Annual Report Regarding OWRD Groundwater Monitoring for U.S. Bureau of Reclamation Project Area in the Upper Klamath Basin

Calendar Year 2024

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Oregon Water Resources Department

OREGON
WATER RESOURCES
DEPARTMENT



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Introduction

The Oregon Water Resources Department (OWRD) has been contracted to provide technical assistance to the U.S. Bureau of Reclamation (USBR) during Federal Fiscal Years (FFY) 2021-2026 under agreement R22AP00039. Technical assistance includes collection and assessment of groundwater use and groundwater level data from wells in Oregon associated with, and proximal to, the USBR's Klamath Project Area ("Project Area") in the Upper Klamath River Basin. This report summarizes water-use data and groundwater level data for Calendar Year 2024.

Background

Prior to 2015, the Klamath Water and Power Agency (KWAPA) managed water bank operations through the Water Use Mitigation Program (WUMP), under the guidance of the USBR. This program was used to augment diversion of surface water for the purpose of irrigation with groundwater pumping. The primary motivation was to enhance instream flows for fisheries during spring and summer. Groundwater users with valid rights, including emergency drought permits, were offered financial incentives to pump groundwater in lieu of surface water, either for land application or pumping directly to USBR-operated canals, and to idle agricultural lands to conserve water. OWRD has provided technical assistance and field presence for the groundwater use and water level monitoring component of the WUMP since 2010. KWAPA was dissolved in 2016 and the water bank program is no longer in effect, but OWRD continues to collect water use data under USBR contracts.

A Governor's drought declaration in 2010 allowed OWRD to issue emergency drought permits for Oregon irrigators. During the 2010 irrigation season the USBR, KWAPA, and area irrigators relied extensively on supplemental groundwater to augment limited surface water supplies, pumping approximately 141,000 acre-feet (AF) of groundwater in Oregon and California. Drought declarations and emergency drought water use permits were also issued in 2012 through 2015, 2018, 2020, and 2021. In 2022, OWRD issued 1 emergency drought permit in the Project Area with limited duty and denied drought permits in areas that had seen groundwater level declines (over 20 feet since the early 2000s). This is in contrast with the 47 drought permits approved in 2021, which was the highest number since 2010 (Table 1). There was no drought declaration in Klamath County in 2023 or 2024 and no drought permits were issued by OWRD in the Project Area.

Table 1: Number of drought permits issued each year in the Project Area (1992-2024).

Drought Year[a]	Number of Drought Permits	Total Acres	Water Applied for (acre-feet)	Metered Use on Drought Permits (acre-feet)
1992	20	3,546	10,639	-
1994	3	535	1,604	-
2001	90	19,630	58,435	6,682
2004	5	12,941	38,823	22,262
2005	6	28,934	67,708	34,643
2010	61	36,097	99,381	47,538
2012	2	145	363	828
2013	15	5,712	16,627	6,069
2014	41	18,760	36,944	19,157
2015	40	21,746	32,508	22,566
2018	37	9,812	10,339	11,467
2020	41	17,487	17,629	22,436
2021	47	24,918	61,863	31,310
2022	1	543	543	0

[a] Years not listed in table had 0 drought permits issued.

After an apparent return to "normal" annual precipitation in 2016, 2017, and 2019 which lead to significantly less groundwater withdrawals in the Project Area, precipitation dropped substantially in 2020 and 2021, based on AgriMet data. In 2022, precipitation recovered to be slightly higher than the 2020 level but was still about 6 inches less than in 2019. In 2023 and 2024, precipitation recovered to above average of the last 23 years. In 2024, metered withdrawals totaled 24,936 AF, approximately 1,500 AF more than the 2023 irrigation season. Groundwater levels continued to increase (recover) from fall 2023 to fall 2024 with 75% of wells measured in both years exhibiting a higher water level as a result of comparatively lower reported groundwater pumping this irrigation season and increased precipitation.

Purpose of This Report

This report presents 2024 groundwater use data from metered production wells within and adjacent to the Oregon portion of the Project Area and groundwater level data from representative wells in Oregon. Overall, 204 wells were visited in the Project Area between October and December 2024 to collect flowmeter data (this timeframe is referred to in this report as the "2024 Synoptic Survey"). A summary of well flowmeter status during the 2024 Synoptic Survey is presented in Table 2 and the complete list of the type of data collected at each well is presented in the Appendix A. The information collected was used to assess the impact of pumping on groundwater resources and to inform water management decisions. These data have been particularly important in recent years due to the dry conditions experienced during the last decade.

2024 Field Data Collection and Analysis

During the 2024 Synoptic Survey, OWRD staff collected flowmeter data between October and December at 204 wells in and adjacent to the Project Area in Oregon (Figure 1 and Appendix A). OWRD or USGS staff also collected static groundwater level measurements from 87 wells (Appendix B). The visited wells represent a subset of all permitted water-supply wells in the Project Area and either have current or historic permit conditions require water metering (i.e., flowmeter installation), were voluntarily metered, or were previously used as water level observation wells. Overall, 24,936 AF of water was reported pumped from 141 metered wells in the Project Area in the 2024 irrigation season (Table 2).

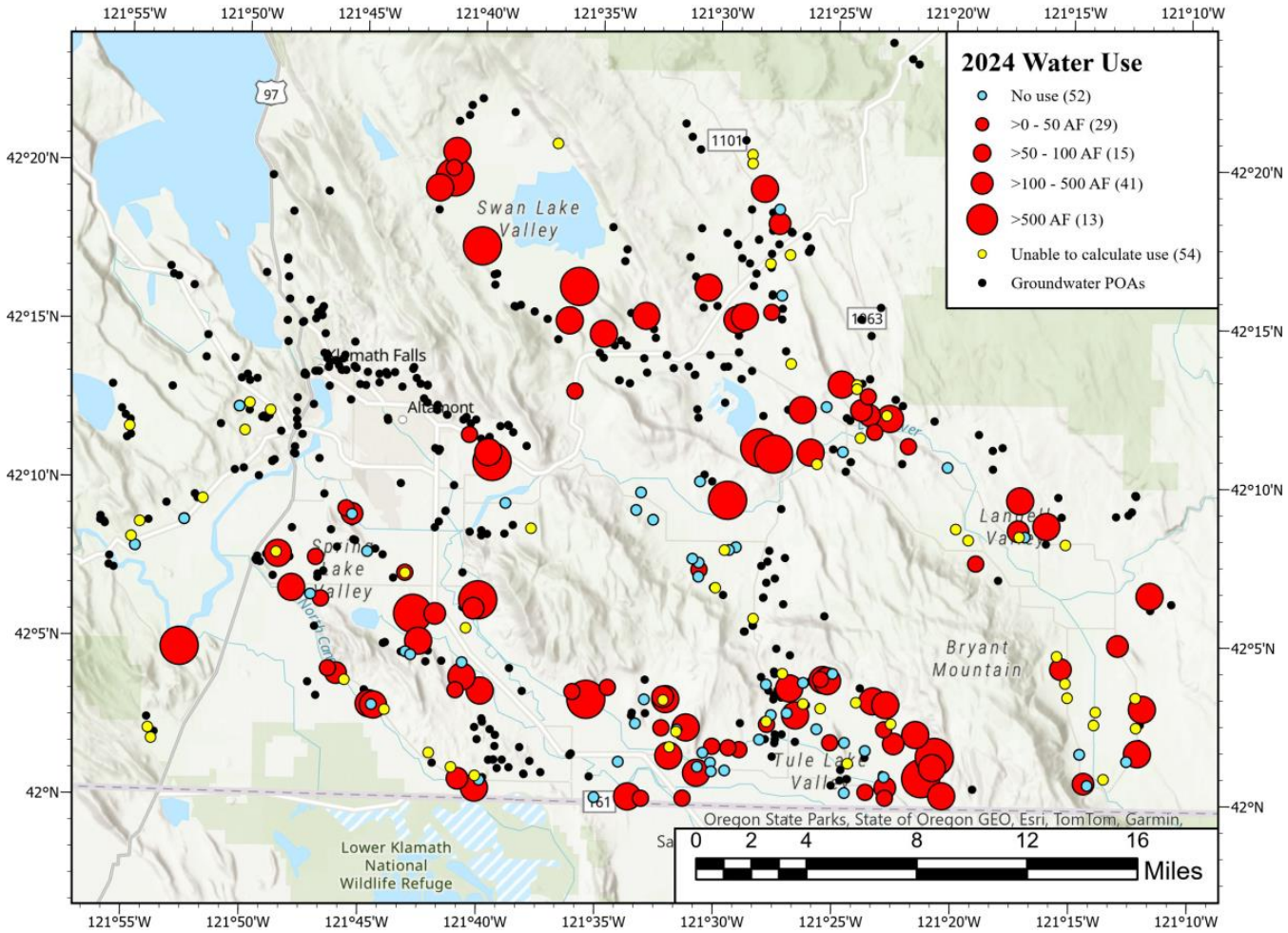

Figure 1: Existing permit wells and wells where water-use was calculated as part of the 2024 Synoptic Survey within the Project Area and vicinity in Oregon. This figure only represents a portion of groundwater extracted in the Project Area as many older groundwater points of appropriation (POA, black dots) do not require metering or reporting of water use.

Metered Groundwater Use

To calculate metered groundwater use in the study area for the 2024 irrigation season, flowmeter readings collected during the 2024 Synoptic Survey were compared to prior years' readings. Of 204 wells visited for water use recording during this synoptic, approximately 75% (153 wells) had working flowmeters. Successive years of flowmeter data allowed OWRD to directly calculate water use for a given well (Table 2). For wells without flowmeter data in 2023 and 2024, water use was obtained from water use reports submitted to OWRD by the water right holder, when available. Indirect methods of estimating groundwater use based on power consumption are sometimes available but were not included in this analysis.

Table 2: Summary of 2024 metered groundwater use and flowmeter status in the Project Area.

		# Records	% Wells Visited	Groundwater Use (AF)
Wells visited by OWRD in the Project Area for Water Use Recording		204		
Visited wells with operable flowmeters		153	75%	
Visited wells where use was calculated		141[a]	69%	24,936
2024 Flowmeter Status[b]	No Flowmeter	33	16%	
	Flowmeter Broken	12	6 %	
	No Access	4	2 %	
	Shared Flowmeter	2	1 %	

[a] Only wells with flowmeter readings in 2023 and 2024 (141 wells) could be used to directly calculate annual use. For an additional 9 wells where flowmeter data was not available, 2024 water use volumes were obtained from water use reports submitted by the water right holder.

[b] Refer to Appendix A for flowmeter status definitions.

Metered or calculated irrigation water use in the Project Area totaled 24,936 AF in 2024, a 6% increase from 2023 (Table 3). Of nearly a thousand authorized groundwater points of appropriation (POAs) in the area, most do not require flowmeters. Therefore, groundwater use volumes in Table 2 and Table 3 represent only a portion of groundwater extracted in the area. However, as the number of metered wells in the area has been similar over time, relative changes in volumes can be estimated by comparing annual data. Additionally, primary groundwater rights, where groundwater is the sole source of irrigation, should have relatively consistent use and acreage from year to year, so changes in annual use may reflect climate conditions (e.g., wetter spring, cooler summer). Of the 141 wells that have both 2023 and 2024 water use data, 67% of wells reported annual use changes of 50 AF or less. The distribution of water use changes from 2023 to 2024 is shown in Figure 2. Annual groundwater use since 2010 is shown in Table 3 for metered wells measured by OWRD during synoptic surveys.

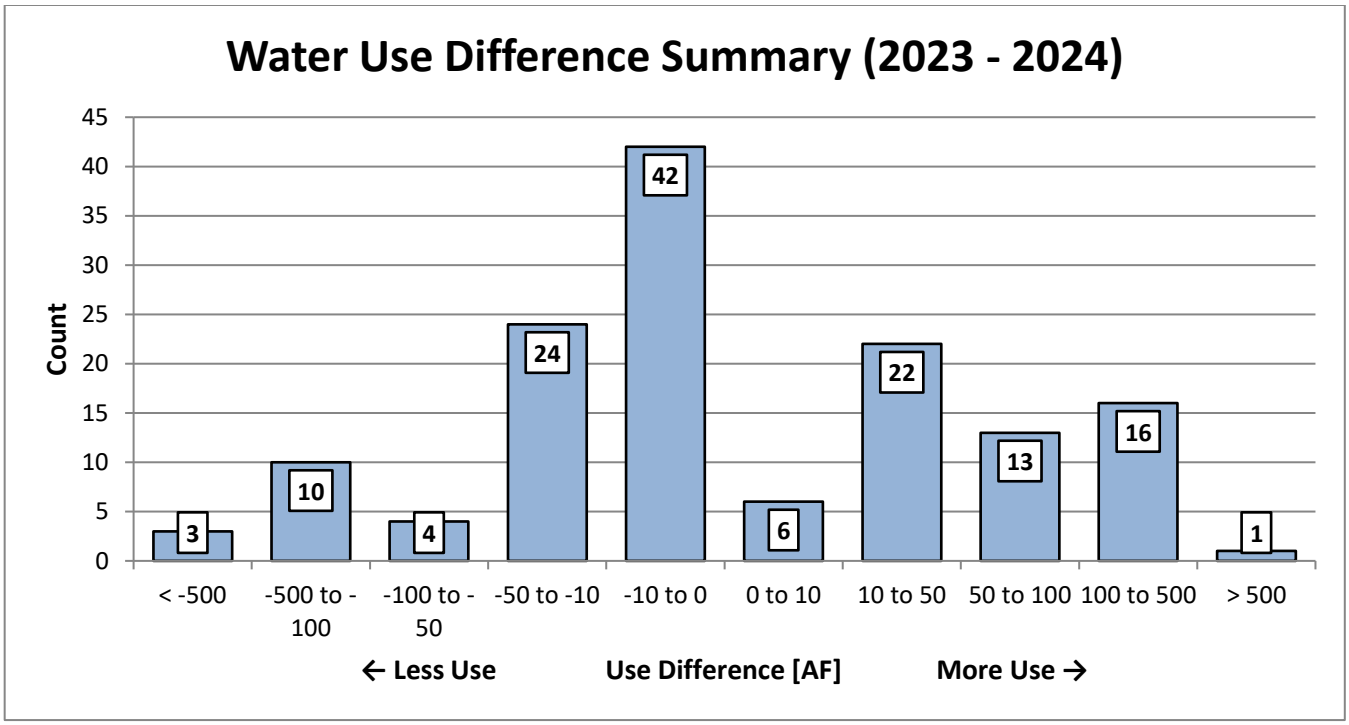

Figure 2: Distribution of reported change in water use from 2023 to 2024 irrigation seasons for wells.

Table 3: Metered groundwater use in the Klamath Project Area, Oregon from 2010 to 2024.

Year	Number of visited wells where use was calculated	Metered Groundwater Withdrawal in Oregon (acre-feet)
2010	204	78,920
2011	209	18,377
2012	223	35,864
2013	233	58,048
2014	249	72,574
2015	238	61,645
2016	173	19,409
2017	190	17,358
2018	194	28,448
2019	166	13,734
2020	153	52,635
2021	156	70,446
2022	148	57,519
2023	159	23,485
2024	**141**	**24,936**

Water Level Data

OWRD and USGS staff also collected water level data from 87 wells in the Project Area during 2024 (Figure 3). Eighty-two wells had fall water level measurements for both 2023 and 2024, allowing water level changes to be calculated. Of those 82 wells, approximately 75% showed a rise in water levels while 20 wells showed a decline (Figure 4). These and other groundwater level data are housed in the OWRD Groundwater Information System (GWIS) database (OWRD, 2025). A subset of this groundwater data can be accessed through a USGS web interface (USGS, 2025).

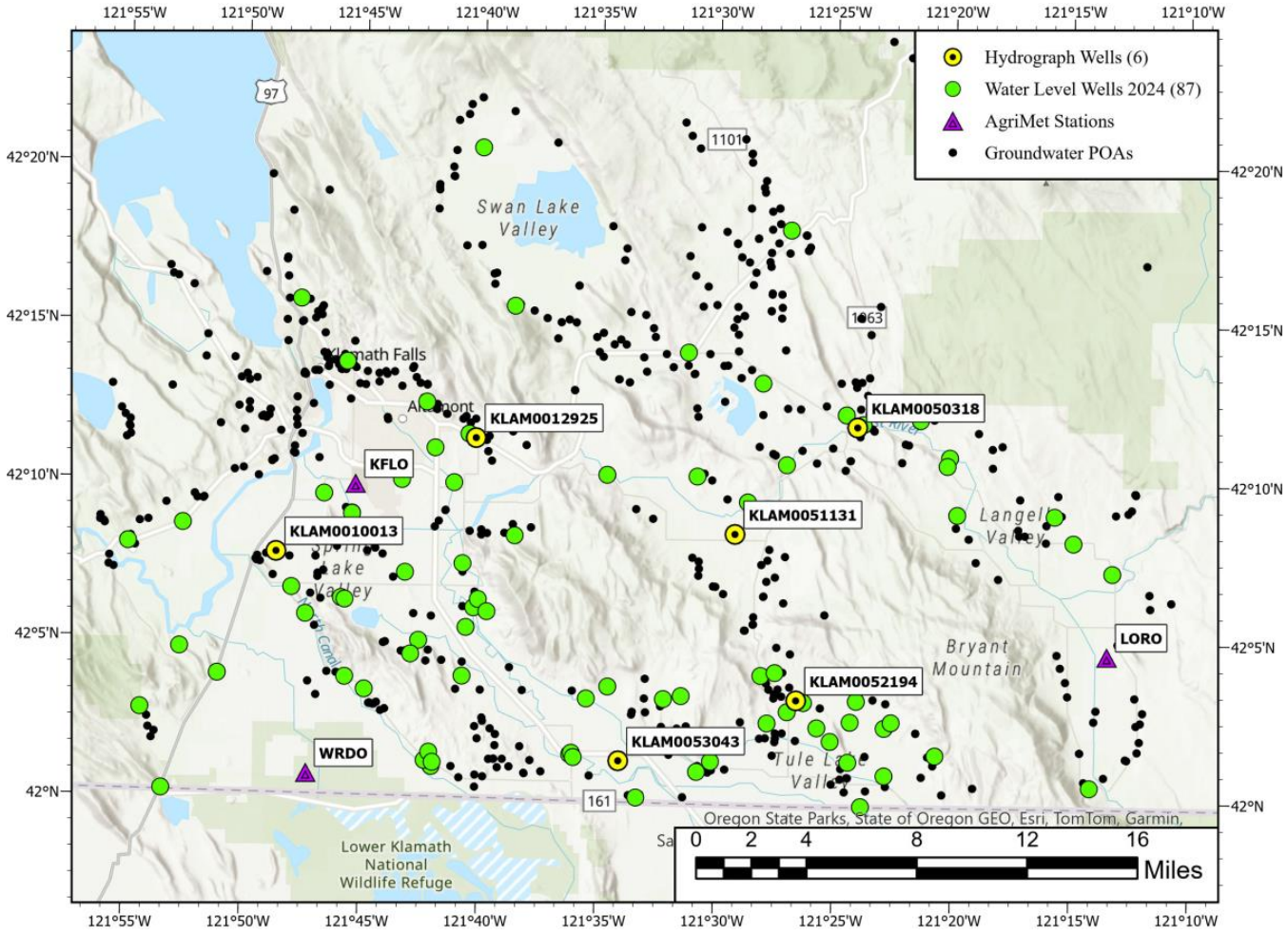

Figure 3: Map of Klamath Project Area wells with measured water levels in 2024, permitted groundwater POAs, select wells with hydrographs, and select AgriMet site locations.

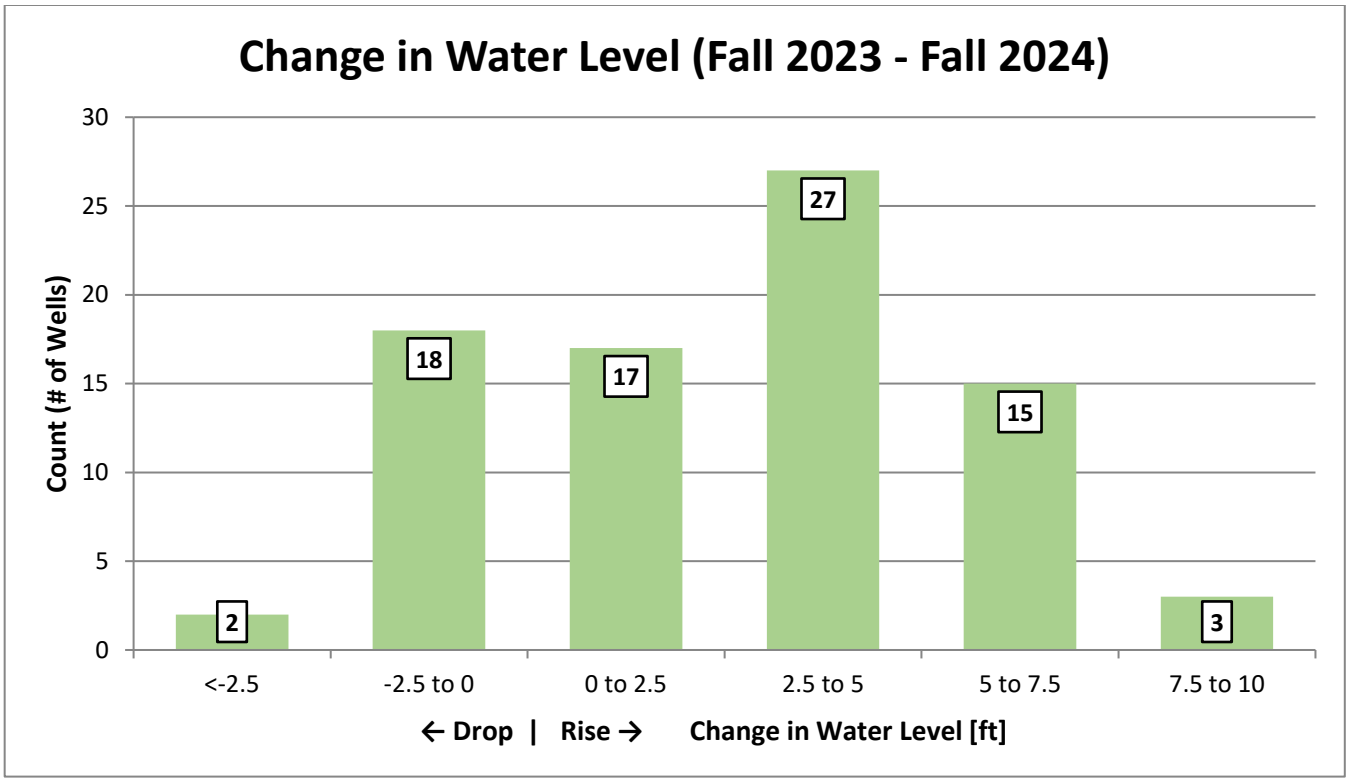

Figure 4: Distribution of change in groundwater level between fall 2023 and fall 2024.

Aquifer Response to Groundwater Pumping

This section presents groundwater level records and analyzes trends from representative wells within the Klamath Project Area in Oregon (Figure 3). These records generally show a long-term response to annual precipitation and a seasonal or multiyear response to groundwater pumping. Groundwater pumping is currently the largest factor controlling groundwater levels in the Project Area (Gannett and Breen, 2015). In years of lower groundwater pumping, groundwater levels show much smaller summer declines and relatively flat year-over-year trends, but there is no evidence of long-term water level recovery. To a lesser degree, recharge from canal leakage can influence water levels in adjacent wells (Pischel and Gannett 2015). It has also been speculated that groundwater levels in the western Project Area, where declines have been smaller, may be buffered by recharge from the Klamath River.

Pumping data are summarized in Table 4, including for the KWAPA Water Bank program for Oregon and California wells from 2002 through 2015 (when the program ended) and metered groundwater pumping recorded by OWRD from 2010 through 2024. Annual precipitation records from three AgriMet stations in Oregon (see Figure 3 for station locations) are also shown (USBR, 2025a). As

expected, there is a general correlation between water-year precipitation and groundwater pumping (Figure 5), as less surface water is available for irrigation during dryer years. The year 2021 marked the highest estimated use of groundwater in the Project Area since 2014 due to extreme drought conditions and closure of the A-Canal due to historically low water supply (USBR, 2021). The mean daily flow of the A-Canal, the main diversion from the Klamath River to the Project Area, from 2019 through 2024 is shown in Figure 6 (USBR, 2025b).

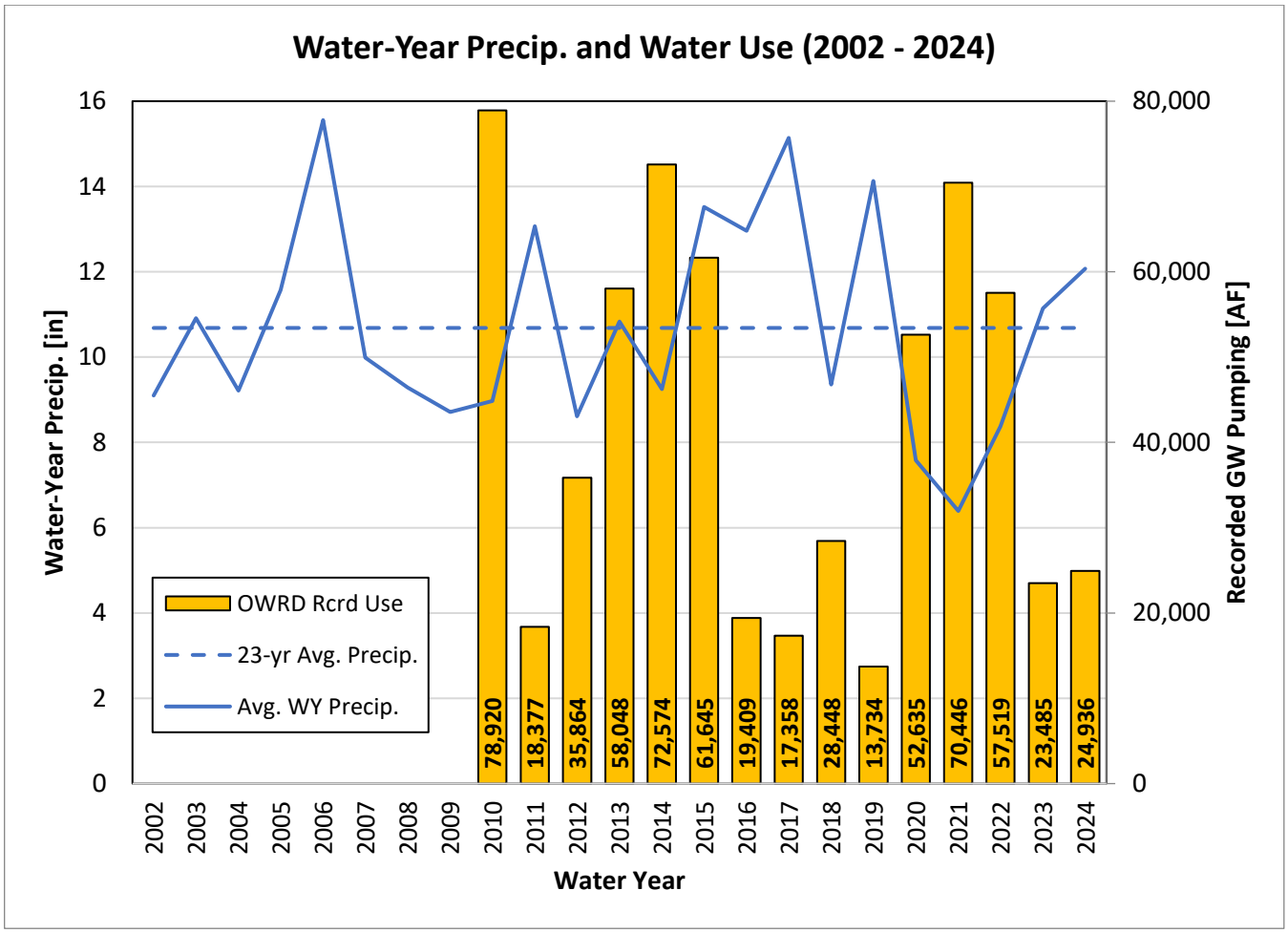

Figure 5: Annual and 23-year average water-year precipitation (from three AgriMet sites) and recorded groundwater pumping by OWRD.

Table 4: Water Bank and metered pumping estimates and water-year precipitation since 2002.

Year	Total Water Bank Pumping, OR and CA[a] (acre-feet)	Total OWRD Metered Pumping (acre-feet)	Total Water-Year Precipitation – AgriMet Stations[b] (inches)		
			Klamath Falls, OR KFLO	Worden, OR WRDO	Lorella, OR LORO
2002	18,569		10.63	8.24	8.42
2003	55,667		11.97	10.12	10.64
2004	73,870		11.54	8.42	7.68
2005	65,710		10.92	10.95	12.85
2006	32,740		15.58	13.47	17.62
2007	47,621		11.25	8.21	10.51
2008	–		10.70	8.17	8.98
2009	–		10.78	7.41	7.95
2010	128,740	78,920	8.10	9.32	9.49
2011	–	18,377	13.00	12.64	13.56
2012	30,363	35,864	9.21	8.05	8.58
2013	64,688	58,048	9.55	10.89	12.06
2014	83,456	72,574	10.16	8.13	9.45
2015	37,742	61,645	12.71	15.56	12.29
2016	N/A	19,409	13.66	13.01	12.21
2017	N/A	17,358	14.93	12.22	18.26
2018	N/A	28,448	9.46	7.88	10.74
2019	N/A	13,734	15.48	12.05	14.85
2020	N/A	52,635	10.71	5.99	6.05
2021	N/A	70,446	8.37	5.15	5.66
2022	N/A	57,519	9.11	7.00	9.01
2023	N/A	23,485	12.50	9.85	11.07
2024	N/A	**24,936**	**13.34**	**10.86**	**12.01**

[a]Pumping data for 2001 through 2007 collected by USBR; data for 2010 through 2015 collected by KWAPA. Water Bank program not operational during 2008 and 2009 while transitioning from USBR to KWAPA administration.

[b]Refer to Figure 3 for AgriMet station locations.

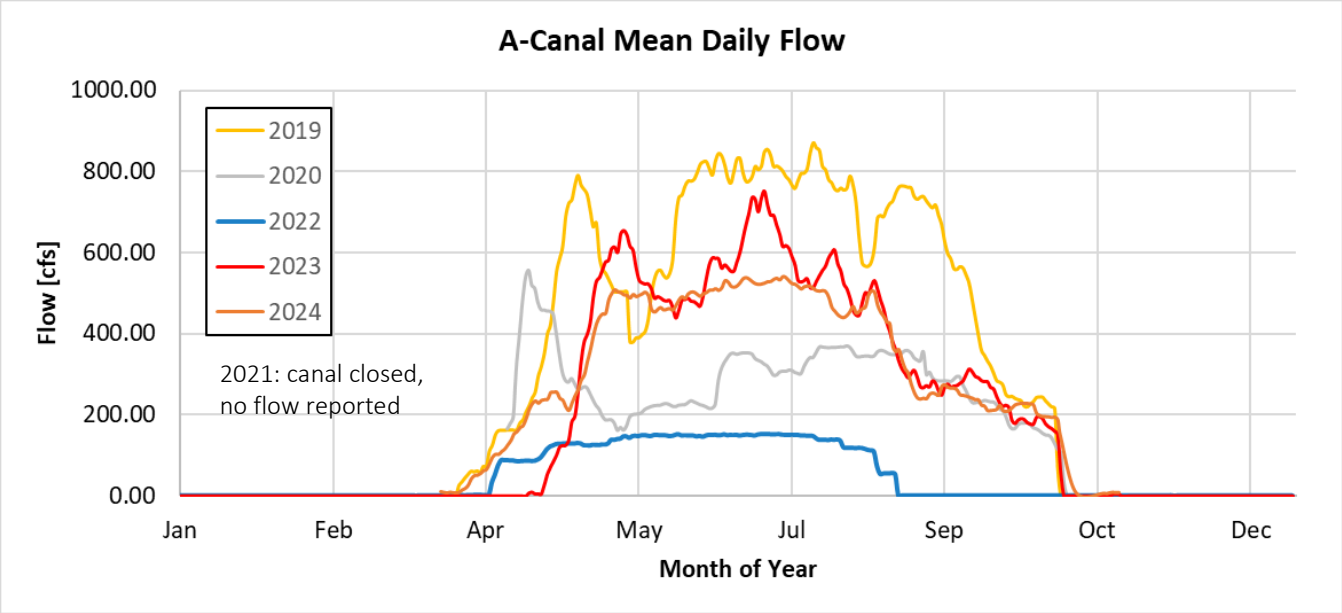

Figure 6: Mean daily flow for A-Canal for the last five years.

Observed groundwater level trends correlate strongly and predictably to historic water use and trends are similar across much of the Project Area. The main observed groundwater level trends are as follows:

- Increased supplemental irrigation pumping beginning in 2001 correlates with a trend of generally declining groundwater levels. Wells that are strongly influenced by surface waters, such as leaky canals or the Klamath River, experienced some recovery after the 2001 groundwater irrigation season, while wells utilizing deep regional aquifers experienced persistent water level declines after 2001. Unfortunately, there was limited water level data collected prior to 2010.
- The Water Bank program did not operate during 2008 and 2009 while administration of the program transferred from USBR to KWAPA. The reduction in supplemental pumping appears to have resulted in relatively constant water levels or even minor water level recovery in some wells, most strongly in those with water levels influenced by canal leakage.
- A sharp increase in supplemental pumping during 2010, 2013, 2014, and 2015 resulted in punctuated seasonal declines in groundwater levels, with incomplete recovery between irrigation seasons.
- The 2016 water year marked the first year without the Water Bank program and, along with 2017, a return to average precipitation. Hydrographs reflect reduced pumping stress with

relatively stable or slightly rising fall water levels between 2016 and 2017 and far less seasonal drawdown than observed in previous years.

- The 2018 water year saw significantly less precipitation across the Project Area. While pumping significantly increased compared to 2016 and 2017, it was still lower than in previous years with similar precipitation (Figure 5). By June, stored surface water was being delivered to the Project Area at nearly the accustomed rate, and many users reduced or ceased groundwater pumping. Subsequently, water levels declined the most between spring and summer, but water levels were beginning to recover by fall.
- The 2019 water year saw slightly above-average precipitation and higher surface water deliveries (Figure 6). Consequently, groundwater pumping was substantially less than previous years, and water levels seemed to continue an upward trend that began in fall 2018.
- The 2020 through 2022 water years saw the lowest precipitation since 2001. The low precipitation in combination with the issuance of drought permits in 2020 and 2021 and increased pumping is reflected in the sharply declining water levels throughout the Project Area.
- During the 2023 and 2024 water years, precipitation was slightly above-average and surface water deliveries were higher than the prior three years. No drought permits were issued in 2023 or 2024, and groundwater pumping in the Project Area decreased substantially. As a result, groundwater levels in most wells have shown an upward trend since fall 2022.

Specific Hydrographs in the Project Area

KLAM 52194

KLAM 52194 is an observation well installed by OWRD about 3.8 miles north of the state line near Malin, OR in the Shasta View Irrigation District (Figure 1). Seasonal fluctuations in the hydrograph (Figure 7) are a response to groundwater pumping in the area. Seasonal fluctuations were substantially less in 2008 and 2009, and again in 2016 and 2017, as a result of the absence of substantial groundwater pumping by irrigation wells in the area. Pumping during 2010, 2013, 2014, and 2015 produced 10-20 feet of decline in each year and incomplete recovery between years. Pumping in 2018 produced slightly over 5 feet of decline early in the irrigation season but the water level recovered through the 2019 irrigation season. Pumping during the 2020, 2021, and 2022 irrigation seasons resulted in 23-35 feet of seasonal decline in each year and incomplete recovery between years resulting in approximately 23 feet of decline when comparing spring static water levels between 2020 and 2023. Groundwater levels recovered 8.4 feet between March 2023 and March 2024 before exhibiting a slight seasonal decline during the 2024 irrigation season. The March 2024 static groundwater level of KLAM 52194 remains 36.84 feet lower than the static groundwater level measured in March 2001.

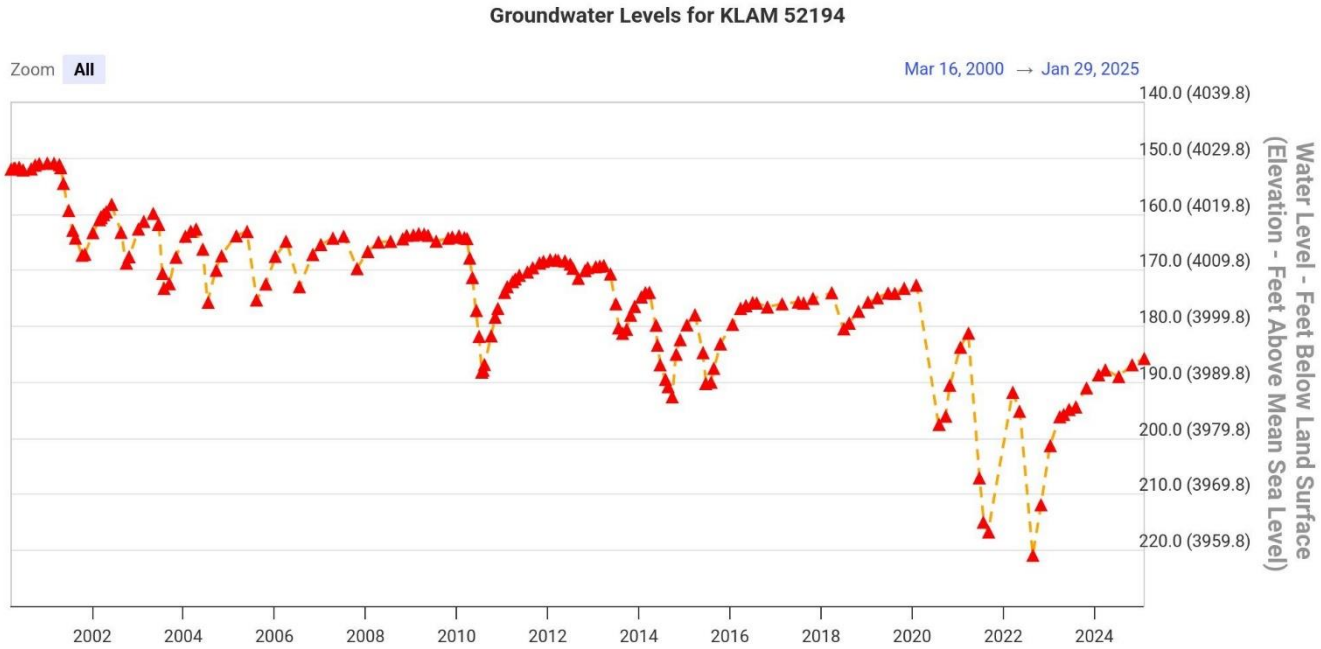

Figure 7: Hydrograph for well KLAM 52194 near Malin, OR.

KLAM 53043

KLAM 53043 is an irrigation well drilled in 2001 about 1.5 miles east of Merrill, OR and just over one mile north of the Oregon-California state line (Figure 1). This well is subject to drawdown interference from the Tulelake Irrigation District wellfield located in California along the state line. The hydrograph for this well (Figure 8) shows groundwater declines of almost 33 feet from spring 2003 to spring 2023. The largest seasonal fluctuations occurred in years with increased groundwater pumping (2010, 2020-2022). The 2010 irrigation season resulted in a 20 feet seasonal decline with only 15 feet of recovery. Groundwater levels showed slight recovery from spring 2016 through 2019. Pumping during the 2020, 2021, and 2022 irrigation seasons resulted in 21-28 feet of seasonal decline in each year and incomplete recovery between years. Groundwater levels declined approximately 22 feet from spring 2020 to spring 2023. Reductions in groundwater pumping during the 2023 irrigation season has seen the March 2024 static water level recover approximately 8.35 feet since March 2023. As of January 2025, the water level in KLAM 53043 has recovered an additional 3.37 feet since March 2024, but remains 25.49 feet below the spring 2003 water level.

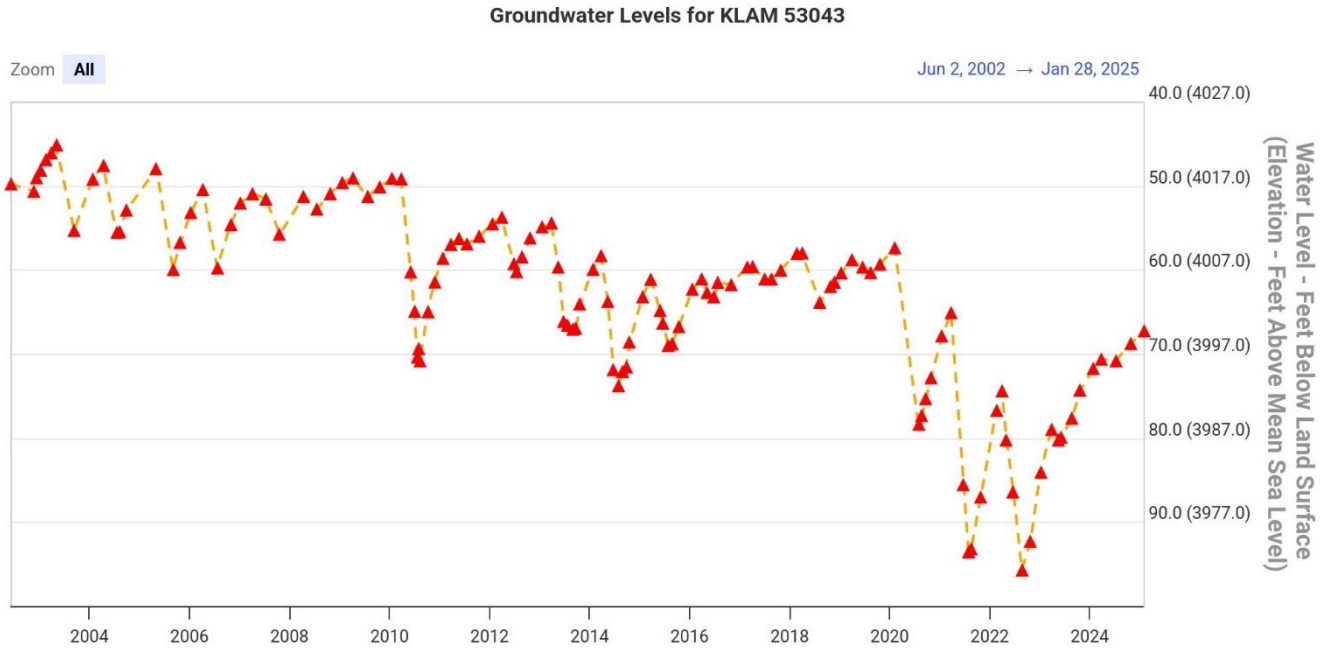

Figure 8: Hydrograph for well KLAM 53043 east of Merrill, OR.

KLAM 10013

KLAM 10013 is a domestic well located just east of the town of Midland in the western portion of the Project Area (Figure 1). Historically, this area has been the source of multiple concerns from local well owners about declining groundwater levels and well-to-well interference. KLAM 10013 is a shallow well that develops water from the volcanic aquifer which is the primary-production aquifer for the area. Water levels at this well (Figure 9) are likely affected by recharge from the Klamath River or canal leakage which accounts for a generally stable long-term trend through 2019. However, this well still shows sharper seasonal declines due to groundwater pumping for irrigation; the sharpest declines were concurrent with years of increased groundwater pumping (2010, 2013-2015, and 2020-2022). Between 2016 and 2019, this well showed seasonal fluctuations that were considerably muted compared to previous years, with only 2 feet drop during the 2019 irrigation season. Pumping during the 2020, 2021, and 2022 irrigation seasons resulted in approximately 18 feet of seasonal decline in each year and incomplete recovery between years. Static groundwater levels in this well dropped approximately 14 feet from spring 2020 to spring 2023 but have recovered 9.14 feet as of January 2025 as a result of decreased pumping in 2023 and 2024. As of January 2025, the observed groundwater level in KLAM 10013 remains 7.63 feet lower than the September 1999 level.

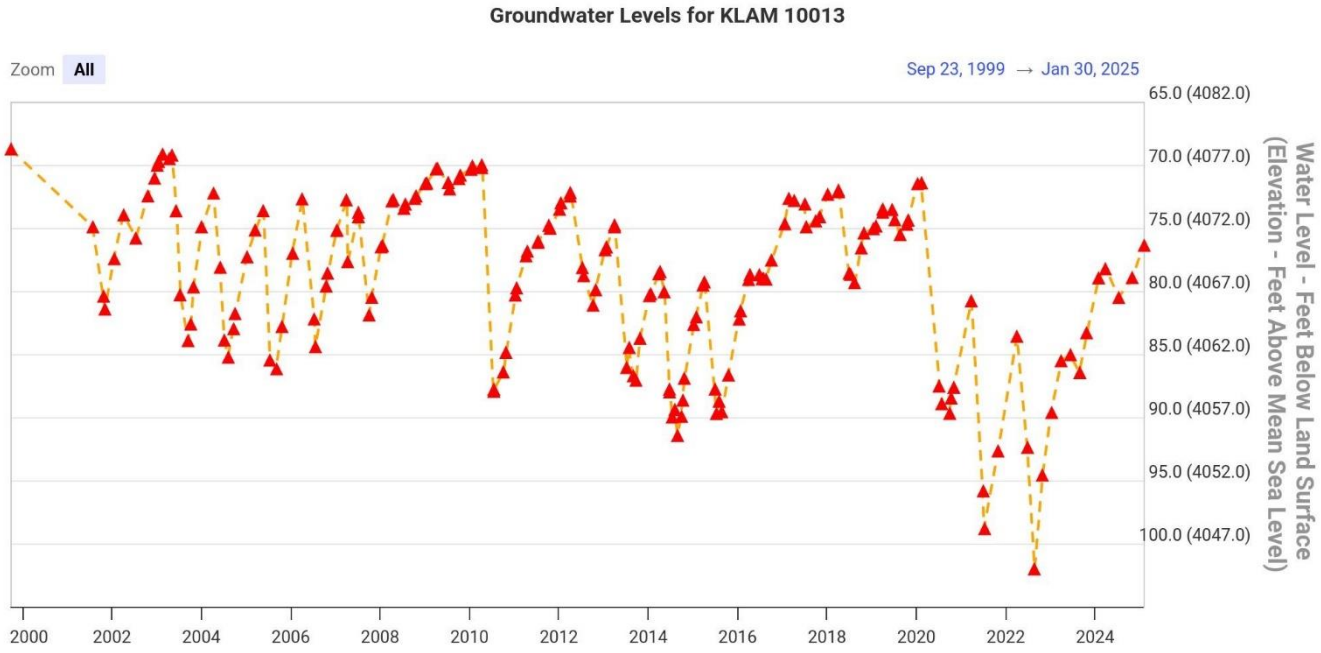

Figure 9: Hydrograph for well KLAM 10013 near Midland, OR.

KLAM 12925

KLAM 12925 is a domestic and stock well located in the Pine Grove area southeast of Klamath Falls, OR (Figure 1) where groundwater levels in the volcanic aquifer and the overlying sediments are strongly influenced by supplemental groundwater pumping in the surrounding area. The hydrograph for this well (Figure 10) displays a trend similar to that observed in wells located along the state line and in the Klamath Valley (e.g., KLAM 52195). Water levels declined approximately 10 feet at this well between 2010 and 2015, with no significant decline or recovery between 2015 and 2019. Spring high water levels declined almost 15 feet between 2020 and 2023. The water level has recovered 5.29 feet from spring 2023 as of January 2025 but remains 20.72 feet below the January 2004 static water level.

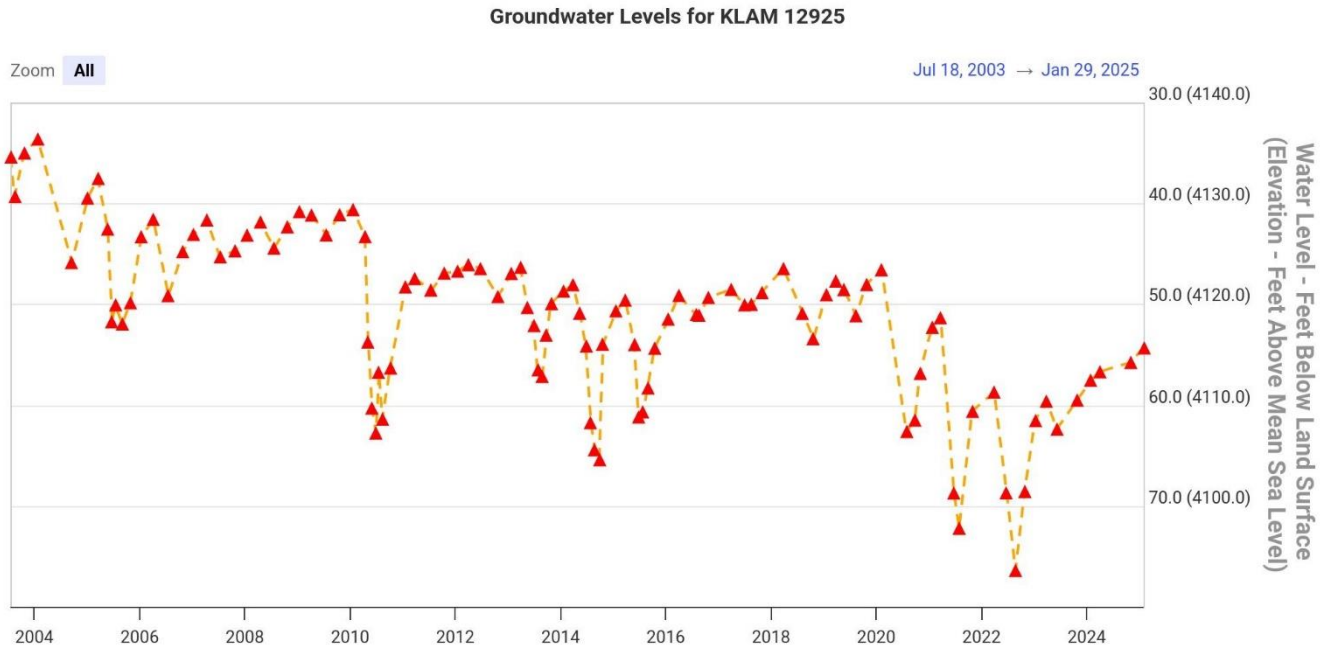

Figure 10: Hydrograph for well KLAM 12925 in the Pine Grove area.

KLAM 51131

KLAM 51131 is an unused irrigation well located in South Poe Valley approximately 2,000 feet from the main channel of the Lost River (Figure 1). The well develops water from both the sedimentary and volcanic aquifers and receives recharge from numerous surrounding surface water features including irrigation canals, lakes, and the Lost River. The hydrograph (Figure 11) displays a more stable, but still declining, water level trend following the extensive groundwater pumping in 2010. Regulation of unauthorized groundwater pumping in the area and the availability of surface water from the Lost River resulted in a significant reduction in groundwater use in mid-season 2010, which likely supported this trend. However, water levels still declined 7 feet between 2010 and 2016, with large seasonal declines in 2014, 2015, and 2018. After a relatively stable period between 2016 and 2019, water levels displayed a year-over-year decline with seasonal highs not recovering to their previous levels beginning in 2020. Annual high water levels declined 8.59 feet between 2020 and 2022 but have recovered to 2020 levels as of January 2025 while remaining approximately 17 feet lower than the May 2000 annual high.

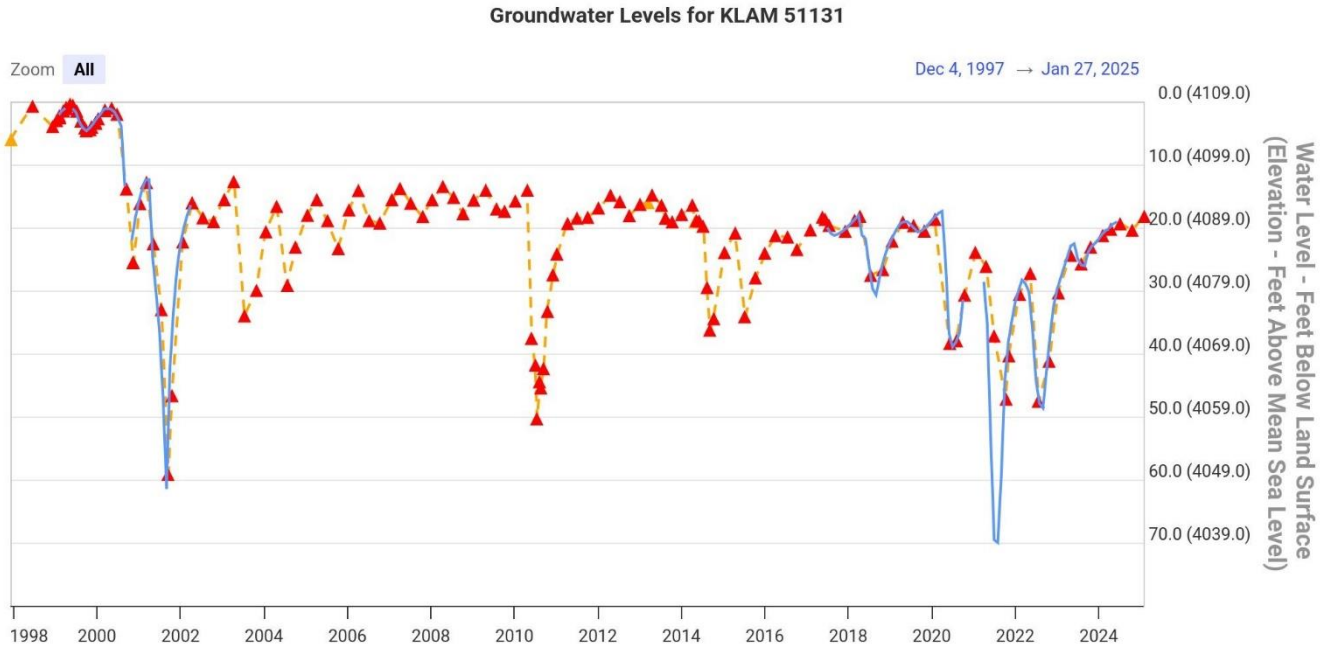

Figure 11: Hydrograph for well KLAM 51131 in South Poe Valley

KLAM 50318

KLAM 50318 is a shallow unused well located in a groundwater discharge area adjacent to the Lost River and near Bonanza, OR and Bonanza Big Springs (Figure 1). The hydrograph (Figure 12) shows a seasonal response to pumping with year-to-year spring high water levels that are relatively stable and appear to reflect climate fluctuations (Figure 5). The seasonal drawdown of groundwater levels was larger during the 2010, 2014, 2015, 2021, and 2022 irrigation seasons as a result of increased groundwater pumping in the area.

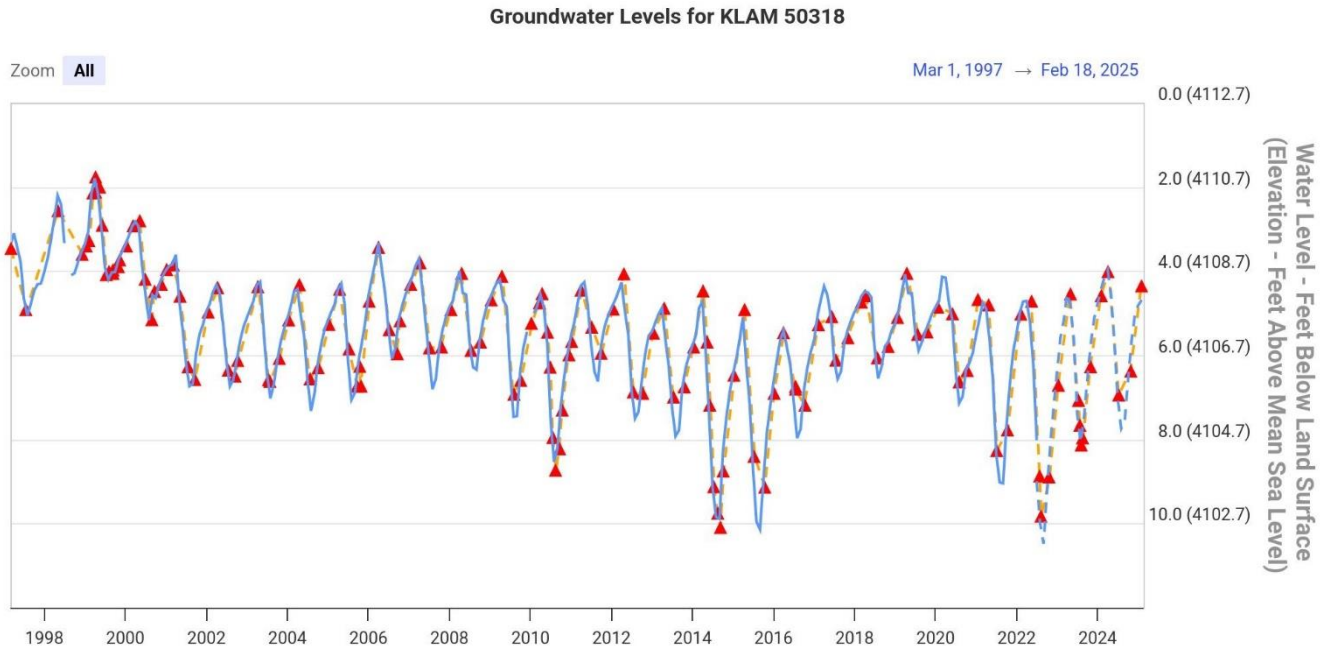

Figure 12: Hydrograph for well KLAM 50318 near Bonanza, OR.

The water level in KLAM 50318 is representative of the head in the part of the aquifer that drives flow to Bonanza Big Springs and thus represents a local discharge zone, which partly explains the low seasonal variability and stable long-term trends observed in the hydrograph. Lower groundwater levels at this well are coincident with lower discharge at the spring outflow adjacent to the river. Groundwater levels generally observe a smooth annual cycle (rising through the fall, lowering through the summer) while river stage often shows discrete changes (rapid increase or decrease in stage). Stage elevation at this location is partly controlled by a diversion structure (Harpold Dam) on the Lost River downstream of the gaging station and groundwater elevation is above river stage elevation for most of

the year (Figure 13). When the river stage elevation exceeds the groundwater level elevation, primarily in summer months when there is increased stage behind the dam, the hydraulic gradient is reversed, at which point surface water can flow into the aquifer via Bonanza Big Springs and potentially contaminate nearby water wells. Consequently, when groundwater levels are within 0.5-foot above river stage, a subset of nearby irrigation wells are curtailed and stage behind Harpold Dam may be reduced to limit groundwater contamination. Groundwater levels in KLAM 50318 were above Lost River stage for most of 2024 but dropped below river stage for a brief period in August (Figure 13).

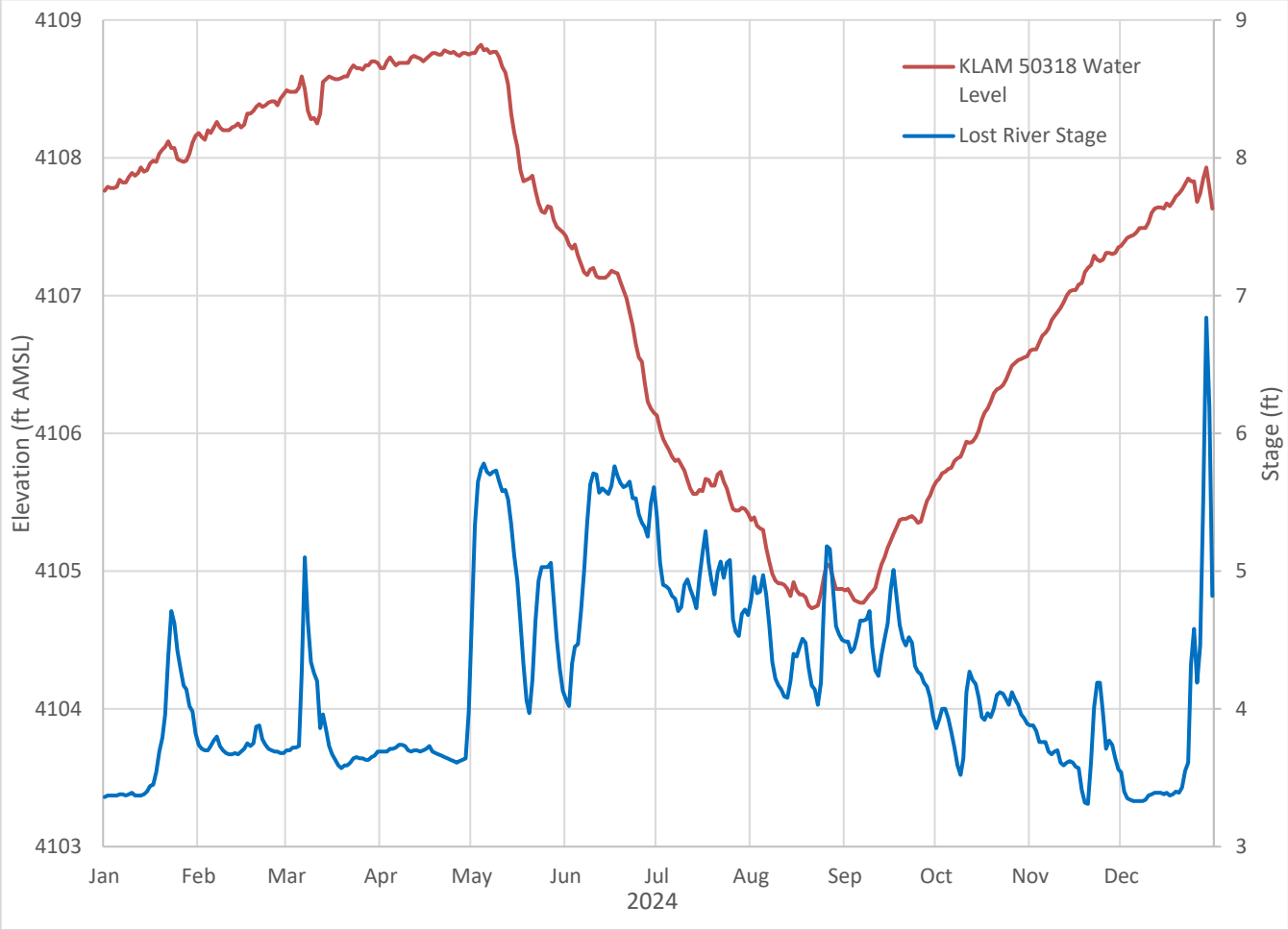

Figure 13: Hydrograph for well KLAM 50318 and the Lost River during 2024.

Summary and Conclusion

Significant reliance on supplemental groundwater pumping since 2001 has resulted in long-term groundwater level decreases marked by punctuated, seasonal declines and incomplete annual recovery in and near the Klamath Project Area in Oregon. The 2024 irrigation season saw slightly above-average precipitation and increased surface water deliveries, similar to 2023, which led to decreased groundwater pumping in the Project Area. There was 24,936 AF of metered or reported groundwater pumped in the 2024 irrigation season. For all years, the reported water use data presented in this report underestimate actual use because flowmeters are only installed and accessible on only a subset of wells. Overall, for wells with data available for 2023 and 2024, 67% showed water use changes within 50 AF and 75% showed higher fall water levels.

The data presented in this report indicate that supplemental groundwater withdrawals have resulted in seasonal declines in some areas and persistent groundwater level declines across most of the Project Area. Drought conditions, reduced surface water deliveries, and increased groundwater pumping between 2020 and 2022 led to significant groundwater declines and lack of recovery between irrigation seasons. Increased precipitation and decreased groundwater pumping in 2023 and 2024 have resulted in increasing groundwater levels since fall 2022, but groundwater levels in portions of the project area have still not recovered to annual highs measured in 2020. These groundwater level declines can reduce groundwater discharge to – and in some cases induce recharge from – streams, springs, and drains, exacerbating already stressed surface water supplies. Additionally, persistent seasonal drawdown can reduce storage potential in aquifers and lead to land subsidence. Seasonal and long-term water level declines result in increased pumping costs incurred by groundwater users, and for hundreds of domestic wells within the Project Area, water levels fell below operating levels.

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Appendix A

List of wells visited as part of 2024 Flowmeter Synoptic Survey

Well ID	*Latitude*	*Longitude*	*Flowmeter Status*	*Flowmeter Analyzed*	*Water Level Measured*
KLAM0002227	42.344815	-121.615235	NOFM	No	No
KLAM0002289	42.32646	-121.688077	NULL	Yes	No
KLAM0002340	42.31154813	-121.45773	NULL	Yes	No
KLAM0002373	42.33554415	-121.4772746	BRK	No	No
KLAM0010013	42.1283878	-121.8105832	NOFM	No	Yes
KLAM0010082	42.34013177	-121.6866392	NULL	Yes	No
KLAM0010181	42.34022906	-121.4774423	NOAC	No	No
KLAM0010242	42.20642169	-121.3986827	NULL	Yes	No
KLAM0010292	42.15844902	-121.4924928	NULL	Yes	No
KLAM0010336	42.29043837	-121.6679675	NULL	Yes	No
KLAM0010352	42.2198018	-121.4018859	NOFM	No	No
KLAM0010353	42.01059	-121.6806	NULL	Yes	No
KLAM0010357	42.2176185	-121.4019108	NULL	No	No
KLAM0010364	42.136637	-121.2537484	NOFM	No	No
KLAM0010368	42.2534023	-121.4870156	NULL	Yes	No
KLAM0010378	42.191886	-121.39916	NULL	No	No
KLAM0010395	42.2021832	-121.3784323	NULL	Yes	No
KLAM0010416	42.2038913	-121.3929659	NULL	Yes	No
KLAM0010421	42.21994329	-121.4127916	NULL	Yes	No
KLAM0010431	42.18449063	-121.4114684	NULL	Yes	No
KLAM0010432	42.18403014	-121.4342463	NULL	Yes	No
KLAM0010440	42.20376161	-121.380584	NOFM	No	No
KLAM0010441	42.009989	-121.665366	NULL	Yes	No
KLAM0010445	42.00294	-121.37959	NULL	Yes	No
KLAM0010449	42.05710012	-121.682849	NULL	Yes	No
KLAM0010454	42.06005136	-121.4474619	NULL	Yes	No
KLAM0010460	42.2080546	-121.4232886	NULL	Yes	No
KLAM0010461	42.21369099	-121.39398	NULL	Yes	No
KLAM0010462	42.0387262	-121.4280086	BRK	Yes	Yes
KLAM0010467	42.14360576	-121.2871712	NULL	Yes	No
KLAM0010473	42.05644998	-121.2035837	NOFM	No	No
KLAM0010475	42.2063377	-121.4403109	NULL	Yes	No
KLAM0010478	42.04702846	-121.4490286	NULL	Yes	Yes
KLAM0010491	42.23051	-121.44865	NOAC	No	No
KLAM0010495	42.0563643	-121.251607	NOFM	No	No
KLAM0010498	42.18306589	-121.4603938	NULL	Yes	No
KLAM0010506	42.0366609	-121.5268045	NOFM	No	No

Well ID	*Latitude*	*Longitude*	*Flowmeter Status*	*Flowmeter Analyzed*	*Water Level Measured*
KLAM0010518	42.0640827	-121.6784444	NULL	Yes	Yes
KLAM0010526	42.1596025	-121.2859606	NULL	Yes	No
KLAM0010539	42.01334468	-121.3541626	NULL	Yes	No
KLAM0010575	42.01036179	-121.2372354	NULL	Yes	No
KLAM0010608	42.14055535	-121.2824593	NULL	Yes	No
KLAM0010634	42.14056612	-121.2864653	NOFM	No	No
KLAM0010641	42.06386687	-121.2531962	NOFM	No	No
KLAM0010642	42.01370738	-121.2257768	NULL	No	No
KLAM0010699	42.1263947	-121.3169183	NULL	Yes	No
KLAM0010712	42.26633474	-121.4555863	NULL	Yes	No
KLAM0010748	42.02672634	-121.2427169	NULL	Yes	No
KLAM0010764	42.0421593	-121.2328169	NOFM	No	No
KLAM0010822	42.20461104	-121.8379499	NULL	Yes	No
KLAM0010870	42.32234695	-121.4686257	NULL	Yes	No
KLAM0010988	42.1124565	-121.5004009	NOFM	No	No
KLAM0011008	42.05177971	-121.3796268	NULL	Yes	No
KLAM0011254	42.0208437	-121.405944	NOFM	No	Yes
KLAM0012203	42.2698544	-121.5989033	NULL	Yes	No
KLAM0012230	42.21486	-121.60123	NULL	Yes	No
KLAM0012283	42.28771078	-121.4500297	NOAC	No	No
KLAM0012404	42.27006034	-121.5077031	NULL	Yes	No
KLAM0012415	42.25496725	-121.481837	NULL	Yes	No
KLAM0012421	42.24516276	-121.581289	NULL	Yes	No
KLAM0013403	42.1877116	-121.3652345	BRK	No	No
KLAM0013427	42.1779062	-121.4296637	BRK	No	No
KLAM0013472	42.18622708	-121.4702166	NULL	Yes	No
KLAM0013578	42.14445084	-121.3312518	NOFM	No	No
KLAM0013583	42.13865457	-121.3223503	NOFM	No	No
KLAM0014060	42.20653978	-121.8306419	NOFM	No	No
KLAM0014124	42.19347964	-121.9153055	NOFM	No	No
KLAM0014254	42.19208806	-121.8337393	NOFM	No	No
KLAM0014324	42.14346118	-121.9071014	NOFM	No	No
KLAM0014580	42.0492764	-121.743612	NOFM	No	No
KLAM0014581	42.0486931	-121.740537	NOFM	No	No
KLAM0014584	42.0463294	-121.7327118	NOFM	No	No
KLAM0014736	42.096474	-121.473494	NOFM	No	No
KLAM0014754	42.06195945	-121.4638555	NULL	Yes	No
KLAM0014763	42.05335888	-121.5497374	NULL	Yes	No
KLAM0014777	42.05316307	-121.5363329	NOFM	No	Yes
KLAM0014819	42.0648949	-121.4255122	NULL	Yes	No
KLAM0014820	42.064665	-121.423947	NULL	Yes	No

Well ID	*Latitude*	*Longitude*	*Flowmeter Status*	*Flowmeter Analyzed*	*Water Level Measured*
KLAM0014821	42.06789646	-121.4170603	NULL	Yes	No
KLAM0014838	42.06411	-121.42084	NULL	Yes	No
KLAM0014844	42.05289009	-121.4004032	NOFM	No	Yes
KLAM0014873	42.0780608	-121.2592939	NULL	No	No
KLAM0014891	42.0837893	-121.2163862	NULL	Yes	No
KLAM0014896	42.050634	-121.198828	NULL	Yes	No
KLAM0014914	42.0239221	-121.7011273	NOFM	No	Yes
KLAM0014937	42.0165123	-121.6853281	NOFM	No	No
KLAM0014939	42.01221448	-121.668475	NOFM	No	No
KLAM0014984	42.00579	-121.6686	NULL	Yes	No
KLAM0014992	42.03888702	-121.5200429	NULL	Yes	No
KLAM0015045	42.03883501	-121.3805742	NULL	Yes	Yes
KLAM0015050	42.0418352	-121.375722	BRK	No	Yes
KLAM0015111	42.06772695	-121.4524575	BRK	No	No
KLAM0015113	42.04069288	-121.2031626	NOFM	No	No
KLAM0015114	42.0246167	-121.3446656	NULL	Yes	Yes
KLAM0015129	42.049023	-121.2316392	BRK	No	No
KLAM0015130	42.02308499	-121.2096319	NULL	Yes	No
KLAM0050168	42.05371528	-121.3886775	NULL	Yes	No
KLAM0050341	42.25484056	-121.5514833	NULL	Yes	No
KLAM0050445	42.33139766	-121.6886538	NULL	Yes	No
KLAM0050623	42.12556686	-121.512315	NULL	Yes	No
KLAM0050763	42.00422848	-121.3396093	NULL	Yes	No
KLAM0051034	42.28296511	-121.463835	BRKQ	No	No
KLAM0051179	42.30413	-121.4577	NULL	Yes	No
KLAM0051231	42.1275795	-121.8092415	NULL	Yes	No
KLAM0051602	42.05193959	-121.4376369	BRK	No	Yes
KLAM0051611	42.03168768	-121.4185139	NULL	Yes	Yes
KLAM0051612	42.0138915	-121.3803157	NULL	Yes	Yes
KLAM0051675	42.20279634	-121.8158943	NOFM	No	No
KLAM0051783	42.15611	-121.86282	NOFM	No	No
KLAM0051920	42.17677627	-121.3374117	NULL	Yes	Yes
KLAM0052633	42.195061	-121.389207	NULL	Yes	No
KLAM0052646	42.03853371	-121.5374857	NULL	Yes	No
KLAM0052647	42.0716	-121.67852	NULL	Yes	No
KLAM0052650	42.07693	-121.71848	NULL	Yes	No
KLAM0052697	42.100044	-121.67088	NULL	Yes	Yes
KLAM0052701	42.14625	-121.26729	NULL	Yes	No
KLAM0052703	42.18216	-121.66176	NULL	Yes	No
KLAM0052706	42.041009	-121.4631258	NULL	Yes	Yes
KLAM0052711	42.05683992	-121.6654889	NULL	Yes	No

Well ID	*Latitude*	*Longitude*	*Flowmeter Status*	*Flowmeter Analyzed*	*Water Level Measured*
KLAM0052712	42.13556012	-121.9129997	NOFM	No	No
KLAM0052759	42.04244411	-121.4633977	NEW	No	No
KLAM0052761	42.0285305	-121.5315293	BRKQ	No	No
KLAM0052765	42.04957997	-121.4254537	NOFM	No	No
KLAM0052776	42.15175618	-121.7616123	NULL	Yes	No
KLAM0052778	42.15278	-121.55685	BRK	No	No
KLAM0052787	42.1308239	-121.910175	NULL	Yes	No
KLAM0052790	42.05363331	-121.5346824	NULL	Yes	No
KLAM0052795	42.015141	-121.512356	NULL	Yes	Yes
KLAM0052797	42.082561	-121.709375	NULL	Yes	Yes
KLAM0052818	42.15557	-121.64922	NULL	Yes	No
KLAM0052824	42.096912	-121.7135654	NULL	Yes	No
KLAM0052825	42.118396	-121.719536	SHAR	Yes	No
KLAM0052910	42.05940542	-121.575613	NULL	Yes	Yes
KLAM0052911	42.16206	-121.55358	NULL	Yes	No
KLAM0052916	42.1065	-121.78603	NULL	Yes	No
KLAM0052918	42.121868	-121.512076	NULL	Yes	No
KLAM0052922	42.12759	-121.51682	NULL	Yes	No
KLAM0052923	42.07535831	-121.7148688	NULL	Yes	Yes
KLAM0052925	42.12925347	-121.7463043	NULL	Yes	No
KLAM0052932	42.05698765	-121.6004806	NULL	Yes	No
KLAM0052935	42.00588916	-121.3932686	NULL	Yes	No
KLAM0052964	42.00830733	-121.3793331	NULL	Yes	No
KLAM0052970	42.10981	-121.79943	NULL	Yes	Yes
KLAM0052972	42.0239438	-121.5320299	NULL	Yes	No
KLAM0052973	42.10447674	-121.667747	NULL	Yes	Yes
KLAM0053043	42.020463	-121.567589	NULL	Yes	Yes
KLAM0053049	42.32084886	-121.6985086	NULL	Yes	No
KLAM0053080	42.118156	-121.512458	NULL	Yes	No
KLAM0053142	42.1489354	-121.7573287	NULL	Yes	Yes
KLAM0053201	42.0183	-121.51177	NULL	Yes	No
KLAM0053250	42.00540236	-121.4081472	NULL	Yes	No
KLAM0053269	42.02059791	-121.5026313	NULL	Yes	Yes
KLAM0053320	42.14507	-121.87567	NULL	No	No
KLAM0053340	42.01900812	-121.346375	NULL	Yes	No
KLAM0053571	42.14495	-121.87573	NULL	Yes	No
KLAM0053581	42.13227	-121.49426	NULL	No	No
KLAM0053717	42.05297663	-121.5906648	NULL	Yes	Yes
KLAM0053732	42.14872494	-121.7574006	NULL	Yes	No
KLAM0053736	42.13388	-121.4862	NULL	Yes	No
KLAM0053737	42.14247725	-121.6309298	NOAC	No	No

Well ID	*Latitude*	*Longitude*	*Flowmeter Status*	*Flowmeter Analyzed*	*Water Level Measured*
KLAM0053738	42.03145	-121.37374	NULL	Yes	No
KLAM0053747	42.04069703	-121.5558284	NULL	Yes	No
KLAM0053755	42.191298	-121.675246	NULL	Yes	Yes
KLAM0053757	42.031744	-121.408369	NULL	Yes	No
KLAM0053758	42.028477	-121.490057	NULL	Yes	No
KLAM0053778	42.07815315	-121.8777643	NULL	Yes	Yes
KLAM0053779	42.16821	-121.51206	NULL	Yes	No
KLAM0053792	42.04593	-121.46021	NULL	Yes	No
KLAM0053940	42.12601404	-121.7826528	NULL	Yes	No
KLAM0054078	42.17725308	-121.6590972	NULL	Yes	No
KLAM0054305	42.13239	-121.49103	NULL	Yes	No
KLAM0054561	42.09700785	-121.697917	NULL	Yes	No
KLAM0055747	42.048897	-121.742004	BRK	No	No
KLAM0055767	42.0022455	-121.5607101	NULL	Yes	No
KLAM0056330	42.054849	-121.536524	NULL	Yes	No
KLAM0056425	42.02915013	-121.5015753	NULL	Yes	No
KLAM0056426	42.02755392	-121.4824049	NULL	Yes	No
KLAM0057366	42.01654	-121.49259	NULL	Yes	No
KLAM0057367	42.1478	-121.54483	NULL	Yes	No
KLAM0057371	42.03295645	-121.4682703	NULL	Yes	No
KLAM0057372	42.04586209	-121.4430354	NULL	Yes	No
KLAM0057387	42.00173	-121.52201	NULL	Yes	No
KLAM0057403	42.02579	-121.50804	NULL	Yes	No
KLAM0057409	42.06301	-121.43782	NULL	Yes	No
KLAM0057410	42.00167	-121.58431	NULL	Yes	No
KLAM0057412	42.11821	-121.71939	SHAR	No	Yes
KLAM0057431	42.03778	-121.52647	NULL	Yes	No
KLAM0057552	42.2574993	-121.4628253	NULL	Yes	No
KLAM0057564	42.02971489	-121.8968673	BRK	No	No
KLAM0057565	42.03521609	-121.8991906	NULL	No	No
KLAM0057660	42.07136586	-121.2564354	NULL	Yes	No
KLAM0058142	42.027619	-121.393706	NULL	Yes	No
KLAM0058146	42.03628	-121.3583	NULL	Yes	No
KLAM0058293	42.00138692	-121.5512489	NULL	Yes	No
KLAM0058594	42.01599751	-121.5019679	NULL	Yes	No
KLAM0058839	42.11002681	-121.1941048	NULL	Yes	No
KLAM0058848	42.25193631	-121.6055472	NULL	Yes	No
KLAM0059347	42.065134	-121.767242	NULL	Yes	No
KLAM0059380	42.02723	-121.20205	NULL	Yes	No
KLAM0060671	42.104224	-121.778624	NULL	Yes	No
KLAM0060840	42.011319	-121.239789	NULL	Yes	No

Well ID	*Latitude*	*Longitude*	*Flowmeter Status*	*Flowmeter Analyzed*	*Water Level Measured*
KLAM0061036	42.061698	-121.761306	NULL	No	No
KLAM0061160	42.06762503	-121.7730201	NULL	Yes	No
LAKE0051215	42.08969706	-121.6761037	BRK	No	Yes

Flowmeter Status

BRK	Flowmeter broken or possibly broken
NEW	New flowmeter or different flowmeter from last visit
NOAC	No access to well or flowmeter
NOFM	No flowmeter located
PTU	Partial use was measured at this visit
RBT	Flowmeter was rebuilt or possibly rebuilt
SHAR	Shared flowmeter between > 1 well

Appendix B

List of wells visited for 2024 synoptic water level measurements

Well ID	*Latitude*	*Longitude*	*Measurement Date*	*Water Level (BLSD)*	*Measured By*
KLAM0002277	42.3417099	-121.66779	10/22/2024	33.87	OWRD
KLAM0010013	42.1283878	-121.8105832	11/1/2024	78.91	OWRD
KLAM0010252	42.15698585	-121.4780849	10/23/2024	50.64	OWRD
KLAM0010253	42.1329779	-121.9150682	10/9/2024	157.68	USGS
KLAM0010258	42.1768023	-121.4508019	10/23/2024	46.74	OWRD
KLAM0010362	42.13663985	-121.248076	10/22/2024	8.39	OWRD
KLAM0010462	42.0387262	-121.4280086	10/29/2024	111.7	OWRD
KLAM0010478	42.04702846	-121.4490286	10/31/2024	123.67	OWRD
KLAM0010518	42.0640827	-121.6784444	10/28/2024	74.56	OWRD
KLAM0010574	42.0081908	-121.2357299	10/22/2024	79.21	OWRD
KLAM0010814	42.18117315	-121.3357208	10/22/2024	10.02	OWRD
KLAM0010948	42.18378815	-121.6991117	10/10/2024	17.61	USGS
KLAM0011059	42.1231508	-121.678907	10/10/2024	50.21	USGS
KLAM0011139	42.2353246	-121.5210406	10/22/2024	37.18	OWRD
KLAM0011254	42.0208437	-121.405944	10/30/2024	98.58	OWRD
KLAM0011656	42.2613827	-121.7950383	10/10/2024	209.47	USGS
KLAM0011950	42.22862549	-121.7619474	10/10/2024	66.85	USGS
KLAM0012487	42.2078098	-121.7053818	10/10/2024	73.28	USGS
KLAM0012925	42.189206	-121.670425	10/30/2024	55.77	OWRD
KLAM0013353	42.20327996	-121.408991	10/22/2024	46.85	OWRD
KLAM0013400	42.20073639	-121.3565348	10/22/2024	141.66	OWRD

Well ID	*Latitude*	*Longitude*	*Measurement Date*	*Water Level (BLSD)*	*Measured By*
KLAM0013456	42.21954245	-121.4681033	10/22/2024	23.19	OWRD
KLAM0013491	42.1702877	-121.5138608	10/23/2024	107.68	OWRD
KLAM0013582	42.1511299	-121.3302969	10/22/2024	10.11	OWRD
KLAM0013800	42.0641717	-121.8509002	10/9/2024	10.57	USGS
KLAM0013812	42.04587679	-121.9050771	10/9/2024	172.51	USGS
KLAM0014525	42.10445837	-121.7643502	10/10/2024	55.56	USGS
KLAM0014559	42.0566123	-121.7472318	10/29/2024	62.66	OWRD
KLAM0014563	42.06308698	-121.761149	10/8/2024	54.75	USGS
KLAM0014625	42.0981072	-121.661531	10/31/2024	150.69	OWRD
KLAM0014777	42.05316307	-121.5363329	10/29/2024	163.53	OWRD
KLAM0014781	42.0548382	-121.5238632	10/8/2024	305.12	USGS
KLAM0014829	42.0675277	-121.4578849	10/31/2024	274.53	OWRD
KLAM0014844	42.05289009	-121.4004032	10/30/2024	177.94	OWRD
KLAM0014882	42.12083496	-121.2204964	10/22/2024	29.43	OWRD
KLAM0014913	42.0195138	-121.70428	10/23/2024	20.65	OWRD
KLAM0014914	42.0239221	-121.7011273	10/29/2024	189.11	OWRD
KLAM0014915	42.01641118	-121.699352	10/23/2024	25.39	OWRD
KLAM0014918	42.02438775	-121.6007001	10/8/2024	76.32	USGS
KLAM0014966	42.02212117	-121.5993084	10/10/2024	15.97	USGS
KLAM0015045	42.03883501	-121.3805742	10/30/2024	37.18	OWRD
KLAM0015050	42.0418352	-121.375722	10/30/2024	176.26	OWRD
KLAM0015051	42.041883	-121.404585	10/30/2024	10.15	OWRD

Well ID	*Latitude*	*Longitude*	*Measurement Date*	*Water Level (BLSD)*	*Measured By*
KLAM0015105	41.9976	-121.3967	10/21/2024	5.03	OWRD
KLAM0015114	42.0246167	-121.3446656	10/30/2024	201.96	OWRD
KLAM0016807	42.1706009	-121.5775147	10/23/2024	22.3	OWRD
KLAM0050228	42.00341388	-121.889395	10/9/2024	118.01	USGS
KLAM0050318	42.19678157	-121.4011608	10/22/2024	6.37	OWRD
KLAM0050325	42.165647	-121.6855166	10/10/2024	8.59	USGS
KLAM0050493	42.2587953	-121.6438126	10/22/2024	138.71	OWRD
KLAM0050934	42.3000856	-121.4492272	10/22/2024	111.2	OWRD
KLAM0051130	42.1036473	-121.7617556	10/10/2024	9.24	USGS
KLAM0051131	42.1401223	-121.4869345	10/23/2024	20.41	OWRD
LAKE0051215	42.08969706	-121.6761037	10/28/2024	35.43	OWRD
KLAM0051602	42.05193959	-121.4376369	10/30/2024	177.44	OWRD
KLAM0051611	42.03168768	-121.4185139	10/30/2024	94.17	OWRD
KLAM0051612	42.0138915	-121.3803157	10/30/2024	45.19	OWRD
KLAM0051795	42.06593318	-121.4678627	10/30/2024	299.77	OWRD
KLAM0051920	42.17677627	-121.3374117	10/22/2024	19.77	OWRD
KLAM0051922	42.19834415	-121.3969723	10/22/2024	7.09	OWRD
KLAM0052096	42.15067816	-121.2614517	10/22/2024	55.03	OWRD
KLAM0052194	42.05306726	-121.4427981	10/31/2024	186.93	OWRD
KLAM0052204	42.15067816	-121.2614517	10/22/2024	32.22	OWRD
KLAM0052697	42.100044	-121.67088	10/28/2024	24.84	OWRD
KLAM0052706	42.041009	-121.4631258	10/29/2024	90.72	OWRD

Well ID	*Latitude*	*Longitude*	*Measurement Date*	*Water Level (BLSD)*	*Measured By*
KLAM0052795	42.015141	-121.512356	10/31/2024	66.37	OWRD
KLAM0052797	42.082561	-121.709375	10/28/2024	63.62	OWRD
KLAM0052864	42.14303	-121.876573	10/29/2024	58.74	OWRD
KLAM0052910	42.05940542	-121.575613	10/29/2024	125.89	OWRD
KLAM0052923	42.07535831	-121.7148688	10/24/2024	104.98	OWRD
KLAM0052970	42.10981	-121.79943	10/29/2024	55.85	OWRD
KLAM0052973	42.10447674	-121.667747	10/31/2024	22.37	OWRD
KLAM0053043	42.020463	-121.567589	10/29/2024	68.76	OWRD
KLAM0053045	42.00128	-121.554918	10/29/2024	24.01	OWRD
KLAM0053142	42.1489354	-121.7573287	10/28/2024	34.19	OWRD
KLAM0053188	42.15916606	-121.7771847	10/28/2024	43.28	OWRD
KLAM0053269	42.02059791	-121.5026313	10/29/2024	68.6	OWRD
KLAM0053531	42.1487826	-121.7573204	10/28/2024	21.49	OWRD
KLAM0053717	42.05297663	-121.5906648	10/29/2024	58.62	OWRD
KLAM0053755	42.191298	-121.675246	10/30/2024	56.92	OWRD
KLAM0053771	42.09584428	-121.7893733	10/29/2024	24.79	OWRD
KLAM0053773	42.01862225	-121.6986104	10/23/2024	77.62	OWRD
KLAM0053778	42.07815315	-121.8777643	10/29/2024	37.82	OWRD
KLAM0054088	42.166895	-121.722358	11/1/2024	13.36	OWRD
KLAM0054529	42.138175	-121.6424	11/1/2024	67.85	OWRD
KLAM0057412	42.11821	-121.71939	11/1/2024	77.16	OWRD
KLAM0060224	42.023583	-121.601774	10/10/2024	72.63	USGS