

**First Report on the Five Year Review of Water Availability  
Western Spink Hitchcock Management Unit of the Tulare Aquifer  
September 17, 2020**

The Water Management Board deemed the Western Spink Hitchcock management unit of the Tulare aquifer as fully appropriated in 2013. In 2014, the South Dakota Legislature provided a process for administering fully appropriated aquifers by placing into law SDCL 46-2A-7 through 46-2A-7.7. These laws provide a process to 1.) notice a determination that a groundwater source is fully appropriated; 2.) accept and hold applications for future consideration; 3.) create a priority list for future appropriations if unappropriated water becomes available; and 4.) conduct a review at least once every five years to determine whether unappropriated water is available. At the time of this report, there are 28 applications to appropriate water on hold for this aquifer management unit and they total 72.79 cubic feet per second (cfs) for the irrigation of 5,374 acres. This report is an assessment of the availability of unappropriated water in the Western Spink Hitchcock management unit of the Tulare aquifer to satisfy the five-year review requirements for fully appropriated aquifers.

**AQUIFER: Western Spink Hitchcock management unit of the Tulare aquifer (T:WSH)**

**HYDROGEOLOGY**

The Tulare aquifer is a Quaternary aged system of interconnected sand and gravel layers that were deposited as outwash by meltwater from receding glaciers (Howells and Stephens, 1968). The Western Spink Hitchcock management unit of the Tulare aquifer is a buried aquifer generally lying immediately above the bedrock (basal) (Hedges et al., 1982). The glacial deposits that created the Tulare aquifer were deposited on top of an existing erosional surface that had exposed the Cretaceous aged Pierre Shale, Niobrara Formation, and in the buried deeply incised bedrock valleys, the Codell Sandstone member of the Carlisle Shale (Howells and Stephens, 1968). The areal extent of the Western Spink Hitchcock management unit has undergone several revisions and they are described in detail by Buhler (Buhler, 2012a). The current areal extent has been delineated as covering an area of 263,016 acres (Buhler, 2012a). Buhler (2013) later notes that this areal extent may have been optimistic. This review did not investigate revising the boundaries of the Tulare: Western Spink Hitchcock management unit, however, there have been over 100 additional test holes or wells drilled within the boundaries of the management unit since 2012 (Water Rights, 2020d).

Buhler's (2013) analysis determined that approximately 76,978 acres of the Tulare: Western Spink Hitchcock aquifer were under unconfined conditions in October 2012, and showed that at that time, the majority of the Tulare: Western Spink Hitchcock aquifer was under confined conditions. The static water level in the Tulare: Western Spink Hitchcock aquifer has ranged from 63 feet below ground surface to rising above ground surface (Water Rights, 2020b). The direction of groundwater flow in the Tulare: Western Spink Hitchcock management unit is generally from the west to the east, towards the James River.

**South Dakota Codified Law 46-2A-9**

Pursuant to SDCL 46-2A-9, a permit to appropriate water may be issued only if there is a reasonable probability that there is unappropriated water available for the applicant's proposed

use, that the proposed diversion can be developed without unlawful impairment of existing rights and that the proposed use is a beneficial use and in the public interest.

## **WATER AVAILABILITY**

The probability of unappropriated water available from an aquifer can be evaluated by considering SDCL 46-6-3.1, which requires “No application to appropriate groundwater may be approved if, according to the best information reasonably available, it is probable that the quantity of water withdrawn annually from a groundwater source will exceed the quantity of the average estimated annual recharge of water to the groundwater source.”

The availability of unappropriated water from the Tulare: Western Spink Hitchcock aquifer was last evaluated in 2013 and was based upon observation well data and through consideration of a hydrologic budget for the aquifer (Buhler, 2013). This report will reevaluate the availability of unappropriated water from the Tulare: Western Spink Hitchcock aquifer based upon additional years of observation well data and the development of a hydrologic budget for the aquifer.

### **Observation Well Data**

In determining the availability of unappropriated water, South Dakota Administrative Rule 74:02:05:07 requires the Water Management Board to rely on the record of observation well measurements in addition to other data, to determine that the quantity of water withdrawn annually from the aquifer does not exceed the estimated average annual recharge to the aquifer. The analysis of observation well data provides a means of assessing the aquifer and provides the best reasonably available information to evaluate the balance between withdrawals from and recharge to the Tulare: Western Spink Hitchcock aquifer.

The Water Rights Program monitors 50 observation wells completed in the Tulare: Western Spink Hitchcock aquifer (Water Rights, 2020b). Hydrographs for five of these observation wells are shown in Figures 2-6 and hydrographs for all 50 are included in Appendix B. The five selected hydrographs are representative of the Tulare: Western Spink Hitchcock aquifer and show that the aquifer readily responds to climatic conditions, with rising water levels during wet years and declining water levels during dry years.

The response of the aquifer as recorded by the observation well measurements can provide insight into the balance of withdrawals to recharge for an aquifer. If discharge (natural and from well withdrawals) from an aquifer is exceeding the recharge to an aquifer, a steady, continual decline of the water level or artesian pressure is expected. In observation wells that show the influence of well withdrawals, a seasonal decline should be observed followed by a return to the pre-pumping water level. If the withdrawals across the entirety of the aquifer are unevenly distributed, the configuration of the potentiometric surface may change to show the effect of these withdrawals. The effects of climate can mask some of these signals for how the aquifer responds to pumping.

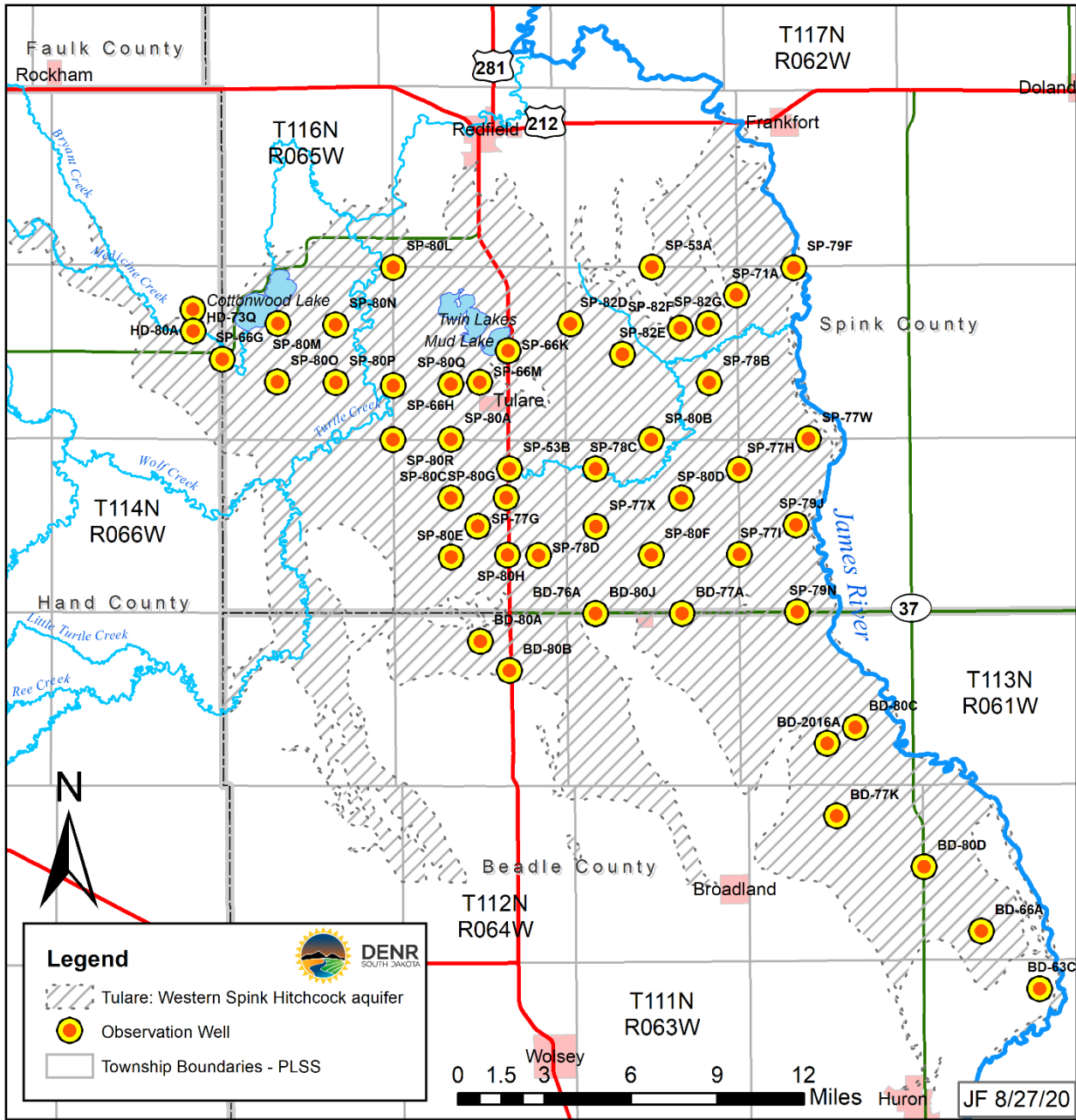


Figure 1. Map of the Western Spink Hitchcock management unit of the Tulare Aquifer showing the location of observation wells in the Tulare: Western Spink Hitchcock aquifer (Modified from Buhler, 2012a; Water Rights, 2020b)

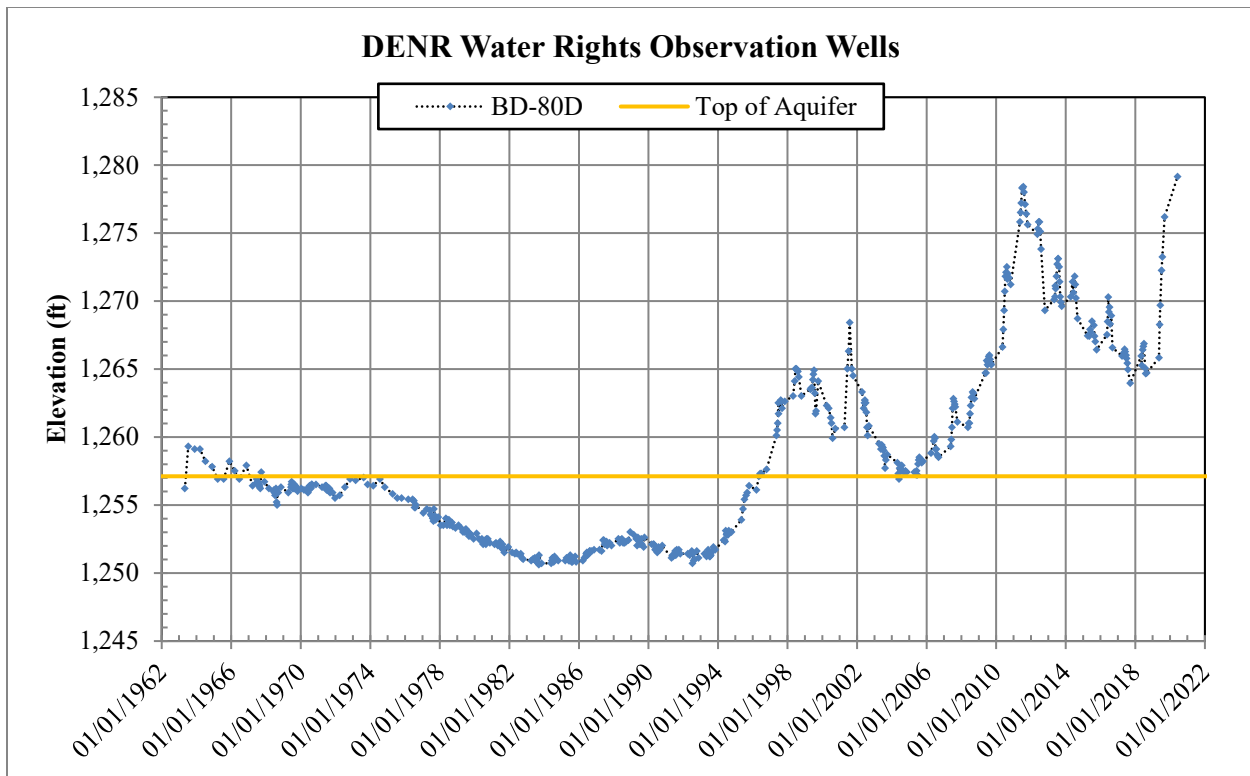


Figure 2. Hydrograph of DENR-Water Rights’ observation well BD-80D (see Figure 1 for location). Ground surface elevation is approximately 1292 ft.

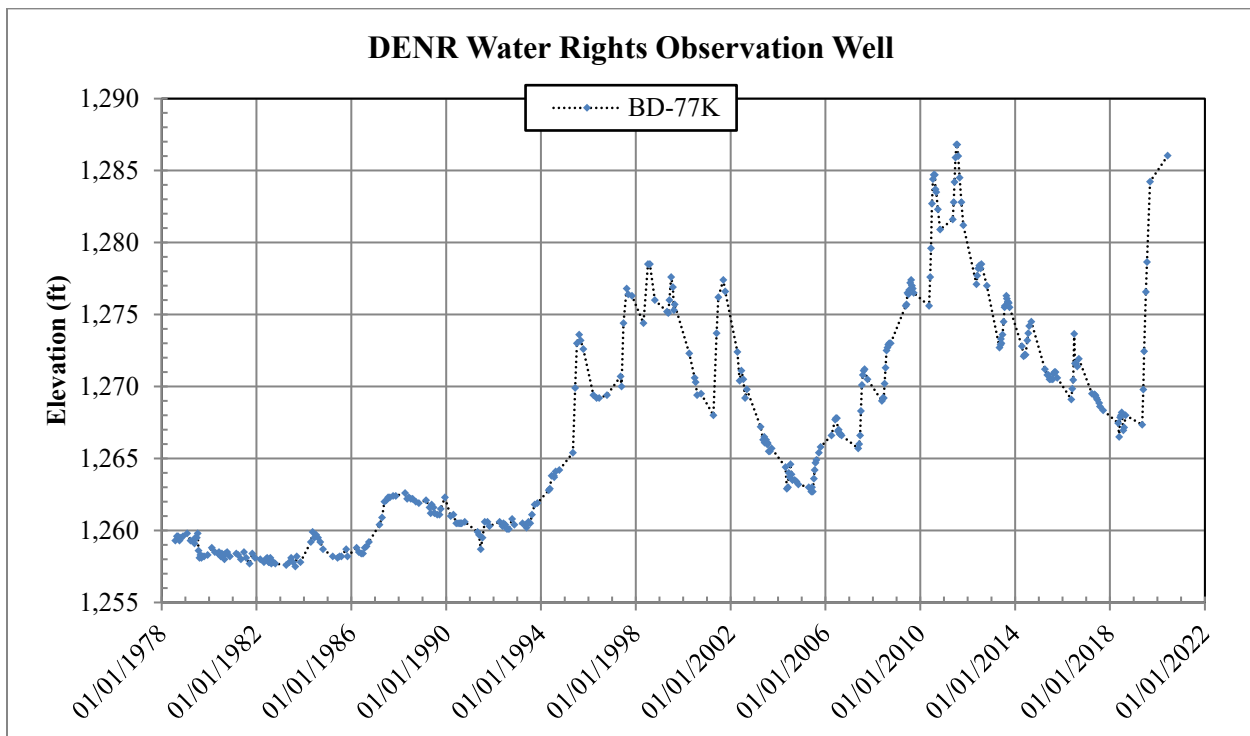


Figure 3. Hydrograph of DENR-Water Rights’ observation well BD-77K (see Figure 1 for location). Top of aquifer elevation is approximately 1239 ft, ground surface elevation is approximately 1313 ft.

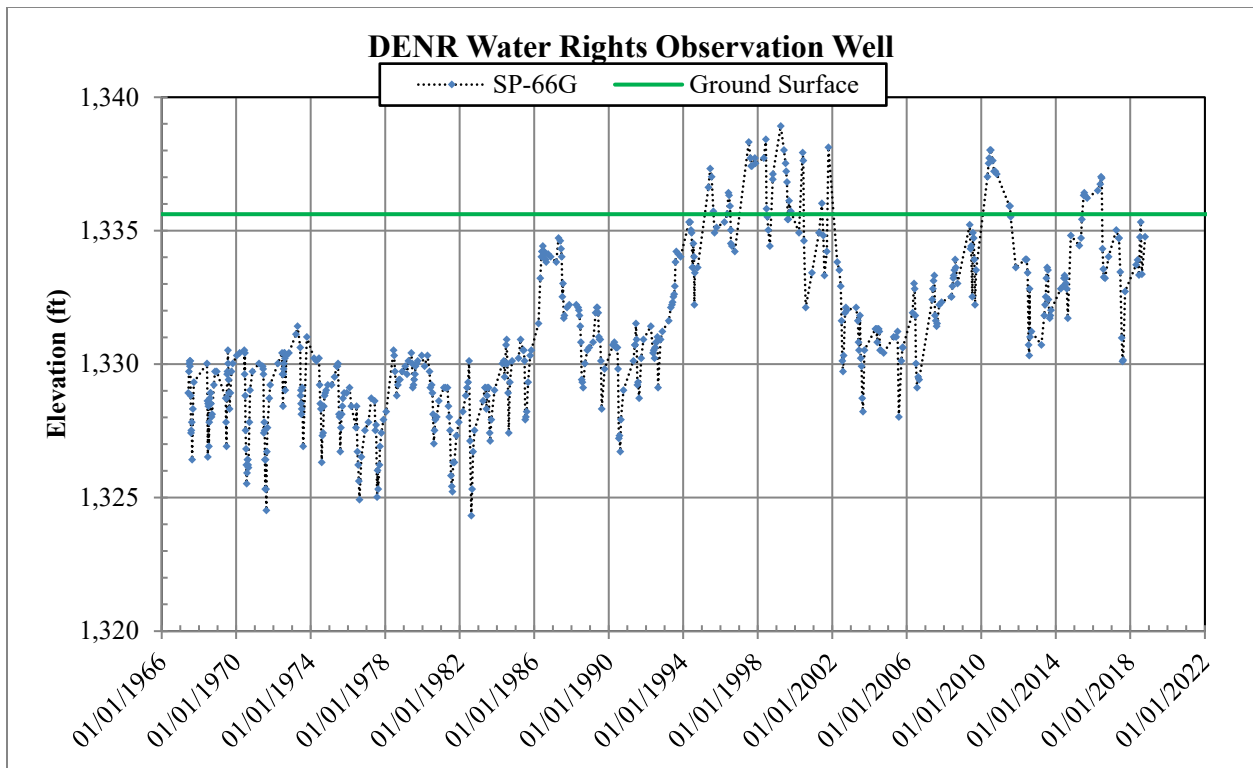


Figure 4. Hydrograph of DENR-Water Rights' observation well SP-66G (see Figure 1 for location). Top of aquifer elevation is approximately 1264 ft.

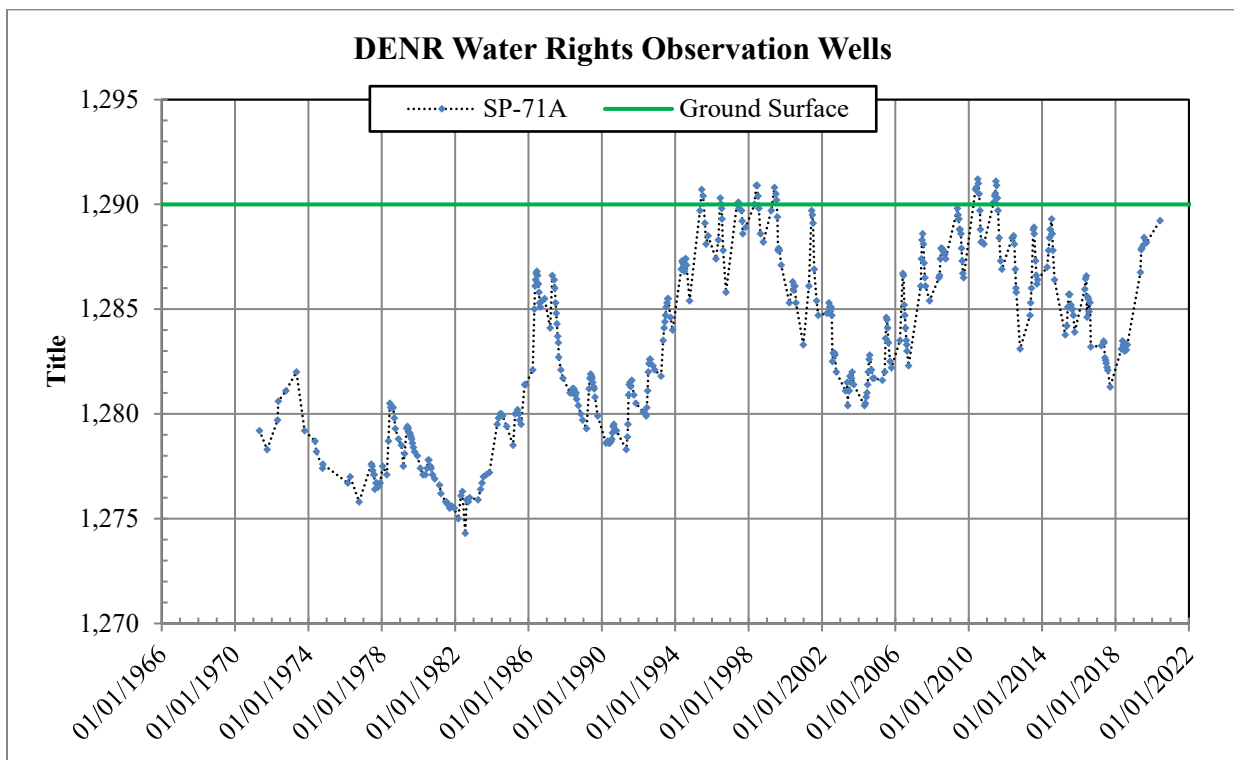


Figure 5. Hydrograph of DENR-Water Rights' observation well SP-71A (see Figure 1 for location). Top of aquifer elevation is approximately 1245 ft.

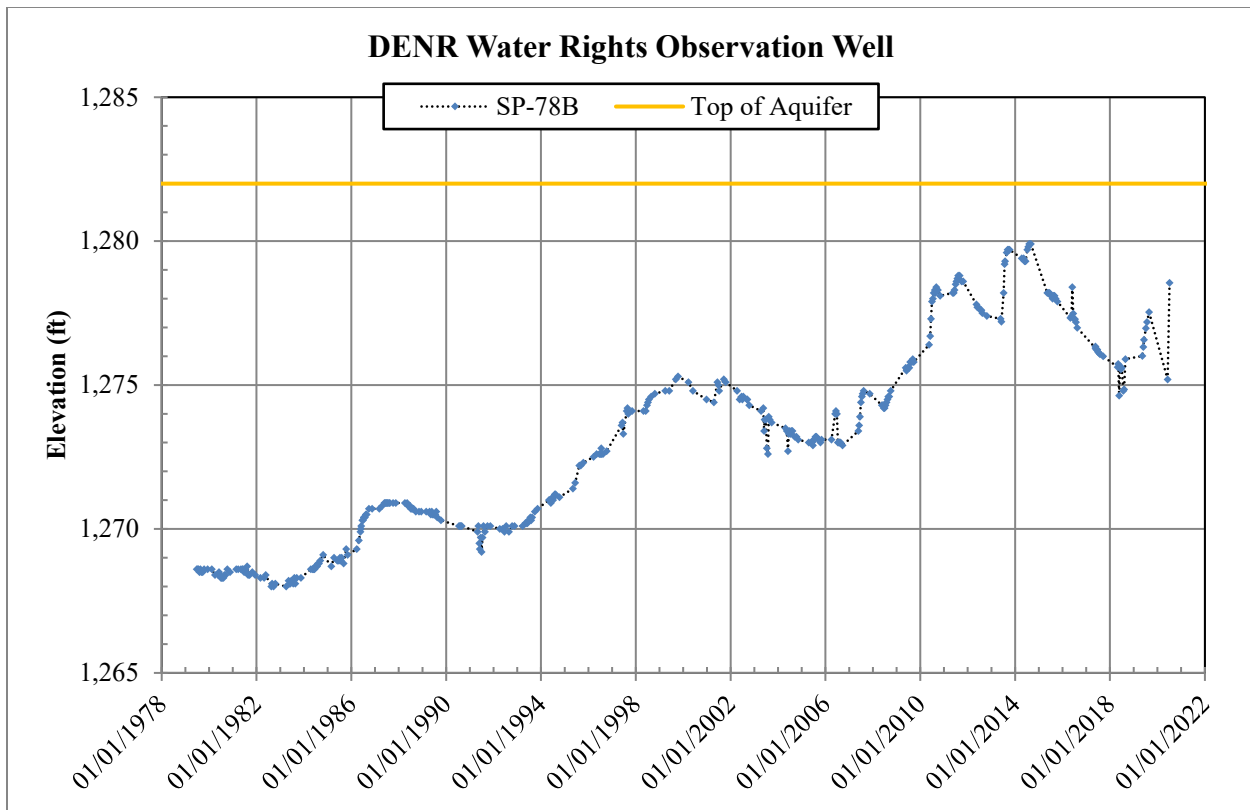


Figure 6. Hydrograph of DENR-Water Rights’ observation well SP-78B (see Figure 1 for location). Ground surface elevation is approximately 1296 ft.

**Observation well water level trends:**

When the discharge (natural and from well withdrawals) exceeds the recharge of an aquifer, a declining water level is an indicator. Conversely, a rising water level in an aquifer is an indicator that the recharge is exceeding the discharge (natural and well withdrawals) of an aquifer. An equation for this relationship is:

$$\Delta S = R - D$$

Where:  $\Delta S$  = change in the volume of water in storage in the aquifer  
 R= Recharge  
 D= Discharge

The observation well data for the Tulare: Western Spink Hitchcock aquifer has documented upward trending water levels throughout the aquifer (Water Rights, 2020b). The average slope of linear trend lines for the 48 observation well hydrographs from the initial measurement in 1983 up to the last measurement of 2019 has been +0.000571 feet per day (+0.209 feet per year). Observation well BD-80B was removed from this analysis due to the well having several periods of missing data and observation well BD-2016A was removed due to having a short period of record. Buhler’s analysis (2013) refined the period of analysis to encompass January 2003 through October 2012 due to no additional appropriations being made over this time period. This time period did not account for the time it took for the appropriations approved in 2002 to place water to beneficial use. All permitted and licensed water rights had placed water to beneficial use starting with the 2008 irrigation season. Analysis of the observation wells over the January 2003 through October 2012 period found the average slope of the linear trend line for

the 48 observation well hydrographs to be +0.003607 feet per day (+1.317 feet per year). Including the time prior to Buhler's analysis, 1983 through October 2012, the average slope of the linear trend line for the 48 observation well hydrographs was found to be +0.000751 feet per day (+0.274 feet per year). In the time since Buhler's analysis up to the end of 2019 (November 2012 through 2019), the average slope of the linear trend line for the 48 observation well hydrographs has been -0.001187 feet per day (-0.433 feet per year). This type of analysis does not account for any errors introduced by including data from observation wells that are influenced by well withdrawals and the year to year variability of those withdrawals or an observation well changing between unconfined and confined behaviors. Observation wells that are under unconfined conditions show the change in storage within the aquifer, while observation wells that are under confined conditions show the change in hydrostatic pressure.

Over the period of record, the upward trend of the water levels indicates recharge to the Tulare: Western Spink Hitchcock aquifer has been greater than the total of the discharges from the aquifer. However, given the decrease in the average slope of the linear trend line since Buhler's analysis (November 2012-end of 2019), consideration of appropriations that have started placing water to beneficial use since November 2012, and the decrease in the long term average slope from the period of 1983 through October 2012 (+0.274 feet per year) to the period of 1983 through 2019 (+0.209 feet per year), the observation well water level trend is indicating that discharge may have exceeded the recharge of the aquifer over the November 2012 through 2019 time period.

Quantifying the change in volume of water stored in the Tulare: Western Spink Hitchcock aquifer is possible through analysis of observation wells that have remained unconfined throughout their period of record. The response of the aquifer when an observation well is under confined conditions is only reflective of the head pressure at that location and does not directly show changes in the volume of water in the aquifer. The hydrograph for observation well BD-80D as shown in Figure 2, visually shows how the observed water level changes between unconfined and confined conditions. The aquifer at observation well BD-80D was under unconfined conditions between 1966 and 1996, and then transitioned to confined conditions when the water level started rising above the top of the aquifer in 1997.

Continuing the methodology used by Buhler (2013), the same five observation wells were used to analyze the Tulare: Western Spink Hitchcock aquifer. These wells were chosen by Buhler because they are located in portions of the aquifer that remained unconfined for their entire period of record and the wells were determined to accurately reflect aquifer conditions. The time period used for this updated analysis was 1983-2019 to allow each observation well to have the same number of water years on record. The water year runs from October 1<sup>st</sup> through September 30<sup>th</sup> and the values used in this analysis are interpolated values for October 1<sup>st</sup> that were obtained using the two adjacent readings on the observation well hydrograph, unless a reading was recorded on October 1<sup>st</sup>. For example, the 1983 water year water level change is the interpolated Oct. 1, 1983 reading minus the interpolated Oct. 1, 1982 reading. The results of the analysis are shown in Table 1.

Buhler (2012a) analyzed the average annual water level change from 1983-2011. Buhler's (2012a) analysis showed an increase in average annual water level of 0.34 feet per year. However, Buhler's 2012 analysis and his subsequent 2013 analysis omitted the last month for

water year 2011 by only factoring in observation well readings from October 2010 through August 2011. The following water year, water year 2012, was calculated correctly from October 1, 2011 to October 1, 2012. The consequence of omitting September 2011 in these calculations is that there are unaccounted for drops in the observation well hydrographs of 3.5 feet for SP-79F, 0.2 ft for SP-78B, 1.2 ft for SP-80B, 1.1 ft for SP-82E, and 1.2 ft for SP-82G. Including September 2011 in the calculations for the annual water level change for 2011 reduces the average annual water level change in Buhler's 2012 analysis from 0.34 feet per year to 0.30 feet per year and for Buhler's 2013 analysis from 0.3152 feet per year to 0.21 feet per year. Buhler's 2013 analysis determined that by using the 0.3152 feet per year of average annual water level change over an unconfined area of 76,978 acres, the recharge exceeded the discharge by an average of 3,640 acre-feet per year. The availability of 3,640 acre-feet per year of unappropriated water applied at an application rate of 9.32 inches would allow the irrigation of 4,686 acres (Buhler, 2013). The Water Management Board approved permits authorizing the irrigation of 4,706 acres. If water year 2011 had included the observation well readings of September 2011, the amount of unappropriated water available would have been reduced by 1,215 acre-feet per year, to 2,425 acre-feet per year. This volume of unappropriated water would have only allowed the irrigation of an additional 3,122 acres, a reduction of 1,564 acres from Buhler's analysis (Buhler, 2013).

In the time since Buhler's report (2013), the average annual water level change has been an increase of 0.47 feet per year (2013-2019), resulting in the long-term average annual water level change being raised from +0.22 feet per year (1983-2012) to + 0.27 feet per year from 1983 to 2019. Given the short period of time since the last appropriations were approved in 2013, anomalously wet or dry years can skew the analysis of short time periods. One such anomalous year is the wet year of 2019, as evidenced in Table 2 by having the smallest amount of reported irrigation, the fewest irrigated acres, and the lowest application rate over the period of record. Excluding the anomalously wet year of 2019, the period of 2013-2018 saw a decrease of 0.02 feet per year, and the long-term period of 1983-2018 saw the average annual water level change lowered to +0.18 feet per year.

This method of estimating a volume of water is approximate as the unconfined area of the aquifer is not static and changes as the elevation of the water changes. This method also assumes that all variables relating to the use of the water are static and does not take into consideration any recent changes that would affect the use of water going into the future. Over the period of record, the observation well data indicates that the average annual recharge to the aquifer has exceeded the average annual discharge from the aquifer. This increase in annual water level change prior to Buhler's report was accounted for in Buhler's report (2013) and appropriations resulting from the report. In the time since Buhler's report and excluding the anomalously wet year of 2019 (2013-2018), the observation well data indicates that the average annual recharge to the aquifer has been nearly adequate to supply the average annual discharge from the aquifer with an average decline of 0.02 feet per year. This small decline, coupled with the time it took for approved appropriations to place their water to beneficial use (Table 5), suggests that additional data from future years is needed to determine if the appropriations made in 2013 from the Tulare: Western Spink Hitchcock aquifer brought the aquifer up to being fully appropriated. Based upon the existing data, the observation well analysis does not show that unappropriated water is available from the Tulare: Western Spink Hitchcock aquifer.



Table 1. Water Level change in feet by water year for select unconfined observation wells with averages calculated for specific time periods (Water Rights, 2020b)

<b>Water Year</b>	<b>SP-79F</b>	<b>SP-78B</b>	<b>SP-80B</b>	<b>SP-82E</b>	<b>SP-82G</b>	<b>Average</b>
1983	0.60	0.26	0.24	0.81	-0.42	0.30
1984	0.98	0.70	0.65	1.01	0.36	0.74
1985	0.73	0.13	0.31	0.10	-0.14	0.23
1986	1.76	1.57	2.14	4.80	1.94	2.44
1987	-2.96	0.20	0.41	-3.69	0.12	-1.18
1988	-0.63	-0.30	-0.41	-1.20	-0.74	-0.66
1989	0.25	-0.28	-0.18	-0.23	-0.33	-0.16
1990	0.40	-0.24	-0.42	0.53	-0.59	-0.06
1991	0.27	0.03	0.10	0.20	0.13	0.15
1992	0.38	-0.05	-0.08	1.62	0.13	0.40
1993	1.50	0.56	0.69	1.46	0.47	0.94
1994	-0.29	0.51	0.79	0.62	0.94	0.51
1995	1.40	1.14	1.76	1.31	3.44	1.81
1996	-1.56	0.42	0.84	-2.31	0.03	-0.52
1997	1.64	1.35	1.94	3.15	3.66	2.35
1998	1.14	0.62	0.80	-0.20	-0.15	0.44
1999	-2.06	0.60	0.45	-1.98	-1.34	-0.87
2000	-1.92	-0.64	-2.29	-1.82	-2.50	-1.84
2001	1.64	0.53	1.70	0.76	1.09	1.14
2002	-1.90	-0.76	-1.76	-1.85	-1.97	-1.65
2003	-0.40	-0.70	-1.14	-0.82	-0.90	-0.79
2004	0.68	-0.49	-0.75	0.50	-0.66	-0.15
2005	-0.14	-0.14	0.22	1.48	0.32	0.35
2006	0.13	-0.13	0.01	-1.25	0.45	-0.16
2007	1.69	1.83	2.26	2.85	2.07	2.14
2008	0.49	0.05	0.38	1.09	1.13	0.63
2009	0.35	1.03	0.99	-0.10	0.67	0.59
2010	0.90	2.46	1.67	0.48	1.42	1.38
2011	0.32	0.32	1.03	-0.69	-0.70	0.05
2012	-2.71	-1.17	-2.34	-1.75	-1.87	-1.97
2013	3.69	2.27	2.69	5.61	2.98	3.45
2014	-3.56	0.00	-1.41	-3.96	-1.35	-2.06
2015	-0.65	-1.75	-0.91	-0.01	-1.35	-0.93
2016	-0.40	-1.08	-0.51	-1.36	-0.80	-0.83
2017	-0.17	-0.89	-1.25	-0.65	-0.87	-0.77
2018	1.65	-0.06	0.36	1.70	1.31	0.99
2019	2.59	1.32	4.90	3.74	4.72	3.45
<i>Average from 1983-2019, period of record</i>	<i>0.16</i>	<i>0.25</i>	<i>0.37</i>	<i>0.27</i>	<i>0.29</i>	<i>0.27</i>
<i>Average from 1983-2011, time period of Buhler (2012a)</i>	<i>0.19</i>	<i>0.36</i>	<i>0.43</i>	<i>0.23</i>	<i>0.27</i>	<i>0.30</i>
<i>Average from 1983-2012</i>	<i>0.09</i>	<i>0.31</i>	<i>0.33</i>	<i>0.16</i>	<i>0.20</i>	<i>0.22</i>
<i>Average from 1983-2018</i>	<i>0.09</i>	<i>0.22</i>	<i>0.25</i>	<i>0.17</i>	<i>0.17</i>	<i>0.18</i>
<i>Average from 2003-2012, time period of Buhler (2013)</i>	<i>0.13</i>	<i>0.30</i>	<i>0.23</i>	<i>0.18</i>	<i>0.19</i>	<i>0.21</i>
<i>Average from 2003-2018, time period of Buhler (2013) through 2018</i>	<i>0.12</i>	<i>0.10</i>	<i>0.08</i>	<i>0.19</i>	<i>0.12</i>	<i>0.12</i>
<i>Average from 2003-2019</i>	<i>0.26</i>	<i>0.17</i>	<i>0.36</i>	<i>0.40</i>	<i>0.39</i>	<i>0.32</i>
<i>Average from 2012-2018, time period since Buhler (2012a)</i>	<i>-0.31</i>	<i>-0.38</i>	<i>-0.48</i>	<i>-0.06</i>	<i>-0.28</i>	<i>-0.30</i>
<i>Average from 2012-2019</i>	<i>0.06</i>	<i>-0.17</i>	<i>0.19</i>	<i>0.42</i>	<i>0.35</i>	<i>0.17</i>
<i>Average from 2013-2018, time period since Buhler (2013)</i>	<i>0.09</i>	<i>-0.25</i>	<i>-0.17</i>	<i>0.22</i>	<i>-0.01</i>	<i>-0.02</i>
<i>Average from 2013-2019</i>	<i>0.45</i>	<i>-0.03</i>	<i>0.55</i>	<i>0.72</i>	<i>0.66</i>	<i>0.47</i>

## **Potentiometric Surface:**

The potentiometric surface of an aquifer is a snapshot of the water level in the aquifer at a selected time. The potentiometric surface will show higher water levels as a result of wetter periods of time and lower water levels during drier times and/or increased periods of withdrawals. An analysis of the potentiometric surface does not provide a clear indication of whether there is unappropriated water available or how much may be available. The potentiometric surface data can show whether there are significant stressors on the aquifer, in other words, if the recharge is able to keep up with the withdrawals from the aquifer. These stressors would show up as a significant change in the general shape/configuration of the potentiometric surface. If there are areas of the aquifer that are showing signs of stress, it is an indicator that the aquifer is over-appropriated. The stressors may be caused by very significant increases in withdrawals in an area over a short period of time, or may be more subtle, such as a slight increase in the withdrawals that cumulatively over the course of 10, 15, 20 years exceed the recharge to the local area. The potentiometric surface of the aquifer would be able to show these stressors because the area that is being stressed is creating a steeper hill for the groundwater to flow down.

The potentiometric surface of the Tulare: Western Spink Hitchcock aquifer was estimated from observation well data for three time periods (Magstadt, 2020). These time periods are May 1988, May 2013, and June 2020. These dates were chosen for comparison of the configuration of the potentiometric surface with the potentiometric surfaces calculated by Buhler (2013). Maps showing the contour lines for these potentiometric surfaces are shown in Figures 6-8.

The potentiometric surface contours shown in Figure 6 show that water levels were generally lower in May 1988 than they were in May 2013. The potentiometric surface contours also show that the water levels were similar in May 2013 and June 2020. The potentiometric surface contour lines generally follow the same shapes for all three dates, indicating that the configuration of the potentiometric surface has not changed significantly over time. The configuration of the potentiometric surface of the aquifer over time is showing that the well withdrawals have not been affecting the general direction of groundwater flow, indicating that the aquifer has not been significantly stressed by withdrawals. The pre-development configuration of the potentiometric surface is unknown.

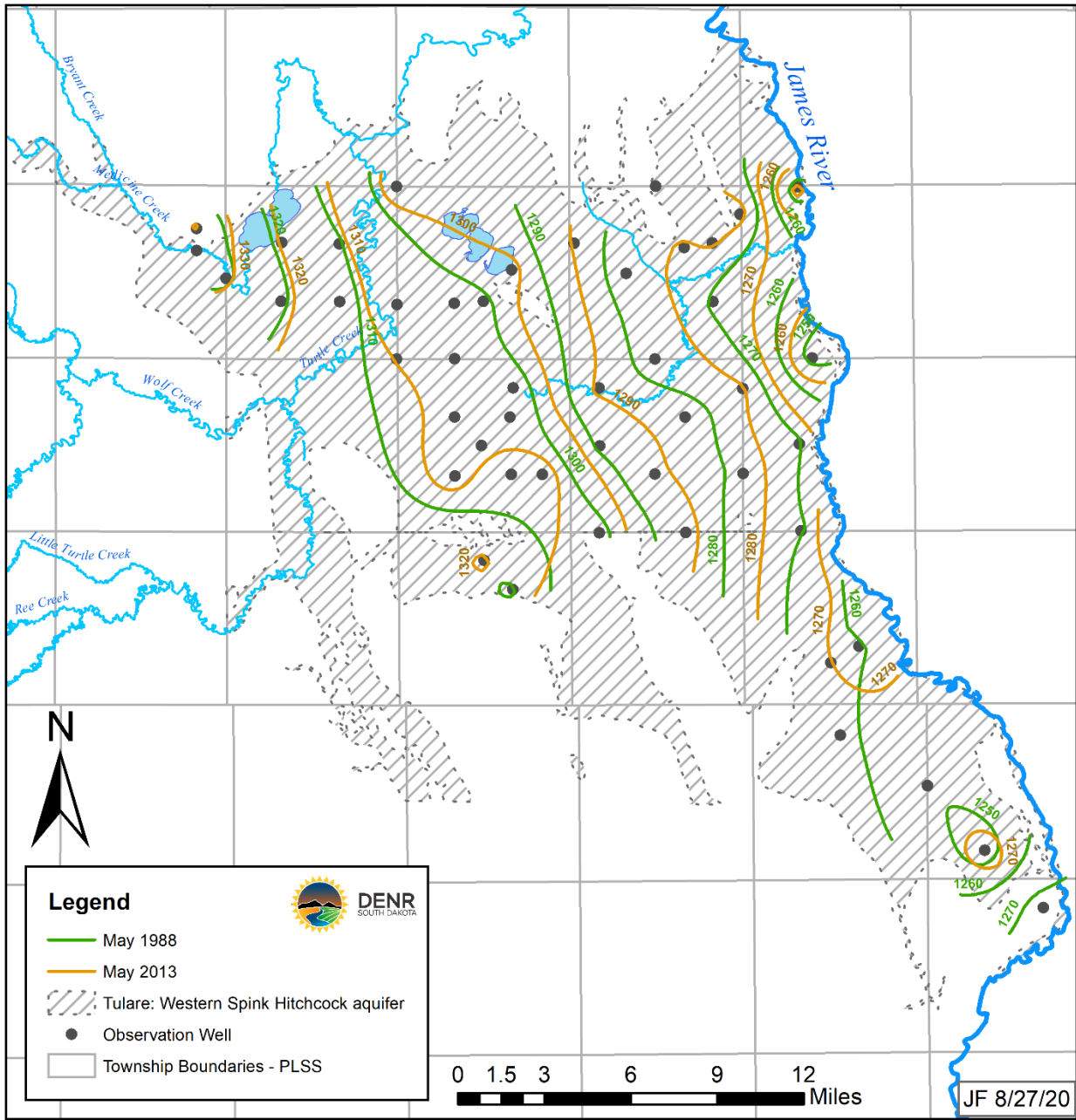


Figure 6. Potentiometric surface contours of the Tulare: Western Spink Hitchcock aquifer for May 1988 (Green) and May 2013 (Yellow)

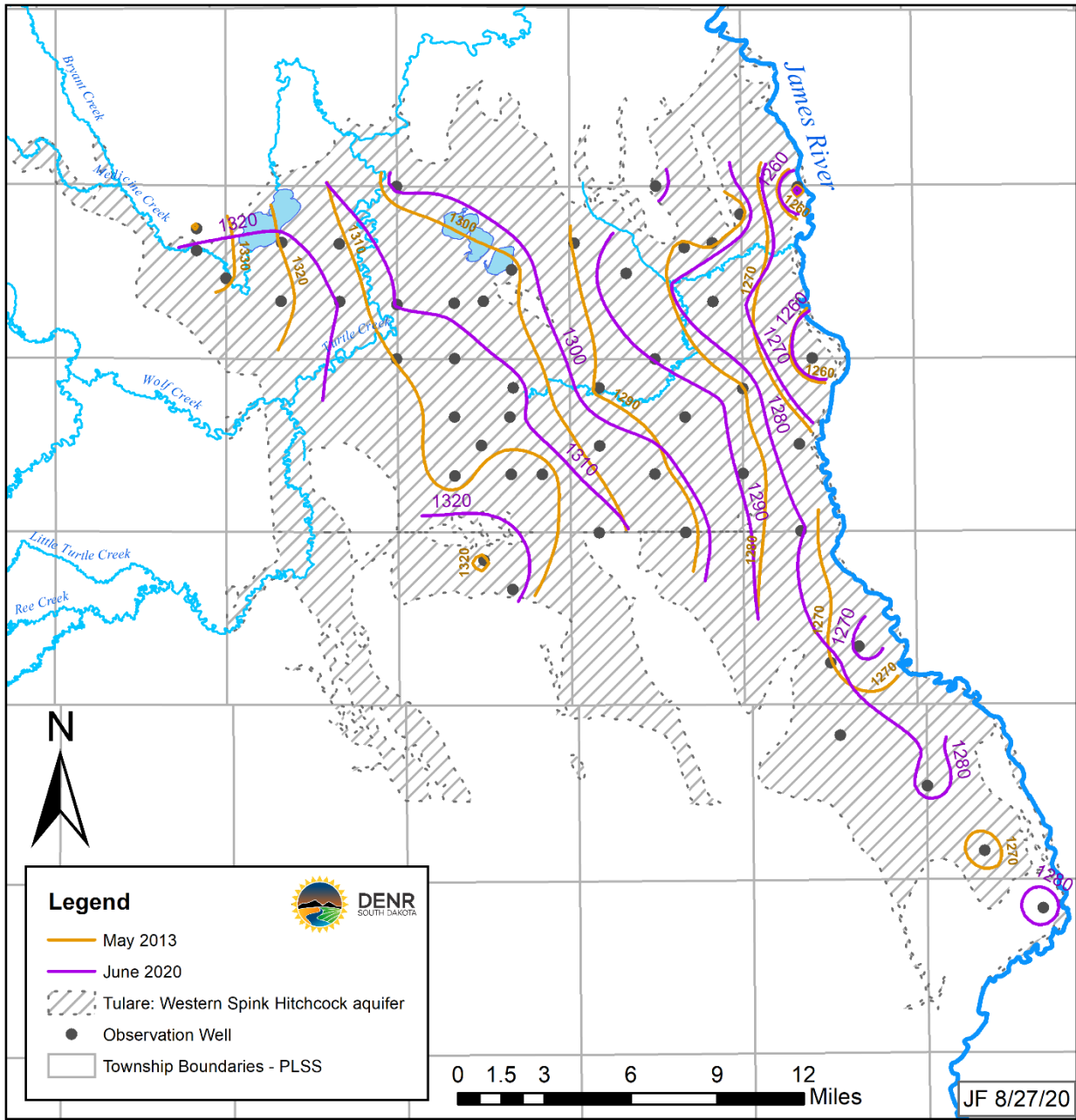


Figure 7. Potentiometric surface contours of the Tulare: Western Spink Hitchcock aquifer for May 2013 (Yellow) and June 2020 (Purple)

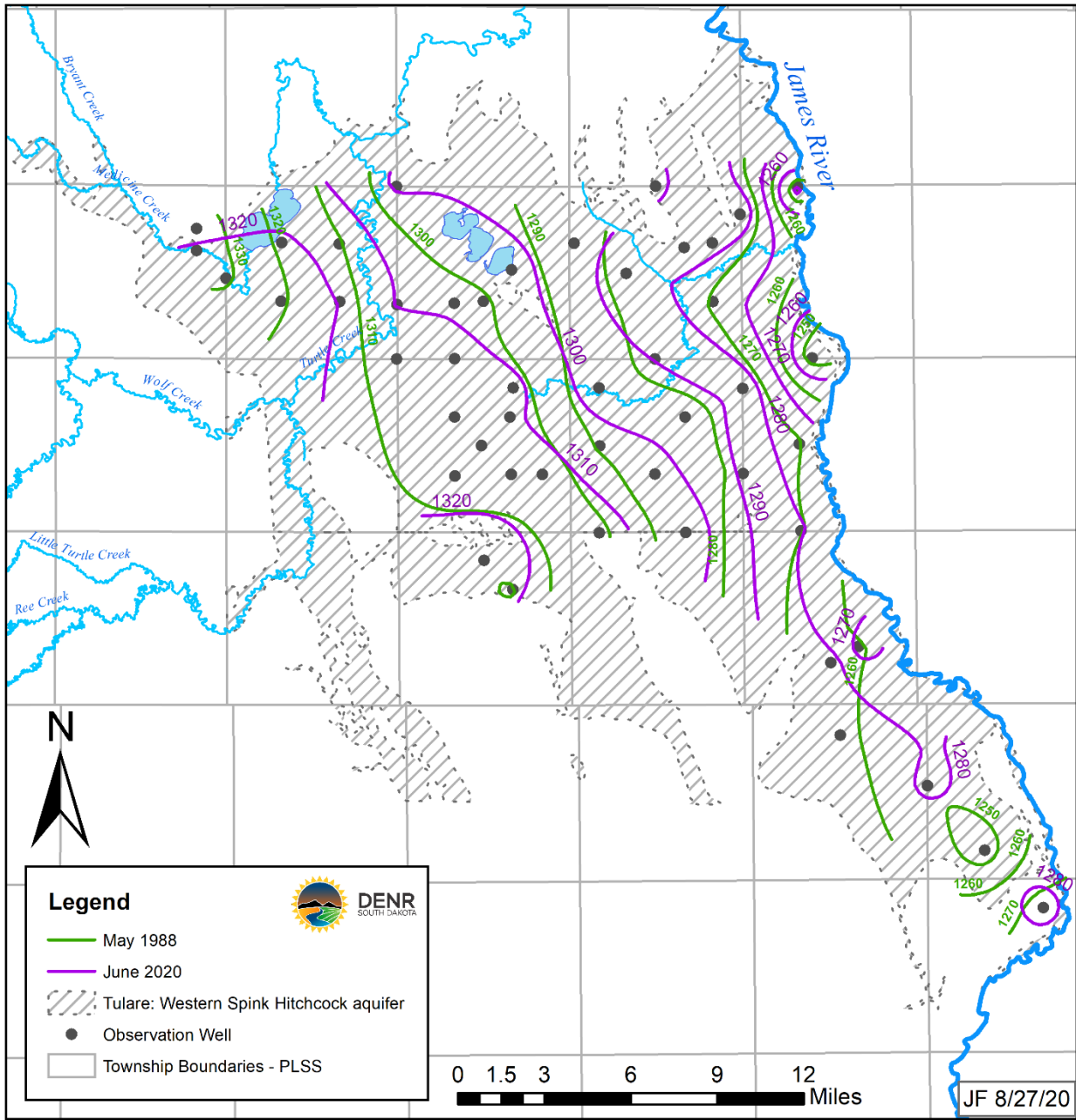


Figure 8. Potentiometric surface contours of the Tulare: Western Spink Hitchcock aquifer for May 1988 (Green) and June 2020 (Purple)

The observation well analysis provides a quantitative analysis based upon measured observations of the aquifer for the determination of the availability of unappropriated water. The annual water level change for the period of 2012-2018 shows that the water level has declined 0.02 feet per year on average. The increase in the annual water level change over the period of 1983-2011 was already accounted for in appropriations made in 2011 and 2012. The observation well analysis does not show that unappropriated water is available from the Tulare: Western Spink Hitchcock aquifer

## **Hydrologic Budget**

### ***Recharge***

Recharge to the Tulare: Western Spink Hitchcock aquifer occurs primarily through infiltration of precipitation where the aquifer is at or near the surface. Recharge from precipitation varies by season, by year, and by location (Hamilton and Howells, 1996). Recharge could also occur from rivers and streams if they are hydraulically connected to the aquifer and if the potentiometric surface of the aquifer was lower than the stage of streams and rivers.

### ***Recharge Estimates:***

#### *Previous Estimates:*

Recharge to the Tulare: Western Spink Hitchcock has been estimated through a variety of methods. Prior to 2002 the Western Spink and Hitchcock management units were considered separately, and the recharge studies may account for one or both management units. Hedges et al. (1985) used data from 17 observation wells to determine the recharge rate to the unconfined portion of the Tulare: Hitchcock is 2.0 inches per year. A regional flow-net analysis of the Tulare: Hitchcock aquifer was also performed by Hedges et al. (1985) and found the estimated recharge rate to the aquifer was 0.24 inches per year. It is unknown what the confined and unconfined areas were for these analyses.

A numerical groundwater flow model (Kuiper, 1984) estimated that the average recharge rate to the Tulare: Western Spink Hitchcock is 0.83 inches per year. Applying the estimated average recharge rate of 0.83 inches across the 527 square miles (337,280 acres) of the model, results in an estimated average annual recharge rate of 23,000 acre-feet per year (Kuiper, 1984). This model used cells that measured 1 mile by 1 mile and compared the response of the aquifer in the model to observation well data from 1968 to 1978 and irrigation questionnaire data from 1978. Estimated recharge in the model was varied throughout the model domain, including 37 square miles around Twin and Mud lakes where the recharge to the aquifer was estimated as being higher than the rest of the model. The model domain did include Beadle, Hand, and Spink Counties and 13 square miles along the James River were included in both model areas A (Tulare: Western Spink Hitchcock) and B (Tulare: East James).

In previous Water Management Board decisions, the Water Management Board has relied upon the 0.83 inches of recharge per year from Kuiper's (1984) results. This recharge rate has been applied over the entirety of Tulare: Western Spink Hitchcock aquifer (263,016 acres), resulting in an estimated average annual recharge of 18,192 acre-feet per year (Buhler, 2012a). There are differences between the modeled area and the area currently delineated as the Tulare: Western Spink Hitchcock aquifer, it is unknown if the modeled recharge rate is reflective of the current area of the aquifer. The boundaries that were used in the development of the model are mostly

consistent with the currently accepted boundaries of the Tulare: Western Spink Hitchcock aquifer, however there are several areas where the model extends the aquifer boundaries to the north and south. The difference in area between Kuiper's model (1984) and Buhler's delineation (2012a) is approximately 74,264 acres (~116 square miles). Most of this extra area, the area not included in Buhler's (2012a) delineation, in Kuiper's model was estimated as having an average recharge rate of 0.8 inches per year, and approximately 1 square mile was estimated as having an average recharge rate of 1.2 inches per year. A simple subtraction of the extra cells from Kuiper's model does not affect the estimated average recharge rate of 0.83 inches per year. It is not clear if a reduction in the area of the model would have affected the estimated recharge rates that Kuiper found to be a best fit for the model area. As part of the modeling process, Kuiper was able to adjust the estimated recharge rate for each cell in order to best fit the model output to the observed water levels in the observation wells that data was available for. As each cell in the model had several input values, changing the extent of the model and adding or removing cells would result in the adjustment of values in other cells to best fit the model output to the observed water elevation data. To account for a change in the model extent, it is unknown if the estimated average recharge rate would increase, stay the same, or decrease.

Buhler (2013) performed a simple regional flow net analysis. This analysis was used to confirm the reasonableness of the average annual recharge estimate from Kuiper (1984). This simple regional flow net analysis is only applicable to the year 2012 and does not provide an estimated average annual recharge rate. The simple regional flow net analysis estimated the recharge rate for 2012 was 0.39 inches per year and showed that Kuiper's average annual recharge estimate was reasonable (Buhler, 2013).

Given the uncertainty involved with applying Kuiper's estimated average annual recharge to the current extent of the Tulare: Western Spink Hitchcock aquifer, it is difficult to determine the estimated average annual recharge to aquifer. The 18,192 acre-feet of recharge per year as calculated by Buhler (2012a) is the best information reasonably available for quantifying the estimated average annual recharge to the Tulare: Western Spink Hitchcock aquifer.

### ***Discharge***

Discharge from the Tulare: Western Spink Hitchcock aquifer occurs through well withdrawals, evapotranspiration from areas where the aquifer is near the land surface, outflow to the James River, and possible outflow to other surface waters.

### ***Domestic water use:***

There are currently 216 domestic water supply wells on file with the DENR-Water Rights Program that appear to be completed into the Tulare: Western Spink Hitchcock aquifer (Water Rights, 2020d). The volume of water used by domestic wells has not been estimated previously for this management unit, however the use can be estimated using the average rural use for the rural water system in the area as done for the Tulare: East James aquifer (Buhler, 2012b). The 2012 estimated domestic use was 7,000 gallons per tap per month, which equates to an estimated average annual use from domestic wells of 56 acre-feet per year. The actual quantity of water these domestic wells withdraw is unknown; this is the best available and reasonable estimate of domestic water use from the Tulare: Western Spink Hitchcock aquifer.

*Appropriative water use:*

As of June 17, 2020, there is a total of 159 Licensed or Permitted Water Rights appropriating water from the Tulare: Western Spink Hitchcock aquifer (Water Rights, 2020c). The appropriative water use from the Tulare: Western Spink Hitchcock aquifer is entirely for the irrigation of crops, except for two water rights for commercial use. The total diversion rate for the two commercial use water rights is 0.134 cubic feet per second (60 gallons per minute). If these two water rights were to pump 60% of the year at their maximum diversion rate, they would withdraw 58.1 acre-feet from the aquifer. The estimate of 60% pumping time is commonly used by the Water Rights Program and has been previously accepted by the Water Management Board (Water Rights, 2020c). The remaining 157 water rights are for irrigation. Figure 9 shows how the number of acres authorized for irrigation at the start of each irrigation season (April 1) has changed from 1979 to 2020 and the reported irrigation data for 1979 and 1983 through 2019. The irrigation questionnaires from 1980 through 1982 could not be located, so those years were not included in any calculations. Authorized acres are the acres approved to be irrigated under an existing water right, and the status of the water right could be permitted or licensed. Irrigated acres are the acres indicated as irrigated on the irrigation questionnaire by the irrigator. The annual irrigation summaries have the reported use for the 1980-1982 time period, however the number of acres that were irrigated are not included on the summaries, and it is impossible to investigate any anomalous data.



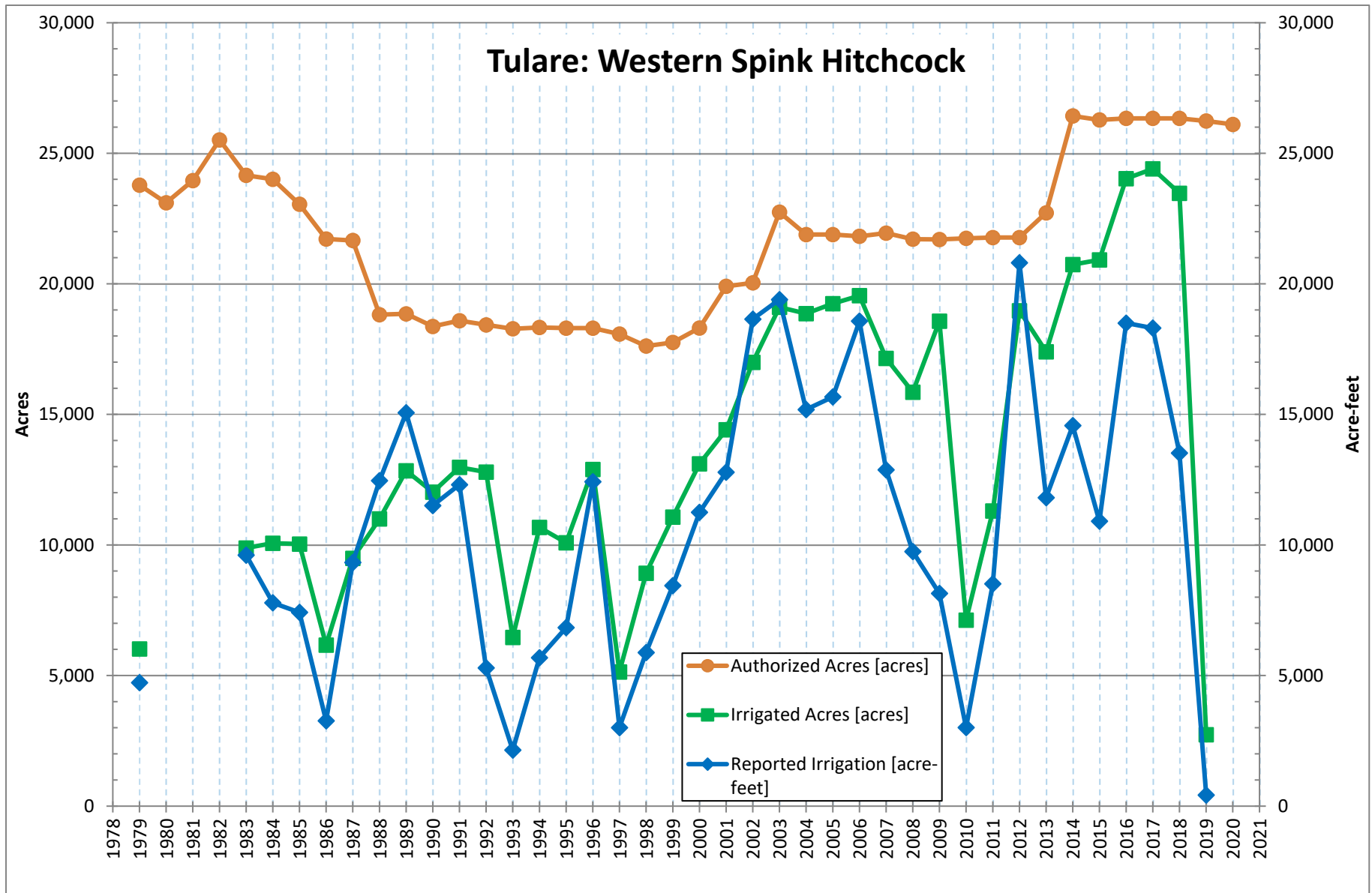


Figure 9. Acres authorized for Irrigation, Irrigated Acres and Reported Irrigation from the Tulare: Western Spink Hitchcock aquifer (Water Rights, 2020c)

Table 2. Irrigation development from the Tulare: Western Spink Hitchcock aquifer (\* data not available), (modified from Buhler, 2012a; Mathiowetz, 2012; Water Rights, 2020a; Water Rights, 2020c)

Year	Permits with Acres	Authorized Acres [acres]	Irrigated Acres [acres]	Utilization Rate (Irrigated Acres/Authorized Acres Percentage)	Reported Irrigation [acre-feet]	Average Application Rate for Irrigated Acres [inches]
1979	132	23,781.00	6,018.00	25.31	4,728.50	9.43
1980	132	23,103.00	*	*	*	*
1981	138	23,955.00	*	*	*	*
1982	149	25,513.00	*	*	*	*
1983	144	24,154.00	9,883.00	40.92	9,611.81	11.67
1984	144	24,006.00	10,067.50	41.94	7,785.91	9.28
1985	138	23,047.10	10,033.50	43.53	7,419.24	8.87
1986	135	21,716.30	6,164.00	28.38	3,264.98	6.36
1987	134	21,659.60	9,487.00	43.80	9,329.14	11.80
1988	121	18,817.60	10,997.00	58.44	12,462.92	13.60
1989	119	18,851.60	12,842.20	68.12	15,061.79	14.07
1990	115	18,367.70	12,024.20	65.46	11,509.49	11.49
1991	115	18,589.60	12,972.80	69.79	12,307.90	11.38
1992	115	18,428.60	12,791.50	69.41	5,291.67	4.96
1993	116	18,279.60	6,728.00	36.81	2,200.30	3.92
1994	115	18,329.60	10,671.00	58.22	5,684.41	6.39
1995	112	18,303.60	10,085.00	55.10	6,833.56	8.13
1996	113	18,303.60	12,891.00	70.43	12,422.89	11.56
1997	110	18,076.60	5,136.00	28.41	3,005.00	7.02
1998	109	17,619.60	8,916.00	50.60	5,878.45	7.91
1999	110	17,755.60	11,068.90	62.34	8,444.64	9.15
2000	114	18,307.60	13,107.10	71.59	11,250.15	10.30
2001	126	19,905.60	13,287.00	66.75	12,786.81	11.55
2002	126	20,037.60	16,995.57	84.82	18,649.47	13.17
2003	138	22,745.00	19,103.77	83.99	19,397.25	12.18
2004	132	21,886.30	18,860.77	86.18	15,185.22	9.66
2005	132	21,886.30	19,240.26	87.91	15,669.49	9.77
2006	132	21,821.30	19,546.26	89.57	18,572.88	11.40
2007	133	21,943.30	17,145.50	78.14	12,878.64	9.01
2008	135	21,709.30	15,849.66	73.01	9,748.11	7.38
2009	132	21,697.90	17,169.60	79.13	8,143.49	5.69
2010	133	21,742.90	7,118.40	32.74	3,007.90	5.07
2011	133	21,771.90	11,300.50	51.90	8,512.07	9.04
2012	133	21,771.90	18,969.00	87.13	20,808.37	13.16
2013	139	22,717.90	17,399.20	76.59	11,811.93	8.15
2014	163	26,429.90	20,735.30	78.45	14,570.73	8.43
2015	161	26,277.90	20,917.70	79.60	10,910.11	6.26
2016	162	26,336.90	24,028.50	91.24	18,496.81	9.24
2017	163	26,335.90	24,404.00	92.66	18,305.35	9.00
2018	163	26,335.90	23,467.70	89.11	13,519.08	6.91
2019	162	26,234.90	2,732.40	10.42	421.52	1.85
2020	159	26,104.90	*	*	*	*
MAX.		26,429.90	24,404.00	92.66	20,808.37	14.07
MIN.		17,619.60	2,732.40	10.42	421.52	1.85
AVE.		21,672.06	13,688.28	63.37	10,681.26	9.06

Using the available reported pumping data from 1979 through 2019, the estimated annual domestic use, and the estimated commercial use, the total well withdrawal from the aquifer is expected to average less than 10,800 acre-feet/year. This total withdrawal from the Tulare: Western Spink Hitchcock aquifer due to pumping is around 0.89% of the estimated recoverable water in storage in the aquifer (10,800 acre-feet pumped per year versus 1,212,330+ acre-feet of recoverable water in storage (Hedges et al., 1982)).

In light of the considerable development that occurred as a result of appropriations made in 2012 and 2013, it is no longer appropriate to consider the entire period of record for determining the estimated average annual withdrawals. Table 3 shows the averages of Table 2 for many different periods of time to include data for comparison from previous reports and methodologies, the effect of a dry year (2012) and the effect of a very wet year (2019). The time periods that have the break between the years of 1979 and 1983 are effectively continuous time periods for all columns, except for the average authorized acres, as demonstrated in the first two rows of data.

Table 3. Averages of data in Table 2 for select time periods.

Period	Average Authorized Acres [acres]	Average Irrigated Acres [acres]	Average Utilization Rate	Average Reported Irrigation [acre-feet]	Average Application Rate for Irrigated Acres [inches]
1979-2019	21,672.06	13,688.28	63.37	10,681.26	9.06
1979, 1983-2019	21,473.25	13,688.28	63.37	10,681.26	9.06
1979-2011	20,791.31	12,250.03	60.09	9,901.47	9.38
1979, 1983-2012	20,494.01	12,466.77	60.96	10,253.30	9.50
1979, 1983-2018	21,344.56	13,984.39	64.80	10,958.55	9.25
2003-2011	21,911.58	16,148.30	73.62	12,346.12	8.80
2003-2018	23,338.16	18,453.51	78.58	13,721.09	8.77
2003-2019	23,508.55	17,528.74	74.57	12,938.76	8.37
2012-2018	25,172.33	21,417.34	84.97	15,488.91	8.74
2012-2019	25,305.15	19,081.73	75.65	13,605.49	7.88
2013-2018	25,739.07	21,825.40	84.61	14,602.34	8.00
2013-2019	25,809.90	19,097.83	74.01	12,576.50	7.12
2014-2018	26,343.30	22,710.64	86.21	15,160.42	7.97
2014-2019	26,325.23	19,380.93	73.58	12,703.93	6.95
2015-2018	26,321.65	23,204.48	88.15	15,307.84	7.85
2015-2019	26,304.30	19,110.06	72.61	12,330.57	6.65

Examination of the average application rate for the time period of Buhler’s (2013) report, 1979-2011, shows that the average application rate has been adjusted slightly from Buhler’s calculated 9.32 inches to 9.38 inches. This is due to corrections of the underlying water right and irrigation questionnaire data, either from data entry errors, missing irrigation questionnaire data that was not included in Buhler’s (2012a) dataset, and resolving instances where the irrigator submitted

data for multiple permits and some values were double counted or not counted at all. The application rate could still change slightly due to corrections in the water right data, locating missing irrigation questionnaire files, identifying when systems were constructed, considering suspensions, and upon further review of the irrigation questionnaires that cover several pivots and/or have been amended, incorporated, or reissued.

In the time since Buhler’s report (2012a), the average application rate has varied due to climatic conditions. The time period of 2012-2018 has an average application rate of 8.74 inches, but with the wet year of 2019, the average application rate dropped to 7.88 inches for the time period of 2012-2019. The year of 2012 was dry and saw a high average application rate, the effect of this can be seen by comparing the average application rates between the time periods of 1979-2011 and 1979, 1983-2012; 2012-2018 and 2013-2018; and 2012-2019 and 2013-2019. For the entire period of record, 1979 through 2019, the average application rate has been 9.06 inches.

In Buhler’s (2012a) report, the average annual withdrawals were calculated by averaging the irrigation questionnaire summary reports for the years 1979-2011 and adding the estimated domestic use. Table 4 shows the data from the irrigation questionnaire summary reports. The data from the irrigation questionnaire summary reports is currently the best information reasonably available to easily determine how much water has been used by irrigation from an aquifer. These summaries have never been revised to reflect updated data or to correct water sources. There are minor differences between the values in Table 2 and Table 4 for the number of permits and the reported irrigation due to more recent data being represented in Table 2.

Table 4. Annual Summary of Reported Irrigation from the Tulare: Western Spink Hitchcock aquifer (Water Rights, 1980-2020)

Year	Number of Permits Reported	Reported Irrigation [acre-feet]
1979	133	5,265.00
1980	134	6,676.00
1981	148	10,255.00
1982	111	6,116.30
1983	116	9,057.14
1984	130	8,255.50
1985	136	7,617.80
1986	136	3,528.00
1987	118	9,524.00
1988	121	13,351.90
1989	118	14,981.20
1990	118	11,801.00
1991	117	12,403.50
1992	114	5,390.00
1993	115	2,255.40
1994	115	5,849.66
1995	114	6,567.52

1996	115	12,596.67
1997	113	3,065.00
1998	112	6,180.06
1999	114	8,633.58
2000	122	11,273.48
2001	118	12,302.56
2002	121	18,649.47
2003	131	19,397.25
2004	129	15,185.22
2005	129	15,669.49
2006	129	18,572.88
2007	130	12,552.56
2008	129	9,655.30
2009	129	8,261.53
2010	130	2,959.35
2011	130	8,512.07
2012	134	20,861.78
2013	149	11,671.04
2014	158	14,934.34
2015	162	10,910.11
2016	162	18,496.81
2017	162	18,305.35
2018	162	13,519.08
2019	159	421.52
<i>MAX</i>		20,861.78
<i>MIN</i>		421.52
<i>AVE</i>		10,523.94

### ***Balance of Recharge to Discharge***

At the December 4<sup>th</sup>, 2002 meeting of the South Dakota Water Management Board, the Western Spink management unit and Hitchcock management unit were combined into a single management unit of the Tulare aquifer. The Tulare: Western Spink Hitchcock management unit was estimated as underlying 288,700 acres, containing 1.212 million acre-feet of recoverable water in storage, and 19,960 acre-feet of annual recharge (Goodman, 2002). Based upon the maximum water use and undeveloped permits, 3,400 acre-ft of water was found to be available. Assuming an application rate of 16 inches, 11 water right permits were issued for the irrigation of 2,654.4 acres as a result of combining management units. The remaining applications were deferred for a period of five years.

In applying SDCL 46-6-3.1, the Sixth Judicial Circuit Court of South Dakota ruled in 2005 that if the Water Management Board uses average annual recharge, then it should also use average annual withdrawals to determine if unappropriated water is available from an aquifer (Hines, Phillip W. v. Department of Environment and Natural Resources, 2005).

At the December 7, 2007 meeting of the South Dakota Water Management Board, the board heard testimony regarding a report on 33 deferred and 4 new water permit applications from the Tulare: Western Spink Hitchcock aquifer management unit (Goodman, 2007). This report used the previous five years of data, 2002-2006, and determined that the reported water use over the 5 years averaged 17,495 acre-feet per year. However, there was “not reported or undeveloped acreage” that were then accounted for by estimating their water use (Goodman, 2007). This estimation brought the estimated average annual use to 19,927 acre-feet per year. The estimated average annual recharge rate was 19,960 acre-feet per year. The 37 water permit applications were denied, and the aquifer management unit was declared fully appropriated.

A set of six new water permit applications were to be brought before the South Dakota Water Management Board on May 2, 2012 in response to the applicants contesting the Chief Engineer’s recommendation of denial. As part of this process, a staff engineer reevaluated the availability of unappropriated water. The areal extent of the Tulare: Western Spink Hitchcock aquifer management unit was revised to be 263,016 acres (Buhler, 2012a). The recharge rate as determined by Kuiper (1984) was applied over this areal extent to determine that the estimated average annual recharge is 18,192 acre-feet per year. The average application rate on irrigated acres was 9.32 inches for the period of 1979 through 2011, excluding 1980-1982 due to a lack of data. Applying 18,192 acre-feet of water at a rate of 9.32 inches would allow the irrigation of 23,423 acres. At the time of the report there were 22,838.8 acres authorized for irrigation, the hydrologic budget showed that an additional 584.2 acres could be irrigated without exceeding the average annual recharge. The observation well analysis as calculated by Buhler (2012a) over the years of 1983 to 2011 showed an average rise of 0.34 feet in the unconfined portions of the management unit. The unconfined area was estimated to be 11,149 acres, using a specific yield for the aquifer of 0.15, results in the average annual recharge exceeding average annual withdrawals by 569 acre-feet which, applied at a rate of 9.32 inches allows the irrigation of an additional 733 acres. The applicants entered a stipulation with the Chief Engineer and the Chief Engineer approved 5 of the 6 applications for 810 acres of irrigation. As discussed earlier in the report, the 2011 water year was calculated for only a partial year, if the entire year was used in the calculation, the average observation well rise would change from 0.34 feet per year to 0.30 feet per year. This would reduce the amount recharge exceeds withdrawals from 569 acre-feet per year to 502 acre-feet per year and would have allowed the irrigation of 646 acres.

After a review was conducted on the Tulare: East James aquifer management unit (Buhler, 2012b), it was realized that the previous analysis on the Tulare: Western Spink Hitchcock aquifer management unit was overly conservative (Buhler, 2013). The recharge to acres method that Buhler used in the 2012 and 2013 reports calculated the number of acres that could be irrigated given the total amount of recharge. The difference in the recharge to acres method between the 2012 and 2013 reports is that the 2013 report factors in the number of acres that were irrigated vs the number of acres that were authorized for irrigation, or the utilization rate. The 2012 report assumed 100% of the acres were being irrigated every year, resulting in an additional 584.4 acres that could be irrigated. The 2013 report calculated that on average 69.02% of acres were utilized over the 2003 to 2011 period. The estimated average annual recharge was 18,192 acre-feet per year, which would allow the irrigation of 23,423 acres. At the time of Buhler’s report there were 23,648.8 acres authorized for irrigation, applying the utilization rate of 69.02%, Buhler calculated that the expected irrigation acreage would be 16,322.4 acres and that an additional

7,100 acres could be irrigated annually. The Water Management Board did not want to speculate on the future usage of any recently approved acres and did not find the recharge to acres method useful (SD Water Management Board, 2013).

Buhler (2013) delineated a new unconfined area of the aquifer using 3D representations of the October 2012 potentiometric surface and the top of the aquifer. This resulted in an increase in the unconfined area from 11,149 acres to 76,978 acres. The observation well analysis was also recalculated to only include water years that were considered fully developed (water year 2003 through water year 2012). This observation well analysis still included the partial calculation of the water year 2011. The period of water year 2003 to water year 2012 is a period when no additional acres were permitted, it was not a period of being fully developed as the water right permits issued in 2002 were still constructing their systems and placing water to beneficial use. Of the 11 water right permits issued in 2002, the last permits to first place their water to beneficial use occurred during the 2008 irrigation season. The observation well analysis as calculated in Buhler’s report (2013) for the period of 2003 to 2012 produced an average rise of 0.3152 feet per year. If the complete water year for 2011 is used in the calculations, the average rise from 2003 to 2012 changes to 0.21 feet per year. If the fully developed period of 2008 through 2012 was used for the calculations, the average rise would be 0.14 feet per year. Using a specific yield of 0.15, the average annual exceedance of recharge to withdrawals would change from 3,640 acre-feet to 2,425 acre-feet for the 0.21 feet per year rise, and 1,617 acre-feet for the 0.14 feet per year rise. Using the average irrigation application rate of 9.32 inches per year, Buhler’s report (2013) showed that an additional 4,686 acres could have been irrigated. The number of additional acres that could have been irrigated is reduced to 3,122 acres for the 0.21 feet per year rise, and 2,081 acres for the 0.14 feet per year rise. 810 acres should be subtracted from these estimates as there were 5 water right applications for a total of 810 acres approved for irrigation in 2012. Twelve water right applications were approved to irrigate 2,131 acres on May 2, 2013 and 11 water right applications were approved to irrigate 1,765 acres on July 11, 2013, for a total of 4,706 acres of irrigation approved in 2012 and 2013.

There is no mention in Buhler’s 2013 report of how the recently developed permits that were approved in 2002 affected the average annual use over the period of 2003-2011 or if the withdrawals due to the recent permits would be accurately reflected in a calculation for that period. Table 5 shows the permits that have been approved since 2002 for the irrigation of “new” acres, acres that were not previously authorized under an existing water right, and when they placed their appropriated water to beneficial use.

Table 5. Water right permits approving new acres since 2002 (Water Rights, 2020c)

Permit No.	Year Approved	Year water placed to beneficial use
6330-3	2002	2008
6331-3	2002	2007
6332-3	2002	2003
6333-3	2002	2008
6334-3	2002	2003
6336-3	2002	2003
6337-3	2002	2003

6338-3	2002	2006
6339-3	2002	2003
6340-3	2002	2006
6343-3	2002	2003
7289-3	2012	2013
7290-3	2012	2013
7291-3	2012	2013
7292-3	2012	2013
7293-3	2012	2013
7391-3	2012	2014
7373-3	2013	2013
7551-3	2013	2014
7570-3	2013	2016
7571-3	2013	2015
7572-3	2013	2015
7573-3	2013	2015
7574-3	2013	2014
7575-3	2013	2016
7620-3	2013	2016
7637-3	2013	2013
7638-3	2013	2017
7639-3	2013	2014
7640-3	2013	2013
7685-3	2013	2014
7716-3	2013	2018
7717-3	2013	2014
7718-3	2013	2014
7719-3	2013	2013
7720-3	2013	2014
7721-3	2013	2017
7722-3	2013	2014
7723-3	2013	2014
7724-3	2013	2016
7725-3	2013	2015

A metric other than the total withdrawals over the entire period of record should be utilized to prevent over-appropriation of water from the Tulare: Western Spink Hitchcock aquifer as a result of the 5-year reviews. For example, using Buhler's (2012b) hydrologic budget methodology repeatedly, if the existing data from 1979-2019 is used, with the average withdrawal of 10,681 acre-feet per year, and the years of 2020 through 2024 (5 years) pump an average of 15,000 acre-feet per year, the estimated average annual use over the entire period would rise to 11,183 acre-feet per year. At the end of that 5-year period, there would be an additional 7,000 acre-feet of water which could be appropriated as a result of the 5-year review because the estimated average



annual use is still below the estimated average annual recharge of 18,192 acre-feet. If the next 5-year period pumps an average of 20,000 acre-feet per year, the estimated average annual use over the entire period would rise to 12,101 acre-feet per year. At the end of this 5-year period, there would be an additional 6,000 acre-feet of water which could be appropriated. If the next 5-year period pumps an average of 25,000 acre-feet per year, the estimated average annual use over the entire period of record would rise to 13,318 acre-feet per year. If withdrawals continued to average 25,000 acre-feet per year with no additional appropriations, it would take fewer than 50 years for the average annual withdrawal over the entire period of record, to exceed the average annual recharge to the aquifer. By the time the average annual withdrawals reach the average annual recharge, the aquifer will be well over-appropriated, and the average annual withdrawals will continue to increase into the future. Repeated use of this methodology will result in the aquifer being over-appropriated in the future.

Figure 9 shows the number of irrigated acres approaching the number of authorized acres, indicating that irrigation practices have changed in the area of the Tulare: Western Spink Hitchcock aquifer. These changes may be due to climate, modern farming practices, crop prices, the production of ethanol, and the consolidation, relocation, and transference of irrigation water rights. Appendix A contains an approximate timeline of events regarding Water Rights in the Tulare: Western Spink Hitchcock aquifer, including the amending and transferring of acres to other lands.

Use of the average application rate and the utilization of acres would be a better determination of the estimated average annual use when the number of authorized acres has not remained constant. The application rate is the reported use divided by the number of irrigated acres and the utilization of acres is the number of irrigated acres divided by the number of authorized acres. The average application rate would account for factors regarding the climate over time, allowing for consideration of both dry and wet periods. The average utilization of acres would account for factors regarding farming practices, this could be looked at on a shorter period to allow for recent changes to be in effect.

As of the beginning of the 2020 irrigation season, there are 26,104.9 acres authorized for irrigation. Applying the average application rate (1979, 1983-2019) of 9.06 inches over the authorized acres results in an estimated average annual use of 19,709 acre-feet of water. While it is impossible for the average percentage of irrigated acres to authorized acres to ever reach 100% over the entire period of record, 4 out of the 8 years (2012-2019) since Buhler’s (2013) report have exceeded 87% utilization of authorized acres with the maximum utilization reaching 92.7% in 2017. The utilization rate of authorized acres and the estimated average annual use using the average application rate of 9.06 inches for authorized acres is calculated in Table 6.

Table 6. Utilization Rate of Authorized Acres and Estimated Average Annual Use calculated using 26,104.9 authorized acres and the application rate of 9.06 inches

Average Utilization Rate of Authorized Acres	Estimated Average Annual Use [acre-feet per year]
100%	19,709
60.1% (1979-2011)	11,845
63.4% (1979-2019)	12,496

73.6% (2003-2011)	14,506
87% (exceeded by 4 out of 8 previous years)	17,147
92.7% (2017)	18,270
85% (2012-2018)	16,753
75.6% (2012-2019)	14,900
88.2% (2015-2018)	17,384
72.6% (2015-2019)	14,309

Kuiper’s model estimated the recharge to the aquifer to best simulate the observed observation well hydrographs over the period of 1968 to 1978. It is unknown how well this model fits the last 42 years of observation well data. Kuiper’s model estimated the average annual recharge to the Tulare: Western Spink Hitchcock aquifer to be 23,000 acre-feet per year, within the boundaries of the model. Given the currently identified boundaries of the Tulare: Western Spink Hitchcock aquifer and the mismatch to the model boundaries, it is improper to assume that a spatially variable recharge rate can be averaged out across the model area and then applied to a significantly reduced aquifer area. The estimated average annual recharge is unknown for the currently identified boundaries of the Tulare: Western Spink Hitchcock aquifer, and while improper, use of the 0.83 inches per year of recharge as calculated from Kuiper’s model across the entire area of the aquifer (263,016 acres) is the best reasonably available estimate of the average annual recharge to the Tulare: Western Spink Hitchcock aquifer. The estimated average annual recharge to the Tulare: Western Spink Hitchcock aquifer is 18,192 acre-feet per year.

Given the uncertainties involved with the estimated average annual recharge model, it is unknown if the estimated average annual recharge rate of 18,192 acre-feet per year as used in past reports is above or below the actual recharge rate. Using the average application rate of 9.06 inches over the period of record and the current authorized acreage, the estimated average annual use for irrigation withdrawals using the average utilization rate (72.6%) for the time period of 2015-2019 is 14,309 acre-feet per year. Excluding the abnormally wet year of 2019, the average utilization rate for the time period of 2015-2018 better reflects the expected usage of the Tulare: Western Spink Hitchcock for the current authorized acreage. Assuming recent irrigation practices continue, the best reasonable estimated withdrawals from irrigation use is the 17,384 acre-feet per year as calculated using the utilization rate from 2015-2018 of 88.2%, the total of 26,104.9 authorized acres, and the average application rate of 9.06 inches on irrigated acres over the period of record. However, during the time period of 2015-2019, permitted appropriations were still being constructed and placed to beneficial use.

With the continual increase in placing water to beneficial use through 2018, it is currently unknown what an average utilization rate may be over a longer period, and it may be more appropriate to estimate the usage from irrigated acres at full utilization. In addition to the new appropriations placing their water to beneficial use, there has been ongoing transferring and moving of acres and diversion points across the management unit (see Appendix A), resulting in existing appropriations being placed to better use. If the authorized acres were fully utilized, with an application rate of 9.06 inches, the estimated average annual use for irrigation is 19,709 acre-feet per year.

The hydrologic budget provides a quantitative approach to the availability of unappropriated water. Within the hydrologic budget, the estimated average annual use for domestic use is 56 acre-feet per year, and the estimated average annual use for commercial use is 58 acre-feet per year. The hydrologic budget also estimates that the estimated average annual use from irrigation is 17,384 acre-feet per year assuming current irrigation trends continue, or 19,709 acre-feet per year assuming that all acres are fully utilized. If the current irrigation trend (2015-2018 time period) continues, the hydrologic budget estimates that there is an average of 17,498 acre-feet of water used per year. If the current irrigation trend does not continue and authorized acres continue to see increasing use, assuming full use of the authorized acres would result in the hydrologic budget estimating that the average annual use is 19,823 acre-feet of water per year. The estimated average annual recharge is 18,192 acre-feet per year. If current irrigation trends continue, there would be 694 acre-feet of water available for appropriation from the hydrologic budget. If current irrigation trends do not continue and there is an increase in the usage of the authorized acres, the maximum estimated average annual use is the full utilization of authorized acres and would exceed the estimated average annual recharge by 1,631 acre-feet per year. In order for the recently developed systems and recently moved systems to be properly reflected in application rate and utilization rate data, it would be reasonable to estimate the average annual use by assuming full utilization of the authorized acres. Based upon the full utilization of acres for irrigation, the hydrologic budget shows that there is no unappropriated water available from the Tulare: Western Spink Hitchcock aquifer.

## CONCLUSIONS

1. The Tulare: Western Spink Hitchcock aquifer is a glacial outwash aquifer that is generally found under confined conditions and buried under a layer of glacial till.
2. The best information currently available indicates that the Tulare: Western Spink Hitchcock aquifer underlies approximately 263,016 acres of Spink, Beadle, and Hand Counties.
3. The SD DENR-Water Rights Program observation well data documents that over the period of 1983 through 2018, the water level in the unconfined portions of the Tulare: Western Spink Hitchcock aquifer has increased an average of 0.18 feet per year.
4. Appropriations made in 2012 and 2013 relied upon the water level increase in the unconfined portions of the Tulare: Western Spink Hitchcock aquifer. There is no water available for appropriation from the 0.18 feet per year rise calculated over the period of 1983-2018 as it was already accounted for in prior appropriations.
5. The SD DENR-Water Rights Program observation well data documents that over the period of 2013 through 2018, the water level in the unconfined portions of the Tulare: Western Spink Hitchcock aquifer has decreased an average of 0.02 feet per year.
6. The SD DENR-Water Rights Program observation well data documents that over the period of record the configuration of the potentiometric surface of the Tulare: Western Spink Hitchcock aquifer has not changed significantly with time or increased development. The elevation of the potentiometric surface has changed throughout time,

however the direction of groundwater flow has not been significantly affected by withdrawals.

7. The estimated average annual recharge to the Tulare: Western Spink Hitchcock aquifer was estimated as 23,000 acre-feet per year by Kuiper's model. The estimated average annual recharge is 18,192 acre-feet per year due to a reduction in the areal extent of the aquifer since the development of Kuiper's model.
8. Kuiper's recharge rate was based upon 11 years of observation well data between 1968 and 1978. Thirty-two observation wells have been drilled into the Tulare: Western Spink Hitchcock aquifer since 1978 and there are 42 additional years of observation well data since 1978.
9. It is improper to assume the spatially variable recharge rate found in Kuiper's model can be averaged across the model domain and then applied to a significantly reduced area. Although it is unknown what the effects of a reduced area are, the current best estimated average annual recharge to the Tulare: Western Spink Hitchcock aquifer is 18,192 acre-feet per year.
10. The Tulare: Western Spink Hitchcock aquifer currently has 159 permitted or licensed water rights appropriating water. Of these, 157 water rights currently authorize the irrigation of 26,104.9 acres. The other 2 water rights are for commercial use for 0.096 cubic feet per second of water.
11. All water right permits approved since 2012 have placed their water to beneficial use as of the 2018 irrigation season.
12. There is one water year over the period of record that would show the balance of recharge to withdrawals from the observation well data at the current level of appropriations, and that year (water year 2019) was an anomalously wet year.
13. The continued moving of authorized acres and diversion points to other lands is increasing the usage of authorized acres over time by placing water to a better beneficial use.
14. Excluding the anomalously wet year of 2019, the authorized acres saw a utilization rate of 88.2% over the years of 2015-2018. Including the anomalously wet year of 2019, the authorized acres saw a utilization rate of 72.6% over the years of 2015-2019.
15. The application rate on irrigated acres over the period of record (1979,1983-2019) is 9.06 inches.
16. Assuming current irrigation trends continue, the estimated average annual use from the Tulare: Western Spink Hitchcock aquifer is 17,384 acre-feet per year at 88.2% utilization of authorized acres.

17. If all acres that are authorized for irrigation (26,104.9 acres) apply the average application rate of 9.06 inches, the estimated average annual use from the Tulare: Western Spink Hitchcock aquifer is 19,709 acre-feet per year.
18. Based upon the downward trend observed in the observation well analysis over the time period of 2013-2018, the hydrologic budget, and the lack of a stable period of development, there is not a reasonable probability that unappropriated water is available from the Tulare: Western Spink Hitchcock aquifer.



John Farmer  
SD DENR – Water Rights Program

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Appendix A: Approximate Timeline of Water Right Activity in the Western Spink Hitchcock Management Unit of the Tulare Aquifer since the year 2000.

Date	Water Right	Action	Water Right Status	Change in Authorized Acres
02/14/2000	6159-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	132
02/21/2000	6160-3	Permit approved by Chief Engineer for Tulare: Western Spink	PE	160
03/20/2000	6175-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	160
04/17/2000	6184-3	Permit approved by Chief Engineer for Tulare: Western Spink	PE	135
06/05/2000	2428A-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	0
06/05/2000	2428-3	Incorporated into Water Right permit 2428A-3	IP	0
06/05/2000	6193-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	90
07/17/2000	6196-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	160
07/31/2000	6200-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	160
07/31/2000	6201-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	480
01/02/2001	6234-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	135
02/12/2001	6238-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	130
02/12/2001	6239-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	260
02/12/2001	6240-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	132
08/13/2001	5798-3	Result of Licensing (160 to 132 acres)	LC	-28
08/13/2001	5771-3	Incorporated into Water Right 6184-3	IL	0
08/13/2001	6184-3	Result of Licensing (135 acres + Inc. 5771-3 135 acres to 270 acres)	LC	0
08/13/2001	2428A-3	Result of Licensing (136 to 136 acres)	LC	0
03/18/2002	6288-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	160
05/31/2002	4912B-3	Water Right 4912A-3 was divided, 4912B-3 took 136 of the 301 acres	LC	0
06/04/2002	6312-3	Permit approved by Chief Engineer for Tulare: Hitchcock	PE	160
07/26/2002	6344-3	Date Received, WMB Deferred at 12-4-02 meeting, WMB Denied at 12-6-07 meeting	DN	
07/26/2002	6345-3	Date Received, WMB Deferred at 12-4-02 meeting, WMB Denied at 12-6-07 meeting	DN	
07/26/2002	6346-3	Date Received, WMB Deferred at 12-4-02 meeting, WMB Denied at 12-6-07 meeting	DN	
07/26/2002	6347-3	Date Received, WMB Deferred at 12-4-02 meeting, WMB Denied at 12-6-07 meeting	DN	
07/29/2002	6348-3	Date Received, Deferred by WMB, Withdrawn due to approval of 6339A-3 on 3-5-03	WI	
08/07/2002	6351-3	Date Received, Recommended for Denial, Withdrawn 11-12-02	WI	
08/08/2002	6352-3	Date Received, WMB Deferred at 12-4-02 meeting, WMB Denied at 12-6-07 meeting	DN	
08/08/2002	6353-3	Date Received, WMB Deferred at 12-4-02 meeting, WMB Denied at 12-6-07 meeting	DN	
09/19/2002	6359-3	Date Received, WMB Deferred at 12-4-02 meeting, WMB Denied at 12-6-07 meeting	DN	
09/19/2002	6360-3	Date Received, WMB Deferred at 12-4-02 meeting, WMB Denied at 12-6-07 meeting	DN	
09/19/2002	6361-3	Date Received, WMB Deferred at 12-4-02 meeting, withdrawn upon approval of 472A-3	WI	

12/04/2002		Board combines Tulare: Hitchcock and Tulare: Western Spink management units		
12/04/2002	6330-3	Permit approved by WMB	PE	157
12/04/2002	6331-3	Permit approved by WMB	PE	157
12/04/2002	6332-3	Permit approved by WMB	PE	153
12/04/2002	6333-3	Permit approved by WMB	PE	320
12/04/2002	6334-3	Permit approved by WMB	PE	267.4
12/04/2002	6336-3	Permit approved by WMB	PE	160
12/04/2002	6337-3	Permit approved by WMB	PE	320
12/04/2002	6338-3	Permit approved by WMB	PE	320
12/04/2002	6339-3	Permit approved by WMB	PE	320
12/04/2002	6340-3	Permit approved by WMB	PE	160
12/04/2002	6343-3	Permit approved by WMB	PE	320
12/05/2002	6374-3	Date Received, WMB Deferred at 3-5-03 meeting, WMB Denied at 12-6-07 meeting	DN	
03/05/2003	6339A-3	Permit approved by Chief Engineer - takes 160 acres from 6339-3	PE	0
03/05/2003	6339-3	Divided, Water Permit 6339A-3 took 160 acres, 6339B-3 is remaining 160 acres	PE	0
03/10/2003	6334A-3	Permit approved to move the location of 133.7 out of 267.4 acres of permit 6334-3	PE	0
03/10/2003	6334-3	Divided, Water Permit 6334A-3 took 133.7 acres, remaining portion permitted as 6334B-3	PE	0
03/13/2003	2471B-3	Licensed, incorporated 2471-3 and 2471A-3 (202 to 202 acres)	LC	0
03/13/2003	2471-3	Incorporated into Water Right 2471B-3	IL	0
03/13/2003	2471A-3	Incorporated into Water Right 2471B-3	IL	0
09/11/2003	386-3	Divided, Water Right 386A-3 took 42.1 acres, 386B-3 took 118.8 acres	OC	0
09/11/2003	386A-3	Ownership Change, took 42.1 acres from 386-3	LC	0
09/11/2003	386B-3	Ownership Change, took 118.8 acres from 386-3	LC	0
09/11/2003	386A-3	Incorporated into Water Right 4167-3	IL	0
09/11/2003	4167-3	Water Right License 4167-3 reissued to incorporate 386A-3	LC	-42.1
12/03/2003	2568-3	Cancelled by WMB for abandonment/forfeiture	CA	-136
12/03/2003	4146-3	Cancelled by WMB for abandonment/forfeiture	CA	-130
12/03/2003	4147-3	Cancelled by WMB for abandonment/forfeiture	CA	-130
12/03/2003	4545-3	Cancelled by WMB for abandonment/forfeiture	CA	-79
12/03/2003	4546-3	Cancelled by WMB for abandonment/forfeiture	CA	-227
12/03/2003	4260-3	Cancelled by WMB for abandonment/forfeiture	CA	-126.8
12/03/2003	386B-3	Cancelled by WMB for abandonment/forfeiture	CA	-118.8
12/29/2003	6159-3	Result of Licensing (132 to 128 acres)	LC	-4
01/16/2004	6334C-3	Date Received, Withdrawn 3-3-04	WI	
01/20/2004	6460-3	Date Received, WMB Deferred at 5/12/04 meeting, WMB Denied at 12-6-07 meeting	DN	
01/20/2004	6461-3	Date Received, WMB Deferred at 5/12/04 meeting, WMB Denied at 12-6-07 meeting	DN	
01/20/2004	6462-3	Date Received, WMB Deferred at 5/12/04 meeting, WMB Denied at 12-6-07 meeting	DN	
01/20/2004	6463-3	Date Received, WMB Deferred at 5/12/04 meeting, WMB Denied at 12-6-07 meeting	DN	



03/03/2004	6201A-3	Permit approved by Chief Engineer - takes 84 acres from 6201-3 and 51 acres from 6343-3	PE	0
03/03/2004	6343-3	Permit Reissued for 269 of 320 acres, 6201A-3 severed 51 acres	PE	0
03/03/2004	6201-3	Permit reissued due to 6201A-3 taking 84 acres	PE	0
03/03/2004	6343-3	Permit reissued due to 6201-3 taking 51 acres	PE	0
02/14/2005	6594-3	Date Received, WMB Deferred at 7/6/05 meeting, WMB Denied at 12-6-07 meeting	DN	
09/12/2005	6660-3	Date Received, WMB Deferred at 12/7/05 meeting, WMB Denied at 12-6-07 meeting	DN	
09/12/2005	6661-3	Date Received, WMB Deferred at 12/7/05 meeting, WMB Denied at 12-6-07 meeting	DN	
09/30/2005	6196-3	Result of Licensing (160 to 136 acres)	LC	-24
09/30/2005	6200-3	Result of Licensing (160 to 136 acres)	LC	-24
09/30/2005	6332-3	Result of Licensing (153 to 136 acres)	LC	-17
11/07/2005	6668-3	Date Received, WMB Deferred at 3/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
11/07/2005	6669-3	Date Received, WMB Deferred at 3/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
11/07/2005	6670-3	Date Received, WMB Deferred at 3/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
11/07/2005	6671-3	Date Received, WMB Deferred at 3/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
01/27/2006	6687-3	Date Received, WMB Deferred at 5/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
01/27/2006	6688-3	Date Received, WMB Deferred at 5/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
01/27/2006	6689-3	Date Received, WMB Deferred at 5/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
02/03/2006	6911-3	Date Received, Withdrawn prior to Chief Engineer's recommendation	WI	
02/09/2006	6693-3	Date Received, WMB Deferred at 5/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
02/09/2006	6694-3	Date Received, WMB Deferred at 5/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
02/09/2006	6695-3	Date Received, WMB Deferred at 5/3/06 meeting, WMB Denied at 12-6-07 meeting	DN	
07/12/2006	6338A-3	Permit approved by Chief Engineer - takes 56 acres from 6338-3, 28 acres each from 6339A-3, 6339B-3, 6340-3	PE	-70
07/12/2006	6338-3	Permit reissued due to 6338A-3 taking 56 of 320 acres	PE	0
07/12/2006	6339A-3	Permit reissued due to 6338A-3 taking 28 of 160 acres	PE	0
07/12/2006	6339B-3	Permit reissued due to 6338A-3 taking 28 of 160 acres	PE	0
07/12/2006	6340-3	Permit reissued due to 6338A-3 taking 28 of 160 acres	PE	0
11/13/2006	6776-3	Date Received, WMB Deferred at 3/7/07 meeting, WMB Denied at 12-6-07 meeting	DN	
01/22/2007	6764-3	Permit approved by Chief Engineer - takes 24 acres from 6336-3 and 28 acres from 6337-3	PE	0
01/22/2007	6336-3	Permit Reissued for 136 of 160 acres, 6764-3 severed 24 acres	PE	0
01/22/2007	6337-3	Permit Reissued for 292 of 320 acres, 6764-3 severed 28 acres	PE	0
01/22/2007	2485-3	Water Right permit 6764-3 authorized moving 130 of 130 acres	LC	0
02/27/2007	6829-3	Date Received, WMB Deferred at 7/11/07 meeting, WMB Denied at 12-6-07 meeting	DN	
02/27/2007	6830-3	Date Received, WMB Deferred at 7/11/07 meeting, WMB Denied at 12-6-07 meeting	DN	
02/27/2007	6841-3	Date Received, WMB Deferred at 7/11/07 meeting, WMB Denied at 12-6-07 meeting	DN	
02/27/2007	6842-3	Date Received, WMB Deferred at 7/11/07 meeting, WMB Denied at 12-6-07 meeting	DN	
03/07/2007	472A-3	Permit approved by Chief Engineer, amended 472-3 and moved all acres	PE	0
03/07/2007	472-3	Incorporated into Water Right 472A-3	IP	0
05/14/2007	6330A-3	Permit approved by Chief Engineer - moved 157 of 157 acres of 6330-3 to new land	PE	0

05/14/2007	3065B-3	Permit approved by Chief Engineer, amended 3065A-3 and moved all acres	PE	0
05/14/2007	6330-3	Amended by Water Right permit 6330A-3	IP	0
06/07/2007	6863-3	Date Received, WMB Denied at 12-6-07 meeting	DN	
06/07/2007	6864-3	Date Received, WMB Denied at 12-6-07 meeting	DN	
06/11/2007	6865-3	Date Received, WMB Denied at 12-6-07 meeting	DN	
06/11/2007	6866-3	Date Received, WMB Denied at 12-6-07 meeting	DN	
07/02/2007	6312A-3	Permit approved by Chief Engineer, took diversion authority for 28 acres from 6312-3, 56 acres from 6333-3, 25 acres from 6331-3	PE	-109
07/02/2007	6312-3	Reissued Permit for 132 of 160 acres, 28 acres went to 6312A-3	PE	0
07/02/2007	6333-3	Reissued Permit for 264 of 320 acres, 56 acres + div rate went to 6312A-3	PE	0
07/02/2007	6331A-3	Permit approved by Chief Engineer, took 132 of 157 acres from 6331-3	PE	0
07/02/2007	6331-3	Divided, Water Permit 6331A-3 took 132 acres, Water Permit 6312A-3 took 25 acres	IL	0
08/01/2007	6240-3	Result of Licensing (132 to 132 acres)	LC	0
08/03/2007	6234-3	Result of Licensing (135 to 134 acres)	LC	-1
08/03/2007	6238-3	Result of Licensing (130 to 130 acres)	LC	0
08/03/2007	6239-3	Result of Licensing (260 to 260 acres)	LC	0
10/09/2007	6288-3	Result of Licensing (160 to 136 acres)	LC	-24
10/29/2007	6333A-3	Permit approved by Chief Engineer - took 100 acres from 6333-3	PE	0
10/29/2007	6333B-3	Permit approved by Chief Engineer - took 134 acres from 6333-3	PE	0
10/29/2007	6333-3	Divided, Water Permit 6333A-3 took 100 acres, 6333B-3 took 134 acres, 30 acres left with no div?	IP	-30
10/30/2007	6160-3	Result of Licensing (160 to 136 acres)	LC	-24
10/30/2007	6336-3	Result of Licensing (136 to 136 acres)	LC	0
11/05/2007	6175-3	Result of Licensing (160 to 136 acres)	LC	-24
11/13/2006	6777-3	Date Received, WMB Deferred at 3/7/07 meeting, WMB Denied at 12-6-07 meeting	DN	
12/06/2007		WMB hearing on 33 deferred applications, all denied		
01/23/2008	6312-3	Result of Licensing (132 of 132 acres)	LC	0
01/24/2008	6142-3	Result of Licensing (100 + 140 (4897-3) to 240 acres)	LC	0
01/24/2008	6337-3	Result of Licensing (292 to 272 acres)	LC	-20
01/24/2008	6331A-3	Result of Licensing (132 of 132 acres)	LC	0
01/24/2008	4897-3	Incorporated into Water Right 6142-3	IL	
01/28/2008	6338-3	Result of Licensing (264 to 264 acres)	LC	0
01/28/2008	6339B-3	Result of Licensing (132 to 132 acres)	LC	0
01/28/2008	6340-3	Result of Licensing (132 to 132 acres)	LC	0
01/28/2008	6339A-3	Result of Licensing (132 to 132 acres)	LC	0
01/28/2008	6338A-3	Result of Licensing (70 to 68 acres)	LC	-2
04/08/2008	6108-3	Result of Licensing (136 + 168 (2569-3) to 304 acres)	LC	0
04/08/2008	2569-3	Incorporated into Water Right 6108-3	IL	0
05/16/2008	6201-3	Result of Licensing (396 to 396 acres)	LC	0
05/16/2008	6334B-3	Result of Licensing (133.7 to 132 acres)	LC	-1.7

05/16/2008	6343-3	Result of Licensing (269 to 264 acres)	LC	-5
05/16/2008	6334A-3	Result of Licensing (133.7 to 132 acres)	LC	-1.7
05/16/2008	6201A-3	Result of Licensing (135 to 132 acres)	LC	-3
05/16/2008	2485-3	Incorporated into Water Right licene 6764-3, 130 of 130 acres	IL	0
05/16/2008	6764-3	Result of Licensing, incorporates 130 acres from 2485-3 and 90 acres from 6193-3	LC	0
05/16/2008	6193-3	Incorporated into Water Right 6764-3	IL	0
06/12/2008	6333B-3	Result of Licensing (134 of 134 acres)	LC	0
10/30/2008	3065B-3	Result of Licensing (130 to 130 acres)	LC	0
10/30/2008	3065A-3	Amended by Water Right 3065B-3, 130 of 130 acres moved	IP	0
11/23/2009	7126-3	Permit approved by Chief Engineer - transferred 45 of 130 acres from 3054A-3	PE	0
11/23/2009	3054A-3	Reissued License for 85 of 130 acres due to approval of 7126-3	LC	0
04/27/2010	7198-3	Date Received, WMB Denied at 12-1-10 meeting	DN	
03/22/2011	4622A-3	Permit approved by Chief Engineer, took 101 acres from 4622-3 and 29 acres from 1523-3	PE	0
03/22/2011	4622-3	Amended by Water Right permit 4622A-3, 101 of 101 acres + diversion transferred	LC	0
03/22/2011	1523-3	29 acres taken by Water Right permit 4622A-3, Water Right license reissued for 131 acres	LC	0
07/12/2011	7863-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
10/05/2011	4622-3	Cancelled due to 4622A-3 taking all acres and diversion	CA	0
12/15/2011	7288-3	Date Received, Withdrawn due to stipulation with Chief Engineer	WI	
04/16/2012	6201B-3	Permit Approved by Chief Engineer, transferred all acres and diversion to other land	PE	0
04/16/2012	6201A-3	Incorporated into Water Right 6201B-3	IP	0
06/29/2012	7378-3	Date received, Chief Engineer recommended denial, withdrawn 9-27-12	WI	
06/29/2012	7379-3	Date received, Chief Engineer recommended denial, withdrawn 9-27-12	WI	
07/11/2012	7289-3	Permit approved by WMB	PE	270
07/11/2012	7290-3	Permit approved by WMB	PE	135
07/11/2012	7291-3	Permit approved by WMB	PE	135
07/11/2012	7292-3	Permit approved by WMB	PE	135
07/11/2012	7293-3	Permit approved by WMB	PE	135
08/23/2012	7390-3	Date received, withdrawn 8-7-13	WI	
10/09/2012	7126A-3	Permit approved by Chief Engineer - transferred acres back to their original location	PE	0
10/09/2012	7391-3	Permit approved by Chief Engineer, additional source (spring + drain tile) on acres covered by 6201B-3	PE	136
10/09/2012	7126-3	Cancelled by approval of 7126A-3, 45 of 45 acres were moved	CA	0
12/06/2012	282-3	Cancelled by WMB for abandonment/forfeiture	CA	-160
02/08/2013	7726-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/08/2013	7752-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/08/2013	7753-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/08/2013	7754-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/08/2013	7755-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/08/2013	7756-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	

02/08/2013	7757-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/08/2013	7759-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/10/2013	7727-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/11/2013	7731-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/11/2013	7732-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/15/2013	7733-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/15/2013	7734-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/15/2013	7736-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/19/2013	7737-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7738-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7739-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7740-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7741-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7742-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7743-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7744-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7745-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/19/2013	7746-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/28/2013	7751-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
02/28/2013	7758-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
03/07/2013	7373-3	Permit approved by WMB	PE	160
03/13/2013	7790-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
03/19/2013	7799-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
04/09/2013	7822-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
04/09/2013	7823-3	Date received, recommended for denial, withdrawn 6-13-13	WI	
05/02/2013	7551-3	Permit approved by WMB, additional acres on 470A-3	PE	90
05/02/2013	7637-3	Permit approved by WMB	PE	135
05/02/2013	7638-3	Permit approved by WMB	PE	135
05/02/2013	7639-3	Permit approved by WMB	PE	135
05/02/2013	7570-3	Permit approved by WMB	PE	280
05/02/2013	7571-3	Permit approved by WMB	PE	160
05/02/2013	7572-3	Permit approved by WMB	PE	140
05/02/2013	7573-3	Permit approved by WMB	PE	160
05/02/2013	7574-3	Permit approved by WMB	PE	160
05/02/2013	7575-3	Permit approved by WMB	PE	280
05/02/2013	7575A-3	Permit approved by Chief Engineer, half of 7575-3	PE	0
05/02/2013	7575B-3	Permit approved by Chief Engineer, half of 7575-3	PE	0
05/02/2013	7640-3	Permit approved by WMB	PE	160

05/02/2013	7620-3	Permit approved by WMB	PE	136
05/02/2013	7575-3	Divided, 140 acres to 7575A-3, 140 acres to 7575B-3	OC	0
07/11/2013	7685-3	Permit approved by WMB	PE	75
07/11/2013	7716-3	Permit approved by WMB	PE	160
07/11/2013	7717-3	Permit approved by WMB	PE	135
07/11/2013	7718-3	Permit approved by WMB	PE	135
07/11/2013	7719-3	Permit approved by WMB	PE	135
07/11/2013	7720-3	Permit approved by WMB	PE	135
07/11/2013	7721-3	Permit approved by WMB	PE	100
07/11/2013	7722-3	Permit approved by WMB	PE	155
07/11/2013	7723-3	Permit approved by WMB	PE	300
07/11/2013	7724-3	Permit approved by WMB	PE	300
07/11/2013	7725-3	Permit approved by WMB	PE	135
07/11/2013	7725-3	7725-3 divided into approved and denied portions, 7725A-3 and 7725B-3	OC	0
07/11/2013	7725A-3	Approved portion of 7725-3	IP	0
07/11/2013	7858-3	Date received, WMB Denied at May 6-7 2015 meeting, 10-30-15 6th Judicial Court dismissed the appeal	DN	
07/11/2013	7859-3	Date received, WMB Denied at May 6-7 2015 meeting, 10-30-15 6th Judicial Court dismissed the appeal	DN	
07/11/2013	7860-3	Date received, WMB Denied at May 6-7 2015 meeting, 10-30-15 6th Judicial Court dismissed the appeal	DN	
07/11/2013	7861-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7864-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7865-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7866-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7867-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7868-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7869-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7870-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7871-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/12/2013	7872-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
07/23/2013	7885-3	Date received, recommended for denial, withdrawn 10-10-13	WI	
09/05/2013	7894-3	Date received, WMB Denied at May 6-7 2015 meeting, 10-30-15 6th Judicial Court dismissed the appeal	DN	
11/01/2013	7920-3	Date received, recommended for denial, withdrawn 1-24-14	WI	
11/01/2013	7979-3	Date received, recommended for denial, withdrawn 5-15-14	WI	
02/08/2014	7725B-3	Denied portion of 7725-3	DN	0
02/15/2014	7735-3	Date received, WMB Denied at 10-3-13 meeting, 8-21-14 6th Judicial Court affirmed the denial	DN	
02/21/2014	4794A-3	Date Received, Withdrawn 3-3-14	WI	

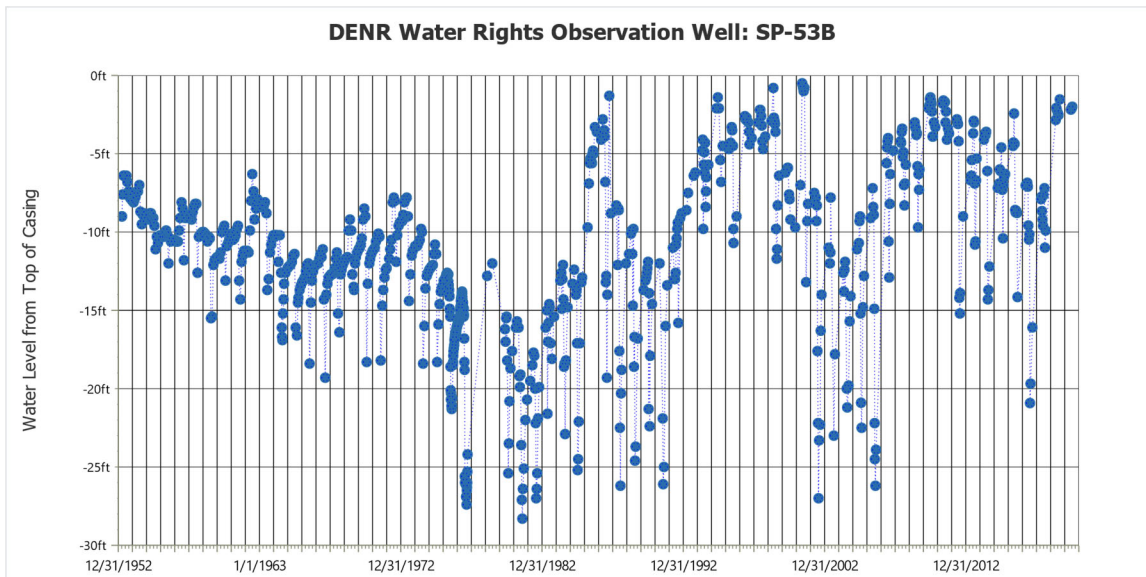
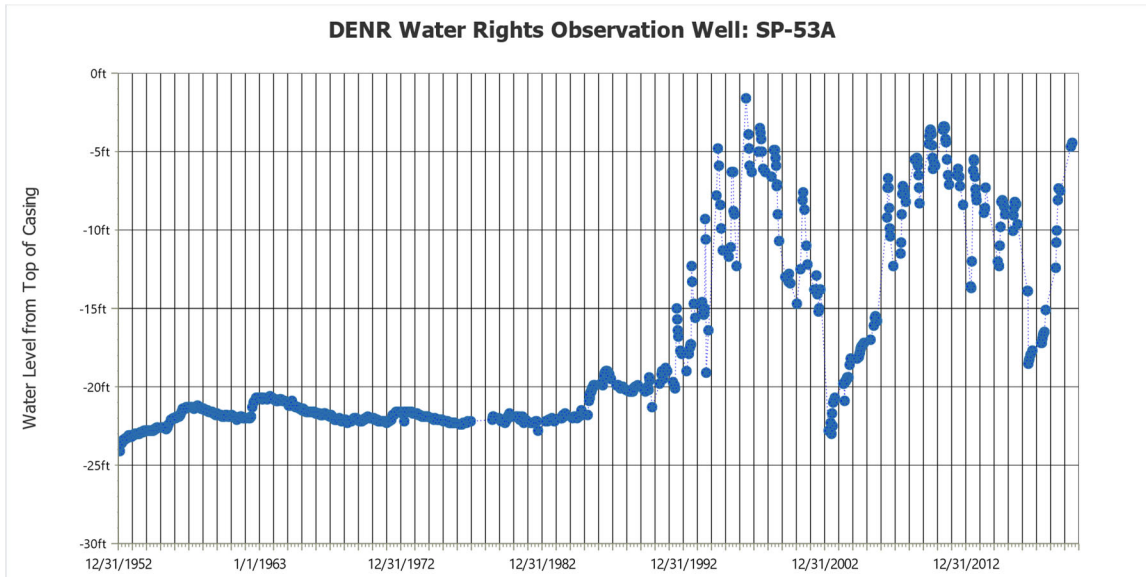
02/21/2014	7721A-3	Date received, withdrawn 3-3-14	WI	
04/28/2014	8013-3	Date received, WMB Denied at 10-22-14 meeting	DN	
05/07/2014	4134A-3	Permit approved by WMB, took 128 of 128 acres from 4134-3	PE	0
05/07/2014	4134-3	Incorporated into Water Right 4134A-3	IP	
05/27/2014	7718A-3	Permit approved by Chief Engineer, amends 7718-3 by moving acres and diversion	PE	0
05/27/2014	7718-3	Amended by Water Right 7718A-3	IP	0
06/30/2014	8034-3	Date Received, Recommended for Denial, Withdrawn 9-16-14	WI	
07/10/2014	4134-3	Cancelled due to 4134A-3 taking all acres and diversion	CA	0
08/25/2014	3321A-3	Permit approved by Chief Engineer, moved acres of 3321-3	PE	0
08/25/2014	3321-3	Incorporated into Water Right 3321A-3	LC	0
09/02/2014	782A-3	Permit approved by Chief Engineer, amends 782-3 by moving acres and diversion	PE	0
09/02/2014	782-3	Amended by 782A-3	IP	0
10/14/2014	7725C-3	Permit approved by Chief Engineer, amends 7725A-3 by moving acres and diversion	PE	0
10/14/2014	7725A-3	Incorporated into Water Right 7725C-3	IP	0
10/22/2014	1613-3	Cancelled by WMB for abandonment/forfeiture	CA	-130
12/24/2014	6201-3	Ownership Change into Water Right 6201C-3 and 6201D-3	OC	0
12/24/2014	6201C-3	Ownership Change, took 264 of 396 acres from 6201-3	LC	0
12/24/2014	6201D-3	Ownership Change, took 132 of 396 acres from 6201-3	LC	0
01/12/2015	3053A-3	Permit approved by Chief Engineer, took 130 of 152 acres of 3053-3	PE	-22
01/12/2015	3053-3	Amended by Water Right 3053A-3, transferred the irrigated acres (152? of 152 acres)	IP	0
02/25/2015	8083-3	Number 24 of 28 in the Random Selection Priority List	HD	
02/25/2015	8084-3	Number 10 of 28 in the Random Selection Priority List	HD	
02/25/2015	8085-3	Number 4 of 28 in the Random Selection Priority List	HD	
02/25/2015	8099-3	Number 13 of 28 in the Random Selection Priority List	HD	
02/25/2015	8100-3	Number 19 of 28 in the Random Selection Priority List	HD	
02/25/2015	8101-3	Number 2 of 28 in the Random Selection Priority List	HD	
02/25/2015	8102-3	Number 16 of 28 in the Random Selection Priority List	HD	
02/25/2015	8103-3	Number 9 of 28 in the Random Selection Priority List	HD	
02/25/2015	8104-3	Number 27 of 28 in the Random Selection Priority List	HD	
02/25/2015	8105-3	Number 11 of 28 in the Random Selection Priority List	HD	
02/25/2015	8106-3	Number 8 of 28 in the Random Selection Priority List	HD	
02/25/2015	8107-3	Number 22 of 28 in the Random Selection Priority List	HD	
02/25/2015	8108-3	Number 17 of 28 in the Random Selection Priority List	HD	
02/25/2015	8109-3	Number 25 of 28 in the Random Selection Priority List	HD	
02/25/2015	8110-3	Number 18 of 28 in the Random Selection Priority List	HD	
02/25/2015	8111-3	Number 14 of 28 in the Random Selection Priority List	HD	
02/25/2015	8120-3	Number 5 of 28 in the Random Selection Priority List	HD	
02/25/2015	8121-3	Number 20 of 28 in the Random Selection Priority List	HD	

02/25/2015	8122-3	Number 23 of 28 in the Random Selection Priority List	HD	
02/25/2015	8128-3	Number 1 of 28 in the Random Selection Priority List	HD	
02/25/2015	8129-3	Number 12 of 28 in the Random Selection Priority List	HD	
02/25/2015	8130-3	Number 21 of 28 in the Random Selection Priority List	HD	
02/25/2015	8131-3	Number 6 of 28 in the Random Selection Priority List	HD	
02/25/2015	8132-3	Number 28 of 28 in the Random Selection Priority List	HD	
02/25/2015	8133-3	Number 15 of 28 in the Random Selection Priority List	HD	
02/25/2015	8135-3	Number 26 of 28 in the Random Selection Priority List	HD	
02/25/2015	8137-3	Number 3 of 28 in the Random Selection Priority List	HD	
02/25/2015	8138-3	Number 7 of 28 in the Random Selection Priority List	HD	
03/25/2015	7570A-3	Date received, permit was issued but later deemed invalid	WI	
05/07/2015	2078A-3	Permit approved by Chief Engineer, moved 132 of 924 acres of Water Right License 2078-3	PE	0
07/06/2015	7571A-3	Permit approved by Chief Engineer, amends 7571-3 by moving acres and diversion	PE	0
07/06/2015	7571-3	Amended by Water Right 7571A-3, transferred acres and diversion to other land	IP	0
07/27/2015	4794B-3	Permit approved by Chief Engineer, moved 28 acres of 4794-3, incorporated 4794-3	PE	0
07/27/2015	7573A-3	Permit approved by Chief Engineer, took 24 acres from 7573-3 and incorporated 4723-3A	PE	0
07/27/2015	7573-3	Reissued Permit for 136 of 160 acres, 7573A-3 transferred 24 acres	PE	0
07/27/2015	4794C-3	Permit approved by Chief Engineer, took 20 acres from 4794-3 and incorporated 104 acres of 3317A-3	PE	0
07/27/2015	4723-3A	Incorporated into Water Right 7573A-3	IP	0
07/27/2015	4794-3	Amended, 4794B-3 moved 28 acres, 4794C-3 transferred 20 acres	IP	0
07/27/2015	3317A-3	Incorporated into Water Right 4794C-3	IP	0
08/31/2015	7620A-3	Permit approved by Chief Engineer, took 72 acres from 7620-3	PE	0
08/31/2015	7620B-3	Permit approved by Chief Engineer, took 64 acres from 7620-3	PE	0
08/31/2015	7620-3	Divided, 72 acres to 7620A-3, 64 acres to 7620B-3	IP	0
09/08/2015	7572A-3	Date received, withdrawn	WI	
11/09/2015	7572B-3	Permit approved by Chief Engineer, amends 7572-3 by moving acres and diversion	PE	0
11/09/2015	7572-3	Amended by Water Right 7572B-3, transferred acres and diversion to other land	IP	0
02/01/2016	7293-3	Result of Licensing (135 to 135 acres)	LC	0
02/01/2016	7373-3	Result of Licensing (160 to 152 acres)	LC	-8
02/24/2016	4794C-3	Result of Licensing (124 to 124 acres)	LC	0
03/03/2016	3243-3	Cancelled by WMB for abandonment/forfeiture	CA	-89
06/29/2016	7292-3	Result of Licensing (135 + 132 (6339B-3) to 266 acres)	LC	-1
06/29/2016	6339B-3	Incorporated all 132 acres into Water Right 7292-3	IL	0
06/29/2016	7292-3	Divided, 133 acres to 7292A-3, 133 acres to 7292B-3	IL	0
06/29/2016	7292A-3	Took 133 of 266 acres from 7292-3	LC	0
06/29/2016	7292B-3	Took 133 of 266 acres from 7292-3	LC	0
09/06/2016	7685-3	Result of Licensing (75 to 75 acres)	LC	0
09/12/2016	7289-3	Result of Licensing (270 to 270 acres)	LC	0

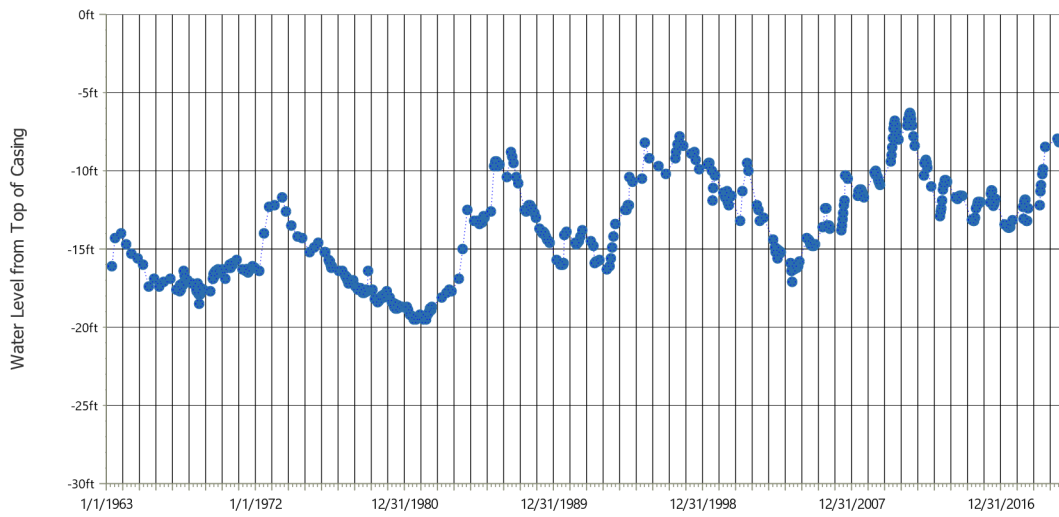
09/12/2016	6343A-3	Ownership Change, took 132 of 264 acres from 6343-3	LC	0
09/12/2016	6343B-3	Ownership Change, took 132 of 264 acres from 6343-3	LC	0
09/12/2016	6343-3	Ownership Change, 132 acres to 6343A-3 and 132 acres to 6343B-3	OC	0
10/11/2016	7718A-3	Result of Licensing (135 to 135 acres)	LC	0
10/24/2016	4134A-3	Result of licensing (128 to 128 acres)	LC	0
06/18/2018	7723A-3	Date received, withdrawn 7-17-18	WI	
12/20/2018	7639-3	Result of Licensing (135 to 135 acres)	LC	0
12/20/2018	4794B-3	Result of Licensing (244 + 135 (7719-3) to 278 acres)	LC	-101
12/20/2018	7719-3	Incorporated into Water Right 4794B-3	IL	0
05/22/2019	4622A-3	Result of Licensing (130 to 130 acres)	LC	0
06/27/2019	3321A-3	Result of Licensing (120 to 120 acres)	LC	0
06/27/2019	2078A-3	Result of Licensing (132 to 132 acres)	LC	0
06/27/2019	2078-3	License reissued for 792 acres	LC	0
01/08/2020	7570-3	Result of Licensing (280 to 259 acres)	LC	-21
01/08/2020	7571A-3	Result of Licensing (160 + 135 (7717-3) to 270 acres)	LC	-25
01/08/2020	7717-3	Incorporated into Water Right 7571A-3	IL	0
02/24/2020	7290-3	Result of Licensing (135 to 135 acres)	LC	0
02/24/2020	7291-3	Result of Licensing (135 to 135 acres)	LC	0
02/24/2020	7573-3	Result of Licensing (136 to 134 acres)	LC	-2
02/24/2020	7574-3	Result of Licensing (160 + 140 (7575A-3) to 268 acres)	LC	-32
02/24/2020	7575B-3	Result of Licensing (140 to 134 acres)	LC	-6
02/24/2020	7725C-3	Result of Licensing (135 to 135 acres)	LC	0
02/24/2020	7573A-3	Result of Licensing (160 to 156 acres)	LC	-4
02/24/2020	7572B-3	Result of Licensing (140 to 135 acres)	LC	-5
02/24/2020	7575A-3	Result of Licensing, Incorporated into Water Right 7574-3	IL	0
03/09/2020	7637-3	Result of Licensing (135 to 135 acres)	LC	0
03/09/2020	7720-3	Result of Licensing (135 to 135 acres)	LC	0
03/13/2020	7640-3	Result of Licensing (160 to 158 acres)	LC	-2
03/25/2020	7551-3	Result of Licensing (90 + 136 (470A-3) to 219 acres)	LC	-7
03/25/2020	782A-3	Result of Licensing (160 to 136 acres)	LC	-24
03/25/2020	470A-3	Incorporated into Water Right 7551-3	IL	0
03/25/2020	472A-3	Result of Licensing (160 to 140 acres)	LC	-20
05/26/2020	6333A-3	Result of Licensing (100 + 157 (6330A-3) to 215 acres)	LC	-42
05/26/2020	7723-3	Result of Licensing (300 + 155 (7722-3) to 405 acres)	LC	-50
05/26/2020	6330A-3	Incorporated into Water Right 6333A-3	IL	0
05/26/2020	7722-3	Incorporated into Water Right 7723-3	IL	0
06/01/2020	7724-3	Result of Licensing (300 to 300 acres)	LC	0
09/09/2020	7716-3	Result of Licensing (160 to 135 acres)	LC	-25



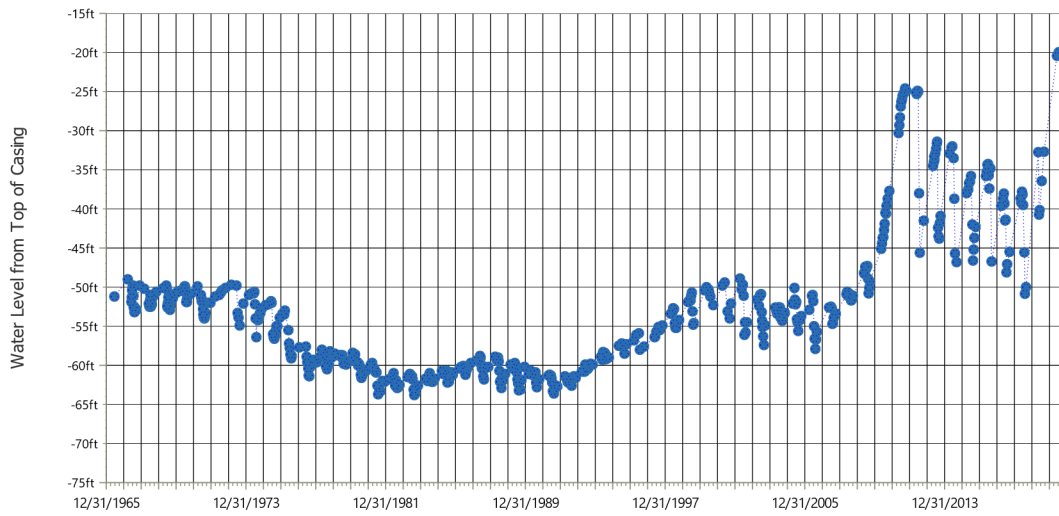
Appendix B: SD DENR-Water Rights Program Tulare: Western Spink Hitchcock aquifer observation well hydrographs (Water Rights, 2020b).



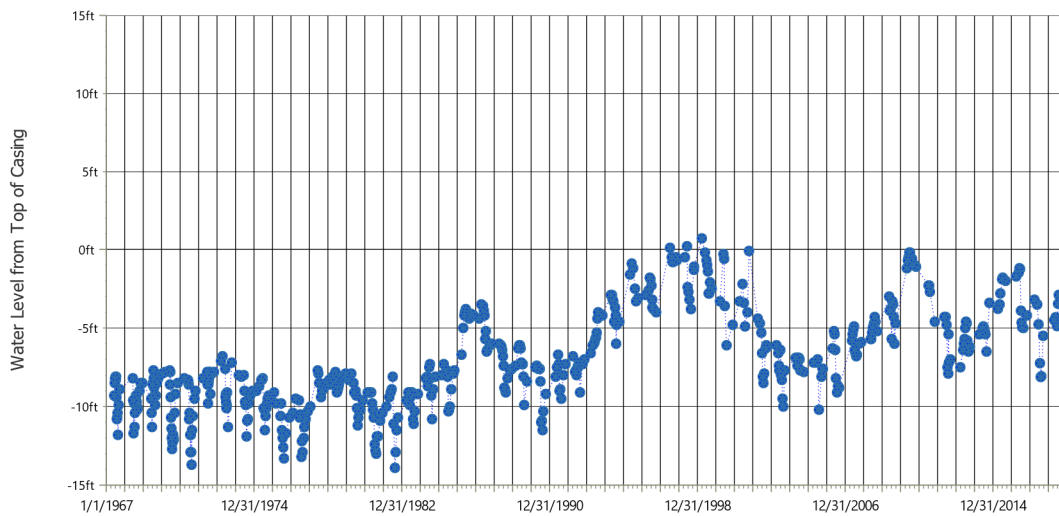
**DENR Water Rights Observation Well: BD-63C**



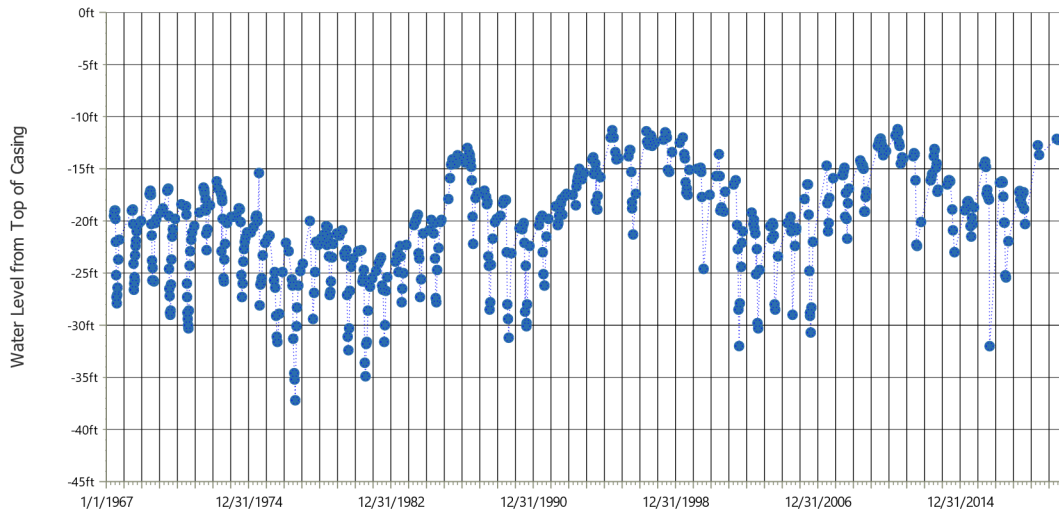
**DENR Water Rights Observation Well: BD-66A**



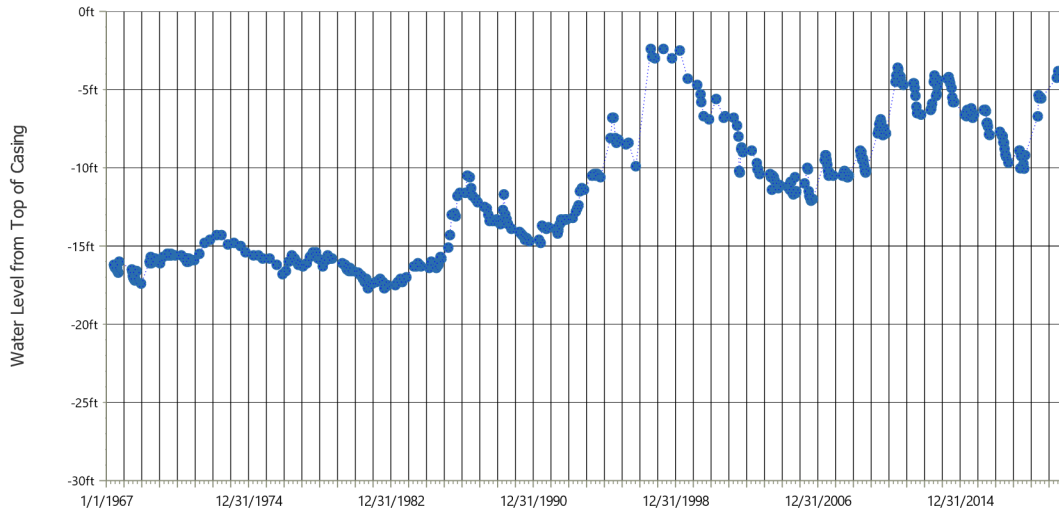
**DENR Water Rights Observation Well: SP-66G**



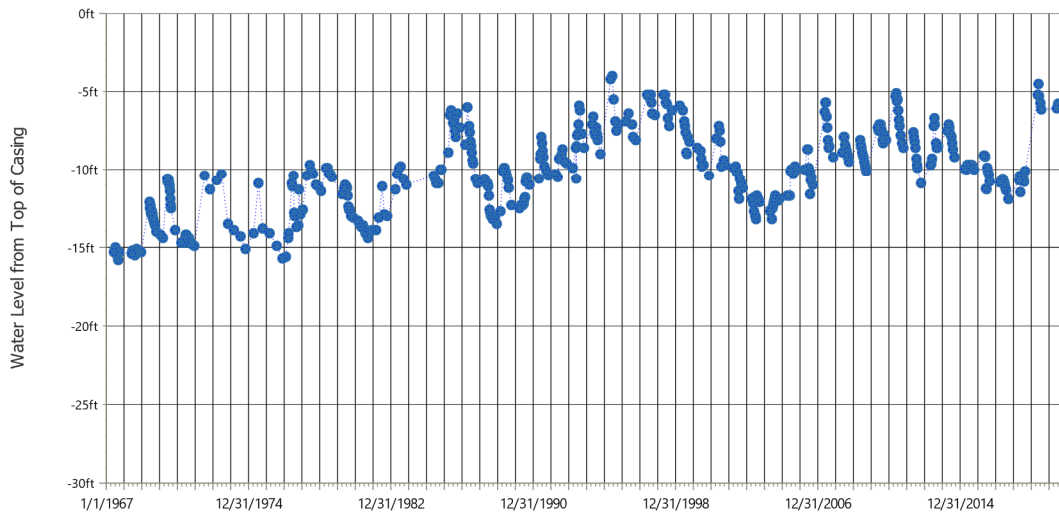
**DENR Water Rights Observation Well: SP-66H**



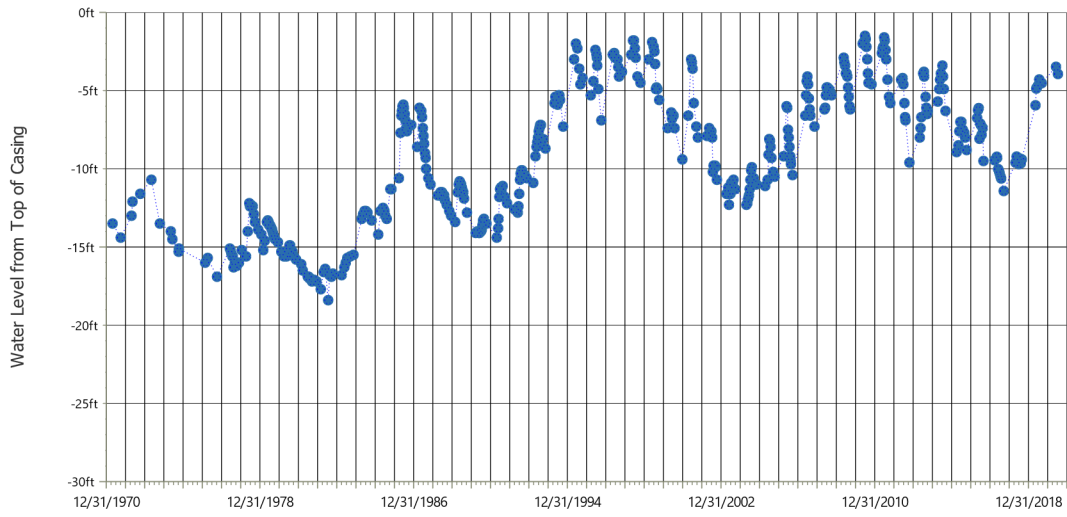
**DENR Water Rights Observation Well: SP-66K**



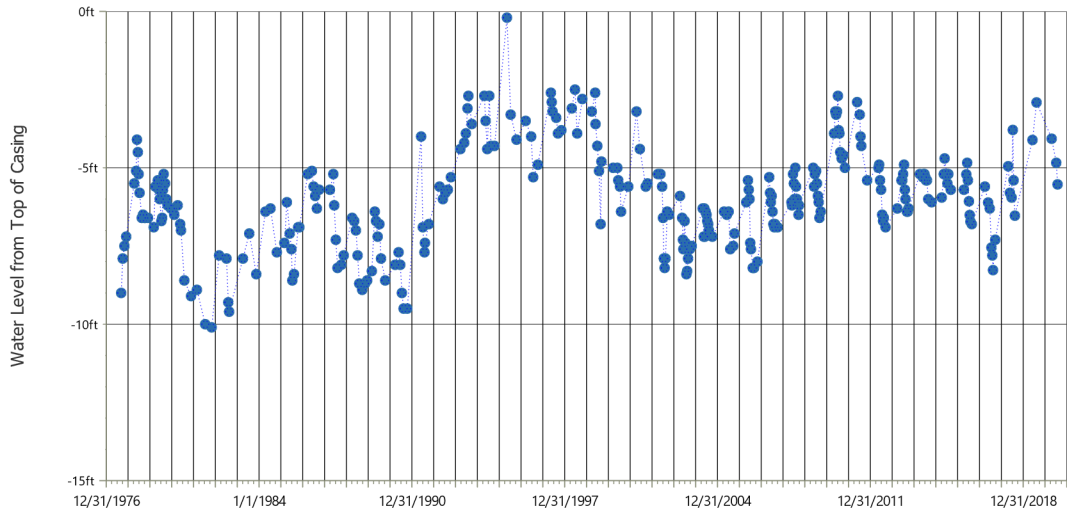
**DENR Water Rights Observation Well: SP-66M**



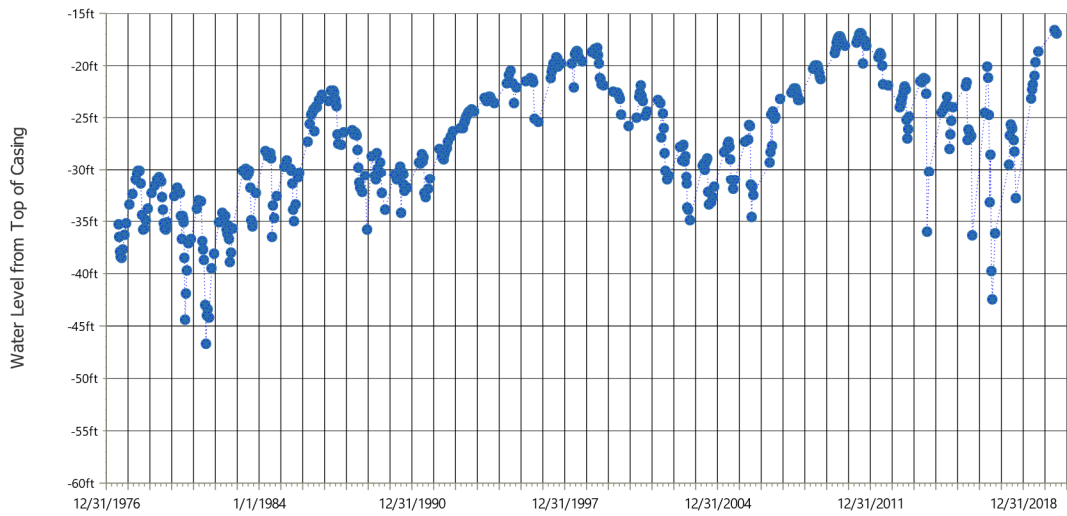
**DENR Water Rights Observation Well: SP-71A**



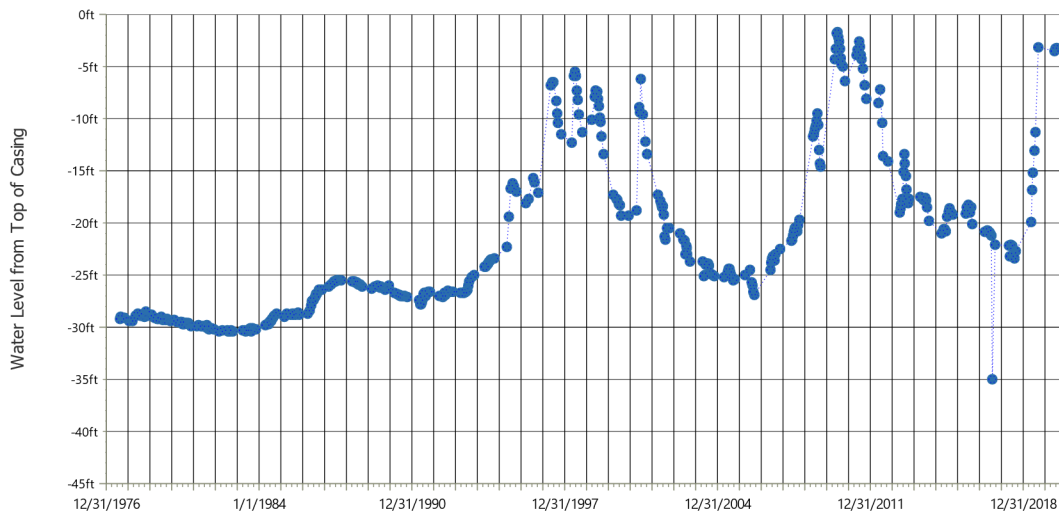
**DENR Water Rights Observation Well: HD-73Q**



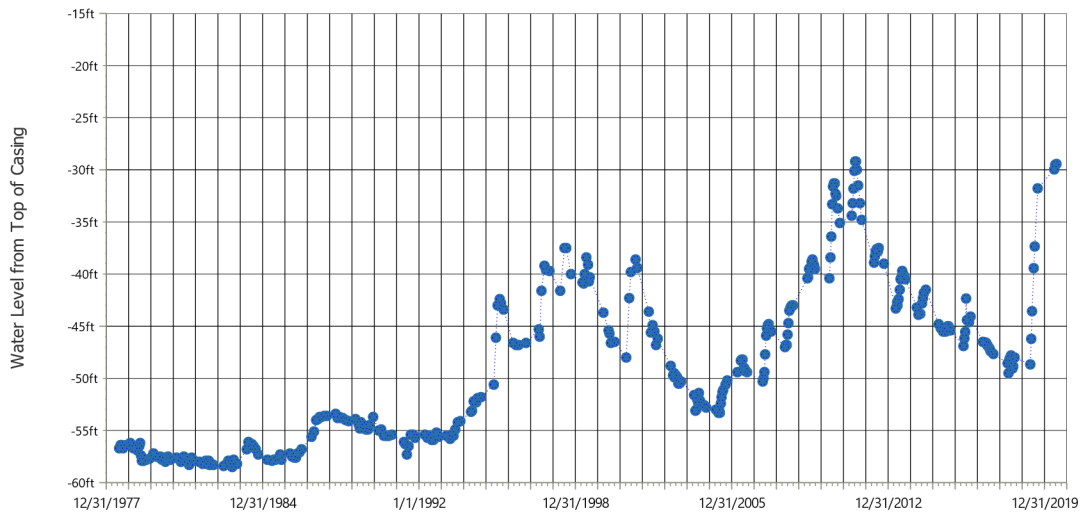
**DENR Water Rights Observation Well: BD-76A**



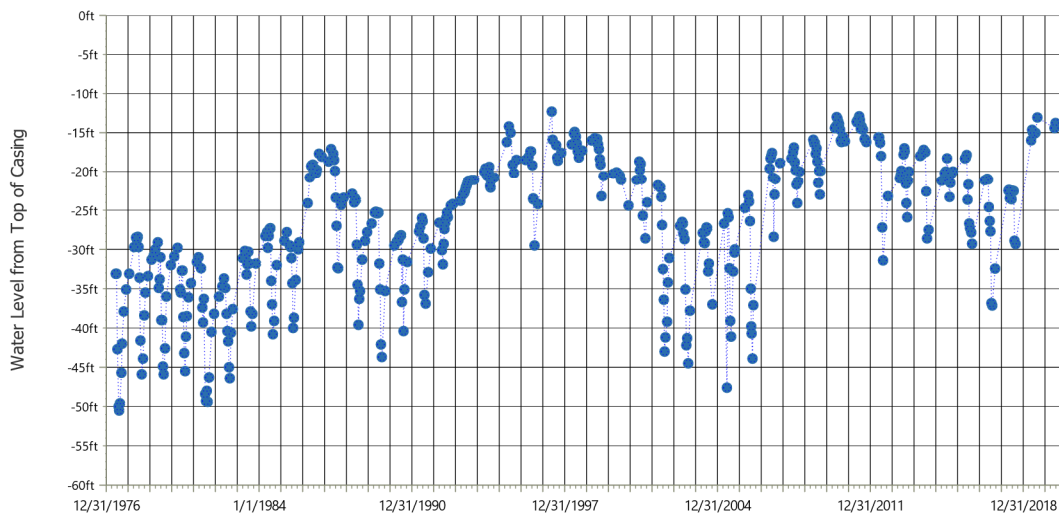
**DENR Water Rights Observation Well: BD-77A**



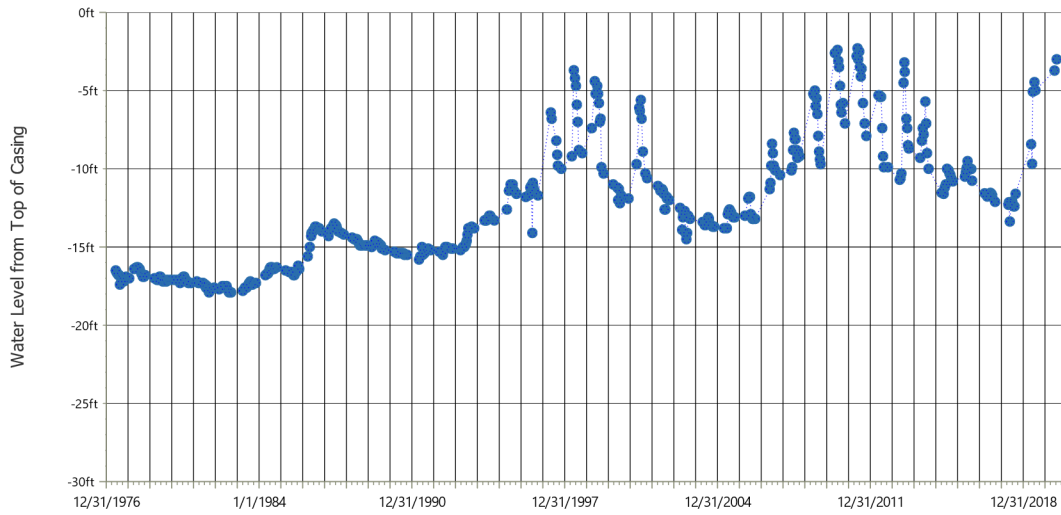
**DENR Water Rights Observation Well: BD-77K**



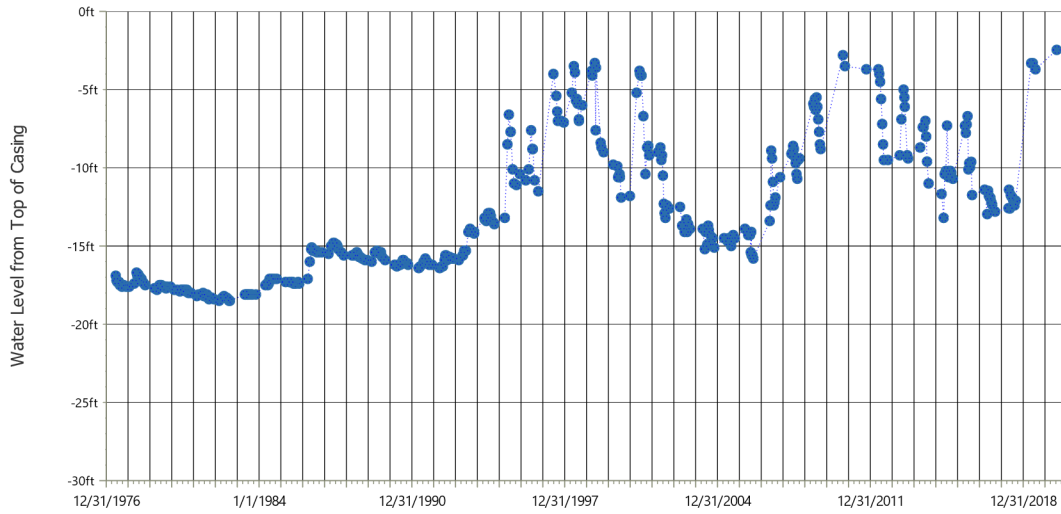
**DENR Water Rights Observation Well: SP-77G**



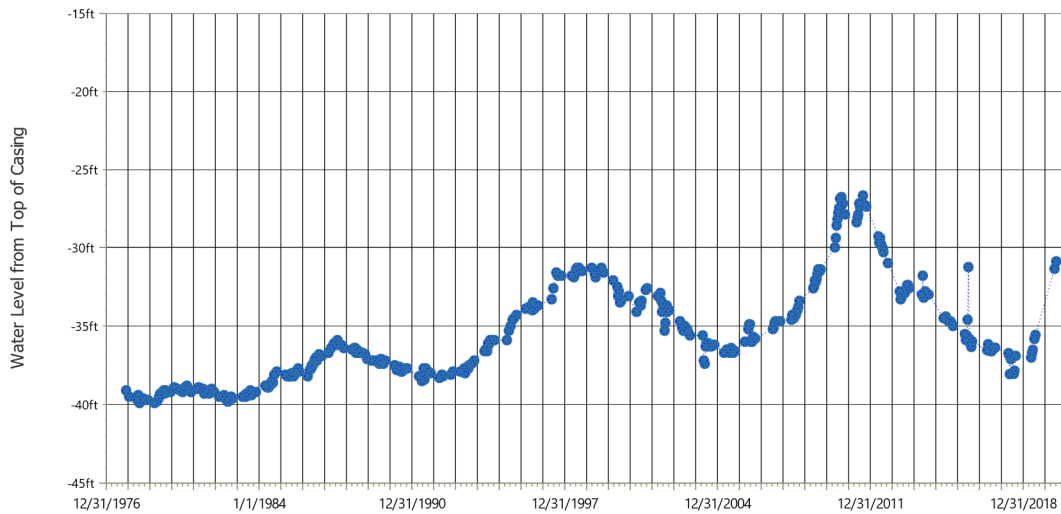
**DENR Water Rights Observation Well: SP-77H**



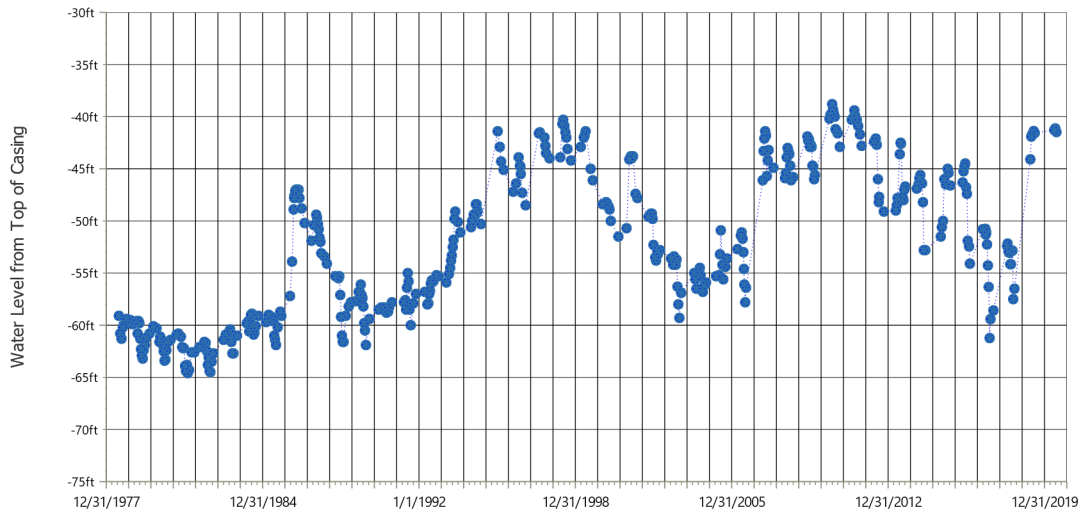
**DENR Water Rights Observation Well: SP-77I**



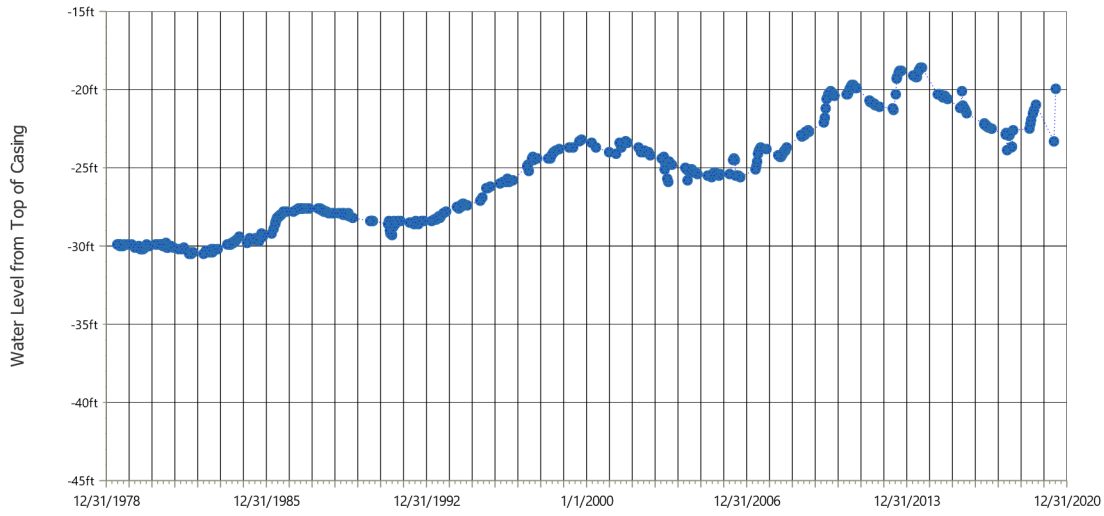
**DENR Water Rights Observation Well: SP-77W**



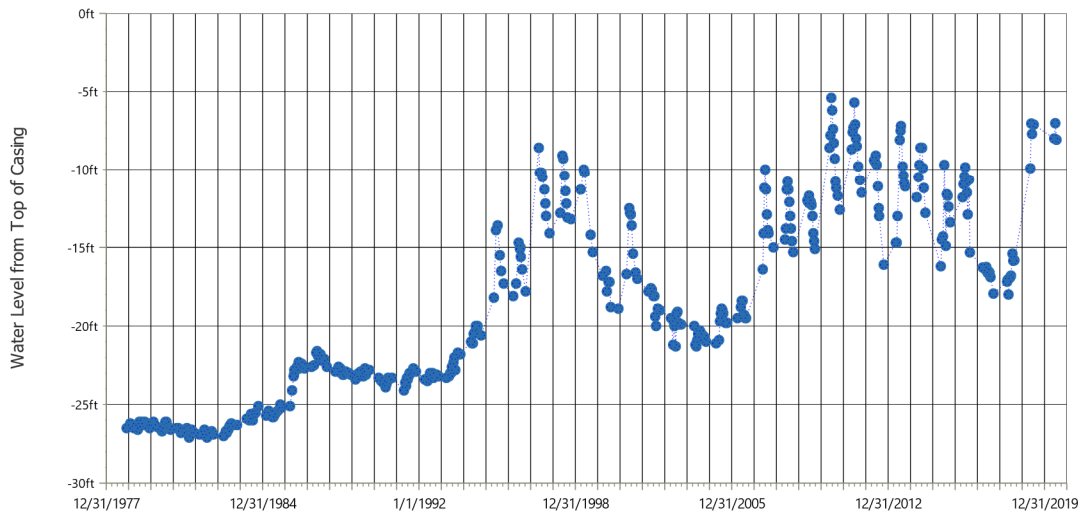
**DENR Water Rights Observation Well: SP-77X**



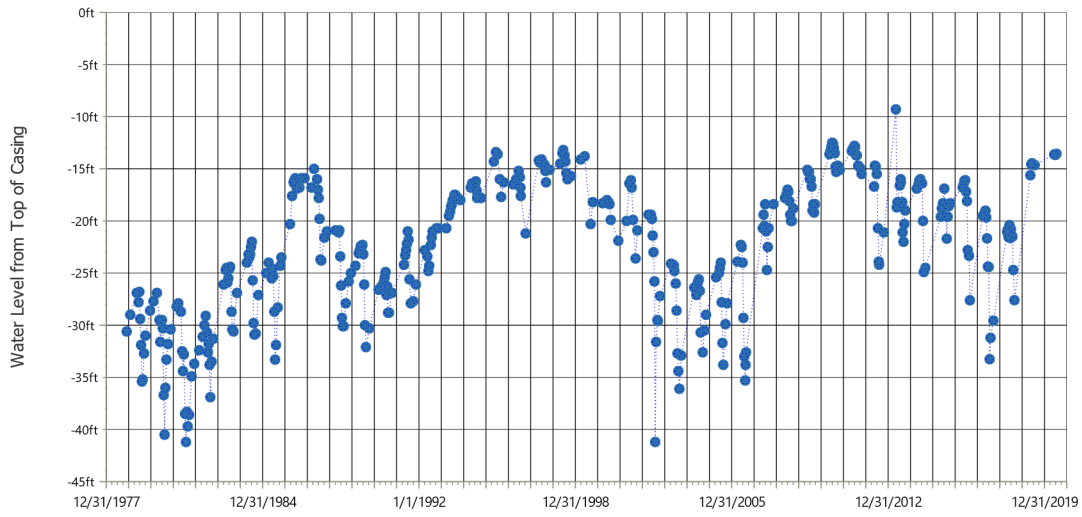
**DENR Water Rights Observation Well: SP-78B**



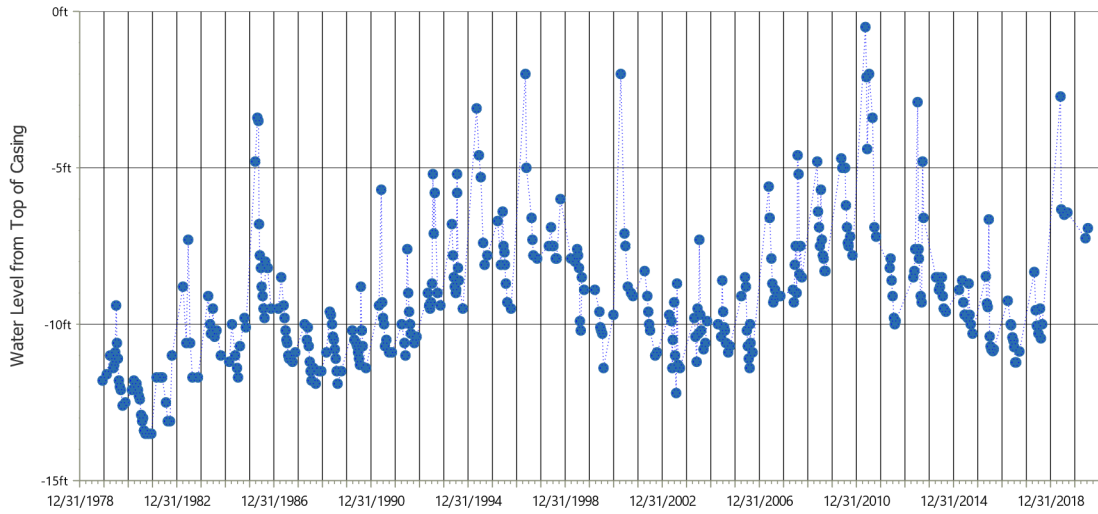
**DENR Water Rights Observation Well: SP-78C**



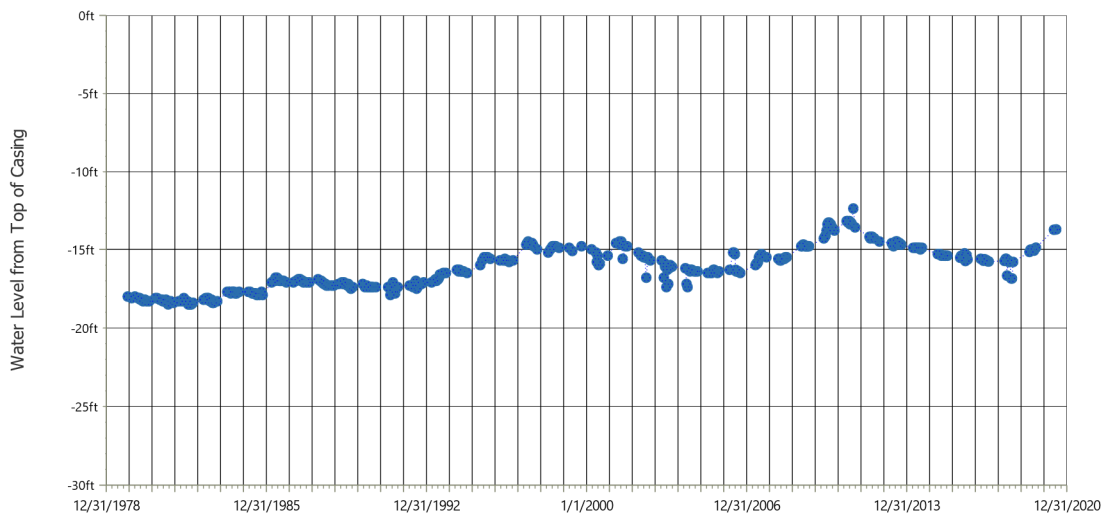
**DENR Water Rights Observation Well: SP-78D**



**DENR Water Rights Observation Well: SP-79F**

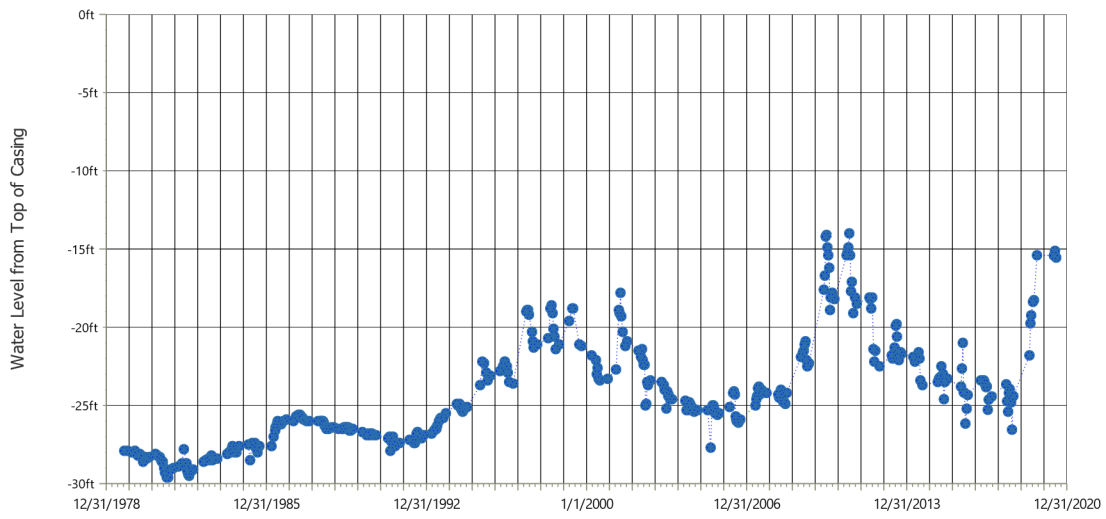


**DENR Water Rights Observation Well: SP-79J**

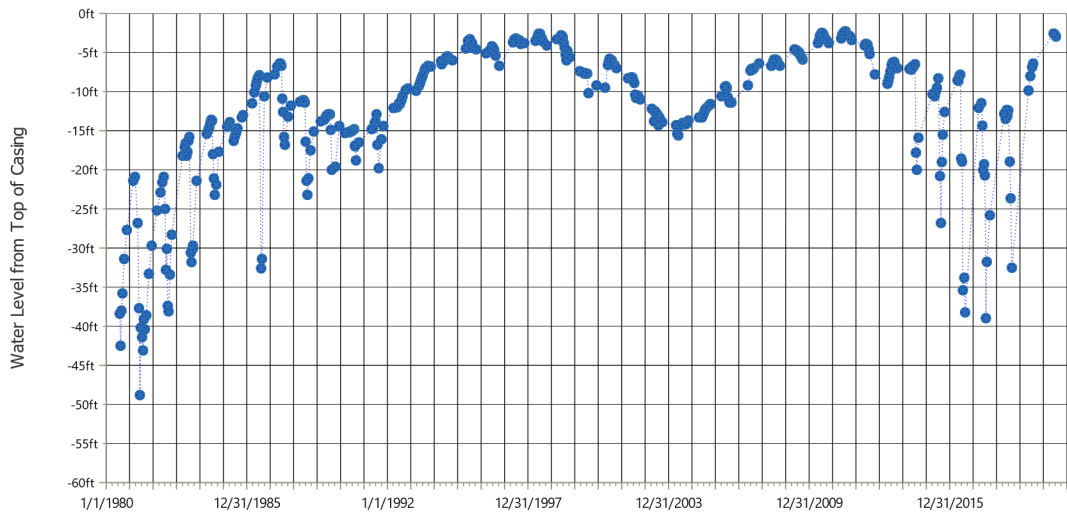




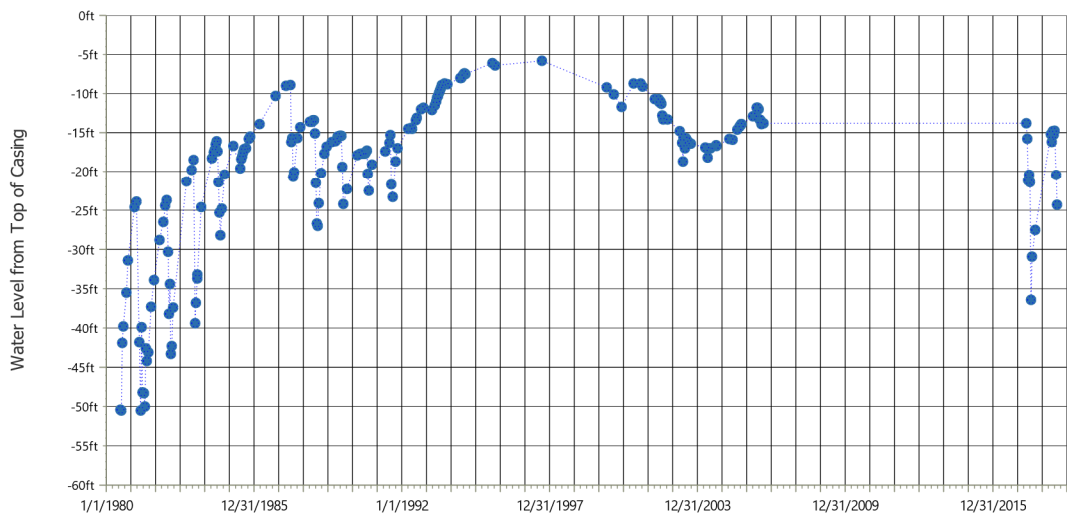
**DENR Water Rights Observation Well: SP-79N**



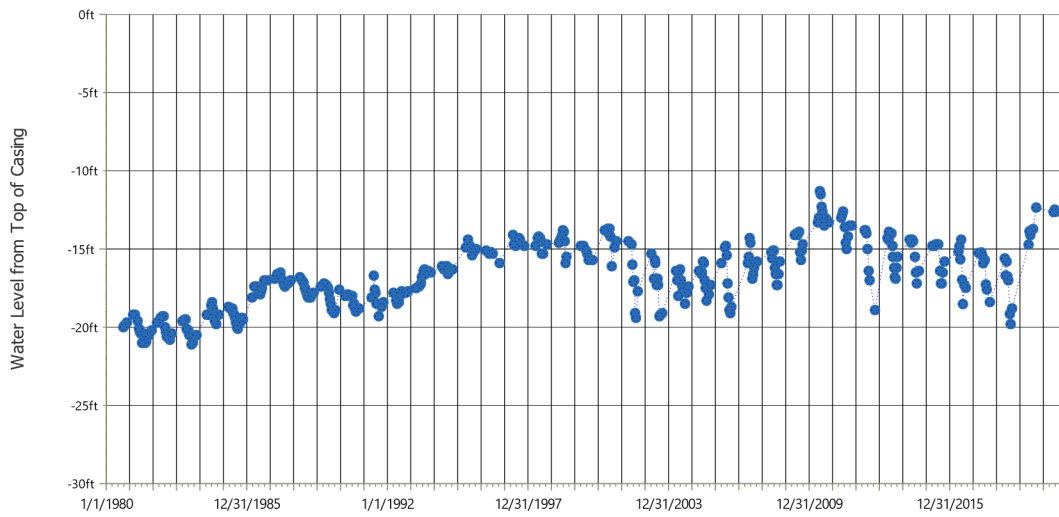
**DENR Water Rights Observation Well: BD-80A**



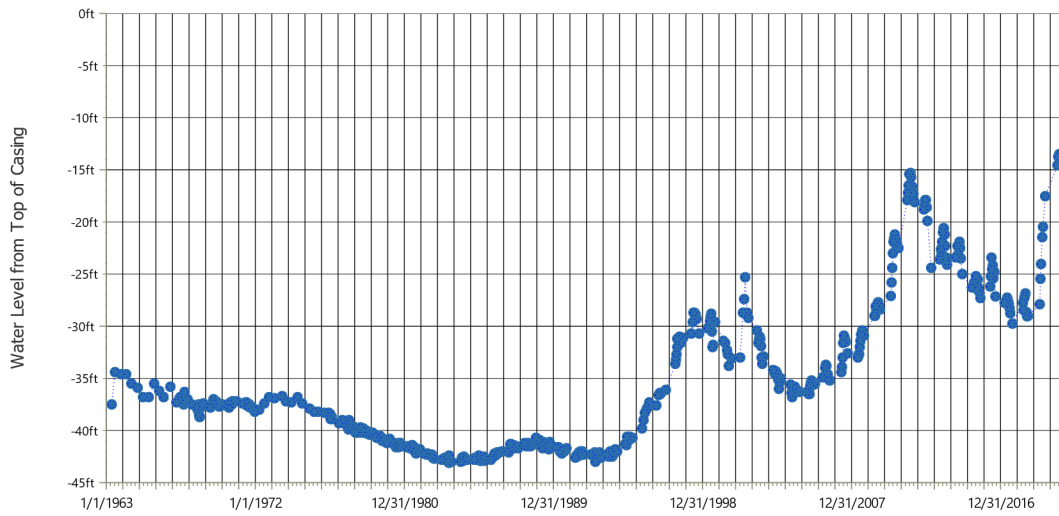
**DENR Water Rights Observation Well: BD-80B**



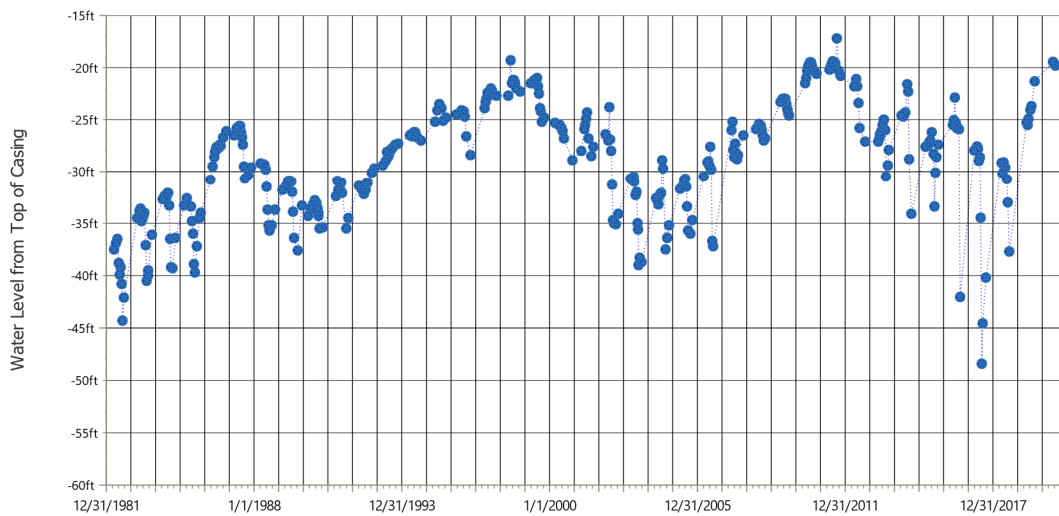
**DENR Water Rights Observation Well: BD-80C**



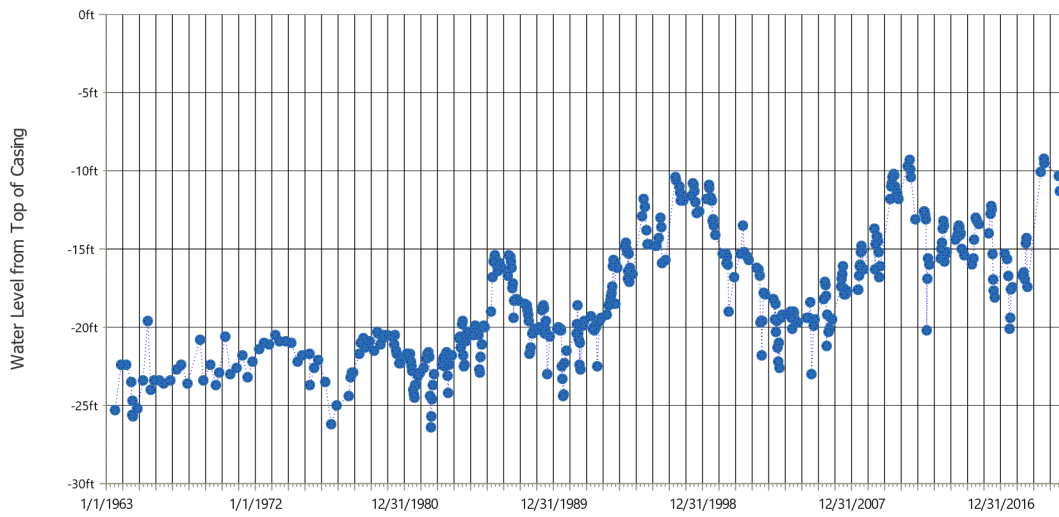
**DENR Water Rights Observation Well: BD-80D**



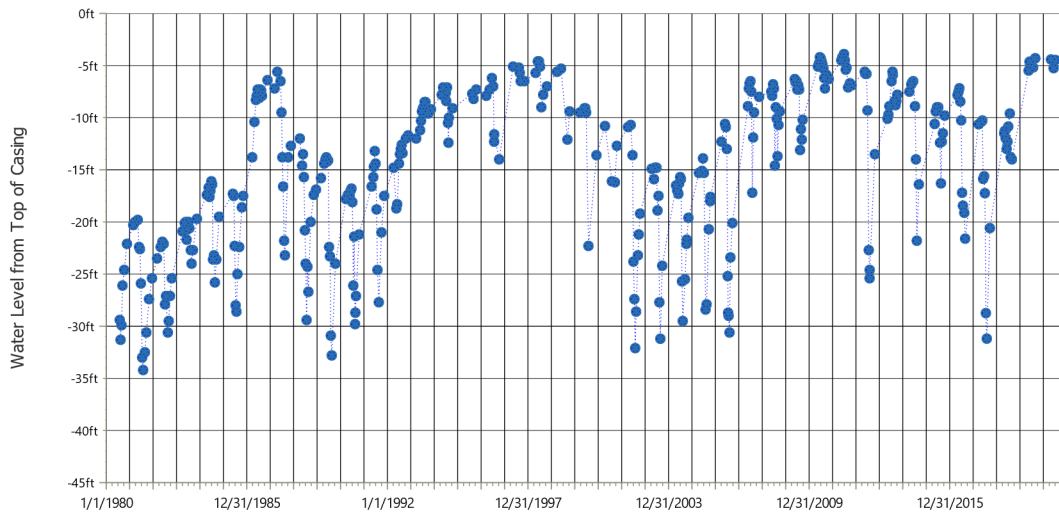
**DENR Water Rights Observation Well: BD-80J**



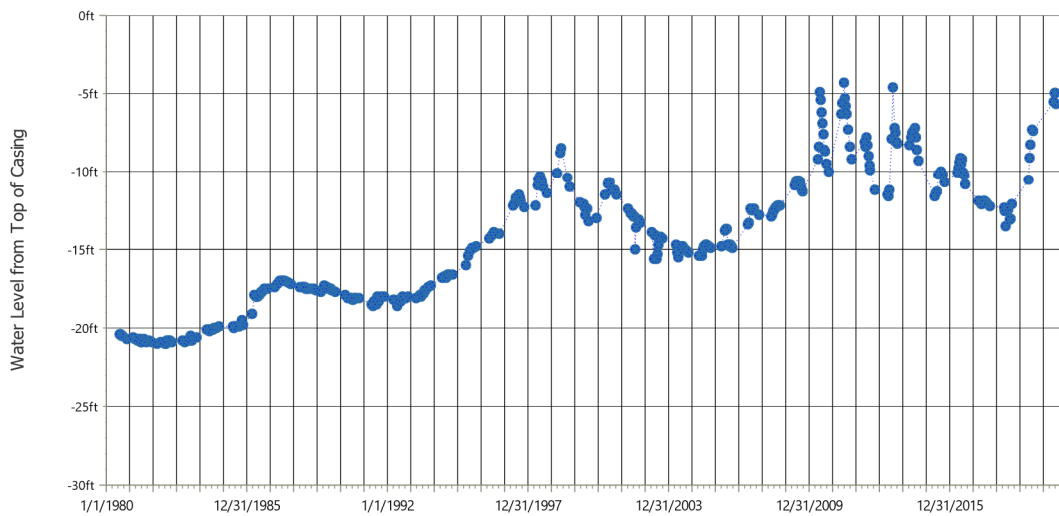
**DENR Water Rights Observation Well: HD-80A**



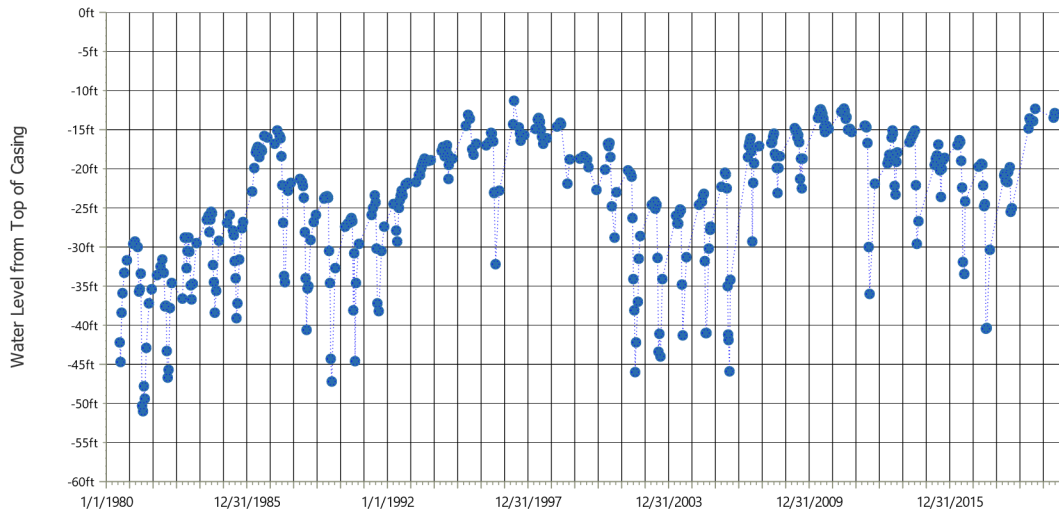
**DENR Water Rights Observation Well: SP-80A**



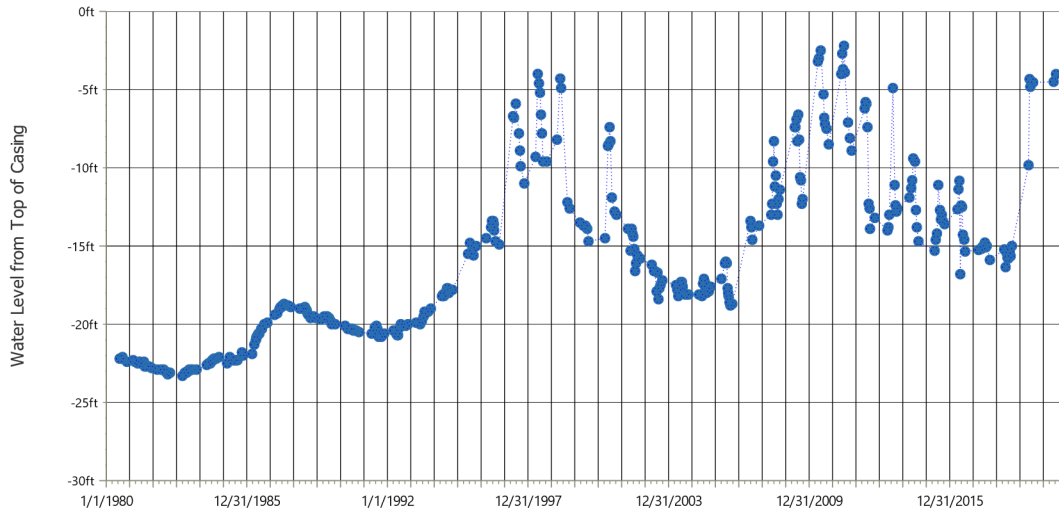
**DENR Water Rights Observation Well: SP-80B**



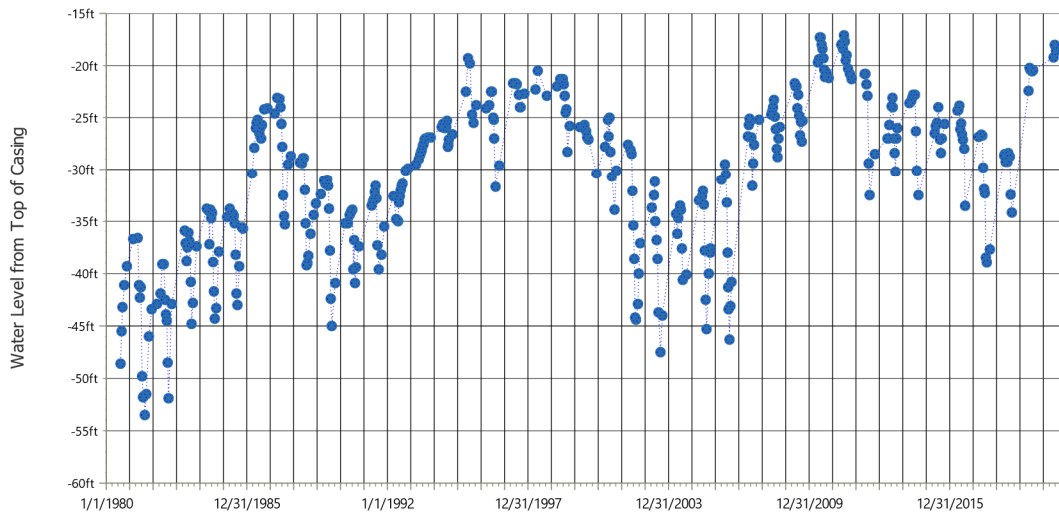
**DENR Water Rights Observation Well: SP-80C**



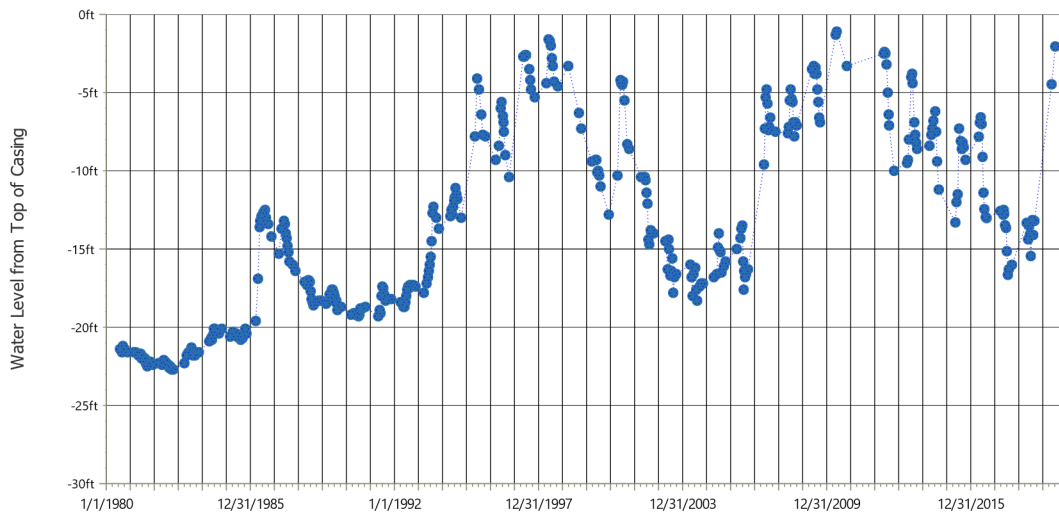
**DENR Water Rights Observation Well: SP-80D**



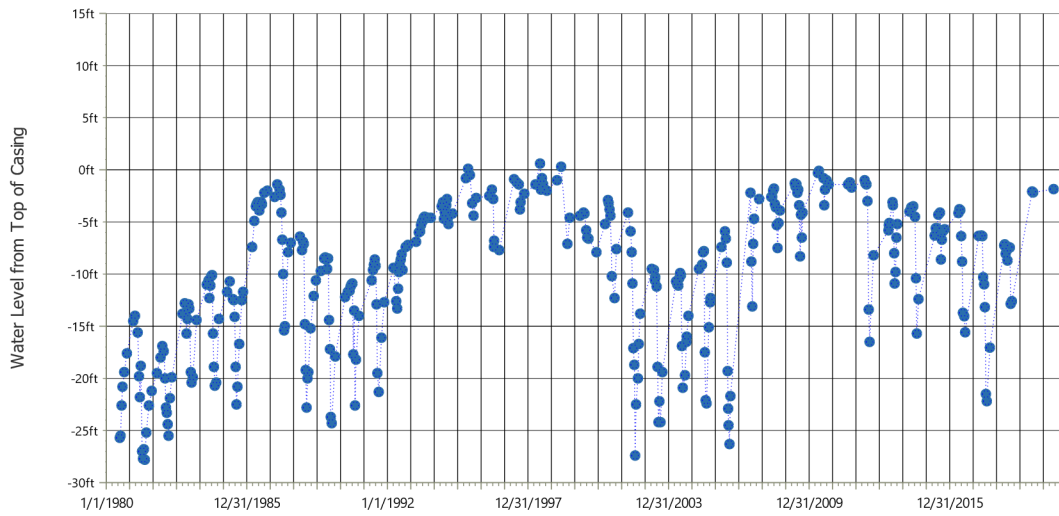
**DENR Water Rights Observation Well: SP-80E**



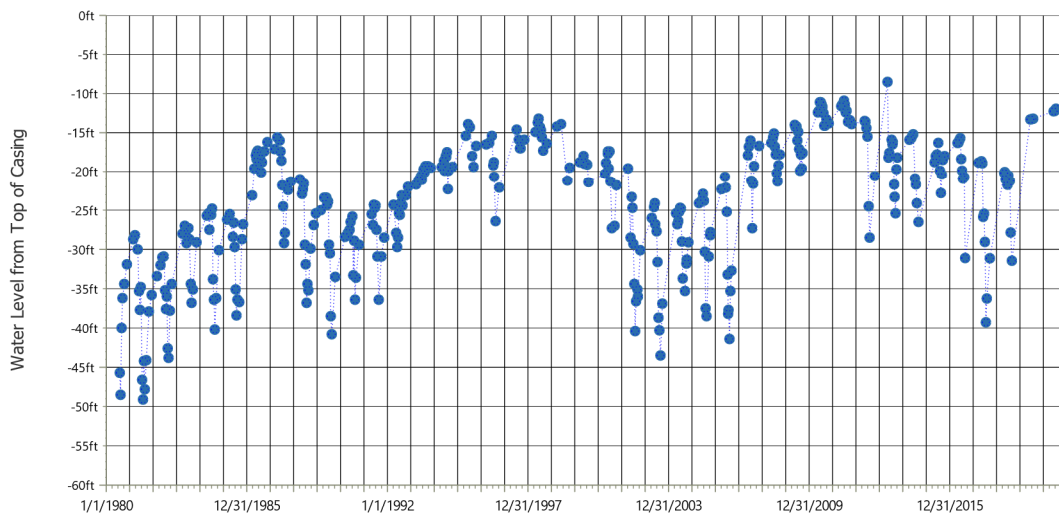
**DENR Water Rights Observation Well: SP-80F**



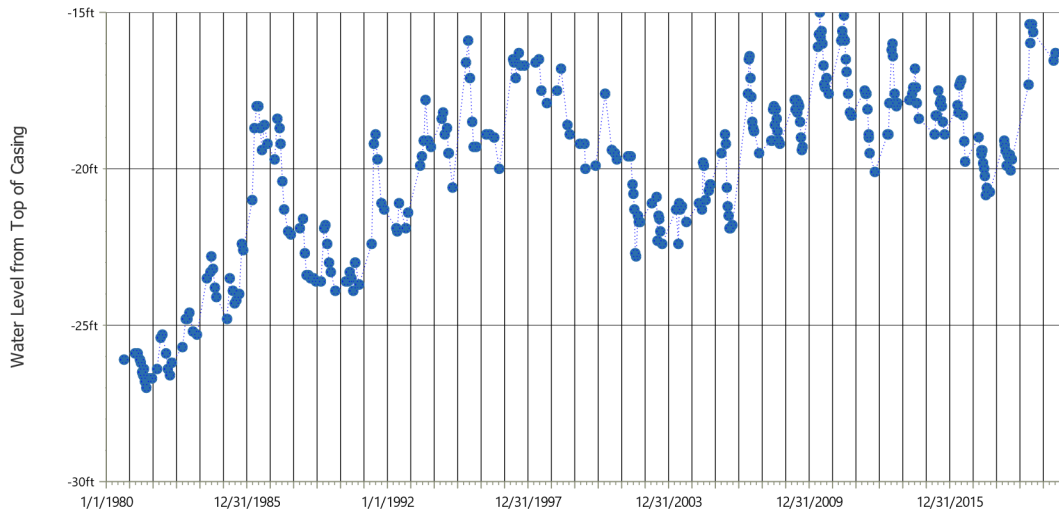
**DENR Water Rights Observation Well: SP-80G**



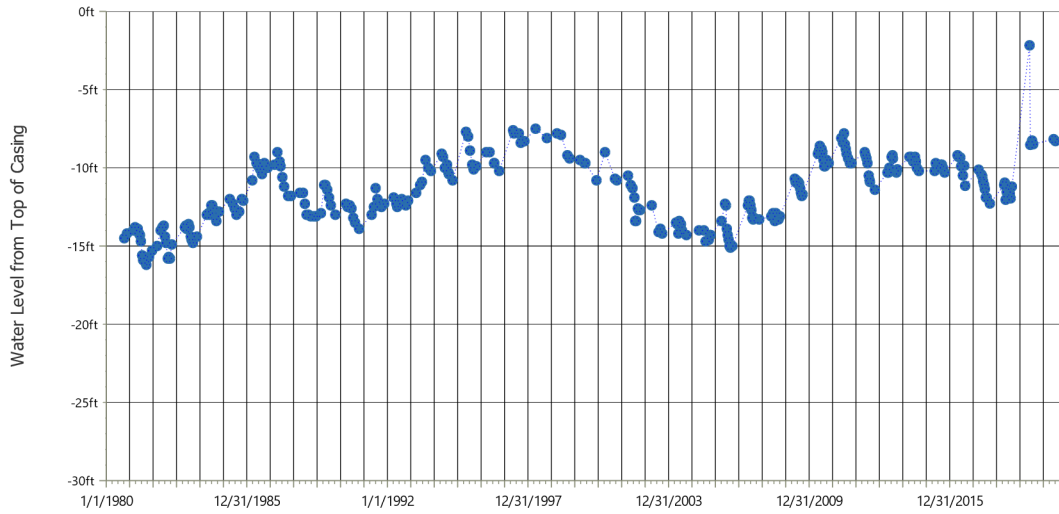
**DENR Water Rights Observation Well: SP-80H**



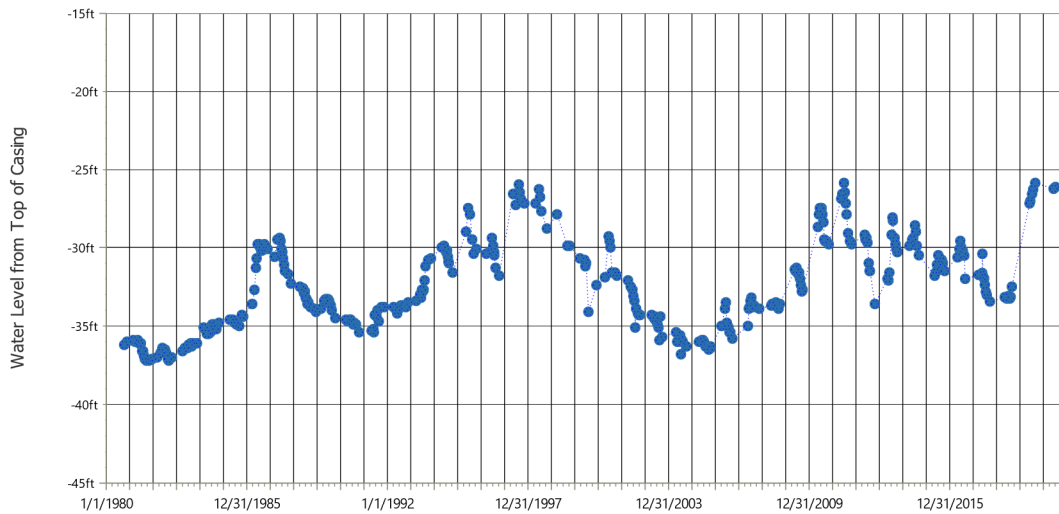
**DENR Water Rights Observation Well: SP-80L**



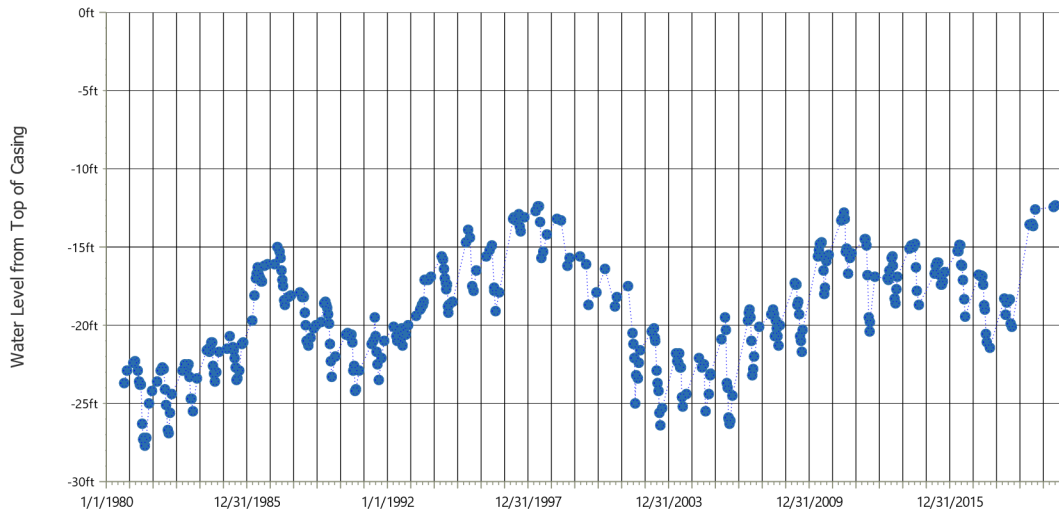
**DENR Water Rights Observation Well: SP-80M**



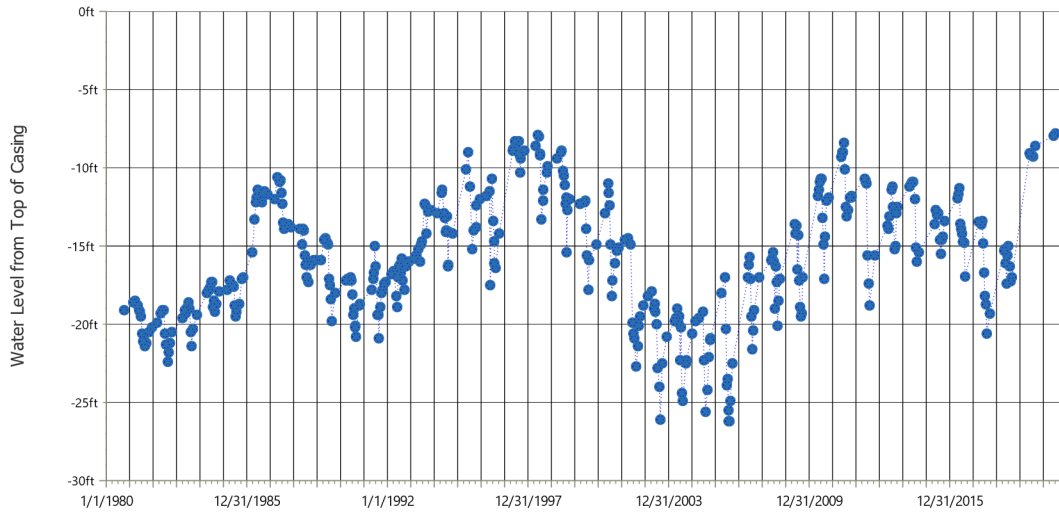
**DENR Water Rights Observation Well: SP-80N**



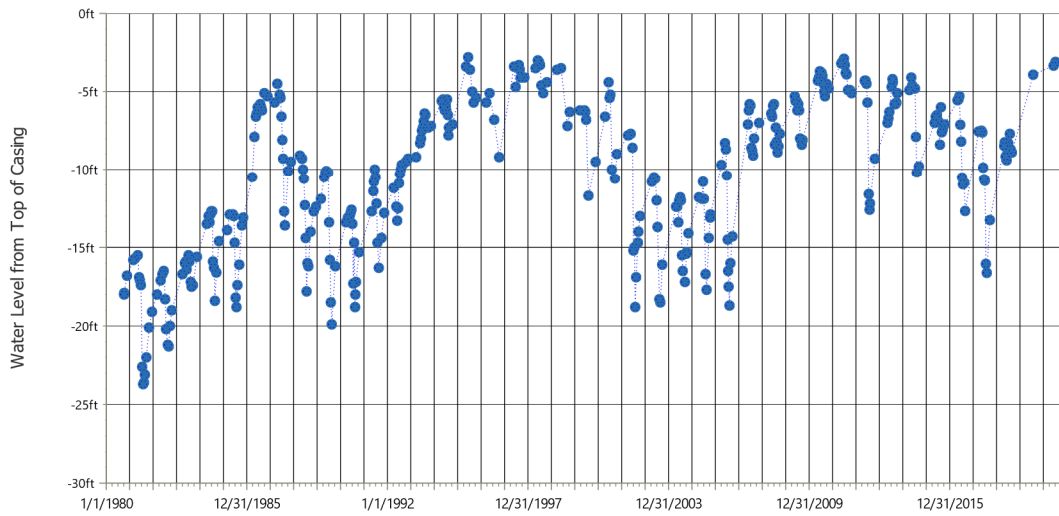
**DENR Water Rights Observation Well: SP-80O**



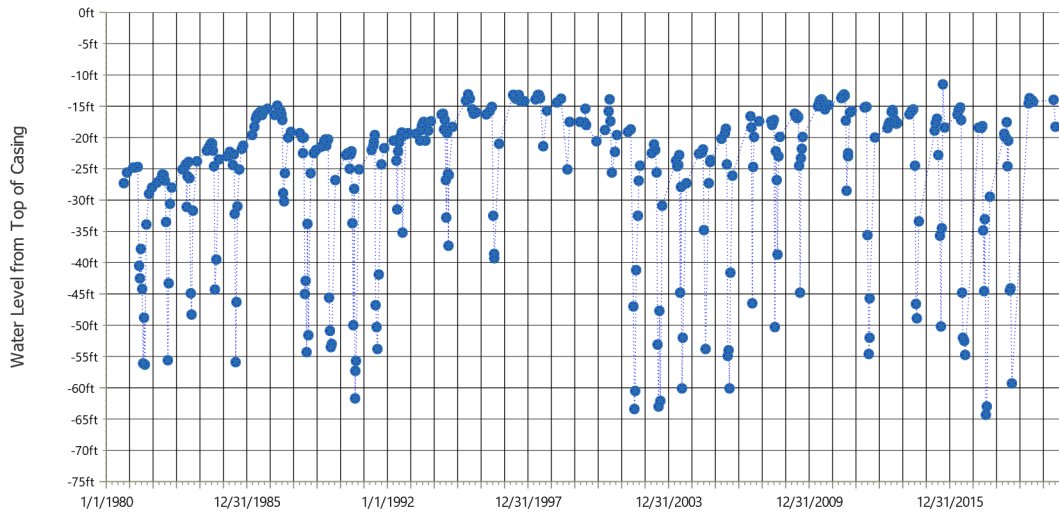
**DENR Water Rights Observation Well: SP-80P**



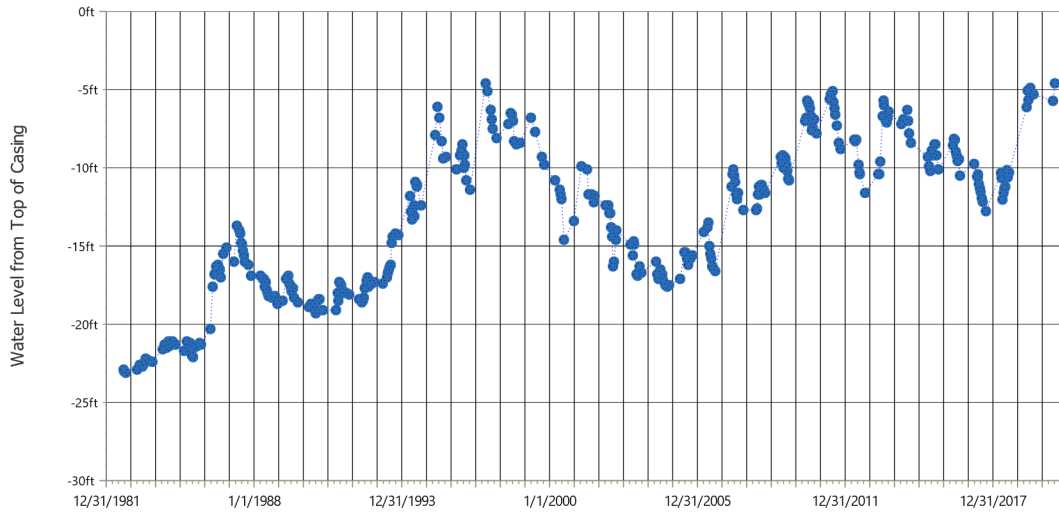
**DENR Water Rights Observation Well: SP-80Q**



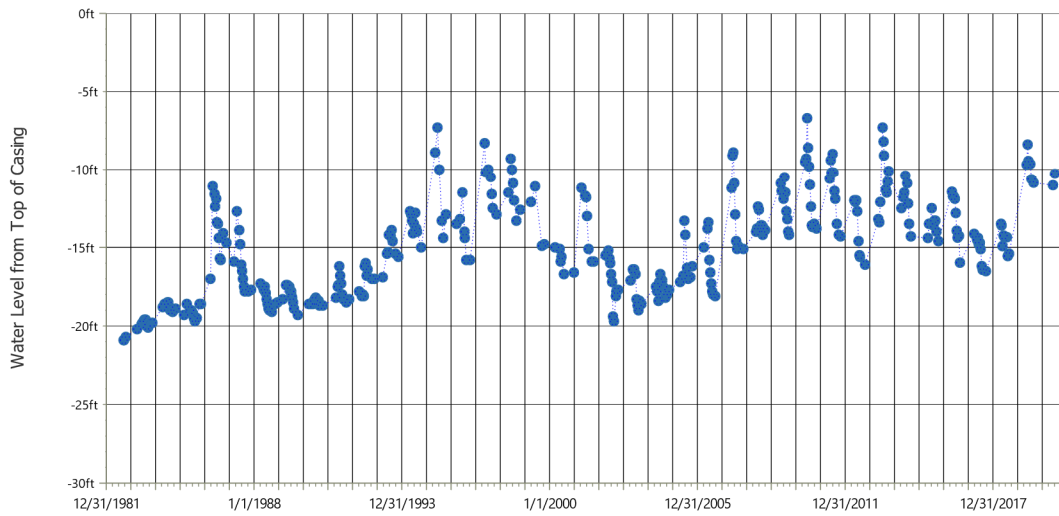
**DENR Water Rights Observation Well: SP-80R**



**DENR Water Rights Observation Well: SP-82D**

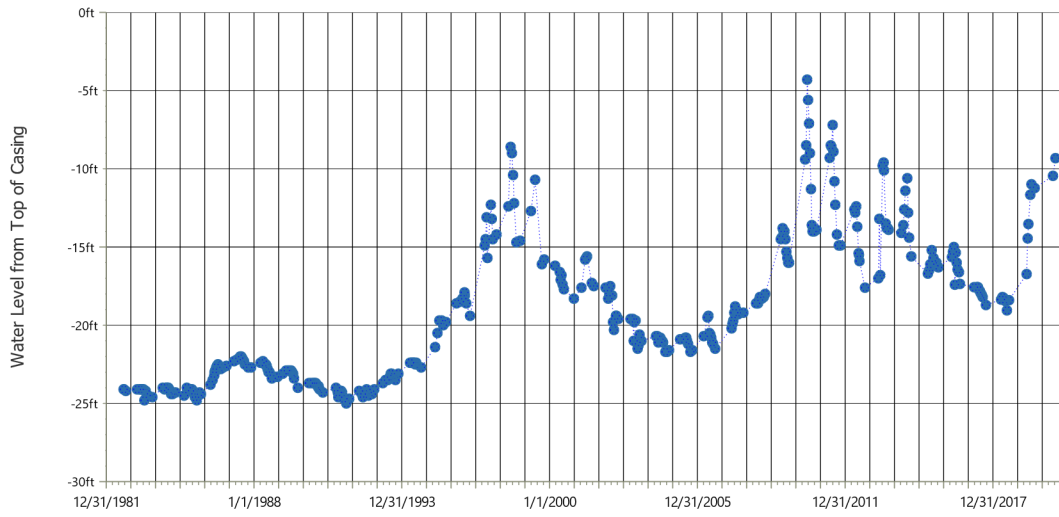


**DENR Water Rights Observation Well: SP-82E**

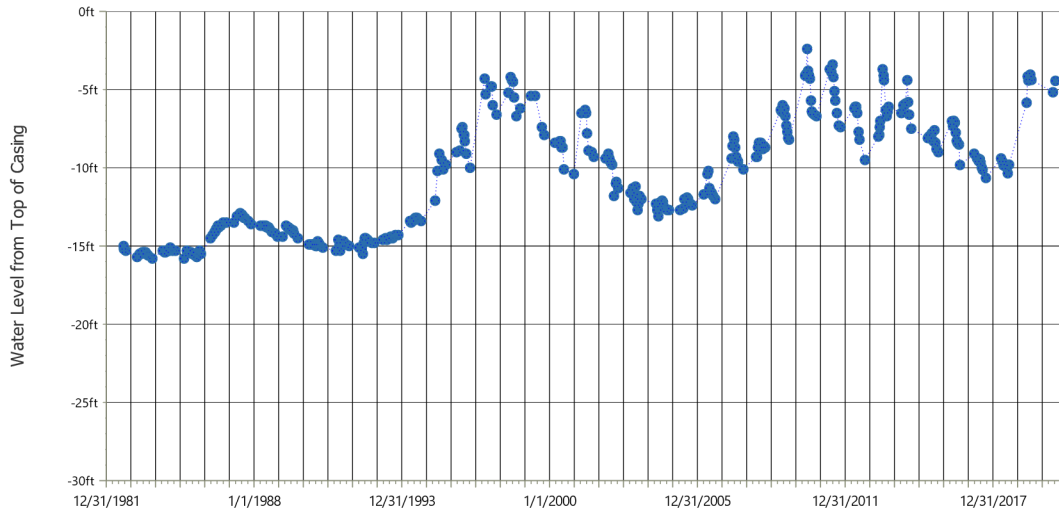




**DENR Water Rights Observation Well: SP-82F**



**DENR Water Rights Observation Well: SP-82G**



**DENR Water Rights Observation Well: BD-2016A**

