WATER RESOURCES DEPARTMENT

MEMO Sept. 24 ,20 15

TO: **Application G-** 18133

FROM: **GW:** Justin Iverson
(Reviewer's Name)

SUBJECT: Scenic Waterway Interference Evaluation – Klamath R.

☒ YES
The source of appropriation is within or above a Scenic Waterway
☐ NO

☒ YES
Use the Scenic Waterway condition (Condition 7J)
☐ NO

☒ Per ORS 390.835, the Groundwater Section is **able** to calculate ground water interference with surface water that contributes to a Scenic Waterway. The calculated interference is distributed below. See Attached Memo

☐ Per ORS 390.835, the Groundwater Section is **unable** to calculate ground water interference with surface water that contributes to a scenic waterway; **therefore, the Department is unable to find that there is a preponderance of evidence that the proposed use will measurably reduce the surface water flows necessary to maintain the free-flowing character of a scenic waterway.**

DISTRIBUTION OF INTERFERENCE

Calculate the percentage of consumptive use by month and fill in the table below. If interference cannot be calculated, per criteria in 390.835, do not fill in the table but check the "unable" option above, thus informing Water Rights that the Department is unable to make a Preponderance of Evidence finding.

Exercise of this permit is calculated to reduce monthly flows in Klamath R. Scenic Waterway by the following amounts expressed as a proportion of the consumptive use by which surface water flow is reduced. See Attached Memo

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

State of Oregon
Water Resources Department

Memorandum

To: Barry Norris – Administrator, Technical Services Division
Dwight French – Administrator, Waterights Division
Tom Paul – Deputy Director
Doug Woodcock – Administrator, Field Services Division

From: Ivan Gall – Manager, Groundwater Section

Date: February 19, 2013

Subject: Analysis of Groundwater Pumping Impacts on Klamath Scenic Waterway Flows

In 1971 the Oregon Legislature created the Scenic Waterway Act, codified by Oregon Revised Statutes 390.805 to 390.925, to preserve for the benefit of the public Waldo Lake and selected parts of the state's free-flowing rivers. The Klamath Scenic Waterway was part of the Act and includes the Klamath River from the John Boyle Dam powerhouse downstream to the Oregon-California border. Under the Act, the Water Resources Commission is allowed to allocate small amounts of surface water for human consumption and livestock watering, as long as issuing the water right does not significantly impair the free-flowing character of these waters in quantities necessary for recreation, fish and wildlife, and the amount allocated may not exceed a cumulative total of one percent of the average daily flow or one cubic foot per second (cfs), whichever is less.

In 1995 the Scenic Waterway Act was modified to address the impact of groundwater uses that, based upon a preponderance of evidence, would measurably reduce the surface water flows within a scenic waterway. "Measurably reduce" means that the use authorized will individually or cumulatively reduce surface water flows within the scenic waterway in excess of a combined cumulative total of one percent of the average daily flow or one cfs, whichever is less.

In 2012 the United States Geological Survey (USGS), in cooperation with OWRD and the US Bureau of Reclamation, completed groundwater flow and management models for the Upper Klamath Basin. The 2012 groundwater flow model uses generally accepted hydrogeologic methods and the relevant field data to model the cumulative effects of groundwater pumping within the Klamath Scenic Waterway, and provides a comprehensive methodology for analyzing the relevant field data necessary to determine whether the cumulative use of groundwater in the Klamath Basin will measurably reduce the surface water flow necessary to maintain the free-flowing character of the Klamath Scenic Waterway.

In September 2012 the OWRD Groundwater Section conducted two model simulations. The two simulations used the 2012 USGS flow model, incorporating groundwater permits issued (61.96 cfs) since adoption of the 1995 Scenic Waterway Act amendment up through 2004. Each simulation was run to steady-state, where inflows and outflows for that model run balanced. An evaluation of the water budgets showed that groundwater discharge to the Klamath Scenic Waterway decreased by 5.88 cfs as a result of the 61.96 cfs of groundwater uses issued between 1995 and 2004. These results indicate to the OWRD that a preponderance of evidence exists to establish that groundwater development occurring in the Upper Klamath Basin in Oregon since 1995 has "measurably reduced" surface water flows within the Klamath Scenic Waterway.

In January 2013 the OWRD Groundwater Section conducted flow model simulations to evaluate impacts to streams from pumping groundwater within the Lost River subbasin. Groundwater pumping was simulated by placing wells in the model that correspond to the center of 39 townships in the southeast part of the Klamath Basin in Oregon. Each of the simulations was run to steady-state, where inflows and outflows for that model run balanced. These results indicate that the scenic waterway is impacted by pumping groundwater in all of the townships evaluated in Oregon in the Lost River subbasin. In summary, a preponderance of evidence exists to establish that groundwater development occurring in Oregon since 1995 in the Upper Klamath Basin and Lost River subbasin has "measurably reduced" surface water flows within the Klamath Scenic Waterway.

References:

Gannett, M.W., Lite, K.E., Jr., La Marche, J.L., Fisher, B.J., and Polette, D.J., 2007. Ground-water hydrology of the upper Klamath Basin, Oregon and California: U.S. Geological Survey Scientific Investigations Report 2007-5050, 84p.

Gannett, M.W., Wagner, B.J., and Lite, K.E., Jr., 2012. Groundwater simulation and management models for the upper Klamath Basin, Oregon and California: U.S. Geological Survey Scientific Investigations Report 2012-5062, 92p.

WATER RESOURCES DEPARTMENT

MEMO Sept. 24, 2015

TO: **Application G-** 18133

FROM: **GW:** Justin Iverson
(Reviewer's Name)

SUBJECT: Scenic Waterway Interference Evaluation - Rogue R.

☒ YES
The source of appropriation is within or above a Scenic Waterway
☐ NO

☒ YES
Use the Scenic Waterway condition (Condition 7J)
☐ NO

☐ Per ORS 390.835, the Groundwater Section is **able** to calculate ground water interference with surface water that contributes to a Scenic Waterway. The calculated interference is distributed below.

☒ Per ORS 390.835, the Groundwater Section is **unable** to calculate ground water interference with surface water that contributes to a scenic waterway; **therefore, the Department is unable to find that there is a preponderance of evidence that the proposed use will measurably reduce the surface water flows necessary to maintain the free-flowing character of a scenic waterway.**

DISTRIBUTION OF INTERFERENCE

Calculate the percentage of consumptive use by month and fill in the table below. If interference cannot be calculated, per criteria in 390.835, do not fill in the table but check the "unable" option above, thus informing Water Rights that the Department is *unable to make a Preponderance of Evidence finding.*

Exercise of this permit is calculated to reduce monthly flows in _____ Scenic Waterway by the following amounts expressed as a proportion of the consumptive use by which surface water flow is reduced.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

PUBLIC INTEREST REVIEW FOR GROUNDWATER APPLICATIONS

TO: Water Rights Section Date **September 24, 2015**

FROM: Groundwater Section **Justin Iverson**
Reviewer's Name

SUBJECT: Application G- **18133** 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: **Crater Lake National Park** County: **Klamath**

A1. Applicant(s) seek(s) **1.34** cfs from **1** well(s) in the **Klamath** Basin, **Wood River** subbasin

A2. Proposed use: **Domestic, Administrative, Fire Protection** 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	KLAM-58507	1	Quaternary Volcanics	1.34	31S/5E – 13 SW-SW	1250'N, 1030'E fr SW cor S 13
2						
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	6179	400	324.5	7/28/15	505	0-95	3-93	9-505	400-420, 440-500	100	12.5	Pump

Use data from application for proposed wells.

A4. **Comments:** KLAM-58507 field location (gps and georeferenced aerial photo) and elevation (1m DEM) by OWRD. OWRD has collected 15-min interval automated water level and barometer records at this well since December 2013. A consultant's well construction and testing report is available for this well (SPF, 2014).

Applicant seeks 0.34 cfs (152 gpm) for domestic and "administrative" uses and 1 cfs (449 gpm) for fire protection, not to exceed 62.8 ac-ft/yr. The rates and duty correspond to those granted under Klamath Adjudication Claim No. 602.

A5. ☐ **Provisions of the** _____ 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: n/a, no adopted rules for the Klamath Basin

A6. ☐ **Well(s) #** _____, _____, _____, _____, _____, tap(s) an aquifer limited by an administrative restriction.
Name of administrative area: _____
Comments: n/a, 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)

7t – modify to "...a minimum **1-inch** inside diameter..."
7n – modify to indicate measurement in May (as opposed to March) and include "The Department may install equipment at the well to continuously record water-level data. If such equipment is installed, then the above measurement requirements for this well are waived. The Department shall bear the cost of the water-level recording equipment and shall also install and maintain the equipment. The Department shall be allowed access to the well for these purposes."
"Large" flow meter condition (totalizing flow meter, monthly records, and annual groundwater use 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 proposed use is assumed to be within the capacity of the groundwater resource. The proposed groundwater use is unlikely to significantly impact existing groundwater users due to the relatively large distance to the nearest neighboring groundwater development. Decline conditions, water level and use reporting, and access for continued groundwater level data collection by the Department are warranted because water level data is scarce in this area and because water level response to groundwater development is unknown. The groundwater conceptual model is as follows:

KLAM-58507 is located within Crater Lake National Park on a volcanic plateau at a saddle-point on the Cascade Crest (Figures 1 and 2). The Cascade Crest is a regional groundwater recharge area (e.g., Gannett and others, 2007) receiving significant precipitation that is readily infiltrated into the permeable volcanic rocks of the area (Hampton, 1967). The park and surrounding Forest Service land is sparsely developed and the nearest known neighboring wells are located at lower elevations approximately 17 miles SE in the Klamath Basin and 17.5 miles SW in the Rogue Basin.

Bacon (2008) reports that, "Groundwater flow in Mount Mazama and in the surrounding volcanic terrain is controlled by gently inclined to horizontal, relatively permeable zones (perched aquifers) such as rubbly tops of lava flows or fragmental

deposits of various kinds. Cold springs commonly occur where such permeability contrasts intersect the ground surface. Deep circulation of ground water is facilitated by the dominantly north-south normal faults that may act as conduits or may retard transverse flow because relatively impermeable gouge is present."

KLAM-58507 ("the well") penetrates an ignimbrite of the climactic eruption of Mt. Mazama and several underlying lava flows. Mapped lava flows encountered by the well were erupted from one or more local vents, including (from youngest to oldest) Union Peak to the SW, Arant Point to the SE, and Whitehorse Bluff to the NW (Bacon, 2008). Two saturated interflow zones between these lava flows constitute the target water bearing zones for the well. The target water bearing zones and other saturated interflow zones in the vicinity of the well are assumed to be broadly interconnected at lava flow margins and potentially where interflow zones are vertically displaced by normal faults. Bacon (2008) mapped three north-south trending normal faults downthrown to the east in the vicinity of KLAM-58507. These faults are located approximately 3500 feet to the west (unnamed), 500 feet to the east (unnamed), and 2500 feet to the east (Annie Spring Fault) of the well (see Figures 1 and 2).

The KLAM-58507 well log indicates that groundwater was first encountered at a depth of 400 feet below ground surface (ft bgs) in "red cinders" and that additional water bearing zones were found in "red cinder" and "soft basalt" water bearing zones to a depth of approximately 500 ft bgs (SPF, 2014). The static water level in the well is approximately 325 ft bgs, 75 feet above the top of the first water bearing zone observed by the driller, denoting the aquifer is at least locally confined and implying a recharge zone higher on the slopes of Union Peak to the SW and/or Mount Mazama to the NE.

Seasonal water level variation in the well is 6 to 12 feet, ranging between approximately 5849 and 5860 ft amsl over almost two years of observation (Figure 3). Water levels rise coincident with recharge from spring snowmelt and precipitation. Water levels decline during summer drought periods, indicating flow away from the recharge area toward discharge areas. Water level declines continue during autumn rainfall periods as the unsaturated deposits at the surface "wet up".

The potential direction of groundwater flow in the vicinity of the well under pre-development conditions is unclear given the following unknowns: a) whether the target aquifer is perched or part of the regional flow system, b) the nature of the connection of surrounding water bearing interflow zones with the target water bearing zone, and c) the horizontal hydraulic gradient in the target water bearing zone. Groundwater in the target water bearing zone may currently flow to the west (Rogue Basin) or east (Klamath Basin) or both (if a groundwater divide exists in the water bearing zone). Further, it is unknown whether or not groundwater flow crosses the north-south normal faults more or less horizontally or is channeled along normal faults to the south and/or to a deeper flow system that discharges at significantly lower elevations outside the local area (e.g., Nathenson, 1990).

For the purposes of conducting this evaluation, the target aquifer is conservatively assumed to be broadly connected across various water bearing zones in the composite volcanic flow structure that makes up the plateau and to be at the crest of a regional flow system that drains to both the Rogue and Klamath basins. This conceptual model assumes groundwater recharged at the Cascade Crest has flow paths that generally mimic surface topography and terminate in discharge to local surface water bodies.

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	**Quaternary Volcanics**	☒	☐
		☐	☐
		☐	☐
		☐	☐
		☐	☐

Basis for aquifer confinement evaluation: The static water level in the well is approximately 325 ft bgs, 75 feet above the top of the first water bearing zone observed by the driller, denoting the aquifer is at least locally confined (refer to Section B3).

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	**Annie Ck > Wood R**	**5855**	**< 5855**	**> 5590**	☒	☐	☐	☐	☒
1	2	**Cold Spring > Annie Ck**	**5855**	**5854**	**14,000**	☐	☒	☐	☐	☒
1	3	**Castle Ck > Rogue R**	**5855**	**< 5855**	**>6775**	☒	☐	☐	☐	☒
1	4	**Thousand Spr > Union Cr**	**5855**	**4963**	**28,065**	☐	☒	☐	☐	☒
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐

Basis for aquifer hydraulic connection evaluation: Multiple potential hydraulic connections with various surface water bodies were considered given the conceptual model described in Section B3. A red band in Figure 1 identifies the approximate elevation range of observed groundwater levels in KLAM-58507 with respect to the location of surface water bodies. Only surface water bodies located at elevations below the water level elevation in the well were considered to be potentially hydraulically connected to the well and assessed for PSI in this section.

1. Annie Creek is identified as a gaining stream reach (groundwater discharge zone) from its headwaters to the National Park boundary by Gannett and others (2007). Groundwater present in the vicinity of KLAM-58507 may flow eastward to discharge to Annie Creek if not intercepted and redirected by intervening fault zones.

2. Cold Spring discharges at the surface at an elevation of 5854 ft amsl, which is lower than the water level in KLAM-58507 only during a portion of the year (see Figure 3). It is unknown whether or not Cold Spring flows during winter and spring when water levels at KLAM-58507 are below the elevation of the spring, though the National Hydrologic Dataset indicates a perennial stream heading at the spring. A flow path from the well through/around Arant Point to the spring is conceivable but seems less likely than a more direct flow path resulting in diffuse groundwater discharge to Annie Creek given the adopted conceptual model. Cold Spring is assumed to be fed by a local flow system and not considered hydraulically connected to the well through a broadly connected groundwater system given current available information.

3. Castle Creek is ungaged and its character (runoff dominated vs groundwater discharge dominated) is unknown. Groundwater present in the vicinity of KLAM-58507 may flow westward to discharge to Castle Creek if not intercepted and redirected by intervening fault zones.

4. Thousand Springs (located SW of the visible area of Figure 1) discharges at the surface at an elevation below the static water level in KLAM 58507, but appears to be the manifestation of groundwater infiltrated in and flowing northwestward along the Basaltic Andesite lava flows of Union Peak (i.e., fed by a local flow system disconnected from the groundwater system intercepted by the well).

Water Availability Basin the well(s) are located within: Wood R > Upper Klamath L – At Mouth and Castle Cr > Rogue R – At Mouth

C3a. **690-09-040 (4):** Evaluation of stream impacts for each well 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 by total appropriation 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: C3a and C3b are not applicable as no streams with potential hydraulic connection (see Section C2) exist within 1 mile of the well.

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
		%	%	%	%	%	%	%	%	%	%	%	%
Well Q as CFS													
Interference CFS													

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													

(A) = Total Interf.												
(B) = 80 % Nat. Q												
(C) = 1 % Nat. Q												
(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: Not explicitly calculated since applicant is requesting no more than 62.8 ac-ft/yr, equating to a distributed average pumping rate of 0.09 cfs, which is less than 1% of the minimum natural streamflow for each potentially impacted WAB (see attached).

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:**

References Used:

Bacon, C.R., 2008, *Geologic Map of Mount Mazama and Crater Lake Caldera, Oregon*: U.S. Geological Survey Scientific Investigations Map 2832, 4 sheets and 49 p. pamphlet.

Gannett, M.W., Lite, K.E. Jr., La Marche, J.L., Fisher, B.J., and Polette, D.J., 2007, *Ground-water hydrology of the upper Klamath Basin, Oregon and California*: U.S. Geological Survey Scientific Investigations Report 2007-5050, 84 p.

Gannett, M.W., Wagner, B.J., and Lite, K.E. Jr., 2012, *Ground-water simulation and management models for the upper Klamath Basin, Oregon and California*: U.S. Geological Survey Scientific Investigations Report 2012-5062, 92 p.

Hampton, E.R., 1957, *Evaluation of Potential Sources of Water in Crater Lake National Park, Oregon*. U.S. Geological Survey Administrative Report, 17 pl

Nathenson, M., 1990, *Temperatures of springs in the vicinity of Crater Lake, Oregon, in relation to air and ground temperatures*: U.S. Geological Survey Open-File Report 90-671, 19 p.

SPF Water Engineering, LLC (SPF), 2014, *Well Construction and Testing Report – Crater Lake National Park Test Well.* Consultant's report prepared for National Park Service, NPS PMIS #203499. January 22, 2014.

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:** _____

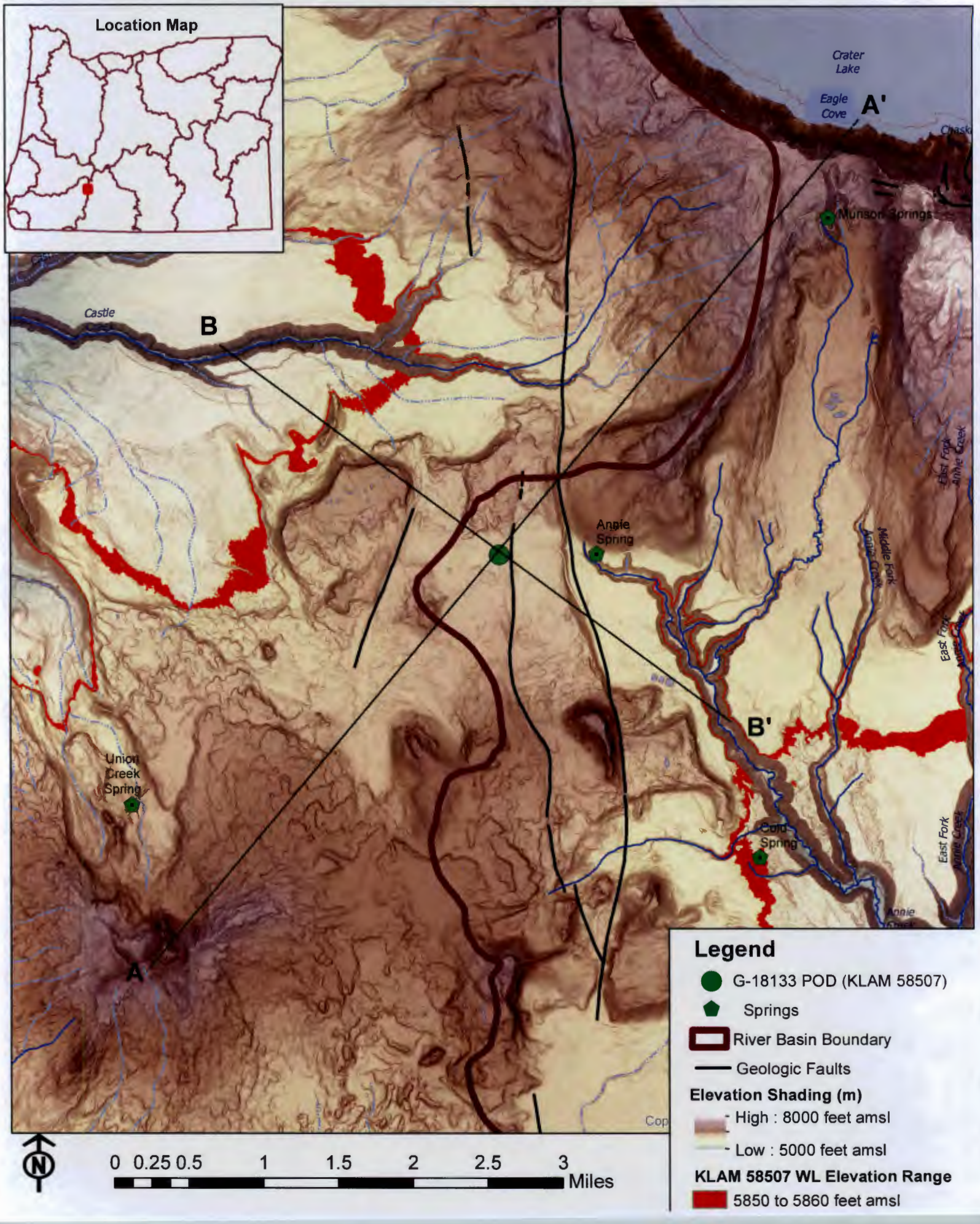
D4. ☐ **Route to the Well Construction and Compliance Section for a review of existing well construction.**

Water Availability Tables

Well Location Map

Water-Level Trends in Nearby Wells

Figure 1: Site Map
Groundwater Technical Review of G-18133 (NPS)



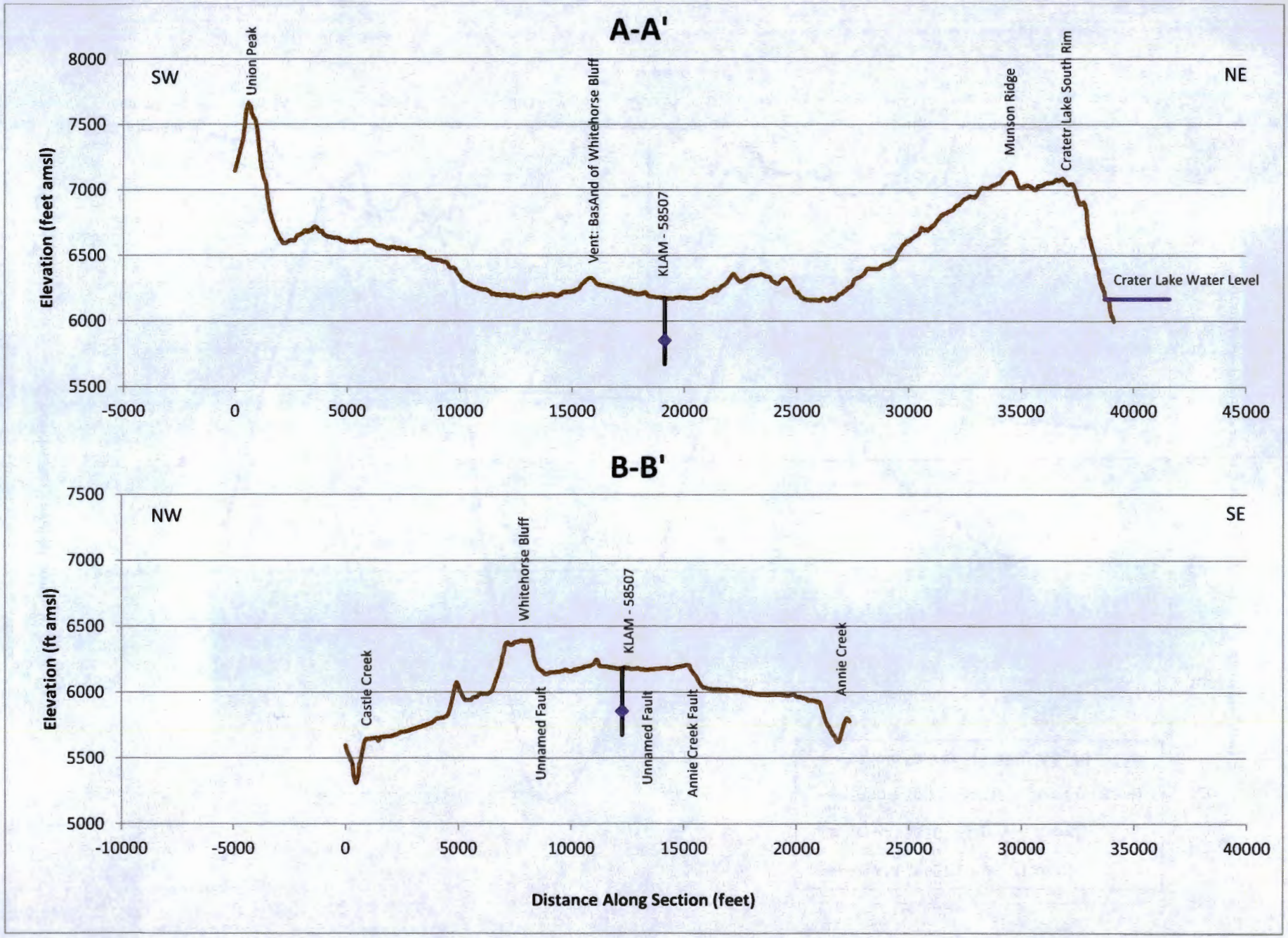
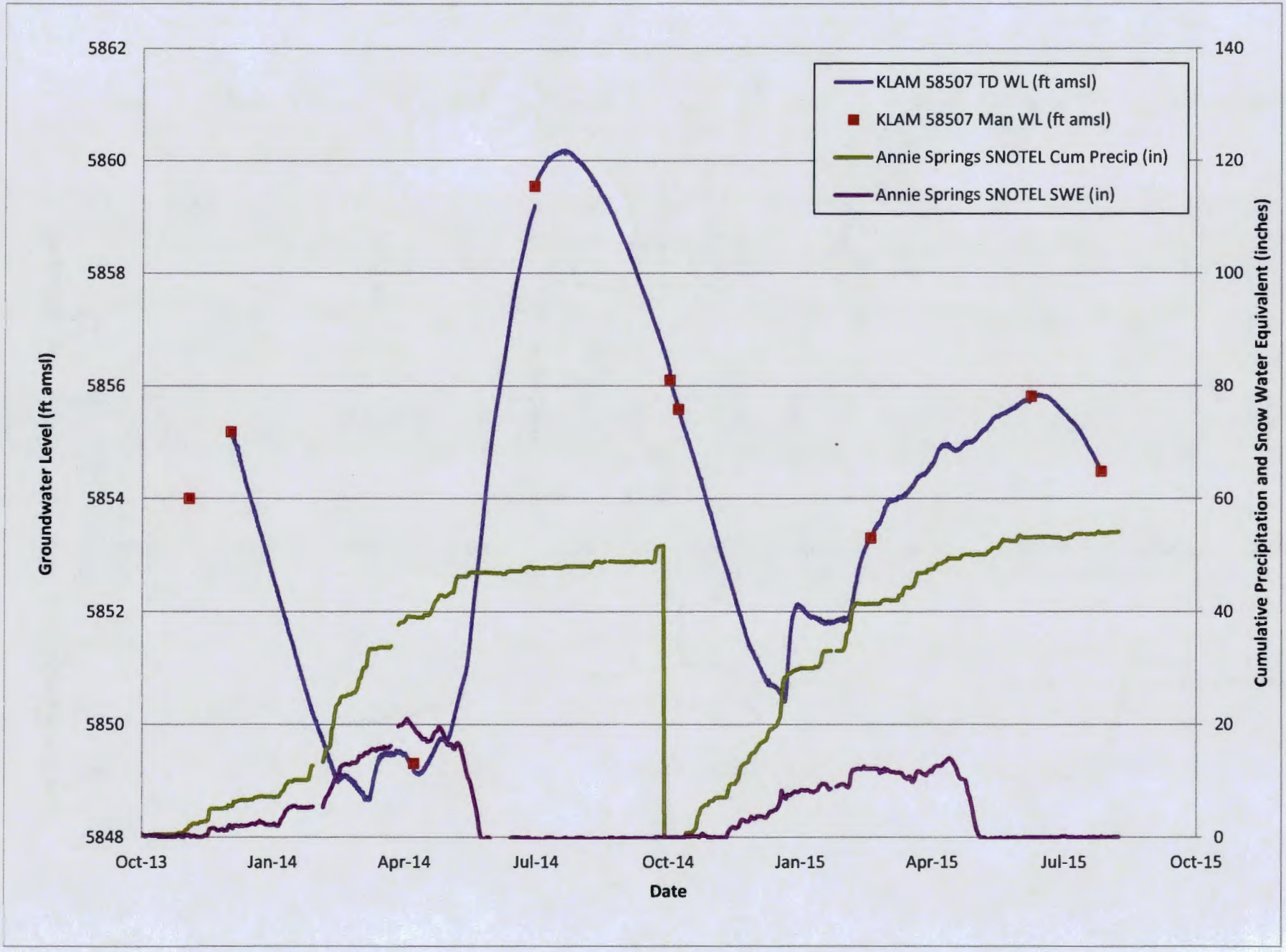

A-A'
SW
NE
Union Peak
Vent: BasAnd of Whitehorse Bluff
KLAM - 58507
Munson Ridge
Cratetr Lake South Rim
Crater Lake Water Level
Elevation (feet amsl)
8000
7500
7000
6500
6000
5500
-5000
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
B-B'
NW
SE
Castle Creek
Whitehorse Bluff
Unnamed Fault
KLAM - 58507
Unnamed Fault
Annie Creek Fault
Annie Creek
Elevation (ft amsl)
7500
7000
6500
6000
5500
5000
-10000
-5000
0
5000
10000
15000
20000
25000
30000
35000
40000
Distance Along Section (feet)

Figure 3: KLAM-58507 Hydrograph,
Cumulative Precipitation and Snow Volume (SWE)



Water Availability Analysis
Detailed Reports

WOOD R > UPPER KLAMATH L - AT MOUTH
KLAMATH BASIN
Water Availability as of 9/8/2015

Watershed ID #: 70829 (Map)
Date: 9/8/2015

Exceedance Level: 80%
Time: 9:14 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	314.00	0.34	314.00	0.00	125.00	189.00
FEB	309.00	0.34	309.00	0.00	125.00	184.00
MAR	315.00	36.30	279.00	0.00	270.00	8.73
APR	334.00	80.30	254.00	0.00	286.00	-32.30
MAY	379.00	192.00	187.00	0.00	323.00	-136.00
JUN	375.00	249.00	126.00	0.00	352.00	-226.00
JUL	371.00	161.00	210.00	0.00	312.00	-102.00
AUG	347.00	95.80	251.00	0.00	277.00	-25.80
SEP	334.00	85.20	249.00	0.00	254.00	-5.23
OCT	335.00	60.90	274.00	0.00	255.00	19.10
NOV	328.00	0.34	328.00	0.00	263.00	64.70
DEC	312.00	0.34	312.00	0.00	125.00	187.00
ANN	281,000.00	58,300.00	222,000.00	0.00	179,000.00	57,100.00

Water Availability Analysis
Detailed Reports

CASTLE CR > ROGUE R - AT MOUTH
ROGUE BASIN
Water Availability as of 9/8/2015

Watershed ID #: 73374 (Map)
Date: 9/8/2015

Exceedance Level: 80%
Time: 9:09 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	30.80	0.00	30.80	0.00	18.00	12.80
FEB	40.50	0.00	40.50	0.00	31.00	9.50
MAR	41.20	0.00	41.20	0.00	31.00	10.20
APR	46.40	0.00	46.40	0.00	31.00	15.40
MAY	45.20	0.00	45.20	0.00	31.00	14.20
JUN	29.10	0.00	29.10	0.00	18.00	11.10
JUL	21.00	0.00	21.00	0.00	15.00	6.00
AUG	16.40	0.00	16.40	0.00	15.00	1.40
SEP	14.80	0.00	14.80	0.00	18.00	-3.20
OCT	16.10	0.00	16.10	0.00	21.70	-5.60
NOV	19.10	0.00	19.10	0.00	30.40	-11.30
DEC	27.20	0.00	27.20	0.00	18.00	9.20
ANN	31,300.00	0.00	31,300.00	0.00	16,700.00	14,500.00