# SECTION 3: PUMPING MANAGEMENT AND GROUNDWATER CONDITIONS

## 2022-2023 OPERATIONS PLAN SUMMARY

In accordance with the Water Agreement, Los Angeles Department of Water and Power (LADWP) prepares an Operations Plan (Plan) each April for the ensuing 12-month runoff year spanning April 1 to March 31. The 2022-2023 Plan includes projected amounts for runoff, pumping, water used in the Owens Valley, water exported to Los Angeles, and an update of the groundwater mining calculations. The plan must also comply with the pumping well On/Off provisions of the Water Agreement based on soil water and vegetation measurements. The Inyo County Water Department (ICWD) reviews LADWP's proposed operations plan, reviewing current conditions and performing an analysis of the effects of LADWP operations on groundwater levels in the Owens Valley. Following a Technical Group meeting to resolve concerns raised by the County, LADWP finalizes the plan.

Predicted runoff from the Owens River watershed during the 2022-23 runoff-year is forecast to be 194,300 acre-feet (ac-ft) or 47% of the 50-year (1971-2020) average. The actual runoff value will be available in 2023 when all surface water measurements that constitute the sum have been verified and tabulated. Planned pumping for 2022-23 is between 67,210 to 86,300 ac-ft. LADWP is predicting 78,890 ac-ft of water will be used in the Owens Valley, 34,750 ac-ft of which is planned for irrigation. The 2022-23 water exports from the Eastern Sierra (Inyo and Mono Counties) is planned to be 62,700 ac-ft (11% of LADWP anticipated annual need).

The Water Agreement and Green Book include procedures to calculate a pumping limit to prevent groundwater mining to ensure that there is no long-term decline in aquifer storage; these calculations are summarized in Table 1.4 of LADWP's 2022-23 Operations Plan and are used to set a maximum pumping limit through September of 2022. Unlike the annual reporting periods which are based on runoff year (April to March), the annual period for the groundwater mining calculation is based on the water-year (October 1 through September 30). The mining calculation is a comparison of LADWP pumping and recharge for each wellfield on a water-year basis for the most recent 20-year period. The 19.5-year total of pumping (through April 2022) is subtracted from 20 years of recharge (recharge estimated through September 2022) to arrive at an April to September 2022 pumping limit for each wellfield and the Owens Valley as a whole.

For the 20-year water mining calculation recharge is approximately 3.2 million ac-ft compared to 1.4 million ac-ft of pumping. The 2020-21 water-year groundwater recharge in the Owens Valley from the mining calculations was approximately 102,169 ac-ft compared to 63,081 ac-ft of pumping, and no wellfield was in violation of the groundwater mining provision in water-year 2020-21.The 2021-22 water-year estimate of groundwater recharge in the Owens Valley from the mining calculations was approximately 101,410 ac-ft compared to 24,472 ac-ft of actual pumping to-date, and no wellfield is projected to be in violation of the groundwater mining provision in 2022. LADWP's Table 1.4 summarized the water mining limits for each wellfield.

*Groundwater Mining Calculation from LADWP's Table 1.4 of its 2022-23 annual Operations Plan.*

## Table 1.4. Summary of Recharge and Pumping for WY 2020 - 2021 and Estimated Pumping Limit for Apr-Sep 2022 (AF)

| **Water Year** | **OWENS VALLEY** Runoff Percent(c) | LAWS Recharge | LAWS Pumping | BISHOP Recharge | BISHOP Pumping | BIG PINE Recharge | BIG PINE Pumping | TABOOSE-THIBAUT Recharge | TABOOSE-THIBAUT Pumping | IND-SYM-BAIRS Recharge | IND-SYM-BAIRS Pumping | LONE PINE Recharge | LONE PINE Pumping | **OWENS VALLEY** Recharge | **OWENS VALLEY** Pumping |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 75% | 11,454 | 5,786 | 38,486 | 11,407 | 21,883 | 25,885 | 26,166 | 27,387 | 32,455 | 14,294 | 13,088 | 1,179 | 143,532 | 85,938 |
| 2004 | 71% | 11,138 | 7,412 | 37,149 | 11,777 | 21,126 | 26,149 | 25,044 | 25,159 | 29,771 | 15,750 | 11,357 | 1,119 | 135,586 | 87,366 |
| 2005 | 120% | 18,389 | 3,841 | 47,471 | 7,093 | 32,686 | 19,423 | 40,500 | 18,674 | 46,441 | 18,585 | 17,191 | 1,128 | 202,678 | 68,744 |
| 2006 | 138% | 35,336 | 3,013 | 54,337 | 5,667 | 39,650 | 20,686 | 47,757 | 15,707 | 53,873 | 9,944 | 19,956 | 1,119 | 250,911 | 56,136 |
| 2007 | 64% | 10,947 | 7,840 | 34,470 | 10,516 | 19,757 | 20,525 | 25,855 | 14,578 | 27,624 | 10,674 | 10,454 | 1,100 | 129,108 | 65,233 |
| 2008 | 68% | 10,855 | 7,939 | 35,850 | 10,228 | 20,432 | 20,243 | 28,619 | 18,542 | 27,759 | 9,219 | 11,563 | 858 | 135,078 | 67,029 |
| 2009 | 73% | 11,049 | 6,233 | 37,416 | 12,123 | 21,555 | 22,891 | 29,385 | 14,751 | 29,359 | 9,603 | 12,147 | 775 | 140,912 | 66,376 |
| 2010 | 93% | 11,154 | 6,333 | 41,987 | 10,509 | 26,566 | 22,514 | 35,541 | 20,239 | 36,863 | 13,031 | 14,252 | 626 | 166,362 | 73,252 |
| 2011 | 134% | 17,375 | 7,188 | 52,182 | 9,889 | 35,539 | 27,089 | 47,562 | 21,933 | 50,619 | 14,527 | 19,057 | 998 | 222,333 | 81,624 |
| 2012 | 72% | 11,058 | 9,514 | 37,315 | 11,134 | 21,297 | 27,220 | 28,369 | 26,156 | 28,905 | 16,570 | 11,538 | 1,048 | 138,482 | 91,642 |
| 2013 | 62% | 10,644 | 6,642 | 34,811 | 11,536 | 19,408 | 26,115 | 24,795 | 25,225 | 24,749 | 17,907 | 10,364 | 721 | 124,771 | 88,146 |
| 2014 | 50% | 10,393 | 6,287 | 31,325 | 10,849 | 16,871 | 22,560 | 21,241 | 15,778 | 20,508 | 11,347 | 8,960 | 946 | 109,297 | 67,767 |
| 2015 | 43% | 10,103 | 5,824 | 30,667 | 10,521 | 15,380 | 19,939 | 18,671 | 15,563 | 18,695 | 11,873 | 7,995 | 925 | 101,512 | 64,645 |
| 2016 | 63% | 10,392 | 6,038 | 34,844 | 10,842 | 19,551 | 22,798 | 25,634 | 20,642 | 25,354 | 18,829 | 10,306 | 984 | 126,082 | 80,133 |
| 2017 | 175% | 45,270 | 2,000 | 67,171 | 4,399 | 56,730 | 22,106 | 71,201 | 12,959 | 66,222 | 9,243 | 24,741 | 915 | 331,335 | 51,622 |
| 2018 | 93% | 14,351 | 8,646 | 41,346 | 9,588 | 25,911 | 23,140 | 34,601 | 18,896 | 35,628 | 12,050 | 13,807 | 973 | 165,643 | 73,293 |
| 2019 | 130% | 34,481 | 7,127 | 53,925 | 5,670 | 40,241 | 21,356 | 47,748 | 17,000 | 49,029 | 9,994 | 18,307 | 973 | 243,731 | 62,120 |
| 2020 | 73% | 10,986 | 11,170 | 37,201 | 9,437 | 22,577 | 18,647 | 28,626 | 21,503 | 28,757 | 9,949 | 11,402 | 985 | 139,548 | 71,691 |
| 2021 | 44% | 10,294 | 8,337 | 30,389 | 10,901 | 15,807 | 11,366 | 19,538 | 22,339 | 18,332 | 9,128 | 7,810 | 1,010 | 102,169 | 63,081 |
| 2022 (a) | 48% | 10,777 | 1,806 | 29,632 | 2,094 | 14,216 | 10,405 | 17,882 | 7,474 | 20,131 | 2,536 | 8,772 | 157 | 101,410 | 24,472 |
| (b) TOTAL | | 316,448 | 128,976 | 807,971 | 186,180 | 507,185 | 431,057 | 644,735 | 380,505 | 671,075 | 245,053 | 263,068 | 18,539 | 3,210,481 | 1,390,310 |
| Estimated Apr-Sep 2022 Pumping Limit | | | 187,472 | | 621,791 | | 76,128 | | 264,230 | | 426,021 | | 244,529 | | 1,820,171 |

(a) Estimated Recharge for the 2022 Water Year; Approximate Pumping for First Half of Water year 2022 (Oct-Mar).

(b) Estimated 20 Year Total for Recharge; actual 19.5 Year Total for Pumping.

(c) Mining calculations are based Water Year (October-September) instead of Runoff Year (April-March).

The Big Pine wellfield is the only wellfield close to its mining limit with pumping at 85% of the total recharge thru water-year 2020-21 (20-yr total recharge of appx. 507,000 ac-ft compared to 431,000 ac-ft pumping). Pumping exceeded recharge during the five-year period of the recent drought (2012-2016). This does not constitute a violation of the groundwater mining provision, but ICWD has suggested that pumping in this wellfield be curtailed to include only sole source, in-valley uses. A significant amount of water was spread into the Big Pine Wellfield in 2017 and 2019 and pumping in Big Pine was reduced in 2020 due to a bacterial infection at the Fish Springs Hatchery. The relatively small difference between pumping and recharge is concerning and will continue to be monitored.

For the Owens Valley, the percentage of pumping to recharge through water-year 2021-22 is projected to be 23% due to reduced runoff and low pumping. Runoff (as an inflow) and pumping (as an outflow) are two of the components of the Owens Valley groundwater budget. It is important to note that evapotranspiration (evaporation and plant transpiration of groundwater primarily by native vegetation along the valley floor) is another primary component (as an outflow) of the groundwater budget; one that is implicitly protected by the Water Agreement. Therefore, looking at groundwater levels which track change in storage of the Owens Valley groundwater system and availability of groundwater to phreatophytic plants is of primary importance.

A more detailed discussion of the 2022-23 Operations Plan is presented in the “2022-23 Pumping” subsection that follows.

## 2021-2022 HYDROLOGIC CONDITIONS

For the past runoff year, April 2021 to through March 2022, the measured runoff was 184,000 ac-ft, approximately 45% of the 1971-2020 long-term average (Figure 3.1) and the lowest recorded runoff. Total LADWP pumping within the Owens Valley from Laws to Lone Pine for 2021-22 was 62,518 ac-ft, which was only 79% of LADWP’s planned maximum pumping amount of 93,000 ac-ft (Table 3.1). Owens Valley water uses for 2021-22 were 85,380 ac-ft including 38,493 ac-ft of irrigation, and Eastern Sierra water exports were approximately 77,000 ac-ft, 15% of LADWP’s anticipated annual demand (494,500 ac-ft).

*Table 3.1. Planned and LADWP actual pumping by wellfield for the 2021-2022 runoff-year. Estimated minimum pumping prepared by Inyo County for sole source uses is included for reference.*

| Wellfield | Estimated Minimum Pumping (ac-ft) | Planned Pumping (ac-ft) | Actual 2021-22 Pumping (ac-ft) | Percent Actual vs. Planned |
|---|---|---|---|---|
| Laws | 6,000 | 9,400 | 8,978 | 96% |
| Bishop | 12,000 | 12,000 | 10,969 | 91% |
| Big Pine | 19,225 | 23,000 | 16,490 | 72% |
| Taboose-Aberdeen | 300 | 8,800 | 7,325 | 82% |
| Thibaut-Sawmill | 8,000 | 11,000 | 8,998 | 82% |
| Ind.-Oak | 6,420 | 8,800 | 6,242 | 71% |
| Symmes-Shepherd | 1,200 | 2,900 | 2,047 | 71% |
| Bairs-Georges | 400 | 2,100 | 441 | 21% |
| Lone Pine | 900 | 900 | 1,028 | 114% |
| **Total** | **54,445** | **78,980** | **62,518** | **79%** |

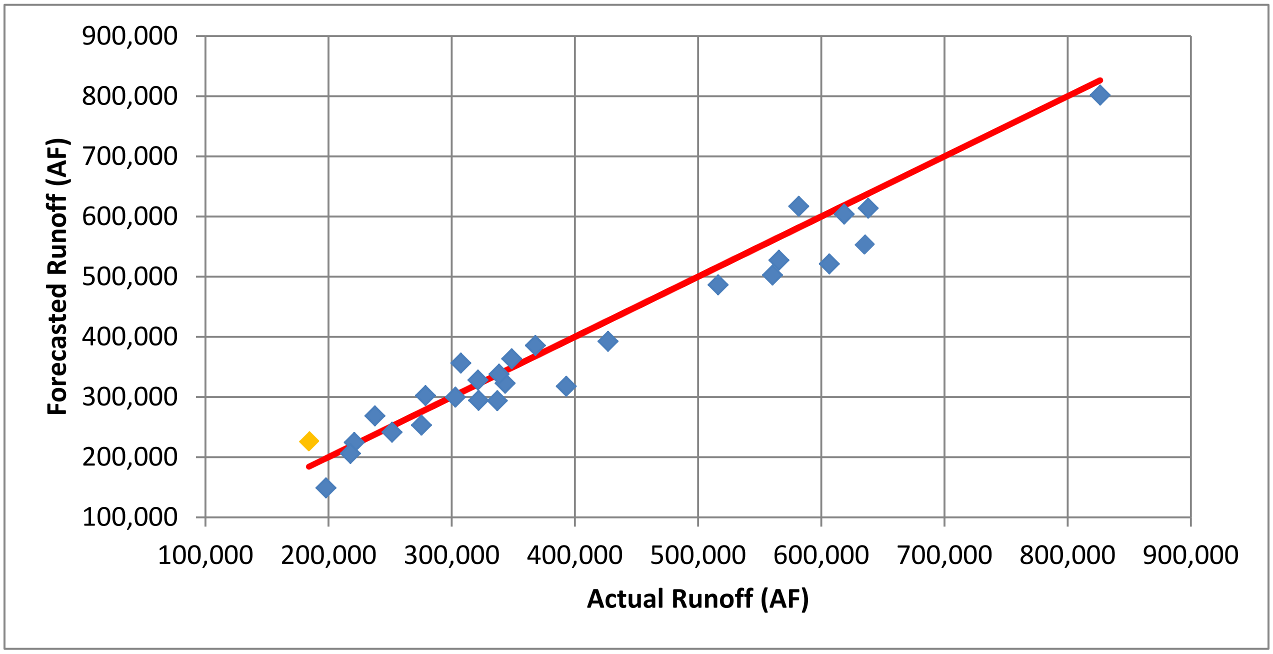


*Figure 3.1. Comparison of actual and forecasted runoff 1994-2022 runoff years with 100% accuracy between forecast and actual runoff in red. The most recent year is the orange diamond (2021 actual runoff was 184,000 ac-ft; forecasted runoff was 226,800 ac-ft).*

ICWD uses groundwater levels from a suite of key monitoring wells (Indicator Wells) located throughout the Owens Valley near LADWP wellfields to both track and predict, using regression models, the effects of groundwater pumping on water tables. The effect of pumping and runoff in 2021-22 on water levels in the Indicator Wells is shown in the histogram in Figure 3.2 and listed in Table 3.2.

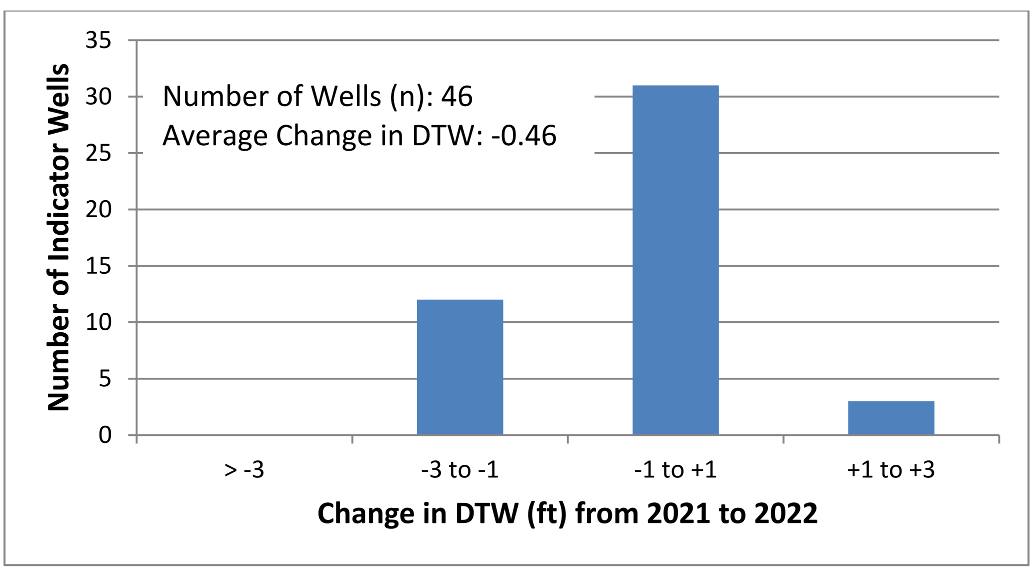


*Figure 3.2. Histogram of change in DTW between April 2021 and April 2022 for 46 Indicator test wells. Positive changes indicate rising (shallowing) water tables.*

Groundwater levels declined in 29 of the 46 Indicator monitoring wells (Figure 3.2) due to a combination of lower runoff (45% of average) and low pumping (87% of 1992-2021 average). The average change in DTW in the 46 wells from 2021 to 2022 was a decline of -0.5 feet, with a median decline of -0.3 feet. The largest declines were in the Laws (-1.5 ft), Thibaut-Sawmill (-0.8 ft) and Bairs-Georges (-1.2 ft) wellfields. Symmes-Shepherd (-0.1 ft), Independence-Oak (-0.6 ft) and Big Pine(-0.1 ft) saw more moderate declines; and Taboose-Aberdeen rose (0.4 ft). Groundwater levels are below levels of the mid-1980's vegetation baseline period in about 72% (33 of 46) of the Indicator wells.

*Table 3.2. Depth to Water (DTW) at Indicator wells, April 2022. All data are in feet from reference point on the test well. Negative values denote a decline in water level. Baseline at monitoring sites is the April average of water levels from years 1985-87. Baseline was predicted from monitoring site/indicator wells regression models if the test well was not present from 1985-87.*

| Station ID, Monitoring site | DTW April 2022 | Change from April 2021 | Deviation from Baseline in 2022 |
|---|---|---|---|
| ***Laws*** | | | |
| 107T | 30.09 | -2.72 | -5.82 |
| 434T | 7.49 | -0.51 | 0.11 |
| 436T | 8.95 | -0.86 | -0.85 |
| 438T | 15.82 | -2.19 | -6.22 |
| 490T | 16.02 | -2.27 | -2.95 |
| 492T | 31.04 | -2.02 | 1.76 |
| 795T, LW1 | 15.75 | -0.19 | -2.46 |
| V001G, LW2 | 20.43 | -1.95 | -0.81 |
| 574T, LW3† | 15.64 | -1.19 | -2.56 |
| ***Big Pine*** | | | |
| 425T | 13.49 | 0.08 | 1.41 |
| 426T | 11.81 | 0.09 | -0.24 |
| 469T | 22.42 | -0.33 | -0.75 |
| 572T | 10.30 | -2.52 | 1.60 |
| 798T, BP1 | 13.08 | 1.56 | 2.97 |
| 799T, BP2 | 19.57 | -0.26 | -1.06 |
| 567T, BP3 | 13.40 | -0.34 | 0.56 |
| 800T, BP4 | 11.49 | 1.00 | 2.10 |

| Station ID, Monitoring site | DTW April 2022 | Change from April 2021 | Deviation from Baseline in 2022 |
|---|---|---|---|
| ***Taboose Aberdeen*** | | | |
| 417T | 29.21 | -0.60 | -2.24 |
| 418T | 8.40 | 0.29 | -0.17 |
| 419T, TA1 | 6.29 | 0.72 | 0.34 |
| 421T | 35.11 | 1.73 | -0.76 |
| 502T | 10.61 | 0.73 | -3.12 |
| 504T | 9.75 | 1.27 | 1.02 |
| 505T | 20.99 | -0.58 | -2.39 |
| 586T, TA4 | 7.81 | 0.58 | 0.51 |
| 801T, TA5 | 15.60 | 0.51 | -2.08 |
| 803T, TA6 | 10.60 | -0.74 | -1.90 |
| ***Thibaut Sawmill*** | | | |
| 415T | 13.11 | -0.76 | 5.39 |
| 507T | 5.69 | -1.07 | -1.02 |
| 806T, TS2 | 10.99 | -0.60 | 2.19 |
| ***Independence Oak*** | | | |
| 406T | 4.11 | -0.08 | -2.54 |
| 407T | 11.81 | 0.24 | -4.51 |
| 408T | 5.44 | 0.16 | -2.31 |
| 409T | 7.07 | 0.31 | -5.47 |
| 546T | 8.01 | -1.74 | -4.58 |
| 809T, IO1 | 13.41 | -2.42 | -6.84 |
| ***Symmes Shepherd*** | | | |
| 402T | 11.00 | -0.20 | -2.97 |
| 403T | 7.36 | -0.25 | -2.03 |
| 404T | 6.37 | 0.02 | -2.80 |
| 447T | 36.10 | -0.68 | -14.23 |
| 510T | 7.67 | -0.05 | -2.67 |
| 511T | 7.46 | 0.43 | -2.83 |
| V009G, SS1 | 17.68 | -0.19 | -10.85 |
| ***Bairs George*** | | | |
| 398T | 7.77 | -1.79 | -1.42 |
| 400T | 6.29 | 0.09 | 0.01 |
| 812T, BG2 | 18.11 | -1.95 | -4.65 |

The history of Owens Valley runoff and pumping since 1970 are presented in Figures 3.3 and 3.4. Since the Water Agreement and Drought Recovery Policy were adopted and implemented (1992), annual pumping has averaged approximately 71,800 ac-ft and runoff 397,500 ac-ft.

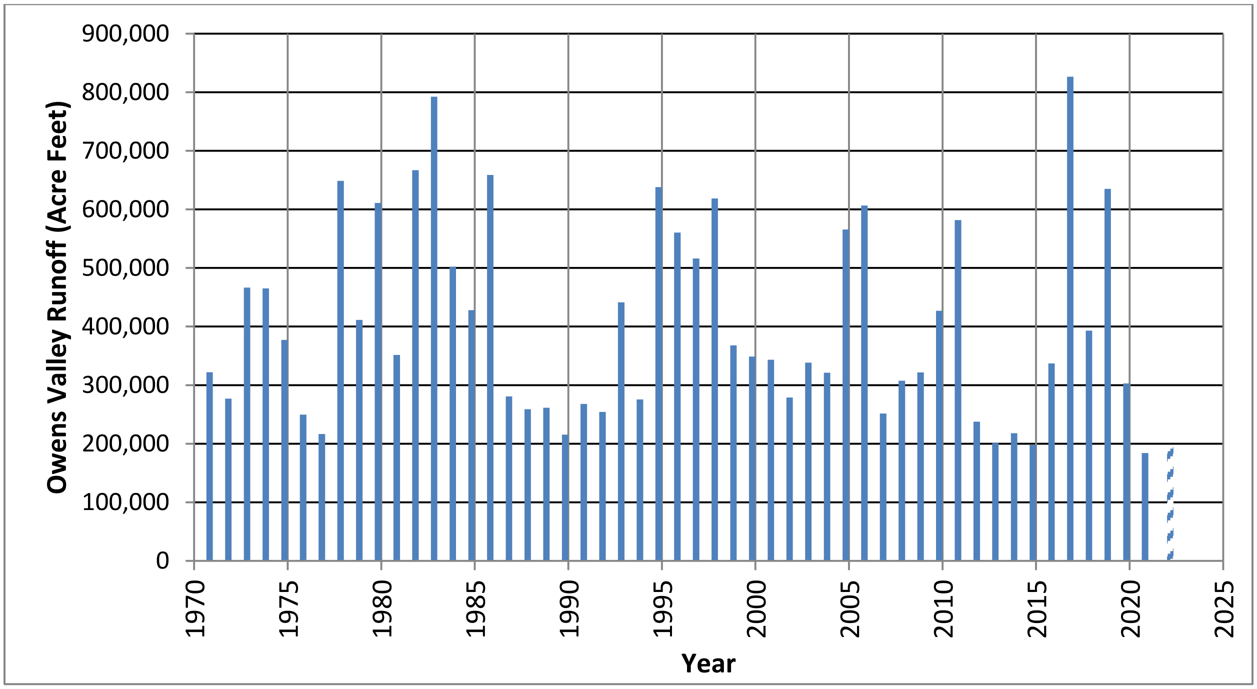


*Figure 3.3. Measured Owens Valley runoff since 1970. Values are for the runoff year (e.g. runoff year 2020 includes April 1, 2021 through March 31, 2022. Dash line is current runoff year estimate.*

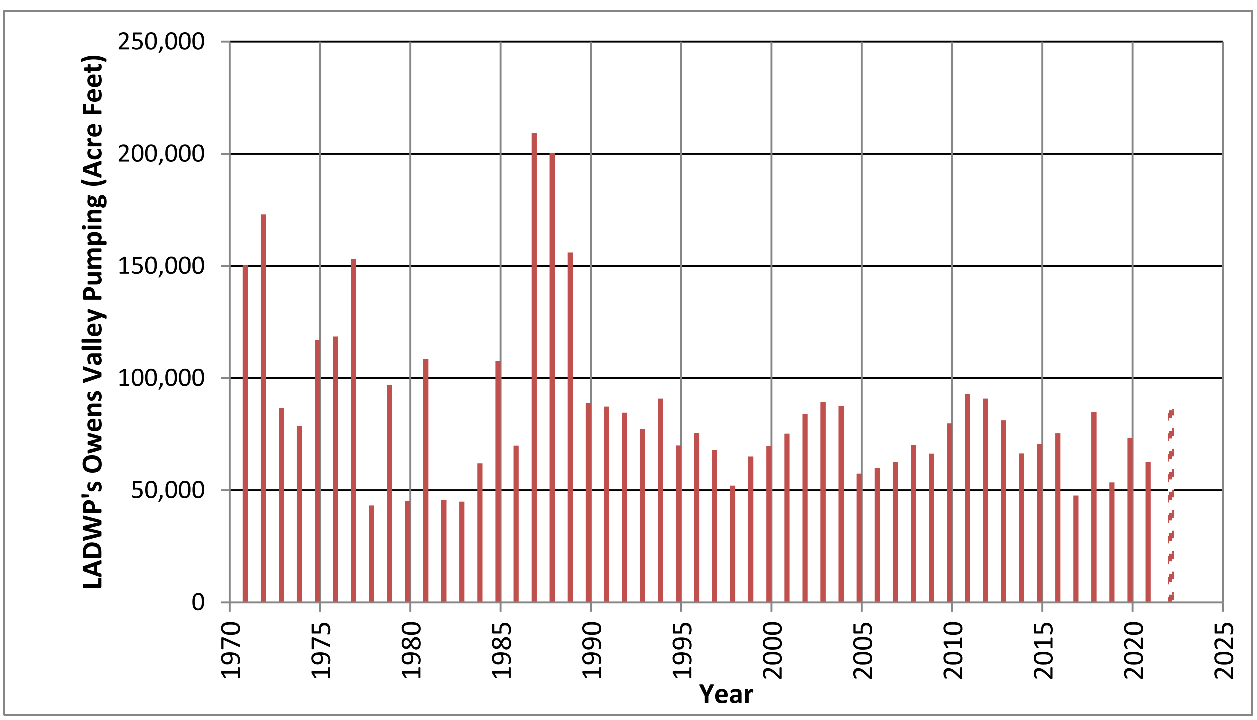

Figure 3.4. Total LADWP pumping in the Owens Valley since 1970 by runoff *year. Dash line is anticipated maximum pumping for current runoff year.*

Groundwater data is collected from several hundred monitoring wells located throughout the Owens Valley each spring and fall. Most wells are also visited on more frequent (monthly-quarterly) schedules. Data presented in this section are depth-to-water (DTW) below ground surface (bgs) measured in feet.

In addition to using Indicator Wells, another method to assess hydrologic conditions in the Owens Valley is to compare recent groundwater levels with historic conditions in monitoring wells across the valley. The LTWA uses the vegetation conditions documented from surveys conducted from 1984 to 1987 as its baseline for comparison of vegetation change. Therefore, ICWD uses the average April groundwater levels from 1985 to 1987 as a hydrologic “baseline.” For more details and current vegetation status see ICWD Annual Report Section 5 “Vegetation Conditions” available at https://www.inyowater.org/documents/reports/inyo-county-water-dept-annual-report/

While this hydrologic baseline is not specifically prescribed in the Water Agreement, it is a useful summary statistic representing the hydrology and the vegetation conditions of the baseline period. Also, the April time-frame is when DTW is typically shallowest each year for many of the wellfields. The hydrologic baseline DTW usually is an adequate indicator related to groundwater and vadose zone moisture availability for phreatophytic vegetation, but should be considered a guide rather than a specific threshold that determines whether vegetation conditions are above or below baseline in the immediate vicinity of a monitoring well. Unlike the vegetation baseline, maintaining baseline DTW is not a requirement of the Water Agreement.

The record winter of 2017 and strong 2019 winter contributed to water table recovery from the preceding 5-year drought. Last year in April 2021, DTWs in many wellfields were at or slightly below baseline levels. However, as predicted, the 45% runoff year of 2021-22 combined with moderate pumping during the two-years of drought has lowered groundwater levels (Figure 3.5). The majority of wellfields are below baseline as of April 2022 (Figure 3.6) based on a set of approximately 175 monitoring wells that have measurements from the mid-1980s to the present. Most wells in Laws, Taboose-Aberdeen, Independence-Oak, Symmes-Shepherd and Bairs-George were below baseline. Average groundwater levels in Big Pine and Thibaut-Sawmill remain above or near baseline.

Hydrographs plotting DTW for selected wells are provided in the following discussions of conditions for each wellfield. The hydrographs presented below were selected as representative wells that provide insight on water level changes over time.

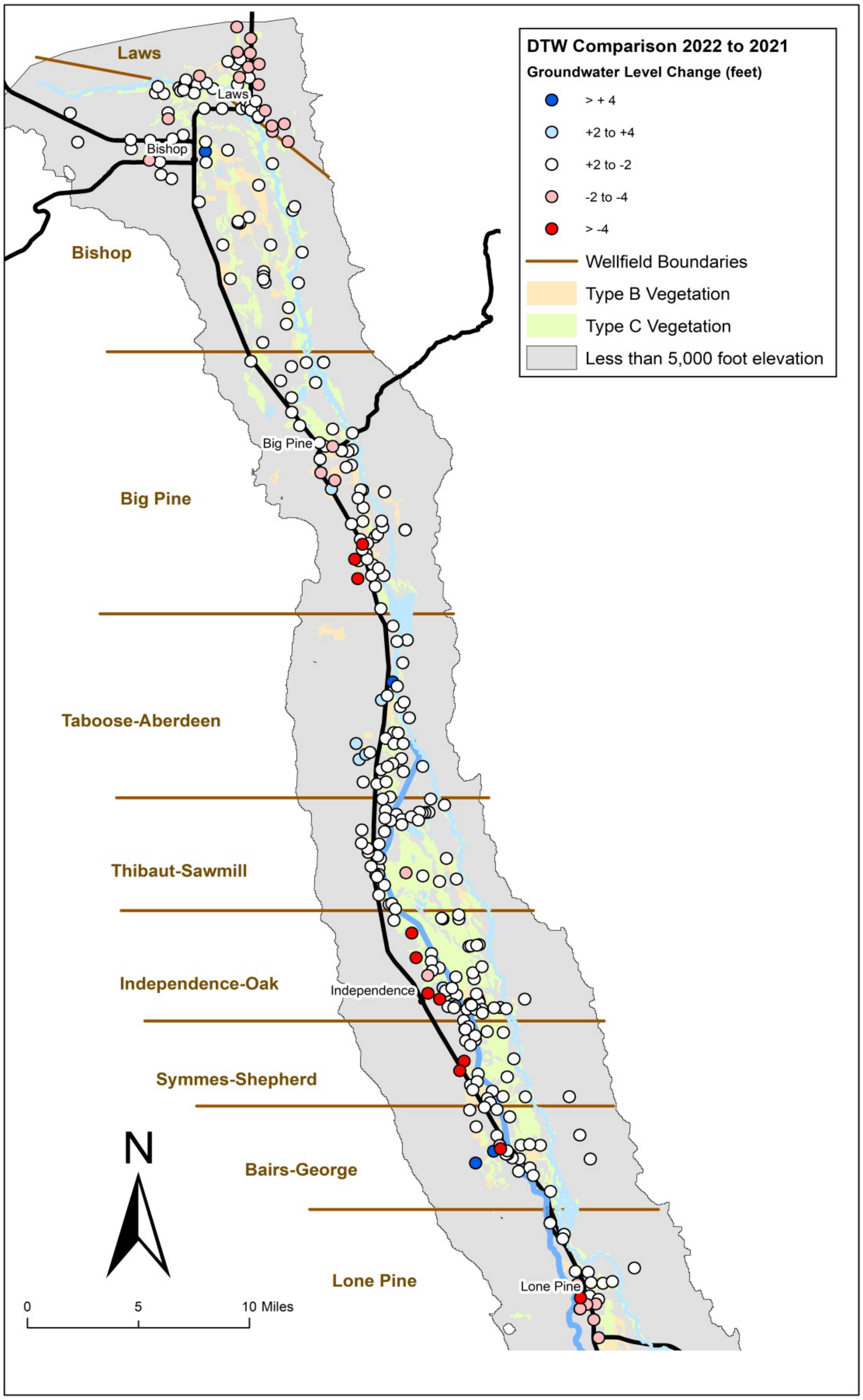


Figure 3.5. Change in water levels in Owens Valley monitoring wells from spring 2021 to 2022.

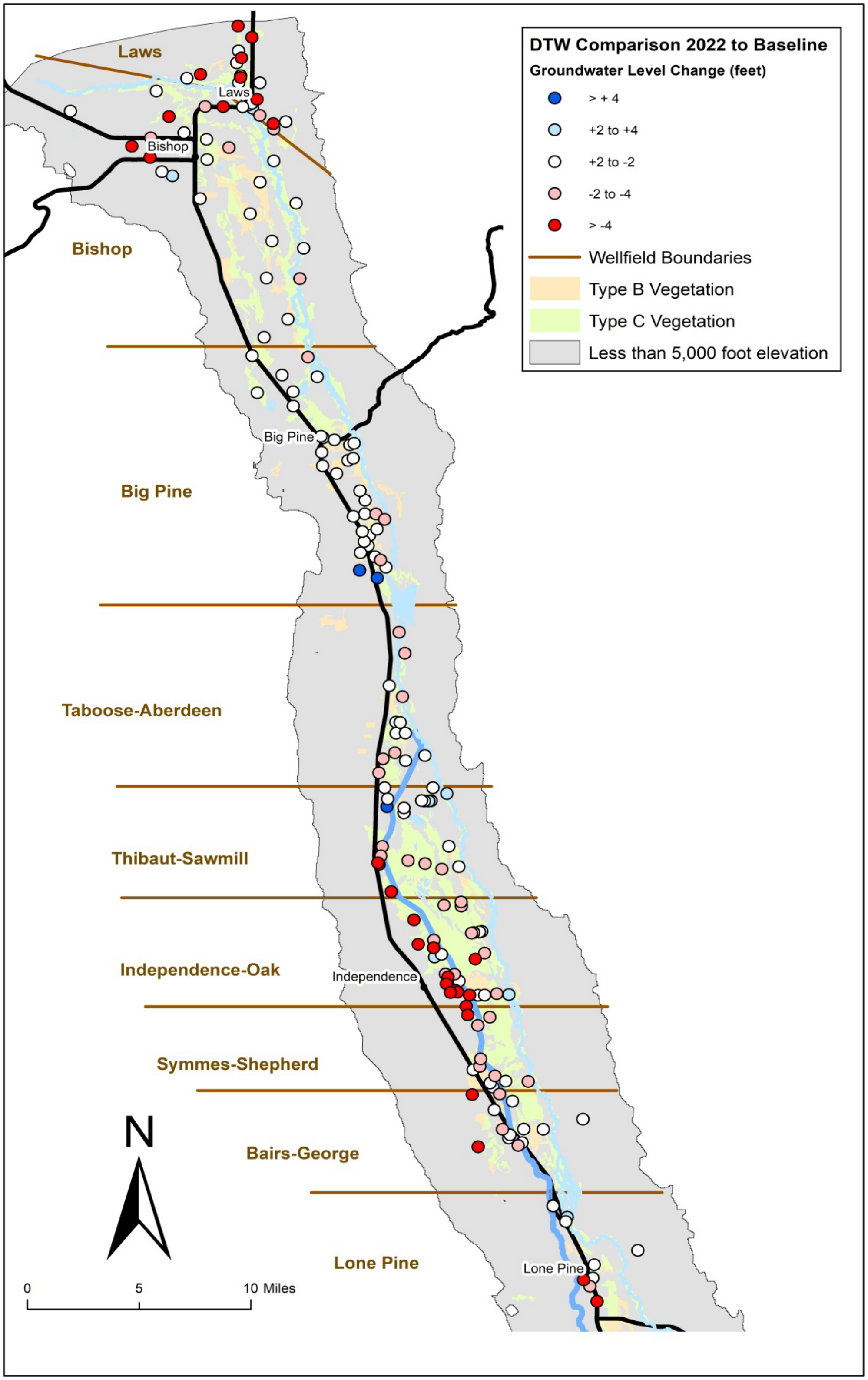


*Figure 3.6. Spring 2022 groundwater levels wells compared with average water level in spring 1985-87.*

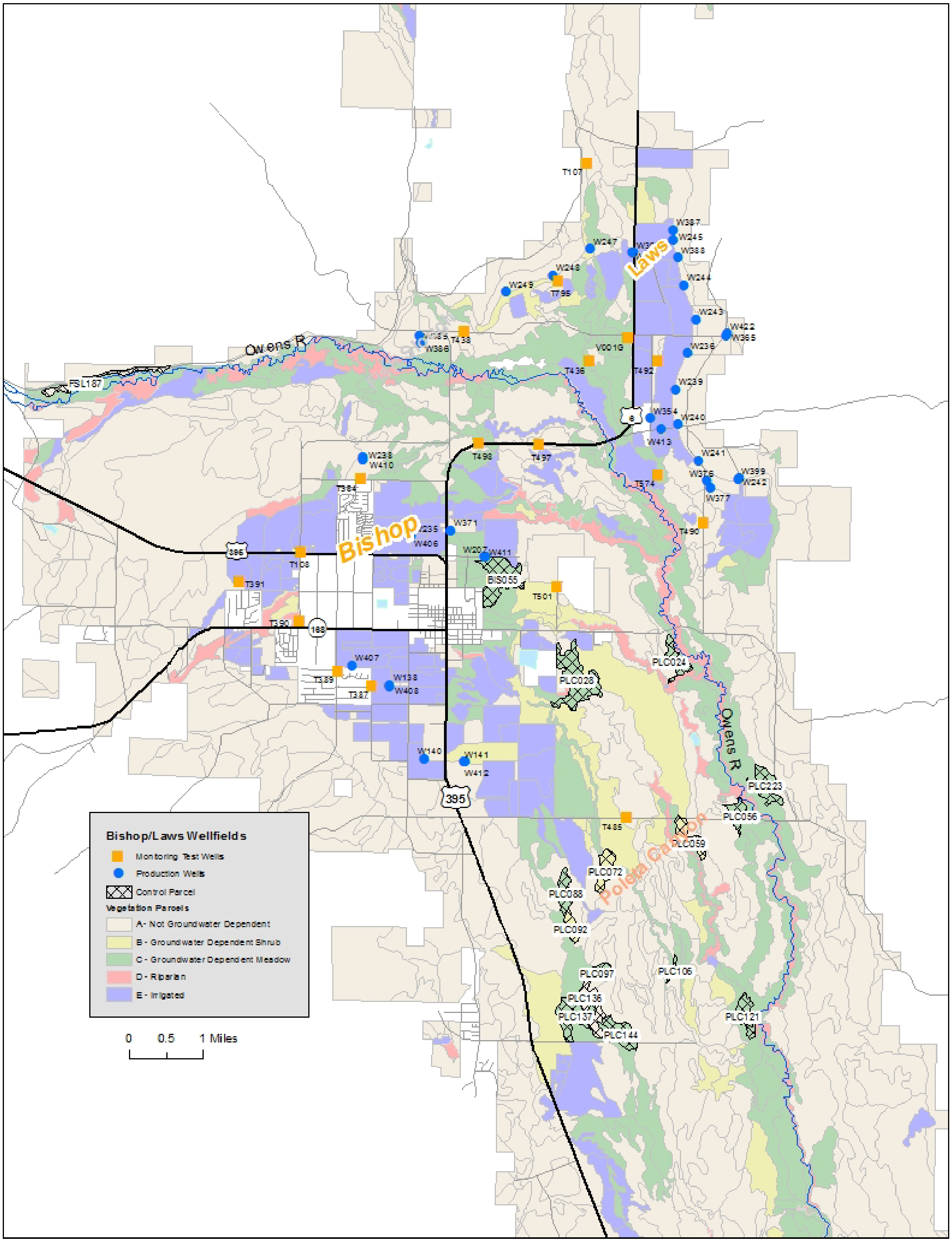


*Figure 3.7. Map of monitoring wells and LADWP production wells in Laws and Bishop wellfields.*

## Laws Wellfield

In the 1970's and 80's, pumping along with irrigation and spreading from the Owens River via the McNally canals in Laws varied greatly from year-to-year causing large fluctuations in the water table (Figures 3.8 and 3.9).

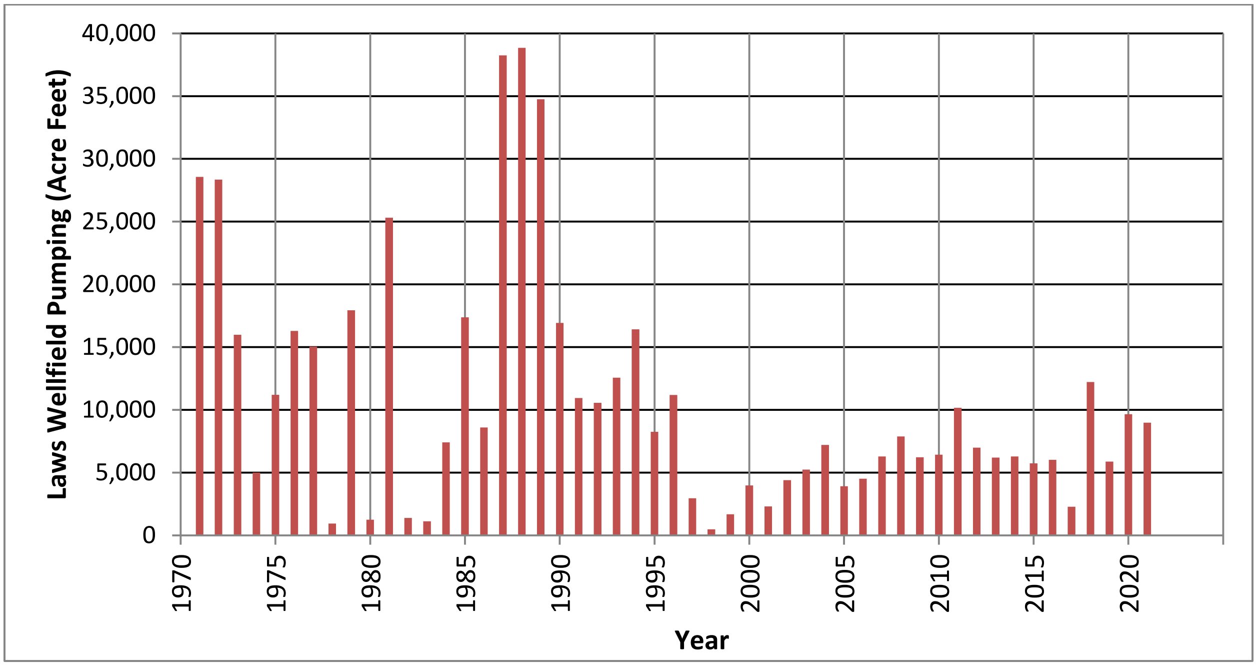


Figure 3.8. Pumping totals for the Laws wellfield.

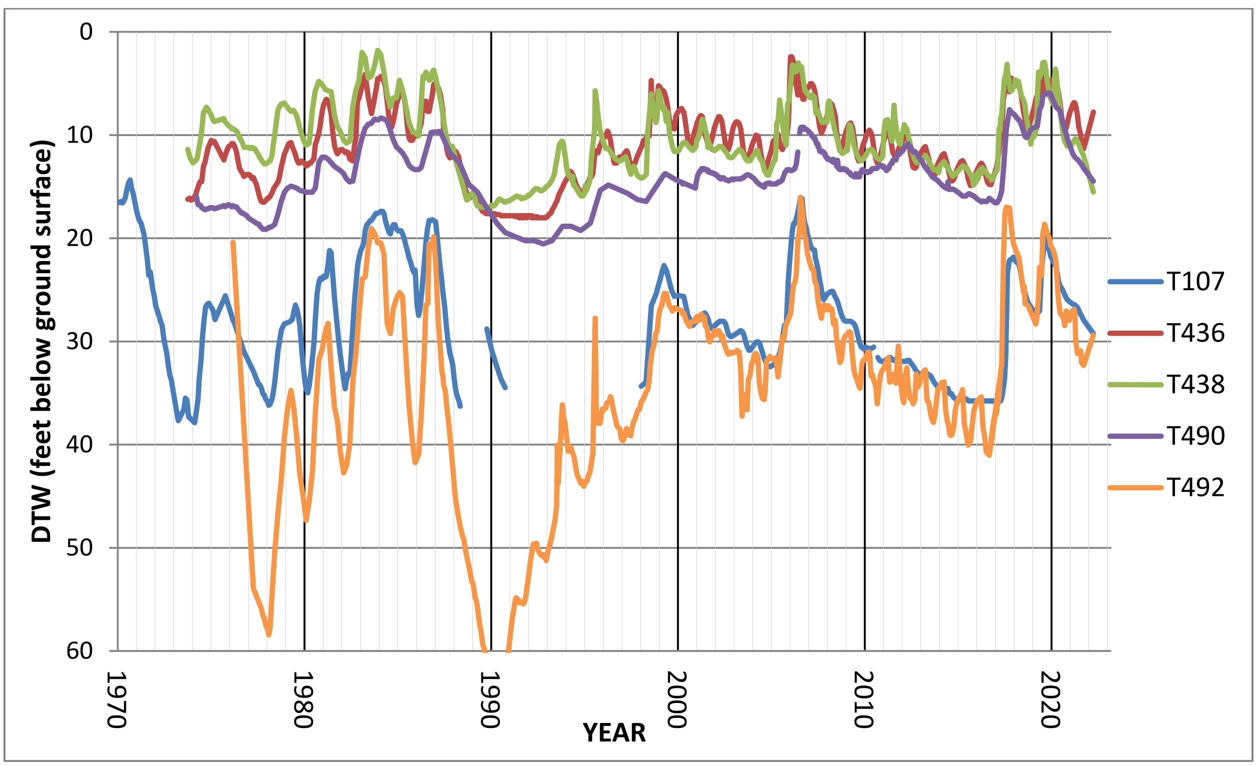

*Figure 3.9. Hydrographs of indicator wells in the Laws wellfield. Well T492 is dry if DTW is below 60 ft, and well T107 is dry if DTW is below 37 feet.*

This was especially true for T107 and T492 due to their proximity to the McNally canals and LADWP pumping wells. Heavy pumping and low recharge in the late 1980's caused severe groundwater level decline in Laws. Under the Water Agreement pumping has remained considerably below the maximum wellfield capacity. As a result, water levels rose, and beginning in 2000, water table fluctuations have been largely driven by pumping for local uses in the surrounding area and by water spreading following heavy snow winters (2005, 2006, 2011, 2017, 2019). In 2021-22, groundwater levels declined in all Indicator wells; and seven of the nine Indicator wells are below baseline as of April 2022 (Table 3.2).

### Bishop Wellfield

Groundwater pumping in the Bishop Wellfield is managed differently than other wellfields due to additional legal requirements governing LADWP operations. The environmental protections and goals of the Water Agreement still apply, however. The Water Agreement requires ICWD and Los Angeles to prepare an annual audit of pumping and uses on the Bishop Cone to demonstrate compliance with the Hillside Decree (the Decree itself does not contain audit procedures). The Hillside Decree is a 1940 Inyo County Superior Court stipulation and order under which LADWP groundwater extractions from both pumped and uncapped flowing wells cannot exceed the annual amount of water used on LADWP-owned land on the Bishop Cone.

It is important to understand that the Bishop Cone Audit is not an accounting of the water balance for the groundwater aquifer. Rather, it is an accounting based on the surface water applications (for irrigation and stockwater) to the Bishop Cone compared to groundwater pumping and flowing wells. Water supplied for irrigation in west Bishop upstream of LADWP pumping wells consists of surface water diverted primarily out of Bishop Creek and the Owens River. Pumped water from the center of the cone is also conveyed for irrigation using the same ditches and canals as the surface water, and most lands are supplied with a combination of pumped and surface water. Because it is impossible to separate surface and groundwater once they comingle in a canal or ditch, the most reliable method to assess compliance with the Hillside Decree is to compare the sum of pumping and flowing water against the sum of water uses applied to the cone.

Uses in the Bishop Cone Audit are calculated as the amount of water applied to a parcel minus the amount of water flowing off the parcel back into the canal or ditch system. In some cases several parcels are grouped into a single account and several monitoring stations are used to measure the water delivered to and exiting from the account. The accounts, as well as the individual deliveries/uses, are only included in the Bishop Cone Audit following a field inspection and Technical Group approval to ensure that appropriate monitoring is in place. Not all lands supplied with water or all water uses are included in the Audit.

The most recent Bishop Cone Audit examined conditions for the 2020-21 runoff year. Total groundwater extraction (pumping and flowing wells) on the Bishop Cone was 15,676 ac-ft compared with 27,335 ac-ft of recorded uses. Therefore, uses on the Bishop Cone exceeded extractions by approximately 11,659 ac-ft. If extractions had exceeded the amount of recorded uses, all groundwater could not have been used on the Bishop Cone and LADWP would be out of compliance with the Hillside

Decree. That situation has not occurred since the audit procedures were implemented as part of the Water Agreement.

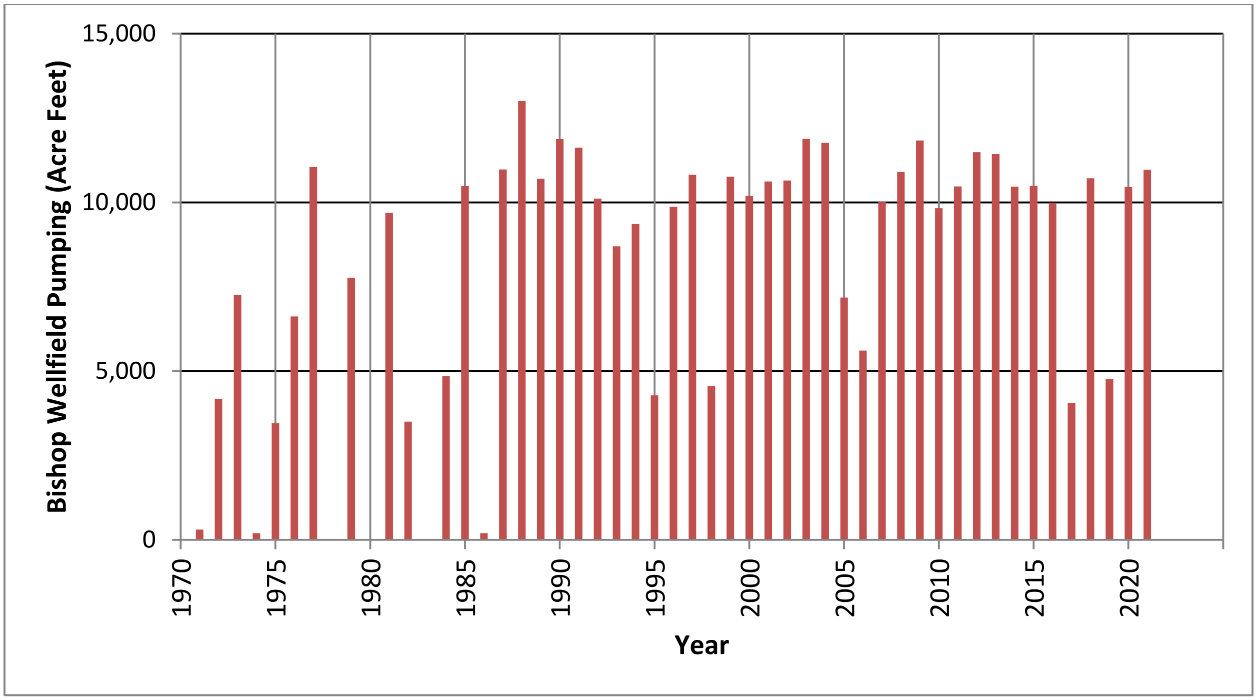


*Figure 3.10. Pumping totals for the Bishop wellfield.*

Pumping in the Bishop Wellfield has been relatively constant for the past 25 years except in above-normal runoff years when pumping decreased, for example 1998, 2006, 2017 and 2019 (Figure 3.10). Because of the Hillside Decree and relatively constant pumping, ICWD does not routinely use indicator wells to analyze LADWP's annual operations plan for this wellfield. Water levels in west Bishop typically peak after the summer irrigation season. Groundwater levels from 1980 to 2021 at several test wells located west, north, and east of the city of Bishop are presented in Figures 3.11.a -c. Constant pumping and consistent recharge from irrigation has historically resulted in relatively stable water levels in the Bishop Wellfield. However, the effects of the 2012 to 2016 drought can be seen in the groundwater levels from Bishop Cone wells, especially wells in the western and northern portions of the wellfield.

It is likely that a combination of diminished surface water flows caused by the 2012-2016 drought and the change in Bishop Creek surface flows negatively affected shallow groundwater levels in west Bishop from fall of 2013 through the winter of 2014. Groundwater levels in dropped precipitously, in some cases to their lowest recorded levels. Several domestic wells went dry. Hydrographs of these groundwater declines can be seen in Figure 3.12. The declining groundwater levels prompted both ICWD and LADWP to increase the frequency of their monitoring on the western half of the Bishop Cone in order to more fully understand the changes in groundwater levels during the prolonged drought.

Groundwater levels recovered from the low water tables of 2013-14. During this recovery, several residents of west Bishop noticed extremely shallow or perched water at their properties. It is theorized that once creek and ditch flows returned to the area in 2014, increased seepage of surface water led to the oversaturation of the near surface sediments. Additional investigations were conducted in 2016, including a report issued by the Department of Water Resources.

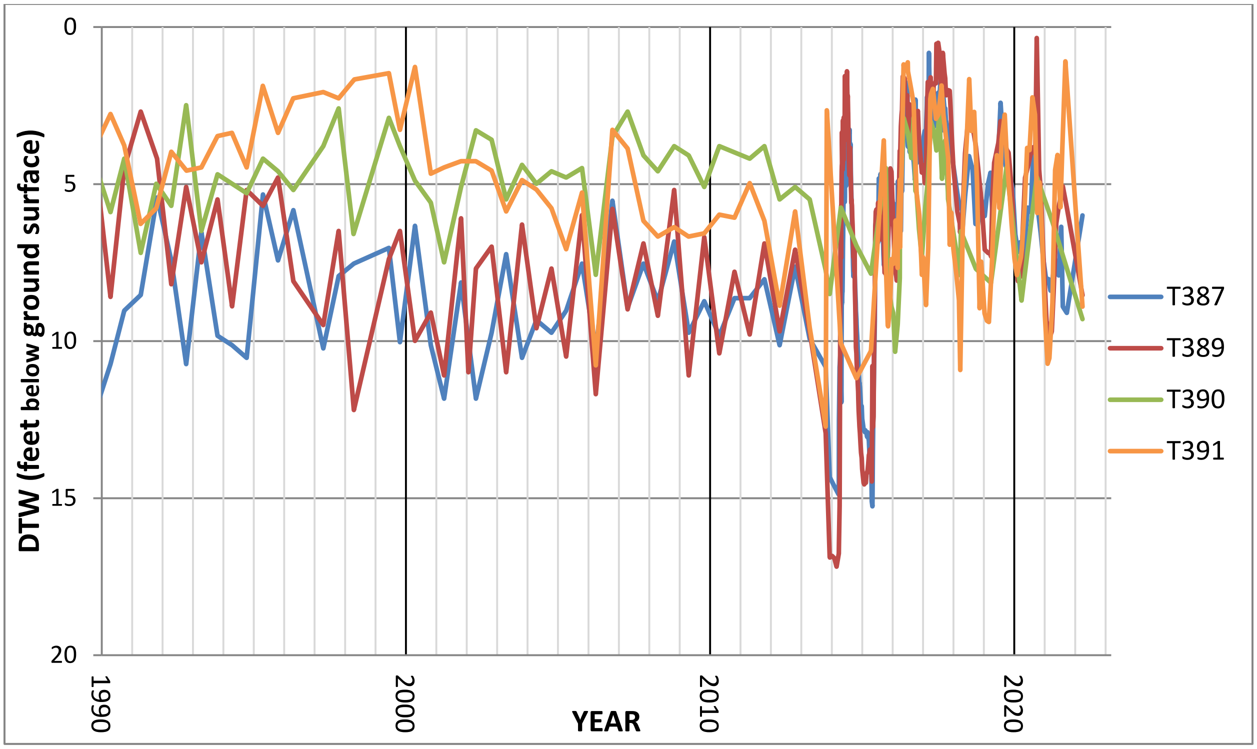


*Figure 3.11.a. Hydrographs of selected monitoring wells in the western Bishop wellfield. Locations of the wells are shown in Figure 3.7.*

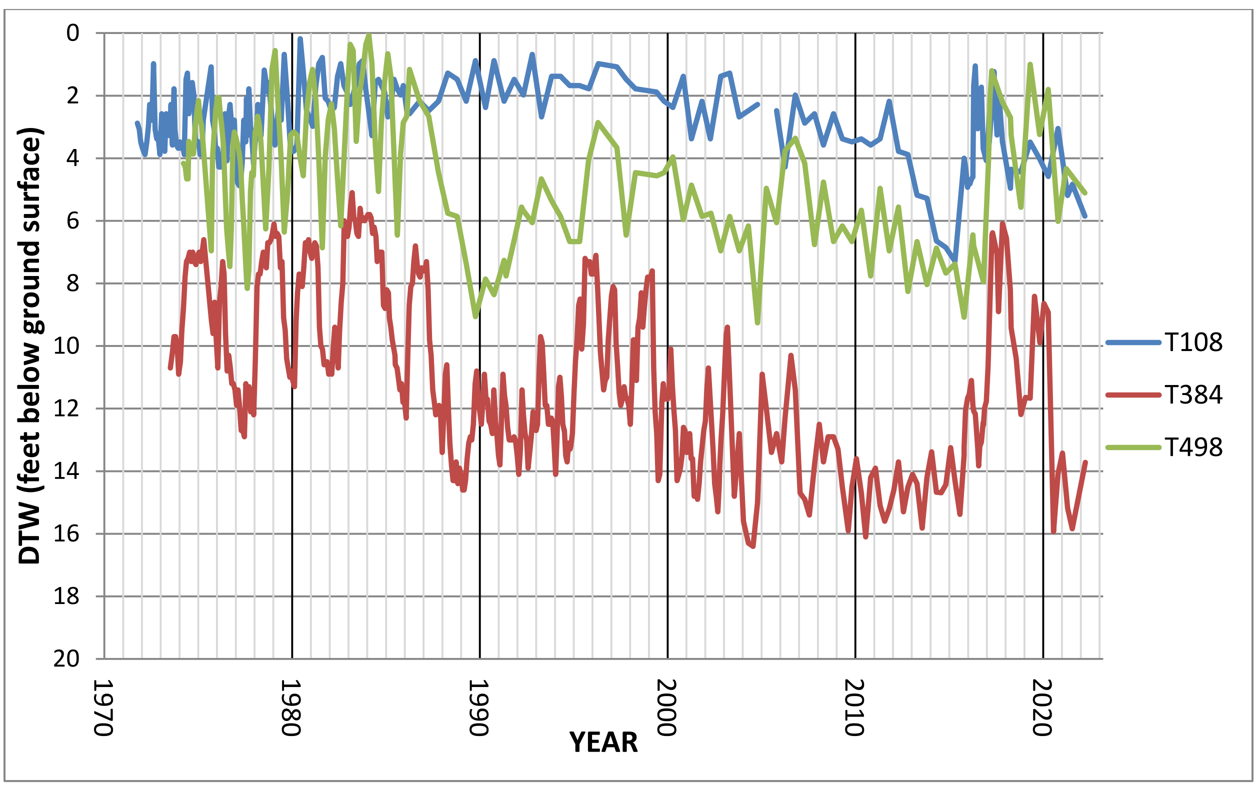


*Figure 3.11.b. Hydrographs of selected monitoring wells in the northern Bishop wellfield. Locations of the wells are shown in Figure 3.7*

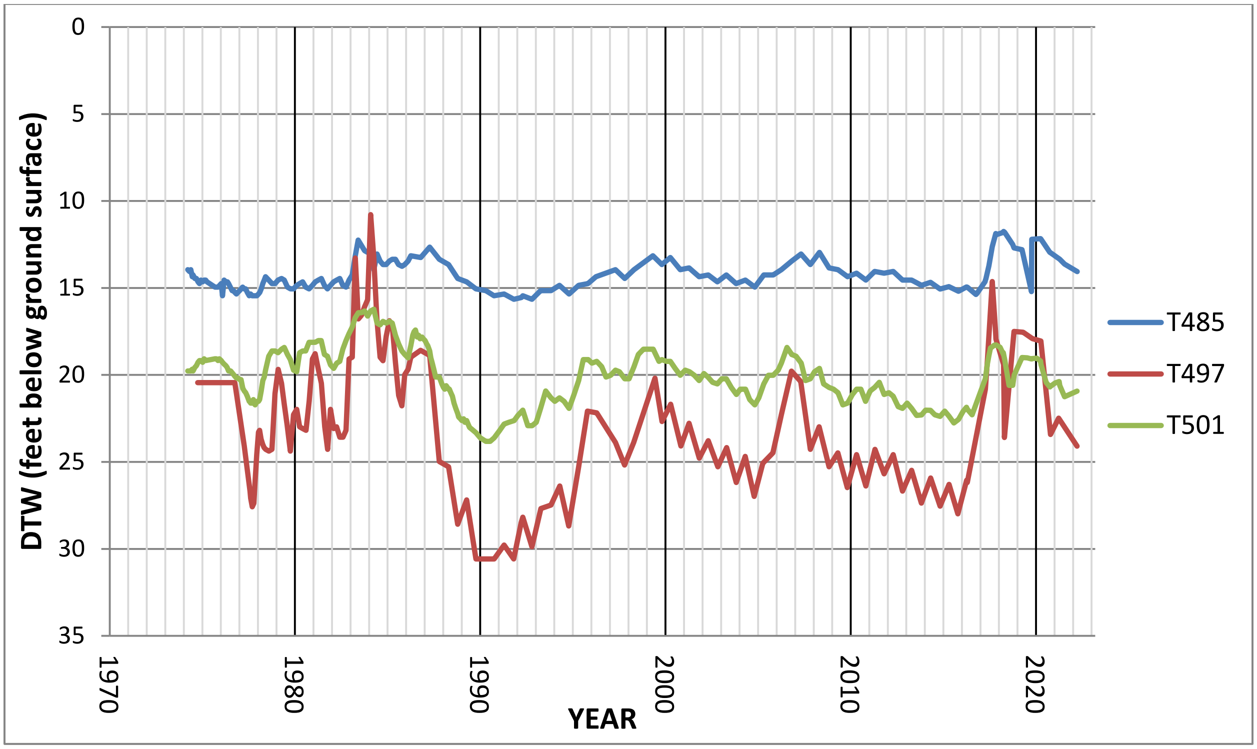


*Figure 3.11.c. Hydrographs of selected monitoring wells in the eastern Bishop wellfield. Locations of the wells are shown in Figure 3.7*

After the summer/fall of 2017, fewer problems with shallow groundwater have been reported and it is probable that the natural sealing caused by decaying biomass in ditches and ponds has led to a decrease in the 2014-15 seepage rates, lowering seepage back to their pre-2014 rates; and that the west Bishop hydrologic system has reverted to its historic equilibrium. Due to another significant winter, the 2019-20 flows in Bishop Creek significantly exceeded both the Chandler Decree minimums and also long-term averages, but no flooding problems were reported.

For 2021-22, snowpack in the Bishop Creek drainage was approximately 46% of average; for 2022-23 snow pack was 43% of the April 1 average. Given the dry antecedent conditions and storage in the Bishop Creek reservoirs, creek flows are expected to be well-below long-term averages and are not expected to meet the primary Chandler flows for the 2022-23 season. Instead, it is likely that Bishop Creek flows will satisfy the drought provisions of the Chandler Decree with inflows to the reservoirs equal to outflows for much of the summer irrigation season. Groundwater levels in spring 2022, however, are still above lows seen in 2013-14 in part because flows in Bishop Creek during winter 2021-22 were at levels that allowed ditches to remain active.

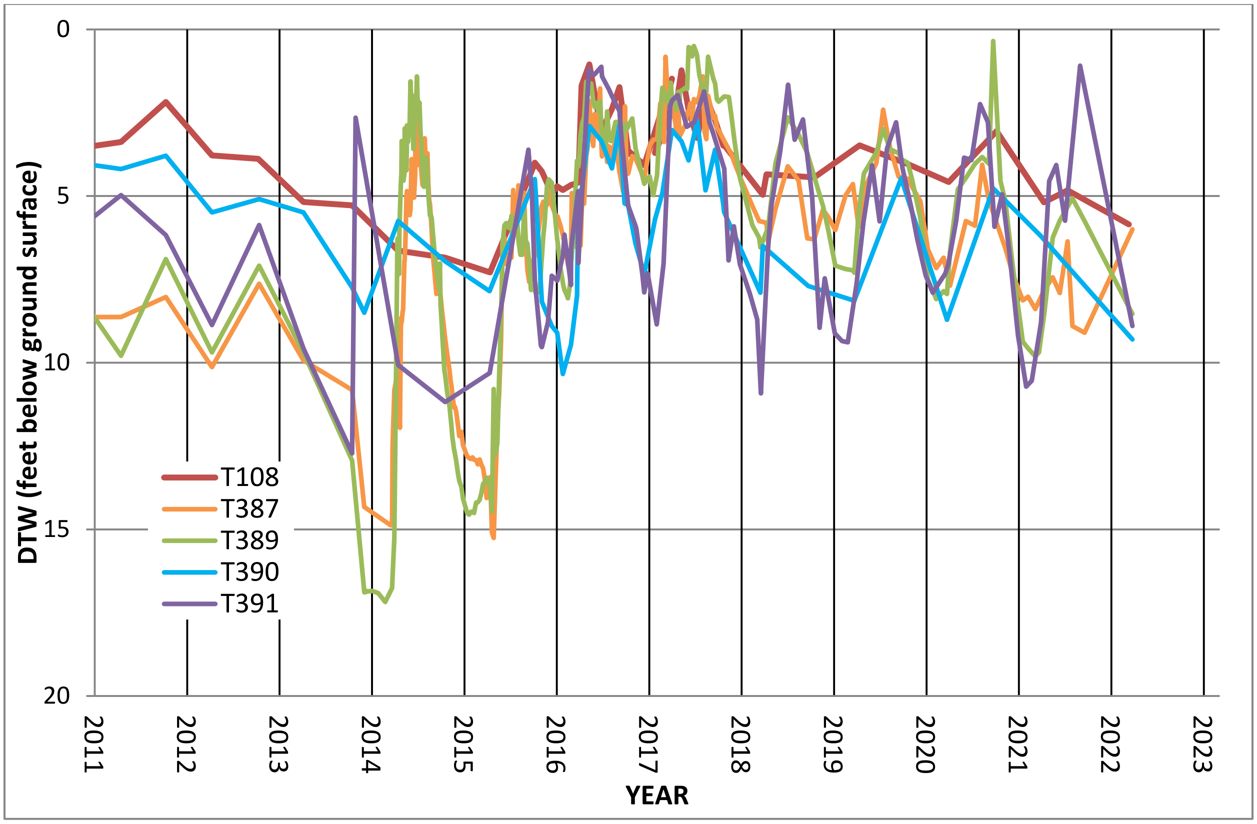


*Figure 3.12. Recent hydrographs of selected monitoring wells in western Bishop wellfield. Locations of the wells are shown in Figure 3.7*

**Important takeaways from recently observed Bishop Cone conditions:**

- Surface water flows play an integral role in recharging shallow groundwater levels in west Bishop; and the interaction between surface water and groundwater recharge is very sensitive to changes in equilibrium conditions
- Semiannual monitoring in spring and fall does not capture the full range of groundwater fluctuations in the Bishop area
- Water management of Bishop Creek flows and the associated diversion and ditch flows should maintain some flow in area ditches during drought and/or low runoff years
- In west Bishop there is a delicate balance between enough surface water seepage to recharge area groundwater and too much seepage to overwhelm infiltration rates, leading to undesirable consequences to landowners from extremely shallow or perched water levels
- Many of the private wells in west Bishop are shallow and are, therefore, more vulnerable to impacts associated with lowered groundwater levels
- Conservative pumping practices should be used on LADWP wells W407 and W408 during drought and/or low runoff years
- Information gathered in west Bishop during the past several years should be taken into consideration in regards to LADWP's potential new wells B2 and B5.

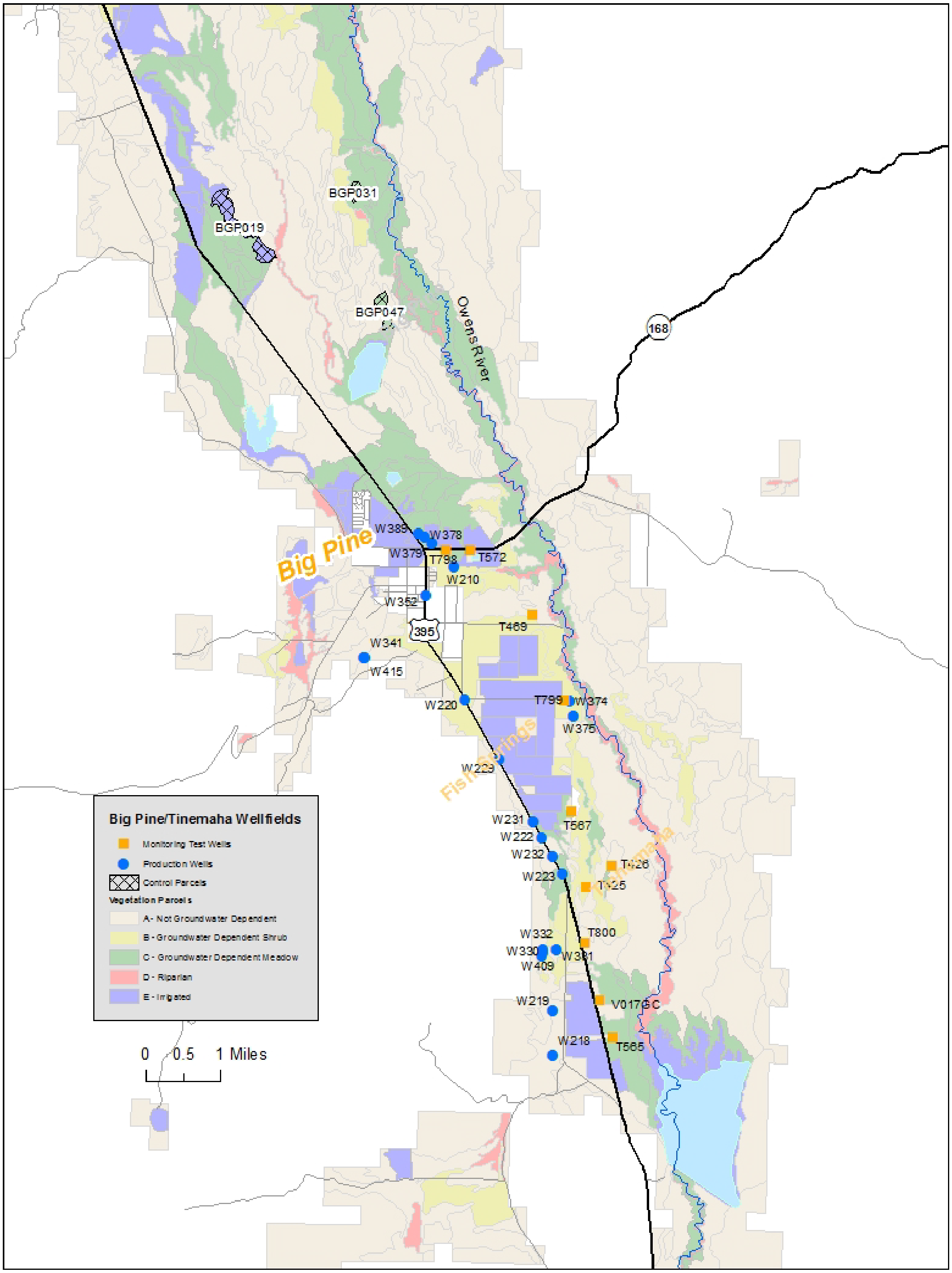


*Figure 3.13. Map of monitoring wells and LADWP production wells in Big Pine wellfield.*

## Big Pine Wellfield

Since 1974, pumping in the Big Pine wellfield (Figure 3.13) has been consistently higher than other wellfields (Figure 3.14). Minimum pumping to supply uses in this wellfield include the Fish Springs Hatchery (approximately 20,000 ac-ft per year), Big Pine town supply (500 ac-ft per year), and the Big Pine northeast re-greening Project (100-ac-ft per year). Pumping under the Water Agreement has largely been to supply these uses. It should be noted that most of the hatchery pumped water also reaches the aqueduct.

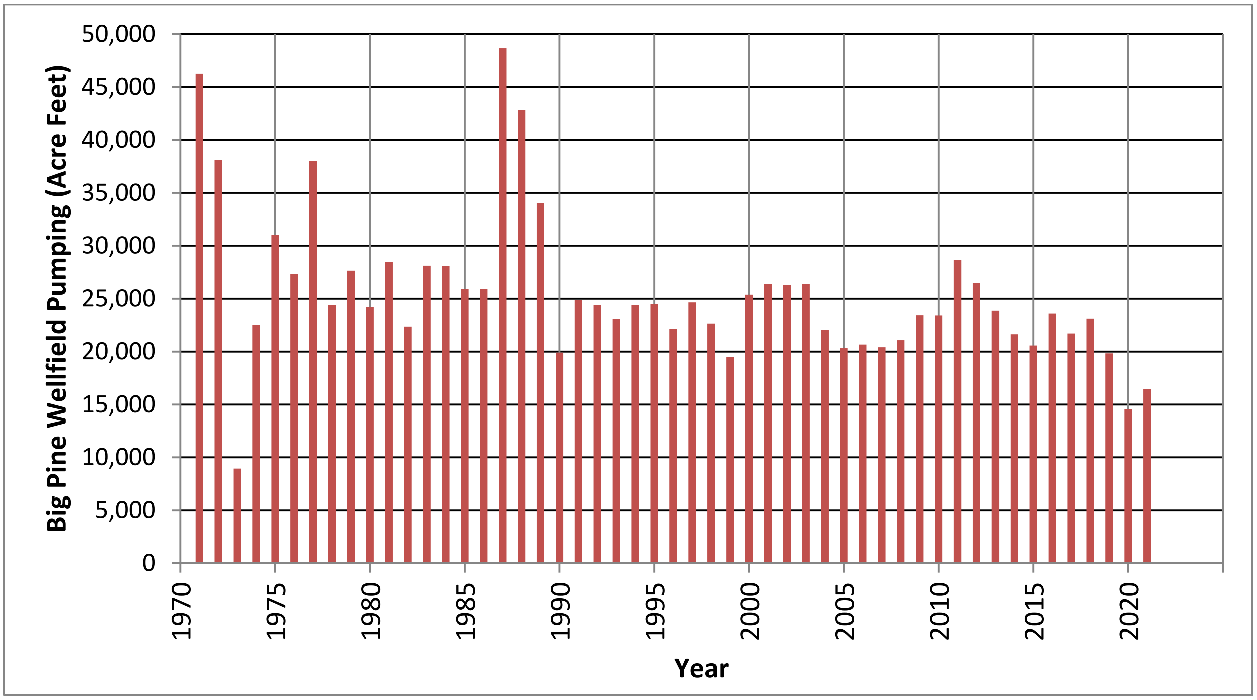


*Figure 3.14. Pumping totals for the Big Pine wellfield*

Groundwater levels declined in five of the eight Big Pine Indicator and monitoring site wells in 2020-21 (Figure 3.15 and Table 3.2). However, six of these eight monitoring wells remained above baseline levels as of April 2021 with the Big Pine average at 0.9 feet above baseline. In addition to the Indicator wells, ICWD also examines two test wells located just east of U.S. 395 near W218 and W219 to assess possible impacts from the additional export pumping during extended droughts (Figure 3.16). Both V017GC and T565 are located in or adjacent to groundwater dependent vegetation. Water levels declined in response to drought and pumping from 2012 to 2016. In 2017 and 2019, LADWP actively spread water into the Big Pine wellfield, notably south of town along the Red Mountain cinder cone. Both V017GC and T565 have recovered significantly since 2017 and also remained above baseline levels as of April 2021.

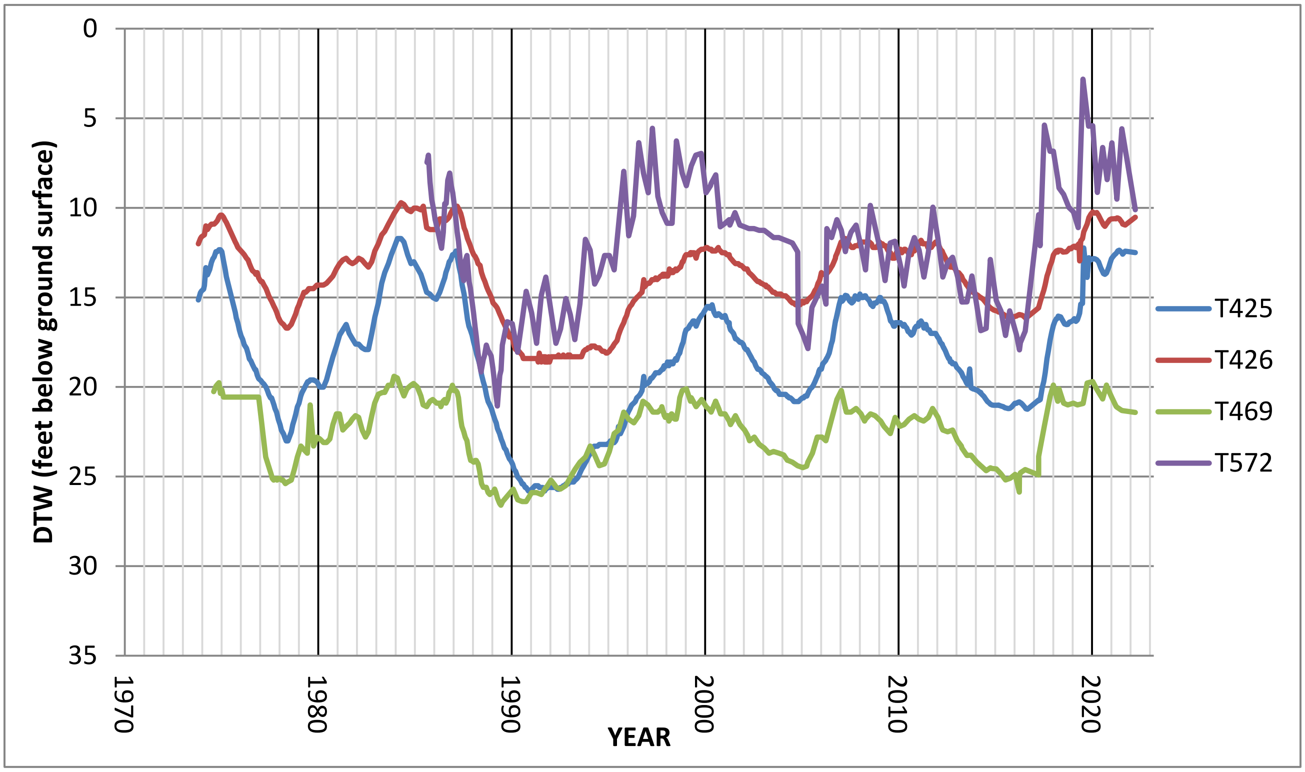


Figure 3.15. Hydrographs of indicator wells in the Big Pine wellfield. *Periods of missing data for T572 occurred when the well was plugged and in need of repair.*

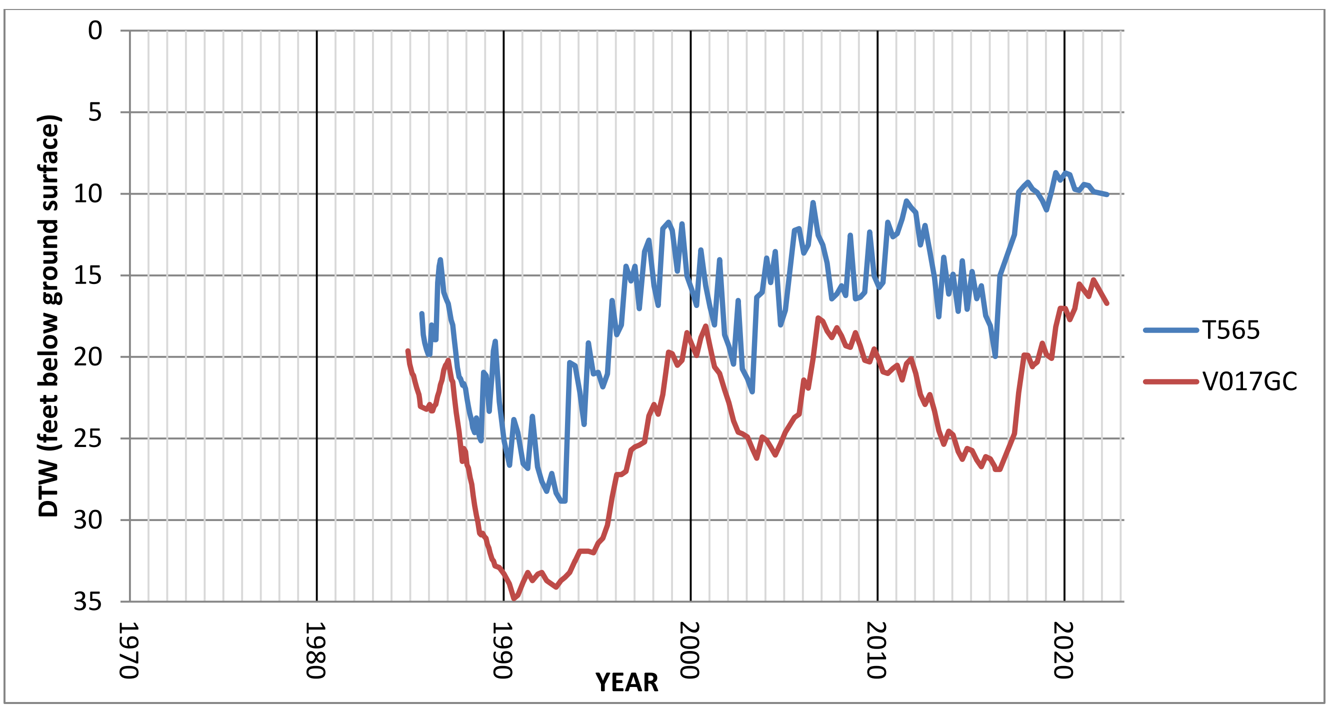


*Figure 3.16. Hydrographs of monitoring wells in the southern Big Pine wellfield near pumping wells W218 and W219.*

In 2020, a bacterial infection at the Fish Springs Fish Hatchery resulted in Department of Fish and Wildlife drying and then disinfecting the hatchery over a several month period. Fry were reintroduced in a portion of the hatchery in spring 2021. Pumping for the hatchery was, therefore, reduced for both runoff years, especially during the August through December 2020 period. ICWD is currently in discussion with DFW and LADWP staff to explore potential opportunities to increase water-use efficiency at the Fish Springs Hatchery with the goal of reducing annual pumping amounts.

To track the groundwater response to the reduced hatchery pumping stress, ICWD staff increased groundwater monitoring frequency with additional focus on wells completed in the volcanic basalt cinders which comprise a deeper hydro-stratigraphic unit that the hatchery wells primarily source water from ("T and V" series wells with total depths in the 100-300 foot range). In the southern half of the Big Pine wellfield, groundwater levels in these V wells recovered between eight and nine feet in this unit. The recovery was less notable in the more distant northern portion of the wellfield where additional hydrologic influences from fall through winter include declining seasonal flows in the Big Pine Creek, Big Pine Canal and the Big Pine ditch systems. Recovery was also less discernible (less than 2 feet) in the shallower "T" wells screened primarily in the water table aquifer and not in the volcanic cinders. In addition to pumping stress, these shallow monitoring wells are also influenced by evapo-transpiration demand, sub-irrigation from nearby fields and pastures, Owens River stage, and reduced runoff in the below-average 2020-22 years. A summary power-point was presented at the March 31, 2021 Water Commission meeting; it can be found online at: https://www.inyowater.org/meetings/water-commission/water-commission-meetings/

Finally, LADWP decommissioned W341, located west of Big Pine, and replaced its pumping with adjacent well W415 for Big Pine town water system supply. W415 has additional capacity as compared to W341 of approximately 1 cfs. On May 6, 2020 the Inyo/Los Angeles Technical Group approved test procedures for the initial period of operation of W415 at pumping amounts above the exemption for town supply that would be consistent with Green Book Section VI strictures and consistent with the Water Agreement, as amended in 2002, which committed LADWP to provide both surface and pumped groundwater for the Big Pine Irrigation and Improvement Association (BPIIA) ditch system. The W415 test of its additional capacity for use in the Big Pine ditch system has not commenced but the hydrologic and vegetation monitoring program is in place. Staff will continue the water level and vegetation monitoring in 2022. The *Proposed 6-month Operational Test of W415* report can be found online at:
https://www.inyowater.org/meetings/inyola-technical-group/inyola-technical-group-meetings/

Additionally, in an exchange of letters in 2020, Inyo and Los Angeles concurred that water exiting the Big Pine Community Service District into Big Pine Creek would be considered pumped make-up water for the BPIIA and issued as a credit.

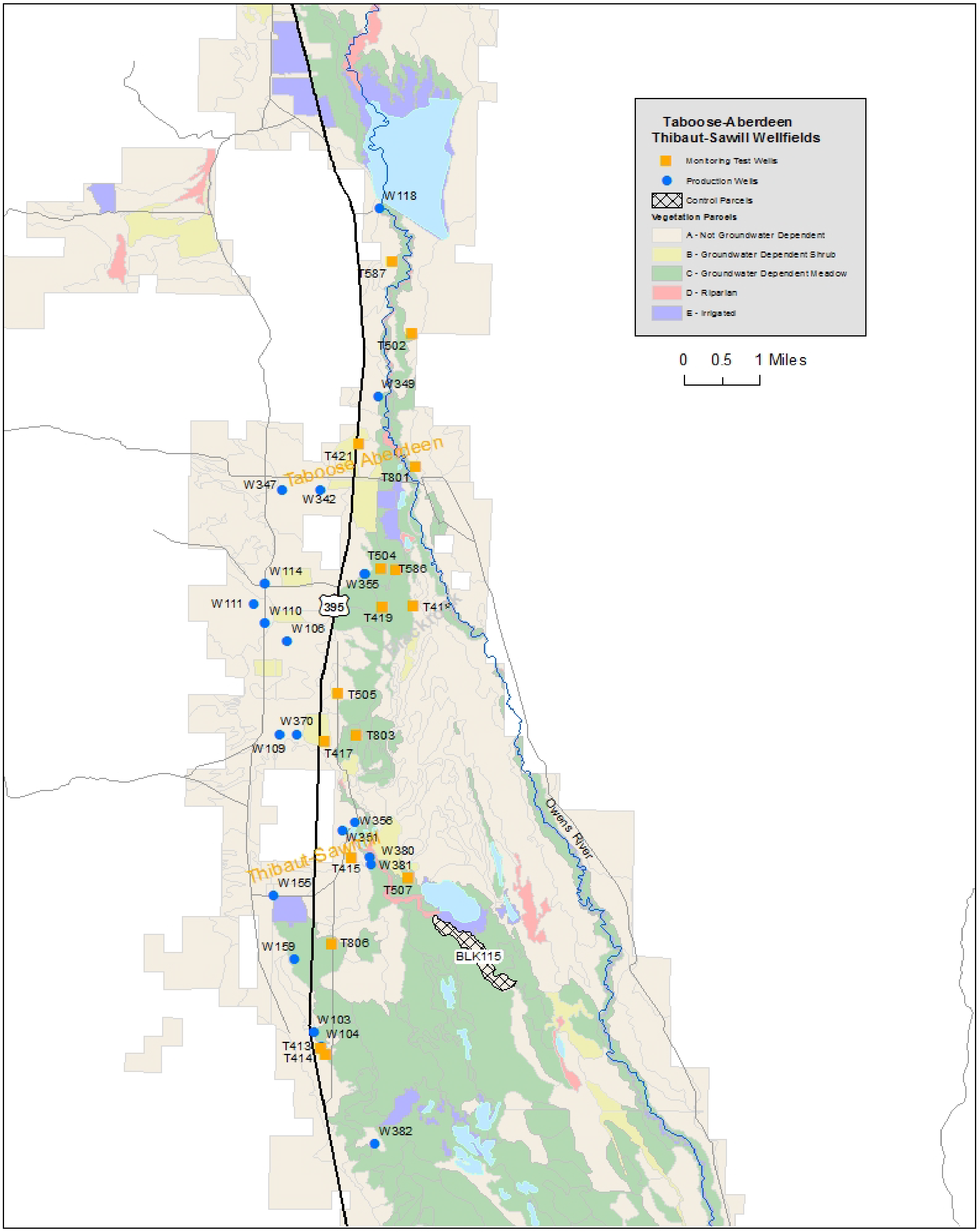


*Figure 3.17. Map of monitoring and LADWP production wells in the Taboose-Aberdeen and Thibaut-Sawmill wellfields.*

## Taboose-Aberdeen Wellfield

Under the Water Agreement, pumping in the Taboose-Aberdeen Wellfield (Figure 3.17) has remained much below the wellfield capacity (Figure 3.18). Minimum pumping for this wellfield is approximately 300 ac-ft to supply two mitigation projects at Big Seeley and Hines Springs, and nearly all of the pumping since 2010 has been for aqueduct supply. In April 2020, groundwater levels were above baseline levels in all but the two northern monitoring wells (T587 and T801). LADWP pumped more than 15,000 ac-ft of water from the wellfield in 2020-21 (the most pumping since 1989), and groundwater levels declined in all 10 Indicator wells by an average of -3.2 feet (Table 3.2). This past year, LADWP's pumping was 7,325 c-ft were stable or recovered slightly. As of April 2022 groundwater levels varied between 1 foot above to three feet below baseline, and the wellfield average was 1.1 feet below baseline. Groundwater levels are still above lows seen in the 2012-16 drought.

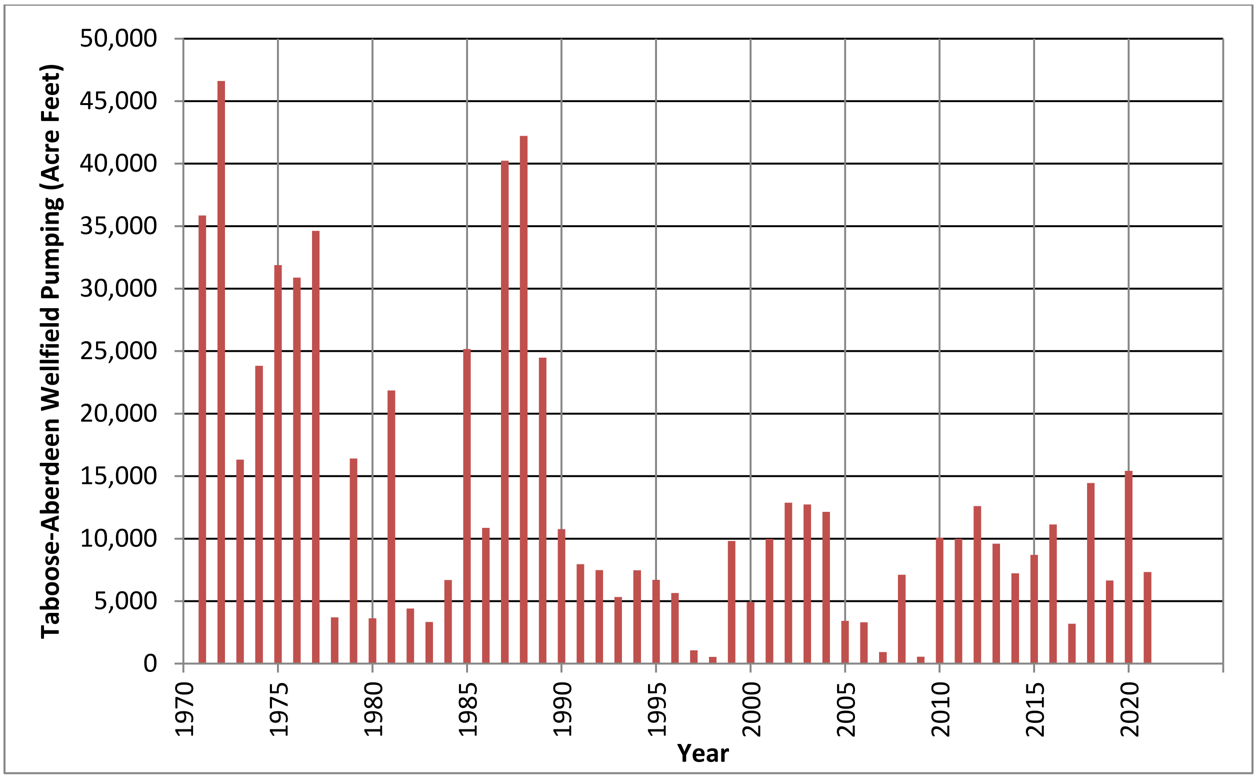


*Figure 3.18 Pumping totals for the Taboose-Aberdeen wellfield.*

Hydrographs for the Indicator wells exhibit similar response to fluctuations in pumping and runoff (Figures 3.19 and 3.20). Most of the recent pumping has been from well W349 and W118 located in the northern portion of the wellfield. Wells W349 and W118 pumped consistently from 2011 to 2016, were off for the majority of the 2017-18 runoff year, but resumed pumping in 2018. Data from monitoring well T587 (a non-Indicator well) is included because it is located adjacent to groundwater dependent vegetation near W118 and W349 and is used to assess the impacts of recent pumping.

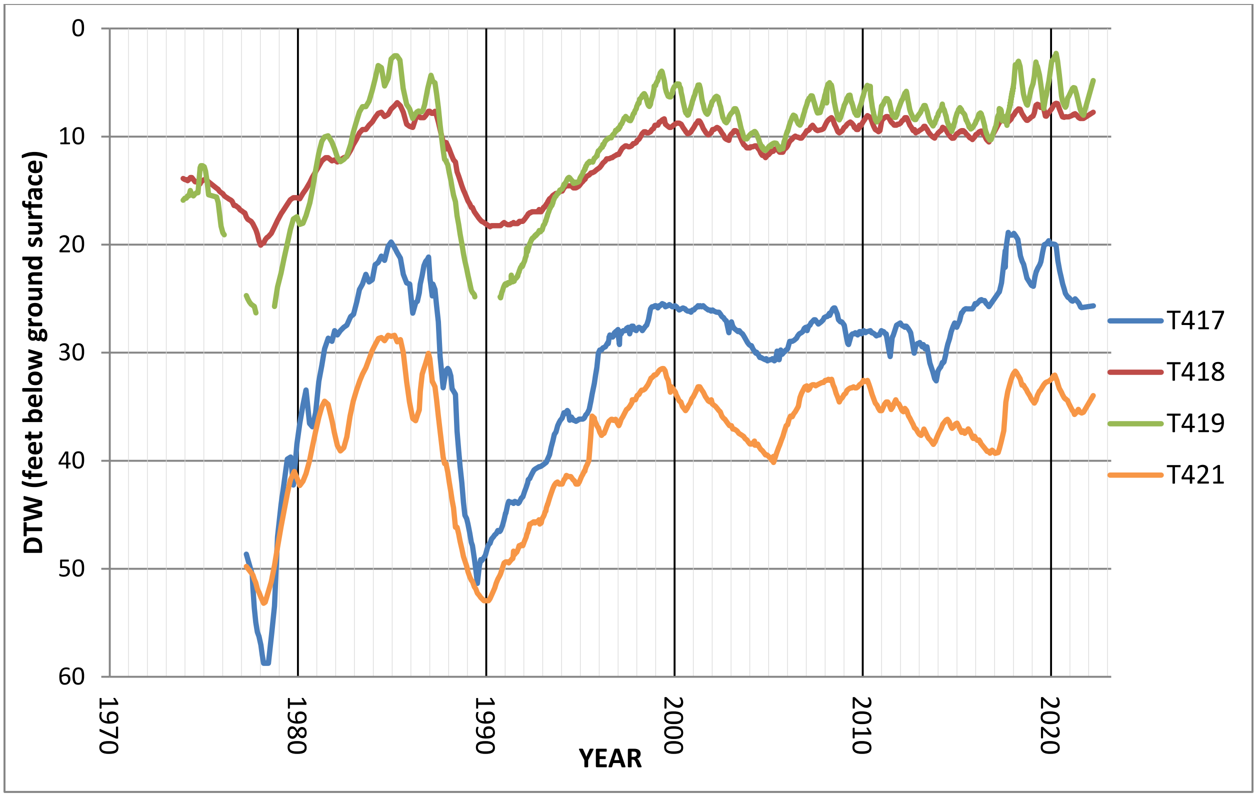


*Figure 3.19. Hydrographs of indicator wells in the Taboose-Aberdeen wellfield. Periods of missing data denote when the test well was dry.*

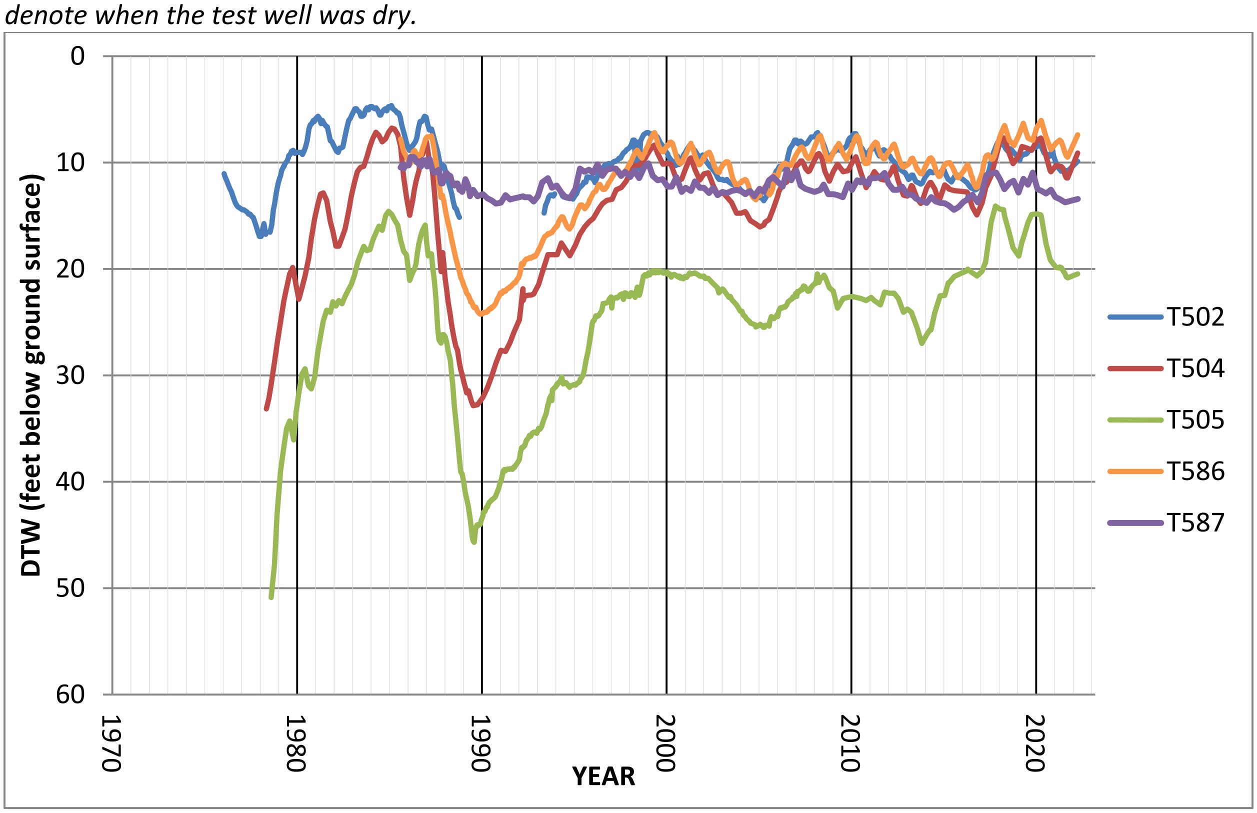


*Figure 3.20. Hydrographs of indicator wells in the Taboose-Aberdeen wellfield. Periods of missing data denote when the test well was dry.*

### Thibaut-Sawmill Wellfield

Historically, most pumping in the Thibaut-Sawmill Wellfield has been to supply approximately 12,200 ac-ft annually to the Blackrock Fish Hatchery (Figure 3.21). In 2014, Inyo and Los Angeles agreed to reduce hatchery pumping to approximately 8,300 ac-ft as part of the settlement to the Black Rock dispute.

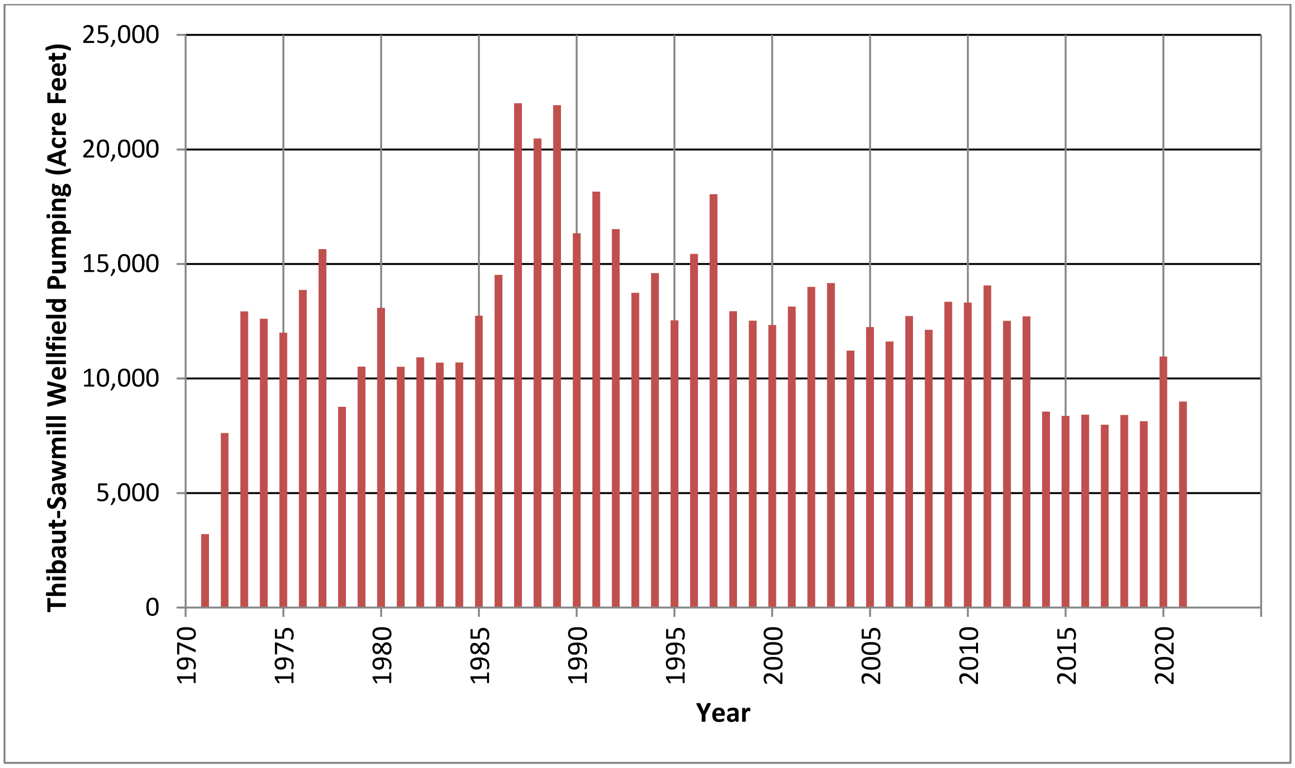


*Figure 3.21. Pumping totals for the Thibaut-Sawmill wellfield.*

Hydrographs of five test wells used to track water levels in Thibaut-Sawmill have exhibited different responses due to local water management within the wellfield (Figure 3.22). Wells T415, T507 and T806, responding to reduced hatchery pumping, exhibited a rising trend from 2014-2017 and are all above baseline levels. Over the past decade, the groundwater level at T507 has also responded to seasonal flooding associated with the Blackrock Waterfowl Management Area. In 2021-22, groundwater levels in these three Indicator wells declined between -0.6 and -1.1 feet from the previous year (Table 3.2) due to increased pumping in the wellfield and reduced runoff. Two of the three indicator wells remain above baseline level.

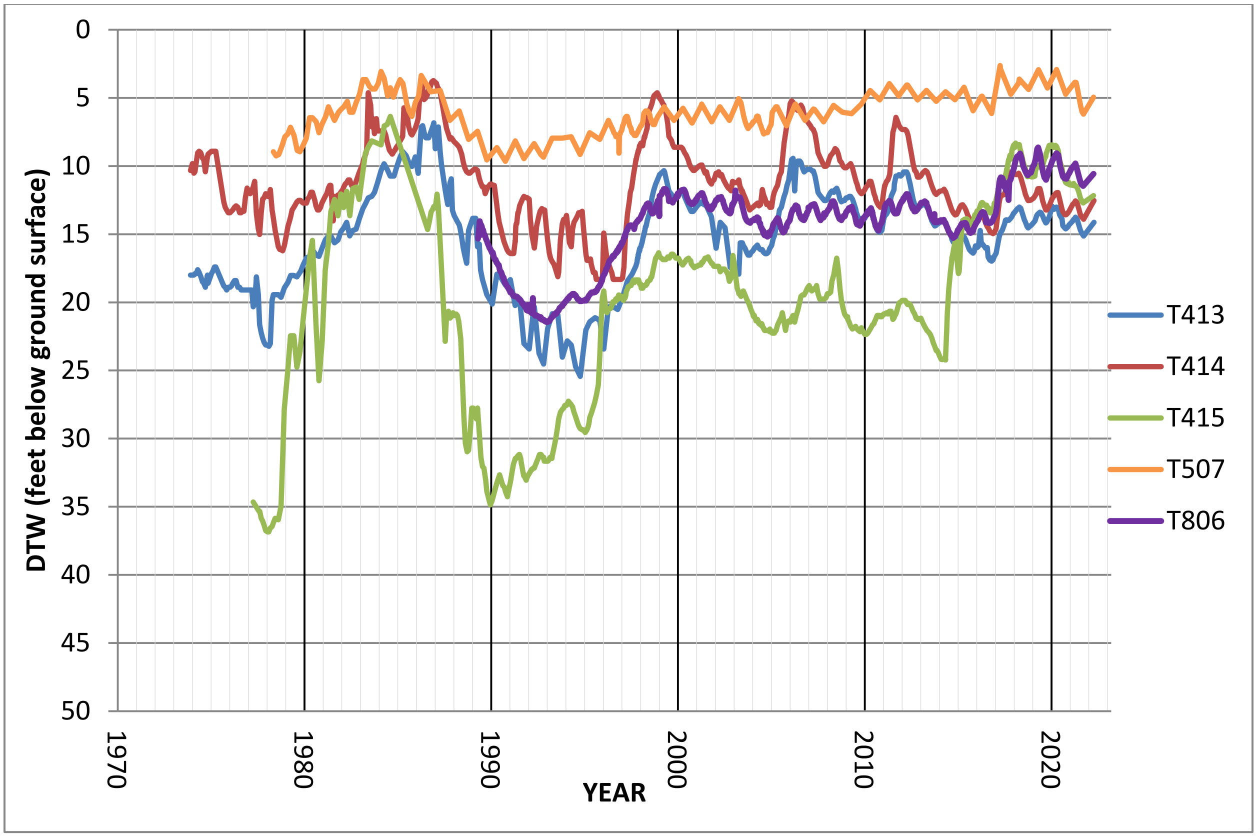


*Figure 3.22. Hydrographs of selected test wells in the Thibaut-Sawmill wellfield.*

Wells T413 and T414 are located in the southern portion of the wellfield and recovered several feet since the end of the recent drought. However, the reduction in the hatchery pumping is not nearly as evident in these wells and the combination of lower runoff and increased pumping in the Thibaut-Sawmill wellfield in recent years (especially W382) has led to declines in these wells. Both monitoring wells remain several feet below their baseline levels.

Two parcels, IND026 and IND029 in the southern portion of this wellfield have chronically depressed water levels and grass cover. ICWD staff have recommended to LADWP that W382 not be pumped in order to recover water levels in the Thibaut Springs area.

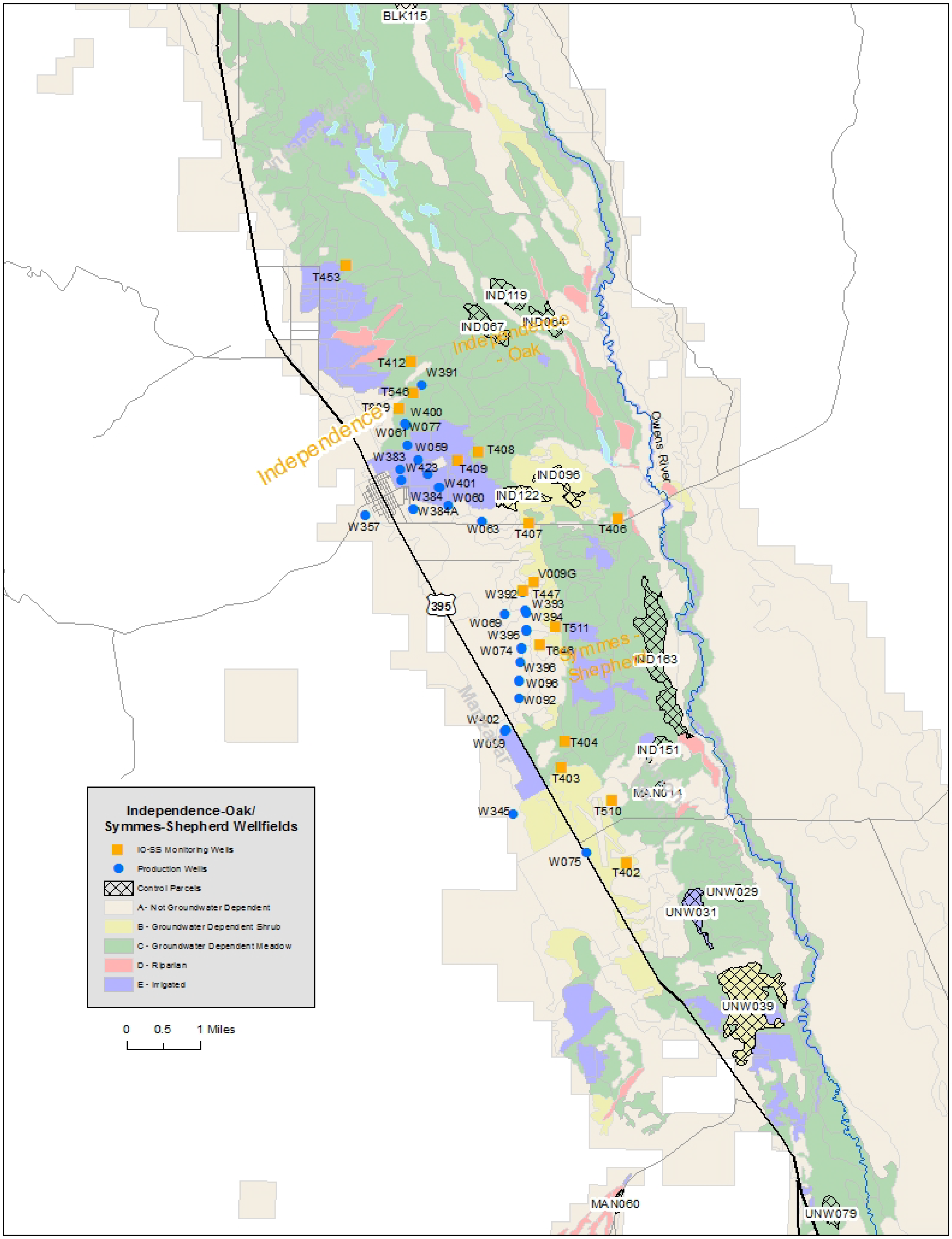


*Figure 3.23. Map of monitoring and LADWP production wells in the Independence-Oak and Symmes-Shepherd wellfields.*

## Independence-Oak Wellfield

Pumping in this wellfield (Figure 3.23) is required to supply approximately 6,500 ac-ft annually for irrigation projects surrounding Independence and for town supply (Figure 3.24). LADWP pumped between 8,600-9,600 ac-ft from 2011 through 2016; however, with heavy 2017-18 and 2019-20 runoff, this wellfield was pumped less (appx. 7,800 ac-ft for 3-yr avg.). During the current drought pumping has averaged about 7,100 ac-ft primarily for irrigation.

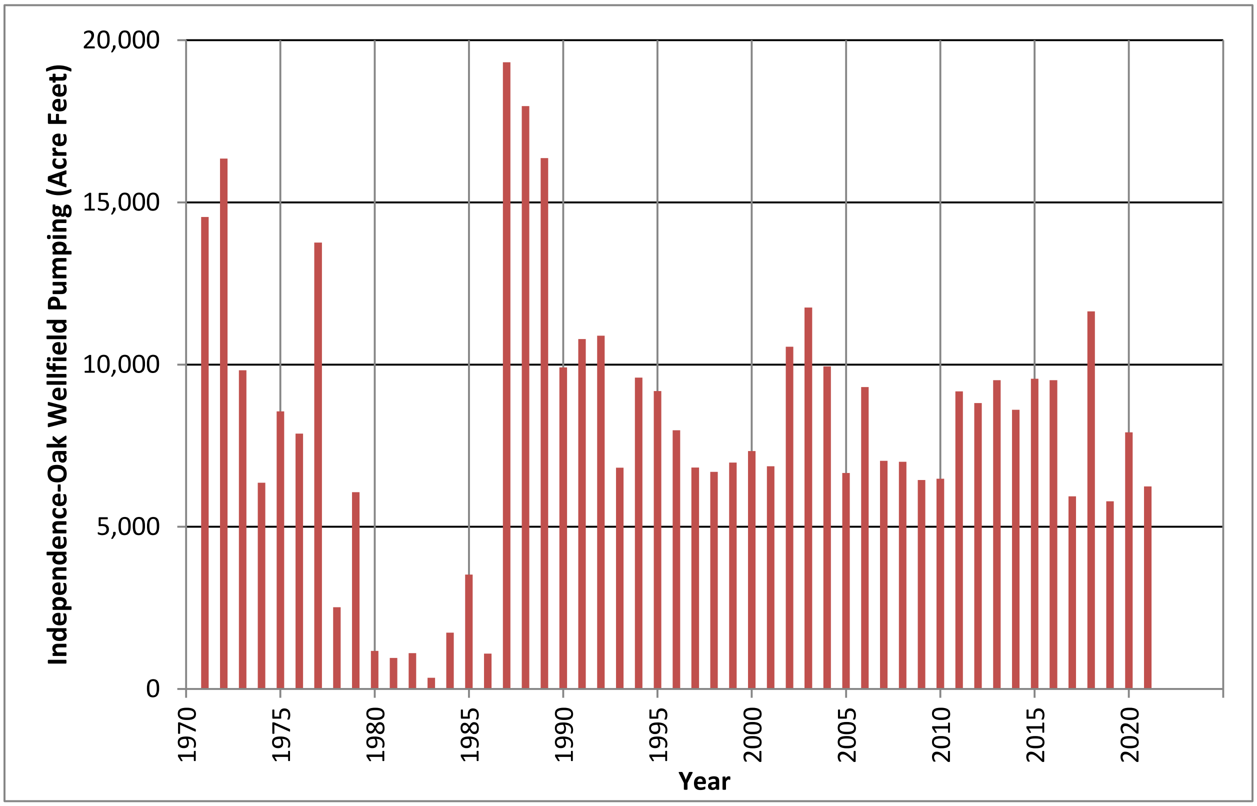


*Figure 3.24. Pumping totals for the Independence-Oak wellfield.*

Water levels were stable through the first decade of 2000 in the wells located in the center of the wellfield (T406, T407, T408, T409), but have declined in response to the increased pumping during the past decade. In 2017 and 2019, the combination of reduced pumping for export and increased recharge from heavy runoff allowed water levels to rebound somewhat; however, as a result of lower runoff during the three-year drought and additional pumping for export in 2020-21, groundwater levels in these wells declined (Table 3.2 and Figures 3.25 and 3.26).

All of the indicator wells in the Independence-Oak Wellfield were below baseline in April 2022 by two to seven feet (Table 3.2). Some of these declines from baseline are due to the additional irrigation associated with the Independence pasture, spring-field and re-greening projects which were implemented after the mid-1980s and, although groundwater levels have declined in many of these wells, the majority are located in Type-E irrigated pastures. However, due to persistent declines in groundwater levels compared with the baseline period along the perimeter of the irrigated pasture lands (T546, T809, T407) ICWD staff has recommended that LADWP pumping for export be minimized in this wellfield, especially during severe droughts like the current one.

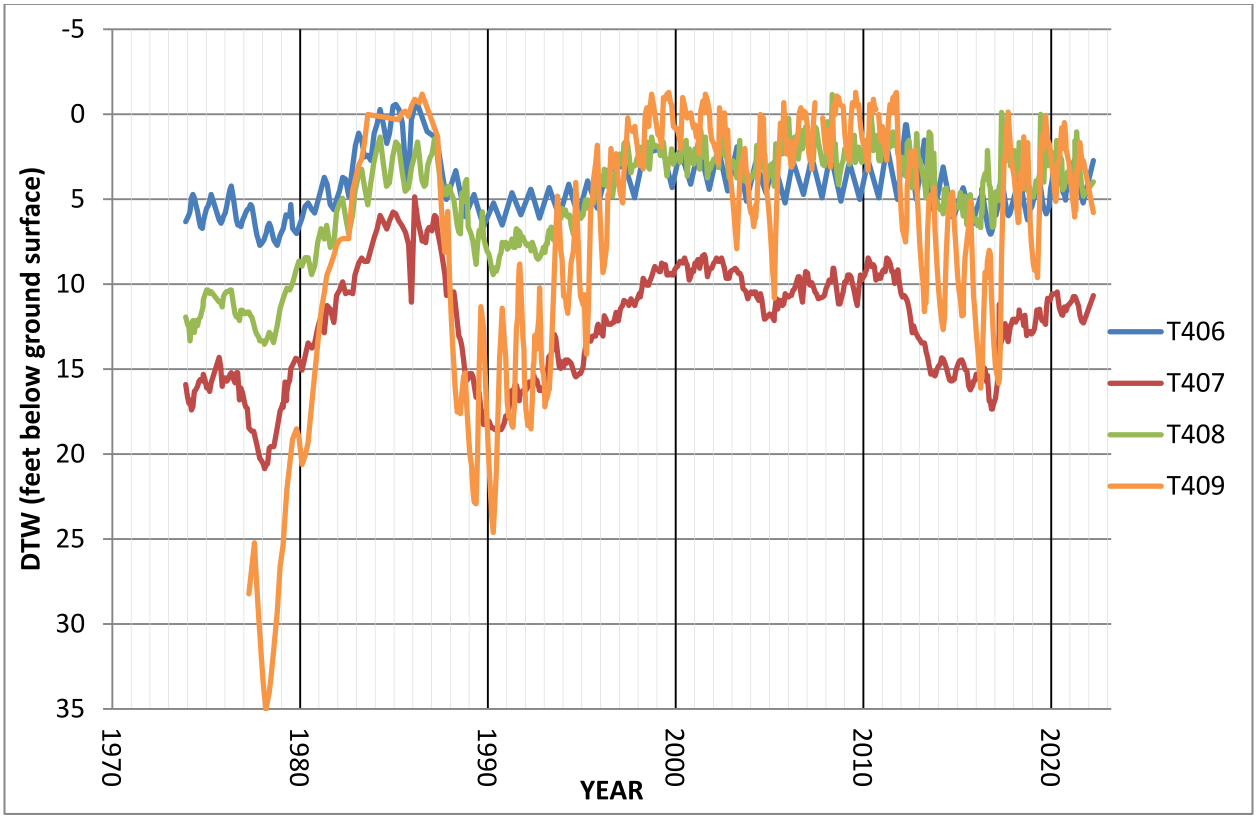


*Figure 3.25. Hydrographs of selected test wells in the Independence-Oak wellfield*

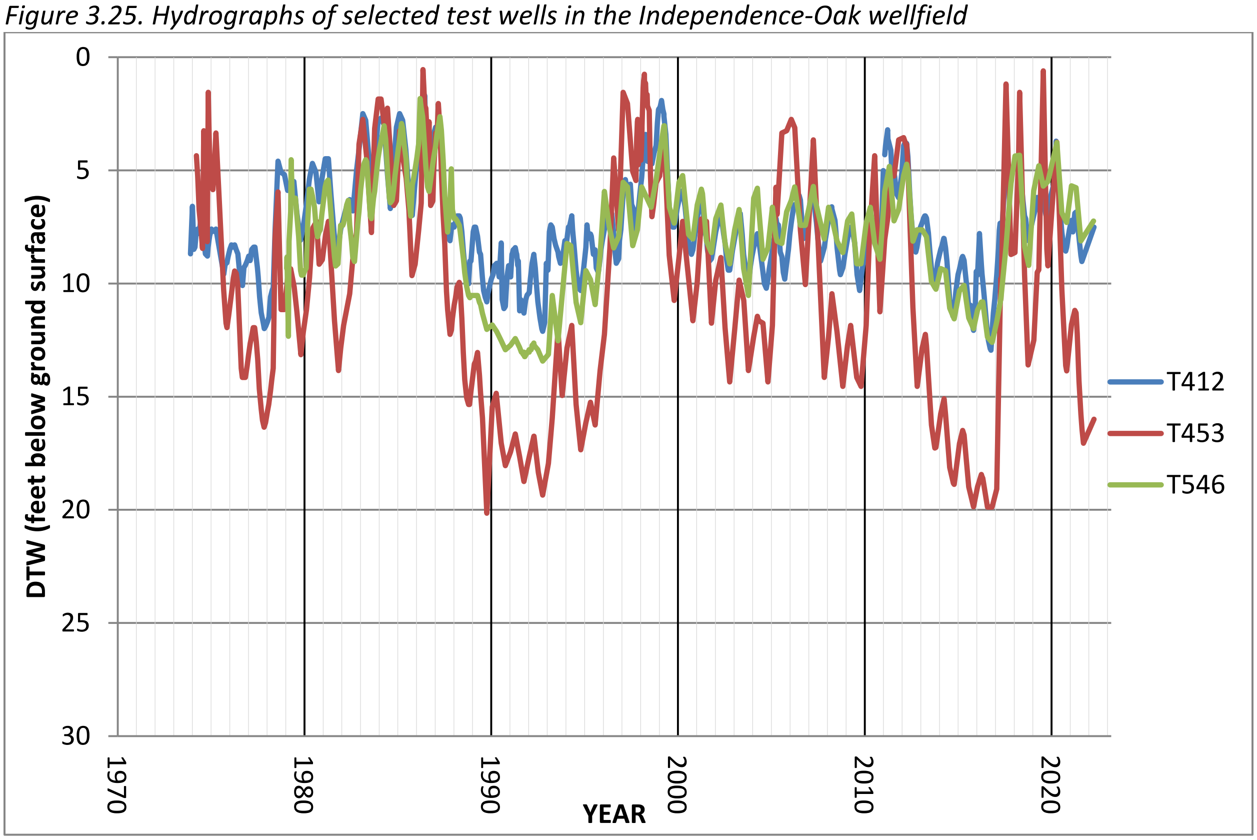


*Figure 3.26. Hydrographs of selected test wells in the Independence-Oak wellfield*

## Symmes-Shepherd Wellfield

In the 1970's and 80's, pumping in the Symmes-Shepherd Wellfield (Figure 3.23) varied considerably (Figure 3.27). Under the Water Agreement, pumping was reduced with many of the wells linked to Green Book OFF status permanent monitoring sites (see Section 4). Approximately 1,200 ac-ft of exempt-status pumping is required to supply one mitigation project (W402). However, pumping for aqueduct supply increased from 2010 to 2016, primarily in the northern part of the wellfield as one of the On/Off sites remained ON during much of that drought. All wells other than W402 did not pump from 2017 through 2020. As of April 2021, On/Off site SS3 went into On-status, and LADWP pumped a limited amount of water from W092 this past year.

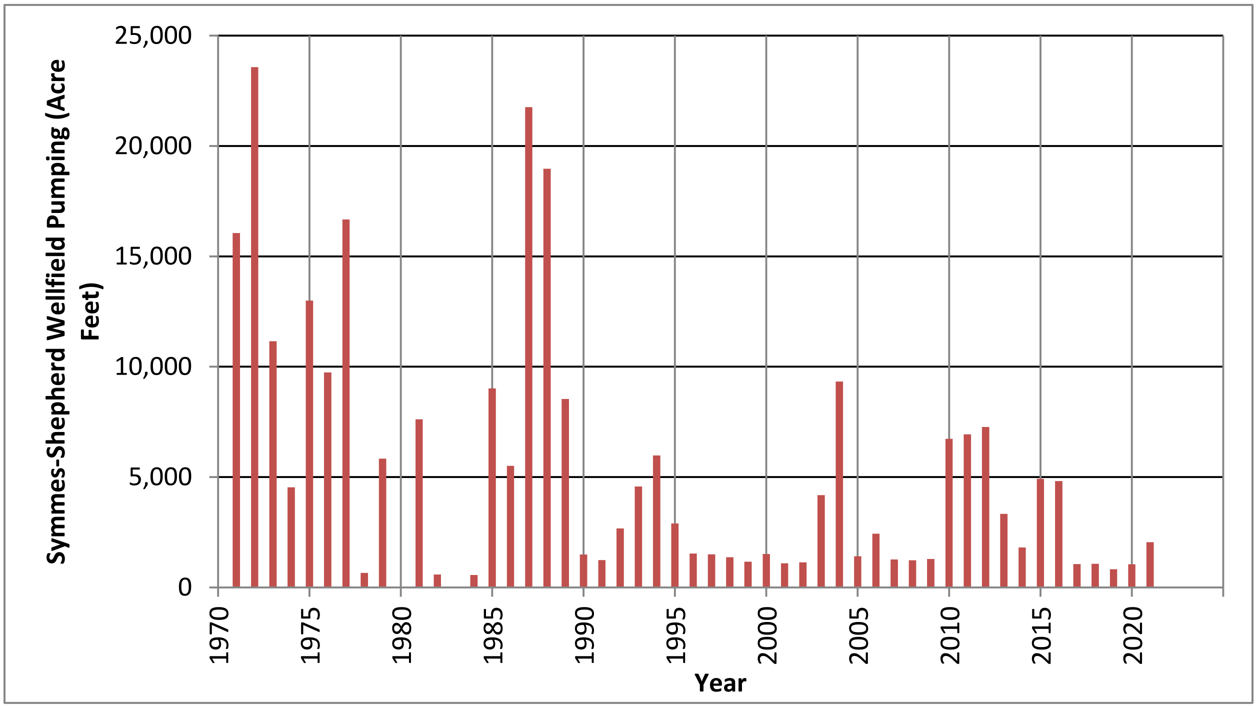


*Figure 3.27. Pumping totals for the Symmes-Shepherd wellfield.*

Groundwater levels were relatively stable in 2021-22, declining slightly overall. Groundwater levels ranged from declines of up to -0.7 feet to one recovery of 0.4 feet (Table 3.2). Some test wells are influenced by their proximity to the Los Angeles Aqueduct (T402-404 and T510-511, see Figures 3.28 and 3.29) and water levels fluctuate little. Test wells T447 and V009G are located near pumping wells in the northwestern portion of the wellfield and water levels responded by rising dramatically due to the reduction in pumping and ample runoff/water spreading in 2017-18. Water levels rose an additional three to four feet during the 2019 runoff year. Although groundwater levels have recovered to some extent, water levels in all monitoring wells continue to be below baseline as of April 2022 (Table 3.2).

Due to the declines in groundwater caused by pumping and the recent drought, Inyo County-owned contaminant monitoring wells at the Independence landfill were dry or within a few feet of becoming dry in spring 2017. Cessation of LADWP export pumping in 2017 combined with recharge has allowed water levels to recover between 15 and 25 feet in these four wells; however, ICWD continues to be concerned with water levels in Symmes-Shepherd that are between two to 14 feet below baseline levels as of 2022.

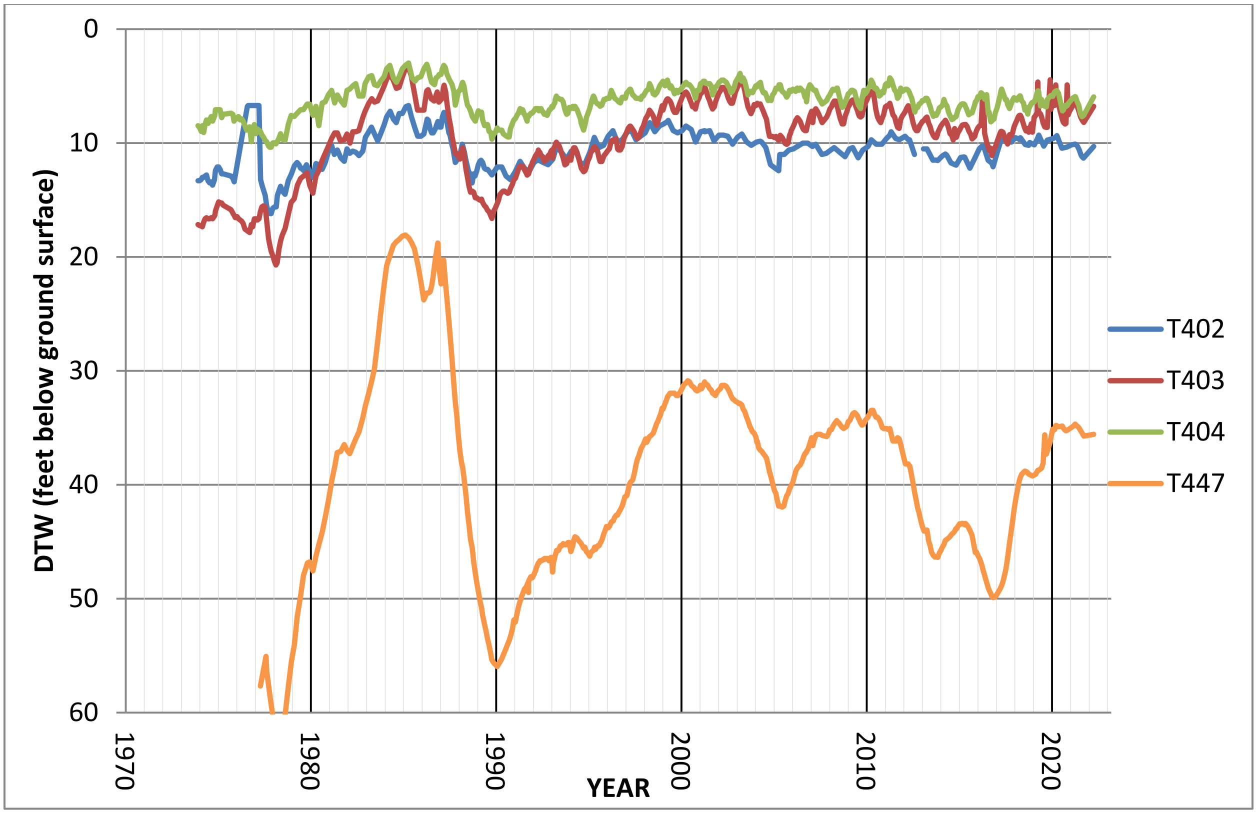


*Figure 3.28 Hydrographs of indicator wells in the Symmes-Shepherd wellfield.*

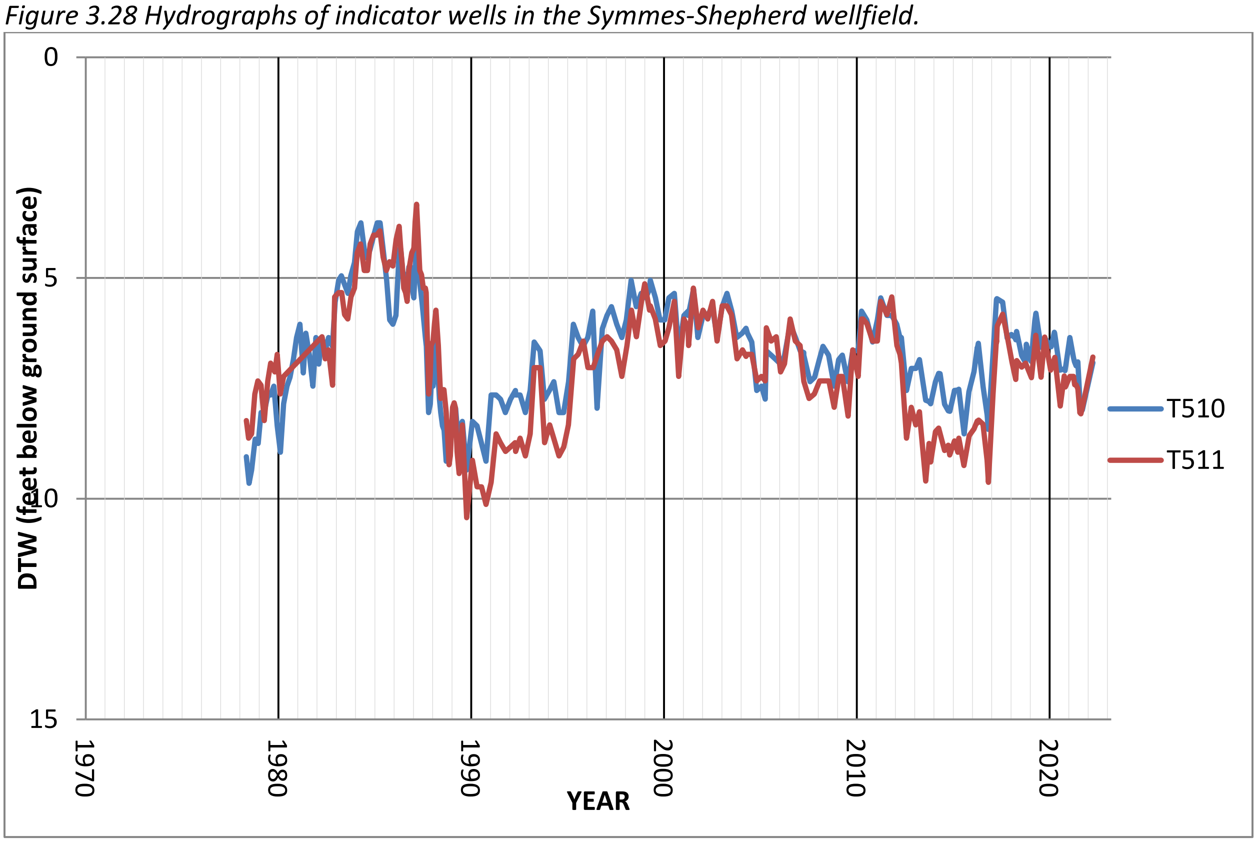


*Figure 3.29 Hydrographs of indicator wells in the Symmes-Shepherd wellfield.*

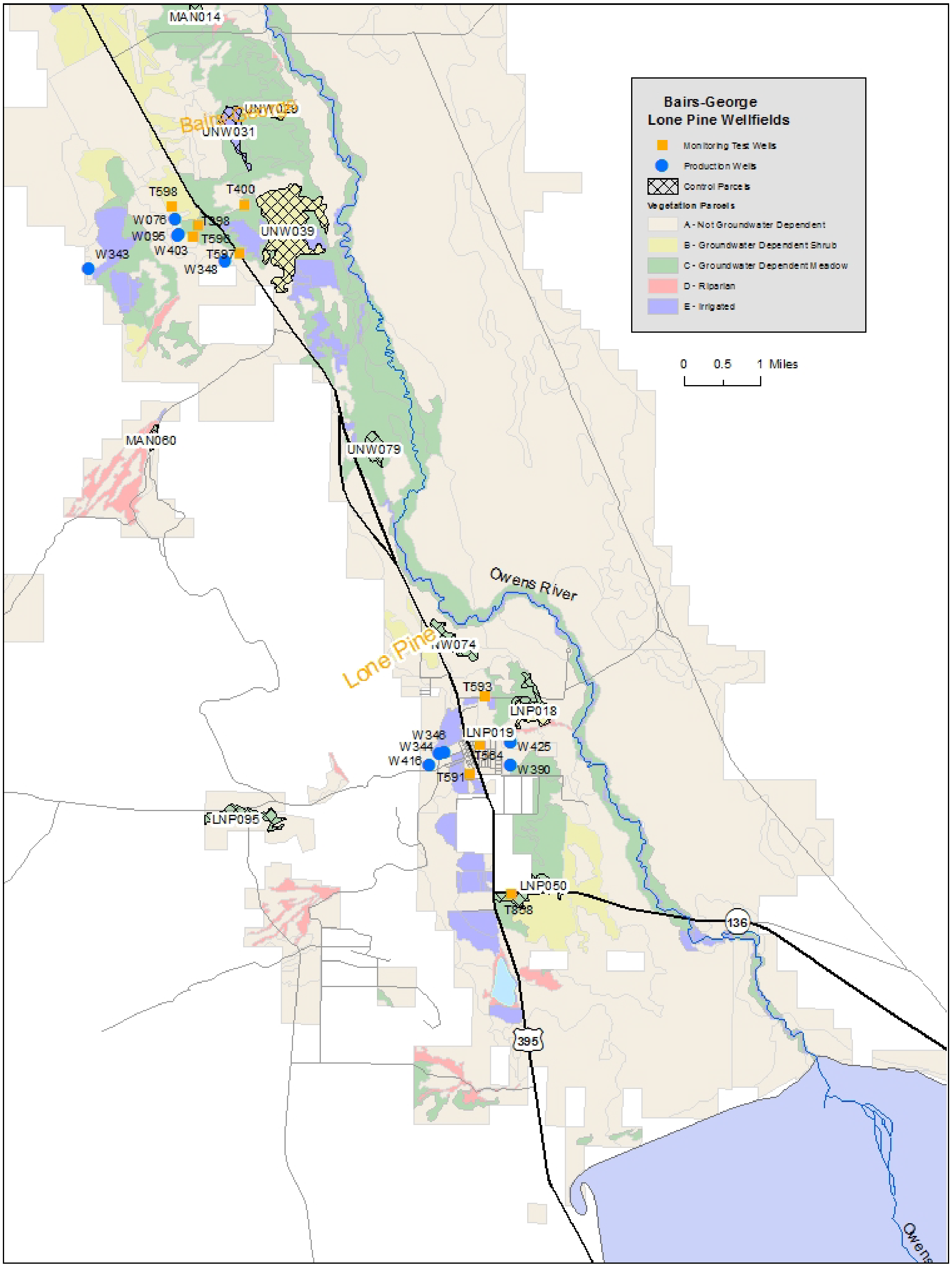


*Figure 3.30. Map of monitoring and LADWP production wells in the Bairs-George and Lone Pine wellfields.*

## Bairs-Georges Wellfield

In the 1970's and 80's, pumping and water levels in the Bairs-George wellfield (Figures 3.30, 3.31) varied considerably, but under the Water Agreement, pumping has been reduced substantially. In dry years when surface flows decline, well W343 is exempt and can be operated to supply irrigated pastures. Since the mid 1990's groundwater levels in the three Indicator wells have been relatively stable. As in other wellfields, pumping for aqueduct supply increased in 2010-2016 compared with the lower amounts during the preceding 20 years. Both in 2018-2019 and 2020-21, LADWP pumped more than 2,000 ac-ft from the wellfield; the most pumping since 1989. Water levels declined several feet in response. As of April 2022, groundwater levels in central Bairs-Georges were at or near baseline levels, but to the north (T598, T812) was more than 4.5 ft below baseline.

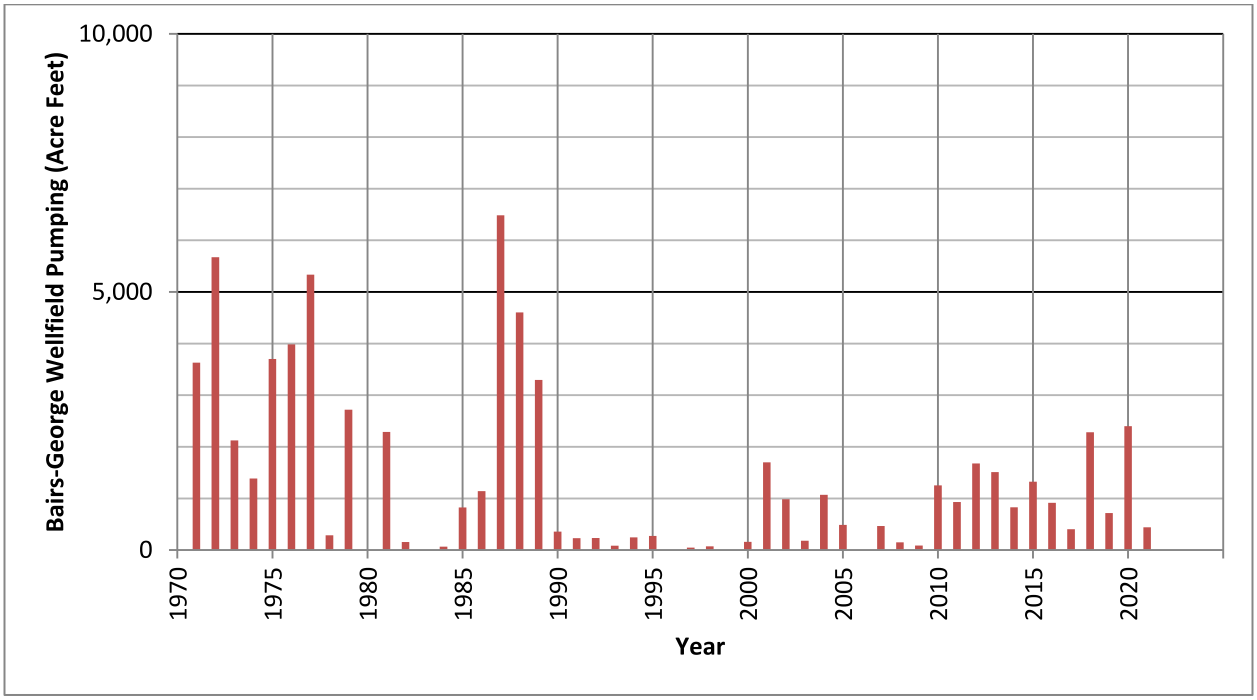


*Figure 3.31. Pumping totals for the Bairs-Georges wellfield.*

The pumping wells are located west of the Los Angeles Aqueduct. Monitoring wells T597 and T398 (Figure 3.32) are in the immediate vicinity of the aqueduct and well T400 is east of the aqueduct. Water table fluctuations in these wells are lessened by the infiltration from the aqueduct, though the water table response from the increase in pumping since 2010 coupled with the 2012-2016 drought is evident in T398 and T597. Pumping effects are less evident in T400.

Monitoring wells T596, T598 and T812 are located west of the aqueduct, and they exhibit larger fluctuations due to pumping (Figure 3.33). Of particular concern are the lower groundwater levels seen from 2012-16 and the recent trend (2020- to date) in T598 and T812. Bairs-Georges is a fault-bounded wellfield (to the west and east) and appears to have more limited recharge than other areas. Relatively low pumping stress in the wellfield and also from southern Symmes-Shepherd appears to have a measureable effect on groundwater levels. ICWD has communicated this concern with LADWP in annual letters regarding the operations plan and also in comments relating to the recent W076 Replacement Well (2021). Pumping in this wellfield and southern Symmes Shepherd should be conservative during multi-year droughts.

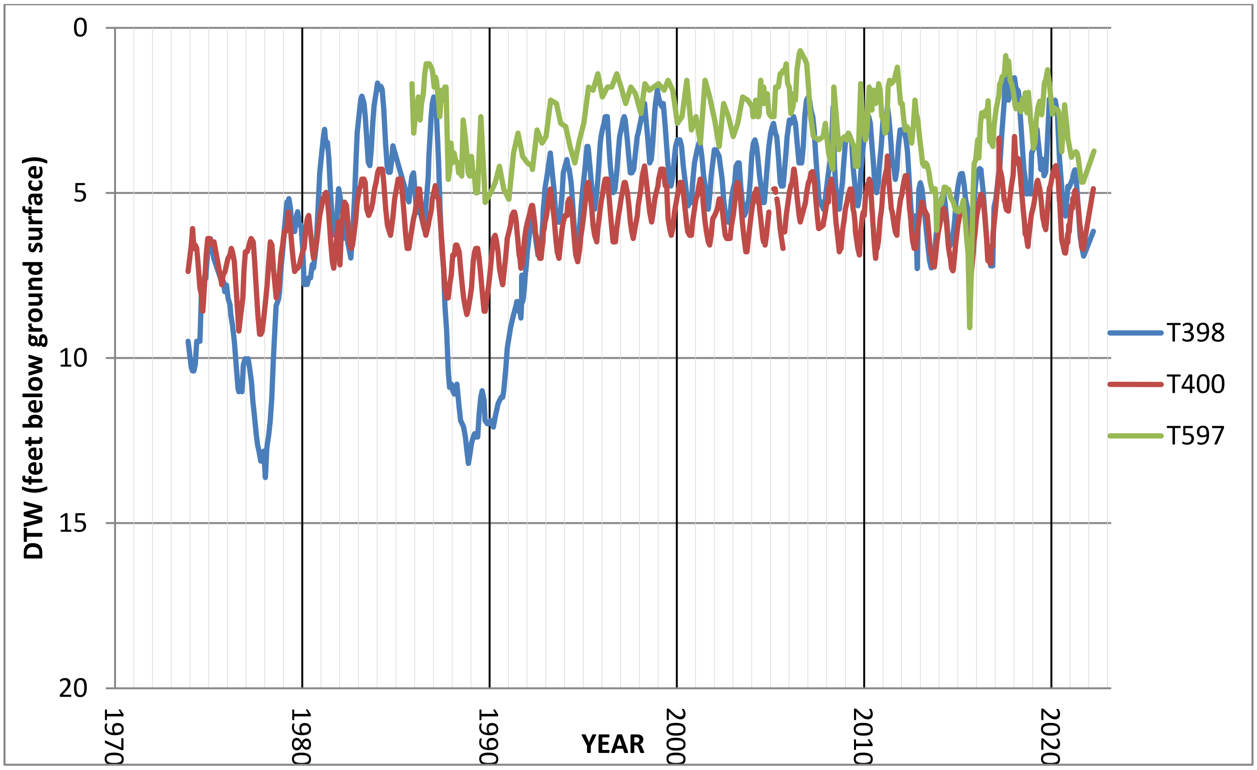


*Figure 3.32. Hydrographs of indicator wells and 597T in the Bairs-Georges wellfield.*

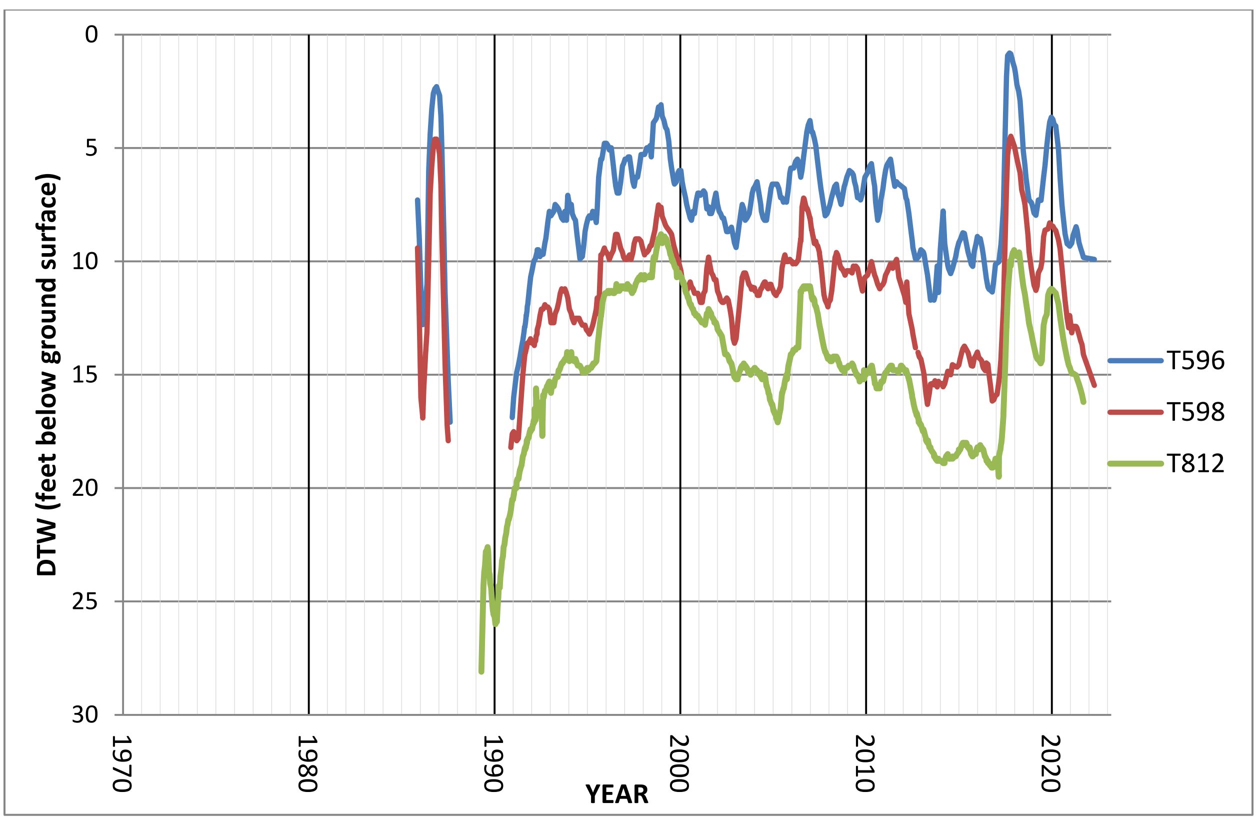


*Figure 3.33. Hydrographs of selected wells in the Bairs-Georges wellfield.*

## Lone Pine Wellfield

Most pumping in the Lone Pine Wellfield (Figure 3.30) has been to supply the town of Lone Pine and one mitigation project (approximately 1,300 ac-ft annually for irrigated agriculture). Pumping increased occasionally (e.g. in 2000) to offset aqueduct water previously supplied to Diaz Lake (Figure 3.34). In 2015, pumping also increased largely due to the operation of a new well (W425) to supply Van Norman field. The previous well (W390) degraded and production declined noticeably in 2008. The new well has capacity to fully supply the project. Because of the relatively constant pumping for sole-source uses, ICWD does not routinely use Indicator wells to analyze the annual operations plan for this wellfield.

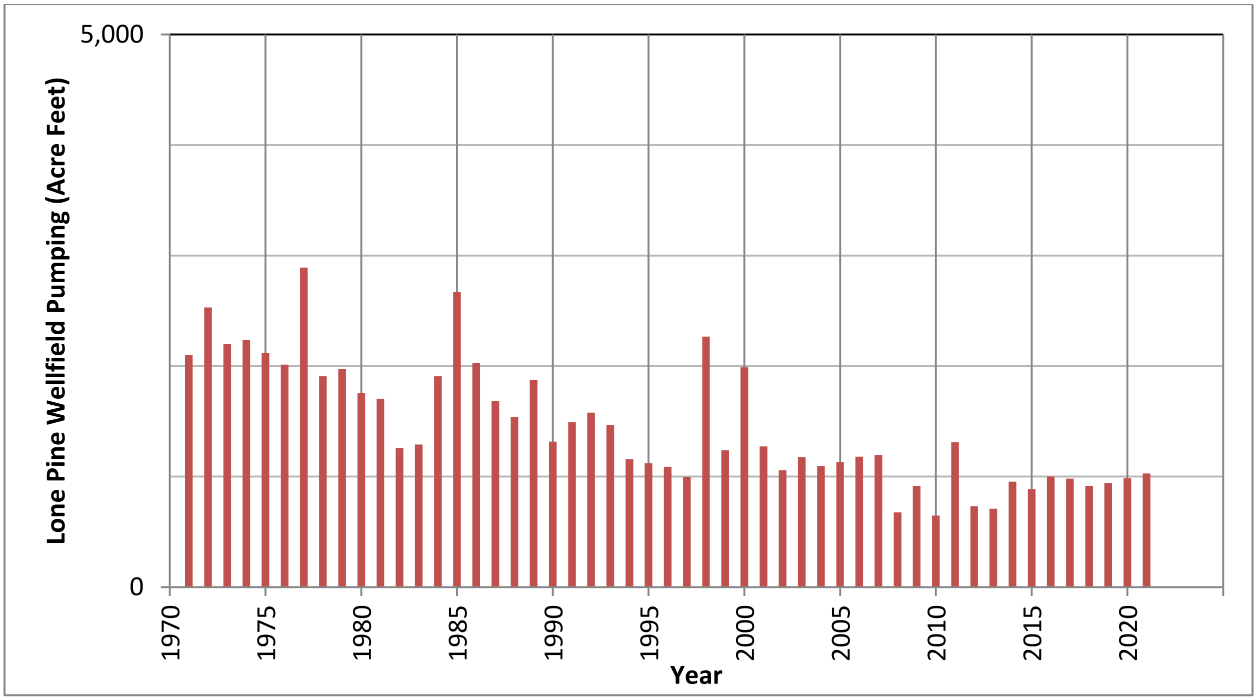


*Figure 3.34. Pumping totals for the Lone Pine wellfield.*

Hydrographs for test wells T564 and T591 are presented in Figure 3.35 to represent water levels near the town of Lone Pine where the LADWP pumping wells are located. Monitoring wells T593 and T858 are located in groundwater dependent vegetation north and south of Lone Pine, respectively. All wells exhibit seasonal fluctuations as well as water table response to decreased recharge due to drought. Pumping effects are not as evident. Water levels rose in 2017 and again in 2019 due to heavy runoff but have declined during the 2020-2022 drought (Figure 3.6 and 3.35).

In early 2010, LADWP tested a new production well, W416, installed to increase aqueduct supply. This new production well has been modified and initial tests to determine well capacity and performance have been completed. However, details of the operational monitoring have yet to be agreed upon by the Technical Group.

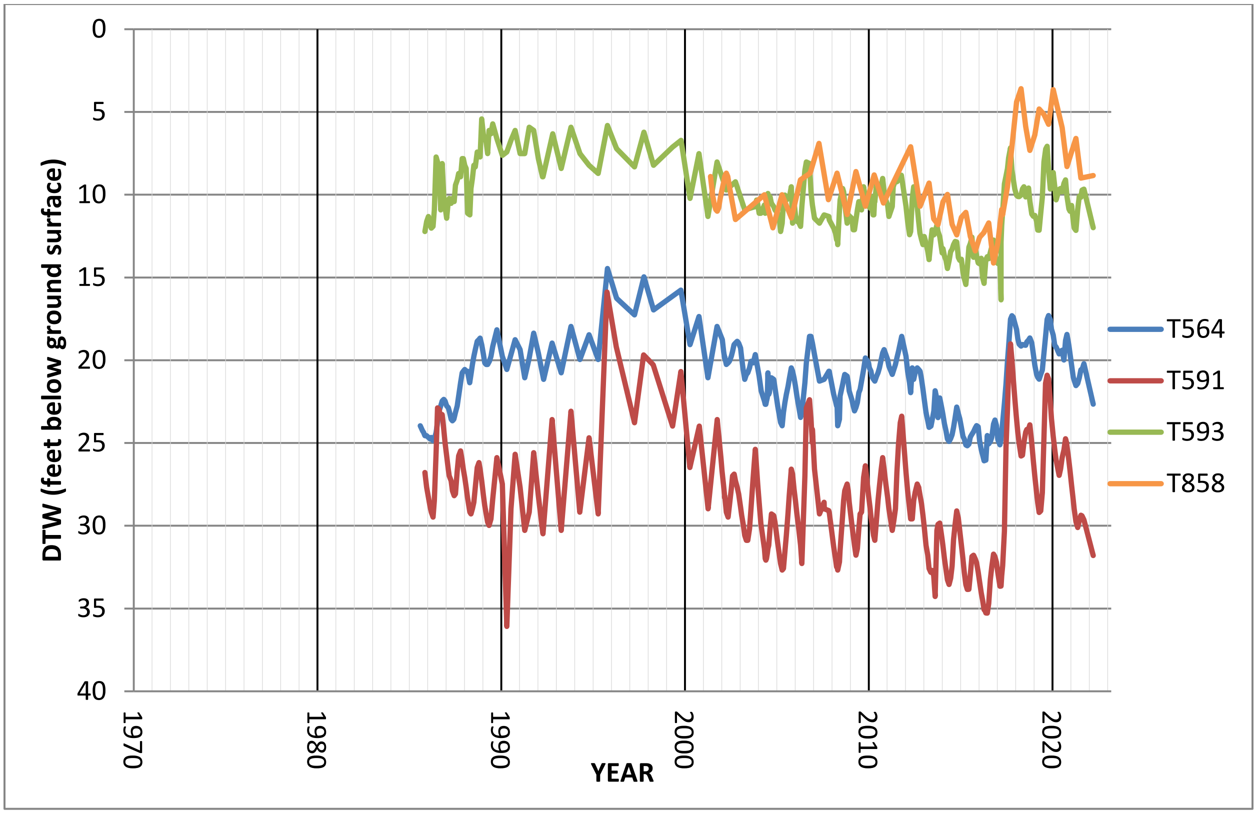

*Figure 3.35. Hydrographs of selected test wells in the Lone Pine wellfield.*

## 2022-23 OPERATIONS PLAN DETAILS

LADWP issued its annual operations plan for the upcoming 2022-23 runoff year on April 20, 2022. The forecasted runoff for the Owens River watershed is 194,300 ac-ft (47% of normal). LADWP provided a range of planned pumping for the year between 67,210 and 86,300 ac-ft (Table 3.3). The pumping, at the low-end, is a mix of sole-source (in valley) and export; under LADWP's high pumping scenario a significant amount of pumping for aqueduct supply is planned (appx. 30,000 ac-ft).

*Table 3.3. Planned LADWP pumping by wellfield for 2022-23 and ICWD reduced pumping.*

| Wellfield | LADWP MIN (67,210 AF) | LADWP MAX (86,300 AF) | In-Valley Min (55,900 AF) | Inyo Reduced (59,540AF) |
|---|---|---|---|---|
| | Ac-ft/year | Ac-ft/year | Ac-ft/year | Ac-ft/year |
| Laws | 8,900 | 10,710 | 8,000 | 8,000 |
| Bishop | 12,000 | 12,000 | 12,000 | 12,000 |
| Big Pine | 20,200 | 23,100 | 18,120 | 18,120 |
| Taboose-Aberdeen | 6,000 | 14,850 | 300 | 2,500 |
| Thibaut-Sawmill | 10,080 | 10,920 | 8,400 | 8,800 |
| Independence-Oak | 7,000 | 8,800 | 6,420 | 6,420 |
| Symmes-Shepherd | 1200 | 2910 | 1,200 | 1500 |
| Bairs-George | 930 | 2,110 | 460 | 1,200 |
| Lone Pine | 900 | 900 | 1,000 | 1000 |
| Sum | 67,210 | 86,300 | 55,900 | 59,540 |

The Water Department analyzed the effect of the operations plan on groundwater levels in the Owens Valley using regression models for several monitoring wells (Table 3.4). Most models rely on measured DTW in April 2022, planned wellfield pumping for the entire runoff year, and Owens Valley runoff to predict water levels next April. For several wells, Owens Valley runoff was not a statistically significant variable in the regression model. Water levels in those wells are correlated with pumping, and the models are still useful for evaluating the pumping plan. Also, models in Laws use the amount of water diverted from the Owens River into the McNally canals as the variable associated with recharge instead of runoff. Water spreading is not planned for Laws in 2022-23 (Table 2.5 of LADWP's Draft Plan), so the McNally Canals were assumed to have no flow for the Laws regression models.

The models used by the Water Department to analyze the annual operations plan predict water levels one year in the future (e.g. April 2022 to 2023) based on annual pumping for each wellfield. Four pumping scenarios are presented in Table 3.4: minimum pumping for In-Valley uses, the upper and lower pumping limits from LADWP's proposed Draft Plan, and ICWD's recommended pumping.

*Table 3.4. Predicted water level changes at indicator wells and monitoring sites for: i) LADWP's proposed minimum pumping, ii) in-valley minimum pumping iii) LADWP's proposed maximum pumping and iv) ICWD's reduced pumping. Negative DTW values denote a decline. Predictions in this table are made to 0.1 ft. Extra digits are presented for rounding transparency.*

| Station ID, Monitoring site | LADWP MIN 67,210 ac-ft 2023 vs 2022 | LADWP MIN 67,210 ac-ft 2023 vs Baseline | LADWP MAX 86,300 ac-ft 2023 vs 2022 | LADWP MAX 86,300 ac-ft 2023 vs Baseline |
|---|---|---|---|---|
| | (DTW change ft) | (DTW change ft) | (DTW change ft) | (DTW change ft) |
| ***Laws*** | | | | |
| 107T | -2.28 | -8.10 | -2.89 | -8.70 |
| 434T | -0.94 | -0.83 | -1.20 | -1.09 |
| 436T | -1.97 | -2.82 | -2.23 | -3.08 |
| 438T | -0.04 | -6.26 | -0.26 | -6.48 |
| 490T | -0.87 | -3.82 | -0.98 | -3.93 |
| 492T | -3.99 | -2.23 | -4.96 | -3.20 |
| 795T | -9.08 | -11.55 | -9.94 | -12.41 |
| V001g | -3.35 | -4.16 | -3.85 | -4.66 |
| 574T | -0.87 | -3.43 | -1.15 | -3.70 |
| ***Big Pine*** | | | | |
| 425T | -1.96 | -0.55 | -2.46 | -1.05 |
| 426T | -1.19 | -1.44 | -1.47 | -1.71 |
| 469T | -0.86 | -1.61 | -1.13 | -1.88 |
| 572T | -2.74 | -1.14 | -3.28 | -1.68 |
| 798T, BP1 | -3.98 | -1.01 | -4.45 | -1.48 |
| 799T, BP2 | -0.48 | -1.54 | -0.74 | -1.80 |
| 567T, BP3 | -2.30 | -1.74 | -2.75 | -2.18 |
| 800T, BP4 | -1.49 | 0.61 | -2.08 | 0.02 |
| ***Taboose Aberdeen*** | | | | |
| 417T | -0.72 | -2.96 | -3.03 | -5.28 |
| 418T | -0.36 | -0.52 | -1.36 | -1.52 |
| 419T, TA1 | -1.05 | -0.71 | -3.44 | -3.09 |
| 421T | -1.53 | -2.29 | -3.95 | -4.70 |
| 502T | -0.62 | -3.74 | -1.73 | -4.85 |
| 504T | -1.38 | -0.36 | -4.34 | -3.32 |
| 505T | -0.65 | -3.04 | -3.01 | -5.40 |
| 586T, TA4 | -0.50 | 0.01 | -2.48 | -1.96 |
| 801T, TA5 | 0.23 | -1.84 | -0.31 | -2.39 |
| 803T, TA6 | -0.90 | -2.80 | -3.09 | -4.99 |
| ***Thibaut Sawmill*** | | | | |
| 415T | -1.24 | 4.15 | -1.89 | 3.50 |
| 507T | 0.48 | -0.55 | 0.34 | -0.68 |
| 806T, TS2 | -0.70 | 1.49 | -0.86 | 1.33 |
| ***Independence- Oak*** | | | | |
| 406T | -0.49 | -3.03 | -0.61 | -3.16 |
| 407T | 0.09 | -4.42 | -0.52 | -5.03 |
| 408T | 0.17 | -2.14 | -0.24 | -2.55 |
| 409T | -1.57 | -7.04 | -2.82 | -8.29 |
| 546T | -1.14 | -5.72 | -1.41 | -5.99 |
| 809T, IO1 | -0.94 | -7.78 | -1.56 | -8.40 |
| ***Symmes Shepherd*** | | | | |
| 402T | 0.01 | -2.96 | -0.18 | -3.16 |
| 403T | 0.27 | -1.76 | -0.27 | -2.30 |
| 404T | 0.53 | -2.27 | 0.33 | -2.47 |
| 447T | -0.74 | -14.98 | -1.99 | -16.22 |
| 510T | 0.55 | -2.12 | 0.36 | -2.31 |
| 511T | 0.38 | -2.45 | 0.18 | -2.65 |
| V009G, SS1 | -0.27 | -11.12 | -1.38 | -12.23 |
| ***Bairs George*** | | | | |
| 398T | 1.19 | -0.23 | -0.42 | -1.84 |
| 400T | -0.03 | -0.02 | -0.33 | -0.32 |
| 812T | -0.44 | -5.09 | -1.83 | -6.48 |

| Station ID, Monitoring site | In Valley MIN 55,900 ac-ft 2023 vs 2022 | In Valley MIN 55,900 ac-ft 2023 vs Baseline | ICWD Reduced 59,540 ac-ft 2023 vs 2022 | ICWD Reduced 59,540 ac-ft 2023 vs Baseline |
|---|---|---|---|---|
| | (DTW change ft) | (DTW change ft) | (DTW change ft) | (DTW change ft) |
| ***Laws*** | | | | |
| 107T | -1.98 | -7.80 | -1.98 | -7.80 |
| 434T | -0.81 | -0.70 | -0.81 | -0.70 |
| 436T | -1.84 | -2.69 | -1.84 | -2.69 |
| 438T | 0.06 | -6.16 | 0.06 | -6.16 |
| 490T | -0.81 | -3.76 | -0.81 | -3.76 |
| 492T | -3.51 | -1.75 | -3.51 | -1.75 |
| 795T | -8.66 | -11.12 | -8.66 | -11.12 |
| V001g | -3.11 | -3.92 | -3.11 | -3.92 |
| 574T | -0.74 | -3.30 | -0.74 | -3.30 |
| ***Big Pine*** | | | | |
| 425T | -1.61 | -0.20 | -1.61 | -0.20 |
| 426T | -0.99 | -1.24 | -0.99 | -1.24 |
| 469T | -0.67 | -1.42 | -0.67 | -1.42 |
| 572T | -2.36 | -0.76 | -2.36 | -0.76 |
| 798T, BP1 | -3.64 | -0.67 | -3.64 | -0.67 |
| 799T, BP2 | -0.30 | -1.36 | -0.30 | -1.36 |
| 567T, BP3 | -1.99 | -1.42 | -1.99 | -1.42 |
| 800T, BP4 | -1.06 | 1.04 | -1.06 | 1.04 |
| ***Taboose Aberdeen*** | | | | |
| 417T | 0.78 | -1.47 | 0.20 | -2.04 |
| 418T | 0.29 | 0.12 | 0.04 | -0.13 |
| 419T, TA1 | 0.49 | 0.83 | -0.10 | 0.24 |
| 421T | 0.03 | -0.73 | -0.57 | -1.33 |
| 502T | 0.09 | -3.03 | -0.19 | -3.30 |
| 504T | 0.53 | 1.54 | -0.21 | 0.81 |
| 505T | 0.88 | -1.51 | 0.29 | -2.10 |
| 586T, TA4 | 0.77 | 1.28 | 0.28 | 0.79 |
| 801T, TA5 | 0.58 | -1.49 | 0.45 | -1.63 |
| 803T, TA6 | 0.51 | -1.39 | -0.03 | -1.93 |
| ***Thibaut Sawmill*** | | | | |
| 415T | 0.06 | 5.45 | -0.25 | 5.14 |
| 507T | 0.75 | -0.27 | 0.69 | -0.34 |
| 806T, TS2 | -0.37 | 1.83 | -0.44 | 1.75 |
| ***Independence- Oak*** | | | | |
| 406T | -0.45 | -2.99 | -0.45 | -2.99 |
| 407T | 0.29 | -4.22 | 0.29 | -4.22 |
| 408T | 0.30 | -2.01 | 0.30 | -2.01 |
| 409T | -1.17 | -6.64 | -1.17 | -6.64 |
| 546T | -1.06 | -5.64 | -1.06 | -5.64 |
| 809T, IO1 | -0.74 | -7.58 | -0.74 | -7.58 |
| ***Symmes Shep.*** | | | | |
| 402T | 0.01 | -2.96 | -0.02 | -3.00 |
| 403T | 0.27 | -1.76 | 0.17 | -1.86 |
| 404T | 0.53 | -2.27 | 0.50 | -2.31 |
| 447T | -0.74 | -14.98 | -0.96 | -15.20 |
| 510T | 0.55 | -2.12 | 0.52 | -2.15 |
| 511T | 0.38 | -2.45 | 0.34 | -2.48 |
| V009G, SS1 | -0.27 | -11.12 | -0.47 | -11.32 |
| ***Bairs George*** | | | | |
| 398T | 1.82 | 0.40 | 0.82 | -0.60 |
| 400T | 0.09 | 0.10 | -0.10 | -0.09 |
| 812T | 0.12 | -4.53 | -0.76 | -5.41 |

The analysis of water level changes if minimum pumping were conducted for specific uses in the Owens Valley is included as a basis for comparison with the higher levels of pumping in LADWP's proposed and Inyo County's reduced pumping amounts. Minimum pumping is not a constant and varies depending on runoff availability to supply irrigation or mitigation projects with surface water instead of groundwater where possible.

The upper limit of the pumping proposed in the Draft Plan is used to evaluate LADWP's proposed pumping because (1) it represents the maximum impact on the water table that the Draft Plan could have, and (2) except in high runoff conditions, LADWP has generally pumped near the upper end of the proposed range.

ICWD's analysis of the Draft Plan and recommendations for reduced pumping are based on the goals and principles of the Water Agreement, the status of individual pumping wells according to Green Book soil water triggers, groundwater dependent vegetation conditions monitored by the Technical Group, water table conditions in each well field, and groundwater uses within each wellfield. ICWD's recommended reduced pumping amount for 2022-23 is 59,540 ac-ft.

Average groundwater levels are expected to decline in all wellfields under LADWP's 2022-23 maximum proposed pumping (Table 3.4). The average groundwater level change in the 46 Indicator wells is predicted to be a decline of -1.9 ft under LADWP's maximum pumping scenario, a decline of -0.6 ft with in-valley minimum pumping, and a decline of -0.8 ft with the ICWD reduced pumping amount. By April 2023, under LADWP's maximum pumping scenario, average predicted water levels will be below baseline in all wellfields except Thibaut-Sawmill. In Big Pine and Bairs-George average water levels would be 1-3 feet below baseline; and in Laws, Taboose-Aberdeen, Independence-Oak and Symmes-Shepard average water levels would be 3-6 feet below baseline. Concerns and recommendations to LADWP's proposed 2022-23 pumping plan were described in the Inyo County Water Department's April 30, 2022 letter to LADWP. A summary of these comments are presented here:

The extraordinarily high amount of runoff in 2017-2018 and 2019-20 promoted a substantial rise in the water table in most areas of the Owens Valley; however, an ongoing drought has reached year three and groundwater levels have fallen several feet in most wellfields. ICWD's analysis and recommendations are based on water table conditions in each well field relative to baseline water levels, groundwater uses within each wellfield, and groundwater dependent vegetation conditions. This year, 2022-23, will mark the third year of drought and the past two years have seen the lowest runoff on record, both under 50% of the long-term average. Soil moisture levels declined slightly last year as described in Section 4 of the annual report, and the majority of On/Off permanent monitoring sites are now on partially or disconnected from water table moisture access.

As in previous years, ICWD does not think it is justified to pump groundwater for aqueduct supply to Los Angeles near vegetation that is measurably and chronically below baseline levels. Adjusting pumping to maintain a shallow water table in some areas of groundwater-dependent vegetation in 2022-23 is necessary to stabilize declines since the onset of the present drought and to potentially avoid impacts should this severe drought resemble recent lengthy droughts like those experienced multiple times during the past 35 years. Shallow groundwater levels are particularly important to maintain perennial grasses which have seen more substantial declines than overall cover; this is especially relevant since preventing conversion of grass-dominated meadows to shrub communities is one of the components of the LTWA.

The primary rationale for ICWD"s reduced pumping recommendation was to allow pumping for in-valley uses like irrigation, town water supply and mitigation projects and also to keep groundwater levels stable in 2022-23. In Laws, Big Pine and Independence-Oak, water levels decline even with in-valley uses, so no additional pumping was recommended. In Thibaut-Sawmill, Symmes-Shepherd, and Bairs Georges, a few hundred acre-feet of pumping in excess of the minimum would still maintain groundwater levels year-to-year; and in Taboose-Aberdeen, a 2,200 additional acre-feet of pumping would also result in stable water levels. ICWD's reduced pumping amount of 59,540 ac-ft is a more prudent recommendation which allows the multiple goals of the Water Agreement to be met with a more responsible and sustainable approach: groundwater would be pumped primarily for use in Owens Valley with some export to Los Angeles, while maintaining hydrologic conditions conducive to vegetation health during an exceptionally dry year.

The Water Department's full comment letter with detailed discussion of each wellfield can be found online at: https://www.inyowater.org/documents/pumping/dwp-annual-operations-plans/

## EVALUATION OF 2021-2022 DEPTH TO WATER PREDICTIONS

As noted in the previous sub-section, ICWD routinely uses linear regression models for Indicator wells to predict the effects of pumping on DTW as part of its analysis of LADWP's annual operations plans. ICWD staff conducts an annual audit which examines the accuracy of these models by comparing the predictions with DTW measurements collected the following year on April 1. The regression models were constructed from historical data for wellfield pumping, Owens Valley runoff, and current water levels. The models in Laws rely on an estimate of the diversions into the McNally canals instead of Owens Valley runoff as the variable related to groundwater recharge. For four of the permanent monitoring sites, a second model was used that relies on predicted DTW in a nearby indicator well that responds similarly to pumping and runoff. The models were originally developed by Harrington (1998) and Steinwand and Harrington (2003) and have been updated periodically. These reports are available on the Water Department website.

This analysis of the predictions includes uncertainty in the input variables (runoff forecast and planned pumping) as well as uncertainty in the empirical-based models. Model uncertainty includes all management actions and environmental conditions not captured in the regression model e.g. atypical recharge or pumping operations near one of the test wells. Predictions for 46 Indicator wells made in April 2021 were compared to actual April 2022 DTWs for this report.

The 2022 predicted DTW values were based on the higher pumping amount planned by LADWP in their 2021-22 pumping plan (78,980 ac-ft). Actual pumping was approximately 79% (62,518 ac-ft) of the planned amount (Table 3.1). Wellfield pumping totals for the year differed by as much as 6,500 acre feet of the planned amounts in wellfields with indicator wells. The discrepancies between planned and actual pumping decrease the accuracy of predictions. The model predictions also rely on forecasted Owens Valley runoff and unavoidably include the uncertainty in that prediction.

The LADWP runoff forecast has tracked actual runoff with accuracy since 1994. However, four of the past six years have seen runoff extremes at both the high and low end of the historic data. In 2018 and 2019 runoff years, LADWP's forecast under-predicted runoff by 75,000 and 81,000 ac-ft, respectively (second and third largest errors since 1994, Figure 3.1). These consecutive under-predictions were possibly due to continued water hold-over from the record 2017-18 winter (second largest) and the large amounts of surface water spread in the valley. Shallow groundwater levels in the Owens Valley, not widely seen since the 1980s, may also have contributed to LADWP's under-predictions. This past runoff year LADWP's prediction was also less accurate (81% of actual, Figure 3.1). The forecasted 2021-22 runoff was well below average (55%) and the combination of dry antecedent conditions and usually warm spring may have contributed to the forecast error compared to the actual runoff (45%).

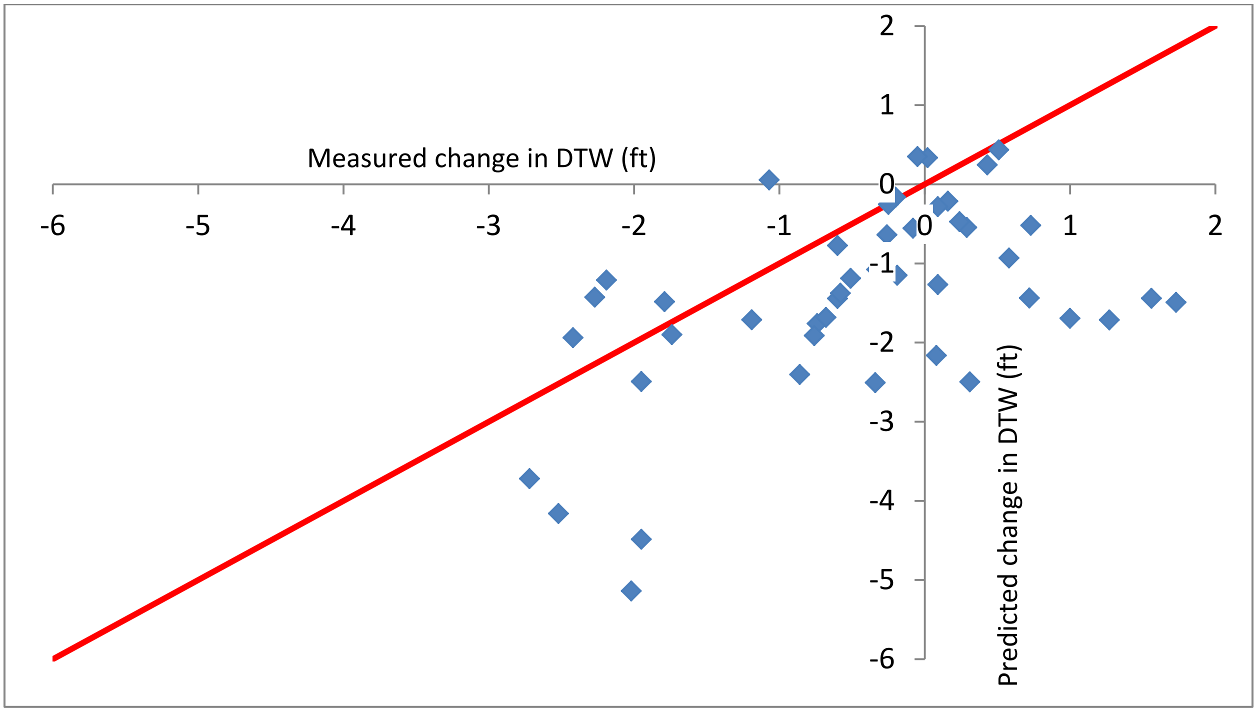


*Figure 3.36. Measured and predicted change in DTW from April 2021 to April 2022 for 46 indicator wells. The solid red line is the 1:1 line. Negative values denote decline in water level. Data points right of the redline indicate actual groundwater level changes were more positive (shallower) than predicted.*

Model performance in 2021-22 was less accurate than previous years due to the combination of less runoff and significantly less pumping than forecast. Measured versus predicted change in DTW are plotted in Figure 3.36. If the models were perfect predictors, the points would fall on the red 1:1 line. Actual groundwater levels were shallower in 38 of the 46 wells due to less pumping than predicted. The average absolute deviation between 2021 water level predictions and 2022 measured water levels was 1.3 ft. More than two-thirds of the Indicator predictions (32 of 46) were within 1.5 ft of the actual deviation. This measure of model performance is similar to prior years.

Despite model predictions being less accurate then past years, the principal sources of error in 2021-22 predictions were a result of inaccurate inputs (less runoff and pumping) but not in the regression models' formulas themselves. For confirmation, the 2021 prediction models were re-run with actual values of runoff and pumping (Figure 3.37). The subsequent model performance was improved, with the average absolute difference between predicted and modeled DTW of approximately 1.1 feet. Model predictions were within 1.5 ft of actual in more than 78% of the wells (38 of 46), and within 1 ft of actual in 60% of the wells (28 of 46). Overall, actual groundwater levels were still shallower than predicted in a majority of the wells (31).

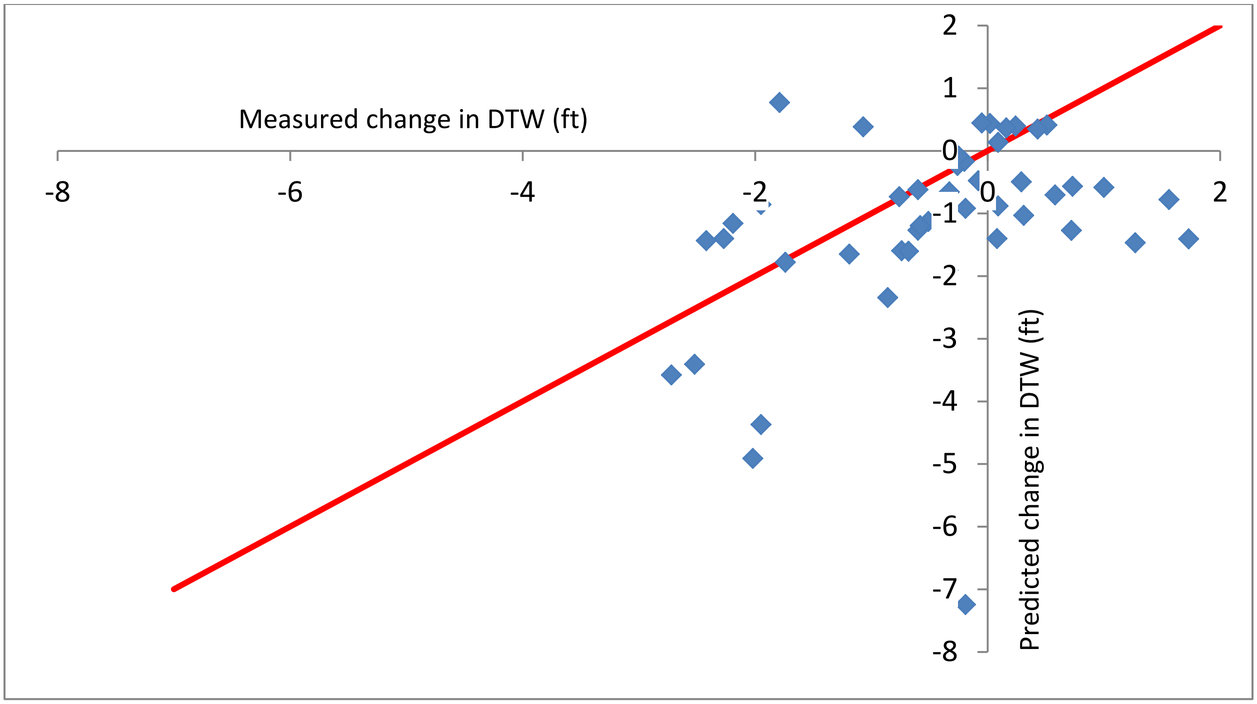


*Figure 3.37. Corrected measured and predicted change in DTW from April 2021 to April 2022 for 46 indicator well using actual pumping and runoff values. The solid red line is the 1:1 line. Negative values denote decline in water level. Data points right of the redline indicate actual groundwater level changes were more positive (shallower) than predicted.*

## References


Harrington, R. F., Multiple regression modeling of water table response to groundwater pumping and runoff, Inyo County Water Department report, 1998.

Steinwand, A.L, and R.F. Harrington. 2003. Simulation of water table fluctuations at permanent monitoring sites to evaluate groundwater pumping. Report to the Inyo/Los Angeles Technical Group, February 25, 2003.