Production Well W385 in Laws Wellfield

Two-Month Pumping Test

April, 2020

Inyo County Water Department

Los Angeles Department of water and Power

Executive Summary

The Los Angeles Department of Water and Power (LADWP) conducted a two-month pumping test in Well W385, located in the Laws Wellfield during the winter of 2019-20. The test was conducted in accordance with the Inyo/LA W385 Settlement Agreement and the amended Monitoring and Mitigation Plan approved by the Technical Group on December 13, 2019. The purpose of this report is to present the data collected during the pumping test. Groundwater levels within the potential area of influence were monitored to evaluate potential impacts to groundwater-dependent vegetation, a nearby private well, or the Fish Slough wetland due to the operation of W385. While groundwater level declines were observed in the vicinity of W385, there were no significant effects to sensitive resources during the pumping test based on measurements collected at 29 nearby monitoring wells.

Groundwater level changes in shallow monitoring wells north of Owens River during the pumping test varied from 1.1 feet rise to 0.8 feet decline. Groundwater levels in the shallow monitoring wells south of Owens River rose up to 1 foot. Groundwater level changes in the deeper monitoring wells varied between 9.5 feet of drawdown close to W385 and 0.2 foot of rise further away. In Fish Slough, groundwater levels rose in all monitoring wells during the pumping test at their typical seasonal trend.

No trigger groundwater levels were reached in any of the trigger wells selected to protect nearby resources during the pumping test. Groundwater quality samples were collected from 7 nearby wells (including W385) prior to pumping and at 8 wells near the conclusion of the pumping test. Based on general chemistry and isotope analyses of the samples, there were no significant changes in the groundwater quality as a result of the pumping test. All groundwater measurements collected during the pumping and recovery phases of the pumping test have been made available to relevant stakeholders. As of March 30, 2020, groundwater levels in the deep aquifer have recovered to pre-pumping levels. Shallow groundwater levels rose slightly following cessation of pumping and are expected to recover further as the stage of the Owens River rises due to higher spring flows. Finally, the groundwater level declines observed in the shallow aquifer were largely consistent with predictions made by the revised Bishop/Laws Groundwater Flow Model and contained in the Initial Study for the test.

Background

Original Design

LADWP installed wells W385 and W386 in Laws Wellfield to help dewater the shallow aquifer in the area surrounding a gravel mining operation. W385 was originally screened from 40 to 550 feet through the shallow and deep aquifers and W386 was originally screened from 50 to 550 feet. W385 and W386 were operated simultaneously from October 1987 to April 1989 for a total volume of 8,801 acre-feet. Due to pumping W385 and W386, groundwater levels in the shallow

aquifer had lowered in the vicinity of these wells and, surprisingly, on the south side of Owens River. As a result, approximately 300 acres of groundwater dependent vegetation mostly south of the Owens River, known as Five Bridges Area, were impacted. Consequently, LADWP stopped operating W385 and W386.

1993-94 Pumping Test

Following the signing of the Inyo County/Los Angeles Water Agreement (Water Agreement), ICWD and LADWP conducted a two-month pumping test of W385 and W386 during the winter of 1993-94.[1] Both wells were pumped simultaneously at a combined pumping rate of 16.3 cfs. Groundwater levels were monitored at monitoring wells north and south of the Owens River. As shown on the hydrographs in **Figure 1**, pumping W385 and W386 affected groundwater levels in all monitoring wells on both sides of the Owens River in both the deep and shallow aquifers.

Construction Modification

In 2014, LADWP modified W385 and W386 by sealing the portions of the wells screened to the shallow aquifer. [2] The upper approximately 330 feet and 360 feet were sealed in W385 and W386, respectively. This resulted in a substantial reduction in the pumping capacity of these wells (from 10.1 cfs to 2.8 cfs in W385 and from 6.2 cfs to 2.8 cfs in W386). A comparison of the original and modified W385 designs is presented in **Figure 2**. W386 original and modified designs were similar to that of W385.

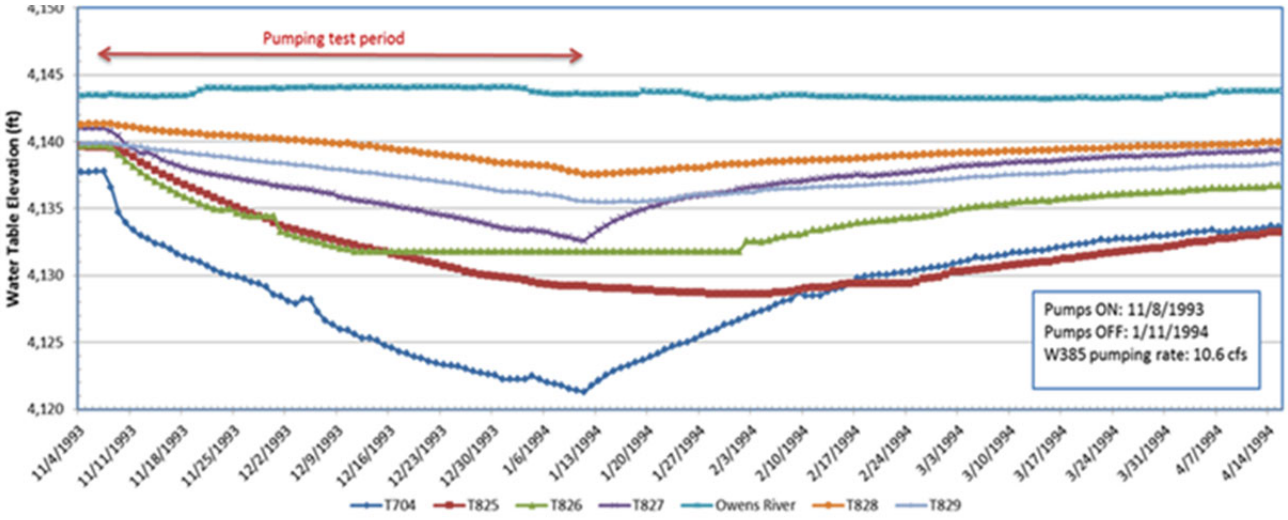

Figure 1 – Groundwater Hydrographs during W385 and W386 Pumping Tests in 1993-94

Original Modified

[1] ICWD. *Draft Report 94-1* (1994).
[2] LADWP. *Owens Valley Well Modification Project* (2015).

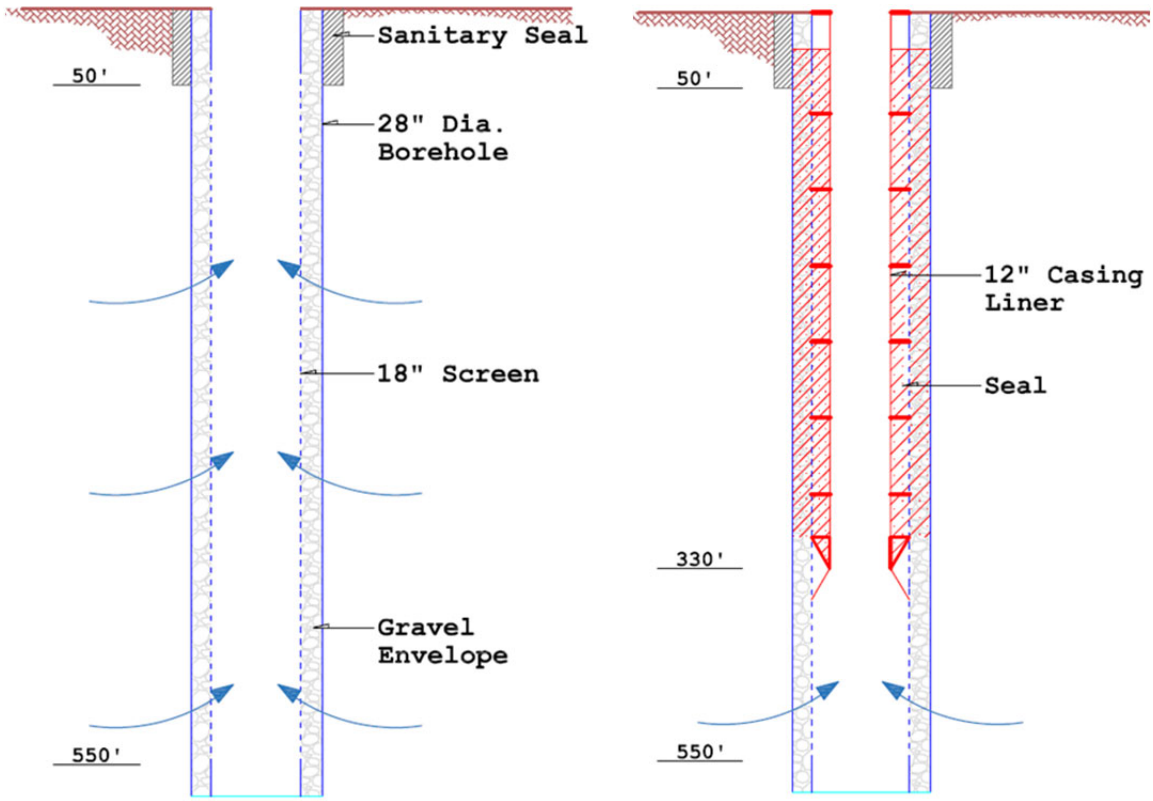

Figure 2 – Comparison of Original and Modified W385 Designs

After sealing the shallow portion of the screen, LADWP contractors conducted 24-hour pumping tests at W385 and W386, which exhibited no effects on shallow groundwater levels (**Figure 3).** Thus, LADWP started the process of activating wells W385 and W386.

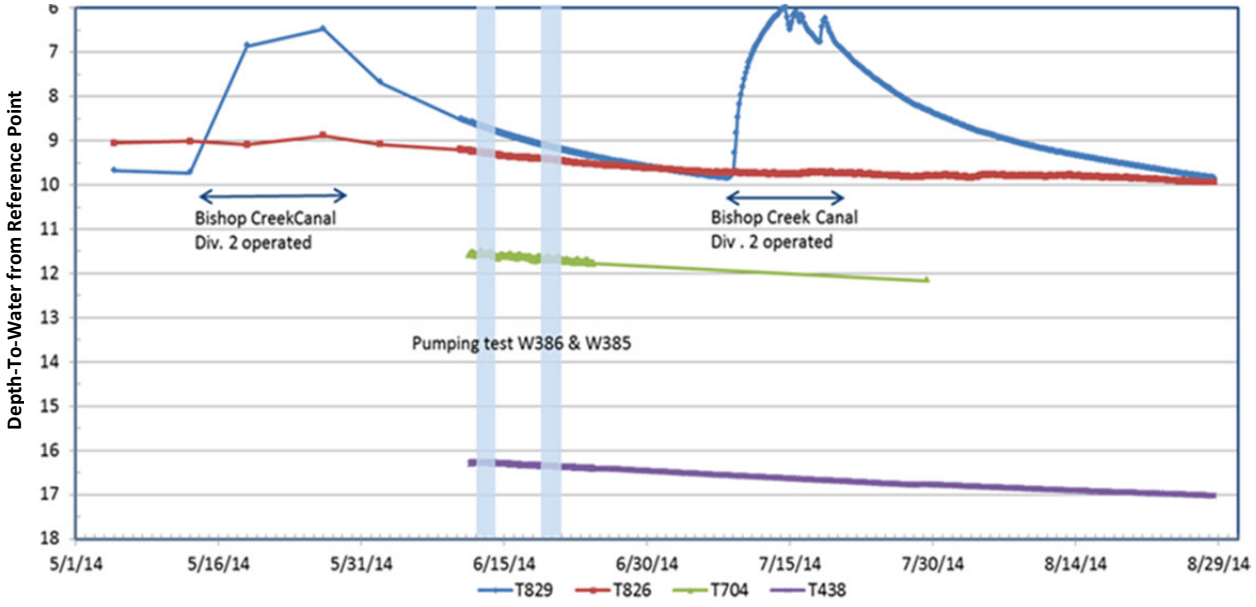

Figure 3 – W385 and W386 Pumping Tests in 2014

Pumping Test

Following concerns expressed regarding the potential effects of pumping the modified wells, LADWP decided to treat W385 and W386 as "new" wells and follow the new well activation process outlined in the Inyo-LA Long Term Water Agreement. While the "new" wells are located at the same locations as the original W385 and W386, the characteristics of these wells have significantly changed:

- W385 and W386 now extract water primarily from the deep aquifer.
- The combined pumping capacity of W385 (during 2-month test) and W386 (during 24-hour test) was significantly reduced and is now approximately 6.5 cfs, compared with 16.3 cfs (a 60% reduction).

As part of operational pumping of W385 and W386, LADWP prepared CEQA documentation, which evaluated potential impacts of operating W385 and W386 on environmental resources. Following settlement of litigation over the CEQA documentation, LADWP conducted a two-month pumping test of W385 (without operating W386) over the winter period of 2019-20 in accordance with a Monitoring and Mitigation Plan adopted by the Technical Group. The test design was similar to the 1993-94 pumping test, and monitored the groundwater levels at nearby wells jointly selected by ICWD and LADWP, which included additional shallow and deep monitoring wells in Fish Slough Area installed at the request of California Department of Fish and Wildlife (CDFW). The 2019-20 pumping test of W385 was conducted to provide the following:

- To document the effectiveness of modifying W385 in minimizing the impact of pumping these wells on shallow groundwater levels nearby,
- To compare the groundwater level measurements from the 1993-94 and 2019-20 tests and groundwater models which provide a good indication of the effect of operating W385 on shallow groundwater level and, consequently, the nearby resources,
- To utilize data from the pumping test to recalibrate the Bishop/Laws groundwater flow model in the area near W385 and to utilize the model to simulate the long-term operation of this well.

Hydrologic Monitoring

Timeline

Pumping at W385 commenced at 10:00 am on December 16, 2019 and continued for 64 days, terminating on February 18, 2020 ("pumping phase"). The pumping rate was measured using a flow meter. The average pumping rate for the entire period of pumping was approximately 3.7 cfs and the total volume pumped during the test was approximately 463 acre-feet. Groundwater levels at wells in the surrounding area and the stage (surface water elevation) of nearby surface water features were also monitored before, during, and after the pumping phase of the test.

After completion of pumping phase of the test, surface and groundwater monitoring continued until the end of March 2020 ("recovery phase"). A timeline of the pumping test is presented in **Figure 4**.

Surface Water Hydrology

Since early 2000, LADWP has diverted water from Diversion #2 of the Bishop Creek Canal three times per year to promote vegetation recovery in the Five Bridges Area. The operation of this diversion raises groundwater levels in the Five Bridges Area south of Owens River (see T829 data in **Figure 2**). In order to isolate any influence on groundwater levels due to W385 pumping from that of this diversion operation, LADWP stopped releasing water from this diversion during the course of the pumping test.

Fish Slough, located north of W385 (location map in **Figure 5**), is another surface water feature that supplies water to Fish Slough Ditch, which flows south to Owens River. Flow out of Fish Slough, measured at monitoring station 3216, demonstrates a seasonal characteristic (**Figure 6**). Annual flows range between 1.4 cfs in the summer and 11 cfs in the winter since April 2001. Flow from Fish Slough is recorded daily by LADWP and has been declining over the past several decades.

McNally Canals, which divert water from the Owens River, are used to carry out spreading and irrigation in the Laws area. To isolate any effects on groundwater levels due to W385 pumping from that of operating McNally Canals, LADWP ceased operation of the canals in October 2019.

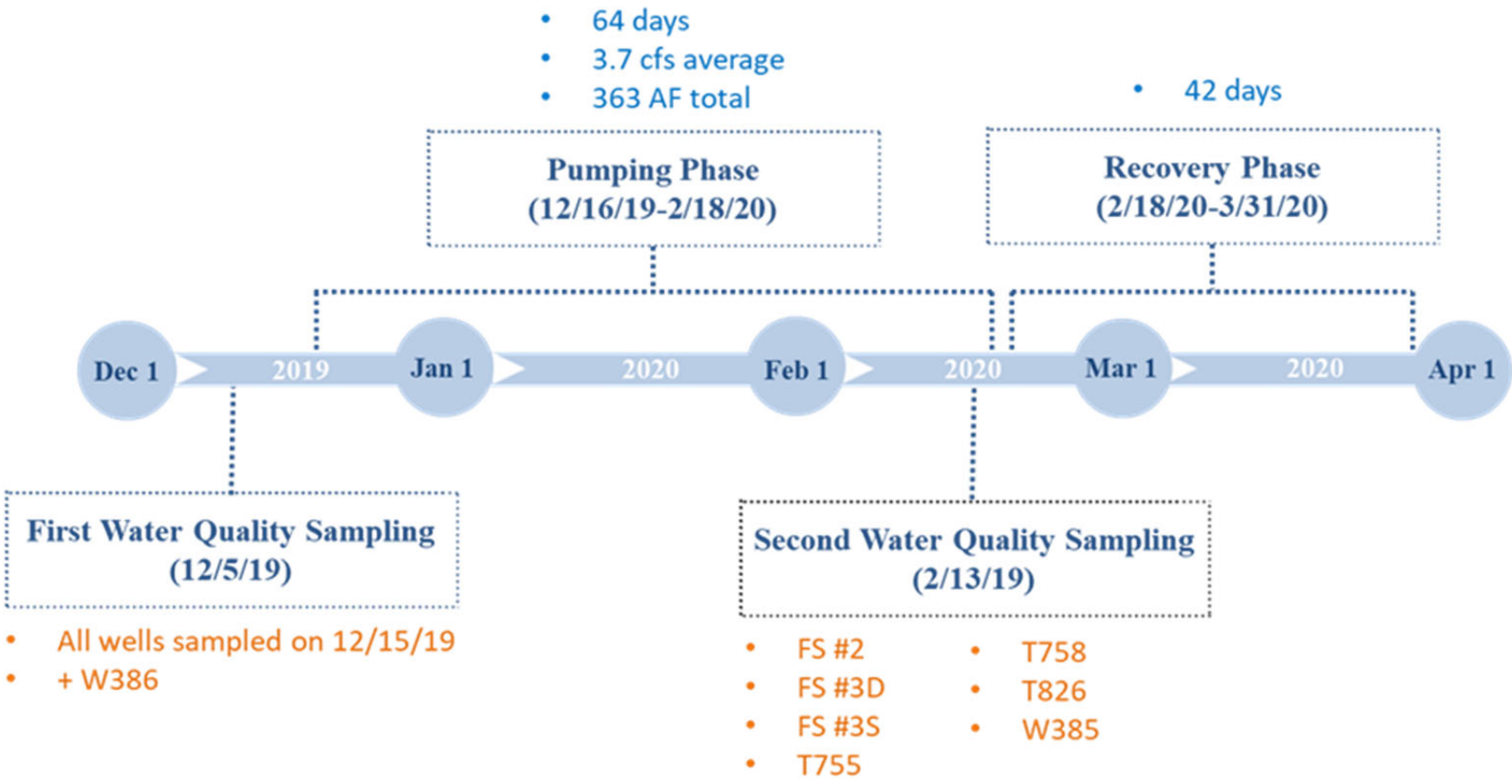

Figure 4 - W385 Two-Month Pumping Test Timeline

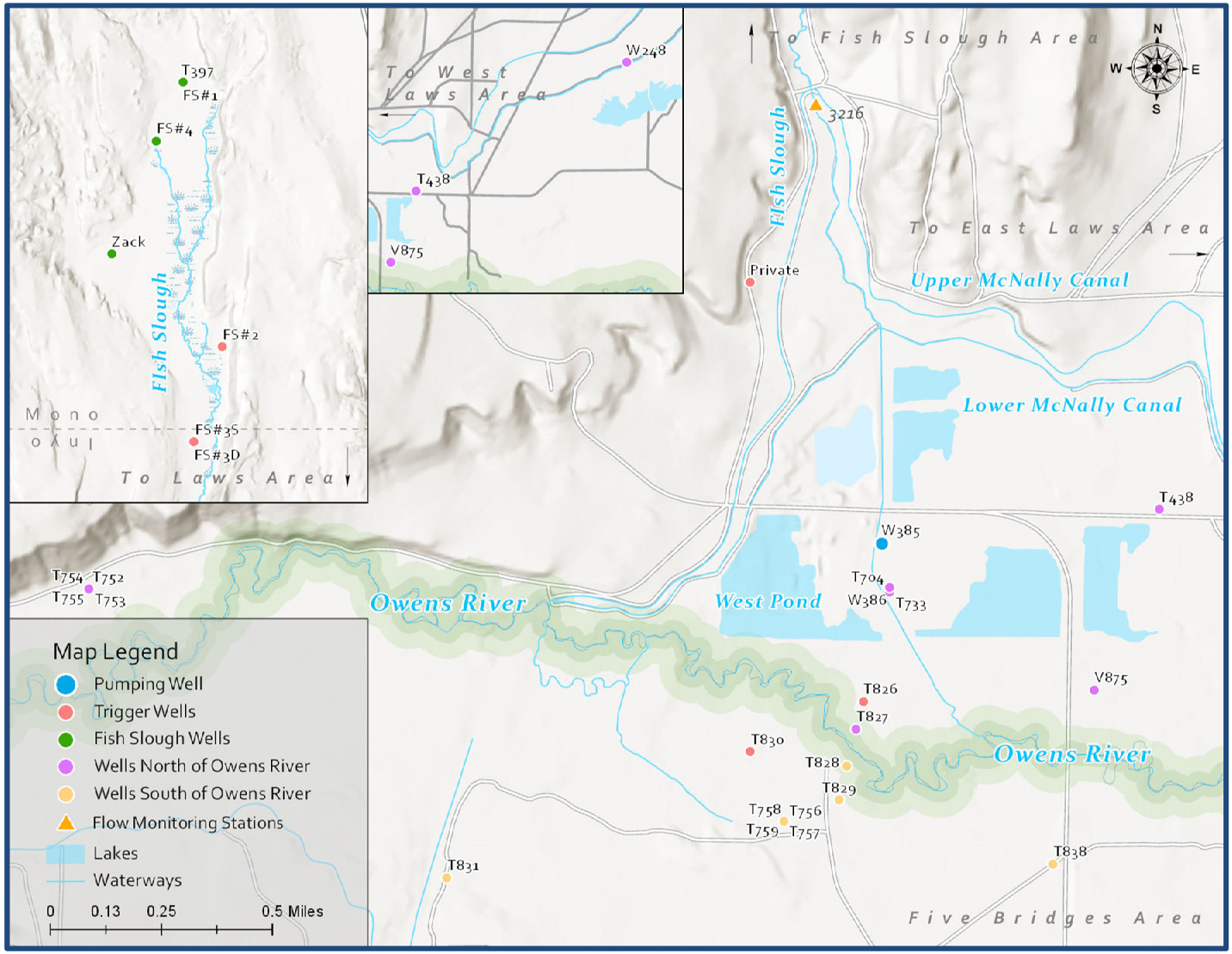

Figure 5 - Map of Laws and Fish Slough Areas

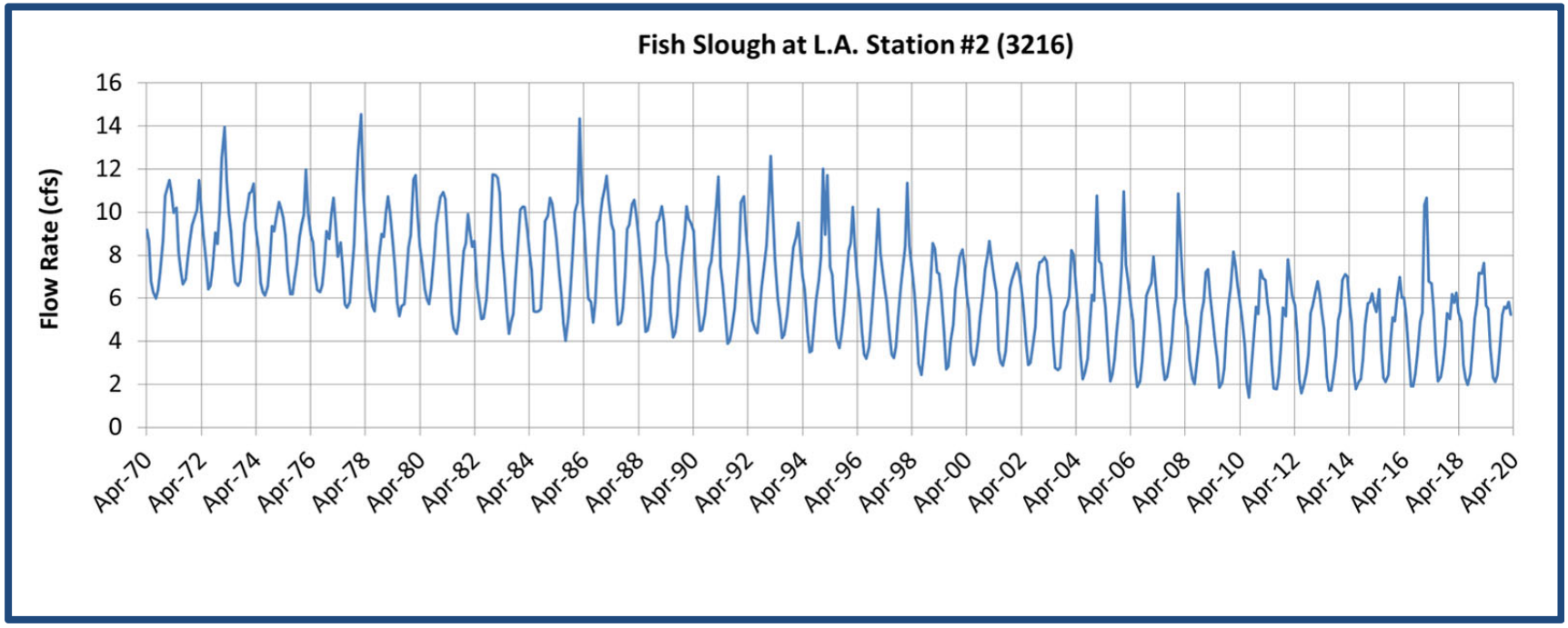

Figure 6 – Historical Flow Out of Fish Slough at Monitoring Station 3216

To measure and separate the effect of changes in the stage of surface water features from the effect of groundwater pumping on groundwater levels in the shallow aquifer, LADWP maintained the outflow from Pleasant Valley Reservoir at approximately 150 cfs from November 15, 2020 to March 2, 2020, and monitored stage at both the Owens River and the gravel pit's West Pond throughout the course of the pumping test. After March 2, 2020, outflow from Pleasant Valley Reservoir reduced to 125 cfs, due to forecasting a dryer than normal runoff year. LADWP personnel installed a staff gauge along a transect connecting monitoring wells T827 and T828 to monitor stage in Owens River. The water level in West Pond, located west of W385, was monitored using a staff gauge installed in the pond. Both staff gauges measured stage daily throughout the pumping test. The locations of Owens River and West Pond are indicated on the map in **Figure 5**.

Groundwater Level Monitoring

To evaluate the effect of pumping W385, ICWD and LADWP personnel monitored groundwater levels at 29 wells located north and south of Owens River. The locations of these monitoring wells are displayed in **Figure 5**.

The groundwater levels at most monitoring wells were monitored by LADWP. ICWD monitored the groundwater levels at select wells in the Fish Slough area (Private Well, Zack Well, and all FS Wells). Most monitoring wells (except Private Well, FS#4, and W248) were equipped with pressure transducers that recorded groundwater levels every hour. The other wells were measured manually with an electric sounder on weekly and bi-weekly bases. A list of the measurement reference points (RPs), depths, and distances from W385 of each well is presented in **Table 1**. Reference points are presented as offsets above ground surface and elevations above mean sea level.

Data from the transducers were downloaded at approximately 10:00 am on days 3, 7, 14, 21, 28, 42, and 60 of the pumping phase, and on days 14, 28, and 56 of the recovery phase. They were transmitted to ICWD and CDFW after performing QA/QC.

Trigger Levels

To ensure that pumping W385 during the test will not impact nearby resources, six wells were selected as trigger wells with assigned trigger levels. Based on ICWD and LADWP's Monitoring Plan, [3] if the groundwater in any of the trigger wells were to reach their respective trigger levels, the pumping phase of the test would stop and recovery data will be collected. ICWD, CDFW, and LADWP assigned groundwater "trigger levels" to wells T830, T826, Private Well, FS #2, FS #3S, and FS #3D located in areas with groundwater dependent vegetation approximately one

[3] LADWP. Pumping Test of W385R in the Laws Wellfield Monitoring Plan (2016).

week before the start of the pumping test (**Table 2**). An additional trigger level was assigned to the Private Well to protect its use as a domestic supply well. No trigger levels were reached during the pumping test.

Table 1 – Characteristics of Wells Monitored during the Pumping Test of W385

Well	Total Depth (ft)	RP Offset from Ground (ft)	RP Elevation (ft-amsl)	Distance from W385 (mi)
FS #1	61	1.82	4201.82*	7.1
FS #2	46	1.80	4185.25	4.0
FS #3D	145	2.59	4194.84	2.8
FS #3S	35	2.76	4194.22	2.8
FS #4	8	1.98	4221.98*	6.4
Private Well	160	1.00	4186.00*	0.6
T397	180	1.87	4230.07	7.1
T438	37	3.21	4142.11	0.6
T704	32	2.33	4150.63	0.1
T733	674	1.44	4151.24	0.1
T752	680	2.97	4200.17	1.8
T753	100	1.97	4199.17	1.8
T754	210	3.82	4201.02	1.8
T755	490	2.99	4200.19	1.8
T756	45	2.00	4154.60	0.7
T757	310	2.26	4154.86	0.7
T758	575	2.24	4154.84	0.7
T759	210	1.78	4154.38	0.7
T826	17	0.94	4148.54	0.4
T827	16	0.25	4147.95	0.4
T828	15	0.98	4147.68	1.0
T829	17	1.98	4149.68	0.6
T830	14	1.05	4154.25	0.6
T831	10	0.99	4176.49	1.2
T838	37	1.89	4137.29	0.8
V875	21	1.84	4132.85	0.6
W248	602	0.28	4141.98	2.0
W385	560	-0.19		-
W386	560	3.64	4153.44	0.1
Zack	257	1.18	4227.18*	5.2

*Ground surface elevation (ft-amsl) was estimated using Google Earth, which provided the highest resolution imagery among other elevation databases.

Table 2 – Trigger Wells and Trigger Levels during W385 Pumping Test

Well	Trigger Level from RP (ft)	Trigger Level AMSL (ft)
T830	6.10	4148.15
T826	7.60	4140.94
Private Well	21.40	4164.60
FS #2	4.70	4180.55
FS #3S	15.30	4178.92
FS #3D	16.00	4178.84

Pumping Phase

Groundwater Levels

Wells measured during the pumping test, except W385, were grouped as Trigger, Fish Slough, North of Owens River, and South of Owens River monitoring wells. Trigger Wells are located in sensitive areas. The other categories are based on the geographical locations of the wells in the Laws area. The weekly groundwater level measurements at the wells of each category during the pumping phase are presented in **Table 3.** Daily data is presented in **Table A-1** in **Appendix A.** All groundwater level data entries are measured as a distance (ft) below Reference Point (RP). Negative numbers indicate a head above RP. The values presented are in the same format presented to relevant stakeholders during the course of the pumping test.

Surface Water Elevations

Monitoring data from staff gauge elevation data at West Pond and Owens River are also presented in **Table 3**. All data entries are presented as elevations above mean sea level (ft-amsl). All data entries presented are preliminary and subject to revision and were recorded at approximately 10:00 am each day.

Water Table Cross-Section

The changes in the shallow groundwater table and surface water elevations from the commencement to the end of the pumping phase in the Laws area are presented in **Figure 7**. Shallow groundwater level data at wells included from south to north are T756, T829, T828, T827, T826, T704, and T438. The stage of Owens River is included and located between T828 and T827. Groundwater and surface water level data are presented in ft-amsl. The position (on the x-axis) of each well is presented as a reference distance (ft) from T756. A satellite view of the cross section is presented in **Figure 8**.

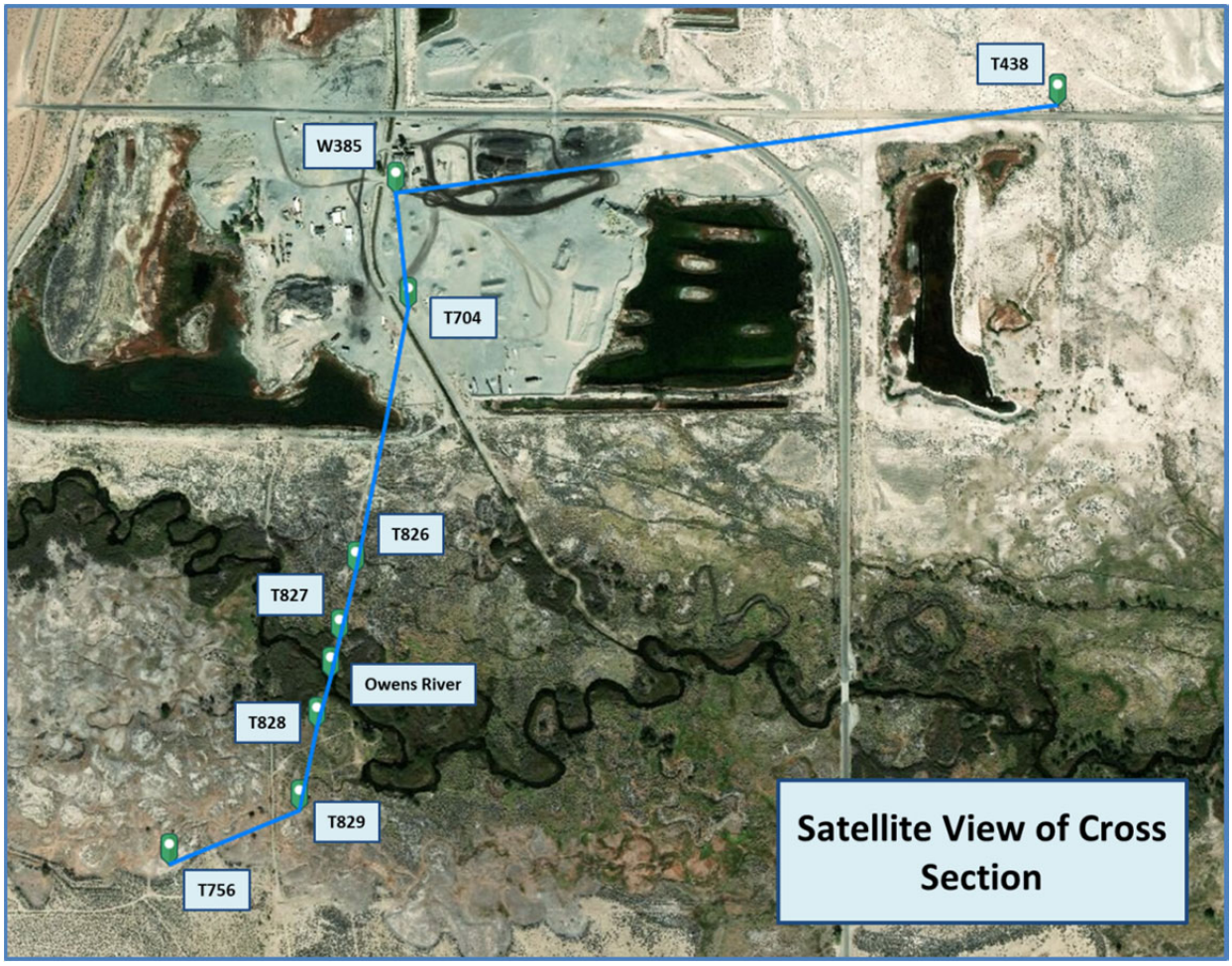

Figure 8– Satellite View of Laws Area Cross-Section

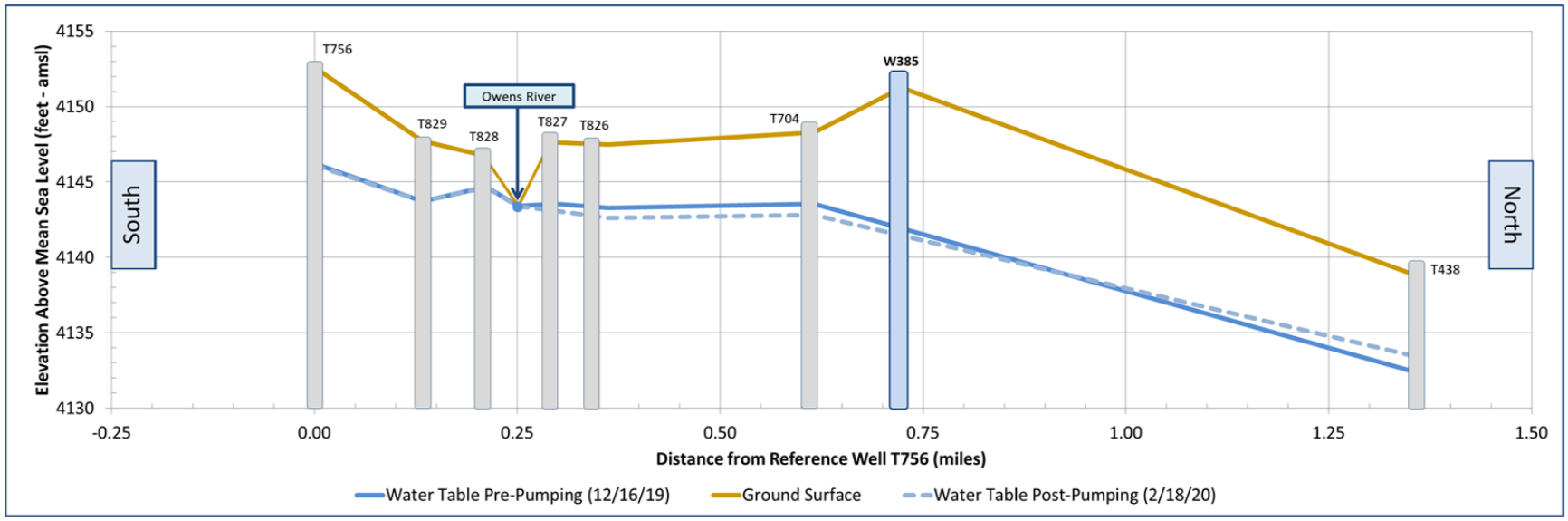

Figure 7 – Laws Area Water Table Cross-Section for Pumping Phase

Table 3 – Pumping Phase Weekly Groundwater Level and Stage Measurements

Week	Date	Depth to Groundwater from Reference Point										
		Pumping Well	Trigger Monitoring Wells						Fish Slough Monitoring Wells			
		W385	T826	T830	Private	FS#2	FS#3S	FS#3D	T397	Zack	FS#1	FS#4
0	12/16/19	Flowing	5.14	4.32	11.18	4.25	14.53	14.10	29.46	25.29	28.66	Dry
1	12/23/19	100.24	5.28	4.30	12.38	4.20	14.46	14.02	29.44	25.22	28.64	Dry
2	12/30/19	107.18	5.41	4.33	12.65	4.17	14.44	14.02	29.41	25.24	28.63	Dry
3	01/06/20	107.18	5.51	4.33	12.85	4.15	14.43	14.03	29.41	25.25	28.64	Dry
4	01/13/20	108.33	5.58	4.33	12.86	4.11	14.38	13.95	29.41	25.21	28.61	Dry
5	01/20/20	-	5.63	4.31	-	-	14.37	13.95	29.42	-	-	-
6	01/27/20	110.63	5.69	4.31	13.12	4.07	14.35	13.92	29.43	25.22	28.64	Dry
7	02/03/20	-	5.73	4.31	-	-	14.31	13.90	29.42	-	-	-
8	02/10/20	107.18	5.78	4.32	13.40	4.04	14.30	13.90	29.42	25.21	28.63	Dry
9	02/16/20	-	5.79	4.29	-	-	14.27	13.93	29.41	-	-	-
-	02/18/20	107.18	5.81	4.32	13.35	4.01	14.28	13.92	29.42	25.19	28.63	Dry
Week	Date	W385	T826	T830	Private	FS#2	FS#3S	FS#3D	T397	Zack	FS#1	FS#4

Week	Date	Depth to Groundwater from Reference Point										
		North of Owens River Monitoring Wells										
		T438	T704	T733	T752	T753	T754	T755	T827	V875	W248	W386
0	12/16/19	9.67	7.07	-3.31	-7.85	1.51	0.49	-8.10	4.29	4.81	-	7.81
1	12/23/19	9.71	7.13	-	-7.96	1.37	0.32	-8.17	4.43	4.27	20.51	15.88
2	12/30/19	9.83	7.32	5.42	-7.90	1.48	0.45	-8.10	4.52	4.29	27.44	16.20
3	01/06/20	9.97	7.43	5.65	-7.79	1.55	0.54	-8.09	4.58	4.24	27.44	16.51
4	01/13/20	10.00	7.48	5.64	-7.94	1.44	0.38	-8.22	4.63	4.20	27.44	16.53
5	01/20/20	10.11	7.55	5.77	-7.99	1.45	0.43	-8.20	4.64	4.14	-	16.73
6	01/27/20	10.17	7.62	5.89	-7.95	1.50	0.45	-8.16	4.69	4.15	28.60	16.87
7	02/03/20	10.21	7.61	5.85	-8.03	1.41	0.34	-8.24	4.71	4.12	-	16.83
8	02/10/20	9.80	7.74	6.07	-7.99	1.49	0.44	-8.20	4.75	4.11	27.44	17.01
9	02/16/20	8.90	7.79	6.11	-8.02	1.45	0.42	-8.23	4.76	4.05	-	17.04
-	02/18/20	8.60	7.81	6.13	-8.01	1.46	0.43	-8.21	4.76	4.06	27.44	17.06
Week	Date	T438	T704	T733	T752	T753	T754	T755	T827	V875	W248	W386

Week	Date	Depth to Groundwater from Reference Point								Staff Gauge Elevations Above Sea Level	
		South of Owens River Monitoring Wells									
		T756	T757	T758	T759	T828	T829	T831	T838	West Pond	Owens River
0	12/16/19	8.10	0.77	0.00	5.65	2.96	5.95	4.20	3.61	4149.25	4143.42
1	12/23/19	8.28	6.70	2.21	7.80	2.93	5.96	3.92	3.43	4149.12	4143.43
2	12/30/19	8.28	6.88	2.43	7.84	3.02	6.01	3.79	3.44	4148.97	4143.37
3	01/06/20	8.28	6.99	2.51	7.92	3.07	6.01	3.71	3.42	4148.91	4143.37
4	01/13/20	8.21	6.95	2.41	7.89	3.06	5.98	3.58	3.38	4148.67	4143.34
5	01/20/20	8.19	7.01	2.49	7.89	2.87	5.95	3.47	3.30	4148.52	4143.38
6	01/27/20	8.19	7.07	2.55	7.93	2.99	5.95	3.41	3.31	4148.40	4143.33
7	02/03/20	8.17	7.03	2.50	7.91	3.00	5.93	3.35	3.28	4148.23	4143.32
8	02/10/20	8.19	7.15	2.62	7.97	3.05	5.95	3.30	3.27	4148.09	4143.37
9	02/16/20	8.18	7.15	2.68	7.95	2.96	5.92	3.26	3.19	4147.96	4143.37
-	02/18/20	8.18	7.16	2.66	7.96	3.04	5.94	3.26	3.20	4147.92	4143.37
Week	Date	T756	T757	T758	T759	T828	T829	T831	T838	West Pond	Owens River

All data entries were recorded at approximately 10:00 am each day

Recovery Phase

Groundwater and Surface Water Levels

Weekly groundwater level and staff gauge elevations measured during the recovery phase are presented in **Table 4**. Daily data is presented in **Table A-2** in the **Appendix A.** All groundwater level data entries are measured as a distance (ft) below RP. Any negative number entries indicate

a head above RP. The values presented are in the same format presented to relevant stakeholders during the course of the pumping test. All stage entries are presented as elevations above mean sea level (ft-amsl). All data entries are also preliminary and subject to revision and were recorded at approximately 10:00 am each day.

Water Table

The diagram presented in **Figure 9** covers the same cross-section presented in **Figure 7** except it presents the changes in shallow groundwater table and surface water elevation from the beginning to the end of the recovery phase. Groundwater and surface water level data is presented in ft-amsl. The position (on the x-axis) of each well is presented as a reference distance (ft) from T756.

Table 4 – Recovery Phase Weekly Groundwater Level and Stage Measurements

Week	Date	Depth to Groundwater from Reference Point										
		Pumping Well	Trigger Monitoring Wells						Fish Slough Monitoring Wells			
		W385	T826	T830	Private	FS#2	FS#3S	FS#3D	T397	Zack	FS#1	FS#4
0	02/18/20	107.18	5.81	4.32	13.35	4.01	14.28	13.92	29.42	25.19	28.63	Dry
1	02/25/20	-	5.68	4.28	-	-	14.28	13.93	29.43	-	-	-
2	03/03/20	64.44	5.63	4.27	11.60	3.97	14.22	13.87	29.42	25.20	28.62	Dry
3	03/10/20	-	5.66	4.29	-	-	14.23	13.87	29.42	-	-	-
4	03/17/20	Flowing	5.62	4.25	-	3.95	14.20	13.82	29.40	25.16	28.63	Dry
5	03/24/20	-	5.64	4.27	-	-	14.20	13.83	29.41	-	-	-
6	03/31/20	Flowing	5.67	4.28	-	3.92	14.19	13.82	29.41	25.20	28.63	Dry
Week	Date	W385	T826	T830	Private	FS#2	FS#3S	FS#3D	T397	Zack	FS#1	FS#4

Week	Date	Depth to Groundwater from Reference Point										
		North of Owens River Monitoring Wells										
		T438	T704	T733	T752	T753	T754	T755	T827	V875	W248	W386
0	02/18/20	8.60	7.81	6.13	-8.01	1.46	0.43	-8.21	4.76	4.06	27.44	17.06
1	02/25/20	7.85	7.68	-2.74	-7.95	1.53	0.52	-8.16	4.56	4.03	-	-
2	03/03/20	7.34	7.72	-3.32	-8.07	1.48	0.42	-8.28	4.54	3.98	25.13	-0.67
3	03/10/20	6.99	7.81	-3.49	-8.10	1.55	0.48	-8.30	4.60	3.98	-	-
4	03/17/20	6.80	7.80	-3.70	-8.23	1.46	0.38	-8.41	4.56	3.92	26.29	Flowing
5	03/24/20	6.88	7.88	-3.76	-8.14	1.53	0.45	-8.35	4.57	3.89	-	-
6	03/31/20	7.16	7.92	-3.76	-8.12	1.59	0.52	-8.32	4.58	3.93	27.44	Flowing
Week	Date	T438	T704	T733	T752	T753	T754	T755	T827	V875	W248	W386

Week	Date	Depth to Groundwater from Reference Point								Staff Gage Elevations Above Sea Level	
		South of Owens River Monitoring Wells									
		T756	T757	T758	T759	T828	T829	T831	T838	West Pond	Owens River
0	02/18/20	8.18	7.16	2.66	7.96	3.04	5.94	3.26	3.20	4147.92	4143.37
1	02/25/20	7.82	0.36	-	5.28	2.96	5.87	3.16	3.23	4147.86	4143.37
2	03/03/20	7.74	-	-2.63	5.12	2.98	5.82	3.09	3.19	4147.77	4143.37
3	03/10/20	7.72	-	-	5.12	3.06	5.84	3.08	3.12	4147.75	4143.21
4	03/17/20	7.66	Flowing	Flowing	5.03	2.88	5.78	2.96	2.98	4147.72	4143.15
5	03/24/20	7.63	-	-	5.02	2.97	5.78	2.96	3.09	-	-
6	03/31/20	7.63	Flowing	Flowing	5.03	2.97	5.80	2.96	3.09	4147.64	4143.24
Week	Date	T756	T757	T758	T759	T828	T829	T831	T838	West Pond	Owens River

All data entries were recorded at approximately 10:00 am each day

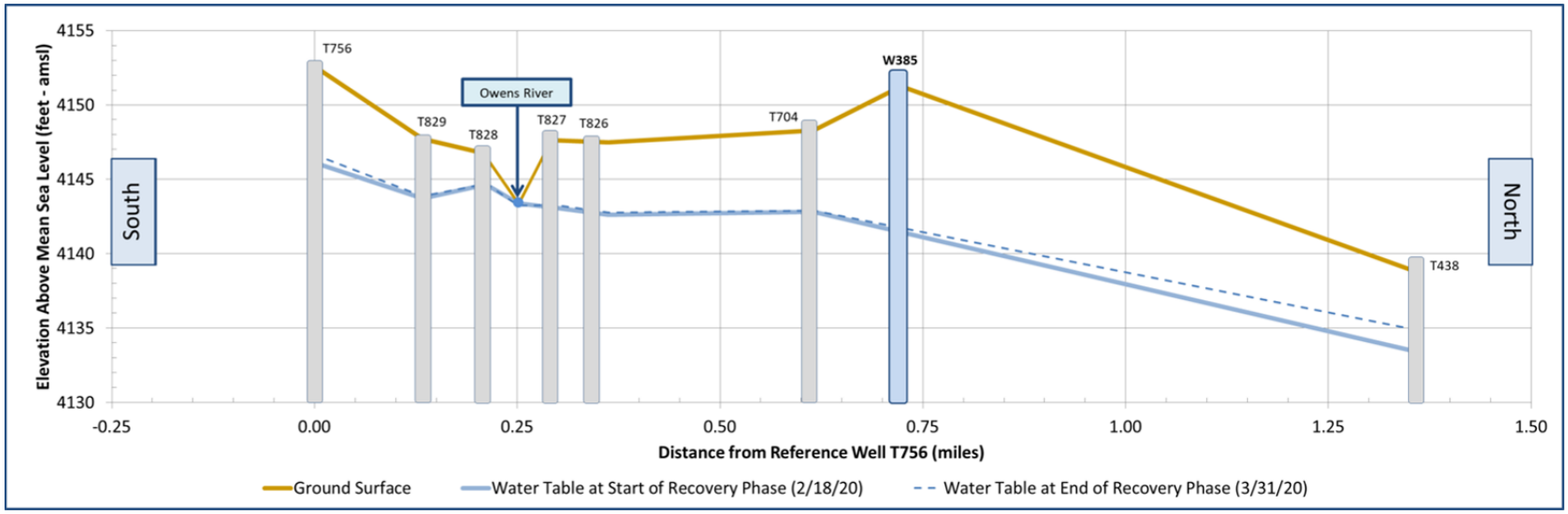

Figure 9 – Laws Area Water Table Cross-Section for Recovery Phase

Select Hydrographs

Pumping and Recovery Phase Hydrographs

Along with a spreadsheet of groundwater level and stage measurements, LADWP submitted select hydrographs of the groundwater levels at W385 and the six trigger monitoring wells to ICWD and CDFW. Hydrographs show changes in groundwater levels during both the pumping and the recovery phases. The hydrographs of W385, T826, T830, Private Well, FS #2, FS#3S, and FS#3D are presented in **Figures 10 to 16**, respectively. Hydrographs of the rest of wells monitored during the pumping test are presented in **Appendix B**. A hydrograph of flow rate at monitoring station 3216 is presented in **Figure 17**.

The groundwater level and stage measurements at the start and end of the pumping phase and recovery phase are presented in **Table 5**. The groundwater level in this section is presented as a "distance from ground surface (feet)", where negative values indicate level below ground and positive values indicate level above ground. The hydrographs are presented in the same manner. Data is presented using Distance to Water instead of Depth to Water to reduce confusion regarding the datum.

Table 5 – Pumping Test Groundwater Level and Stage Measurements

Date	Distance from Ground Surface (feet)										
	Pumping Well	Trigger Monitoring Wells						Fish Slough Monitoring Wells			
	W385	T826	T830	Private	FS#2	FS#3S	FS#3D	T397	Zack	FS#1	FS#4
12/16/19	Flowing	-4.20	-3.27	-10.18	-2.45	-11.77	-11.51	-27.59	-24.11	-26.84	Dry
02/18/20	107.37	-4.87	-3.27	-12.35	-2.21	-11.52	-11.33	-27.55	-24.01	-26.81	Dry
03/31/20	Flowing	-4.73	-3.23	-	-2.12	-11.43	-11.23	-27.54	-24.02	-26.81	Dry

Date	Distance from Ground Surface (feet)										
	North of Owens River Monitoring Wells										
	T438	T704	T733	T752	T753	T754	T755	T827	V875	W248	W386
12/16/19	-6.46	-4.74	4.75	10.82	0.46	3.33	11.09	-4.04	-2.97	-	-4.17
02/18/20	-5.39	-5.48	-4.69	10.98	0.51	3.39	11.20	-4.51	-2.22	-27.16	-13.42
03/31/20	-3.95	-5.59	5.20	11.09	0.38	3.30	11.31	-4.33	-2.09	-27.16	Flowing

Date	Distance from Ground Surface (feet)								Staff Gauge Elevations Above Sea Level (feet)	
	South of Owens River Monitoring Wells									
	T756	T757	T758	T759	T828	T829	T831	T838	West Pond	Owens River
12/16/19	-6.10	1.49	2.24	-3.87	-1.98	-3.97	-3.21	-1.72	4149.25	4143.42
02/18/20	-6.18	-4.90	-0.42	-6.18	-2.06	-3.96	-2.27	-1.31	4147.92	4143.37
03/31/20	-5.63	Flowing	Flowing	-3.25	-1.99	-3.82	-1.97	-1.20	4147.64	4143.24

All data entries were recorded at approximately 10:00 am each day

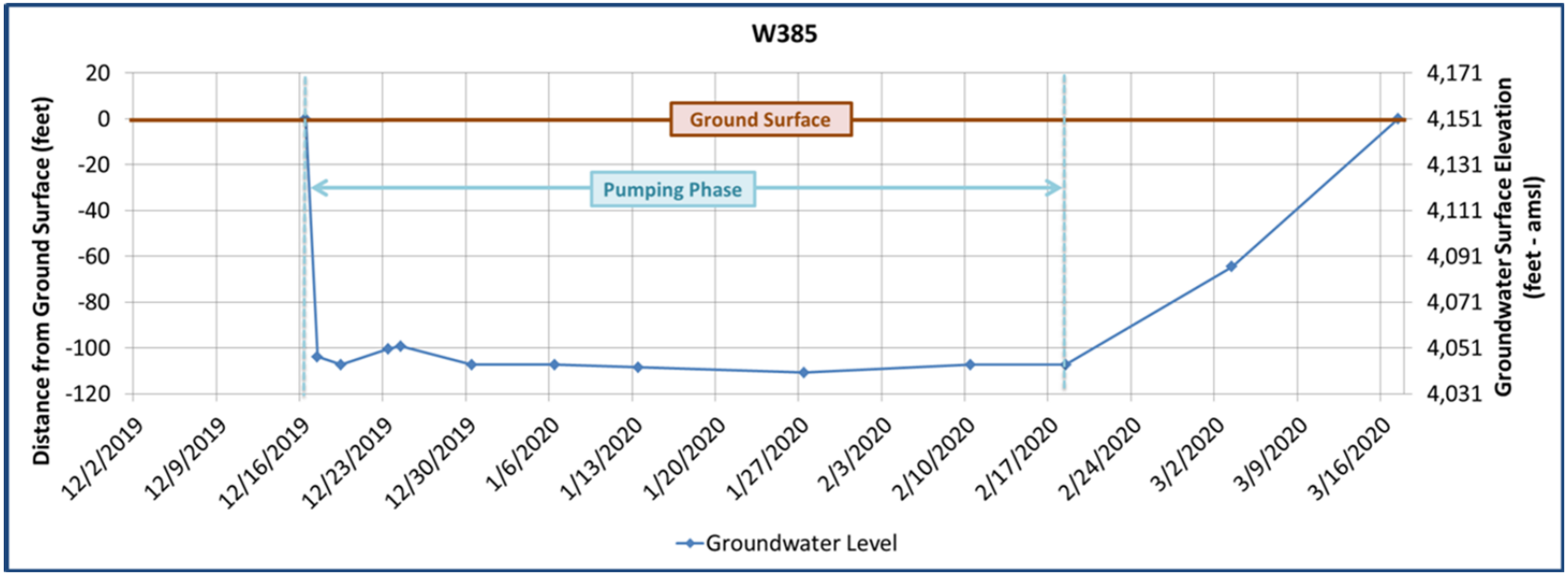

Figure 10

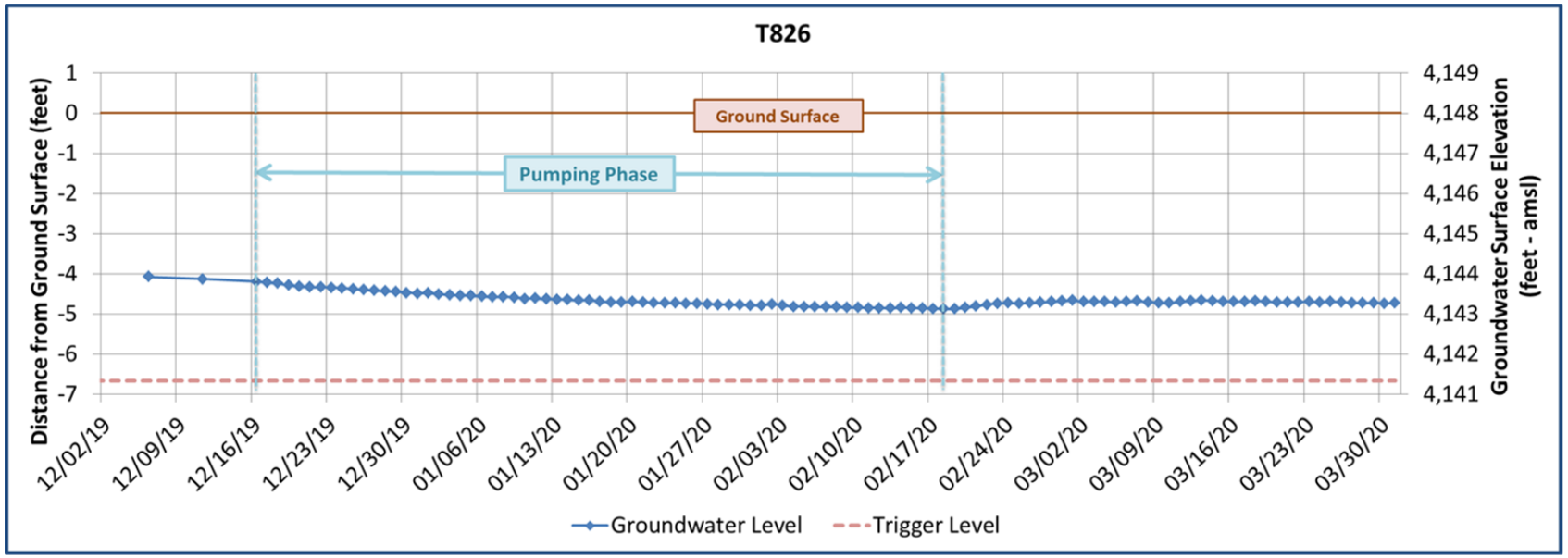

Figure 11

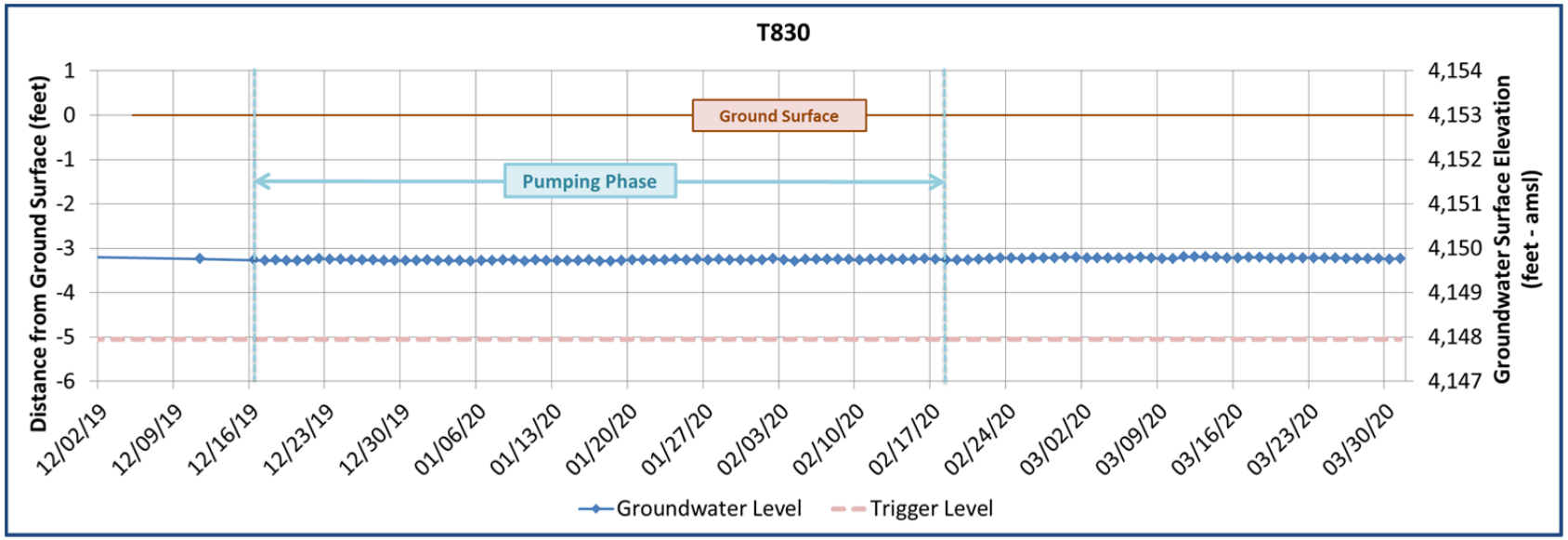

Figure 12

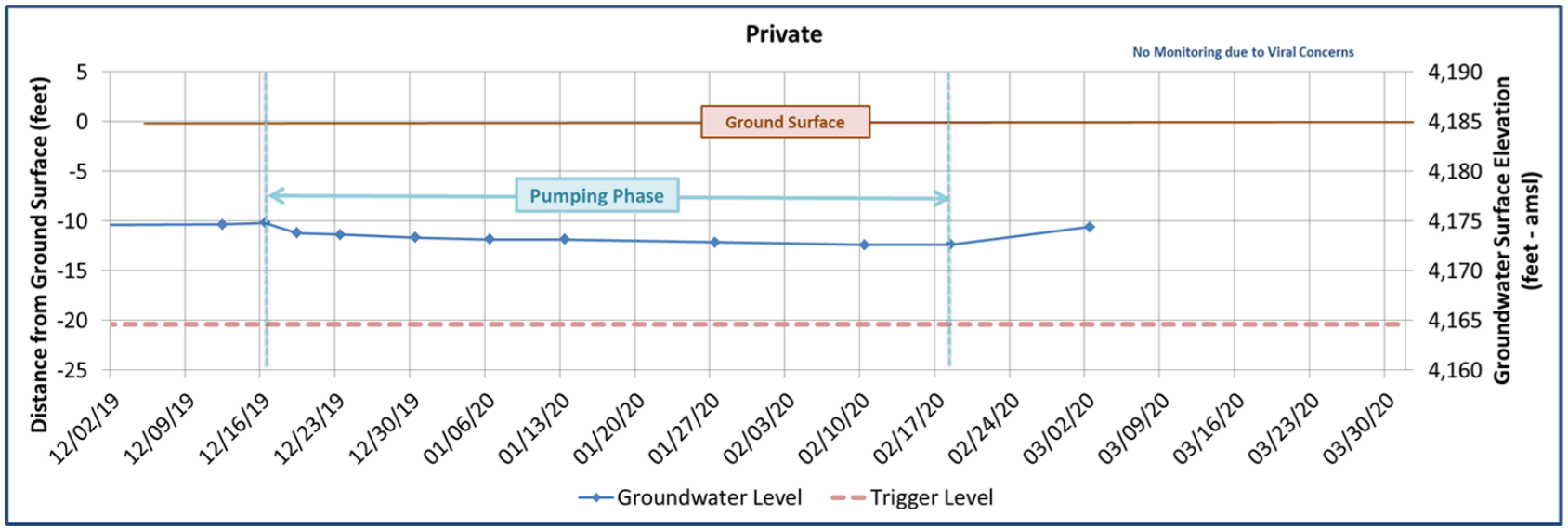

Figure 13

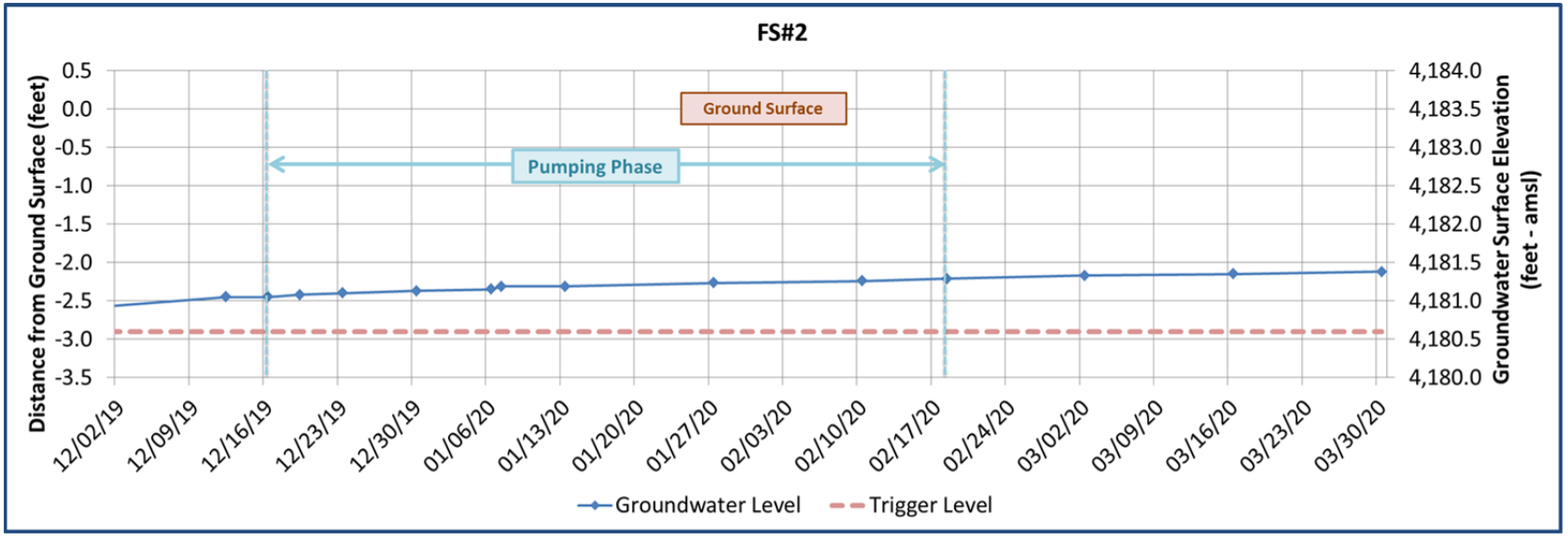

Figure 14

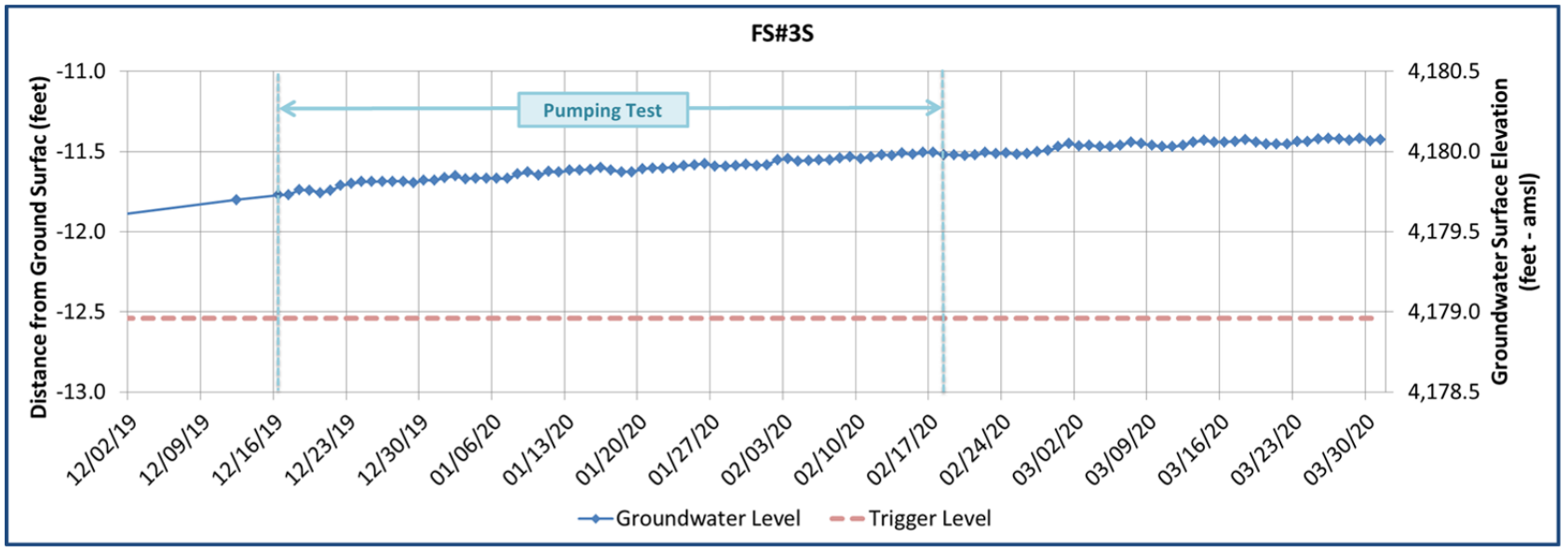

Figure 15

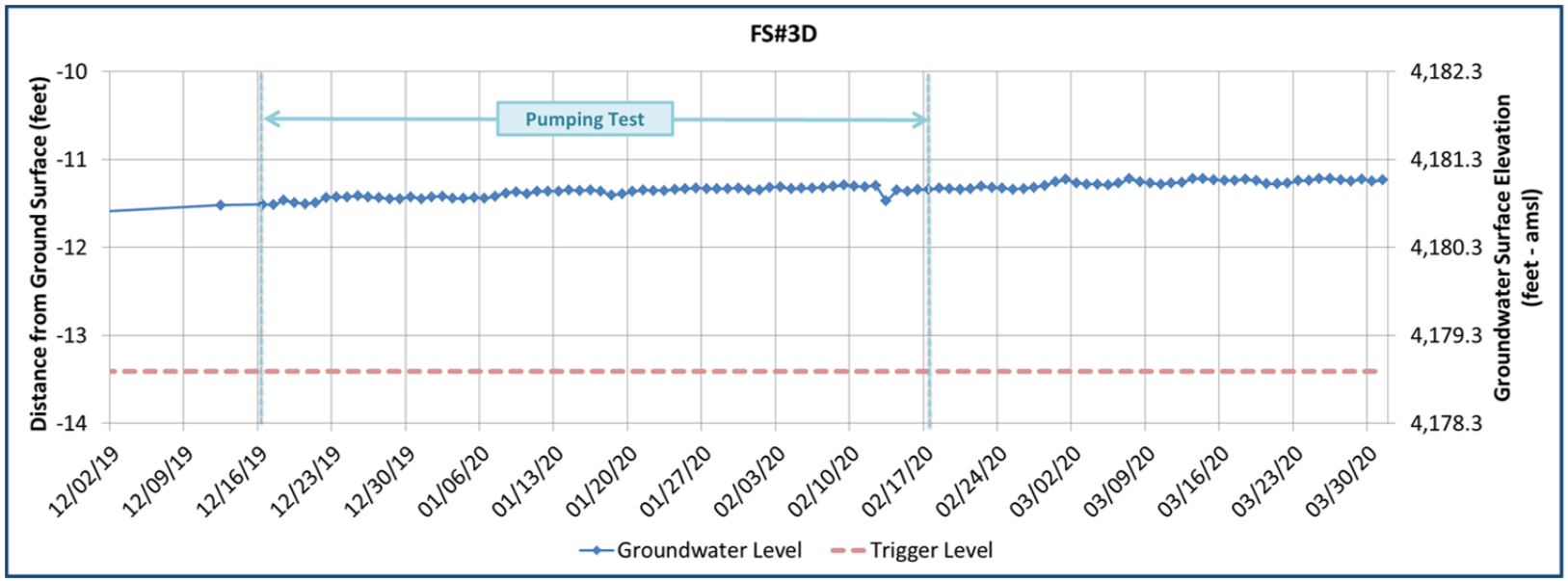

Figure 16

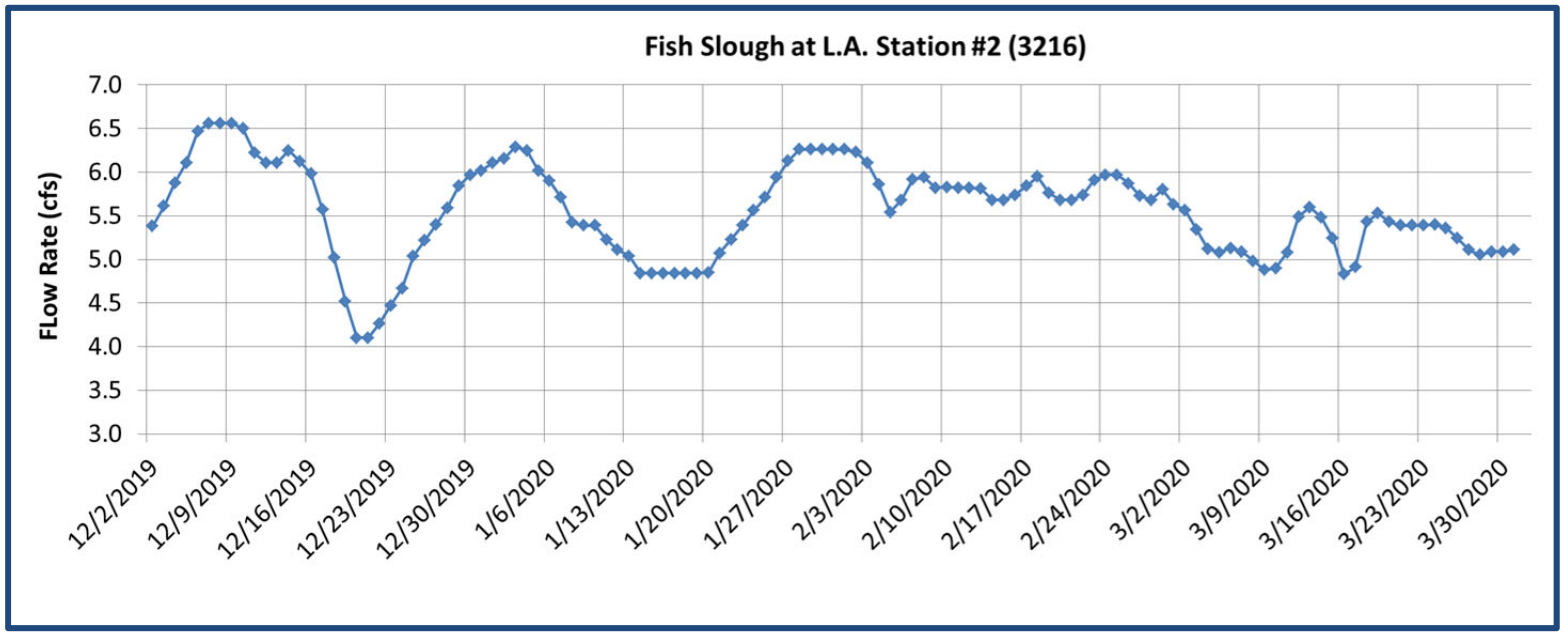

Figure 17

Water Quality Sampling

Water Quality and Isotope Sampling

LADWP collected groundwater samples from representative wells to document effects of pumping W385 on groundwater quality in the area around the well. The seven representative wells (FS #2, FS #3S, FS #3D, T755, T758, T826, and W385) were selected because they are distributed throughout the area of influence. Samples were taken at the wells 11 days prior to the commencement of the pumping phase and 5 days prior to the end of the pumping phase (60 days after the first water quality sampling). W386 was also sampled additionally to better understand the water quality of the aquifer at that location compared to the W385 location. Both sets of samples underwent field chemistry, general chemistry, and isotope analyses. All wells were sampled between 8:00 am and 2:00 pm.

The field chemistry parameters measured before and just before the end of the pumping test are presented in **Table 6**.

The general chemistry parameters measured before and towards the end of the pumping test are presented in **Table 7**.

Isotope Chemistry

Isotope analyses were conducted by Isotech Laboratories, a third-party laboratory. The parameters measured were *tritium*, *deuterium*, and *oxygen-18*. Isotope measurements were conducted to determine if there were changes in the source of groundwater recharge for the water pumped from W385. The most common isotope measurements for determining recharge source are deuterium and oxygen-18. Tritium, a radioactive isotope, was also measured for relative age-dating of the groundwater.

The isotope chemistry parameters measured before and near the end of the pumping test are presented in **Table 8**. A plot comparing the percentages of Oxygen-18 and Deuterium relative to the Vienna Standard Mean Ocean Water (VSMOW) of representative wells in the Laws area, in addition to wells in areas along the same flow path (Fish Slough Area, Adobe Valley, White Mountain Creeks, and Tri-Valley), are presented in **Figure 18**. Supporting isotope data from the other regions are presented in **Table C-1** in **Appendix C**.[4]

[4] Zdon et. al. Identification of Source Water Mixing in the Fish Slough Spring Complex, Mono County, California, USA (2019).

Table 6 – Field Chemistry Parameter Results

Parameter	Unit	FS #2		FS #3D		FS #3S		T755		T758		T826		W385		W386	
		12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20
Dissolved Oxygen Concentration	mg/L	4	5.50	1.6	1.60	4.7	4.30	1.1	2.60	5.5	-	1.6	1.00	2.2	1.90	-	0.9
Dissolved Oxygen Saturation	%	44	59	19	20	54	54	14	30	63	-	18	11	34	29	-	11
Fluid Turbidity	NTU	4.44	0.47	19	2.6	3.92	9.12	0.52	0.26	0.64	0.46	0.95	1.2	2.77	0.25	-	1.44
General Appearance	-	1	-	4	2	1	-	1	-	1	-	3	-	1	-		-
Odor	-	1	-	4	3	1	-	3	-	1	-	1	-	1	-	-	-
pH	-	7.8	7.88	8.43	7.84	8.08	7.96	7.88	8.21	8.6	7.16	7.12	7.21	7.84	7.77	-	8.35
Specific Conductance	µS/cm	447	433	511	527	515	520	455	465	227	535	625	530	543	536	-	354
Temperature	°C	13.3	11	17.5	17.6	18.2	17.4	15.2	27.9	15.2	17.2	15	13.8	31.8	28.9	-	19.6

Table 8 – Isotope Chemistry Parameter Results

Parameter	Unit	FS #2		FS #3D		FS #3S		T755		T758		T826		W385		W386	
		12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20
Oxygen-18	%	-16.08	-16.02	-17.48	-17.53	-17.46	-17.36	-18.58	-18.59	-17.7	-17.7	-12.92	-13.64	-16.67	-16.89	-	-17.74
Deuterium	%	-121.4	-120.9	-136.9	-137.3	-135.9	-135.5	-141.6	-141.7	-134.9	-134.9	-107.5	-110.2	-129.2	-131.3	-	-136.2
Tritium	TU	< 0.52	TBD	< 0.65	TBD	< 0.54	TBD	< 0.45	TBD	< 0.41	TBD	2.23 ± 0.2	TBD	< 0.51	TBD	-	TBD

Table 7 – General Chemistry Parameter Results

Parameter	Unit	FS #2		FS #3D		FS #3S		T755		T758		T826		W385		W386	
		12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20	12/5/19	2/13/20
Aluminum	ug/L	43.9	ND	419	44.6	217	2680	ND	ND	ND	ND	14.3	21.2	ND	ND	-	ND
Antimony	ug/L	14.1	7.9	ND	ND	ND	ND	ND	ND	ND	ND	3.2	3.8	ND	ND	-	ND
Arsenic	ug/L	8.2	7.9	1.4	1.5	12.9	13.8	19.9	21.7	13.4	13.5	46.3	45.9	7.3	7.6	-	14.1
Barium	ug/L	14.2	13.6	ND	ND	ND	21.4	78.5	84.8	31.1	14.0	39.0	33.3	21.6	17.4	-	25.5
Beryllium	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
Bicarbonate (HCO3), H2SO4 Titration	mg/L	-	158	-	194	-	173	-	153	-	86.5	-	251	-	228	-	164
Bicarbonate Alkalinity, Total (as CaCO3)	mg/L	-	130	-	159	-	142	-	126	-	83.6	-	206	-	187		138
Boron	ug/L	140	161	354	344	369	372	419	436	ND	148	1080	1090	436	469	-	305
Bromide, Ion-Chromatography	mg/L	0.0329	0.0322	0.0672	0.0567	0.0547	0.0567	0.0386	0.0438	ND	ND	0.0913	0.0764	0.0623	0.102	-	0.0324
Cadmium	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
Calcium	mg/L	46.4	45.2	11.3	13.3	13.6	14.5	7.29	6.89	1.49	1.26	31.3	26.8	21.8	23.2	-	6.02
Chloride, Ion-Chromatography	mg/L	9.92	8.85	19.4	16.4	16.7	17.4	32.6	32.8	6.70	6.38	31.4	25.0	22.2	21.1	-	16.9
Chromium	ug/L	1.0	ND	2.3	ND	ND	4.5	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
Copper	ug/L	3.5	ND	4.7	ND	ND	4.3	ND	ND	ND	ND	12.9	5.2	22.9	ND	-	ND
Fluoride, Ion-Chromatography	mg/L	0.858	0.908	2.50	2.58	2.54	2.57	7.54	7.75	1.91	1.92	1.51	1.55	2.14	2.28	-	2.09
Lead	ug/L	1.7	ND	0.52	ND	ND	1.7	ND	ND	5.4	1.3	ND	ND	5.8	0.88	-	ND
Magnesium	mg/L	2.90	2.80	2.30	1.65	0.799	1.31	0.951	0.896	ND	ND	8.17	6.83	1.09	1.10	-	0.246
Manganese	ug/L	2.6	ND	45.6	62.0	ND	60.6	20.5	21.5	ND	ND	283	276	128	ND	-	18.7
Nickel	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.9	12.9	ND	ND	-	ND
Nitrate (as N), Ion-Chromatrography	mg/L	0.366	0.360	ND	ND	0.170	0.158	ND	ND	ND	ND	ND	4.96	0.213	0.136	-	ND
Potassium	mg/L	2.16	1.64	6.37	4.95	3.69	4.34	3.65	3.17	1.66	1.37	7.51	6.00	6.33	5.76	-	3.63
Selenium	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
Silica, ICP-OES	mg/L	89.8	88.1	66.2	83.5	97.6	102	88.0	86.1	79.8	79.9	43.5	38.9	110	106	-	77.5
Silver	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
Sodium	mg/L	43.5	42.1	97.1	93.5	94.1	94.7	86.6	84.0	49.1	47.8	91.7	80.1	90.2	84.1	-	73.1
Sulfate, Ion-Chromatography	mg/L	75.7	72.4	53.3	59.3	76.6	75.4	26.7	27.4	13.3	12.9	36.7	28.0	36.8	32.9	-	16.5
Thallium	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
Phosphorus, Total (as P), Colorimetry	mg/L	0.040	ND	0.211	0.10	0.045	0.066	0.053	0.046	0.064	0.058	0.145	0.11	0.029	NA	-	0.036
Phosphorus, Total (as PO4), Colorimetry	mg/L	0.123	-	0.647	-	0.138	-	0.162	-	0.196	-	0.445	-	0.089	-	-	-
Uranium	ug/L	27.2	22.2	ND	ND	2.3	2.8	ND	ND	ND	ND	86.1	71.9	7.8	8.5	-	ND
Vanadium	ug/L	6.1	6.5	ND	ND	ND	ND	ND	ND	ND	ND	3.3	3.2	ND	ND	-	ND
Zinc	ug/L	21.8	12.2	34.2	ND	ND	ND	17.7	ND	ND	ND	ND	ND	ND	ND	-	ND

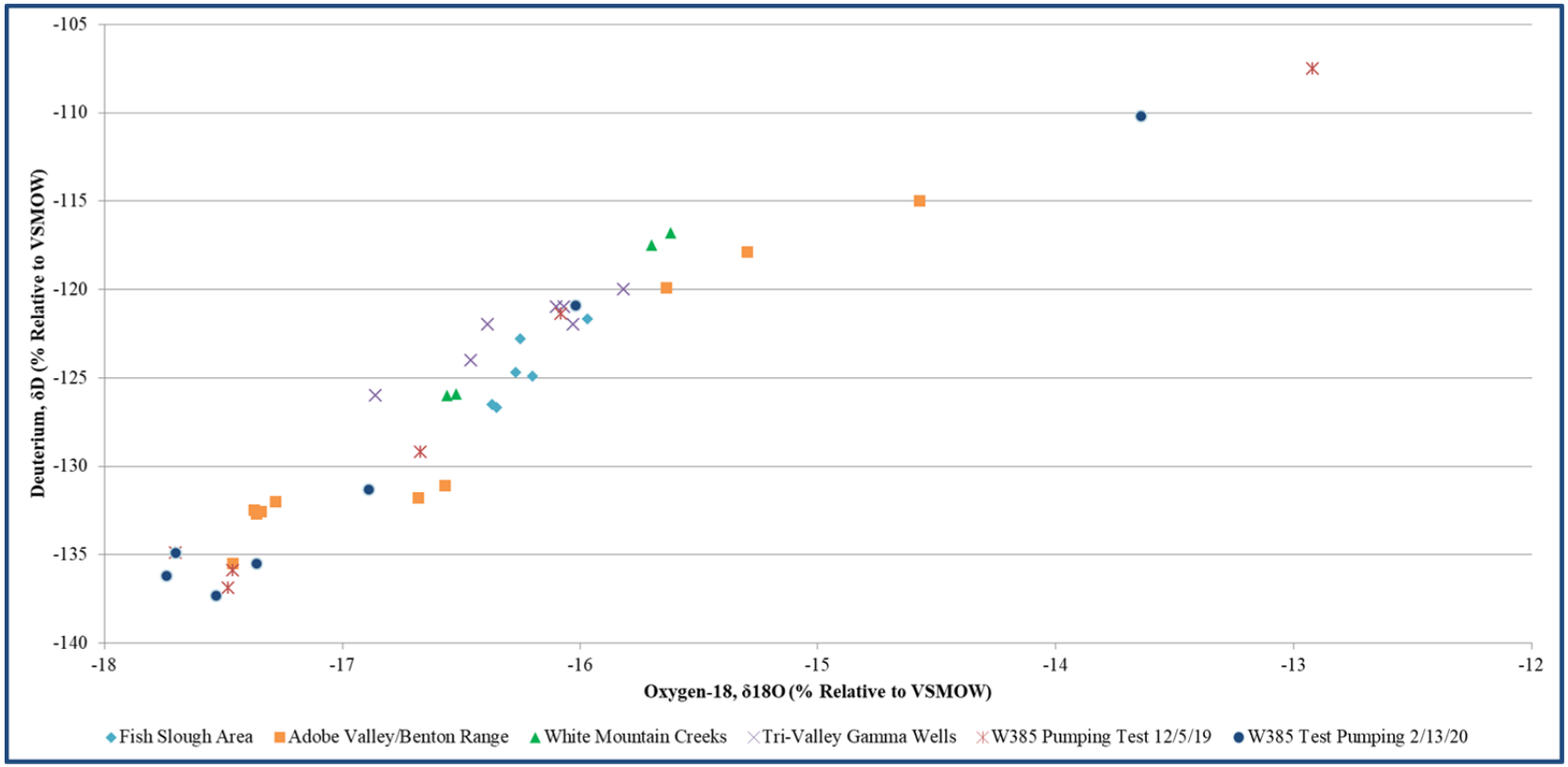

Figure 18– Isotope Chemistry Parameter Results

Appendices

A – Pumping Test Daily Measurements

B – Hydrographs of Non-Trigger Wells

C – Historical Isotope Measurements of Nearby Regions

References

1. ICWD. *Draft Report 94-1* (1994).
2. LADWP. *Owens Valley Well Modification Project* (2015).
3. LADWP. Pumping Test of W385R in the Laws Wellfield Monitoring Plan (2016).
4. Zdon et. al. Identification of Source Water Mixing in the Fish Slough Spring Complex, Mono County, California, USA (2019).