Replacement for Production Well W061 in Independence-Oak Wellfield

Pre-Construction Evaluation Report

1. PURPOSE

Well W061, located in the Independence-Oak Wellfield, has been out of service due to age and deterioration and was converted to a deep monitoring well in early 2019. The City of Los Angeles Department of Water and Power (LADWP) converted this well to a monitoring well in 2018 and is planning to replace it utilizing current well construction and installation standards. The purpose of this report is to satisfy the requirement of Section IV.B of the Green Book (Technical Appendix to the Inyo/Los Angeles Agreement), Guidelines for Drilling and Activating New Production Wells.

2. BACKGROUND

2.1 Introduction

LADWP owns over 100 production wells in the Owens Valley. Over time, some of LADWP's wells fail for a variety of reasons including corrosion, casing defects, damage, and general degradation with time. LADWP has to replace failed wells to maintain operational flexibility in Owens Valley. Replacement wells are drilled using the current industry standards with the goal of maximizing pumping efficiency and minimizing possible effects to nearby resources.

LADWP and Inyo County entered into an agreement for the long-term management of groundwater in the Owens Valley in 1991 (Water Agreement). According to Section VI of the Agreement, LADWP may replace existing wells and construct new wells in areas where hydrologic conditions are favorable. Since the implementation of the Agreement, LADWP has replaced a number of wells that had failed for a variety of reasons throughout the Owens Valley.

Originally constructed in 1924, W061 was taken out of service in mid-2017 due to ongoing problems resulting from casing degradation due to age. The replacement for well W061 is planned to be installed in the vicinity of the current W061 location.

2.2 Location

Figure 1 shows a map of the Independence-Oak Wellfield in the vicinity of well W061. The Independence-Oak Wellfield is the oldest LADWP wellfield in the Owens Valley. The main landmarks near the wellfield include Independence Creek and Oak Creek flowing east from the Sierra Nevada Mountains, the Los Angeles Aqueduct (LAA), and the Owens River to the east of the wellfield. Well W061 is located approximately midway between the US-395 and the LAA, near the middle of the wellfield boundary, and is used for irrigation and LAA supply.

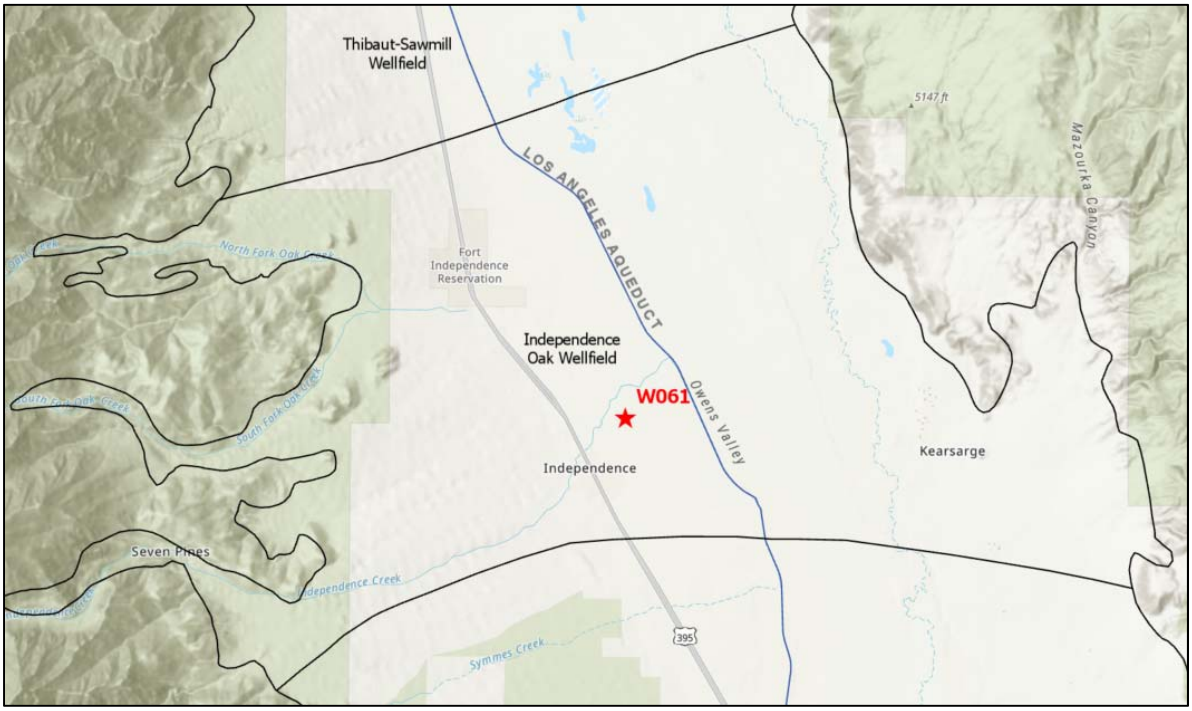

Figure 1: Independence Oak Wellfield

3. HYDROGEOLOGIC CONDITIONS

3.1 Geology

The conceptual geological framework of the Owens Valley is presented in a United States Geological Survey (USGS) report in 1991 (Hollett, et. al., 1991). The Owens Valley was formed by a graben that is filled by debris eroded from the White/Inyo Mountains to the east and Sierra Nevada Mountains to the west. The Independence-Oak Wellfield is located on the valley floor. The sediments underlying the Independence-Oak Wellfield are a combination of alluvial deposits originating from the eastern flanks of the Sierra Nevada Mountains and fluvial/lacustrine deposits stemming from the ancestral

Owens River and the associated lake environment in the Owens Lake Basin. Figure 2 shows an east-west hydrogeologic cross section near Independence.

The main geologic feature near the Independence-Oak Wellfield is the long alluvial fans to the west composed of interbedded clay, sand, and gravel on the margins of the valley, grading into smaller grains with more pervasive clay layers toward the middle of the valley. The clay layers form a confining unit in the Independence Area, which limits interaction of shallow unconfined aquifer and the deep, confined aquifer. The 1872 Fault runs in a north-south direction in the Independence Area. This fault that acts as a groundwater flow barrier affecting the flow of groundwater from west to east.

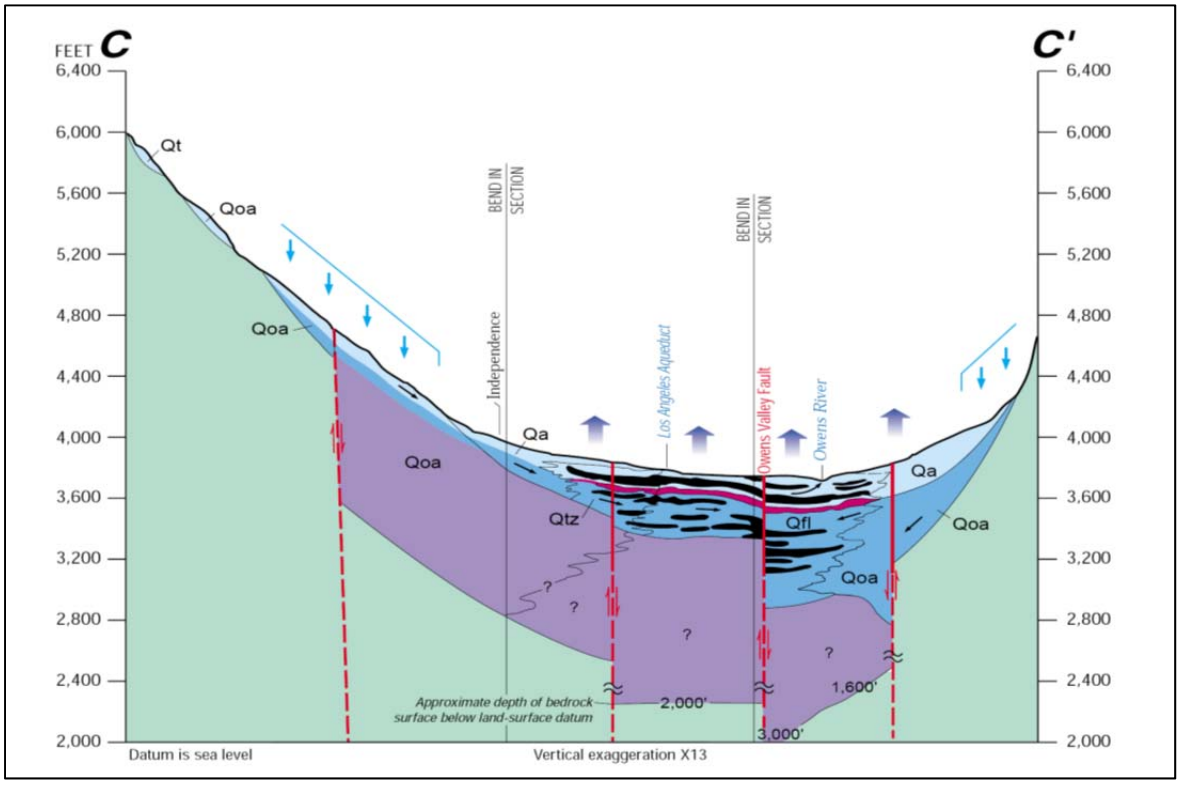

Figure 2: Hydrogeologic Cross Section in East-West Direction near Independence, CA. *From USGS Water Supply Paper 2370-H, Figure 5*

3.2 Hydrology

3.2.1 Groundwater

Groundwater in the Independence-Oak Wellfield flows generally from north to south and also from the Sierra Nevada Mountain range, west of the wellfield. Percolation from the

Owens River, Independence Creek, Oak Creek, and LAA recharges the groundwater aquifer in this wellfield.

The Independence-Oak Wellfield is one of LADWP's larger wellfields in the Owens Valley. LADWP owns 13 production wells in the Independence-Oak Wellfield, ten of which have been active in recent years. Figure 3 shows the location of the production wells in the vicinity of Independence and Table 1 lists annual pumping from these wells since the 1972-73 runoff year. The annual pumping rate from the Independence-Oak Wellfield in recent years has been on average 7,200 acre-feet per year. Most of the wells in the Independence-Oak Wellfield are designated for supplying irrigation water.

There are over 50 shallow and deep monitoring wells in the Independence-Oak Wellfield. Figure 3 also shows the location of select monitoring wells, with Table 2 listing their total depth and recent average depth to water.

The deep aquifer in the Independence area is confined by a thick clay layer, as exhibited by 11 artesian wells in the wellfield.

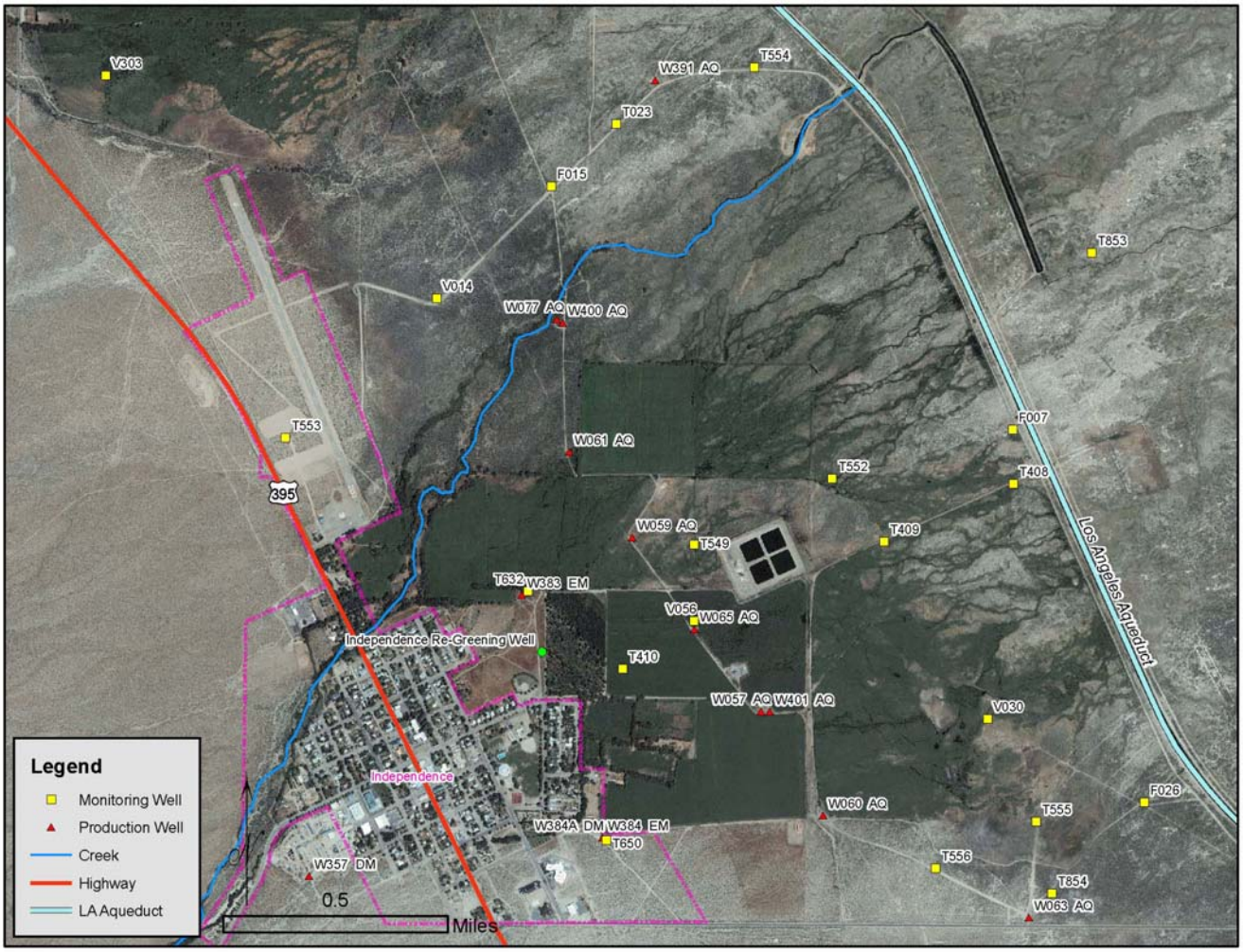

Figure 3: Selected Groundwater Wells in the Independence Area

Table 1: Groundwater Pumping in the Independence-Oak Wellfield in Acre-feet per year

RO Year	W391	W400	W061	W063	W059	W060	W065	W401	W383	W384	W357	Total
1972-73			1,590	1,527	1,780	2,135	3,600					**10,632**
1973-74			189	1,349	1,221	886	1,827					**5,472**
1974-75			337	902	622	345	736					**2,942**
1975-76			129	774	718	551	2,942					**5,114**
1976-77			0	35	696	1,718	2,031					**4,480**
1977-78			1,204	1,230	1,389	1,715	2,004				2,079	**9,621**
1978-79			64	56	65	0	92				1,598	**1,875**
1979-80			0	786	291	1,328	20				801	**3,226**
1980-81			0	0	0	3	0				390	**393**
1981-82			196	0	24	32	49				569	**870**
1982-83			36	32	35	50	52				307	**512**
1983-84			2	0	0	2	0				342	**346**
1984-85			132	0	178	261	270				336	**1,177**
1985-86			424	305	239	496	405				359	**2,228**
1986-87			1	0	0	600	0				337	**938**
1987-88			2,121	1,804	2,030	2,033	2,902		873	386	376	**12,525**
1988-89			1,828	1,701	2,096	1,987	2,945		1,043	881	416	**12,897**
1989-90			1,706	16	1,928	3,055	3,406		1,701	1,188	454	**13,454**
1990-91	12		935	84	1,260	1,931	2,084		1,653	1,099	425	**9,483**
1991-92	0		802	14	1,601	2,898	1,831		1,667	1,164	422	**10,399**
1992-93	0	0	1,182	92	1,221	2,023	1,681	2,406	1,345	501	441	**10,892**
1993-94	112	75	940	75	66	2,514	1,060	0	967	505	508	**6,822**
1994-95	0	94	1,434	62	154	3,085	1,827	343	1,215	878	504	**9,596**
1995-96	0	0	1,146	0	0	2,392	1,315	823	1,693	1,337	477	**9,183**
1996-97	0	0	1,256	0	0	1,721	1,529	0	1,784	1,178	510	**7,978**
1997-98	64	44	1,239	44	39	1,709	1,458	78	1,004	669	477	**6,825**
1998-99	127	97	1,195	20	79	1,681	1,387	171	936	554	445	**6,692**
1999-00	0	0	1,237	0	0	1,615	1,167	0	1,152	615	1,195	**6,981**
2000-01	0	33	1,311	32	30	1,748	1,166	57	1,135	1,110	705	**7,327**
2001-02	0	0	1,061	0	0	1,654	1,372	0	1,189	1,021	567	**6,864**
2002-03	0	0	1,063	0	979	1,897	1,012	3,009	1,340	723	534	**10,557**
2003-04	0	0	1,087	0	1,807	1,935	923	3,355	1,005	1,084	563	**11,759**
2004-05	0	0	1,019	0	384	2,490	1,429	2,443	997	696	485	**9,943**
2005-06	0	0	1,090	0	38	2,110	1,163	171	1,010	608	467	**6,657**
2006-07	216	14	1,147	0	1,194	2,020	1,543	997	1,121	578	477	**9,307**
2007-08	0	127	898	0	37	2,012	1,567	0	1,089	781	522	**7,033**
2008-09	0	0	1,018	0	0	1,918	1,599	0	1,209	761	498	**7,003**
2009-10	0	0	956	0	0	1,767	1,398	0	1,040	810	472	**6,443**
2010-11	0	0	956	0	0	1,873	1,389	0	1,036	784	460	**6,498**
2011-12	0	0	939	0	7	2,899	2,096	1,066	919	786	438	**9,150**
2012-13	17	0	964	0	0	1,654	1,591	1,625	875	740	490	**7,956**
2013-14	17	11	1,824	11	0	1,605	1,005	3,252	767	683	444	**9,620**
2014-15	23	17	1,728	18	0	1,613	1,008	2,482	495	720	444	**8,549**
2015-16	0	0	1,724	0	485	2,731	1,827	1,986	702	704	336	**10,494**
2016-17	0	0	820	0	0	2,988	1,022	2,860	639	701	420	**9,450**
2017-18	0	181	537	0	0	1,500	1,335	509	523	777	413	**5,774**
2018-19	0	554	0	1,471	1,815	1,520	1,837	2,752	489	708	424	**11,570**
5-yr Average	**5**	**150**	**962**	**298**	**460**	**2,070**	**1,406**	**2,118**	**570**	**722**	**407**	**9,168**

Table 2: Selected Monitoring Wells in the Independence-Oak Wellfield

Well No.	Well Depth (ft)	Ref. Point	Measurement Date	DTW (ft)	WTE (ft)
T809	27	3,841.91	8/22/2019	12.89	3,829.02
T451	20	3,778.19	4/22/2019	9.40	3,768.79
T553	21	3,901.48	7/23/2019	20.8	3,880.68
T409	42	3,826.98	8/12/2019	3.32	3,823.66
T550	17	3,804.48	4/24/2019	3.27	3,801.21
T407	20	3,810.24	8/12/2019	13.28	3,796.96
T405	20	3,770.56	8/21/2019	5.35	3,765.21
T556	42	3,855.28	4/29/2019	38.65	3,816.63
T650	71	3,907.33	7/23/2019	69.25	3,838.08
T633	136	3,908.96	4/24/2019	108.3	3,800.66
T813	200	3,849.91	7/23/2019	21.18	3,827.84

3.2.1 Surface Water

The main surface water features in the Independence-Oak Wellfield include Independence Creek, Oak Creek, the LAA, and the Owens River that all contribute to recharging the aquifer. The Owens River runs in a north-south direction and is located east of the wellfield. Independence Creek and Oak Creek run off the Sierra Nevada Mountains and supply water to the wellfield. Figure 4 shows the location of various surface water flow measuring gauges in the Independence-Oak Wellfield in the vicinity of well W061. Table 3 lists flow measurements for the gauges shown in Figure 4.

The weather station in Independence, located at Independence LADWP Yard, is one of the oldest in the Owens Valley with over 100 years of data. The long-term average precipitation at Independence Yard is 5.5 inches per year.

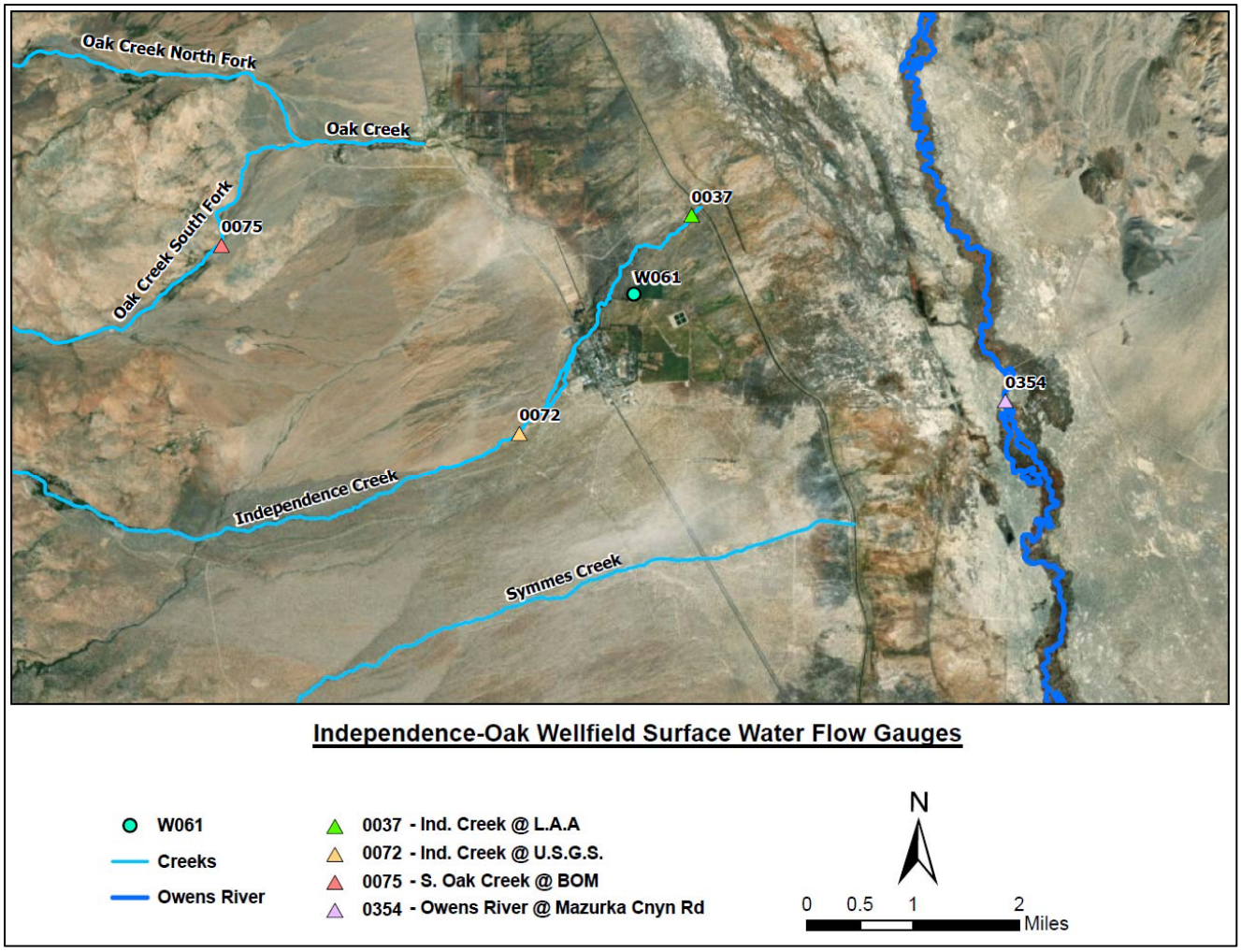

Figure 4: Surface Water Flow Measuring Gauges

Table 3: Selected Surface Water Flow in the Independence Area in Acre-feet

Runoff Year	Ind. Creek @ U.S.G.S.	Ind. Creek @ L.A.A.	S. Oak Creek @ BOM	Owens River @ Mazurka Cnyn Rd	Ind. Area Flowing Wells
1971-72	5,280	1,315	3,216		1,559
1972-73	2,967	66	2,095		370
1973-74	10,399	5,251	5,644		406
1974-75	10,089	5,644	5,639		1,109
1975-76	6,108	2,332	3,710		810
1976-77	5,575	2,602	3,048		400
1977-78	4,699	1,921	2,971		229
1978-79	11,284	7,659	6,347		681
1979-80	8,868	5,079	5,096		1,736
1980-81	8,455	5,113	7,431		3,287
1981-82	6,972	3,390	4,310		3,915
1982-83	14,573	9,361	8,109		4,456
1983-84	11,952	6,603	7,895		5,499
1984-85	13,181	8,715	7,318		6,041
1985-86	11,171	6,459	5,896		4,841
1986-87	7,958	3,596	8,165		5,285
1987-88	4,610	836	2,904		1,332
1988-89	5,394	1,413	3,285		479
1989-90	6,202	2,403	3,551		251
1990-91	3,086	276	2,086		801
1991-92	5,933	2,668	3,494		1,176
1992-93	6,406	2,578	3,629		1,229
1993-94	9,532	4,290	6,098		1,574
1994-95	5,847	1,850	3,292		1,269
1995-96	12,223	6,817	7,090		1,762
1996-97	15,704	10,130	7,868		2,608
1997-98	16,670	9,912	7,907		3,273
1998-99	13,905	9,014	7,611		3,972
1999-00	7,681	4,183	4,684		3,788
2000-01	7,041	3,649	4,462		3,866
2001-02	7,560	4,018	4,667		3,698
2002-03	5,967	2,645	4,049		3,092
2003-04	7,875	3,979	4,740		2,612
2004-05	8,063	3,882	5,105		2,505
2005-06	14,537	8,519	8,884		2,914
2006-07	7,746	3,155	7,371		3,654
2007-08	4,053	828	3,077	35,678	3,737
2008-09	7,388	3,940	4,364	36,974	3,695
2009-10	7,112	4,003	4,120	38,870	3,713
2010-11	10,423	6,564	6,690	41,294	3,664
2011-12	14,008	9,718	7,767	40,752	4,987
2012-13	2,952	440	2,123	43,327	2,150
2013-14	3,018	239	2,063	40,493	1,738
2014-15	4,715	1,378	3,076	36,218	1,857
2015-16	3,030	452	2,184	34,984	1,446
2016-17	7,943	4,152	4,120	39,511	1,168
2017-18	15,577	10,100	10,750	59,080	2,510
2018-19	6,605	3,741	4,379	40,264	2,249
3-Year Average	10,042	5,997	6,416	46,285	1,976

4. ENVIRONMENTAL RESOURCES

4.1 Vegetation in the vicinity of the Replacement Well

Figure 9 shows the vegetation parcels in the area near well W061 that were inventoried for baseline conditions in 1984-85. These parcels were classified according to the Agreement based on water use with designations of Type A to Type E. Well W061 is located in vegetation parcel IND111, a Type C parcel. IND111 is classified as Nevada Saltbush Meadow with total perennial cover of 41% in 1985. Of 41% total perennial cover, 31% was shrub cover and 10% was grass cover. IND111 has been monitored by LADWP since 2004. Total perennial cover in 2018 was 33%.

4.2 Springs, Seeps, Flowing Wells

As a result of confining layers near the center of the valley, the deep confined aquifer in the Independence Wellfield is under artesian head, which results in wells that are screened in the deep aquifer to flow to the Owens River. There are 22 flowing wells in the Independence Wellfield, located adjacent to Owens River. The long-term average total flowing volume from these wells is 3,826 acre-feet per year.

5. POTENTIAL IMPACTS ON ENVIRONMENTAL RESOURCES

5.1 Area of Influence (AOI) Analysis

An existing groundwater flow model for the southern portion of The Owens Valley was used to estimate the AOI of the proposed replacement well. The pumping distribution in model layers was determined based on the planned screen depth in the well that will replace W061 in Independence-Oak Wellfield. The assumed total pumping rate is 2.5 cubic-feet per second (CFS) (216,000 cubic-feet per day [CFD]), determined based on historical pumping values. The estimated screen depth of the replacement well is from 300 feet to 700 feet below ground surface, with a total screen length of 400 feet.

Two pumping scenarios were simulated: (1) 6 months of pumping in W061 at 2.5 CFS, and (2) 1 year of pumping in W061 at 2.5 CFS. With the flow distribution previously described, MODFLOW model was run for a total duration of 1 year in both scenarios. Drawdown contours from W061 pumping were recorded at the end of the 6-months and 1-year simulation, as shown in Figures 5 to 8.

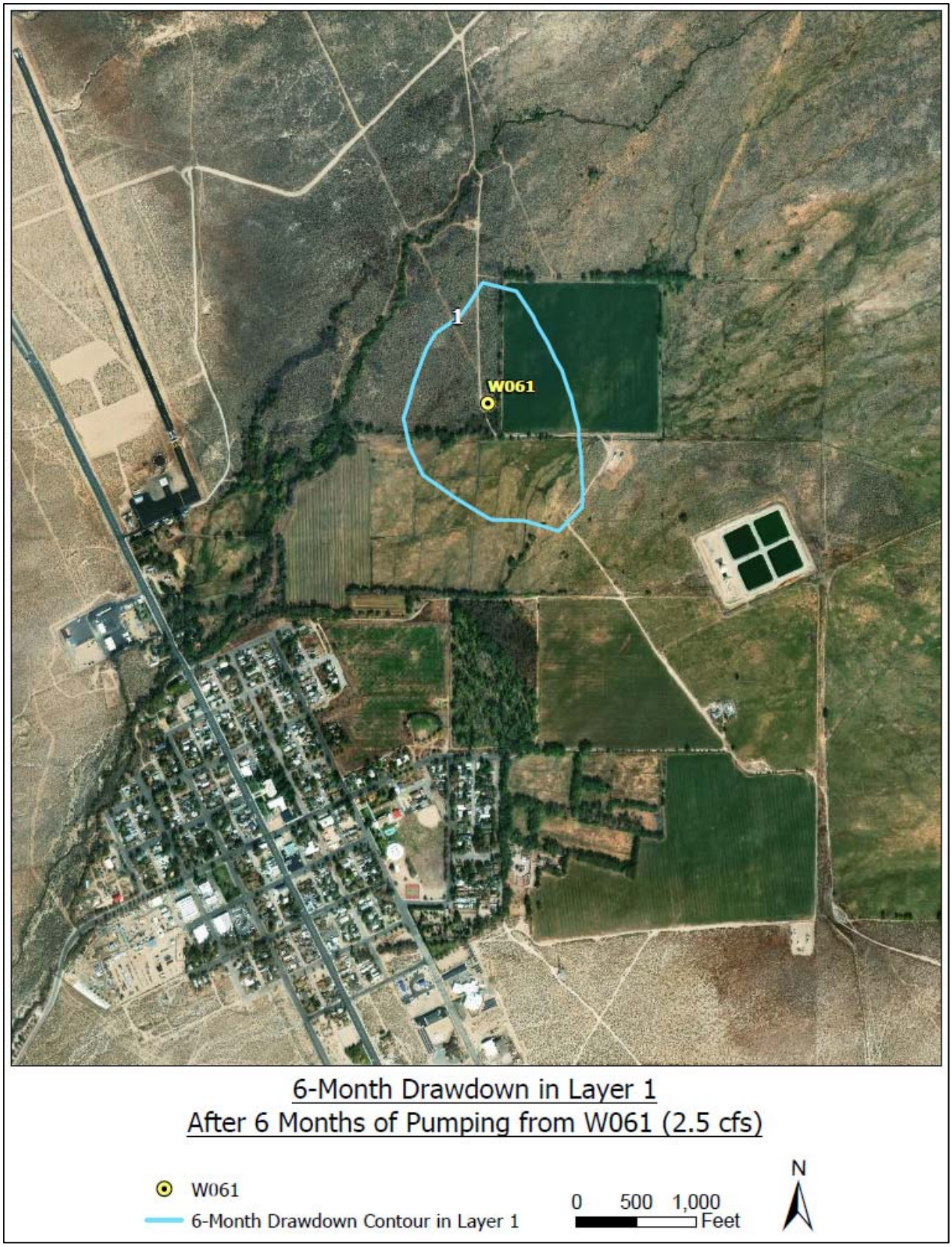

Figure 5: Six month drawdown after six months of pumping

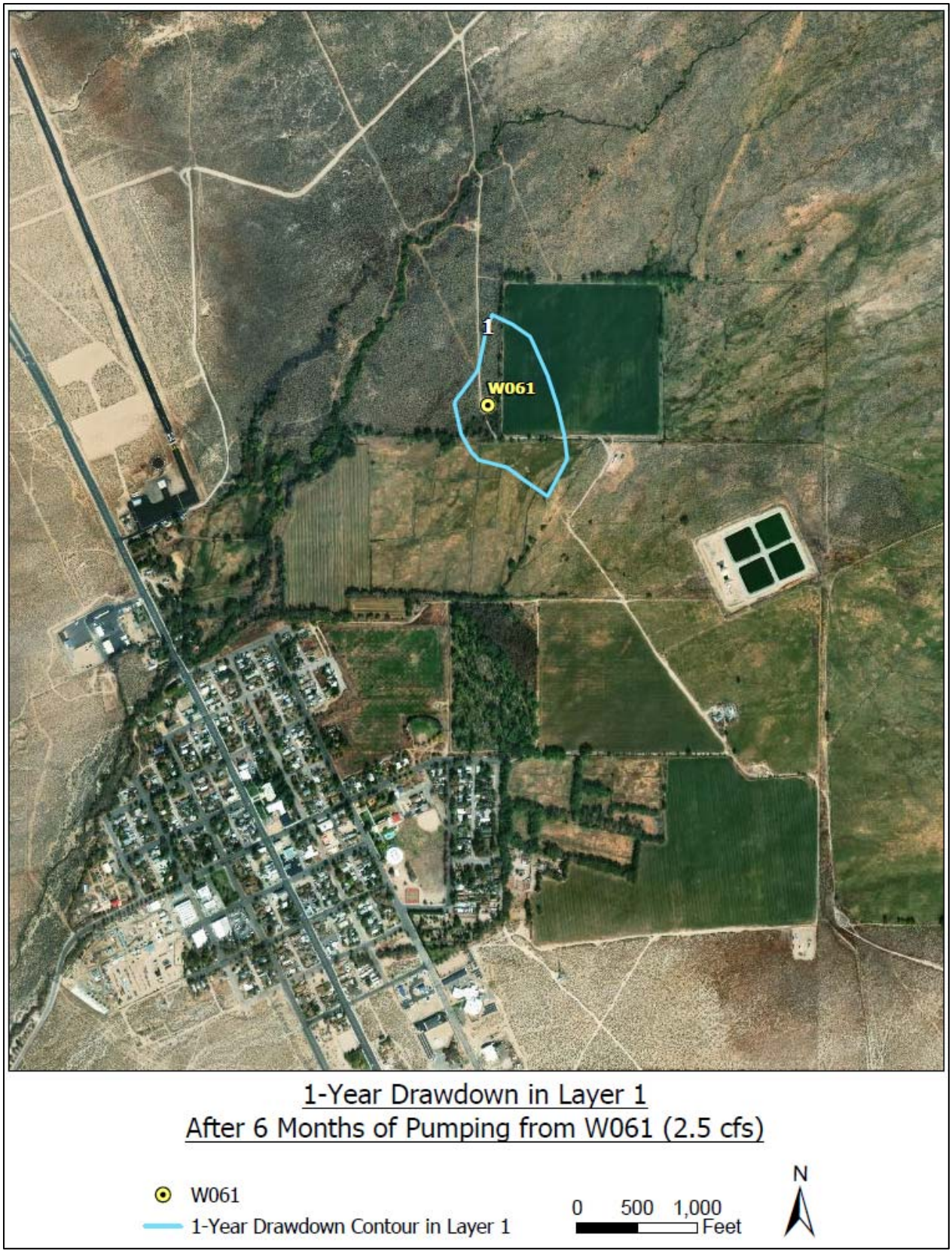

Figure 6: One year drawdown after six months of pumping

Figure 7: Six month drawdown after one year of pumping

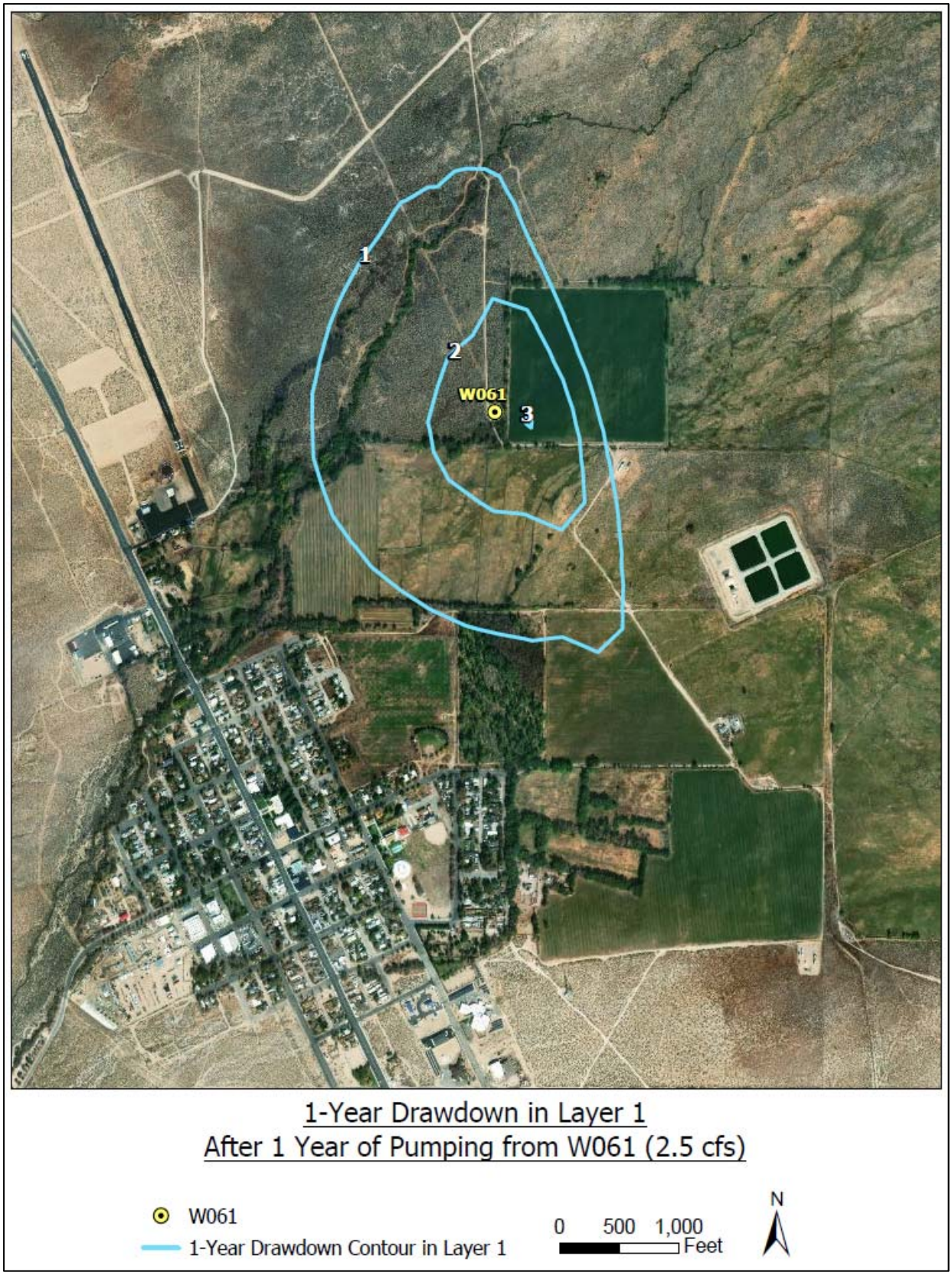

Figure 8: One year drawdown after one year of pumping

After proposed wells are drilled and pumping tests data are analyzed, the model will be re-calibrated using the updated aquifer characteristics near well W061. The updated model will then be used to prepare an updated AOI for well W061.

5.2 Potential Drawdown Effect on Resources within the AOI

The area of influence (AOI) one foot drawdown contour after one year of pumping from W061 at 2.5 cfs falls mainly within three vegetation parcels: IND111, IND189, and IND190 (Figure 9). Of these three parcels, IND111 was classified as Type C Nevada Saltbush Meadow while IND 189 and IND190 were classified as Type E Irrigated Agriculture in 1985. The AOI also intersects a small portion of three other Type E parcels (IND188, IND242, and IND244). No impact to vegetation is expected in any of Type E parcels mentioned above because they are irrigated. IND111 could be affected if the water table is drawn down below the root zone of the existing Type C vegetation. This is unlikely however, since the proposed operation is comparable to historic operation.

The AOI is projected to fall mainly in the southern portion of the parcel (Figure 10). There are 5 transects (8, 10 through 13) in the section which is dominated by Nevada saltbush with cover values ranging between 18 and 32%. Other species found in the area include rubber rabbitbrush, big sagebrush, alkali sacaton, inland saltgrass, narrowleaf willow, locust, and elm trees. Figure 11 shows vegetation cover fluctuations between 2004 and 2018 along with annual pumping at W061, The Owens Valley runoff, and precipitation at Independence. With resuming pumping at W061, a similar pattern of vegetation cover fluctuations is expected.

In conclusion resuming pumping at W061 should result in no to little impact on vegetation cover in the close vicinity of W061.

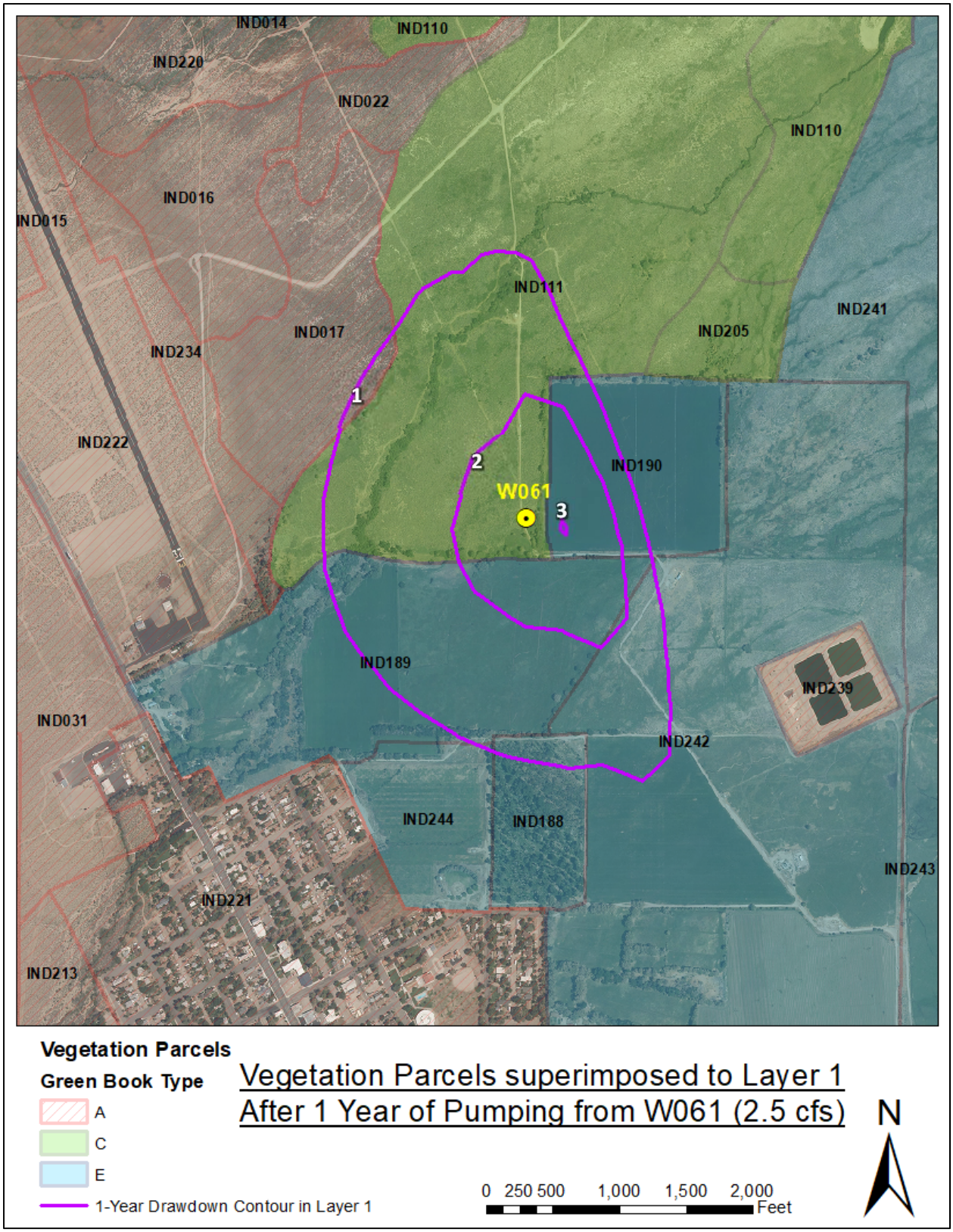

Figure 9: Vegetation parcels in close proximity to W061with the projected drawdown

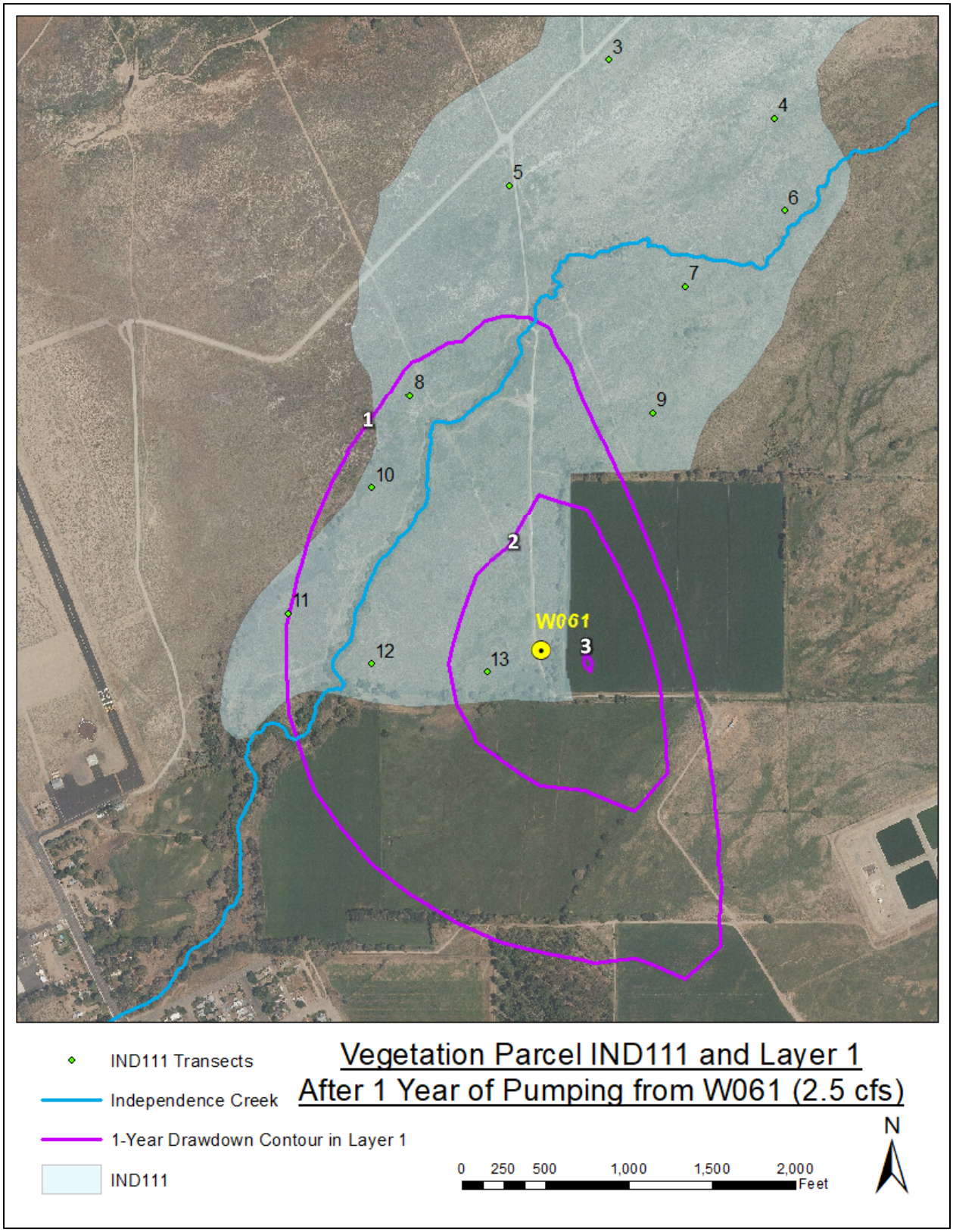

Figure 10: Vegetation parcels IND111 and its monitoring transects with the projected drawdown

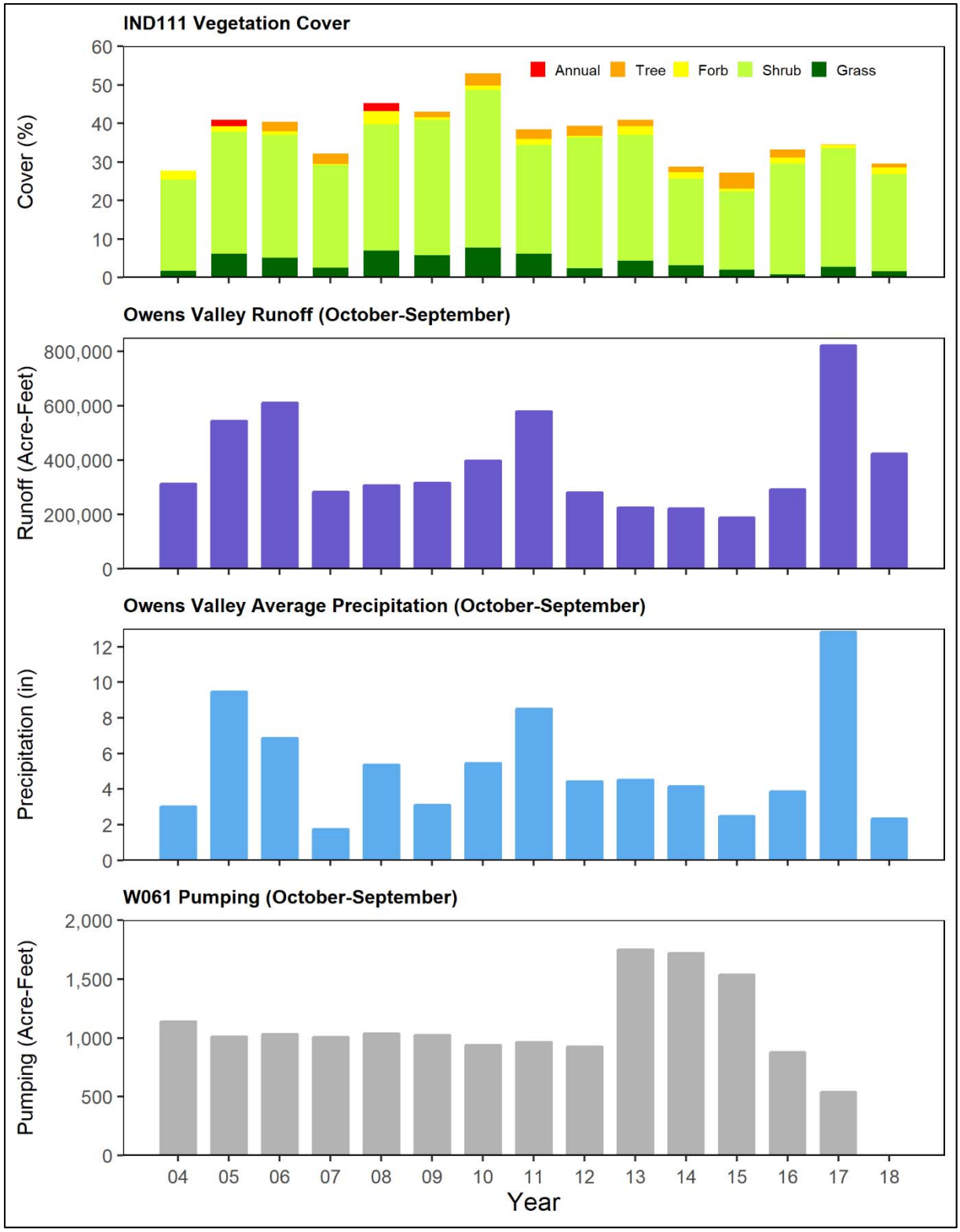

Figure 11: Vegetation cover based on 5 transects in IND111 and other factors including pumping at W061

6. CONSTRUCTION AND TESTING

6.1 New Well Design

The planned location of the replacement for Well W061 will be in the immediate vicinity of the current location.

A review of the driller's log for Well W061 shows that the borehole encountered multiple clay layers (0-46, 58-66, 71-77, 84-95, 101-118, 150-153, and 163-171 feet). The extent of these clay zones are inferred to extend southward based on the descriptive logs from other nearby wells (W059 and W065). As shown on Figure 12, gravel and sandy zones appear at depths of 46-58, 66-71, 77-84, 95-101, 118-150, 153-163, and 171-237 feet. In an effort to minimize potential impact on the shallow aquifer, the borehole for the replacement well will be drilled to 700 feet below ground surface and geologic and geophysical logging will be performed. The replacement well will be screened within the deeper zone of the formation, the exact interval to be determined after a review of driller's and geophysical log. The replacement well will be pumping from deep aquifer and the screen length should be approximately 300 feet. Figure 13 shows the preliminary design of the replacement well subject to the review of the geologic and geophysical logs.

The replacement well will be drilled using mud rotary method and constructed with a pre-fabricated casing and screen, along with placing a properly sized gravel pack in the annular space between the screen and the borehole wall. The casing and screen diameter will be 18 inches.

The capacity of the replacement well is expected to be approximately the same as that of W061. In the event that the initial pumping test shows that the replacement well has capacity more than the current documented capacity of the existing W061, LADWP will either adjust the pump size to limit pumping capacity to that of the existing well or will treat the additional capacity as a new well.

FORM 1452

WELL LOG

DEPARTMENT OF WATER & POWER

CITY OF LOS ANGELES

Well Number or Name 61

LOCATION Independence

SE 1/4, SW 1/4 Sect 8 T-13-S, R-35-E Base MAP No.

WORK STARTED July 11, 1924 WORK COMPLETED No record

ft. of 16	in.	lb./ga. casing		left in well
"	"	"	"	" "
"	"	"	"	" "
"	"	"	"	" "

Type of perforator used Mills

Perforated ft. to ft. holes per ft.

" " " " " "

" " " " " "

" " " " " "

" " " " " "

" " " " " "

" " " " " "

" " " " " "

" " " " " "

Diameter of perforations ½ in., length 3½ in.

Depth at which water was first found ft.

Standing level before perforating ft.

Standing level after perforating ft.

Note your observation of any change in water level while drilling

Date tested , 19

Water level when first started test 30 ft.

Draw down from standing level Broke suction 72 ft.

G. P. M. at beginning of test

G. P. M. at completion of test

Draw down at completion of test ft.

If reducing strings of casing were cut off, state how cut

Depth from surface cut ft.

Size of casing cut in.

Lap in larger casing ft.

Was adapter or cement used?

If casing was swedged or repaired, state depth, describe repairs and condition in which casing was left and probable future effect:

Swedge lost and driven to bottom

Is well straight top to bottom, if not, what is the variation?

Will there be any detrimental effect on pump, and if so, what?

Give any additional data which may be of future value: Tested with #12 Kimball pump. Broke suction 30 sec. pumping. 72' pump & suction. Pumped 50 inches at 900 RPM.

(over)

Total depth of well 237 ft.

Formation: Mention size of water gravel—

0	ft. to 21	ft.	Clay
21	" 46	"	Sand and clay
46	" 58	"	Coarse gravel
58	" 66	"	Clay
66	" 71	"	Gravel - water
71	" 77	"	Clay
77	" 84	"	Sand - gravel
84	" 87	"	Clay - gravel
87	" 95	"	Clay
95	" 101	"	Gravel
101	" 118	"	Clay
118	" 150	"	Gravel - rock
150	" 153	"	Clay
153	" 163	"	Gravel
163	" 171	"	Gravel - clay
171	" 237	"	Sand - gravel

" " 16" casing

Pumped 70's, 60's & 70's

8" Kimball 5-25-60

" " adapted 20' 4-24-73

Date of Report , 19

BeM Lawrence, Lee Pierce Driller.

In charge

SHOW LOCATION ON BACK

Figure 12: Well W061 Well Log

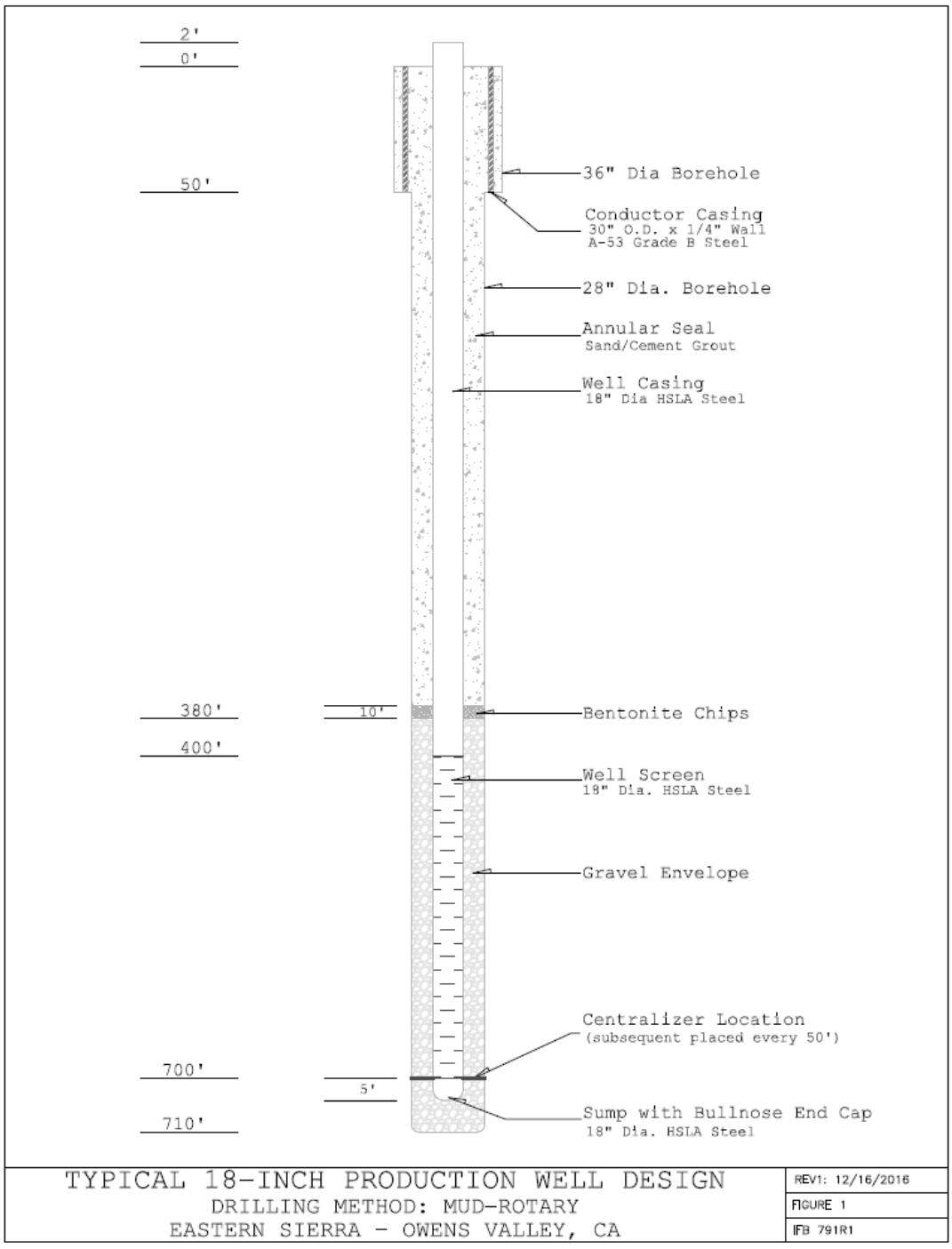

Figure 13: Replacement Well Design

6.2 Aquifer Test

Following the installation of the replacement for Well W061, the contractor will perform a step-drawdown test with up to four steps and a 24-hour constant rate pumping test of the new well, to include collecting water level data from nearby observation wells. Data from the pumping test will be used to estimate aquifer characteristics to be utilized to calculate the capacity of the replacement well. It is expected that the capacity of the replacement well to be approximately the same as that of Well W061.

6.3 Initial Operation

Using the analysis results of the data collected during the pumping tests, the pump equipment will be designed appropriately and installed. Operation of the replacement W061 is exempt from the On/Off Provisions of the Long Term Water Agreement during the irrigation season but will be subject to the provisions and associated monitoring activities.

6.4 Operation Plan Development

After the completion of the initial operation of well W061, the operational plan of the well will be included in LADWP's annual operation plan for The Owens Valley.

7. ENVIRONMENTAL ASSESSMENT

The replacement for Well W061 will be located adjacent to the existing well, pump from the deeper aquifer, with the capacity limited to that of the existing well, and water will be used for the same purposes as the well it is replacing. Therefore, no further impact to vegetation is expected from the operation of this well. Additional assessment will not be conducted for the replacement well and LADWP plans to file a Notice of Exemption under the California Environmental Quality Act with Inyo County Recorder's Office.

REFERENCES

City of Los Angeles, Inyo County, Technical Appendix to the Long-Term Groundwater Management Plan "Green Book", June 1990.

Hollett, Kenneth J., Wesley R. Danskin, William F. McCaffrey, Caryl L. Walti. Geology and Water Resources of Owens Valley, California. USGS Water Supply Paper 2370-B. 1991.

Inyo / Los Angeles Long-Term Groundwater Management Plan, Superior Court of California, County of Inyo, Case No. 12908, 1991.