

MEMO

State of Idaho

Department of Water Resources

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Date: January 11, 2019

To: James Cefalo, Hearing Officer

From:  Dennis Owsley, Hydrology Section

CC: Sean Vincent, Hydrology Section Manager

Subject: Application for Transfer No. 82318 in the Name of Telford Lands LLC

Per your request, I have developed this staff memorandum with respect to the Application for Transfer #82318, in the name of Telford Lands, LLC. More specifically, this memo addresses the following three questions that were posed in your request:

1. Will the changes proposed in Application 82318 have any effect on the rising waters at the south end of the Big Lost River Valley?
2. If you find that the diversion of ground water from the proposed Hansen Well will have an effect on the rising waters, would casing the well (maintaining a zone of no perforations) to any depth minimize or eliminate the effect on the rising waters?
3. Please describe the composition (sand, gravel, basalt, etc.) of the aquifer layers supplying water to each of Telford's existing wells and describe the hydrologic connection between the existing wells and the proposed wells, if one exists.

Application #82318 is a request to stack 29.84 cubic feet per second (cfs) of ground water rights in a group of nine ground water points of diversion (PODs). One well, the "Folkman Well", will be decommissioned through this transfer and one well, the "Hansen Well" will be drilled to an unknown depth. No other distribution modifications are requested through the application.

The application does not specify the individual well pumping rates. Therefore, various hypothetical diversion scenarios are evaluated herein to help analyze the potential hydrologic effects of the transfer. As a basis for reference, a "baseline" scenario is presented that represents the conditions based on the existing water right diversion rates.

1. Will the changes proposed in Application 82318 have any effect on the rising waters at the south end of the Big Lost River Valley?

The “rising waters” at the south end of the Big Lost Valley near Arco refers to aquifer discharge that appears in forms of springs, seepage into sloughs, and gains along a five-mile reach of the Big Lost River between the Arco Diversion and the southern extent of irrigation in the Big Lost Valley (Figure 1). Sources for the rising waters include seepage from the Big Lost River, and incidental recharge from irrigation canal losses and on-farm practices between Moore and Arco (Figure 1).

Historically, these recharge sources were of sufficient magnitude to elevate the shallow water table above the base of the river channel resulting in the flow of water from the aquifer into the river in the Moore-to-Arco reach. The resulting river gains frequently sustained flow in the channel extending downstream of the Arco Diversion until late in the irrigation season. In the last 30 years, however, increases in ground water pumping, periods of drought, and changes in irrigation practices have lowered the shallow water table and reduced the river gains. As a result, the rising waters have diminished to the point of being practically non-existent (Owsley, 2013).

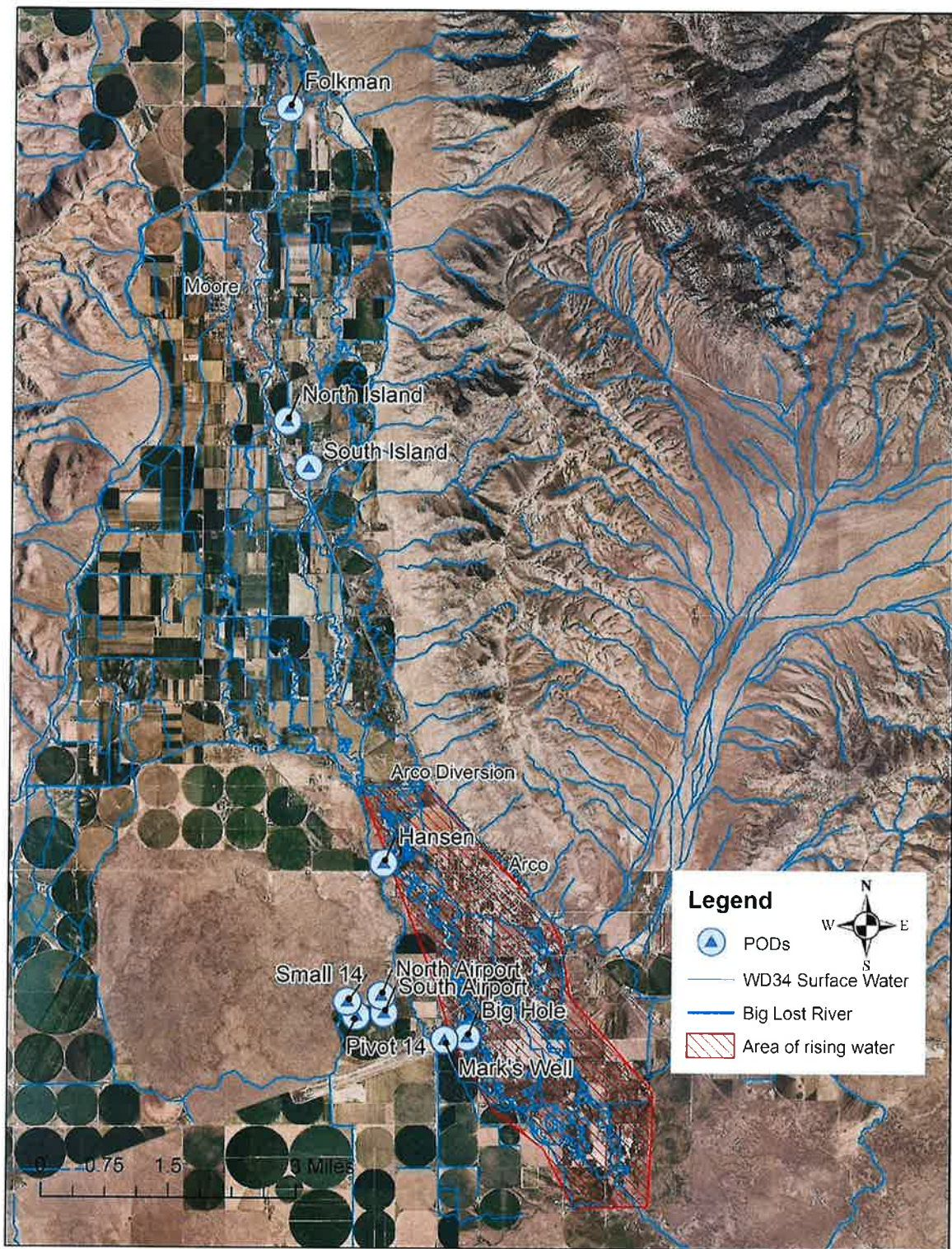


Figure 1. Map of the PODs and area of rising water associated with Transfer #82318.

Based on a report published by the U.S. Geological Survey (Crosthwaite, 1970), the shallow water table historically intercepted the bottom of the river channel in two places at the south end of the valley: 1) just north of Moore, and 2) near the Arco Diversion structure (see Figure 2, upper elevation profile). However, by 1998 the aquifer connection near the Arco Diversion had been broken, and the only hydraulic connection between the river and the aquifer at the south end of the valley was near the town of Moore (see Figure 2, lower elevation profile). And by 2012, the river and aquifer are hydraulically disconnected throughout the south end of the valley.

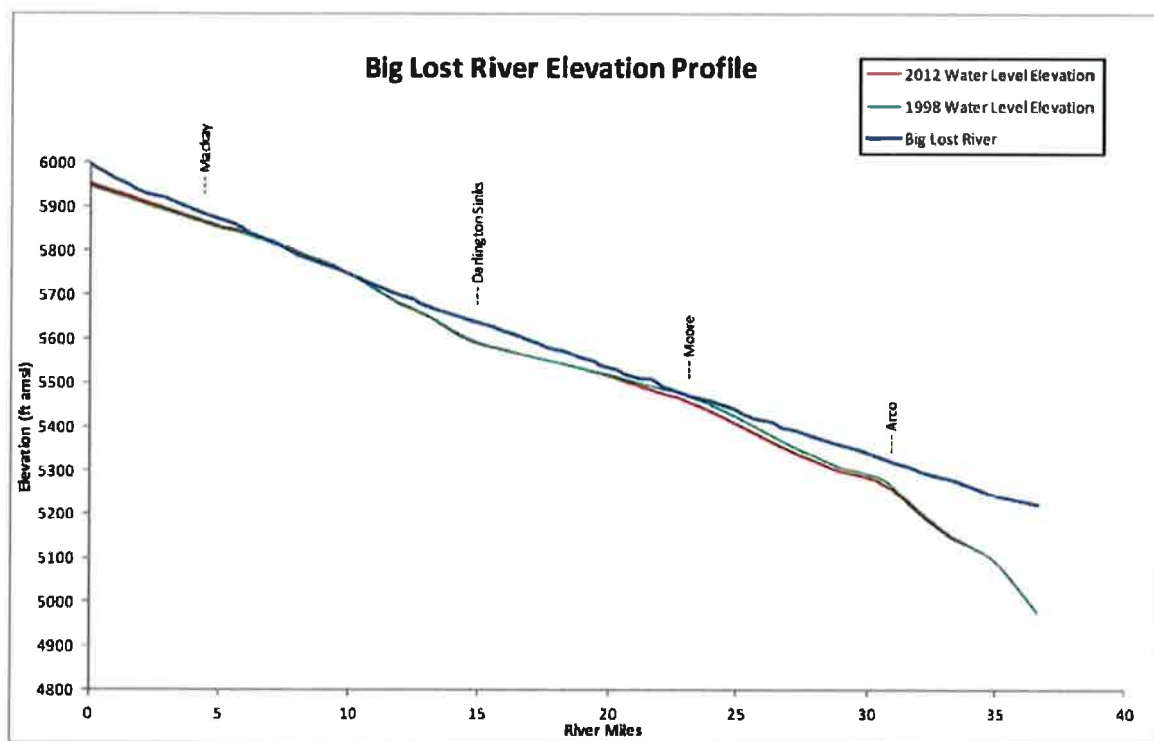
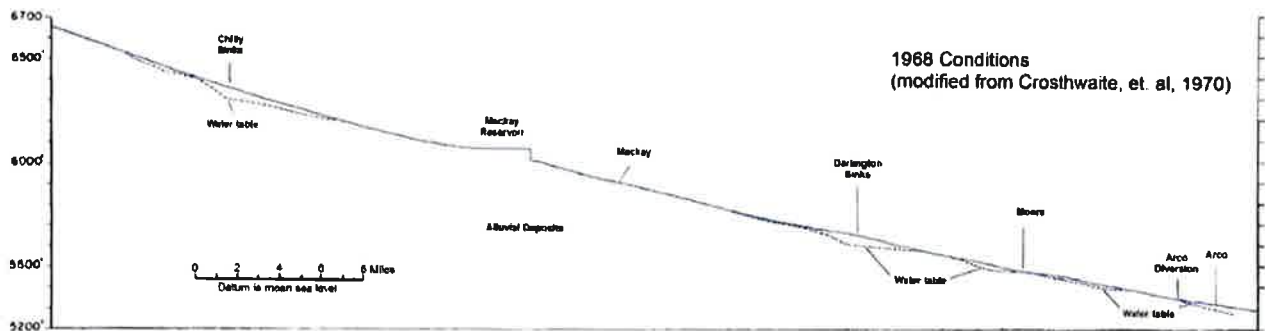


Figure 2. Elevation profiles (Owsley, 2013).

Potential Effects on Rising Waters

To examine the potential effects on rising waters of the transfer, a simplified drawdown analysis was conducted for five pumping scenarios using the series approximation of the Theis (1935) solution. Results from the analysis were assessed at two historical rising waters locations: 1) approximately four miles north of Moore, and 2) one mile north of the Arco Diversion (Figure 3).

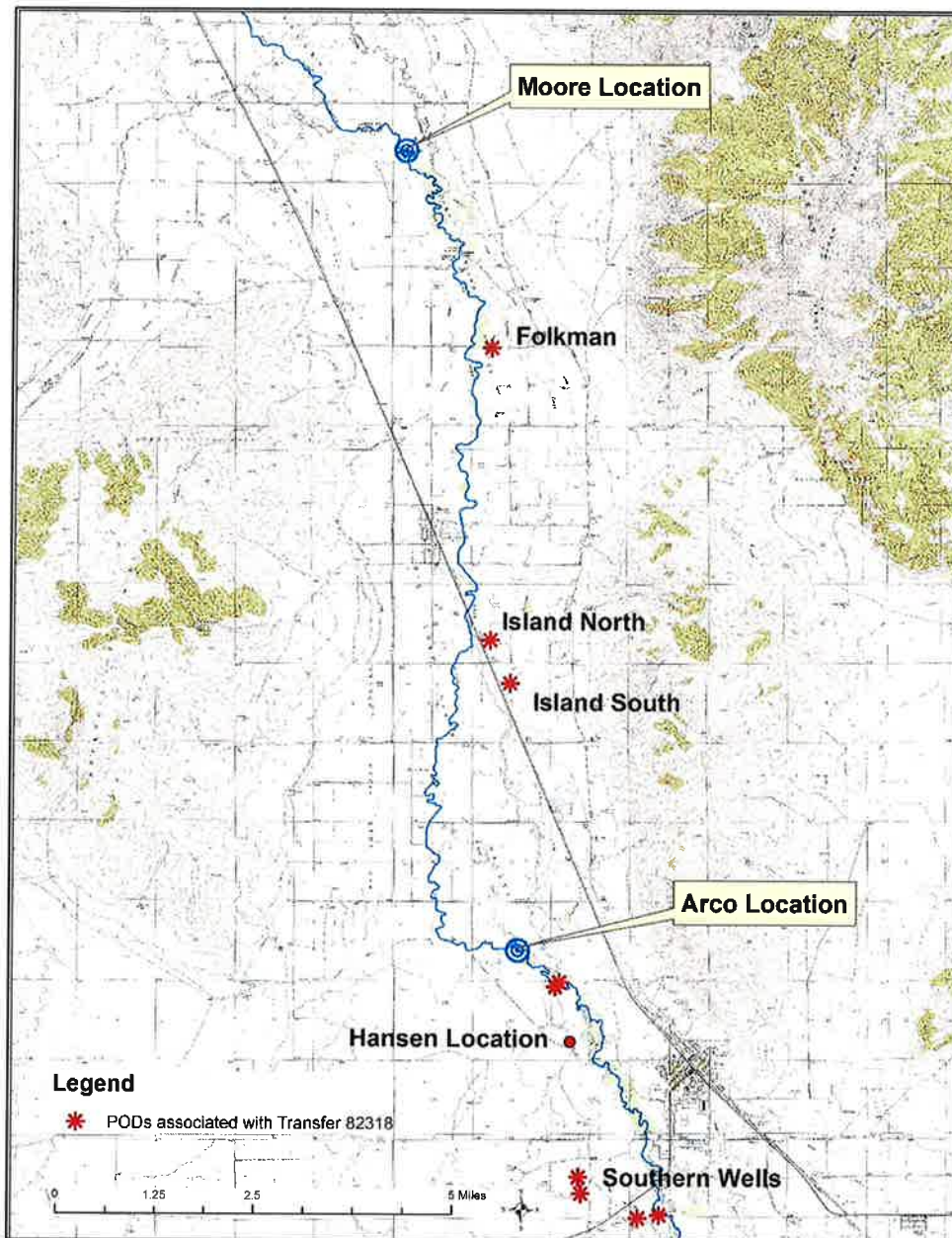


Figure 3. Map of inspection points associated with the drawdown analysis.

In order to quantify pumping effects, drawdowns associated with the baseline scenario that represents the pre-transfer water right diversion rates were calculated for comparison with the five pumping scenarios.

The following assumptions were utilized in all scenarios:

- Pumping duration was 183 days.
- The North and South Island wells were analyzed as one well.
- The six Southern Wells were analyzed as one well.
- Calculated drawdowns of less than 0.01 feet were considered “unmeasurable”, and reported as zero.
- The aquifer transmissivity is 38,000 ft²/day and the storage coefficient is 0.15. These values are based on previous estimates of aquifer properties of the valley and appear to be reasonable estimates (IDWR, 2013).

The following distances between the wells and the assessment locations were used in the calculations:

Well	Moore Location (miles)	Arco Location (miles)
Island Wells	6.5	3.7
Southern Wells	13.4	3.4
Hansen Location	11.4	1.5
Folkman Well	2.6	7.6

The results of the drawdown analysis are presented in Table 1.

Table 1. Calculated drawdown at the Arco Location based on various pumping scenarios.

	Baseline		Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	Q (cfs)	Draw- down @ Arco (feet)	Q (cfs)	Draw- down @ Arco (feet)	Q (cfs)	Draw- down @ Arco (feet)	Q (cfs)	Draw- down @ Arco (feet)	Q (cfs)	Draw- down @ Arco (feet)	Q (cfs)	Draw- down @ Arco (feet)
Folkman	5.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Island Wells	12.00	0.10	17.34	0.14	12.00	0.10	17.34	0.14	29.84	0.24	0.00	0.00
Hansen Well	0.00	0.00	0.00	0.00	5.34	0.79	12.50	1.85	0.00	0.00	29.84	4.42
Southern Wells	12.50	0.16	12.50	0.16	12.50	0.16	0.00	0.00	0.00	0.00	0.00	0.00
Totals	29.84	0.26	29.84	0.30	29.84	1.05	29.84	1.95	29.84	0.24	29.84	4.42
Difference (Baseline – Scenario)				-0.04		-0.79		-1.69		+0.02		-4.16

When compared to the baseline scenario, the drawdown at the Arco location increases in four of the five scenarios. The drawdowns at Arco range from a decrease of 0.02 feet to an increase of 4.16 feet (Table 1). Note that the scenario that creates the largest drawdown at the Arco location (Scenario 5)

assumes a diversion rate of 29.84 cfs at the Hansen well, a scenario that is not likely, as this diversion rate exceeds what could be expected to be withdrawn from single well.

Table 2. Calculated drawdown at the Moore Location based on various pumping scenarios.

	Baseline		Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	Q (cfs)	Draw-down @ Moore (feet)	Q (cfs)	Draw-down @ Moore (feet)	Q (cfs)	Draw-down @ Moore (feet)	Q (cfs)	Draw-down @ Moore (feet)	Q (cfs)	Draw-down @ Moore (feet)	Q (cfs)	Draw-down @ Moore (feet)
Folkman	5.34	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Island Wells	12.00	0.00	17.34	0.00	12.00	0.00	17.34	0.00	29.84	0.00	0.00	0.00
Hansen Well	0.00	0.00	0.00	0.00	5.34	0.00	12.50	0.00	0.00	0.00	29.84	0.00
Southern Wells	12.50	0.00	12.50	0.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	29.84	0.21	29.84	0.00	29.84	0.00	29.84	0.00	29.84	0.00	29.84	0.00
Difference (Baseline – Scenario)				+0.21		+0.21		+0.21		+0.21		+0.21

The transfer results in a positive change of 0.21 feet in the aquifer level (i.e., less drawdown) at the Moore location when compared to the baseline scenario (Table 2). The Folkman Well is the only POD in close enough proximity to have measurable drawdown at the Moore location, and all scenarios reduce pumping at this POD because this well will be decommissioned as part of the transfer. Therefore, all five of the transfer scenarios result in a net increase in aquifer levels at the Moore location.

In summary, the changes proposed in this transfer would reduce the measurable drawdown in the area north of Moore and increase the measurable drawdown near the Arco Diversion. Note that this analysis assumes no increase in the combined pumping rate so the proposed transfer has no impact on the aquifer water budget.

Discussion of the Effects of Canal Seepage on Rising Waters

The water that seeps from the canals while being conveyed to the place of use can be calculated using the delivery factors produced by BLRID (IDWR, 2018). Assuming all of the water that seeps during delivery is available as a contributing source to the rising water, changes in these seepage volumes if Transfer #82318 is approved can be quantified. Seepage during conveyance from the proposed Hansen Well would likely not have a significant contribution to the area of rising water, due to the location of the well and conveyance system, but will be included in the analysis as a conservative measure. Additionally, seepage due to conveyance diversions from the Southern Wells are considered negligible regarding impacts to the rising waters.

In order to quantify the effects on the rising waters of the transfer, the seepage rates for each of the scenarios have been estimated based on 2016 and 2017 daily delivery factors provided by BLRID and computed into a seasonal factor by IDWR that resulted in the following: 0.49 for Folkman, 0.64 for the

Island Wells, and, based on proximity to the Munsey Canal, 0.174 for the Hansen Well location (IDWR, 2018).

Table 3. Calculated seepage rates.

	Baseline		Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	Q (cfs)	Seepage (cfs)	Q (cfs)	Seepage (cfs)	Q (cfs)	Seepage (cfs)	Q (cfs)	Seepage (cfs)	Q (cfs)	Seepage (cfs)	Q (cfs)	Seepage (cfs)
Folkman	5.34	2.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Island Wells	12.00	4.32	17.34	6.24	12.00	4.32	17.34	6.24	29.84	10.74	0.00	0.00
Hansen Well	0.00	0.00	0.00	0.00	5.34	0.93	12.50	2.18	0.00	0.00	29.84	5.19
Southern Wells	12.50	0.00	12.50	0.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	29.84	7.04	29.84	6.24	29.84	5.25	29.84	8.42	29.84	10.74	29.84	5.19
Difference (Baseline – Scenario)				-0.80		-1.79		1.38		3.70		-1.85

Based on the assumed delivery factors, the calculated changes in seepage range from a loss of 1.85 cfs to an increase of 3.70 cfs (Table 3). Converting the seepage rates into seasonal volumes results in a baseline seepage of 2,555 acre-feet (AF), with the seepage associated with various pumping scenarios ranging from 1,884 to 3,054 AF of seepage (Figure 4). Until the actual diversions occur, the net gain or loss to the water budget from canal seepage cannot be definitively determined, but would likely fall within the ranges presented in Table 3.

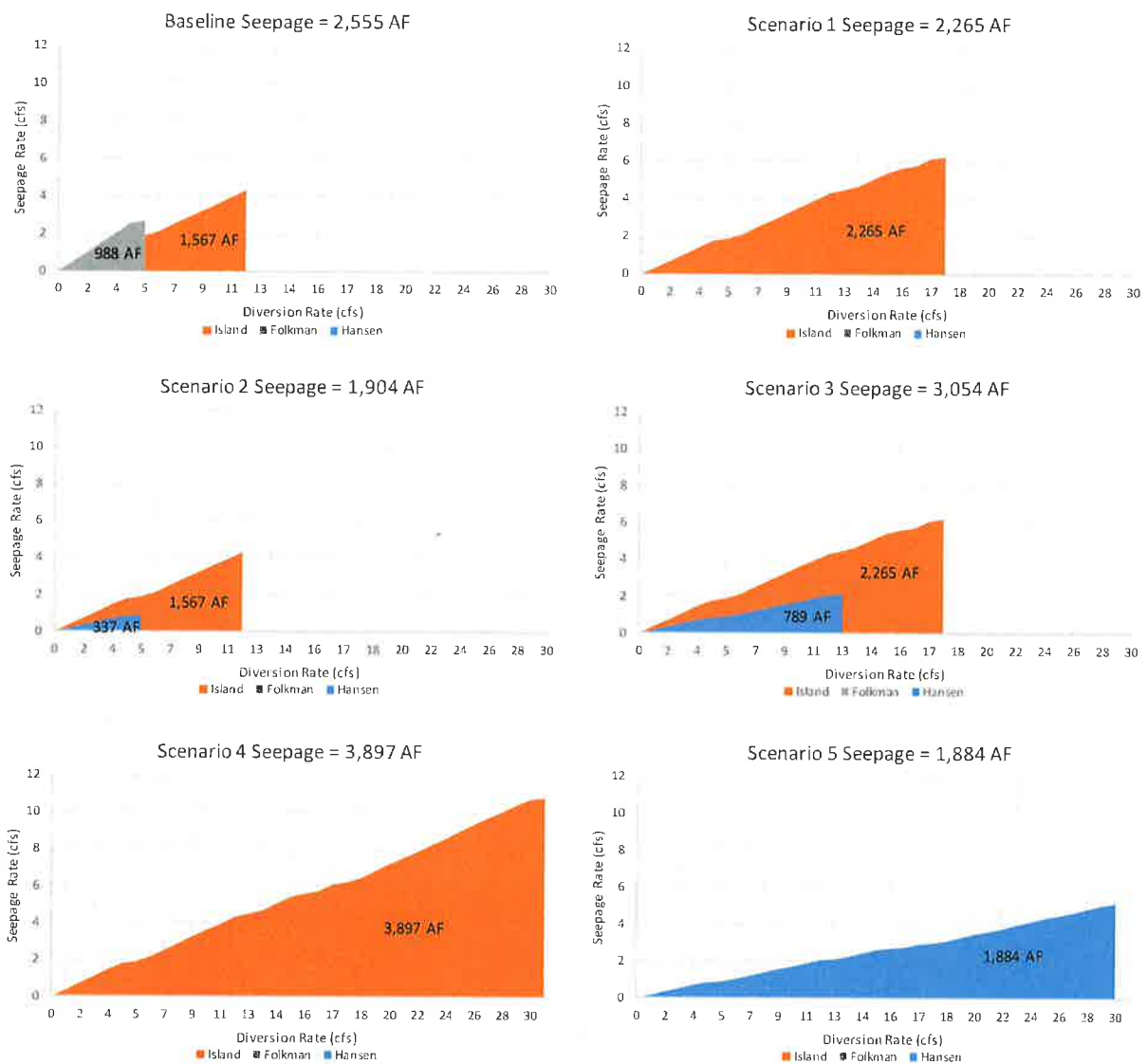


Figure 4. Graphical representation of the volumetric seepage losses calculated for the various pumping scenarios.

- 2. If you find that the diversion of ground water from the proposed Hansen Well will have an effect on the rising waters, would casing the well (maintaining a zone of no perforations) to any depth minimize or eliminate the effect on the rising waters?**

The location of the proposed Hansen Well is on the northwest corner of the area of rising water. Depth to water at this location is approximately 50 feet below land surface. Therefore, with respect to rising waters, the uppermost portion of the aquifer that may contain perched or shallow ground water could source the rising waters, rather than the regional aquifer system. Therefore, sealing off the uppermost portion of the aquifer would help eliminate any potential to pump shallow ground water that may emerge as rising water.

Based on a review of driller's reports from wells near the Hansen Well, a conceptual lithologic plot was created. As shown in Figure 5, five of the eight wells used in the plot indicate saturated conditions above what appears to be the regional aquifer. Clay, or sandy clay horizons were noted in nearly all of the driller's reports reviewed in the area, indicating a lithologic horizon to place a well seal when trying to eliminate pumping effects to any of the uppermost saturated zones.

Assuming the hydrogeologic conditions encountered when drilling the Hansen Well are similar to what is shown on Figure 5, a well seal completed down into a significant clay layer (thicker than 10 feet) would reduce the potential of pumping any shallow, perched ground water. Based on the nearby lithologic reports, such a clay layer would likely be encountered in the uppermost 75 feet of the subsurface. If no significant clay layers are encountered, a standard seal depth of 38 feet would be appropriate.

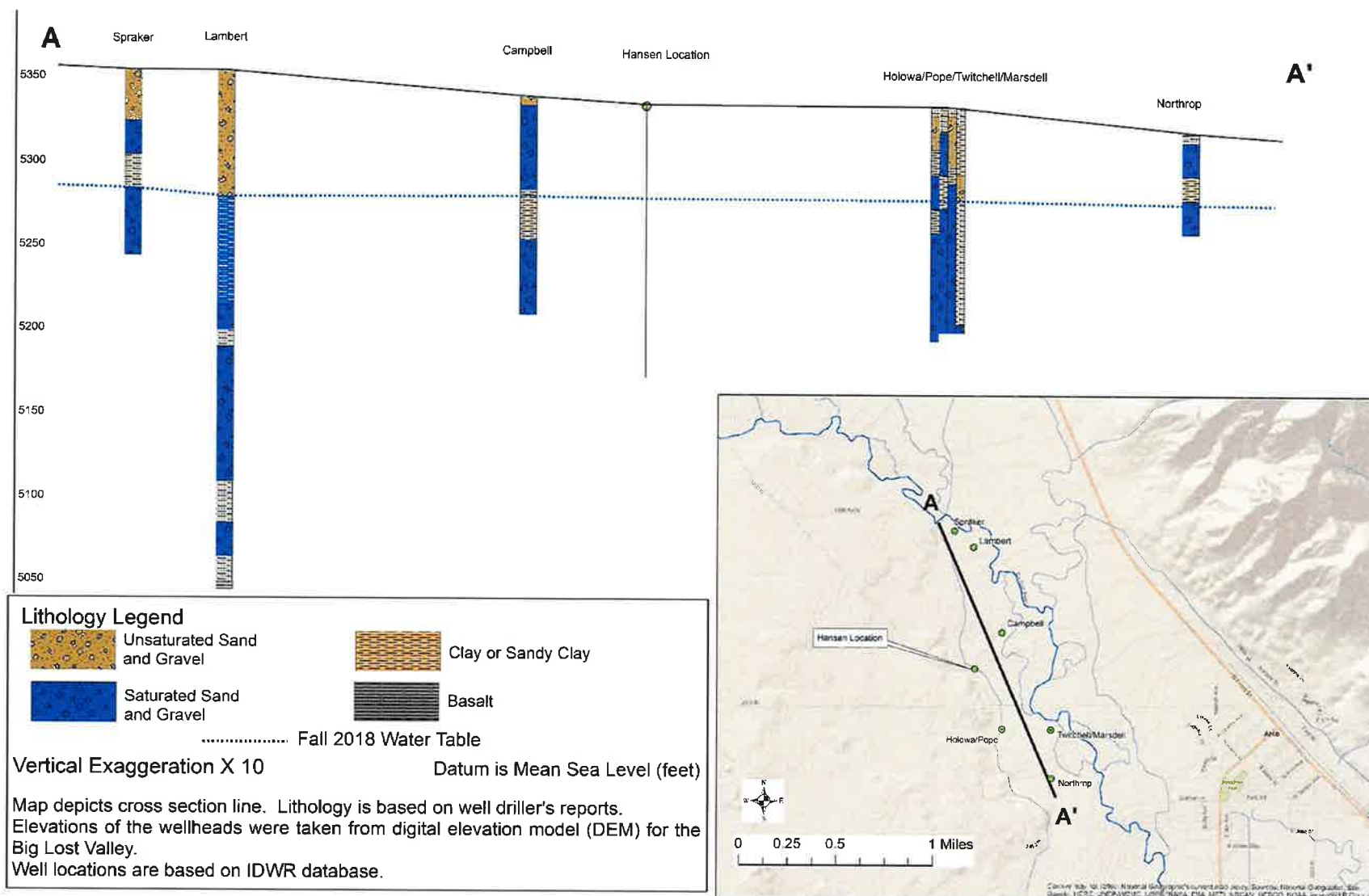


Figure 5. Lithologic plots of nearby wells at the Hansen Well location.

3. Please describe the composition (sand, gravel, basalt, etc.) of the aquifer layers supplying water to each of Telford's existing wells and describe the hydrologic connection between the existing wells and the proposed wells, if one exists.

There are 10 wells associated with this transfer (nine existing and one proposed). The table below provides a summary of the wells and information known about each of them. As Table 3 indicates, driller's logs are only available for six of the nine existing wells. Therefore, some assumptions have been made in order to describe the aquifer material encountered in each well and the hydraulic connection between them.

Table 4. Well information

<u>Well Name</u>	<u>Total Depth</u>	<u>PLS</u>	<u>Aquifer Material</u>
Folkman	unknown	05N 26E 15 NWNENW	alluvial?
North Island	171	05N 26E 34 SENWSW	alluvial
South Island	224	04N 26E 03 NESENW	alluvial
Hansen	Not Drilled	04N 26E 26 NESWSW	alluvial?
Big Hole	585	03N 26E 01 SWSESW	basalt
Small 14	145	03N 26E 03 NENESE	alluvial/basalt
South Airport	465	03N 26E 02 SENESW	alluvial/basalt
Marks Well	64	03N 26E 12 NWNWNW	alluvial
Pivot 14	unknown	03N 26E 02 SWNWSW	unknown
North Airport	unknown	03N 26E 02 SWSENW	unknown

Working from north to south, the first well encountered associated with this transfer is the Folkman well, located north of Moore (Figure 6). A well driller's log is not available for this well, however, a review of driller's logs for wells near the Folkman well indicate that this well is most likely completed in alluvial material composing the Big Lost Valley aquifer system. The total depth and open intervals of this well are currently unknown.

The next well encountered in the valley is the North Island well (Figure 6). The North Island well is 171 feet deep, with a screened interval from 35 feet down to 165 feet below land surface. The lithology reported on the driller's log includes sequences of sand, gravel, and clay. Saturated material was encountered between 2 and 105 feet and the depth to water was 9 feet below land surface, on August 23, 1976.

Moving south down the valley, the South Island well is the next POD encountered (Figure 6). The South Island well is 224 feet deep with a screened interval from 25 to 214 feet. The lithology reported on the driller's log includes layers of sand, gravel, and clay. Water was encountered between 14 and 30 feet below land surface, with a static water level of 9 feet below land surface on May 19, 1982.

The proposed Hansen well location is the next POD south. While this well has not yet been drilled, a review of driller's logs in the vicinity of this location indicate that the well will most likely be completed in alluvial aquifer material. However, if this well was to be drilled to a depth of approximately 350 feet,

it is likely that basalt will be encountered that could produce water. Until the well is drilled, it is unknown as to what aquifer material this well will be producing from.

At the southern end of the valley, six of the wells associated with this transfer are clustered within an approximate one mile radius (Figure 6). These wells include the Big Hole, Small 14, Pivot 14, Mark's Well, North Airport, and South Airport wells.

The Big Hole well is 585 feet deep, encountering a significant sequence of clay layers and unsaturated basalt above a saturated zone of basalt that is providing water to this well. Although ground water was encountered in a shallow zone of sand and gravel between 30 to 35 feet, the well is cased to 330 feet and completed as an open hole down to 585 feet. Static water level in this well was 510 feet below land surface when the well was completed on September 10, 1991.

The Small 14 well is 145 feet deep and is completed in both alluvial aquifer material and a shallow zone of saturated basalt. This well is screened from 35 feet to 115 feet below land surface. Depth to water in this well was 30 feet below land surface when the well was completed on July 5, 1966.

The South Airport well is 465 feet deep. The upper 245 feet of lithology of this well is unknown, as the well was deepened from 245 to 465 feet deep on July 8, 1991. Below 245 feet, sequences of clay, sand and gravel, and basalt were encountered. A small zone of saturated sand and gravel between 265 and 280 feet provides water to this well in addition to two saturated zones of basalt encountered at 340 feet and 455 feet below land surface. This well is screened from 238 to 248 feet below land surface and completed as an open hole between 335 to 465 feet below land surface. The static water level at the time the well was deepened was 245 feet below land surface on July 8, 1991.

Based on what is believed to be the correct driller's report, Mark's well is 64 feet deep. It is completed in a sequence of sand, gravel, and clay. The well is screened from 20 to 62 feet below land surface. The static water level in the well was 23 feet below land surface in 1966.

Driller's reports for the Pivot 14 and North Airport wells are unavailable. Due to the heterogeneous hydrogeologic conditions in this portion of the basin, it is not reasonable to predict what aquifer material is producing water to these wells.

To help describe the hydrologic connection between the wells associated with Transfer #82318, a generalized hydrogeologic cross section was developed for the area of interest (Figure 7). Lithologic units were plotted for the PODs of interest in this transfer. Nearby wells were also used as control points to develop the diagram, but the lithologies were omitted to keep the illustration simple and the focus on the PODs.

Previous studies have shown that ground water flow in this portion of the Big Lost Valley is from north to south with downward hydraulic gradient (Crosthwaite et al., 1970). Hydrographs from wells in this

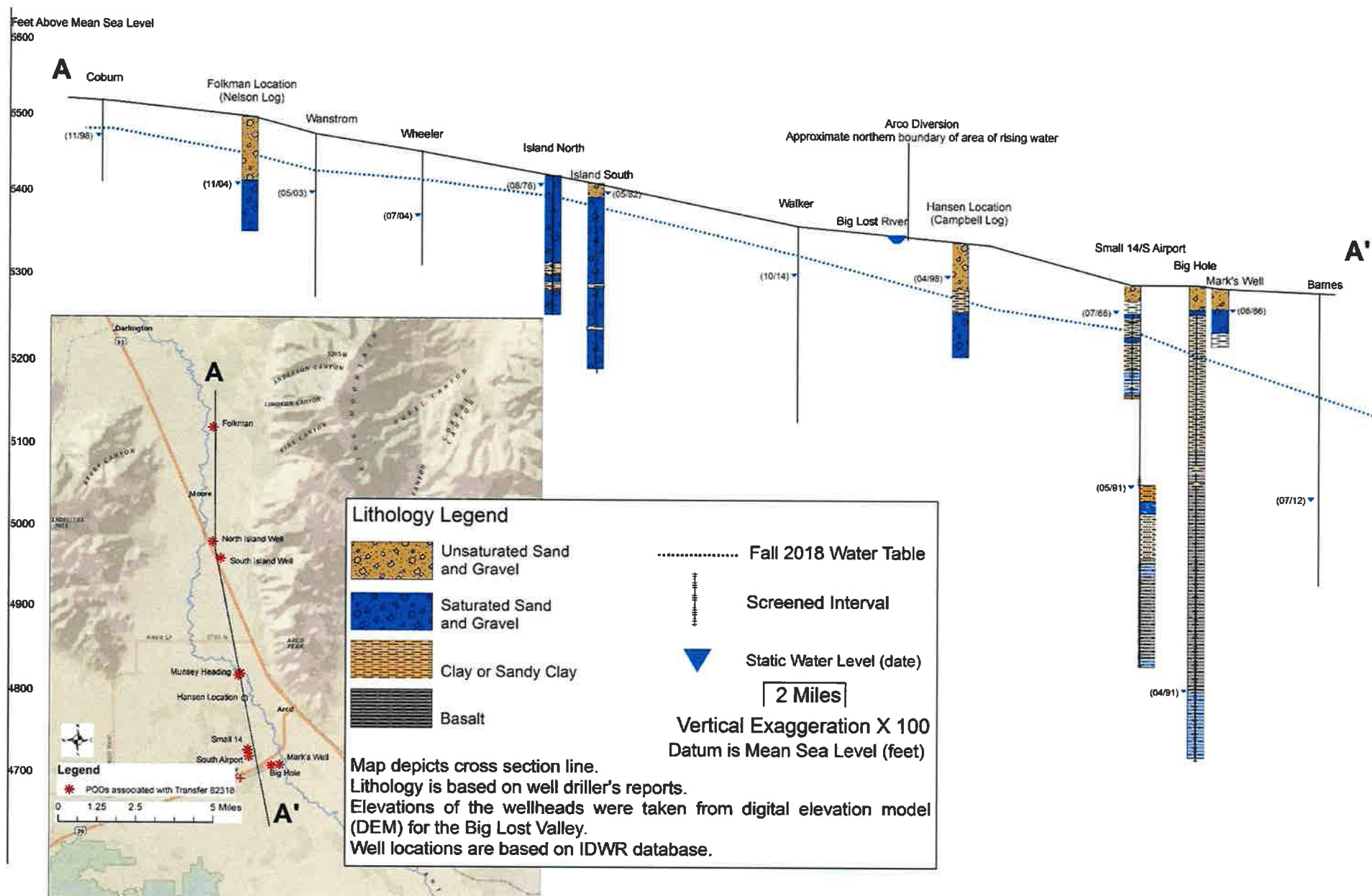


Figure 6. Lithologic plots of PODs associated with Transfer #82318.

area show similar trends, indicating that the wells are completed in an aquifer that is in hydraulic communication spatially (Sukow, 2017).

The hydrogeologic conditions become more complex at the mouth of the valley where the Big Lost aquifer merges with the Eastern Snake Plain Aquifer. Clay layers and basalt flows are more abundant, with a steepening of the hydraulic gradient through this transition zone due to an increase in volume of lower hydraulic conductivity material.

Therefore, the wells associated with Transfer #82318 are in hydraulic communication with one another, drawing water from the same source. The wells in the northern portion of the valley are diverting water from the alluvial aquifer prior to that water flowing through the aquifer transition zone at the mouth of the valley where the Southern Wells are located.

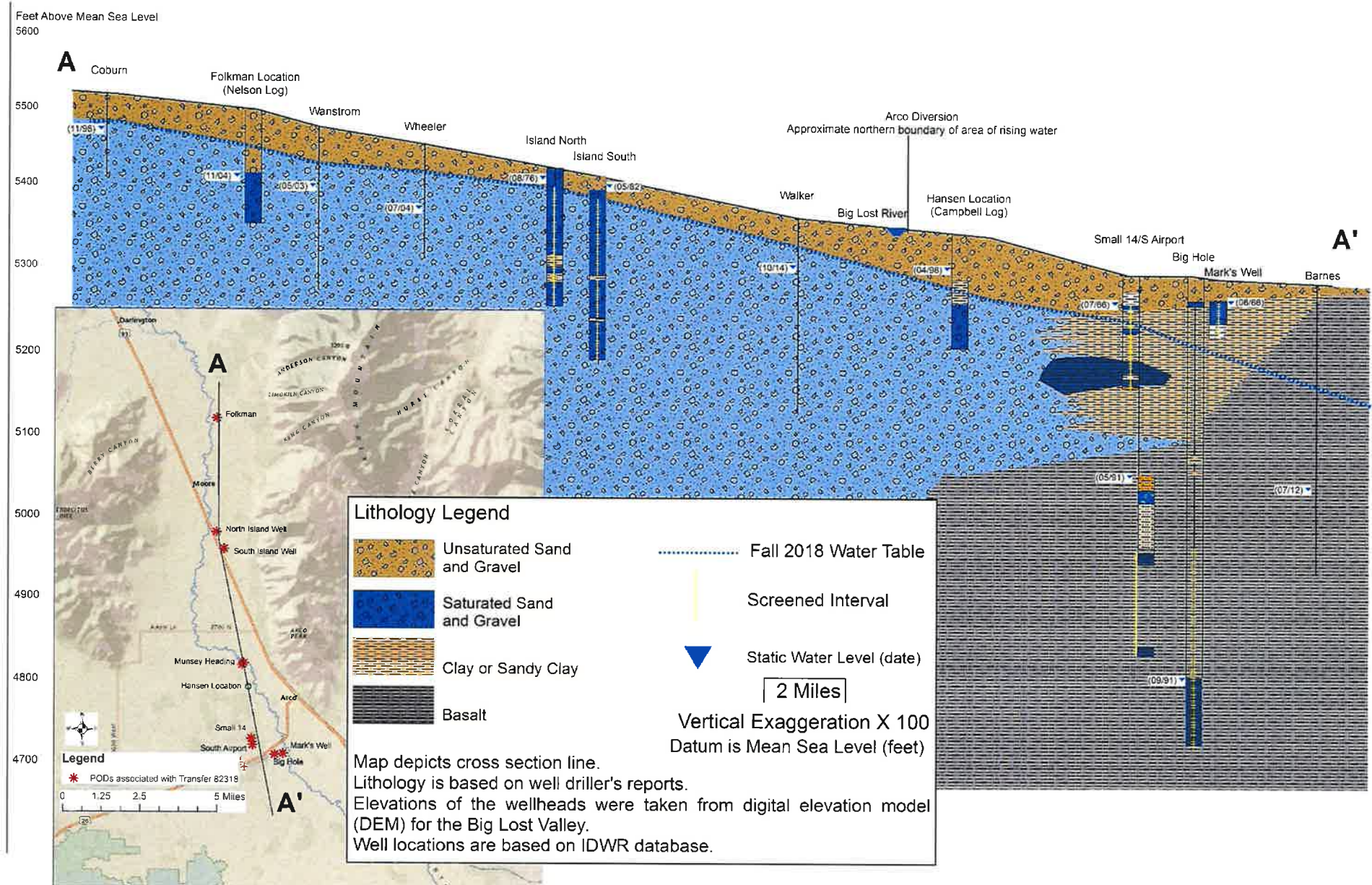


Figure 7. Conceptual hydrogeologic cross section of area of interest.

Conclusions

In summary, there are three primary conclusions based on the foregoing analysis:

1. The changes proposed in this transfer will result in a spatial redistribution of aquifer withdrawals but it is not assumed to change the overall aquifer withdrawal. In this case, the net effect on the aquifer discharge due to pumping will remain unchanged.
2. The changes in pumping locations proposed in this transfer will likely result in less drawdown near Moore, and an increase in drawdown near the Arco Diversion. Less drawdown near Moore will tend to increase the magnitude and duration of river gains near Moore as compared to the baseline conditions. Therefore, the proposed transfer could be expected to increase aquifer discharge to the Big Lost River near Moore.
3. Incidental recharge from the seepage of the conveyance of the water may increase or decrease, depending on the pumping rates and conveyance systems associated with the PODs included in this transfer. Therefore, the location and quantity of aquifer recharge may be changed through this transfer.

The scenarios presented in this memo provide an indication of the magnitude of effects that may be observed in the aquifer and the rising waters at the southern end of the basin. If limitations could be imposed on this water right that would minimize the net overall change to the aquifer budget, effects of this transfer would be minimal when compared to the baseline conditions.

References

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