Great West Engineering, Inc.

Judith Basin
2021 Monitoring Data Summary Report

Central Montana Regional Water Authority

November 2021

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WESTERN GROUNDWATER SERVICES

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1. INTRODUCTION

The Central Montana Regional Water Authority (CMRWA) is in the process of constructing the Musselshell-Judith Regional Water System (MJRWS). As part of this work, CMRWA has undertaken monitoring of water resources in Judith Basin pursuant to a water resources plan[1] and the associated monitoring program (**Figure 1**).[2] This report is presenting data collected from the inception of the monitoring program through part of 2021. The monitoring program is ongoing and will collected and publish data on an approximately annual basis.

The Judith Gap RWIS[3] station is operated by the Montana Department of Transportation (MDT). CMRWA contributed a precipitation monitoring instrument to this location that was installed in late 2016. Big Spring near Lewistown is monitored by FWP using instrumentation and data acquisition equipment and software paid for through a State grant sponsored by CMRWA. Judith River near Sapphire Village is monitored by the U.S. Geological Survey. This gauge was reinstated in 2014 pursuant to the watershed monitoring plan prepared by CMRWA. Data from these locations are presented in this report.

This report is also presenting water quality data for two private wells, Osmundson Ranch and Peterson Ranch, located in Judith Basin. The Osmundson Ranch well is a converted oil wildcat well constructed in 1955. The Peterson Ranch well is a Kootenai aquifer well that was monitored for pressure as part of the monitoring program.

Great West Engineering, Inc. is the engineer for the MJRWS project. Western Groundwater Services, LLC prepared this report while working as a subconsultant to Great West Engineering.

2. TIME HISTORY PLOTS

Groundwater data are current up to early July 2021. Data for the Judith Gap RWIS, Big Spring and Judith River are current through October 2021. The monitoring system was started in 2016. Changes to the monitoring system since that time include:

- The Jenni Ranch well monitoring was completed from April to September 2017. It was discontinued because this well is flowing artesian and is not frost protected other than by the warm groundwater discharge. The pressure transducer used to monitor water level could not be reliably protected from freezing.

- The CMRWA #3 well was constructed in late 2019. A monitoring instrument was installed in the well in July 2020. The instrument was damaged after November 2020, and was repaired and reset into the well in July 2021. Data are presented for the period for July to November 2020. Data collection is ongoing in this well.

1 Western Groundwater Services, LLC (2014) Water Resources Monitoring Plan, Central Montana Regional Water Authority, report to Great West Engineering, Inc.

2 Western Groundwater Services, LLC (2020) Judith Basin Monitoring System, Final Report, Central Montana Regional Water Authority, report to Great West Engineering, Inc.

3 Road Weather Information System

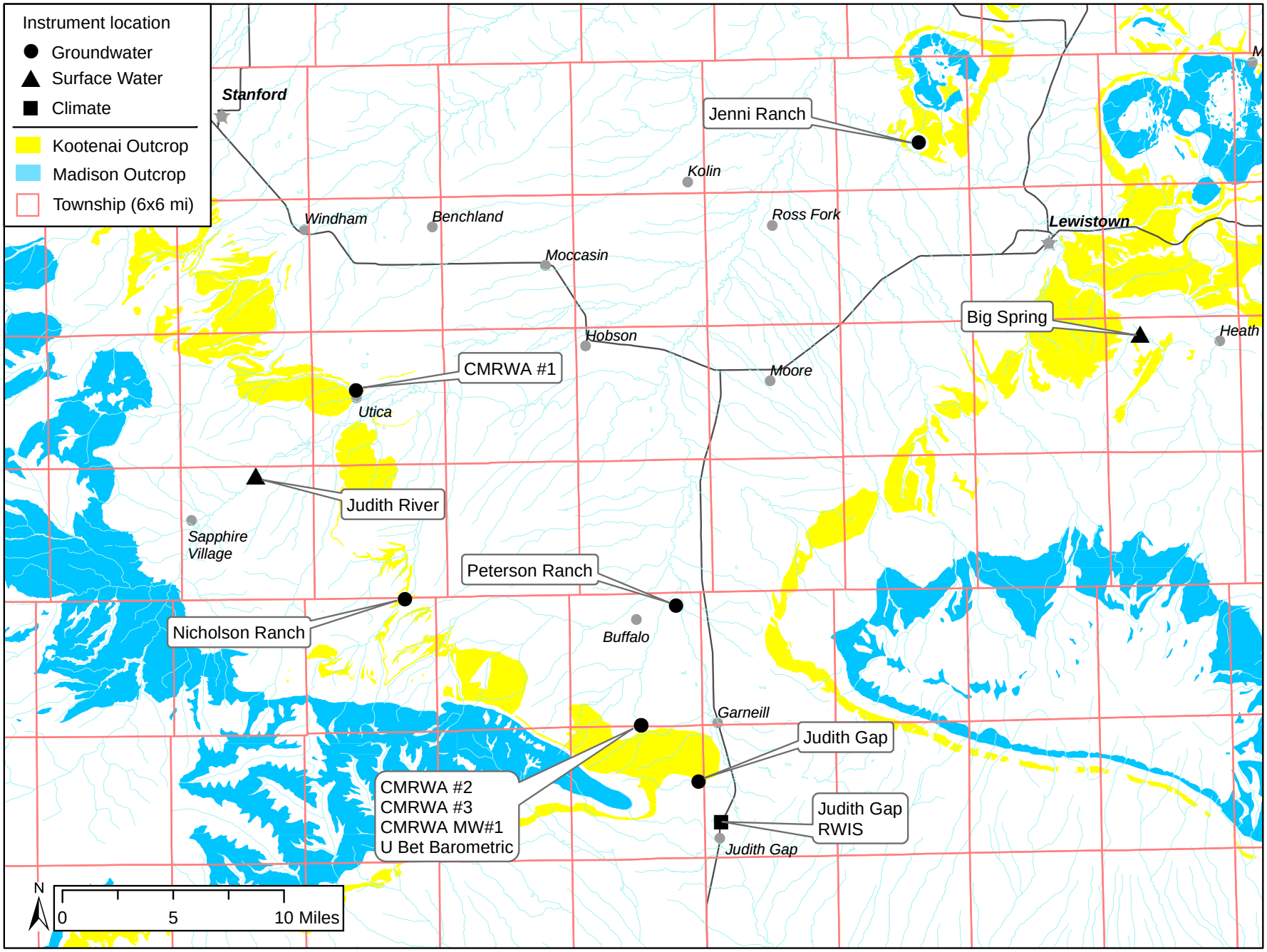


Figure 1. Location Map

- The Peterson Ranch well is no longer monitored because a pump has been installed in the well and the monitoring location that was being used no longer is reflecting the well pressure. This well also is flowing artesian, but when pumped does not flow. It is not possible to install the pressure transducer down the well due to insufficient casing diameter.

Plots of the Judith Gap RWIS, well data, Big Spring and Judith River are provided on :**Figure 2** through **Figure 13**. Well data and Big Spring flow rates are also archived on the Montana Bureau of Mines and Geology Ground Water Information Center (GWIC) website.[4] The GWIC identification number listed on these plots can be used to access the data. Judith River data are available directly from the USGS stream flow monitoring site.[5] The Judith Gap RWIS data are available through a public information request directly to MDT.[6]

Water level data for the Madison wells, CMRWA #1 and CMRWA #2, exhibit large amplitude seasonality on top of a longer period trend. There are few data available for the CMRWA #3 well, however, from what is shown, it does not fluctuate nearly as much. Both CMRWA #1 and CMRWA #2 are completed in the top of the Madison aquifer, whereas CMRWA #3 penetrates nearly 700-ft of formation. The CMRWA MW#1 Kootenai monitoring well also exhibits seasonality and longer-term trends, but these data lack the clarity of the Madison well data. Big Spring, which is a Madison aquifer discharge, is shown to fluctuate from 84- to 100-cfs, with a declining trend over the past year.

Water temperature data are also measured in the downhole instruments of wells CMRWA #1, CMRWA #2, CMRWA #3, CMRWA MW #1, and Nicholson Ranch. These data are exhibiting a long-term trend of increasing temperature. This trend is consistent in the wells except for CMRWA #3, which exhibits a -0.3 °F/year decreasing trend. The trend based on the CMRWA #2 data is about 0.06 °F/year, and based on CMRWA #1 is 0.07 °F/year. The CMRWA MW#1 Kootenai monitoring well exhibits a temperature trend of 0.03 °F/year. A similar trend occurs in the Nicholson Ranch well, which is a pumping well completed at shallow depth in the Kootenai aquifer. The estimated trend in this well is 0.07 °F/year.

4 http://mbmggwic.mtech.edu/

5 https://waterdata.usgs.gov/mt/nwis/uv/?site_no=06110020

6 https://www.mdt.mt.gov/mdt/information_request.shtml. Re: Judith Gap RWIS atmospheric data in converted units. These data require processing to obtain precipitation as daily totals.

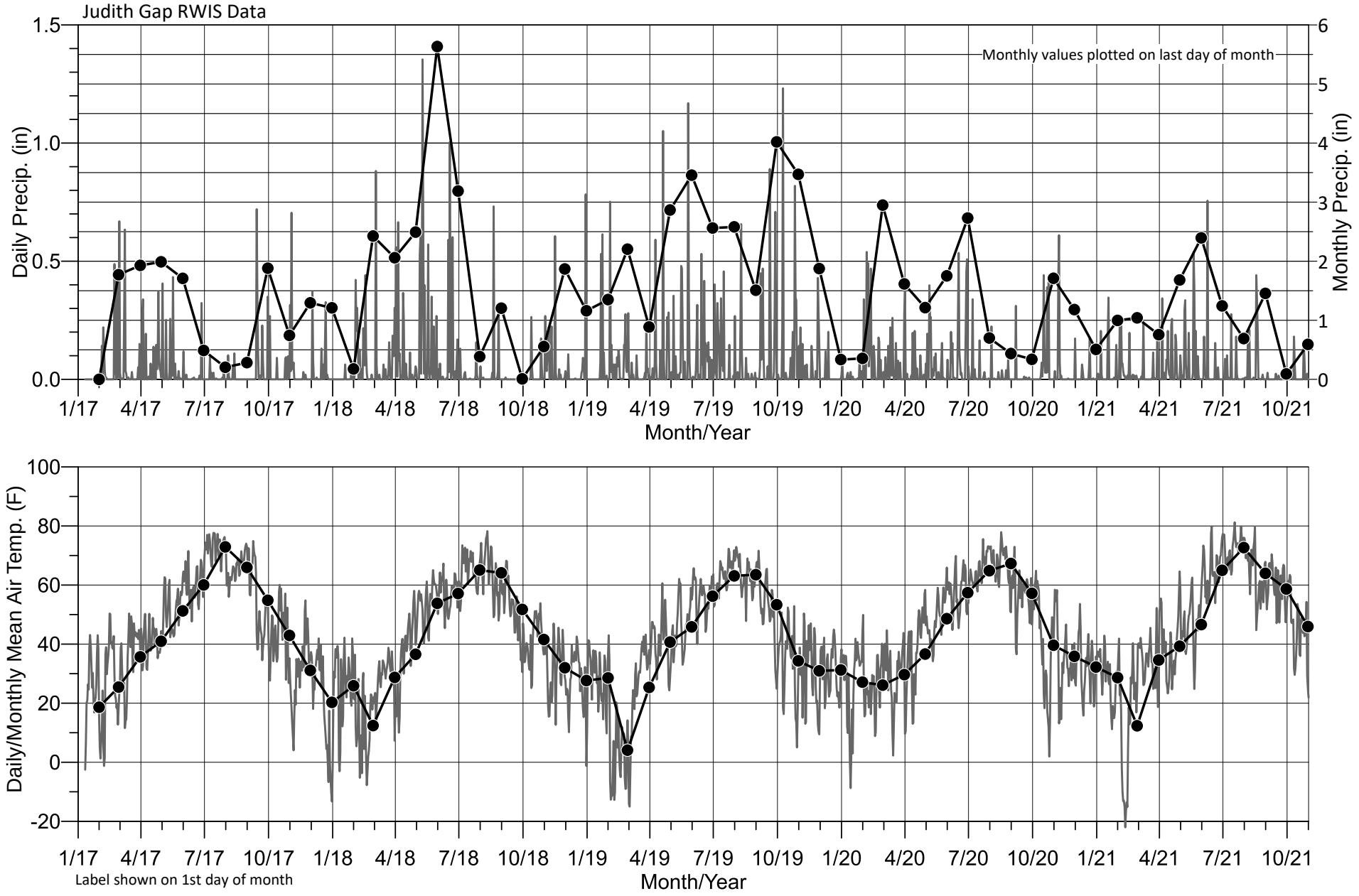


Figure 2. Judith Gap RWIS

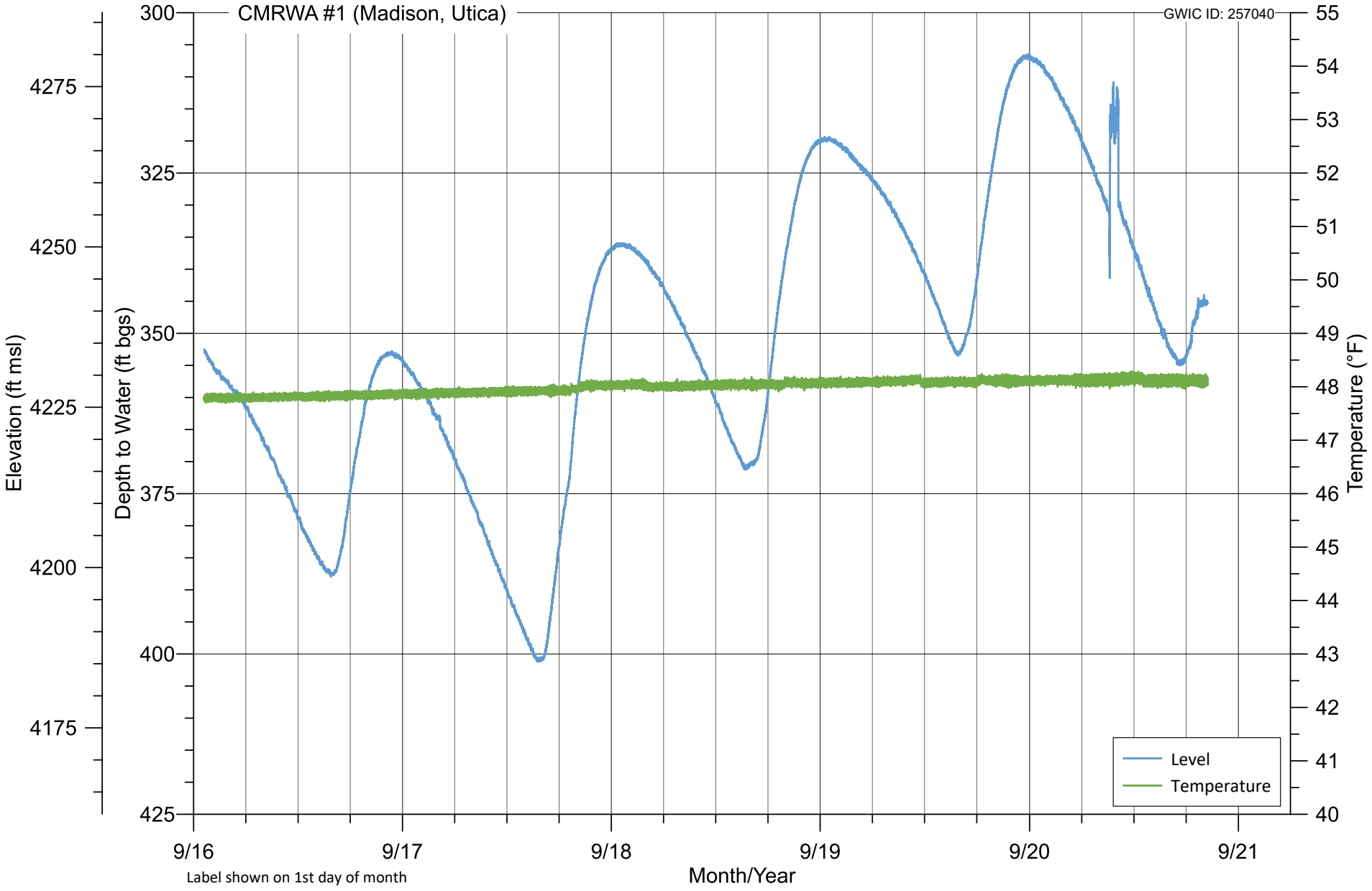


Figure 3. CMRWA #1

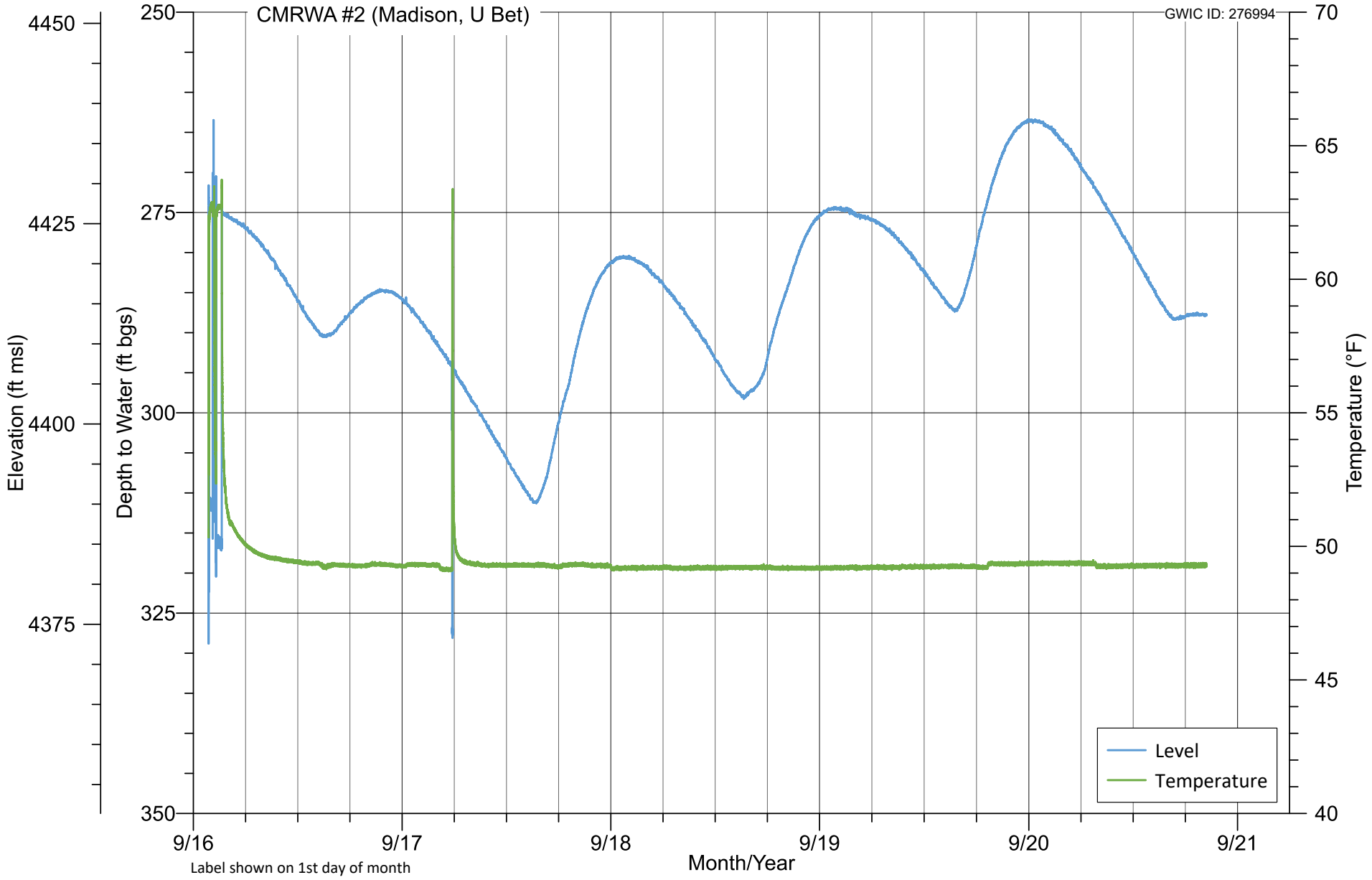


Figure 4. CMRWA #2

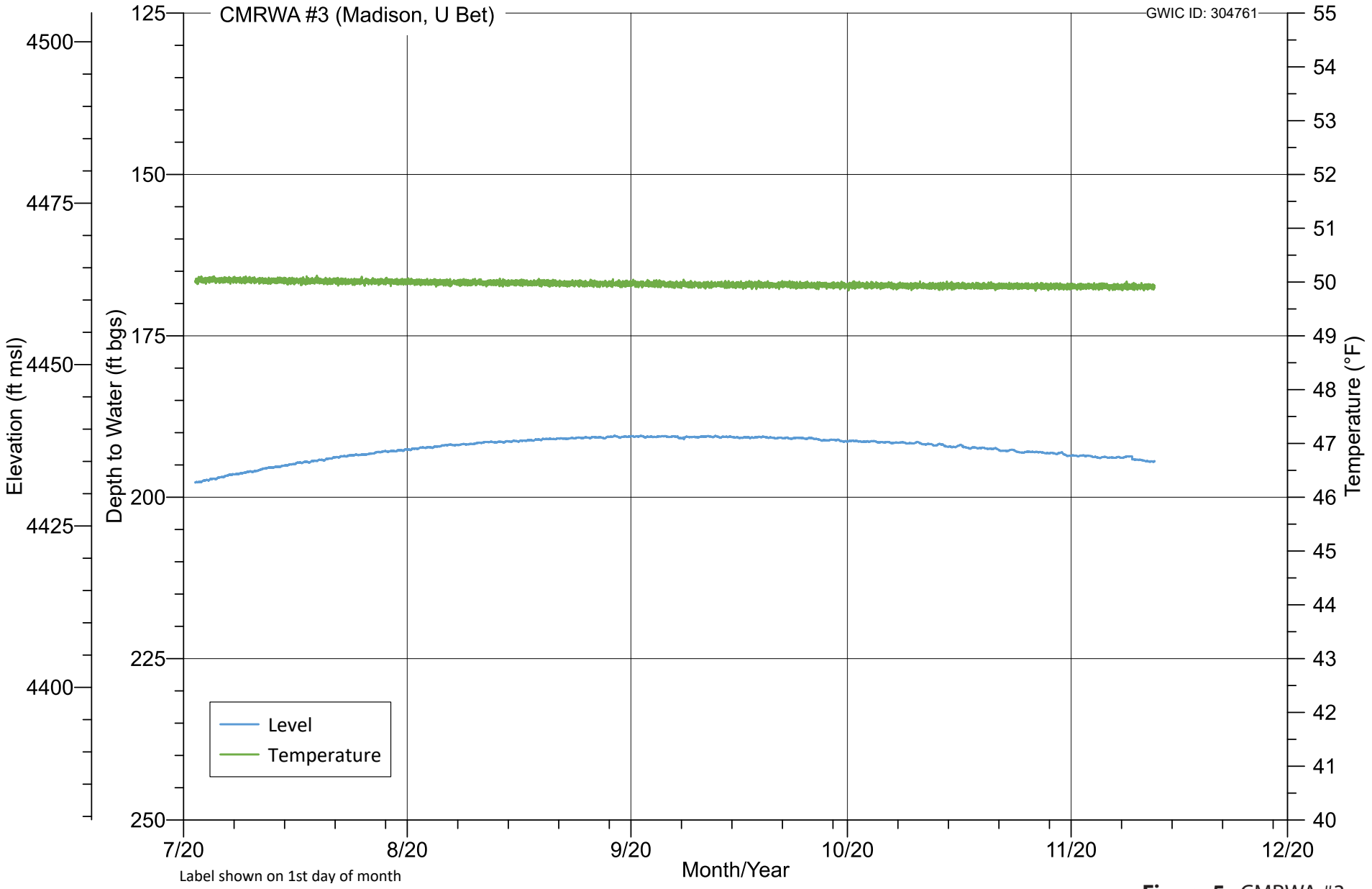


Figure 5. CMRWA #3

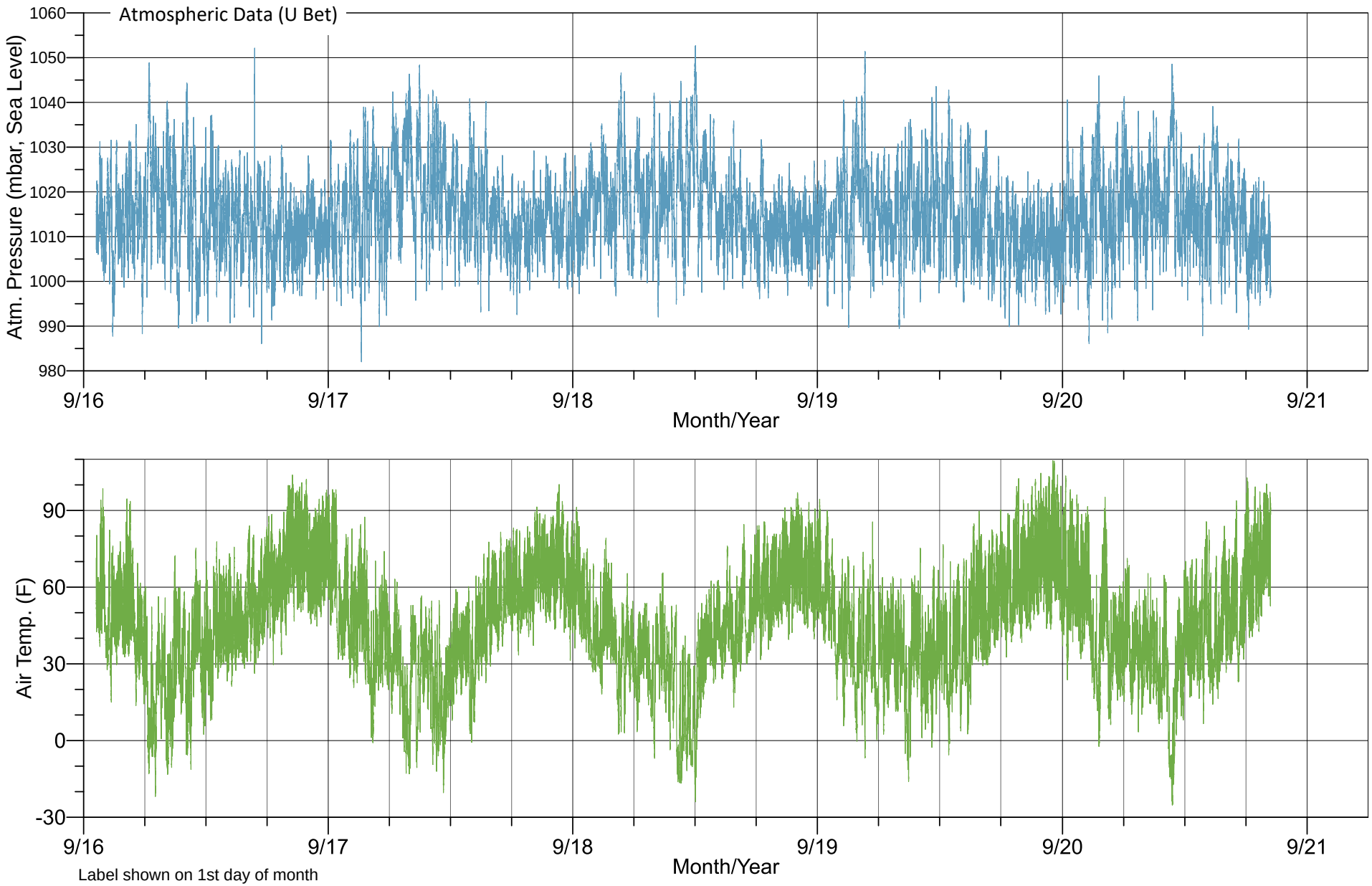


Figure 6. CMRWA Barometric

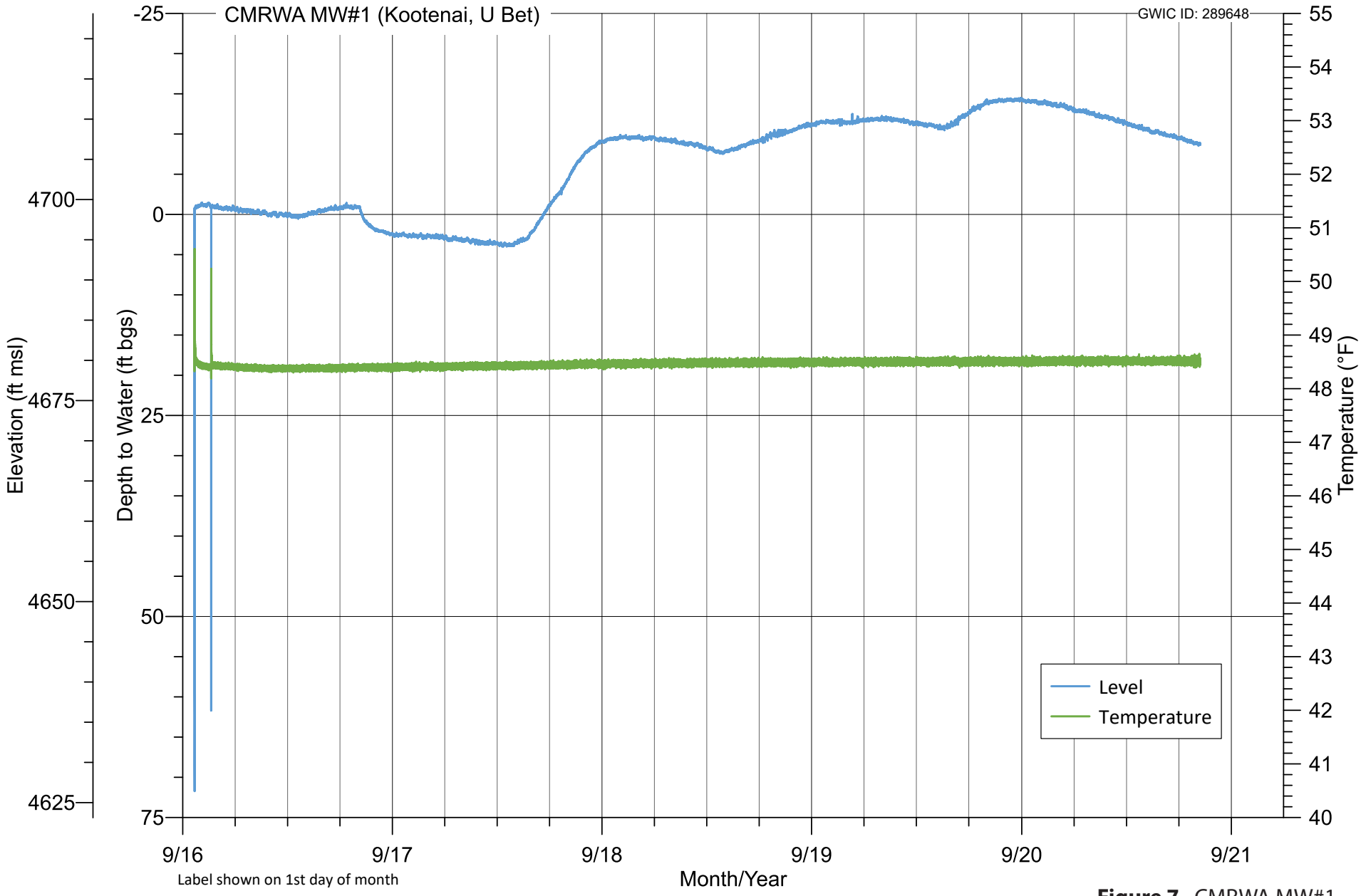


Figure 7. CMRWA MW#1

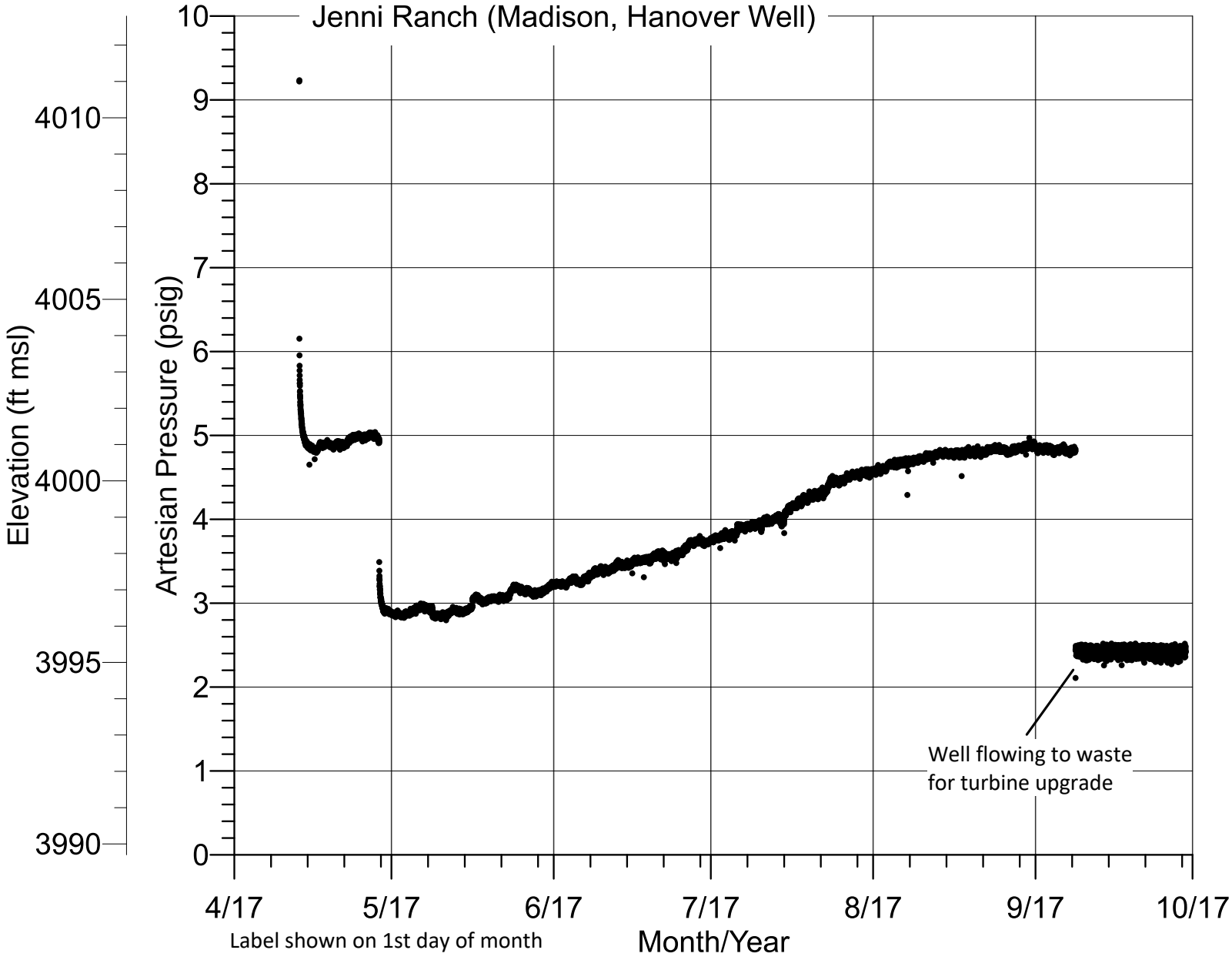


Figure 8. Jenni Ranch

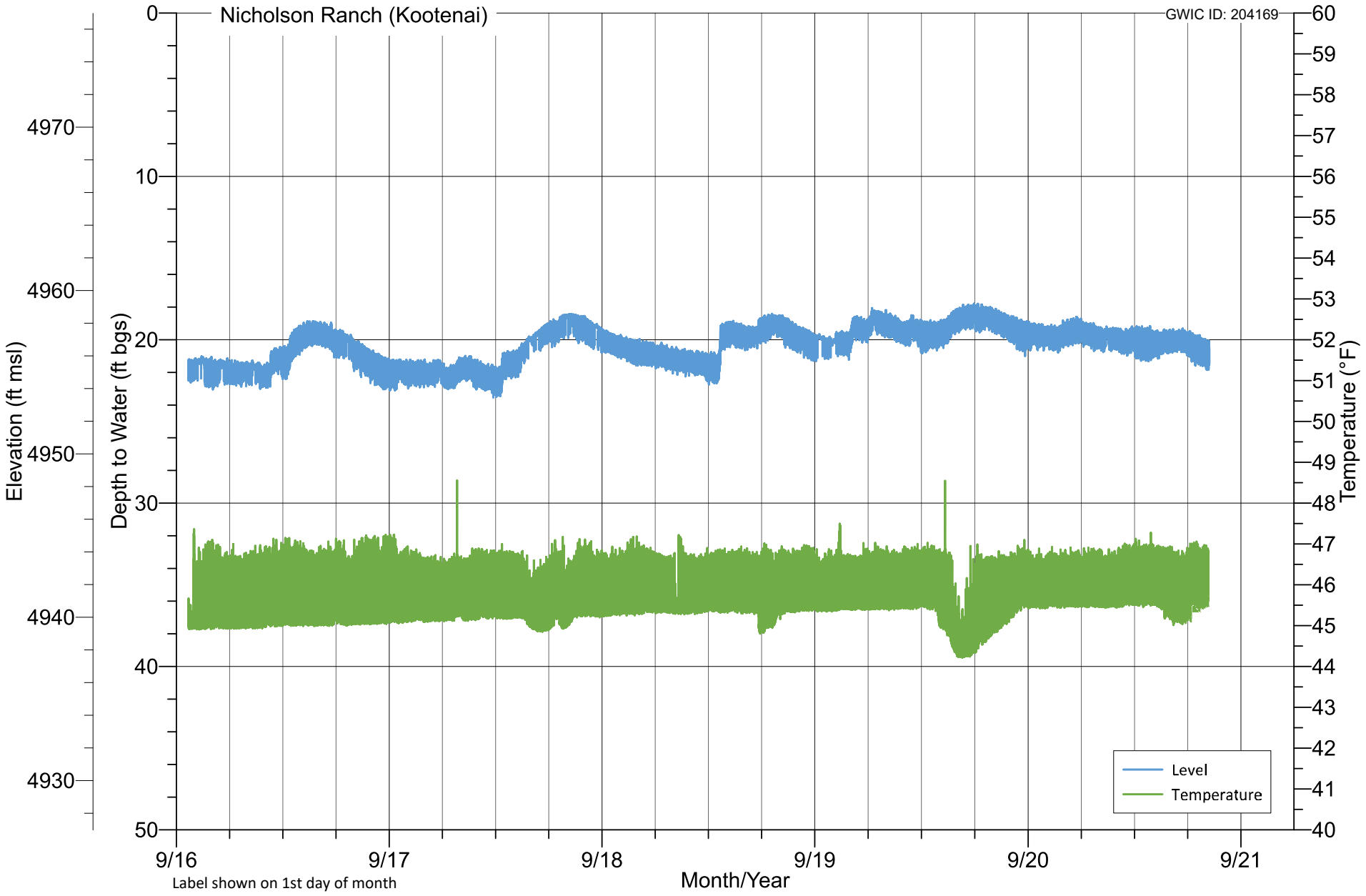


Figure 9. Nicholson Ranch

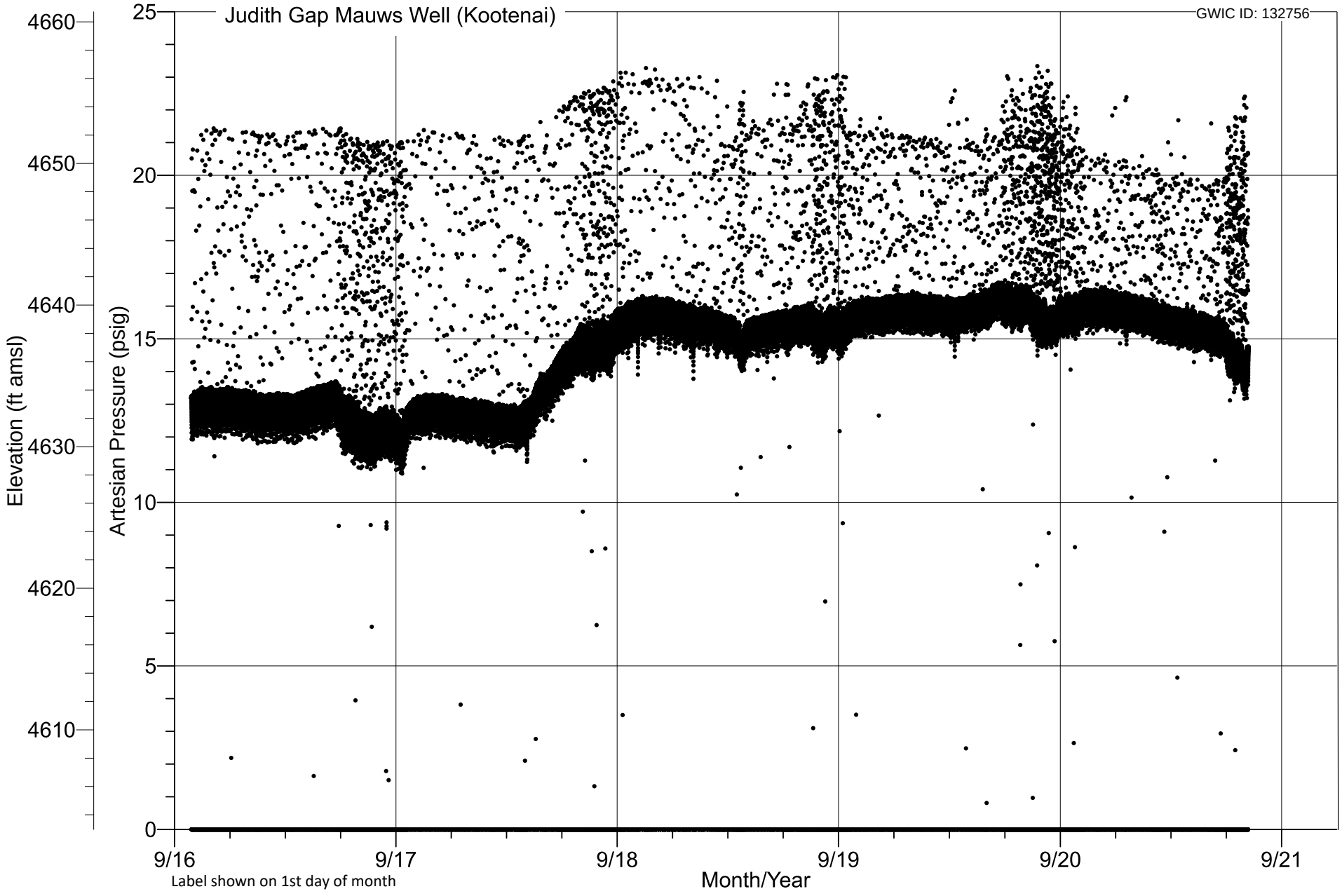


Figure 10. Judith Gap

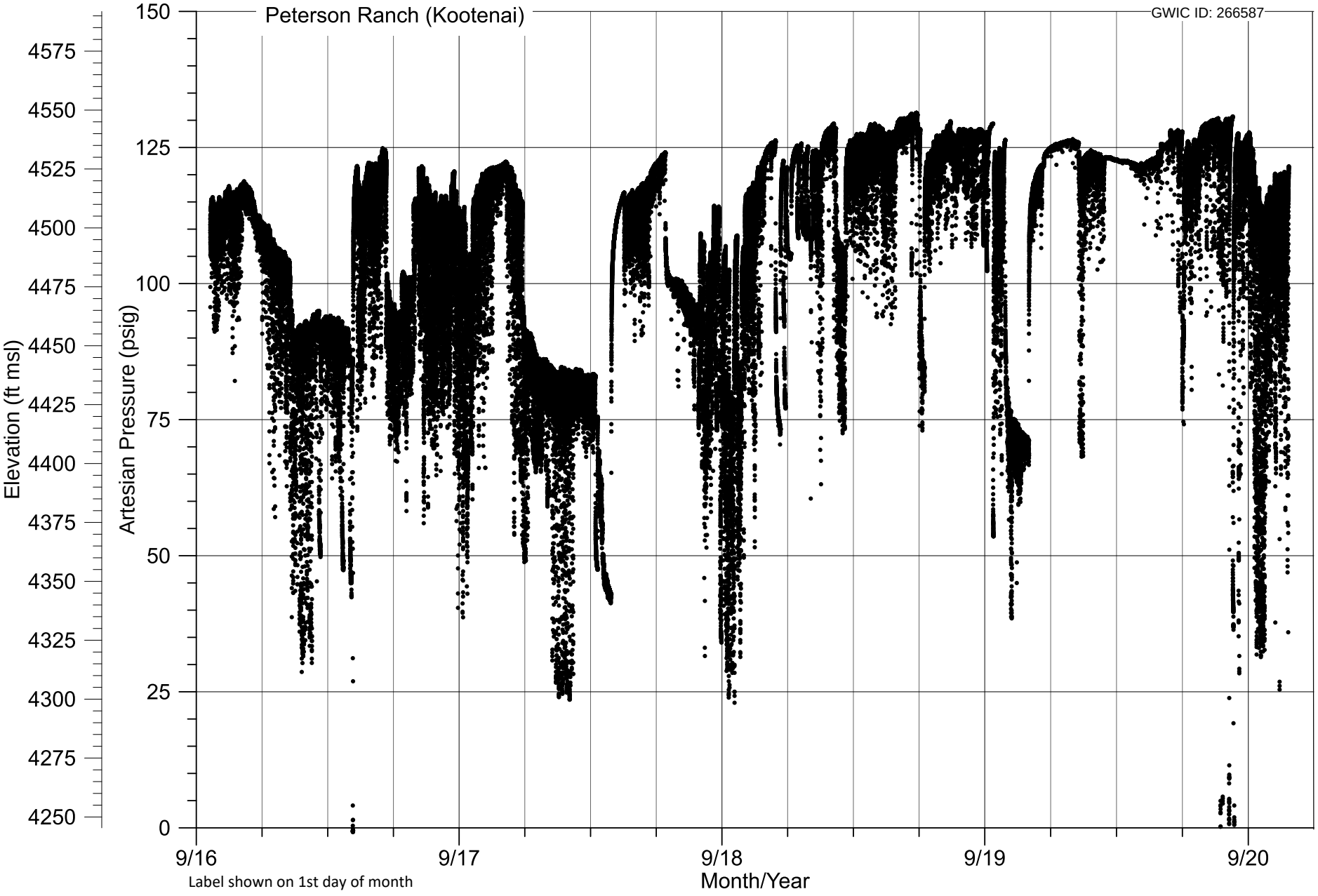


Figure 11. Peterson Ranch

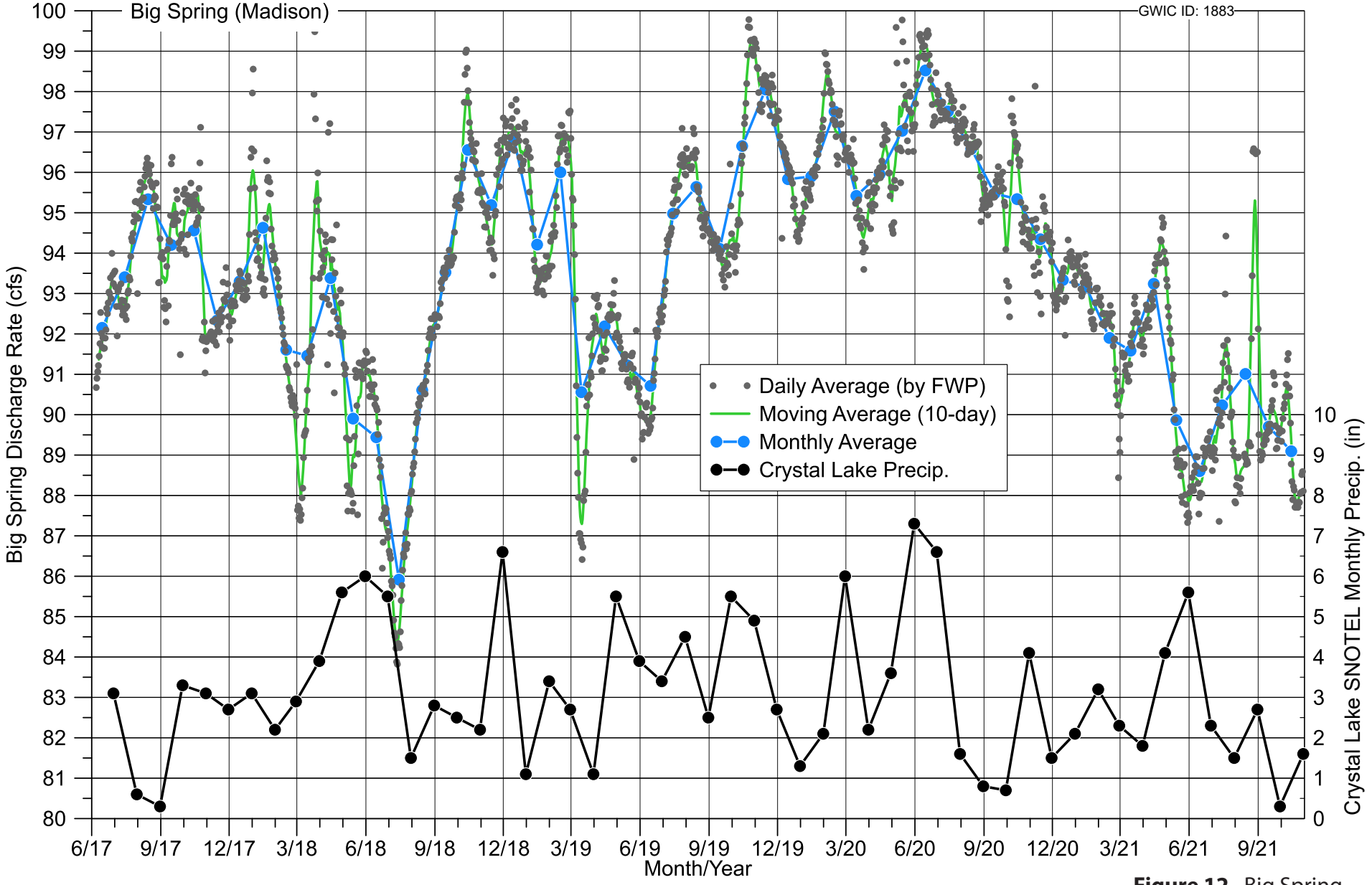


Figure 12. Big Spring

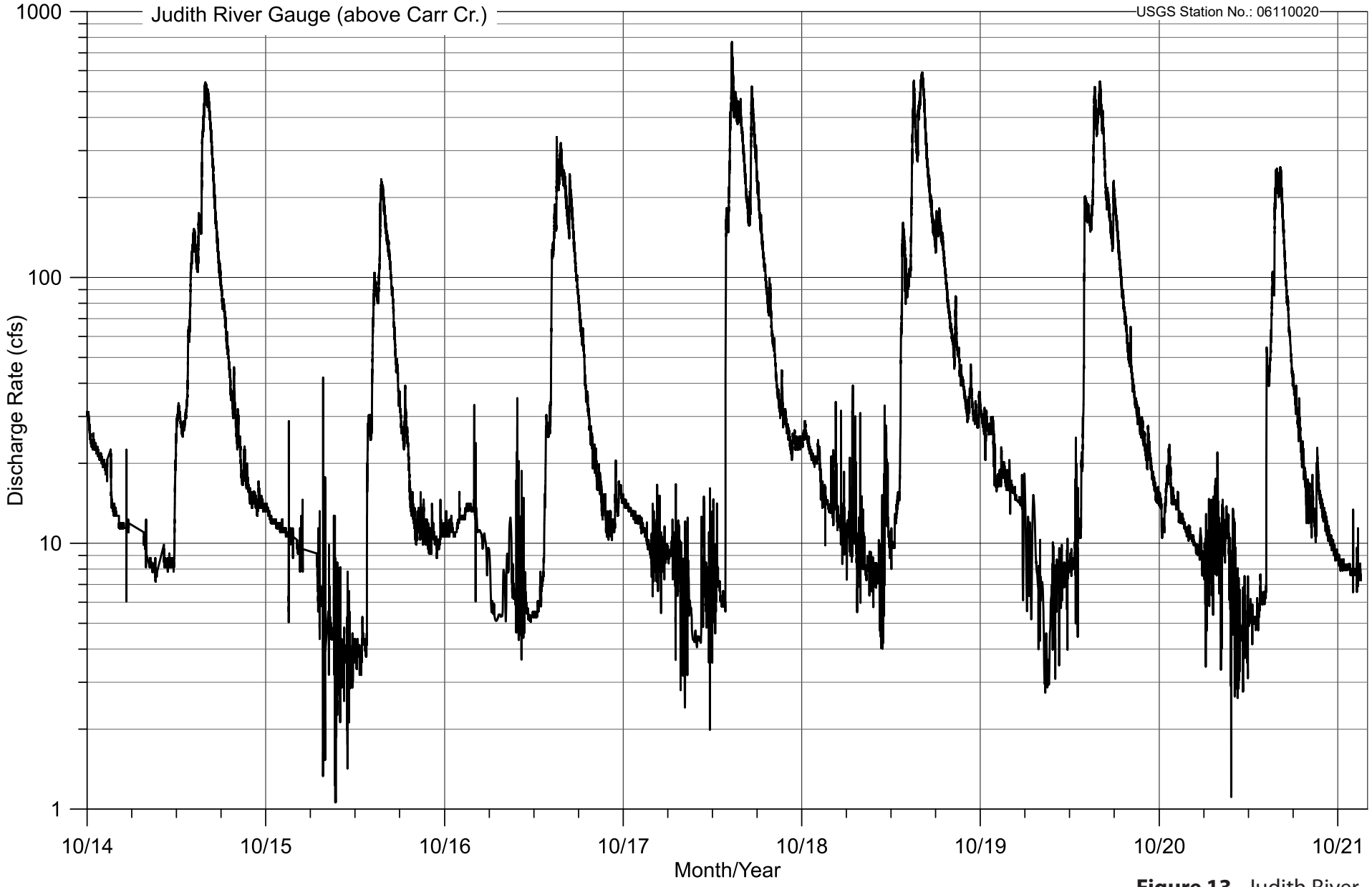


Figure 13. Judith River

3. WATER QUALITY

Water quality data were collected from the Osmundson Ranch and Peterson Ranch wells on July 8, 2021. Field parameters were measured at the time of sampling. Laboratory analyses for conventional water quality parameters were completed by Pace Analytical LLC in Sheridan, WY. Stable isotope and tritium analyses were completed at the University of Arizona, Environmental Isotope Laboratory, in Tucson, AZ. Laboratory reports are provided in **Appendix A**.

The Osmundson Ranch well is a converted wildcat oil well drilled in 1955 (**Figure 14**). The conversion to a water well was completed at the time of drilling. Documentation for the well is provided in **Appendix B**. Based on the information filed at the Montana Board of Oil and Gas Conservation (MBOGC), this well is producing groundwater from the Kibbey formation, which is within the Big Snowy Group (**Figure 15**). The well is flowing artesian and is producing groundwater from the depth interval between 610- and 800-ft below ground. The Madison Group rocks (Charles, Mission Canyon, and Lodgepole formations) underlie the Kibbey formation and are sealed off from contributing to the well production. Static water in the Madison Group formations is estimated to be at least 200- to 300-ft below ground surface, and therefore, would not result in artesian flow.

3.1 Field Parameters

Field parameters were measured in grab samples using a calibrated Horiba U52 multi-sensor (**Table 1**). Data collected from other Madison and Kootenai wells are included for comparison. These data were collected with the same instrument, but with discharge occurring continuously through a flow cell.

The Osmundson well is notably more mineralized and has lower pH than the other wells. The high oxygen concentration may be in part impacted by the aerated discharge out the top of the flowing artesian well. The Peterson Kootenai well is comparable but not identical to the CMRWA MW#1 well, which is also a Kootenai well, but located nearer to the recharge area. Both wells have low or no oxygen dissolved in the groundwater. By comparison, the Madison aquifer has significant dissolved oxygen and slightly higher mineral content.

Table 1. Field Parameters

Well ID	Osmundson	Peterson	CMRWA #2	CMRWA #3	CMRWA MW #1
Aquifer	Kibbey	Kootenai	Madison	Madison	Kootenai
Date	7/8/21	7/8/21	10/19/2016	11/5/2019	9/20/2016
Time	10:56 AM	12:28 PM	1:13 PM	9:51 AM	2:08 PM
Temp (C)	10.24	14	16.84	17.89	11.06
pH (s.u.)	6.83	7.51	7.54	7.17	8.26
ORP (Eh, V)	0.424	0.058	0.152	0.211	-0.047
SC (us/cm)	2140	475	598	732	292
Turb (NTU)	0.5	20.4	0.5	0.0	15
DO (mg/L)	8.37	0.00	4.45	4.43	0.44
ORP – oxidation-reduction potential; SC – specific conductance; Turb – turbidity; DO – dissolved oxygen					

3.2 Lab Parameters

Lab parameters are used for comparison of water quality among the wells. The Stiff Diagrams (**Figure 16**) illustrate major ion concentrations. The Osmundson well is a calcium sulfate dominated groundwater, which is most likely reflecting dissolved anhydrite that occurs commonly in the Kibbey formation. The magnitude of the calcium and sulfate is substantially greater than other wells, requiring a scale out to 25 milliequivalents per liter (meq/L). The Peterson well has similar major ion chemistry as the CMRWA MW#1 well.

The Piper Diagram (**Figure 17**) is a useful plot for graphically showing how different waters compare to one another. Peterson well water matches up reasonably close to the CMRWA MW#1 data, as both are producing Kootenai groundwater. The Osmundson well is significantly different from the other groundwaters, owing to the high calcium and sulfate concentrations.

Series plots (**Figure 18**) were found useful for comparing samples from several different locations to assess if they were sourced from the Madison aquifer.[7] The variables shown include the stable isotopes Carbon-13 and Sulphur-34, the saturation index of the mineral quartz, and the radionuclide tritium. Tritium is providing clear differentiation among the groundwaters. It is non-detectable in the CMRWA MW#1 and Peterson wells, and measured slightly over the detection limit in the Osmundson well. In contrast, tritium is measured at 3 TU[8] or greater in the Madison groundwater. The Osmundson well groundwater has similar carbon-13 and sulphur-34 concentrations as Madison groundwater. These similarities are likely reflecting that both formations contain significant marine carbonate rocks of similar age. The higher quartz saturation index for the Osmundson well may be caused by pore water equilibrium with quartz sandstone of the Kibbey formation.

7 Western Groundwater Services, LLC (2017) Judith Basin Spring Inventory Report, Central Montana Regional Water Authority, report to Great West Engineering, Inc.

8 TU symbolizes 'tritium units'. 1 TU = 1 ^{3}H atom per 10^{18} hydrogen atoms. In water it also equals 3.19 pCi/L.

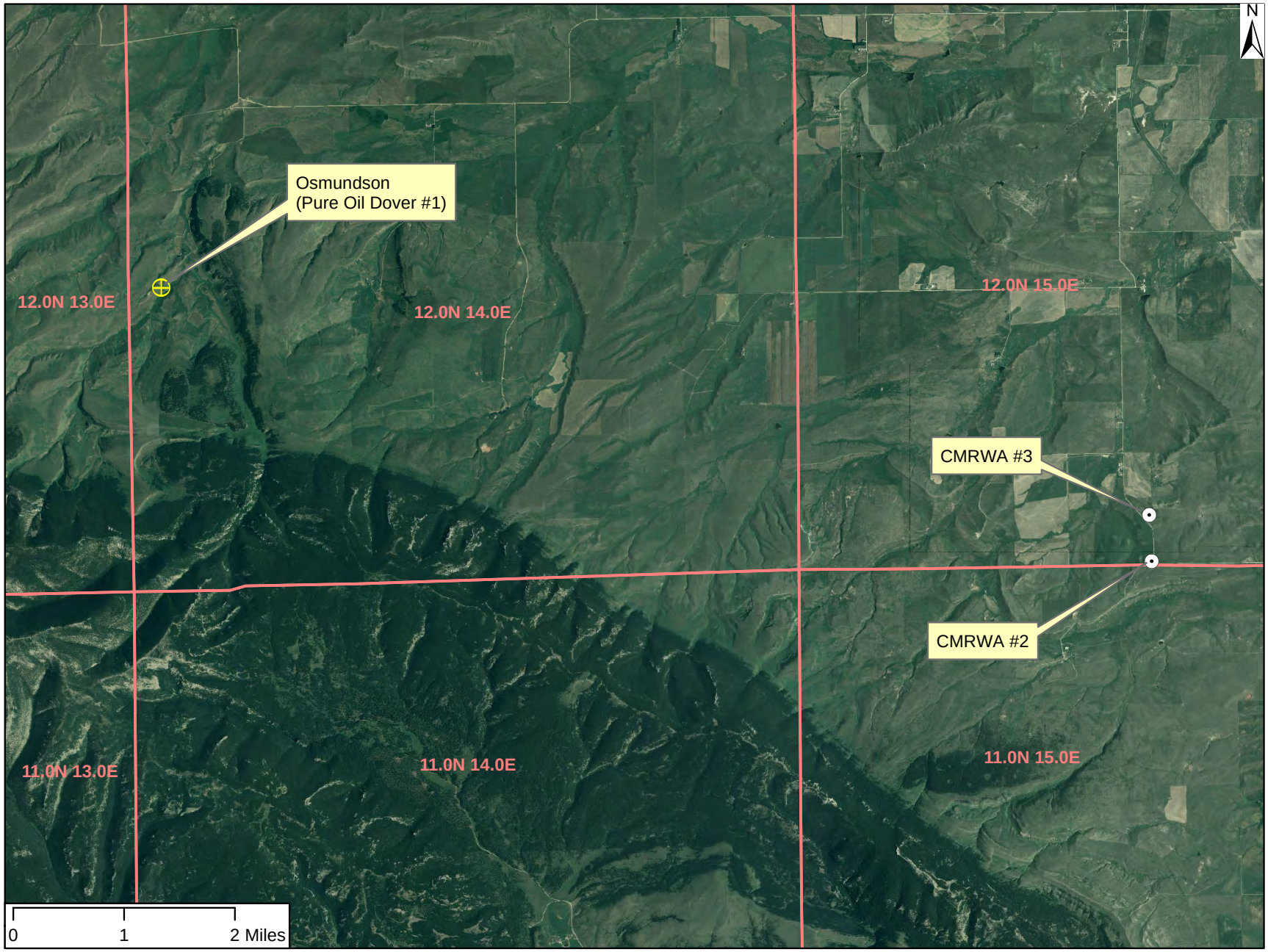


Figure 14. Osmundson Well Location Map

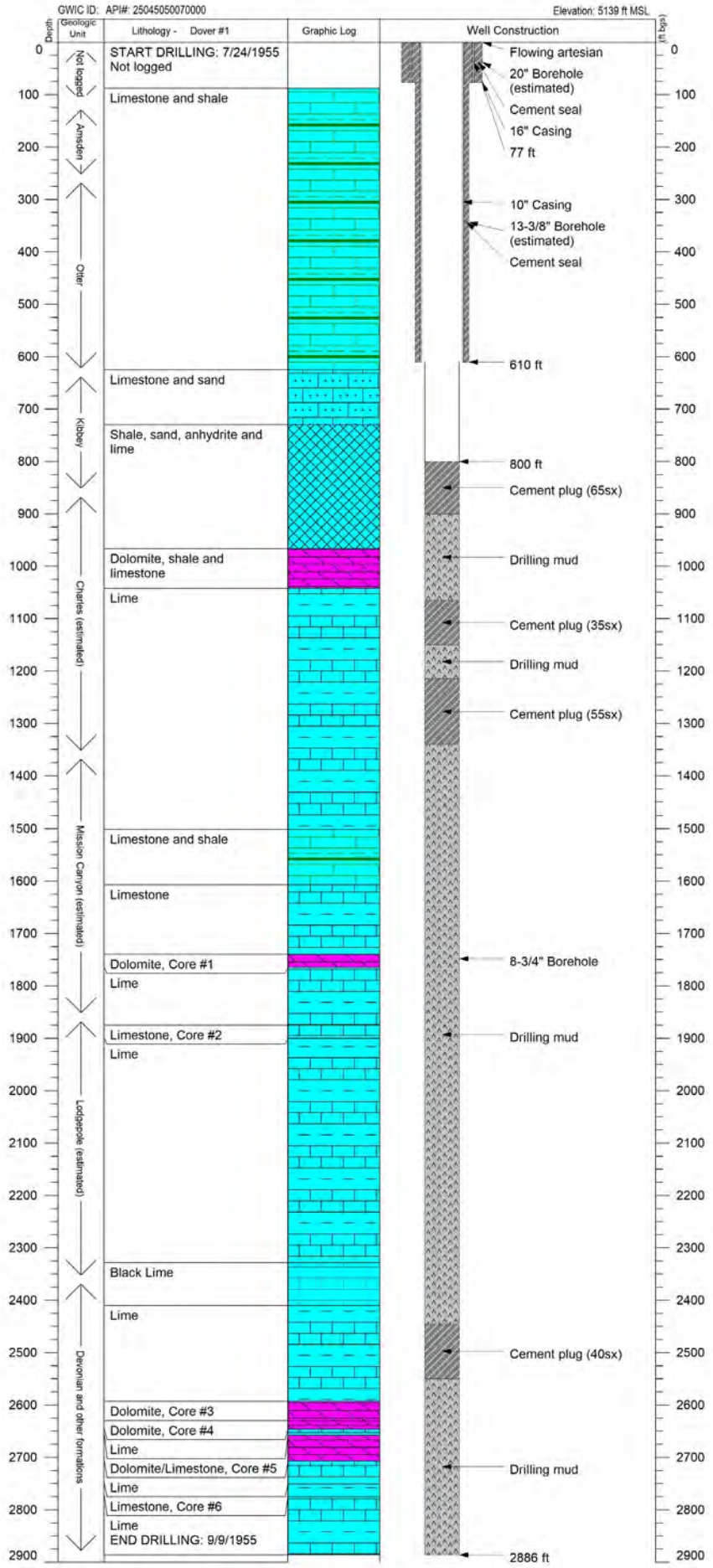
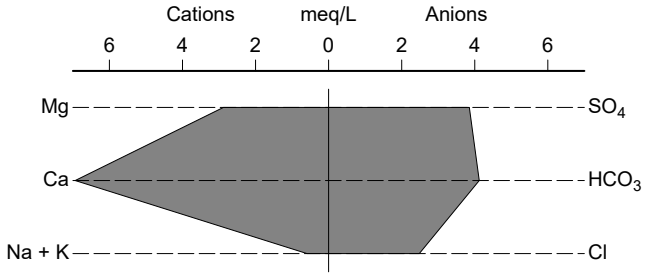
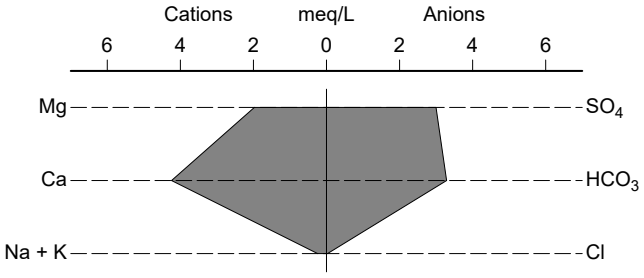


Figure 15. Osmundson Ranch Well Log

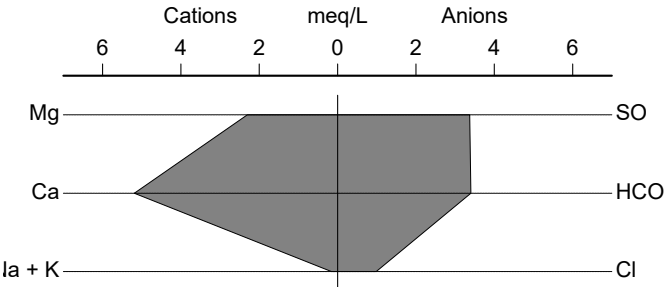
A. CMRWA #1



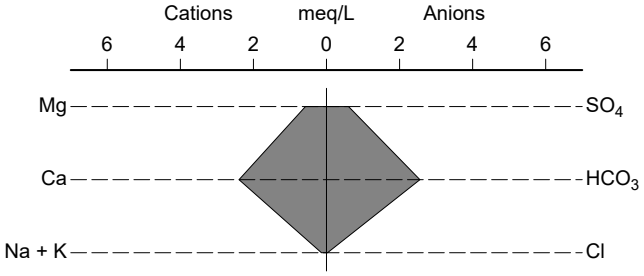
B. CMRWA #2



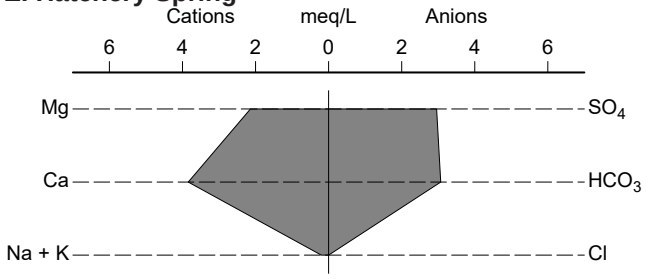
C. CMRWA #3



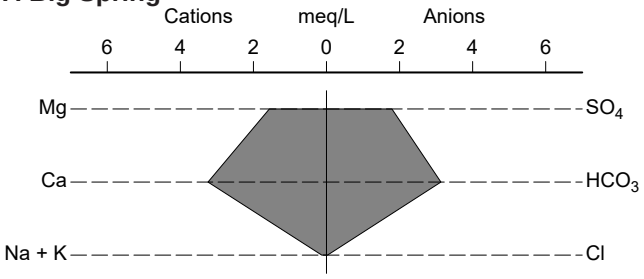
D. CMRWA MW#1



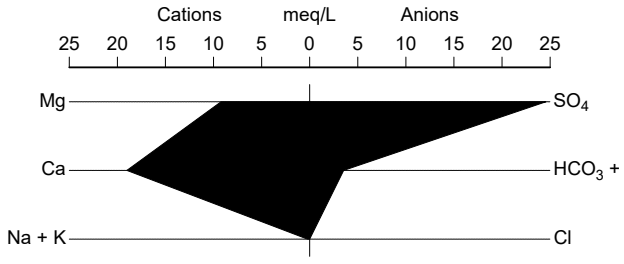
E. Hatchery Spring



F. Big Spring



G. Osmundson



H. Peterson

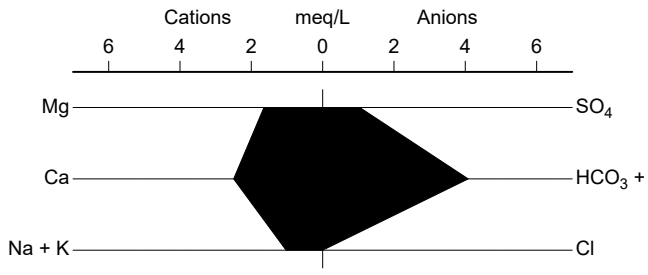


Figure 16. Stiff Diagrams

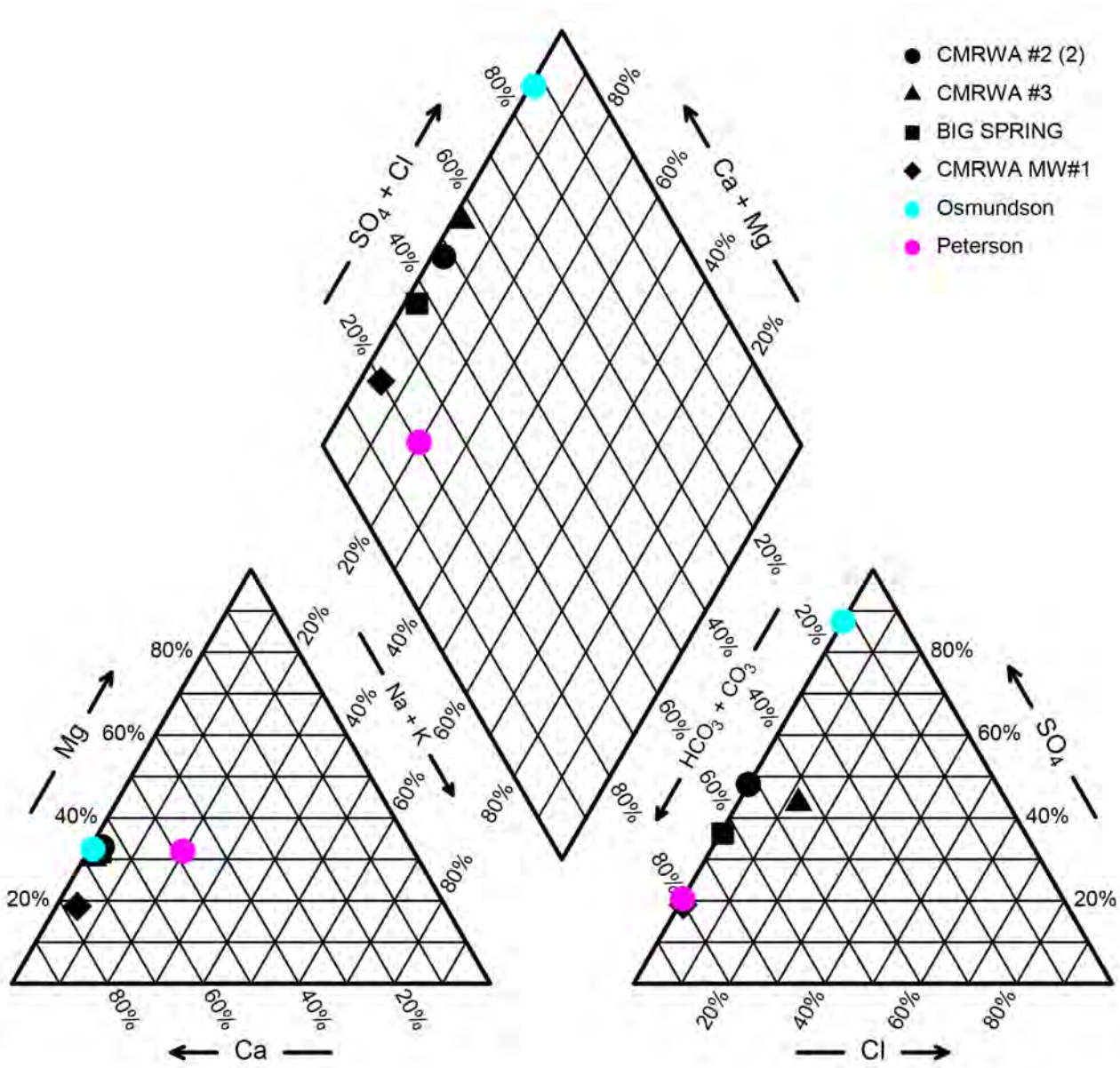


Figure 17. Piper Diagram

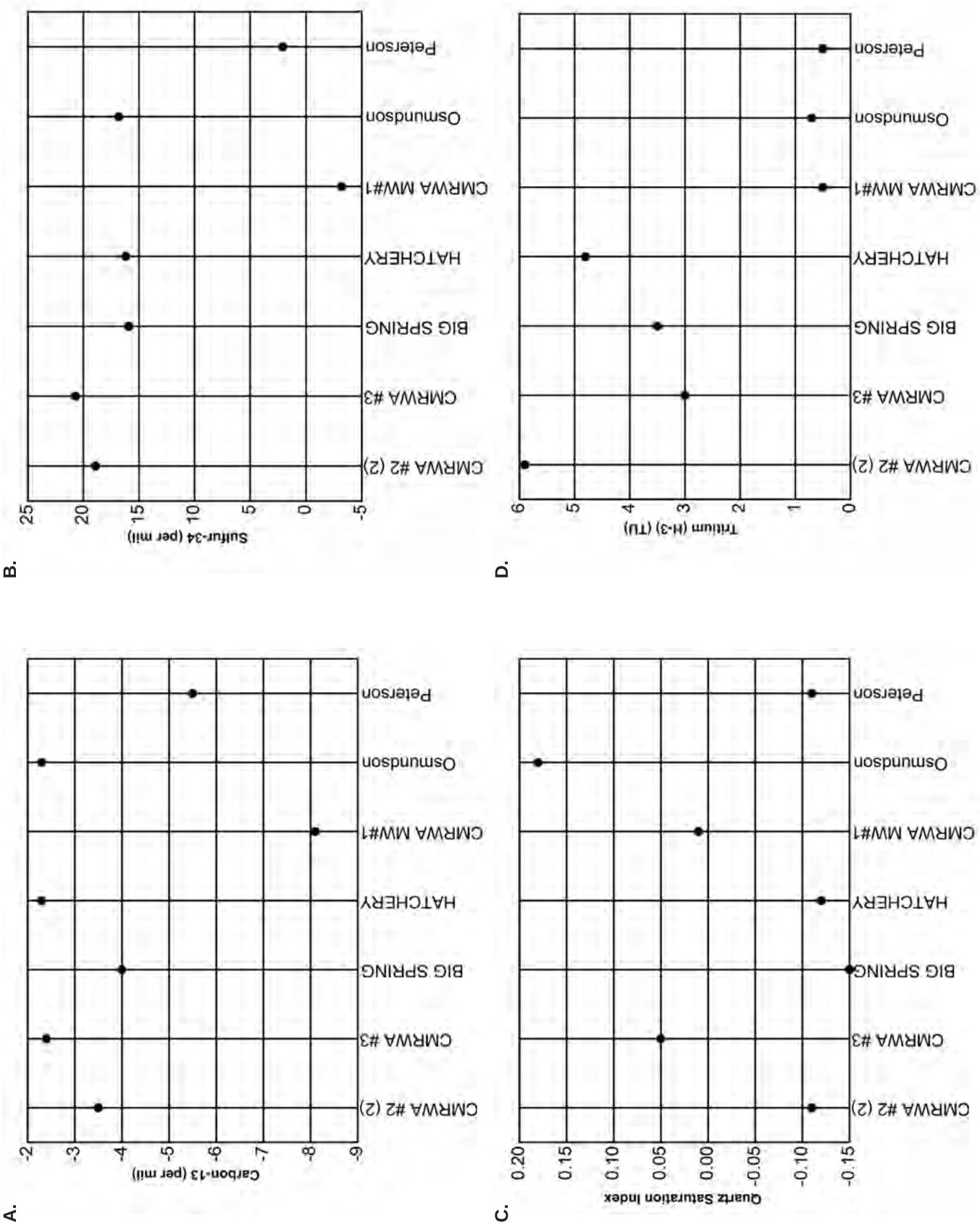


Figure 18. Series Plots

APPENDIX A – LAB WATER QUALITY DATA

Pace Analytical® Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Date: 7/22/2021

CLIENT: Western Groundwater Services
Project:
Lab Order: S2107226

CASE NARRATIVE

Report ID: S2107226001

Samples OR 070821 MC and PR 070821 MC were received on July 14, 2021.

All samples were received and analyzed within the EPA recommended holding times, except those noted below in this case narrative. Samples were analyzed using the methods outlined in the following references:

"Standard Methods For The Examination of Water and Wastewater", approved method versions
Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition
40 CFR Parts 136 and 141
40 CFR Part 50, Appendices B, J, L, and O
Methods indicated in the Methods Update Rule published in the Federal Register Friday, May 18, 2012
ASTM approved and recognized standards

All Quality Control parameters met the acceptance criteria defined by EPA and Pace Analytical (Formerly Inter-Mountain Laboratories) except as indicated in this case narrative.

Qualifiers by sample

S2107226-001 - General Parameters/Nitrogen, Nitrate (As N) - Holding times for preparation or analysis exceeded
S2107226-001 - General Parameters/Phosphorus, Orthophosphate as P - Holding times for preparation or analysis exceeded
S2107226-002 - General Parameters/Nitrogen, Nitrate (As N) - Holding times for preparation or analysis exceeded
S2107226-002 - General Parameters/Phosphorus, Orthophosphate as P - Holding times for preparation or analysis exceeded

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Pace Analytical
Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Groundwater Services
6595 Bear Claw Lane
Bozeman, MT 59715

Date Reported: 7/22/2021
Report ID: S2107226001

Work Order: S2107226
Collection Date: 7/8/2021 11:50:00 AM
Date Received: 7/14/2021 10:53:00 AM
Sampler:
Matrix: Water
COC: 190506

Project:
Lab ID: S2107226-001
Client Sample ID: OR 070821 MC

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
General Parameters						
pH	8.0	0.1		s.u.	07/16/2021 12:11 ACE	SM 4500 H B
Electrical Conductivity	2000	5		µmhos/cm	07/16/2021 12:11 ACE	SM 2510B
Total Dissolved Solids (180)	2150	10		mg/L	07/14/2021 15:06 SMA	SM 2540
Solids, Total Dissolved (Calc)	1790	10		mg/L	07/22/2021 09:00 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	179	5		mg/L	07/16/2021 12:11 ACE	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1410	1		mg/L	07/22/2021 09:00 JJ	SM 2340B
Nitrogen, Nitrate (As N)	ND	0.5	H	mg/L	07/14/2021 14:34 AB	EPA 300.0
Phosphorus, Orthophosphate as P	ND	0.5	H	mg/L	07/14/2021 14:34 AB	EPA 300.0
Sulfide	ND	0.01		mg/L	07/15/2021 10:05 KB	HACH 8131
Total Organic Carbon	ND	1		mg/L	07/20/2021 16:44 AB	SM 5310B
Sulfide as H2S	ND	0.01		mg/L	07/15/2021 10:05 KB	HACH 8131
Anions						
Alkalinity, Bicarbonate as HCO3	219	5		mg/L	07/16/2021 12:11 ACE	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/16/2021 12:11 ACE	SM 2320B
Chloride	ND	1		mg/L	07/14/2021 14:34 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	07/16/2021 12:11 ACE	SM 4500FC
Sulfate	1180	5		mg/L	07/16/2021 14:15 AB	EPA 300.0
Cations						
Calcium	381	1		mg/L	07/15/2021 17:20 SRH	EPA 200.7
Magnesium	112	1		mg/L	07/15/2021 17:20 SRH	EPA 200.7
Potassium	2	1		mg/L	07/15/2021 17:20 SRH	EPA 200.7
Sodium	4	1		mg/L	07/15/2021 17:20 SRH	EPA 200.7
Dissolved Metals						
Aluminum	ND	0.05		mg/L	07/15/2021 17:20 SRH	EPA 200.7
Iron	ND	0.05		mg/L	07/15/2021 17:20 SRH	EPA 200.7
Manganese	ND	0.02		mg/L	07/15/2021 17:20 SRH	EPA 200.7
Silicon	5.7	0.1		mg/L	07/15/2021 17:20 SRH	EPA 200.7
Strontium	13.0	0.02		mg/L	07/15/2021 17:20 SRH	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- D Report limit raised due to dilution
- E Value above quantitation range
- G Analyzed at IML Gillette laboratory
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by another laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- U Analyte below method detection limit
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Pace Analytical
Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Groundwater Services
6595 Bear Claw Lane
Bozeman, MT 59715

Date Reported: 7/22/2021
Report ID: S2107226001

Work Order: S2107226
Collection Date: 7/8/2021 1:10:00 PM
Date Received: 7/14/2021 10:53:00 AM
Sampler:
Matrix: Water
COC: 190506

Project:
Lab ID: S2107226-002
Client Sample ID: PR 070821 MC

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
General Parameters						
pH	8.2	0.1		s.u.	07/16/2021 12:37 ACE	SM 4500 H B
Electrical Conductivity	469	5		µmhos/cm	07/16/2021 12:37 ACE	SM 2510B
Total Dissolved Solids (180)	280	10		mg/L	07/14/2021 15:07 SMA	SM 2540
Solids, Total Dissolved (Calc)	270	10		mg/L	07/22/2021 09:00 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	204	5		mg/L	07/16/2021 12:37 ACE	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	206	1		mg/L	07/22/2021 09:00 JJ	SM 2340B
Nitrogen, Nitrate (As N)	ND	0.5	H	mg/L	07/14/2021 14:47 AB	EPA 300.0
Phosphorus, Orthophosphate as P	ND	0.5	H	mg/L	07/14/2021 14:47 AB	EPA 300.0
Sulfide	ND	0.01		mg/L	07/15/2021 10:11 KB	HACH 8131
Total Organic Carbon	ND	1		mg/L	07/20/2021 17:11 AB	SM 5310B
Sulfide as H2S	ND	0.01		mg/L	07/15/2021 10:11 KB	HACH 8131
Anions						
Alkalinity, Bicarbonate as HCO3	249	5		mg/L	07/16/2021 12:37 ACE	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/16/2021 12:37 ACE	SM 2320B
Chloride	ND	1		mg/L	07/14/2021 14:47 AB	EPA 300.0
Fluoride	0.6	0.1		mg/L	07/16/2021 12:37 ACE	SM 4500FC
Sulfate	50	5		mg/L	07/14/2021 14:47 AB	EPA 300.0
Cations						
Calcium	50	1		mg/L	07/15/2021 17:22 SRH	EPA 200.7
Magnesium	20	1		mg/L	07/15/2021 17:22 SRH	EPA 200.7
Potassium	6	1		mg/L	07/15/2021 17:22 SRH	EPA 200.7
Sodium	20	1		mg/L	07/15/2021 17:22 SRH	EPA 200.7
Dissolved Metals						
Aluminum	ND	0.05		mg/L	07/15/2021 17:22 SRH	EPA 200.7
Iron	1.96	0.05		mg/L	07/15/2021 17:22 SRH	EPA 200.7
Manganese	0.03	0.02		mg/L	07/15/2021 17:22 SRH	EPA 200.7
Silicon	3.4	0.1		mg/L	07/15/2021 17:22 SRH	EPA 200.7
Strontium	1.03	0.02		mg/L	07/15/2021 17:22 SRH	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
D	Report limit raised due to dilution
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analyte below method detection limit
C	Calculated Value
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

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Geosciences Department
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FINAL DATA REPORT

UA EIL Project # WA1252

15 September 2021

Data report for:

Mark Cunnane
Western Groundwater Services
6595 Bear Claw Lane
Bozeman, MT 59715

406-585-5947
markc@westerngroundwaterservices.com

REPORT OF ANALYSES

2 measurements of $\delta^{18}O$ ‰ and $\delta^{2}H$ ‰ in H_2O
2 measurements of $\delta^{34}S$ ‰ in water sulfate (SO_4)
2 measurements of $\delta^{13}C$ ‰ in Dissolved Inorganic Carbon (DIC) in H_2O
2 measurements of tritium in H_2O

			O and H isotopes in water			C isotopes in DIC		S isotopes in water sulfate		Tritium			
Sample name	**Date**	**Time**	**W#**	**$\delta^{18}O$ ‰ VSMOW**	**$\delta^{2}H$ ‰ VSMOW**	**D#**	**$\delta^{13}C$ ‰**	**S#**	**$\delta^{34}S$ ‰ CDT**	**AT#**	**Tritium (TU) at collection date**	**Error (TU)**	
PR 070821 MC	7/8/2021	13:09	W78533	-17.7	-133.8	D3683	-5.5	S18098	2.1	AT-6851	*< 0.5 detection limit*		***<--PETERSON RANCH***
OR 070821 MC	7/8/2021	11:50	W78534	-17.3	-134.2	D3684	-2.3	S18099	16.8	AT-6852	0.7	0.2	***<--OSMUNDSON RANCH***
		Analytical precision, 1-sigma		0.1	1.0		0.2		0.2	Detection Limit, 9.5 x enrichment, 1500 minutes counting 0.5 TU			

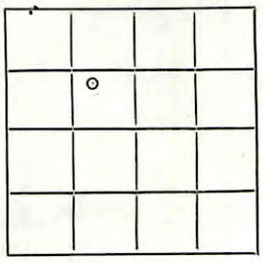
Explanation of tritium data: The detection limit, 0.5 TU, is calculated as 0 + 2 sigma for low-counting samples, and applies for 10-fold enrichment and 1500 minutes of counting. Lower limits are possible for higher enrichment factors.

A sample with a mean calculated TU value between 0 and 1 sigma , say 0.20 ± 0.35 TU, is reported thus: <0.9 TU (= 0.2 + 2 x 0.35). A sample with a mean calculated TU value between 1 and 2 sigma , say 0.51 ± 0.38, is reported thus: <1.3 (Apparent 0.5), where 1.3 = 0.51 + 2 x 0.38, rounded. Samples with calculated TU values greater than 2 are reported thus: 1.1 ± 0.4 TU.

David Dettman
Research Scientist
Director, Environmental Isotope Laboratory

APPENDIX B – OSMUNDSON WELL DATA

LOCATE WELL CORRECTLY



Form No. 4
(Gen. Rule 206.3 & 231)

RECEIVED
OCT 20 1955
OIL AND GAS CONSERVATION COMMISSION
OF THE STATE OF MONTANA

(SUBMIT IN TRIPLICATE)
TO
OIL AND GAS CONSERVATION COMMISSION
OF THE STATE OF MONTANA
BILLINGS OR SHELBY

RECEIVED
OCT 20 1955
OIL AND GAS CONSERVATION COMMISSION
OF THE STATE OF MONTANA - BILLINGS

LOG OF WELL

Company The Pure Oil Company Lease J.W. Dover Well No. 1

Address P.O. Box 1597, Billings, Montana Field (or Area) Wildcat

The well is located 1642 ft. from (N) (S) line and 1829 ft. from (E) (W) line of Sec. SE¼ NW¼

Sec. 19; T. 12 N; R. 14 E; County Judith Basin; Elevation K.B. 5148 Gr. 5139 (D.F., R.B. or G.L.)

Commenced drilling July 24, 19 55; Completed September 9, 19 55

The information given herewith is a complete and correct record of the well. The summary on this page is for the condition of the well at the above date.

Completed as Dry Hole (oil well, gas well, dry hole)

Signed T. L. Washuton JB

Title Division Chief Production Clerk

Date October 12, 1955

IMPORTANT ZONES OF POROSITY

(denote oil by O, gas by G, water by W; state formation if known)

From 612'	to 830'	Kibby - W	From 2527	to 2760	Devonion - W
From 1320'	to 1370'	Mission Canyon	From 2790	to 2850	Devonion - W
From 1540'	to 1600'	Mission Canyon	From	to	
From 1780'	to 1860'	Mission Canyon	From	to	

CASING RECORD

Size Casing	Weight Per Ft.	Grade	Thread	Casing Set	From	To	Sacks of Cement	Cut and Pulled from
16"	65#	H-40	8-V	65'	77'	Surface	175	
10-3/4"	40.5#	J-55	8-V	610'	604'	Surface	315	

TUBING RECORD

Size Tubing	Weight Per Ft.	Grade	Thread	Amount	Perforations

COMPLETION RECORD

Rotary tools were used from Zero to 2886

Cable tools were used from to

Total depth 2886 ft.; Plugged back to 2445 T.D.; Open hole from to

PERFORATIONS			ACIDIZED, SHOT, SAND FRACED, CEMENTED			
Interval From	Interval To	Number and Size and Type	Interval From	Interval To	Amount of Material Used	Pressure
			2550	2445	40 sx cement	
			1340	1215	55 sx cement	
			1150	1065	35 sx cement	
			900	800	65 sx cement	

(If P&A show plugs above)

INITIAL PRODUCTION

Well is producing from Dry Hole (pool) formation.

I. P. barrels of oil per hours (pumping or flowing)

Mcf of gas per hours.

barrels of water per hours, or % W.C.

(OVER)

15M—5-55

19 12N 14E

INITIAL PRODUCTION—(Continued)

Initial 10-day average production _____ (bbl./day) (if taken)
Pressures (if measured): Tubing _____ psi flowing; _____ psi shut-in
Casing _____ psi flowing; _____ psi shut-in
Gravity _____ ° API (corrected to 60° F.)

DRILL STEM TESTS

D.S.T. No.	From	To	Tool Open (Min.)	Shut-In	F.P.	S.I.P.	Recovery	Cushion
1	2802	2809	68 min.	30	I.F. 210 F.F. 1115	1160	2061' Clear water	
2	2555	2607	30 min	30	I.F. 255 F.F. 785	810	1780' Clear water	

LOGS RUN

Type	Intervals	
	From	To
Lane-Wells Electric Log	604'	2886'

FORMATION RECORD

From	To	SAMPLE AND CORE NO. AND DESCRIPTION	Top of Formation
0	88	Surface	
88	625	Limestone and shale	
625	730	Limestone and sand	
730	967	Shale, sand, Anhydrite and lime	
967	1042	Dolomite, shale and limestone	
1042	1501	Lime	
1501	1607	Limestone and shale	
1607	1740	Limestone	
1740	1765	Core No. 1 - See below.	
1765	1875	Lime	
1875	1900	Core No. 2-See attached sheet.	
1900	2328	Lime	
2328	2410	Black Lime	
2410	2593	Lime	
2593	2630	Core No. 3 - See attached sheet.	
2630	2646	Core No. 4 - See attached sheet.	
2646	2658	Lime	
2658	2707	Core No. 5 - See attached sheet.	
2707	2751	Lime	
2751	2775	Core No. 6 - See attached sheet.	
2775	2886	Lime	
	2886	Total Depth	

Core No. 1 - 1740' to 1765', recovered 20'.

5' Dolomite, tan, firm to medium Xlyn, good porosity.
2' Dolomite, tan, very finely Xlyn. Slight to fair porosity.
7' Limestone, dense, fossiliferous, some vugular porosity.
6' Dolomite, grey totan very finely Xlyn, tight. No show of oil or gas.

19-12N-14E

Core No. 2 - 1875' to 1900', recovered 21 feet.

16'- Limestone, white to buff and tan, dense, fossiliferous, with packets of brown, very finely Xlyn limestone. No shows.
5'- Limestone, reddish brown, slightly fossiliferous, dense and shaly. No. shows.

Core No. 3 - 2593 to 2630, 37 feet, recovered 20 feet.

3'- Dolomite, tan and brown, dense, with many large vugs.
6 1/2'- Dolomite, medium to dark gray, slightly pyritic, dense.
1 1/2'- Dolomite, brown to dark brown, hacky fractures, much dead oil stain.
1 1/2'- Dolomite, buff to brown, gray, finely Xlyn, fair vug. porosity.
4' - Dolomite, dark gray to black, platy dense.
1 1/2' - Dolomite, brown, dense, fractured, much dead oil stain.
2' - Dolomite, medium to dark gray, platy shaly.

Core No. 4 - 2630' to 2646', 16 feet. Recovered 7'

3 1/2' - Dolomite, gray, sub lith, dense, some dead oil stain.
1' - Dolomite, white, buff tan, dense, slight vug. porosity, hacky fracture sub. lith.
2 1/2' - Dolomite, dark brown, sub lith. to very finely xlyn, shaly, slight to fair, vug. porosity.

Core No. 5 - 2658' to 2707', 49 feet. Recovered 20'.

14' - Dolomite, light gray to gray, dense to very finely xlyn, with some porosity; vuggy. One foot shale, gray green, limy, waxy.
5' - Limestone, buff to white and brown, shaly, very finely xlyn to dense. Few small vugs.

Core No. 6 - 2751' to 2775', 24 feet. Recovered 20'6".

3' - Limestone, white to buff, chalky and soft.
17' 6" - Limestone, dolomitic, tan to brown, very finely crystalline to dense. Some vugs, fair porosity.