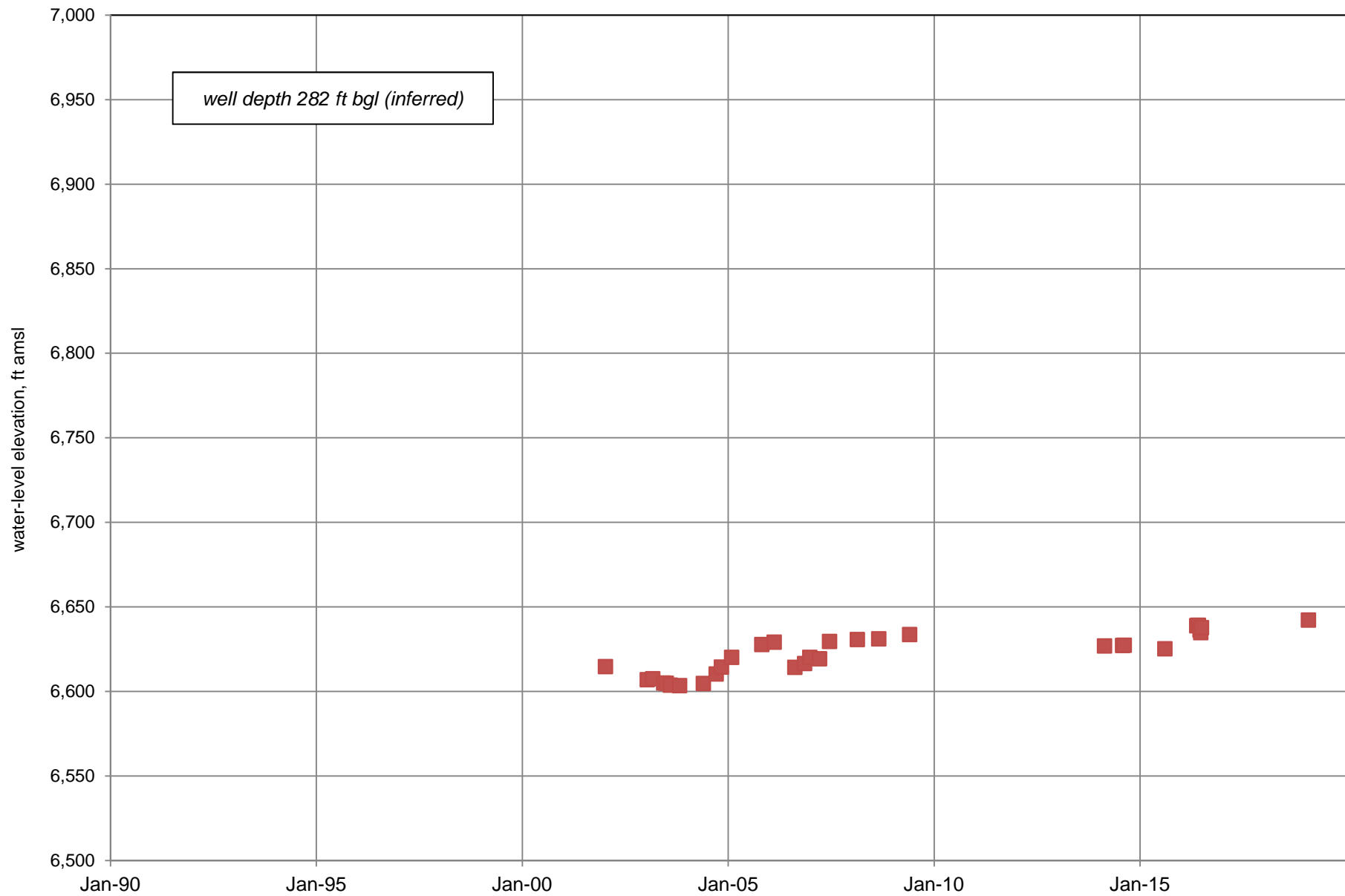


Figure C3. Water-level elevations for Group C well DBS-1D, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

Appendix D.

**Graphs showing water levels in Section 6.b wells of the Northwest Well and
City Well Field Monitoring Program**

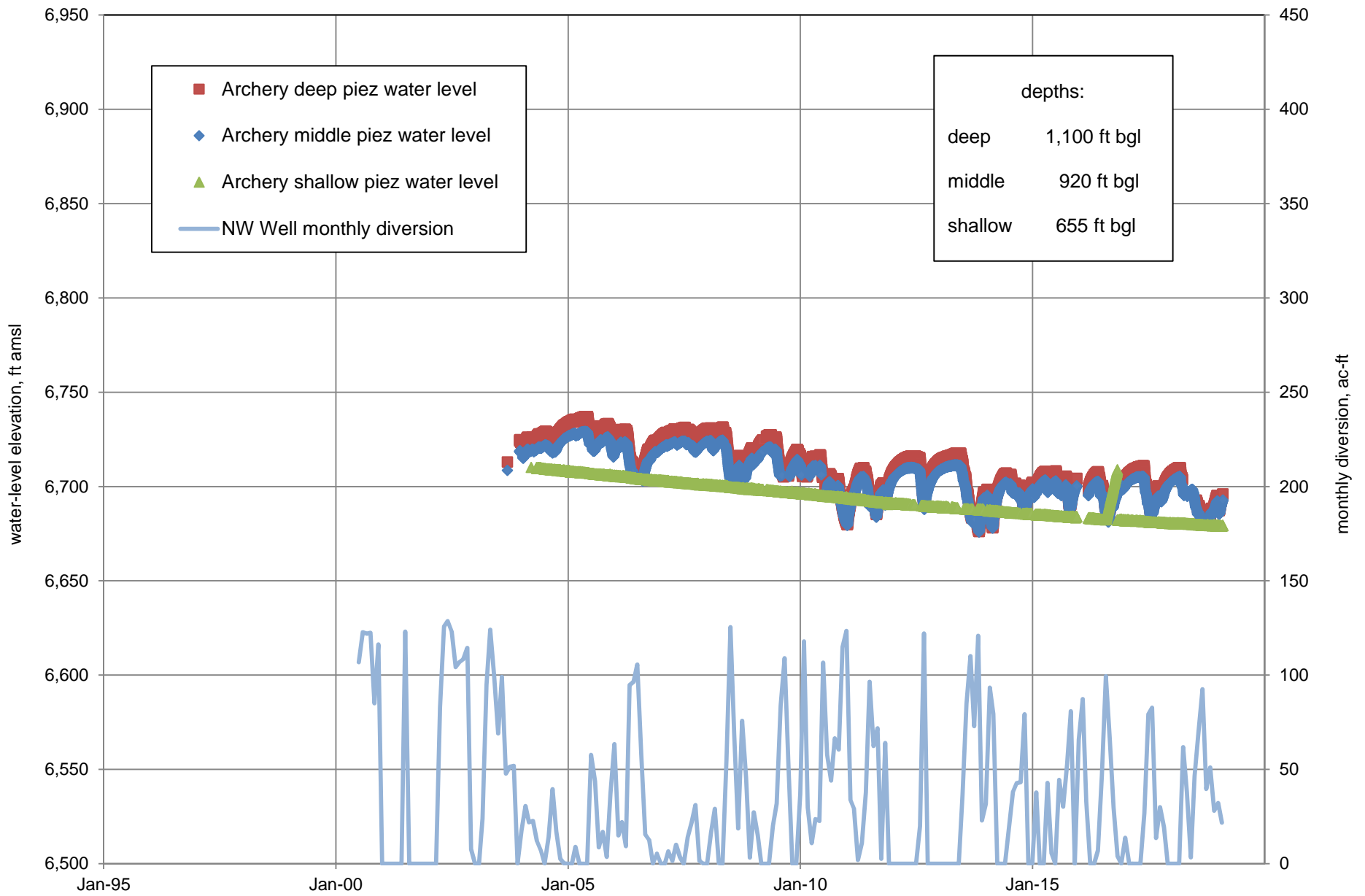


Figure D1. Water-level elevations for Section 6.b wells Archery shallow, middle, and deep piezometers, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

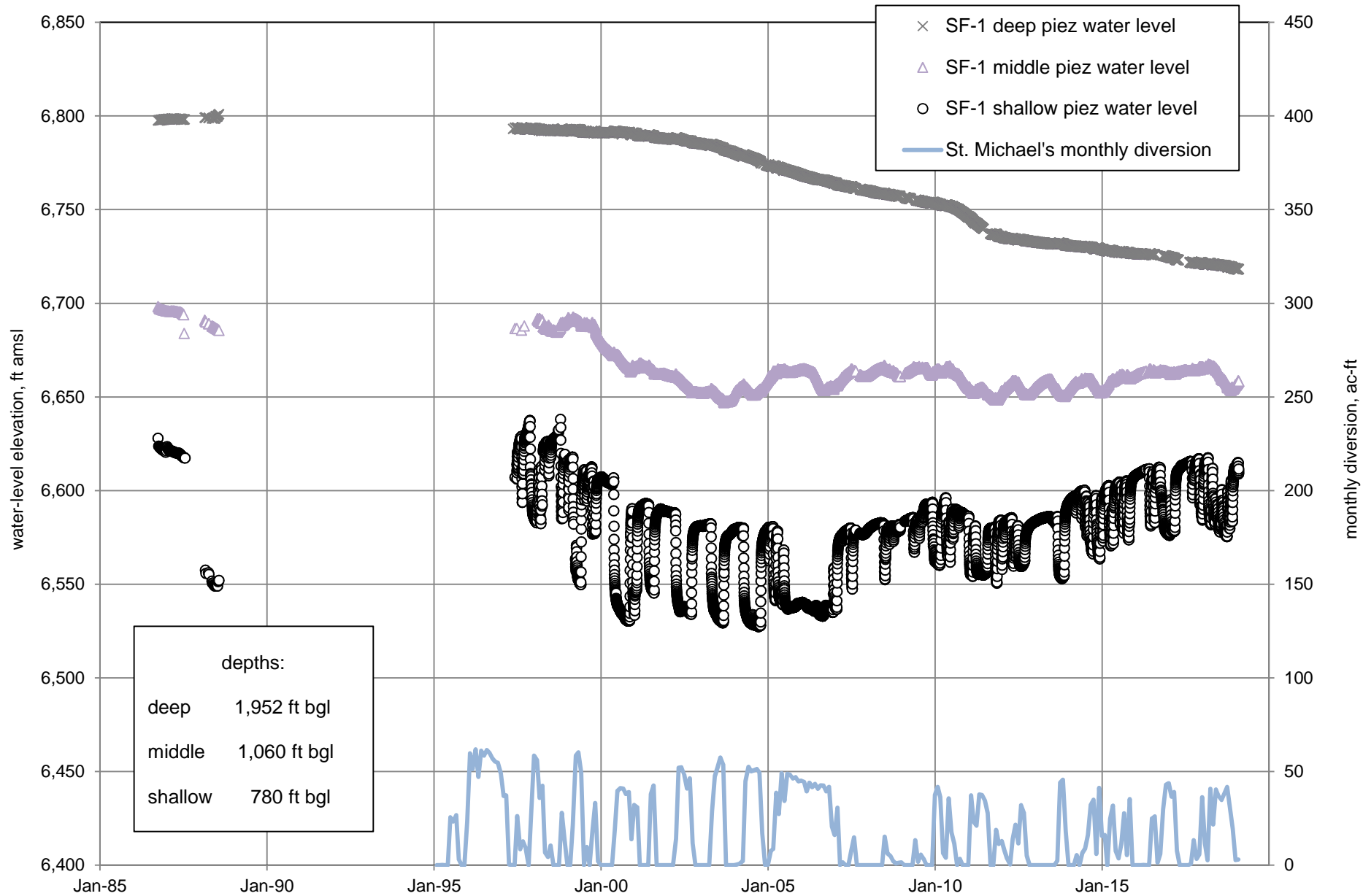


Figure D2. Water-level elevations for Section 6.b wells SF-1 shallow, middle, and deep piezometers, Northwest Well Monitoring Plan, Santa Fe, New Mexico.

Appendix E.

Water-level data used for contouring

Appendix E. Water-level data used for contouring

well	ID-2	USGS ID	category	TRSq4q16q64	X_UTM83, m	Y_UTM83, m	TD, ft	elev, ft amsl	Fig. 2			Fig. 3			Fig. 4	comment	NMBGMR ID
									DTW, ft	WLE, ft amsl	WL date	DTW, ft	WLE, ft amsl	WL date	2014-2019 change in WL, ft		
RG-25463	BMP		domestic		407017	3956720	841	6664.00	470.68	6193	1/7/2014	472.12	6192	1/29/2019	-1.4		
La Tierra Deep Monitoring Well	BMP		observation		406436	3955825	1200	6595.00	373.31	6222	1/14/2014	374.73	6220	1/28/2019	-1.4		
RG-79509	BMP		domestic		406889	3954249	800	6745.00	527.61	6217	2/7/2014	529.19	6216	1/29/2019	-1.6		
EB-475	Group A		monitoring well		412514	3950334	460	6999.03				359.15	6640	3/11/2019		Ortiz 1 (Ortiz Park Landfill MW-1)	EB-475
RG-49683	Group A		domestic	17N.09E.1.4141	415431	3954452	600	7178.50	282.28	6896	Feb-13					SDC1	EB-080
RG-73001	Group A		domestic		412656	3954692	805	7160.00									
RG-78218	Group A		domestic		411717	3957024	1000	6810.00									EB-275
St. Michael's	Group B		municipal		412595	3946570	795	6853.45	255.75	6598	1/31/2014	250.70	6603	12/31/2018	5.1		
Osage	Group B		municipal		411324	3948080	770	6750.00	121.49	6629	1/31/2014	116.80	6633	1/31/2019	4.7		
Santa Fe	Group B		municipal		412858	3948427	725	6871.60	312.70	6559	8/31/2013	308.60	6563	1/31/2019	4.1	2014 WLs represented pumping WLs	
Agua Fria	Group B		municipal		412124	3948689	740	6797.65	175.80	6622	1/31/2014	174.80	6623	7/31/2018	1.0	8/2018-1/2019 DTW represent pumping WLs	
New Alto	Group B		municipal		413015	3949504	725	6861.40	213.50	6648	4/30/2014	201.00	6660	1/31/2019	12.5	Jan-2014 WL represented recovery WL	
Ferguson	Group B		municipal		413347	3949741	750	6877.00	231.62	6645	5/31/2014	227.00	6650	1/31/2019	4.6	Jan-2014 WL represented recovery WL	
Torreon	Group B		municipal		412462	3949430	1230	6828.00	148.64	6679	4/30/2014	103.70	6724	1/31/2019	44.9	Jan-2014 WL represented pumpingWL	
Hickox 2	Group B		observation		414198	3949035	860	6965.00	205.71	6759	1/31/2014	212.60	6752	1/31/2019	-6.9	WL not representative of regional flow field	
Alto St MW-3	Group C		monitoring well		413029	3949523	415	6873.90				249.85	6624	2/4/2019			
Alto St MW-5	Group C		monitoring well		412691	3949465	235	6842.80				210.46	6632	2/4/2019			
Alto St MW-7	Group C		monitoring well		413018	3948987	520	6892.70				276.41	6816	2/4/2019			
Alto St MW-9	Group C		monitoring well		413026	3949523	160	6873.90				159.70	6714	2/4/2019			
CSF-1	Group C		monitoring well		413187	3848709	284	6913.00				284.67	6628	2/4/2019			
CSF-2A	Group C		monitoring well		412467	3948553	554	6858.00				225.76	6632	2/4/2019			
CSF-2B	Group C		monitoring well		412467	3948553	668	6858.00				232.77	6625	2/4/2019			
DBS-1D	Group C		monitoring well		413401	3949861	282	6885.73	258.75	6627	2/22/2014	243.46	6642	2/4/2019	15.3		
RG-62069			domestic	17N.09E.4.233	410410	3954860	940	6980.00								Welsh Family Expl	EB-108
RG-61371			domestic		412320	3953853	710	7160.00									
EB-011	NMBGMR		domestic	17N.09E.23.23214	413539	3950220	260	6894.90	239.83	6655	2/21/2014					MWB Wood Well	EB-011
EB-273	NMBGMR		domestic	17N.09E.2.3231	413205	3954305	800	7214.47	573.33	6641	2/20/2014					Tano Rd - Stapleton; WL may be influenced by pumping cycles	EB-273
EB-274	NMBGMR		domestic	17N.09E.3.2411	412424	3954893	800	7101.00	443.76	6657	2/20/2014					Cowden Henry MW1	EB-274
MW-7	NMBGMR		monitoring well	17N.09E.22.221	412158	3950630	435	7028.67	381.07	6648	2/20/2014						EB-473
EB-066	NMBGMR		domestic	17N.10E.6.343	416340	3954065	725	7345.00	298.32	7047	Feb-13					Circle Drive	EB-066
EB-091	NMBGMR		domestic	18N.09E.33.324	410225	3956040	1040	6994.00	636.80	6357	Feb-13					Spiegel	EB-091
EB-093	NMBGMR		domestic	17N.09E.2.111	412794	3955412	650	7114.60	450.82	6664	Feb-13					SDC4; Sharp	EB-093
EB-098	NMBGMR		domestic	18N.09E.34.212	412169	3957033	840	6946.00	284.54	6661	Feb-13					TanoVistaGrande Expl	EB-098
EB-107	NMBGMR		domestic	17N.09E.2.31	412977	3954837	640	7155.00	488.07	6667	Feb-13					Rancho de los Cuervos	EB-107
EB-110	NMBGMR		domestic	17N.09E.18.213	407200	3952020	730	6718.00	493.28	6225	Feb-13					Brenner; Vallecitos #1	EB-110
EB-136	NMBGMR		domestic	17N.09E.3.313	411150	3954500	860	7068.20	700.20	6368	Feb-13					Heartstone Development Exp	EB-136
EB-272	NMBGMR		domestic	17N.09E.2.3244	413500	3954201	618	7255.50								Tano Rd - Dulaney	EB-272
EB-108	NMBGMR		domestic		410410	3954860	940	6978.00	625.50	6353	Feb-13						EB-108
Northwest Well	NW		municipal		412027	3952586	2000	7124.00	429.67	6694	5/31/2014	475.87	6648	1/22/2019	-46.2		
Archery Shallow	USGS	354321105573703	nested peizometer	17N.09E.11.124	413149	3953989	665	7223.00	536.56	6686	5/23/2014	543.83	6679	2/7/2019	-7.3		
Archery Middle	USGS	354321105573702	nested peizometer	17N.09E.11.124	413149	3953989	920	7223.00	521.62	6701	5/23/2014	530.14	6693	2/7/2019	-8.5	Jan-2014 WL influenced by nearby pumping	
Archery Deep	USGS	354321105573701	nested peizometer	17N.09E.11.124	413149	3953989	1100	7223.00	516.93	6706	5/23/2014	526.95	6696	2/7/2019	-10.0	Jan-2014 WL influenced by nearby pumping	EB-295
17N.09E.24.343	USGS	354100105562701	USGS-monitored	17N.09E.24.343	414866	3949234	180	6990.00	57.38	6933	4/17/2014						
SF-1 Shallow	USGS	353945105574503	nested peizometer	17N.09E.35.123	412748	3946908	780	6880.00	281.88	6598	5/22/2014	268.51	6611	2/5/2019	13.4	Jan-2014 WL influenced by nearby pumping	
SF-1 Middle	USGS	353945105574502	nested peizometer	17N.09E.35.123	412748	3946908	1060	6880.00	220.88	6659	5/22/2014	221.62	6658	2/5/2019	-0.7	Jan-2014 WL influenced by nearby pumping	
SF-1 Deep	USGS	353945105574501	nested peizometer	17N.09E.35.123	412748	3946908	1952	6880.00	149.68	6730	5/22/2014	161.76	6718	2/5/2019	-12.1		
NMOSE Fairgrounds Shallow	USGS	353825105594703	nested peizometer		409790	3944508	540	6625.00	159.98	6465	1/1/2014	161.09	6464	2/5/2019	-1.1		
NMOSE Fairgrounds Middle	USGS	353825105594702	nested peizometer		409790	3944508	1380	6625.00	192.47	6433	1/10/2014	192.36	6433	2/5/2019	0.1		
NMOSE Fairgrounds Deep	USGS	353825105594701	nested peizometer		409790	3944508	1700	6625.00	207.8	6417	1/10/2014	208.53	6416	2/5/2019	-0.7		
USGS-9	USGS	354013105580601	USGS-monitored	17N.09E.27.441	412363	3947810	989	6845.00	243.3	6602	2/20/2014						
USGS-8	USGS	354100105562701	USGS-monitored	17N.09E.24.343	414814	3949238	180	6990.00	57.38	6933	4/17/2014						
USGS-2	USGS	353636106021001	USGS-monitored	16N.08E.13.444	406092	3941174	337	6395.00	261.98	6133	2/21/2014						

USGS - U.S. Geological Survey
 NMBGMR - New Mexico Bureau of Geology and Mineral Resources
 NMOSE - New Mexico Office of the State Engineer

BMP - Buckman Monitoring Program
 DTW - depth to water
 WLE - water level elevation

TD - total depth
 ft amsl - feet above mean sea level
 WL - water level

Appendix F.

CD with water-level and pumping data