Appendix FF-3

AquiferTek Report
(November 2014)

AquiferTek

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November 7, 2014

Re: Validation of Marsland Expansion Area (MEA) Agricultural Well Impact Analysis

As requested, we have completed an update and validation of the Marsland Expansion Area (MEA) Agricultural Well Impact Analysis (dated December 10, 2013) based on results of recent water level monitoring at the MEA. Our analysis included the calibration of the groundwater flow model using water level data collected during the 2014 irrigation season, and calculation of the calibrated 30-year capture zone of irrigation well 732.

WATER LEVEL MONITORING

Water level elevation data was collected from eight shallow monitoring wells (AOW-4, AOW-5, AOW-9, AOW-10, BOW-4A, BOW-5, BOW-9, and BOW-10) at the MEA from 12/11/2013 to 10/9/2014. Water level data were collected using downhole in-situ Troll® dataloggers equipped with pressure transducers. Water levels were collected once per day from each monitoring well over the monitoring period, and are plotted in **Attachment A**.

Results of water level monitoring indicate the operation of irrigation well 732 caused a maximum of 2.2. feet of drawdown in the nearest monitoring well cluster (AOW-9/BOW-9) over a 100-day (3.3 month) irrigation well pumping period. Drawdown in other shallow monitoring wells was not significant and less than 0.5 feet. Drawdown measured in AOW-9 and BOW-9 was very similar, indicating the shallow Arikaree and Brule aquifers are in hydraulic communication as previously noted in the December 2013 summary report.

IRRIGATION WELL 732 OPERATING CONDITIONS

Pump operating and monitoring data collected during the 2014 irrigation season indicates irrigation well 732 pumped 57,742,980 gallons of groundwater over an approximate 100-day (3.3 month) period from late April to early August 2014. This equates to an average continuous pumping rate of 401 gpm over the 3.3 month operating period. Because the actual operating pumping rate of well 732 is approximately 800 gpm, we can infer well 732 pumped at a rate of

800 gpm for 12 hours each day during operating period. The observed 2014 irrigation operating conditions differed somewhat from the estimated operating conditions used in our December 2013 impact analysis (well 732 operating 11 hours per day for 5-months, or an average continuous pumping rate of 373 gpm).

GROUNDWATER FLOW MODEL CALIBRATION

The groundwater flow model used in the original December 2013 impact analysis was calibrated by simulating observed changes in water level elevation (drawdown) in shallow monitoring wells AOW-9/BOW-9 during the 2014 irrigation season using the updated irrigation well 732 operating conditions.

Aquifer parameters used in the "high transmissivity scenario" of the December 2013 irrigation well impact analysis were used as initial conditions for the model calibration. In order to calibrate the flow model and achieve a reasonable match between observed and simulated drawdown, the specific yield of the shallow Arikaree/Brule aquifer was lowered slightly from 0.1 to 0.048. A summary of calibrated flow model parameters and irrigation well operating conditions is summarized below:

Hydraulic conductivity - 8.2 ft/day.

Transmissivity - 1656 ft^2/day (aquifer thickness 202 feet).

The hydraulic gradient – 0.004.

Porosity – 0.15

Specific Yield – 0.048 (adjusted downward from 0.1 to calibrate the model)

Pumping rate – 401 gpm for 3.3 months (100 days).

Results of the flow model calibration are shown in Figures 1 and 2. Observed and simulated drawdowns in wells AOW-9/BOW-9 are very similar, and simulated drawdown in other shallow monitoring wells is less than 0.5 feet as observed. Given these results, the model has been adequately calibrated and can be used to make predictions with a reasonable degree of accuracy.

REVISED IRRIGATION WELL IMPACT ANALYSIS

The calibrated groundwater flow model was used to calculate the 30-year capture zone of irrigation well 732. Particle-tracking techniques were used to illustrate the 30-year capture zone

of irrigation well 732 to assess whether a hypothetical shallow casing leak from the MEA wellfields could potentially impact the irrigation well.

For purposes of this analysis, we have assumed a conservative (worse-case) scenario in which irrigation well 732 pumps the maximum allowable amount of groundwater (251 acre-ft/year, 373 gpm for 5-months) and a hypothetical shallow casing leak occurs at some time along the downgradient portion of the adjacent ISR wellfields at the MEA. These are the same operating conditions assumed in the original December 2013 impact analysis, which are considered to be more conservative than conditions observed during the 2014 growing season (e.g. 3.3 month operating period, 70% of permitted water right).

RESULTS AND CONCLUSIONS

The revised 30-year capture zone of irrigation well 732 is illustrated in Figure 3. Based on the results of this analysis, MEA wellfields are not located within the capture zone of irrigation well 732. A shallow casing leak within the MEA wellfields will not impact irrigation well 732 at any time in the future given similar operating conditions. This conclusion is identical to the original December 2013 impact analysis.

Given the location of other irrigation and domestic wells in the area (Figure 1, Appendix A Technical Report) and configuration of the worse-case capture zone, it is reasonable to conclude there are no other wells outside the MEA boundary that will be impacted by a potential release of MEA regulated material to the shallow aquifer. Therefore, the current MEA shallow groundwater monitoring network is adequate to ensure the protection of human health and environment.

If you have any questions or comments concerning this report, please contact me directly at 303-522-1118.

Sincerely,
AquiferTek

Robert L. Lewis, P.G.
Principal Hydrogeologist

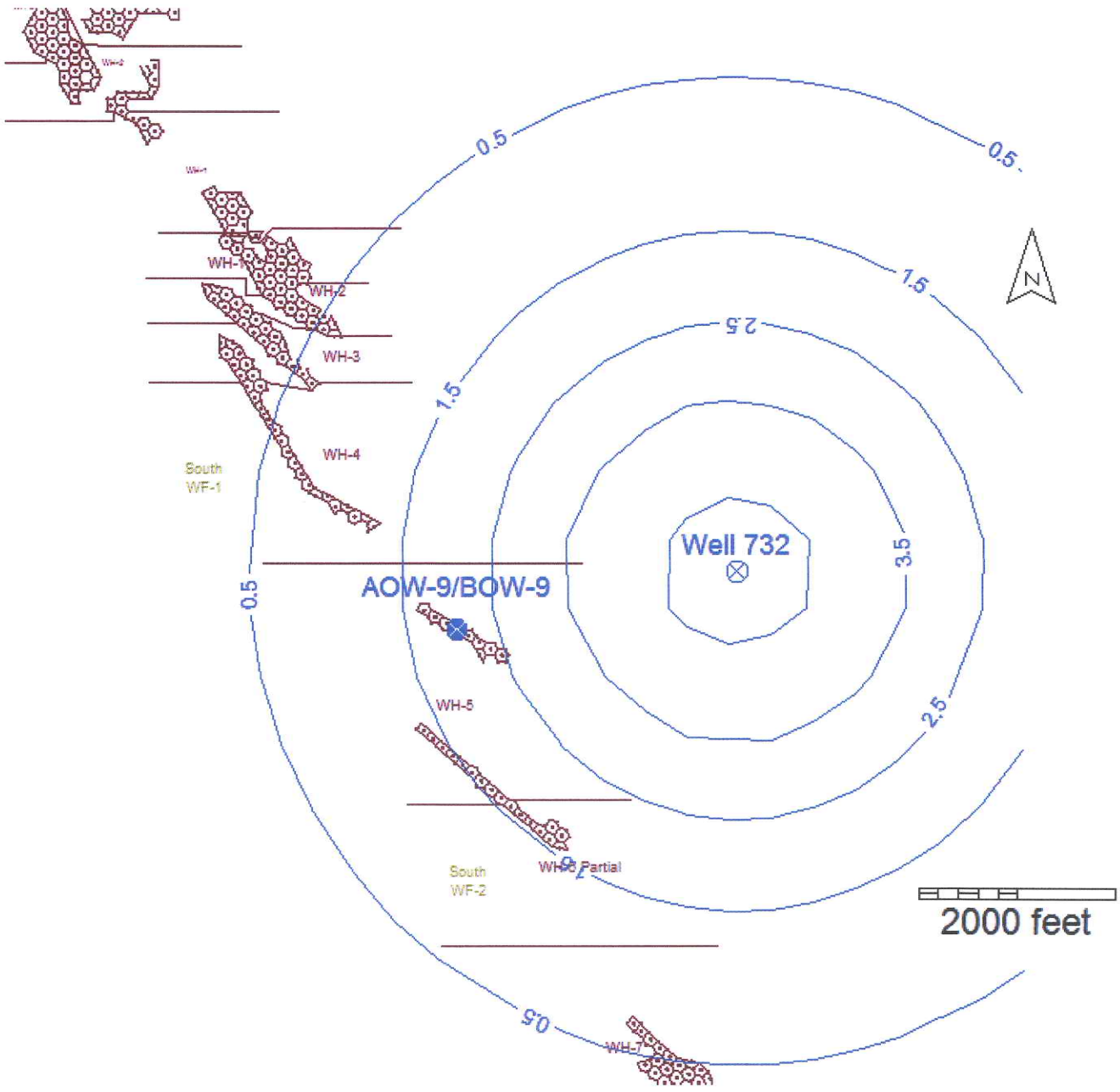


Figure 1. Calibrated maximum drawdown contour map, 2014 Irrigation Season.

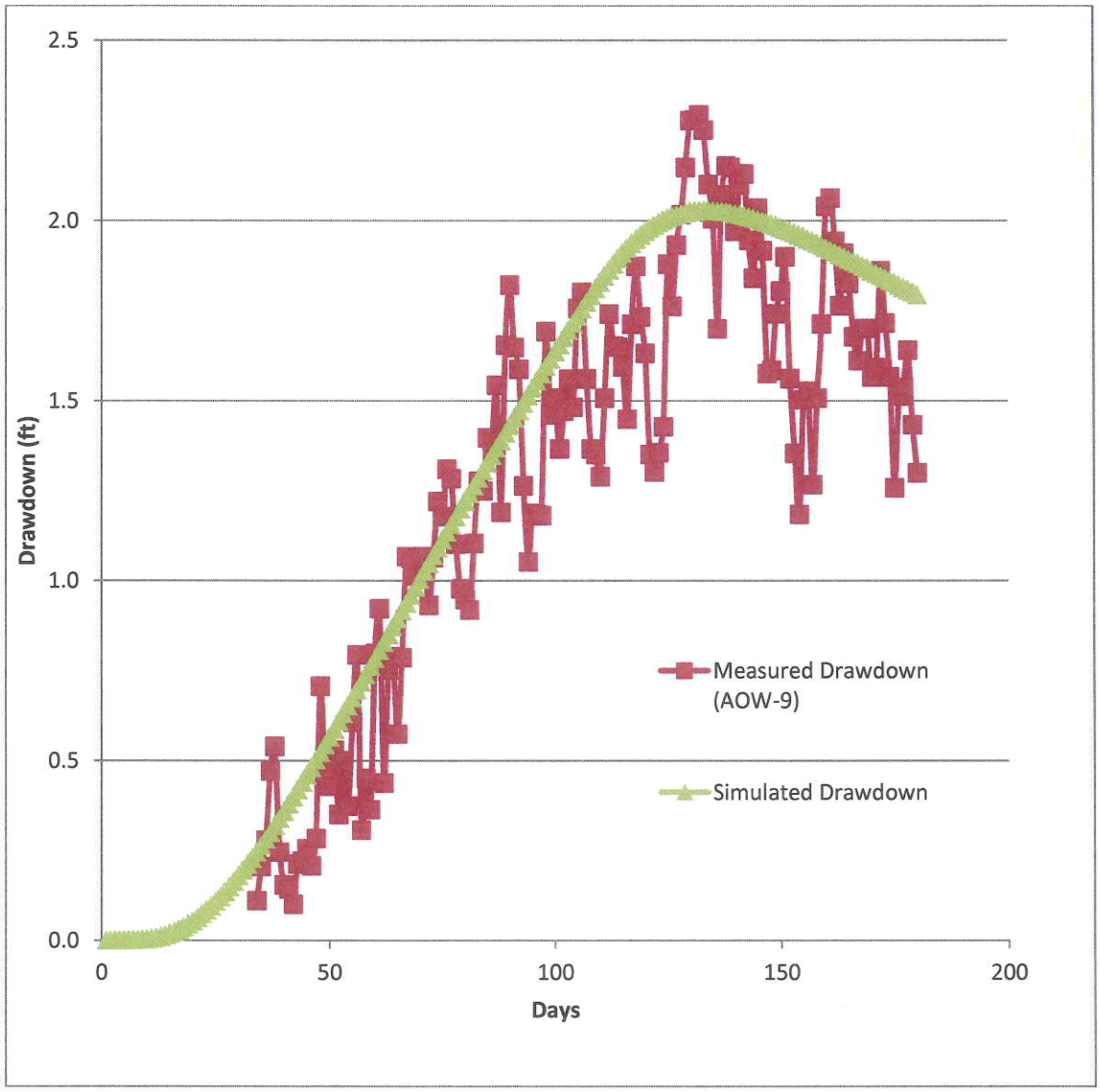


Figure 2. Simulated vs. Observed Drawdown in shallow monitoring well AOW-09, Irrigation Well 732 calibration .

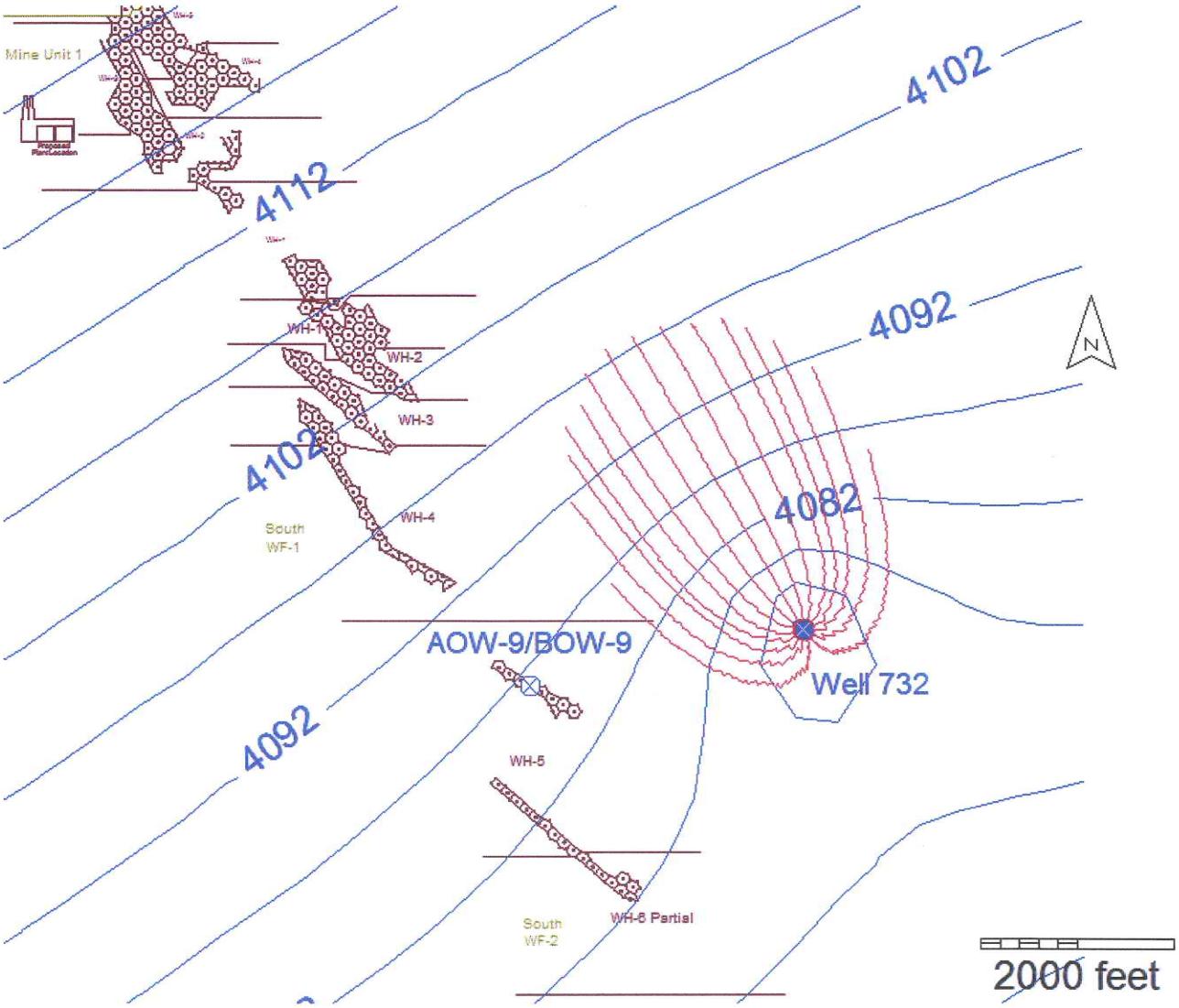
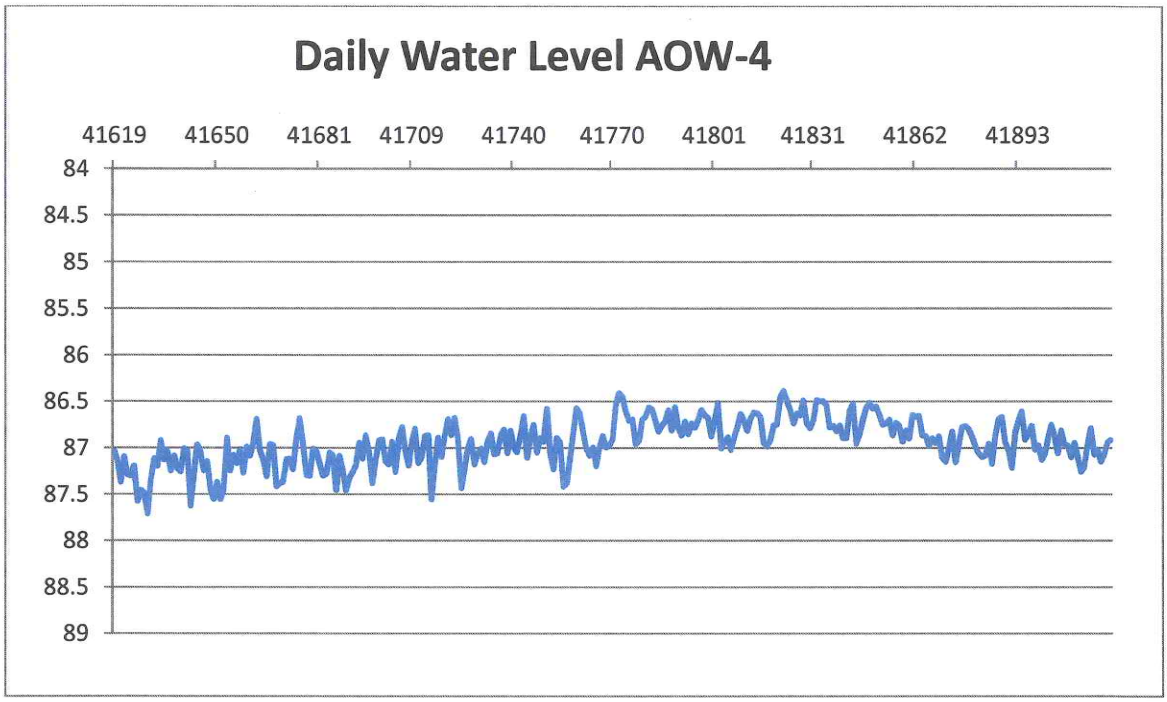


Figure 3. 30-year capture zone of Irrigation Well 732.

ATTACHMENT A

WATER LEVEL MONITORING DATA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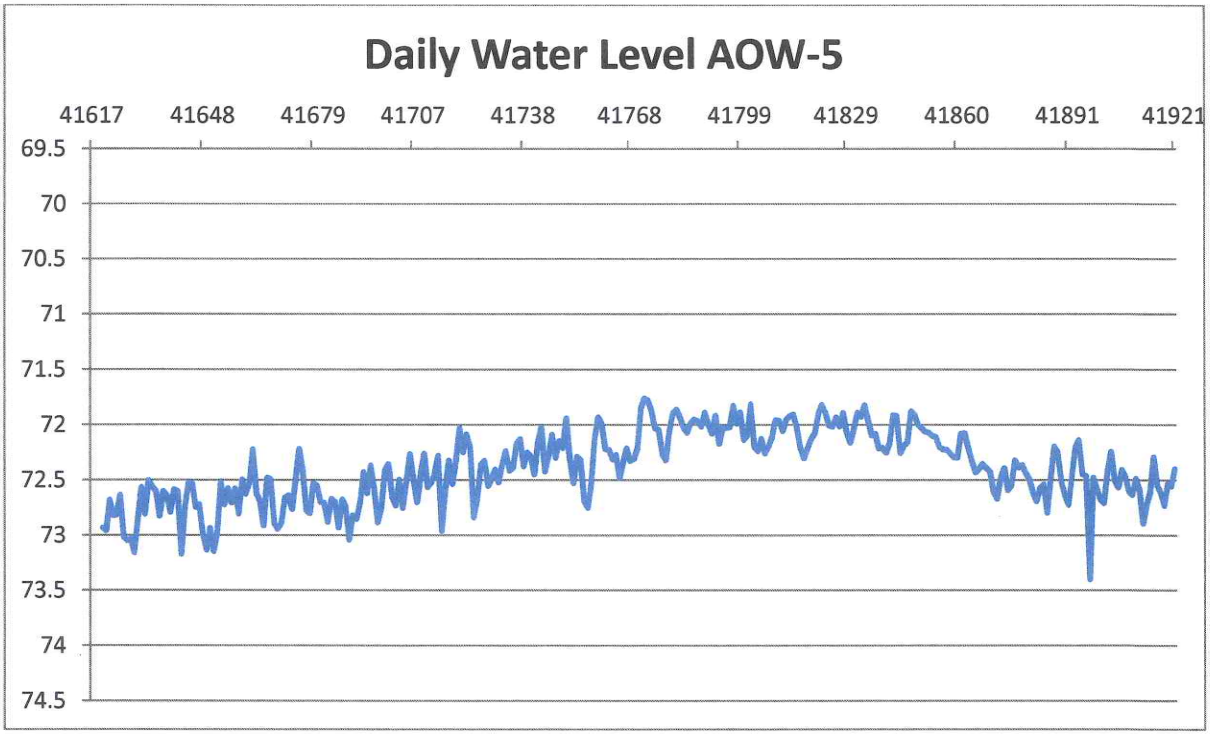
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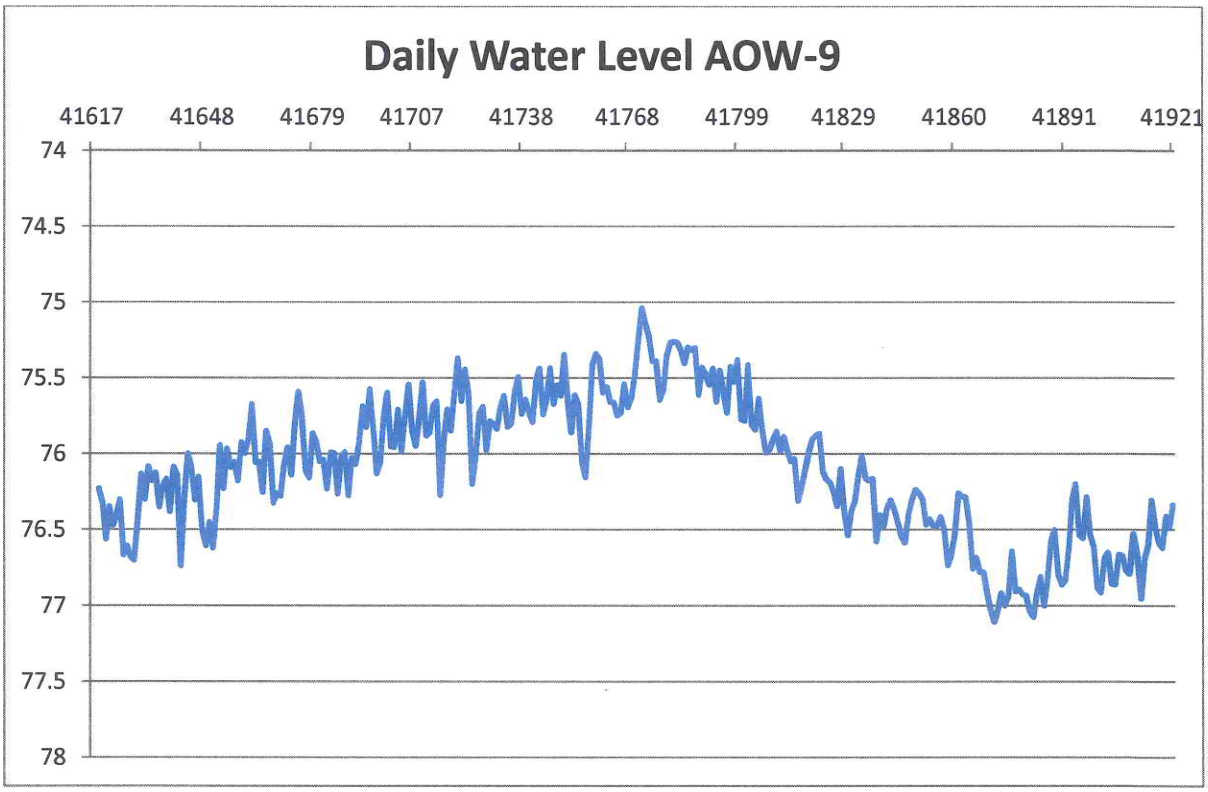
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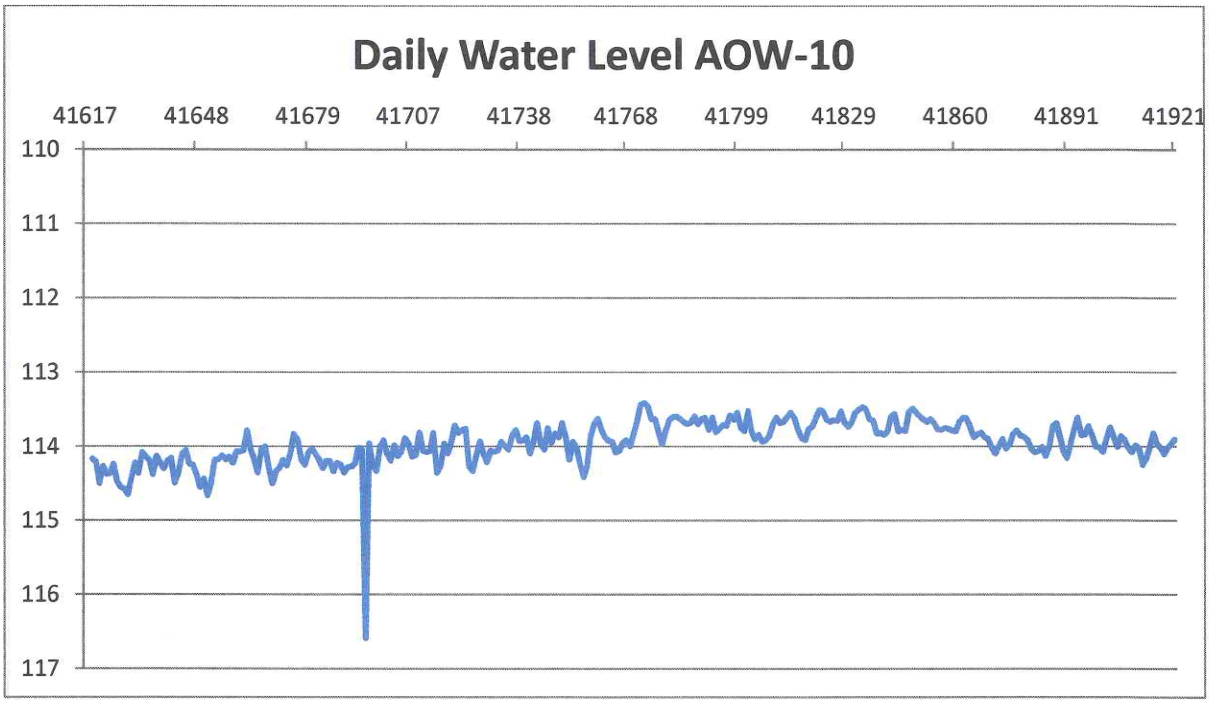
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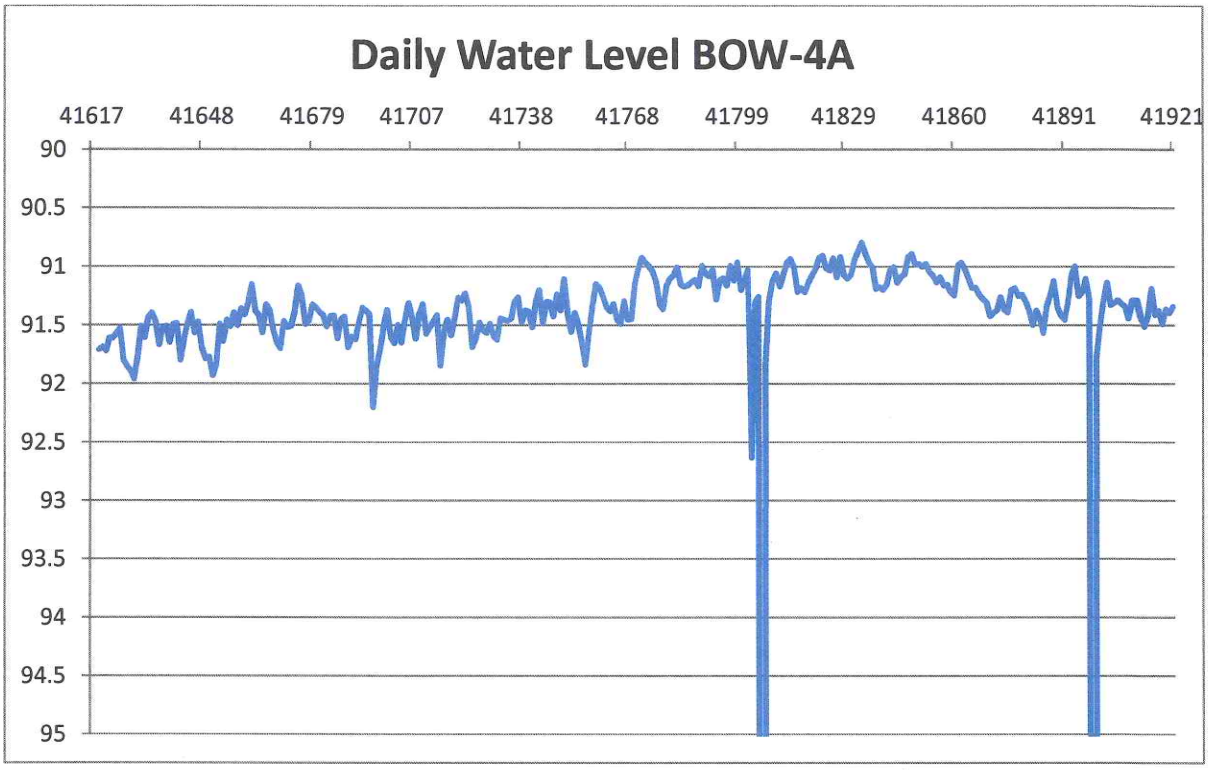
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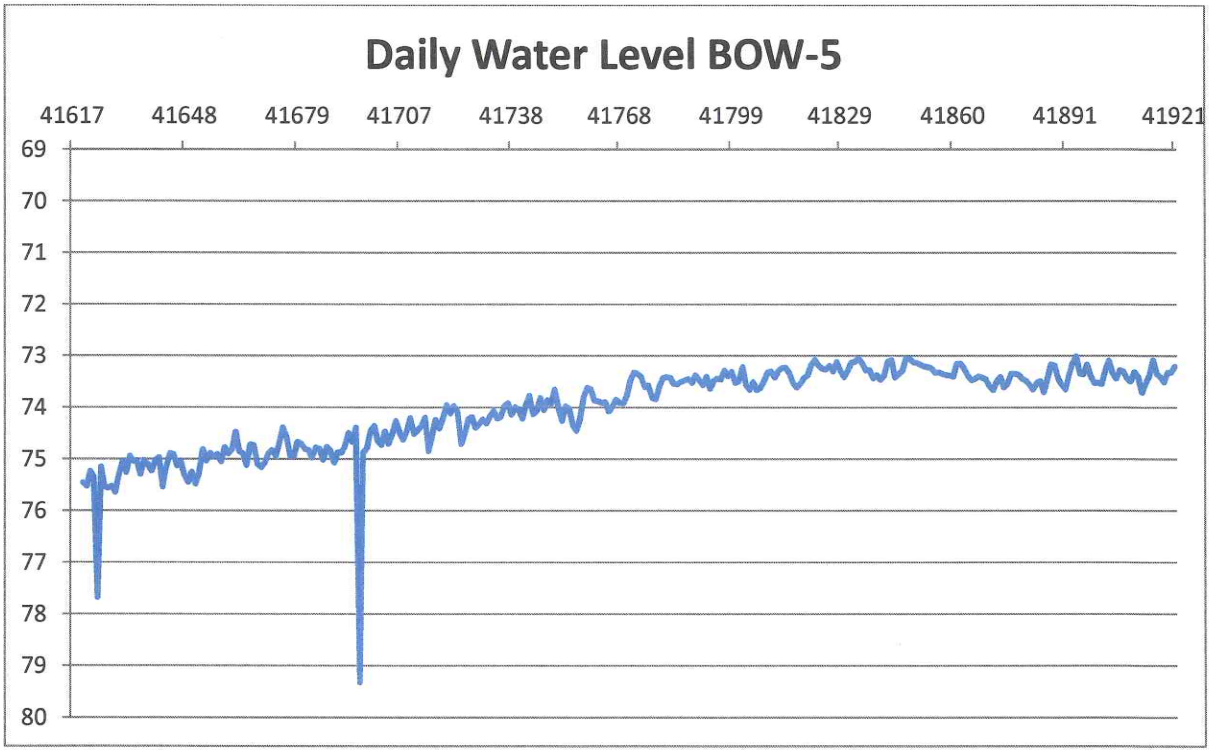
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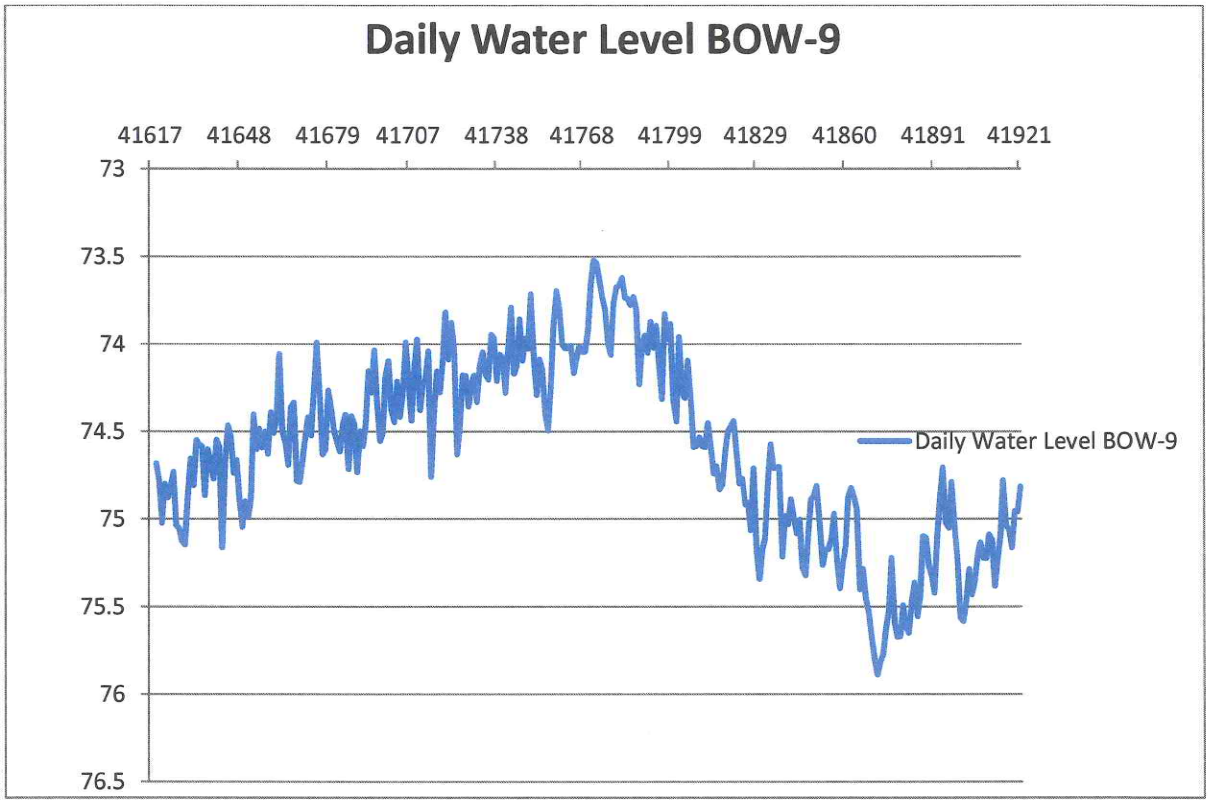
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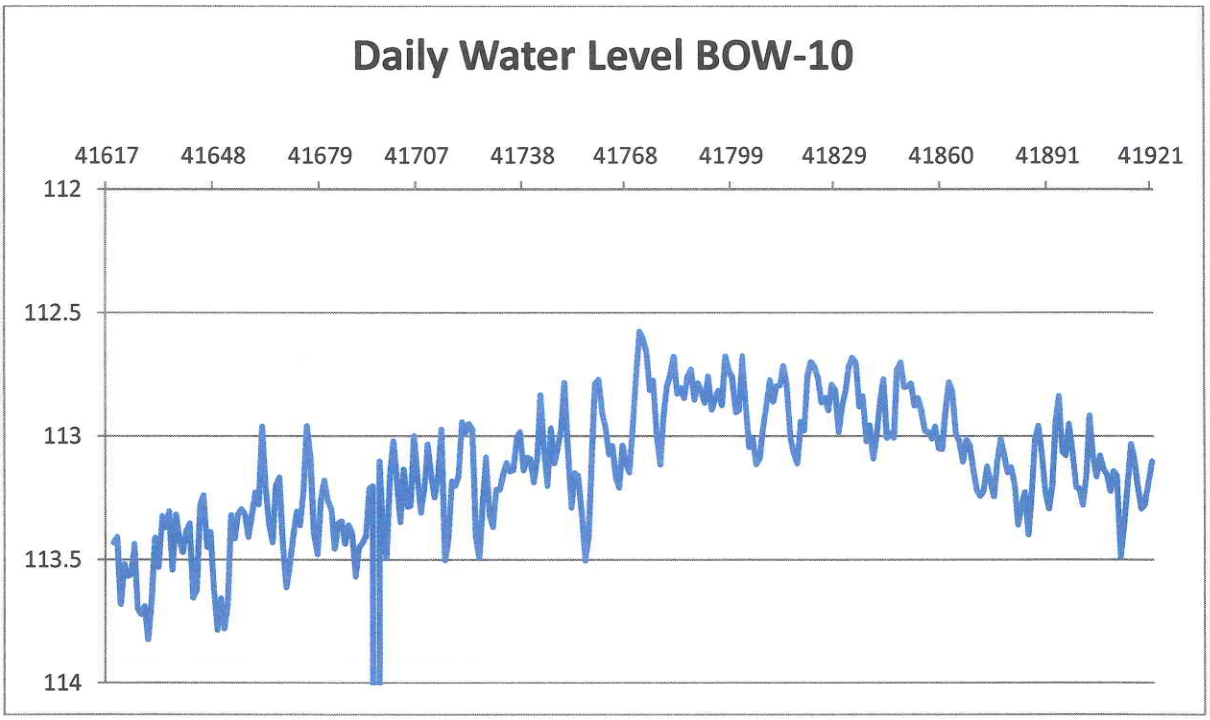
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