Groundwater Application Review Summary Form

Application # G- 18595

GW Reviewer D. BOSCHMANN **Date Review Completed:** 8/30/2018

Summary of GW Availability and Injury Review:

[ ] Groundwater for the proposed use is either over appropriated, will not likely be available in the amounts requested without injury to prior water rights, OR will not likely be available within the capacity of the groundwater resource per Section B of the attached review form.

Summary of Potential for Substantial Interference Review:

[ ] There is the potential for substantial interference per Section C of the attached review form.

Summary of Well Construction Assessment:

[ ] The well does not appear to meet current well construction standards per Section D of the attached review form. Route through Well Construction and Compliance Section.

8/30/18

This is only a summary. Documentation is attached and should be read thoroughly to understand the basis for determinations and for conditions that may be necessary for a permit (if one is issued).

OR - KJ

MEMO

To: Kristopher Byrd, Well Construction and Compliance Section Manager

From: Joel Jeffery, Well Construction Program Coordinator

Subject: Review of Water Right Application G-18595

Date: August 31, 2018

The attached application was forwarded to the Well Construction and Compliance Section by Water Rights. Darrick Boschmann reviewed the application. Please see Darrick's Groundwater Review and the Well Information Reports.

Applicant's Well SVE #1 (LAKE 52530): The only reports that exist for this well are a Department generated information report and an oil or gas well lithographic description. A Water Supply Well Report does not exist. Because there is no water supply well report certified by a licensed well constructor for this well, the Department is not able to determine if the construction of the well meets minimum well construction standards. (See OAR 690 Division 210).

My recommendation is that the Department **not issue** a permit for Applicant's Well SVE #1 (LAKE 52530) unless it is brought into compliance with current minimum well construction standards or information is provided showing that it is in compliance with current minimum well construction standards.

Applicant's Well SVE #2 (LAKE 52529): The only reports that exist for this well are a Department generated information report and an oil or gas well lithographic description. A Water Supply Well Report does not exist. Because there is no water supply well report certified by a licensed well constructor for this well, the Department is not able to determine if the construction of the well meets minimum well construction standards. (See OAR 690 Division 210).

My recommendation is that the Department **not issue** a permit for Applicant's Well SVE #2 (LAKE 52529) unless it is brought into compliance with current minimum well construction standards or information is provided showing that it is in compliance with current minimum well construction standards.

Bringing Applicant's Wells SVE #1 and SVE #2 into compliance with minimum well construction standards may not satisfy hydraulic connection issues.

PUBLIC INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date 08/30/2018
FROM: Groundwater Section Darrick E. Boschmann
Reviewer's Name
SUBJECT: Application G-18595 Supersedes review of N.A.
Date of Review(s)

PUBLIC INTEREST PRESUMPTION; GROUNDWATER

OAR 690-310-130 (1) *The Department shall presume that a proposed groundwater use will ensure the preservation of the public welfare, safety and health as described in ORS 537.525.* Department staff review groundwater applications under OAR 690-310-140 to determine whether the presumption is established. OAR 690-310-140 allows the proposed use be modified or conditioned to meet the presumption criteria. **This review is based upon available information and agency policies in place at the time of evaluation.**

A. GENERAL INFORMATION: Applicant's Name: Surprise Valley Electrification Corp County: Lake

A1. Applicant(s) seek(s) (300gpm) 0.67 cfs from 2 well(s) in the Goose & Summer Lakes Basin, Summer Lake/Lake Abert subbasin

A2. Proposed use INDUSTRIAL/POWER DEVELOPMENT FROM GEOTHERMAL FLUID
Seasonality: year round

A3. Well and aquifer data **(attach and number logs for existing wells; mark proposed wells as such under logid):**

Well	Logid	Applicant's Well #	Proposed Aquifer*	Proposed Rate(cfs)	Location (T/R-S QQ-Q)	Location, metes and bounds, e.g. 2250' N, 1200' E fr NW cor S 36
1	LAKE 52530 (production well)	SVE#1	Volcanic rock aquifer unit	0.67 (300 gpm)*	33.00S-18.00E-23-NW SW	2090 FT N AND 1275 FT E FROM SW CORNER OF SECTION 23
2	LAKE 52529 (production well)	SVE#2	Volcanic rock aquifer unit	0.67 (300 gpm)*	33.00S-18.00E-23-SW NE	2665 FT N AND 1725 FT W FROM SE CORNER OF SECTION 23
3						
4						
5						

* Alluvium, CRB, Bedrock

Well	Well Elev ft msl	First Water ft bls	SWL ft bls	SWL Date	Well Depth (ft)	Seal Interval (ft)	Casing Intervals (ft)	Liner Intervals (ft)	Perforations Or Screens (ft)	Well Yield (gpm)	Draw Down (ft)	Test Type
**1	4490	75-105	140	?	1360	0-900	0-900	806-1310	806-1310	1300	?	?
**2	4472	?	131	?	1260	0-495	0-495	445-1210	445-1210	2500	?	?

Use data from application for proposed wells.

A4. **Comments:**

Note: This application is generally identical to LL-1727. This review is related to G-18594, which covers the production and injection portions of the low temperature geothermal project.

This application proposes to produce low-temperature geothermal fluids (bottom hole temperature <250°F) from two wells in the Goose and Summer Lakes Basin. The total consumptive use from the two wells is up to 300 gpm for the power plant cooling process.

The proposed wells are located in Lake County just outside the city of Paisely along the Chewaucan River. The area immediately underlying the wells was mapped by Walker (1963) as QTs (sedimentary deposits) which are described as lacustrine, fluviatile, and aeolian sedimentary rocks, interstratified tuff, ashy diatomite, and unconsolidated clay, sand, silt, and gravel. Proposed production well SVE#1 is located very near the contact with the underlying unit Tvb (basalt flows). Also mapped in the vicinity of the wells underlying the QTs unit are Ttf (tuff of rhyolitic and dacitic composition, tuffaceous sedimentary rocks, and aerially restricted rhyodacititc and andesitic rocks), and Taf (tuff, tuff, breccia, tuffaceous sedimentary rocks, gray and reddish claystones, hornblende andesite flows and less abundant altered basalt flows). Walker's 1963 map explanation indicates that the stratigraphic relation between unit Tvb and the Ttf/Taf units cannot be implied by stratigraphic position; therefore their relative stratigraphic relation is unknown.

The two production wells are located within the Summer Lake Hot Springs Known Geothermal Resource Area (KGRA) (Muffler, 1979) and the injection well just outside of the KGRA boundary. The geothermal system discharges to the surface

at several natural hot springs and has an estimated mean reservoir temperature of 118±6°C (~245°F) (Muffler, 1979). The geologic and structural setting of the area strongly suggests the geothermal system here is analogous to other structurally-controlled geothermal systems of the Great Basin, wherein upwelling of geothermal fluids in most systems is not related to upper crustal magmatic heat sources, but is instead related to crustal extension, faulting, and high heat flow (e.g. Coolbaugh, 2005; Faulds, 2015).

SVE#1: Formation descriptions for proposed production well SVE#1 (LAKE 52530) depict an interval from 0 to 530 comprised of predominantly unconsolidated gravels, sands, and clay which is likely correlative with Walker's QTs unit. This interval is underlain from 530 to 1360 (TD) by a series of altered/mineralized volcanic deposits including basalt, andesite, rhyolite, tuff, ash, pumice, and cinders, which is likely correlative with Walker's Ttf/Taf and/or Tvb unit. Note that the interval from 1080 to 1360 (TD) was a lost circulation zone with intermittent sample recovery from uncertain depths, however all samples recovered through this interval are volcanic. The well is continuously cased and continuously sealed through the QTs sedimentary unit into the underlying volcanic rock aquifer unit.

Proposed production well SVE#1 (LAKE 52530) has a reported bottom-hole temperature of 239.2°F.

SVE#2: Formation descriptions for proposed production well SVE#2 (LAKE 52529) depict an interval from 0 to 410 feet comprised of predominantly volcanic rocks and rounded volcanic sediments herein interpreted as unconsolidated sedimentary deposits on the basis of mapped stratigraphy and comparison with nearby well logs (LAKE 52506; LAKE 52683; LAKE 1628/LAKE 1626), which is likely correlative with Walker's QTs unit. This interval is underlain from 410 to 1070 by a series of altered/mineralized volcanic deposits including basalt, andesite, rhyolite, and tuff, with minor sand which is likely correlative with Walker's Ttf/Taf and/or Tvb unit. Note that the interval from 530 to 1070 is described entirely as basalt and/or andesite. Note also that the interval from 1070 to 1260 was a lost circulation zone with no samples recovered. Based on mapped stratigraphy and intermittent sample recovery from the lost circulation zone in LAKE 52530 it is reasonable to assume that this interval is a continuation of the Ttf/Taf and/or Tvb unit. The well is continuously cased and continuously sealed through the QTs sedimentary unit into the underlying volcanic rock aquifer unit.

Proposed production well SVE#2 (LAKE 52529) has a reported bottom-hole temperature of 225.4°F.

*Total combined rate from both wells not to exceed 300 gpm.

**All information from application materials and available DOGAMI permit files.

Note that all proposed wells are currently authorized under the DOGAMI geothermal permitting process (LAKE 52530/SVE#1 under DOGAMI API# 36-037-90009; LAKE 52529/SVE#2 under DOGAMI API# 36-037-90032; LAKE 52812/SVE#3 under DOGAMI API# 36-037-9032).

Note: proposed production wells LAKE 52530 and LAKE 52529 currently serve as authorized POD 2 and POD 3, respectively, under transfer T-11894. As such, some portion of the groundwater produced from these wells may be diverted for supplemental irrigation of up to 400 acres during the irrigation season.

A5. ☒ **Provisions of the** Goose & Summer Lake Basin rules relative to the development, classification and/or management of groundwater hydraulically connected to surface water ☐ **are**, *or* ☒ **are not**, activated by this application. (Not all basin rules contain such provisions.)
Comments:

A6. ☐ **Well(s) #** _____, _____, _____, _____, _____, tap(s) an aquifer limited by an administrative restriction.
Name of administrative area:
Comments: Currently no administrative area.

B. GROUNDWATER AVAILABILITY CONSIDERATIONS, OAR 690-310-130, 400-010, 410-0070

B1. **Based upon available data,** I have determined that groundwater* for the proposed use:

a. ☐ **is** over appropriated, ☐ **is not** over appropriated, *or* ☒ **cannot be determined to be** over appropriated during any period of the proposed use. * This finding is limited to the groundwater portion of the over-appropriation determination as prescribed in OAR 690-310-130;

b. ☐ **will not** *or* ☒ **will** likely be available in the amounts requested without injury to prior water rights. * This finding is limited to the groundwater portion of the injury determination as prescribed in OAR 690-310-130;

c. ☐ **will not** *or* ☐ **will** likely to be available within the capacity of the groundwater resource; or

d. ☒ **will, if properly conditioned**, avoid injury to existing groundwater rights or to the groundwater resource:
   i. ☒ The permit should contain condition #(s) **7A; Flowmeter/reporting**;
   ii. ☐ The permit should be conditioned as indicated in item 2 below.
   iii. ☒ The permit should contain special condition(s) as indicated in item 3 below;

B2. a. ☐ **Condition** to allow groundwater production from no deeper than _____ ft. below land surface;

b. ☐ **Condition** to allow groundwater production from no shallower than _____ ft. below land surface;

c. ☐ **Condition** to allow groundwater production only from the _____ groundwater reservoir between approximately _____ ft. and _____ ft. below land surface;

d. ☐ **Well reconstruction** is necessary to accomplish one or more of the above conditions. The problems that are likely to occur with this use and without reconstructing are cited below. Without reconstruction, I recommend withholding issuance of the permit until evidence of well reconstruction is filed with the Department and approved by the Groundwater Section.

Describe injury –as related to water availability– that is likely to occur without well reconstruction (interference w/ senior water rights, not within the capacity of the resource, etc): _____

B3. **Groundwater availability remarks:**

The nearest state observation well to the proposed location is State Observation Well 374 (**LAKE 1633**) located ~1.5 miles to the northeast which has a period of record from 1963 to 2017. The long term annual groundwater level trend in this well indicates an overall year-year water level decline of about 19 feet from 1980 to 2017, or roughly 0.5 feet per year since 1980. Formation descriptions on the well log for LAKE 1633 indicate the well is completed in the basin fill sediments.

Observation well **LAKE 52683** (permit condition obs well under permit G-17434; 380ft TD/115°F) located within the project area has a period of record from 2015 to 2018. No long term annual groundwater level trend can be identified in this well due to the short period of record; however there are no immediate signs of water level decline. Formation descriptions on the well log for LAKE 52683 indicate the well is completed in the basin fill sediments.

March static water levels reported to the department under the permit condition program for **LAKE 1628** ("Little Hot Well"; 432 ft TD/175°F) indicate a 73 foot water level decline over the period 3/2015 – 30/2017. March static water levels reported to the department under the permit condition program for **LAKE 52506** ("SVE#4" industrial use/cooling water; 378 ft TD/118°F) indicate a 20 foot water level decline over the period 3/2015 – 3/2016. These reported records suggest significant rates of decline in the immediate vicinity of proposed production well LAKE 52529 (see following paragraphs).

Miscellaneous water level data made available to this reviewer by the applicant supplement the data available from the OWRD GSIS database. Review of these data presents an alternate interpretation from that made based on the permit condition program data alone for LAKE 1628 and LAKE 52506.

It is clear from the supplemental data that the "static" water level reported to the department for 03/01/2016 and 03/22/2017 for **LAKE 1628** was affected by a recent period of pumping either in that well, or in LAKE 52506, or possibly both, and that the water level reported represents a pumping or recovery/rising level, rather than a true static water level which could be directly compared to the March level from the previous year. Due to the year-round pumping/recovery cycles at this well it is difficult to determine whether or not any year-to-year water level declines are occurring, however since regular pumping began in 2015 the well has never fully recovered to its pre-2015 static water levels, and the full record does seem to indicate that declines may be occurring.

It is clear from the supplemental data that the "static" water level reported to the department for 03/01/2016 for **LAKE 52506** was affected by a recent period of pumping in that well; and that the water level reported represents a pumping or recovery/rising level, rather than a true static water level which could be directly compared to the March level from the previous year. The period of record for LAKE 52506 provided in the supplemental data covers 05/12/2014 – 01/16/2018. Due to the year-round pumping/recovery cycles at this well it is difficult to determine whether or not any year-to-year water level declines are occurring; although from October 2014 to October 2017 (two periods for which there appears to be no direct pumping influence), the record does indicate approximately 7-8 feet of overall decline; or approximately 2.5 ft/yr.

The supplemental water level data made available to this reviewer by the applicant also includes the two proposed production wells and several other nearby wells:

Proposed production well **LAKE 52530** (SVE#1) has a period of record from 6/6/2014 to 1/16/2018. Due to the year-round pumping/recovery cycles at this well it is difficult to determine whether or not any year-to-year water level declines are occurring, however there are no apparent signs of significant water level declines.

Proposed production well **LAKE 52529** (SVE#2) has a period of record from 6/17/2014 to 1/16/2018. Due to the year-round pumping/recovery cycles at this well it is difficult to determine whether or not any year-to-year water level declines are occurring, however there are no apparent signs of significant water level declines.

LAKE 1638 ("Mud Well"; unused irrigation well/livestock?; 775 ft TD/120°F) has a period of record from 3/28/2014 to 5/2/2017. The hydrograph for this reportedly unused irrigation well shows a clear and consistent decline trend from 2014 through spring of 2017 of approximately 6-10 feet over the period of record; or approximately 2 – 3.3 ft/yr. Formation descriptions on the well log for LAKE 1638 indicate the well is completed in the basin fill sediments.

LAKE 1625 ("Corky's"; unused irrigation well; 610 ft TD/175°F) has a period of record from 3/28/2014 to 5/2/2017. The hydrograph for this reportedly unused irrigation well shows a clear and consistent decline trend from 2014 through spring of 2017 of approximately 6-7 feet over the period of record; or approximately 2 ft/yr. Formation descriptions on the well log for LAKE 1625 indicate the well is completed in the basin fill sediments.

LAKE 1637 ("Trailer Court"; livestock; 153 ft TD/~75°F) has a period of record from 3/28/2014 to 5/2/2017. Due to the year-round pumping/recovery cycles at this well it is difficult to determine whether or not any year-to-year water level declines are occurring. Formation descriptions on the well log for LAKE 1637 indicate the well is completed in the volcanic rock unit.

LAKE 4278 ("Paisley"; unused; 515 ft TD/115°F) has a period of record from 3/28/2014 to 1/16/2018. The hydrograph for this well does not indicate any apparent signs of significant water level declines. Formation descriptions on the well log for LAKE 4278 indicate the well is completed in the volcanic rock unit.

LAKE 51059 ("ZX"; unused; 1412 ft TD/78°F) has a period of record from 3/28/2014 to 1/16/2018. The hydrograph for this well indicates a decline trend from spring of 2014 through spring of 2017 of approximately 3.25 feet over the period of record; or approximately 1 ft/yr. Formation descriptions on the well log for LAKE 51059 indicate the well is completed in the volcanic rock unit.

Nearby wells with elevated temperatures are presumably hydraulically connected to the deep geothermal reservoir. Additionally, public comment received by the department asserts that direct interference between the SVE production wells and existing authorized irrigation wells is occurring.

Firstly, proposed production wells LAKE 52530 and LAKE 52529 currently serve as authorized POD 2 and POD 3, respectively, under transfer T-11894. As such, some portion of the groundwater produced from these wells may be diverted for supplemental irrigation of up to 400 acres during the irrigation season. Any groundwater production authorized under this application has the potential to interfere with the use currently authorized under T-11894.

Proposed production well LAKE 52530 is located ~445 feet north of POD 1 under transfer T-11894 (**LAKE 1627 "Hot Well"**). LAKE 1627 (reconditioning log LAKE 4448) has a reported water temperature of 212 degrees F. The potential increase in interference at LAKE 1627 was calculated using the Theis equation (see attachment). The values for the calculation are conservative and appropriate until better values become available. The calculations use an intermediate storage coefficient (0.001). The transmissivity used in the calculation (5,050 ft^2/day [1ft^2/day ≈0.37 darcy-ft]) is the transmissivity of the deep geothermal aquifer derived from the Geologica multi-well interference test (report dated 04/19/2018). At the maximum proposed pumping rate for LAKE 52530 (0.67 cfs), the results show an increase in drawdown of ~9 feet after 365* days, which should be within the capacity of the well.

***Note:** interference will continue to increase after the 365 day calculated value for this proposed year-round use.

If a permit is issued, the following conditions are recommended:

7A:Monitoring Plan: The water user shall develop a plan to monitor and report the impact of water use under this permit. The plan shall be submitted to the Department before water use begins under this permit and shall be subject to the approval of the Department.

Flow meter condition: Apply the "Large" water use reporting condition to all production and injection wells to monitor and report both the total volume produced and total volume reinjected at each well. An additional flow meter is required at any diversion points that supply groundwater for irrigation authorized under any other water right, or any other consumptive use authorized from these wells.

C. GROUNDWATER/SURFACE WATER CONSIDERATIONS, OAR 690-09-040

C1. **690-09-040 (1):** Evaluation of aquifer confinement:

Well	Aquifer or Proposed Aquifer	Confined	Unconfined
1	**Volcanic Rock Aquifer Unit**	☒	☐
2	**Volcanic Rock Aquifer Unit**	☒	☐
		☐	☐
		☐	☐
		☐	☐

Basis for aquifer confinement evaluation:

No detailed studies of the groundwater system in this part of the Summer Lake Subbasin have been reported, but numerous studies within the broader Goose and Summer Lakes Basin serve as analogues for understanding the general characteristics of the groundwater flow system regionally. Reports across the Goose and Summer Lakes Basin indicate that groundwater generally occurs in a basin fill sediment unit overlying a predominantly volcanic/volcaniclastic rock unit under both confined and unconfined conditions (e.g. Brown, 1957 – upper Summer Lake subbasin; Hampton, 1964 – Fort Rock Basin; Miller, 1986 – Fort Rock Basin; Morgan, 1988 – Goose Lake Basin; McFarland, 1991 – Fort Rock Basin). In the Ana Springs area in the northern Summer Lake Basin Brown (1957) describes the occurrence of groundwater under both confined and unconfined conditions, and describes flowing wells producing groundwater from the volcanic rock aquifer unit. In the Fort Rock Basin Miller (1986) indicates that the Quaternary unconsolidated deposits constitute an upper groundwater reservoir reflecting a somewhat higher head system with lower transmissivities than the underlying main ground water reservoir. In the Goose Lake Basin Morgan (1988) found that regionally the volcanic units and basin fill deposits together comprise a single groundwater flow system; unconfined groundwater commonly occurs within the upper 10-20 feet of saturated sediments; confined conditions prevail with increasing depth; and that 100 feet below the water table, groundwater is confined nearly everywhere in the basin fill deposits. Hampton (1964), Miller (1986), and McFarland (1991) all describe natural discharge of groundwater from the volcanic unit to surface water at the northern end of the Summer Lake Subbasin at Ana Springs. Hampton (1964), Morgan (1988) and McFarland (1991) all indicate that given the lithology and depositional environment within both the basin fill and the underlying volcanic section, a high degree of anisotropy is characteristic of the groundwater flow system - vertical hydraulic conductivity is less than horizontal hydraulic conductivity. Within the volcanic section Morgan argues for a ratio of vertical to horizontal hydraulic conductivity of 1:1000; and suggests ratios from 1:2 up to 1:170 within the basin fill.

Several thermal springs occur approximately 5 miles to the northwest of the proposed location. Additionally, numerous wells in the vicinity of the proposed location with elevated temperatures (>80°F) range in depth from 130 to 983 feet, suggesting groundwater from the deep thermal reservoir has some degree of vertical connection with the shallower parts of the groundwater flow system in this area, possibly to some degree by way of sub-vertical faults behaving as conduits for vertical fluid migration.

A 10-day, multi-well interference test completed by the applicant involved pumping ~1300 gpm from production well SVE#1 (LAKE 52530) while simultaneously reinjecting the produced fluids into injection well SVE#3 (LAKE 52812). Aquifer response was monitored during the test by measuring water levels in SVE#2 (LAKE 52529) as well as 4 shallower wells nearby ("Mud Well" – LAKE 1638; "Corky's" – LAKE 1625; "ZX" – LAKE 51059; "City Well" – unknown well log). Production well SVE#2 (LAKE 52529) exhibited a clear pressure response both to pumping from production well SVE#1 (LAKE 52530) and to injection into SVE#3(LAKE 52812). The four shallower wells did not exhibit any significant pressure response.

Given the above considerations, the deep thermal reservoir appears to exist under confined to semi-confined conditions, resulting from both the vertical heterogeneity of aquifer materials, and the anisotropy of hydraulic conductivity within the various geologic materials comprising the aquifer system; some degree of vertical hydraulic connection between the deeper and shallower parts of the system is apparent as described above, possibly to some degree by way of sub-vertical faults behaving as conduits for vertical fluid migration.

C2. **690-09-040 (2) (3):** Evaluation of distance to, and hydraulic connection with, surface water sources. All wells located a horizontal distance less than ¼ mile from a surface water source that produce water from an unconfined aquifer shall be assumed to be hydraulically connected to the surface water source. Include in this table any streams located beyond one mile that are evaluated for PSI.

Well	SW #	Surface Water Name	GW Elev ft msl	SW Elev ft msl	Distance (ft)	Hydraulically Connected? YES	NO	ASSUMED	Potential for Subst. Interfer. Assumed? YES	NO
1	**1**	**Chewaucan River**	**4,350**	***4,350**	***7,500**	☒	☐	☐	☐	☒
2	**1**	**Chewaucan River**	**4,340**	***4,340**	***7,000**	☒	☐	☐	☐	☒
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation:

The reach of the Chewaucan River closest to proposed well HARN 52530 (SVE#1) is about 2,020 feet away at an elevation of about 4,415 feet. The reach of the Chewaucan River closest to proposed well HARN 52529 (SVE#2) is about 995 feet away at an elevation of about 4,395 feet.

*At these closest reaches the river appears to be above the static groundwater level in these wells; however the river quickly drops in elevation downstream to the elevation of the static groundwater level. The 4,350 river elevation is about 7,500 feet away from HARN 52530. The 4,340 river elevation is about 7,000 feet away from HARN 52529. The reaches at these distances are presumed to be where hydraulic connection with the Chewaucan River begins, and as such are the distances used in the table above and calculations below.

Water Availability Basin the well(s) are located within: CHEWAUCAN R > L ABERT - AT MOUTH

C3a. **690-09-040 (4):** Evaluation of stream impacts for <u>each well</u> that has been determined or assumed to be **hydraulically connected and less than 1 mile** from a surface water source. Limit evaluation to instream rights and minimum stream flows that are pertinent to that surface water source, and not lower SW sources to which the stream under evaluation is tributary. Compare the requested rate against the 1% of 80% *natural* flow for the pertinent Water Availability Basin (WAB). If Q is not distributed by well, use full rate for each well. Any checked ☒ box indicates the well is assumed to have the potential to cause PSI.

Well	SW #	Well < ¼ mile?	Qw > 5 cfs?	Instream Water Right ID	Instream Water Right Q (cfs)	Qw > 1% ISWR?	80% Natural Flow (cfs)	Qw > 1% of 80% Natural Flow?	Interference @ 30 days (%)	Potential for Subst. Interfer. Assumed?
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐
		☐	☐			☐		☐		☐

C3b. **690-09-040 (4):** Evaluation of stream impacts <u>by total appropriation</u> for all wells determined or assumed to be **hydraulically connected and less than 1 mile** from a surface water source. **Complete only if Q is distributed among wells.** Otherwise same evaluation and limitations apply as in C3a above.

	SW #		Qw > 5 cfs?	Instream Water Right ID	Instream Water Right Q (cfs)	Qw > 1% ISWR?	80% Natural Flow (cfs)	Qw > 1% of 80% Natural Flow?	Interference @ 30 days (%)	Potential for Subst. Interfer. Assumed?
			☐			☐		☐		☐
			☐			☐		☐		☐
			☐			☐		☐		☐
			☐			☐		☐		☐

Comments: No analysis here. The proposed wells are greater than one mile from where hydraulic connection with surface water begins.

C4a. **690-09-040 (5):** Estimated impacts on **hydraulically connected surface water sources greater than one mile** as a percentage of the proposed pumping rate. Limit evaluation to the effects that will occur up to one year after pumping begins. This table encompasses the considerations required by 09-040 (5)(a), (b), (c) and (d), which are not included on this form. Use additional sheets if calculated flows from more than one WAB are required.

Non-Distributed Wells Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	1	0.15 %	0.15 %	0.15 %	0.15 %	0.15 %	0.15 %	0.15 %	0.15 %	0.15 %	0.15 %	0.15 %	0.15 %
Well Q as CFS		0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Interference CFS		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Distributed Wells Well	SW#	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													
(A) = Total Interf.		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
(B) = 80 % Nat. Q		33.8	64.9	103.0	161.0	314.0	234.0	81.9	47.4	42.3	42.2	34.4	32.8
(C) = 1 % Nat. Q		0.338	0.649	1.03	1.61	3.14	2.34	0.819	0.474	0.423	0.422	0.344	0.328
(D) = (A) > (C)		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
(E) = (A / B) x 100		%	%	%	%	%	%	%	%	%	%	%	%

(A) = total interference as CFS; (B) = WAB calculated natural flow at 80% exceed. as CFS; (C) = 1% of calculated natural flow at 80% exceed. as CFS; (D) = highlight the checkmark for each month where (A) is greater than (C); (E) = total interference divided by 80% flow as percentage.

Basis for impact evaluation:

Hunt (2003) was used to calculate the interference between Well 2 and SW #1; the closest well outside of a mile from hydraulically connected surface water. The values used for the calculation are conservative and appropriate until better values become available. The calculations use an intermediate storage coefficient (0.001). The transmissivity used in the calculation (5,050 ft^2/day [1ft^2/day ≈0.37 darcy-ft]) is the transmissivity of the deep geothermal aquifer derived from the Geologica multi-well interference test (report dated 04/19/2018).

Qw = 0.67 cfs (proposed pumping rate)
tpon = 365 days (year round use)
a = 7000 ft (distance to 4340 ft river elevation)
K=10.1 ft/day (K*b = 5050 ft2/day)
b = 500 ft (K*b = 5050 ft2/day)
S = 0.001 (intermediate value used)
Kva = 0.072 ft/day (Transmissivity of basin fill from 2016 aquifer test/saturated thickness)
ba = 500 ft (derived from formation descriptions LAKE 52812 and land surface geometry)
babs = 475 ft (estimated stream geometry)
ws = 50 ft (derived from imagery)

Interference is calculated to be less than 1% of the natural flow at 80% exceedance for all months evaluated.

C4b. **690-09-040 (5) (b) The potential to impair or detrimentally affect the public interest is to be determined by the Water Rights Section.**

C5. ☐ **If properly conditioned**, the surface water source(s) can be adequately protected from interference, and/or groundwater use under this permit can be regulated if it is found to substantially interfere with surface water:
- i. ☐ The permit should contain condition #(s)_____;
- ii. ☐ The permit should contain special condition(s) as indicated in "Remarks" below;

C6. **SW / GW Remarks and Conditions:**

If a permit is issued, the following conditions are recommended:

7A:Monitoring Plan: The water user shall develop a plan to monitor and report the impact of water use under this permit. The plan shall be submitted to the Department before water use begins under this permit and shall be subject to the approval of the Department.

Flow meter condition: Apply the "Large" water use reporting condition to all production and injection wells to monitor and report both the total volume produced and total volume reinjected at each well. An additional flow meter is required at any diversion points that supply groundwater for irrigation authorized under any other water right, or any other consumptive use authorized from these wells.

References Used:

Walker, G.W., 1963, Reconnaissance geologic map of the eastern half of the Klamath Falls (AMS) quadrangle, Lake and Klamath Counties, Oregon. U.S. Geological Survey Mineral Investigations Field studies Map MF-260, 1:250000.

Davis, L., et al., 2013. Multi-well interference test of the Paisley geothermal reservoir. Industry report.

Brown, S.G., 1957. Occurrence of ground water near Ana Springs, Summer Lake basin, Lake County, Oregon: US Geol. *Survey open-file report.*

Miller, D.W., 1986. *Ground Water Conditions in Fort Rock Basin, Northern Lake County, Oregon*. State of Oregon, Water Resources Department.

Morgan, D.S., 1988. *Geohydrology and numerical model analysis of ground-water flow in the Goose Lake Basin, Oregon and California* (Vol. 87, No. 4058). US Department of the Interior, US Geological Survey.

Muffler, L. J. P., 1979. Assessment of geothermal resources of the United States, 1978 (No. USGS-CIRC-790). Geological Survey, Reston, VA (USA). Geologic Div.

Faulds, J.E. and Hinz, N.H., 2015, April. Favorable tectonic and structural settings of geothermal systems in the Great Basin region, western USA: Proxies for discovering blind geothermal systems. In Proceedings of the World Geothermal Congress, Melbourne, Australia (pp. 19-25).

Coolbaugh, M. F., Arehart, G. B., Faulds, J. E., Garside, L. J., Rhoden, H. N., Steininger, R. C., & Vikre, P. G. (2005). Geothermal systems in the Great Basin, western United States: Modern analogues to the roles of magmatism, structure, and regional tectonics in the formation of gold deposits. In Geological Society of Nevada Symposium (pp. 1063-1081).

OWRD water well reports, water level data, and/or hydrographs.

Oregon Administrative Rules.

DOGAMI permit files.

Supplemental data provided by the applicant.

D. WELL CONSTRUCTION, OAR 690-200

D1. **Well #:** _____ **Logid:** _____

D2. **THE WELL does not appear to meet current well construction standards based upon:**

a. ☐ review of the well log;
b. ☐ field inspection by _____;
c. ☐ report of CWRE _____;
d. ☐ other: (specify) _____

D3. **THE WELL construction deficiency or other comment is described as follows:** _____

D4. ☐ **Route to the Well Construction and Compliance Section for a review of existing well construction.**

Water Availability Tables

Water Availability Analysis
Detailed Reports

CHEWAUCAN R > L ABERT - AT MOUTH
GOOSE & SUMMER LAKE BASIN
Water Availability as of 5/23/2018

Watershed ID #. 31300602 (Map)
Date 5/23/2018

Exceedance Level 50%
Time 8:56 AM

Water Availability Calculation | Consumptive Uses and Storages | Instream Flow Requirements | Reservations | Water Rights | Watershed Characteristics

Water Availability Calculation

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	33.80	0.87	32.93	0.00	0.00	32.93
FEB	64.90	1.15	63.80	0.00	0.00	63.80
MAR	103.00	23.80	79.20	0.00	0.00	79.20
APR	161.00	113.00	48.00	0.00	0.00	48.00
MAY	314.00	300.00	14.40	0.00	0.00	14.40
JUN	234.00	250.00	-15.70	0.00	0.00	-15.70
JUL	81.90	83.52	-1.62	0.00	0.00	-1.62
AUG	47.40	48.29	-0.81	0.00	0.00	-0.81
SEP	42.30	40.90	1.41	0.00	0.00	1.41
OCT	42.20	22.60	19.60	0.00	0.00	19.60
NOV	34.40	0.63	33.76	0.00	0.00	33.73
DEC	32.80	0.73	32.10	0.00	0.00	32.10
ANN	120,000.00	53,600.00	66,400.00	0.00	0.00	66,400.00

Well Location Map

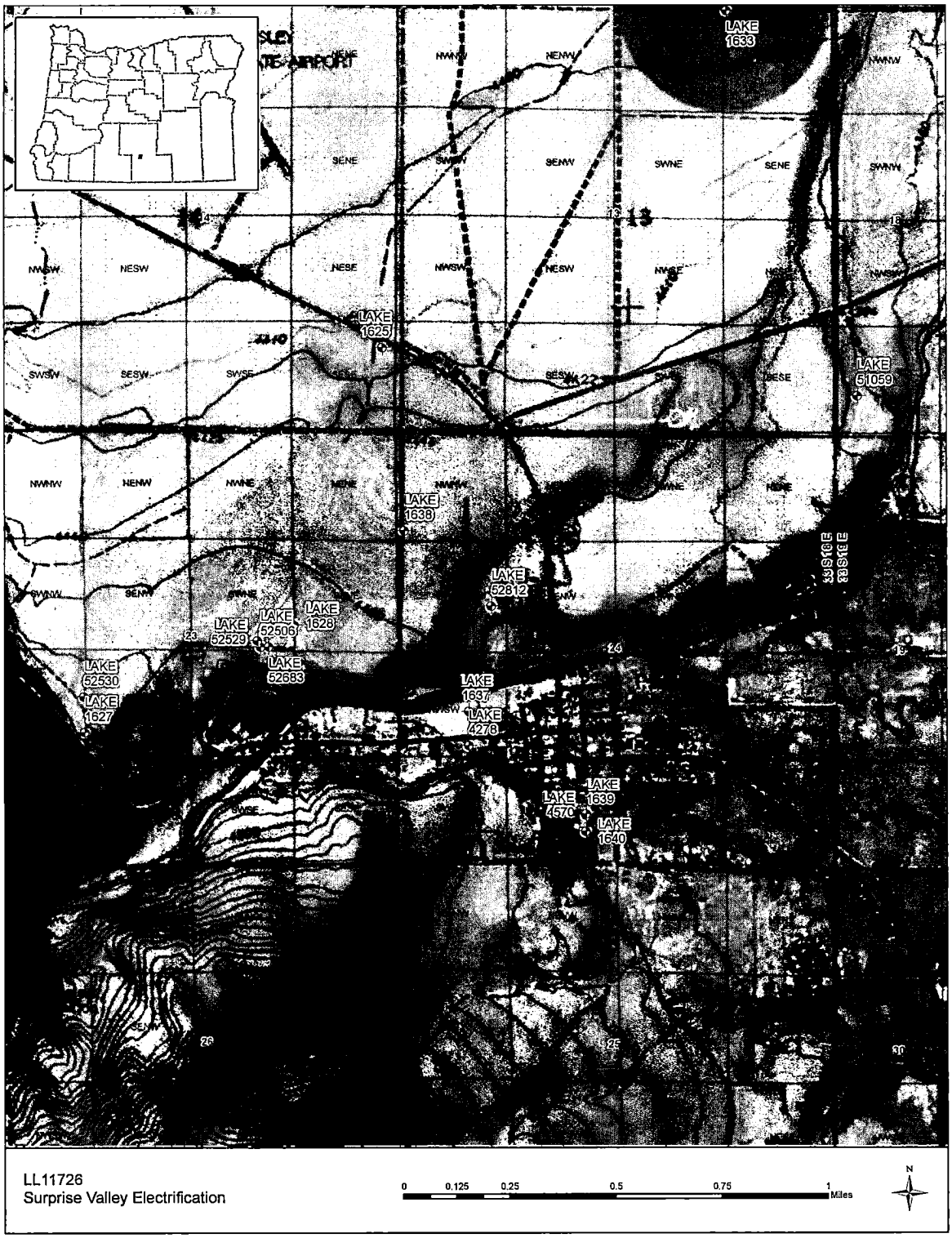


Figure 1: Location map.

Water-Level Trends in Nearby Wells

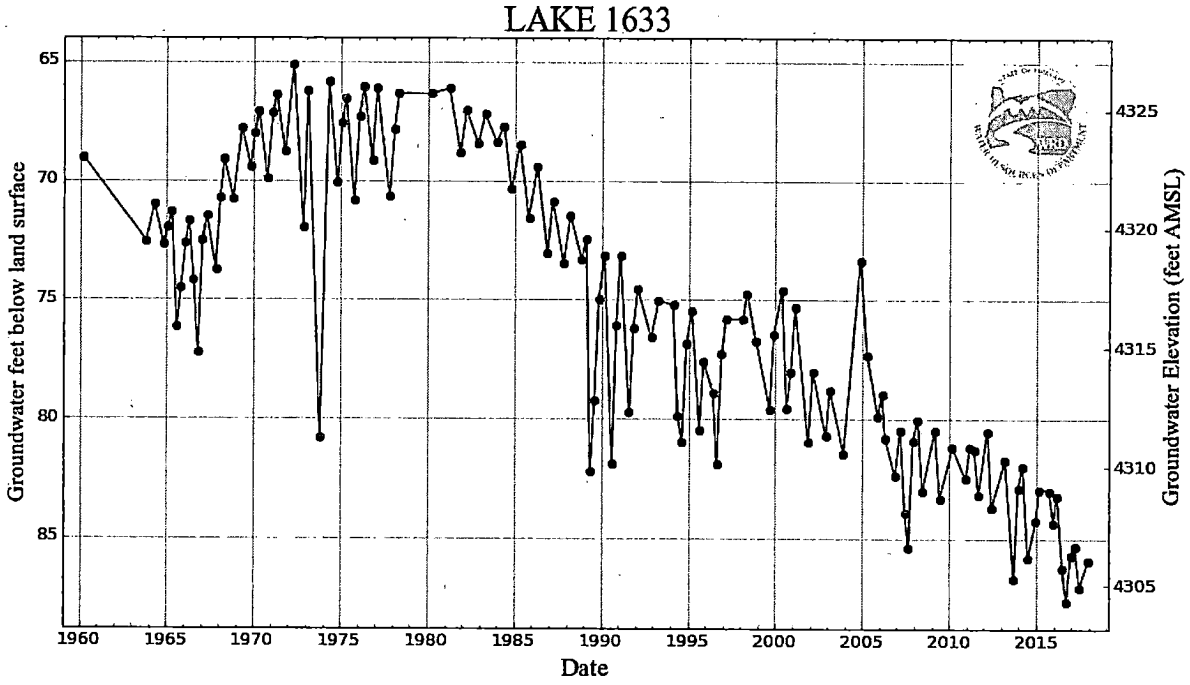


Figure 2: Hydrograph for LAKE 1633.

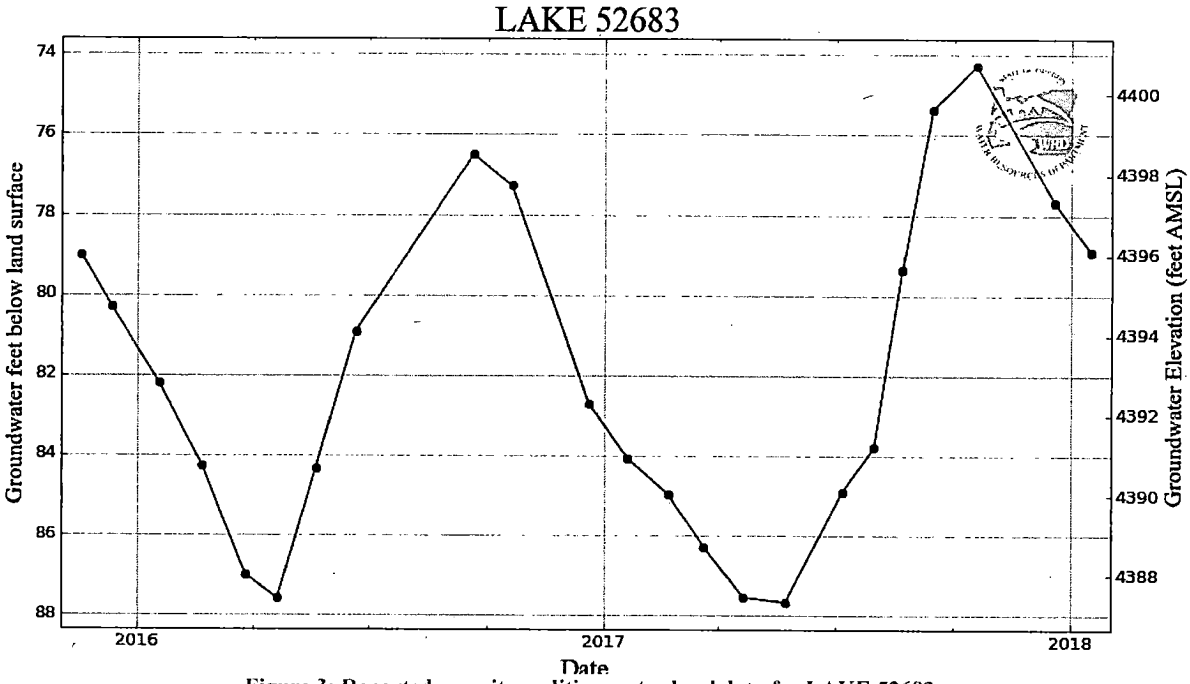


Figure 3: Reported permit condition water level data for LAKE 52683.

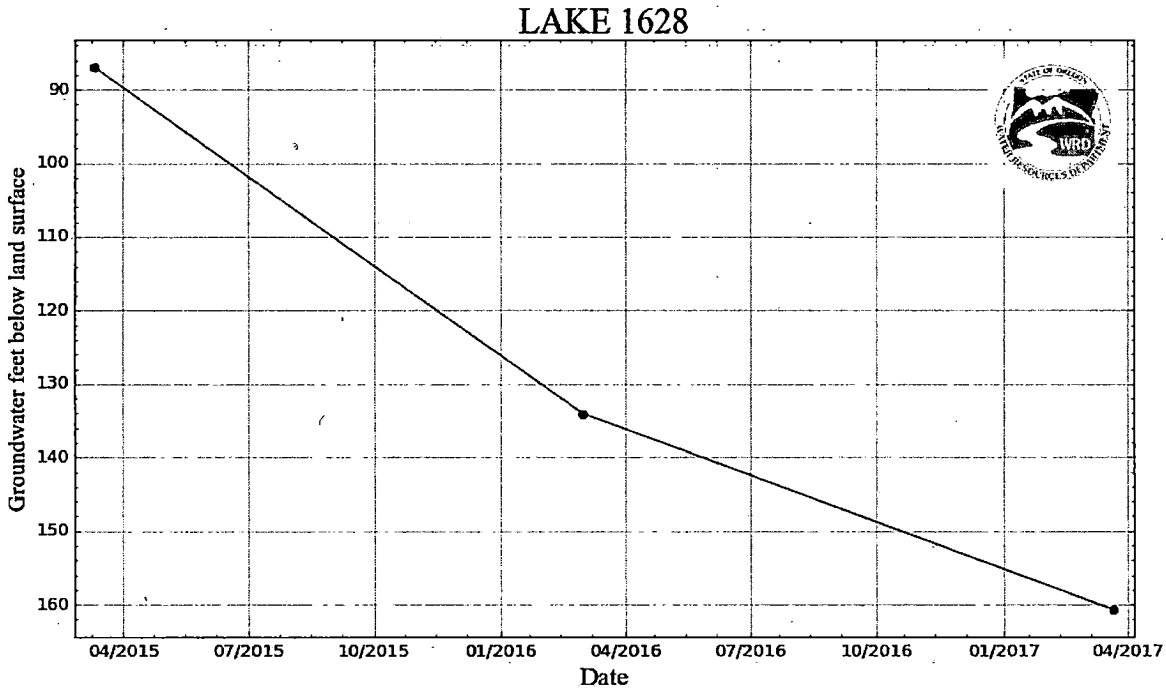


Figure 4: Reported permit condition water level data for LAKE 1628.

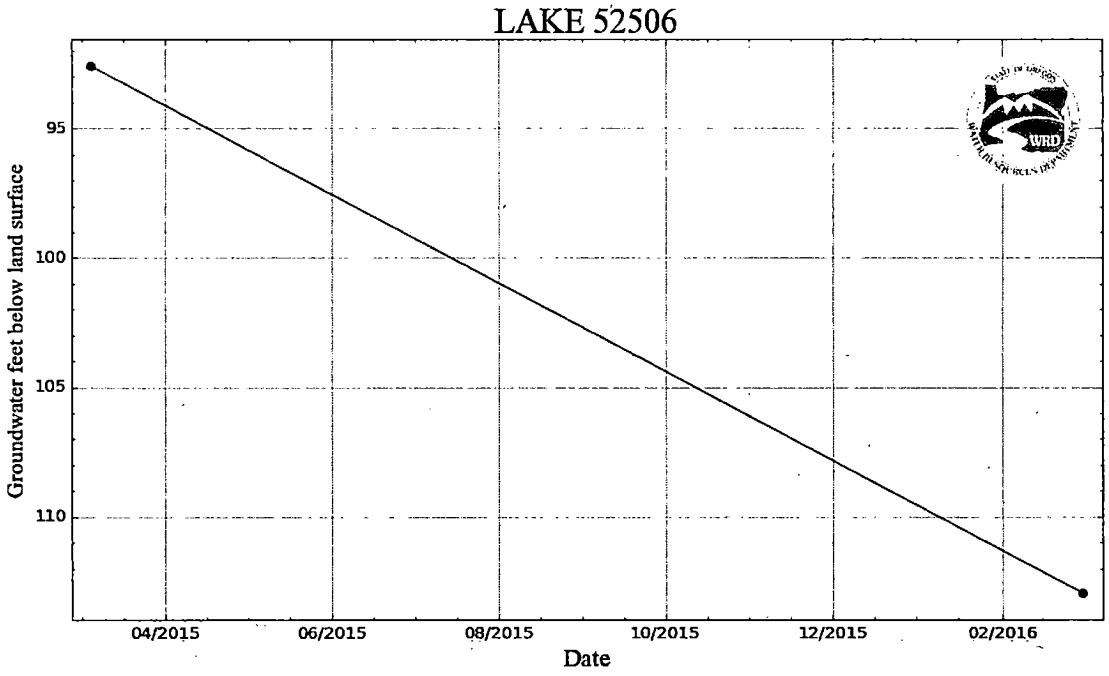


Figure 5: Reported permit condition water level data for LAKE 52506.

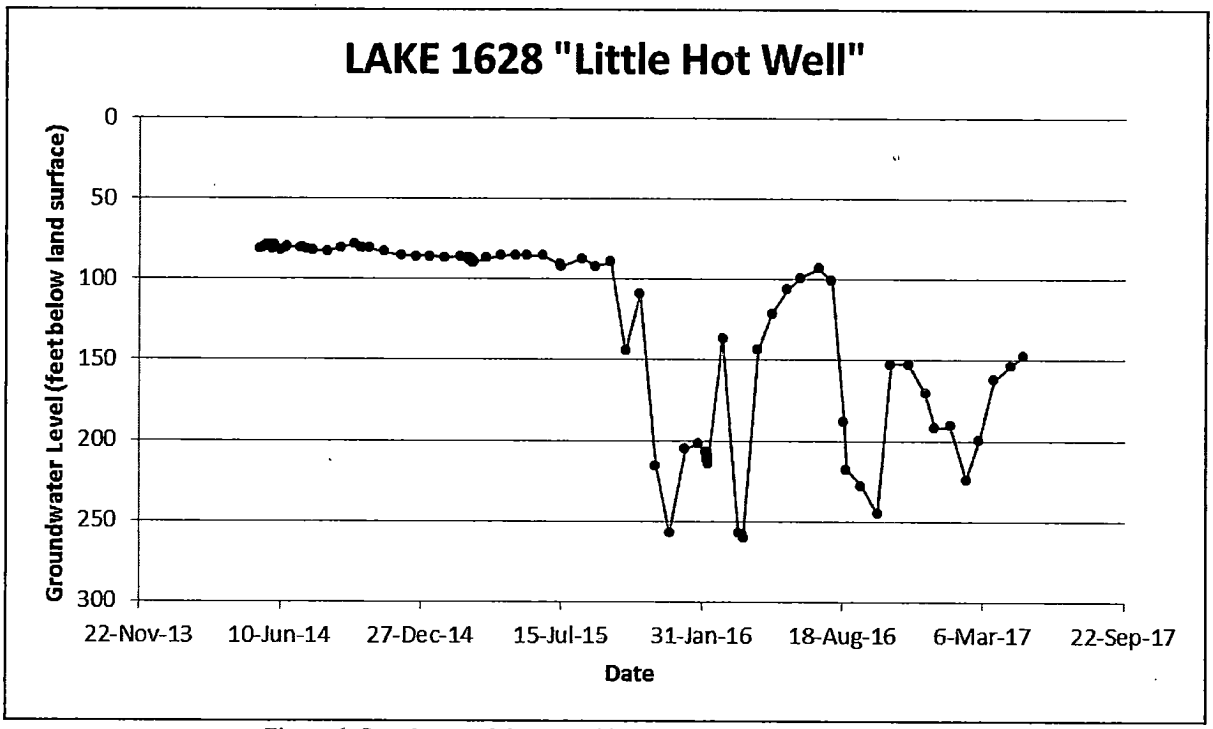


Figure 6: Supplemental data provided by the applicant - LAKE 1628.

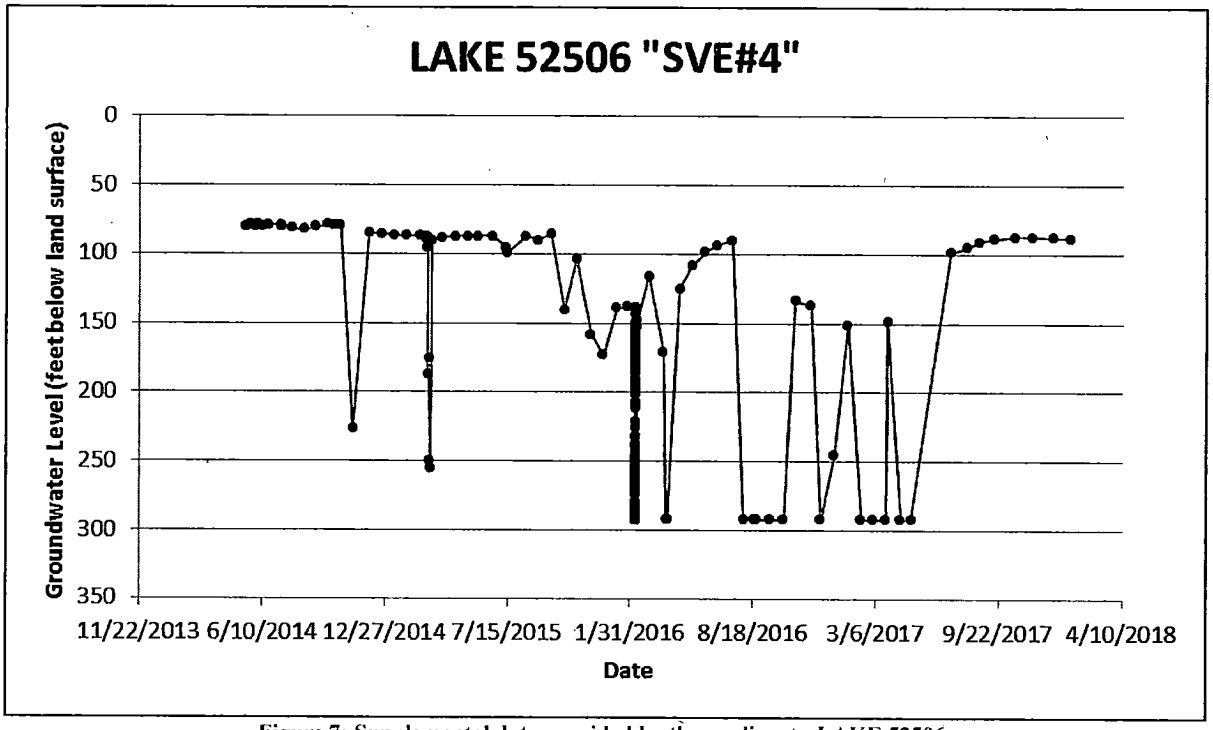


Figure 7: Supplemental data provided by the applicant - LAKE 52506.

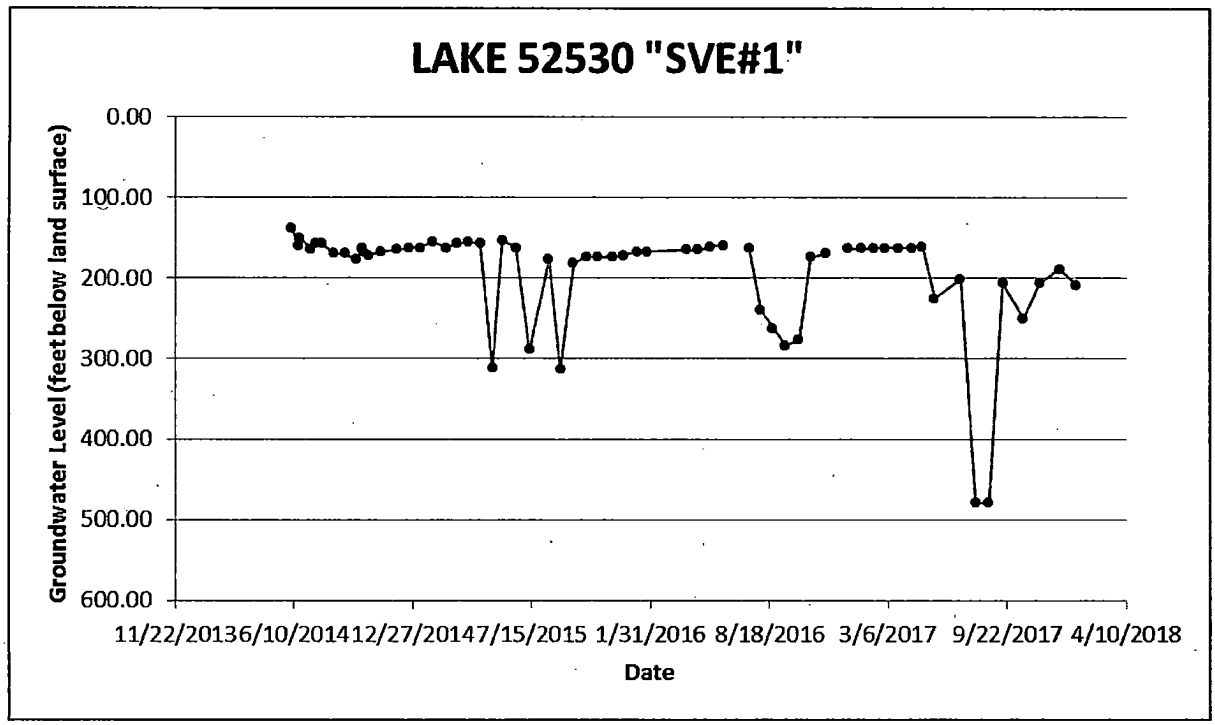


Figure 8: Supplemental data provided by the applicant - LAKE 52530.

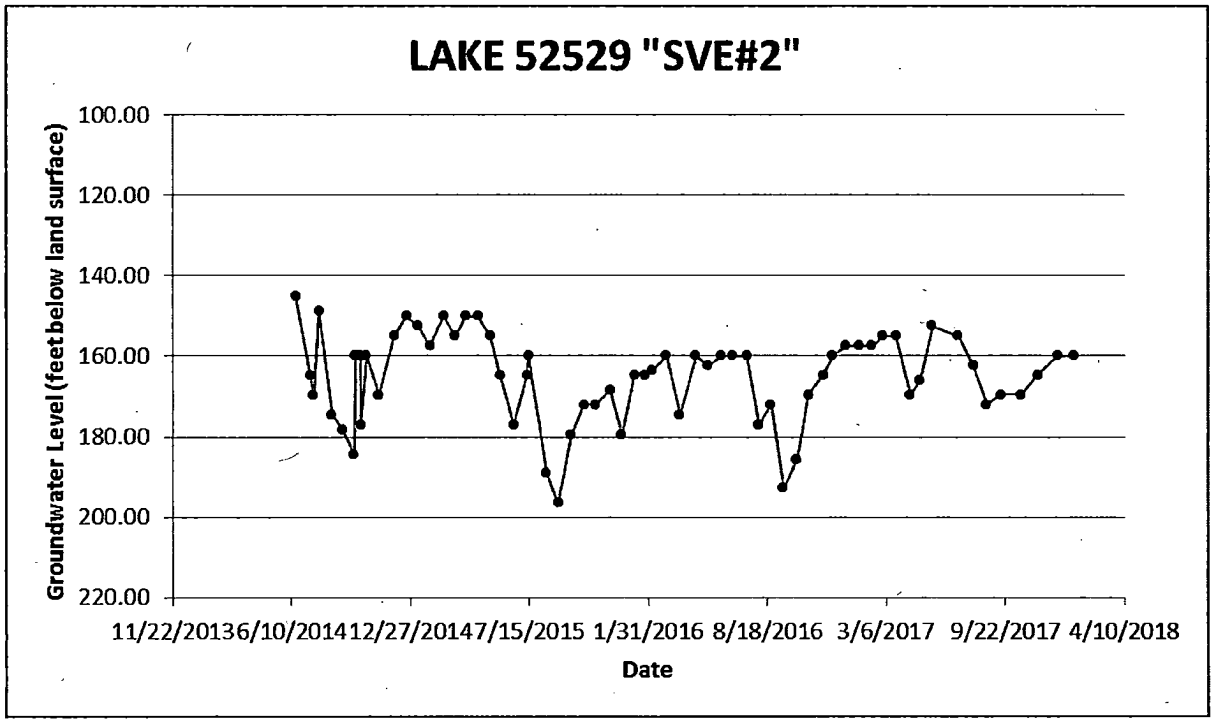


Figure 9: Supplemental data provided by the applicant - LAKE 52529.

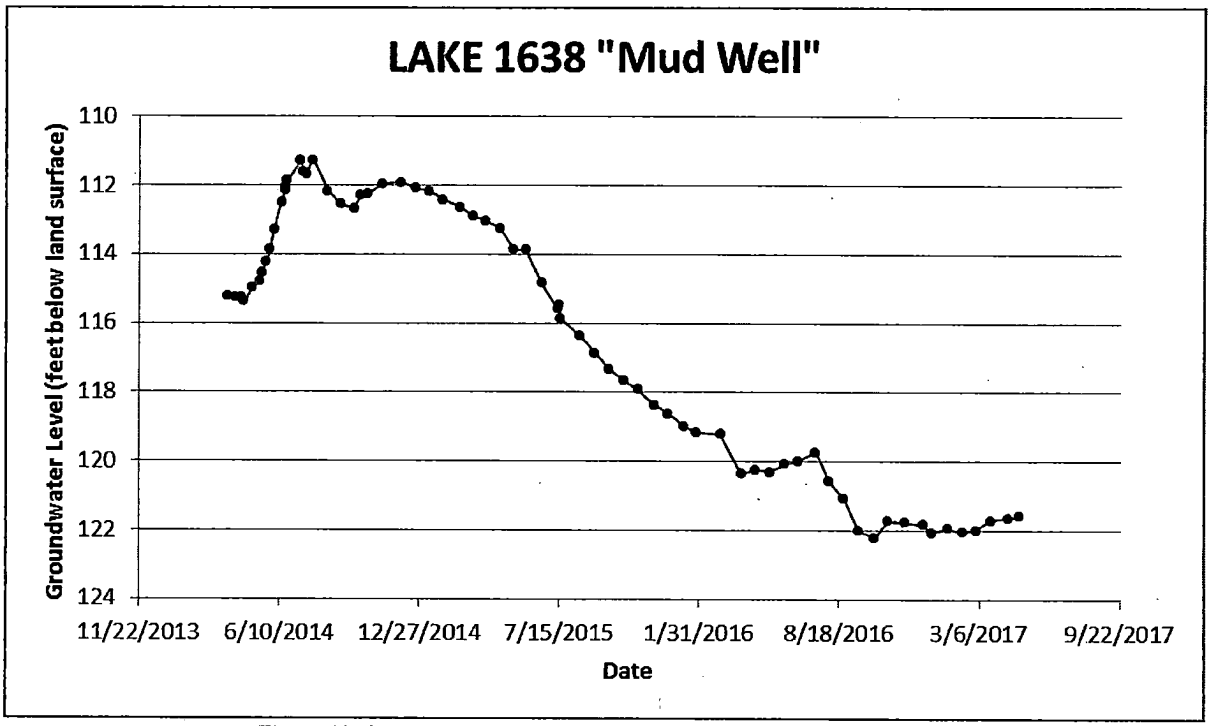


Figure 10: Supplemental data provided by the applicant - LAKE 1638.

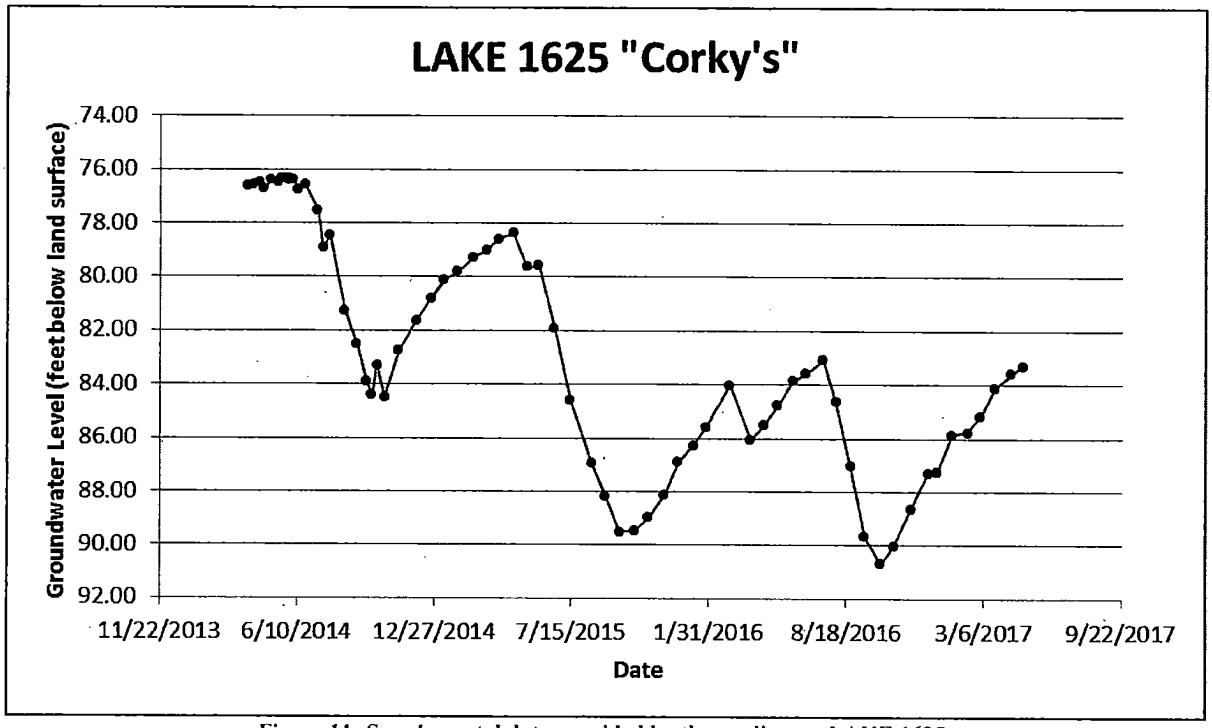


Figure 11: Supplemental data provided by the applicant - LAKE 1625.

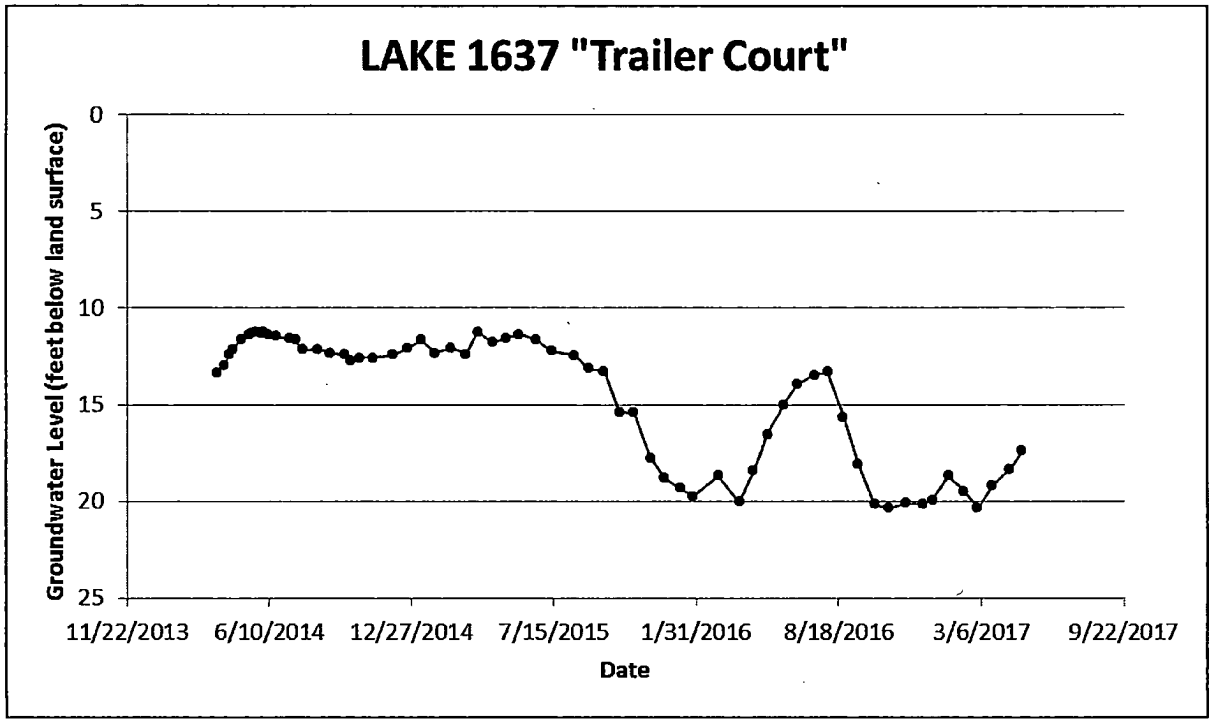


Figure 12: Supplemental data provided by the applicant - LAKE 1637.

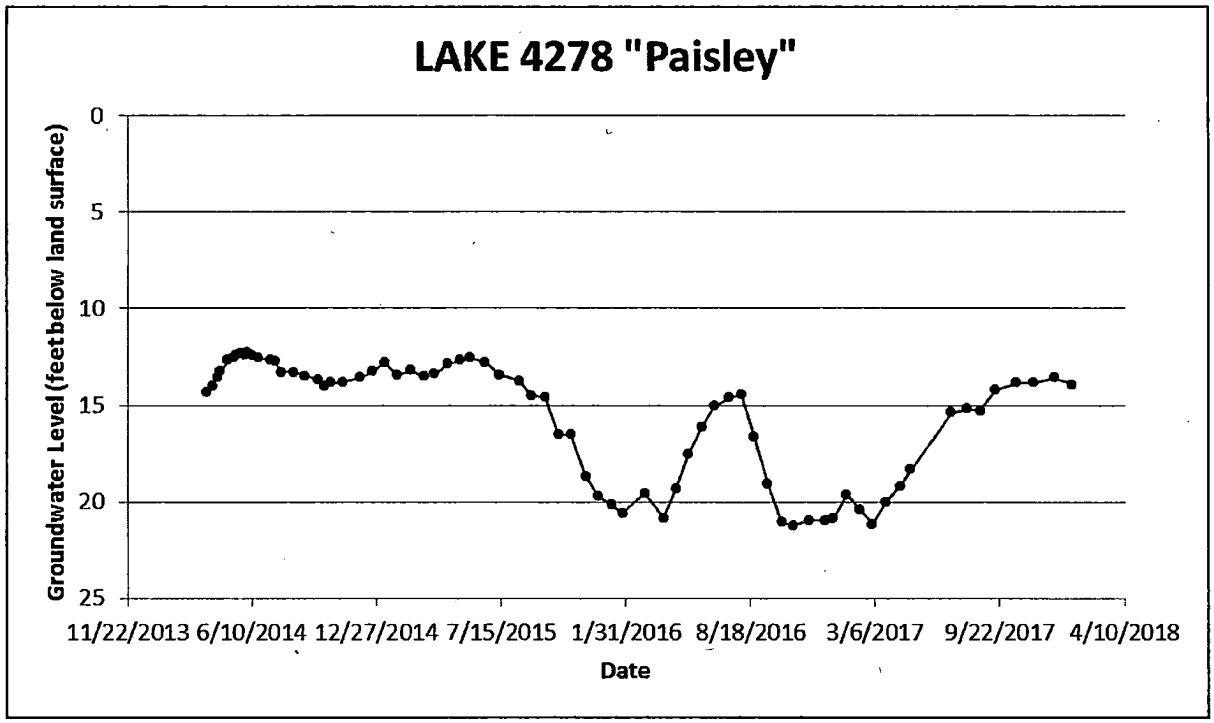


Figure 13: Supplemental data provided by the applicant - LAKE 4278.

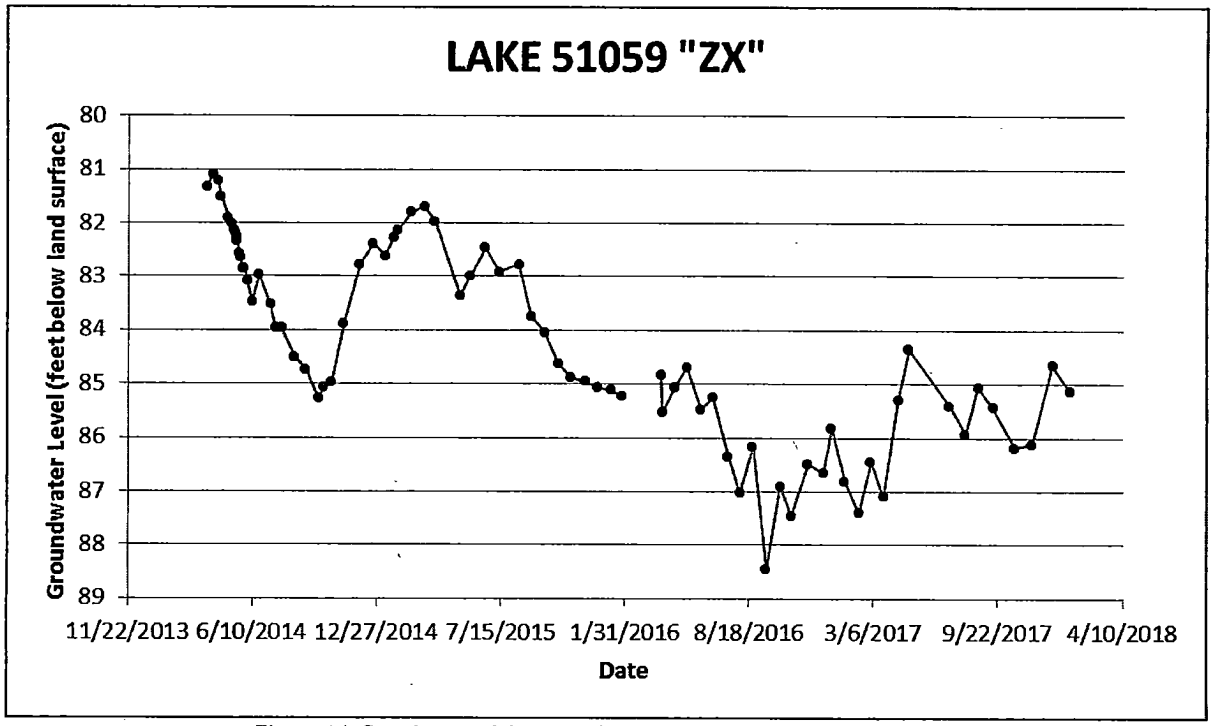


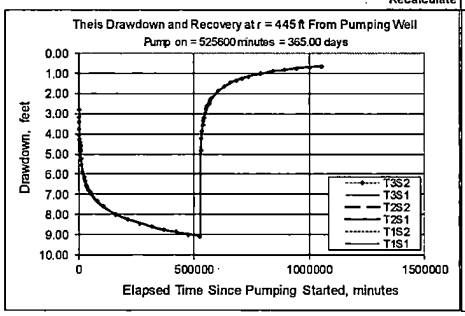
Figure 14: Supplemental data provided by the applicant - LAKE 51059.

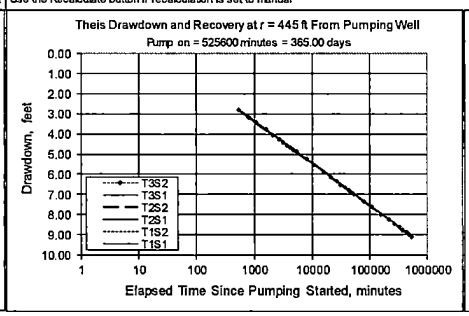
Theis Time-Drawdown Worksheet v.3.00

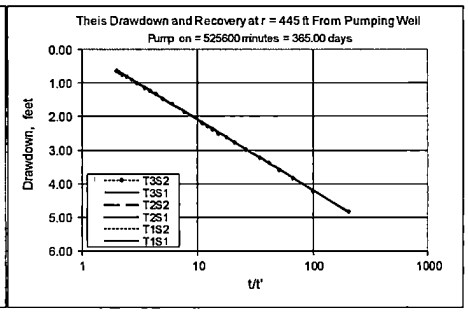
Calculates Theis nonequilibrium drawdown and recovery at any arbitrary radial distance, r, from a pumping well for 3 different T values and radial distance, r, from a pumping well for 3 different T values and 2 different S values.

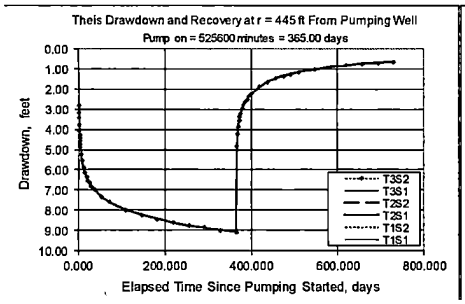
Written by Karl C. Wozniak September 1992. Last modified December 30, 2014

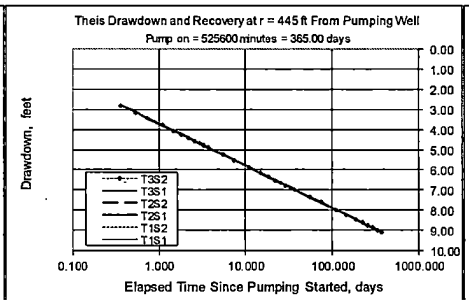
Input Data:	Var Name	Scenario 1	Scenario 2	Scenario 3	Units	
Total pumping time	t		365		d	
Radial distance from pumped well:	r		445.00		ft	Q conversions
Pumping rate	Q		0.7		cfs	300.70 gpm
Hydraulic conductivity	K	51	51	51	ft/day	0.67 cfs
Aquifer thickness	b		100		ft	40.20 cfm
Storativity	S_1		0.00100			57,888.00 cfd
	S_2		0.00100			1.33 af/d
Transmissivity Conversions	T_ft2pd	5,050	5,050	5,050	ft2/day	
	T_ft2pm	3.5069	3.5069	3.5069	ft2/min	
	T_gpdpft	37,774	37,774	37,774	gpd/ft	
	Recalculate	Use the Recalculate button if recalculation is set to manual				

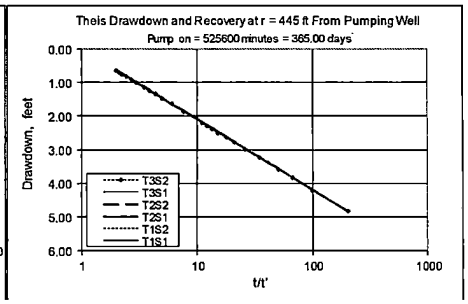


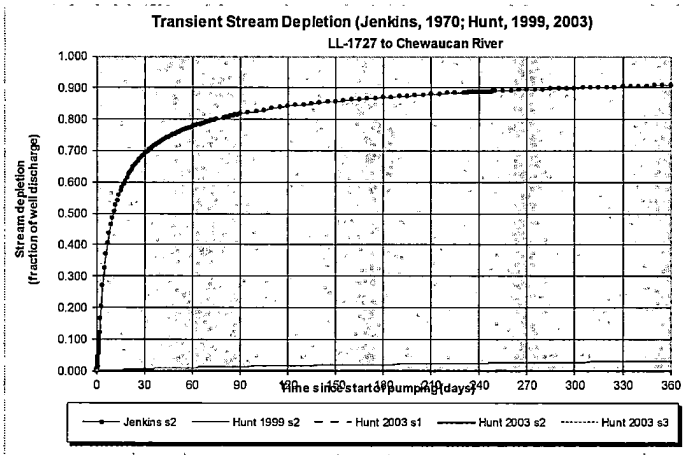












Output for Stream Depletion, Scenerio 2 (s2):	Time pump on (pumping duration) = 365 days											
Days	30	60	90	120	150	180	210	240	270	300	330	360
J SD	68.8%	77.6%	81.6%	84.1%	85.7%	87.0%	87.9%	88.7%	89.3%	89.9%	90.3%	90.8%
H SD 1999	0.6%	1.0%	1.3%	1.6%	1.8%	2.0%	2.2%	2.4%	2.6%	2.7%	2.9%	3.0%
H SD 2003	0.14%	0.14%	0.14%	0.15%	0.15%	0.15%	0.16%	0.16%	0.16%	0.17%	0.17%	0.17%
Qw, cfs	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670
H SD 99, cfs	0.004	0.007	0.009	0.011	0.012	0.014	0.015	0.016	0.017	0.018	0.019	0.020
H SD 03, cfs	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Parameters:		Scenario 1	Scenario 2	Scenario 3	Units
Net steady pumping rate of well	Qw	0.67	0.67	0.67	cfs
Time pump on (pumping duration)	tpon	365	365	365	days
Perpendicular from well to stream	a	7000	7000	7000	ft
Well depth	d	0	0	0	ft
Aquifer hydraulic conductivity	K	10.1	10.1	10.1	ft/day
Aquifer saturated thickness	b	500	500	500	ft
Aquifer transmissivity	T	5050	5050	5050	ft*ft/day
Aquifer storativity or specific yield	S	0.001	0.001	0.001	
Aquitard vertical hydraulic conductivity	Kva	0.072	0.072	0.072	ft/day
Aquitard saturated thickness	ba	500	500	500	ft
Aquitard thickness below stream	babs	475	475	475	ft
Aquitard porosity	n	0.2	0.2	0.2	
Stream width	ws	50	50	50	ft
Streambed conductance (lambda)	sbc	0.007579	0.007579	0.007579	ft/day
Stream depletion factor	sdf	9.702970	9.702970	9.702970	days
Streambed factor	sbf	0.010505	0.010505	0.010505	
input #1 for Hunt's Q_4 function	t'	0.103061	0.103061	0.103061	
input #2 for Hunt's Q_4 function	K'	1.397228	1.397228	1.397228	
input #3 for Hunt's Q_4 function	epsilon'	0.005000	0.005000	0.005000	
input #4 for Hunt's Q_4 function	lamda'	0.010505	0.010505	0.010505	

Input data

yellow = required blue = recommended

Parameter	Scenario 1	Scenario 2	Scenario 3	Unit	Description
Plot Title		LL-1727 to Chewaucan River			Plot title
Qw		0.67		cfs	Net steady pumping rate of well
tpon		365		days	Time pump on (pumping duration)
a	7000	7000	7000	ft	Perpendicular distance from well to stream
d				ft	Well depth
K	10.1	10.1	10.1	ft/day	Aquifer hydraulic conductivity
b	500	500	500	ft	Aquifer saturated thickness
S	0.001	0.001	0.001		Aquifer storativity or specific yield
Kva	0.072	0.072	0.072	ft/day	Aquitard vertical hydraulic conductivity
ba	500	500	500	ft	Aquitard saturated thickness
babs	475	475	475	ft	Aquitard thickness below stream
n	0.2	0.2	0.2		Aquitard porosity
ws	50	50	50	ft	Stream width

Recalculate

Parameter	Scenario 1	Scenario 2	Scenario 3	Units	
Qw	0.67	0.67	0.67	cfs	
T	5,050	5,050	5,050	ft*ft/day	= K*b
T	37,774	37,774	37,774	gpd/ft	= K*b
sbc	0.007579	0.007579	0.007579	ft/day	= Ks*ws/bs
sdf	9.702970	9.702970	9.702970	days	= (a^2*S)/(T)
sbf	0.010505	0.010505	0.010505		= sbc*a/T
t'	0.103061	0.103061	0.103061	1/days	= T/(a^2*S) input #1 for Hunt's Q_4 function
K'	1.397228	1.397228	1.397228		= (Ks/bs)*a^2/T input #2 for Hunt's Q_4 functio
epsilon'	0.005000	0.005000	0.005000		= S/n input #3 for Hunt's Q_4 function
lamda'	0.010505	0.010505	0.010505		= sbc*a/T input #4 for Hunt's Q_4 function