

**First Semi-Annual 2017 Groundwater
Monitoring and Reclamation Progress Report
for the
State 1-18 Lease Site
Lincoln County, Colorado
COGCC Case 4320**

Prepared for:

Mr. Jason Kosola
Colorado Oil and Gas Conservation Commission
1120 Lincoln Street, Suite 801
Denver, Colorado 80203

And

Mr. Peter Fiorini
Ritchie Exploration, Inc.
8100 East 22nd Street North
Building 700
Wichita, Kansas 67226-2328



Nicholson GeoSolutions, LLC
3433 East Lake Drive
Centennial, CO 80121

May 2017

1.0 INTRODUCTION

Nicholson GeoSolutions LLC was retained by Ritchie Exploration, Inc. (Ritchie) to continue groundwater monitoring and reclamation activities at the State 1-18 Lease, a formerly active oil well site located in Lincoln County, Colorado. The site is located on the floodplain of Big Sandy Creek near Limon, Colorado in the SE $\frac{1}{4}$ of the SW $\frac{1}{4}$, Section 18, T9S, R56W. The Big Sandy Creek aquifer is classified as a protected groundwater basin.

The site formerly consisted of one wellhead, a production facility, a lined evaporation pond, and a tank battery with two 400-bbl storage tanks. Produced water from the well was discharged into the evaporation pond until August 2007, at which time the well was shut in. In accordance with Colorado Oil and Gas Conservation Commission (COGCC) regulations, a release of salt water from the evaporation pit was reported using COGCC Form 19 on August 30, 2007 and a Site Investigation and Remediation Workplan (COGCC Form 27) was prepared and submitted.

A series of groundwater monitoring wells were installed and first sampled at the site in September and October 2007. The frequency of groundwater monitoring was reduced to semi-annual starting with the April 2012 sampling event with the approval of the COGCC. In addition, analysis of BTEX was discontinued.

This report provides the results of groundwater monitoring conducted at the site on April 24th, 2017 and compares these results to previous sampling results. In addition, this report provides an assessment of the progress of revegetation efforts at the site.

2.0 GROUNDWATER MONITORING

2.1 Field Procedures

Groundwater samples were collected from three wells (MW-3, MW-4, and MW-12) on April 24th, 2017. Prior to sampling, water levels were measured in all site monitoring wells using an electronic water level indicator. The site layout and the locations of the monitoring wells are shown on Figure 1.

Samples were collected using a new polyethylene bailer for each well. Prior to sampling, at least three casing volumes of water were removed from the well by bailing. Measurements of pH, temperature, and specific conductance were made at 1.5-gallon intervals during well purging. Purging continued until at least three casing volumes of water had been removed and consecutive readings of pH, temperature, and specific conductance were within 10 percent, indicating that all stagnant water had been removed from the well casing and that fresh groundwater was present for sampling.

Samples were collected in appropriate pre-preserved containers supplied by the laboratory and placed on ice in a cooler. All samples were shipped to Environmental Science Corporation (ESC) Lab Sciences in Mt. Juliet, Tennessee for analysis of sulfate and chloride by EPA Method 9056, and Total Dissolved Solids (TDS) by EPA Method SM 2540C.

2.2 Water Levels and Aquifer Flow

Water level data are provided in Table 1 and shown on Figure 1. Groundwater flow direction at the site is generally to the east-southeast.

Table 1 Water Level Elevations

Well ID	Elevation of Top of PVC Casing (feet above mean sea level)	Depth to Water (feet below ground surface)	Elevation of Groundwater Surface (feet above mean sea level)
MW-1	5285.20	12.78	5272.42
MW-3	5283.81	12.83	5270.98
MW-4	5282.63	12.13	5270.50
MW-5	5281.93	11.98	5269.95
MW-6	5282.58	12.14	5270.44
MW-8	5286.38	15.06	5271.32
MW-9	5284.48	12.82	5271.66
MW-11	5281.98	11.70	5270.28
MW-12	5283.64	11.64	5272.00

2.3 Conductivity, pH, and Temperature Measurements

Table 2 presents measurements of conductivity, pH, and temperature collected during sampling. Conductivity in well MW-4 slightly exceeded the background (upgradient) value of 2,930 micromhos/centimeter ($\mu\text{mhos/cm}$) measured in well MW-12.

Table 2 Field Parameters Measured During Sampling

Well ID	pH (Standard Units)	Specific Conductance ($\mu\text{mhos/cm}$)	Temperature (° Celsius)
MW-3	7.57	2,840	12.1
MW-4	7.76	3,260	11.9
MW-12 (upgradient)	7.52	2,930	12.3

2.4 Analytical Results

Analytical results for groundwater samples collected during this sampling event are provided in Table 3 and shown on Figure 2. The laboratory data report is included in Appendix A.

Table 3 Groundwater Analytical Results – April 24th, 2016

Well ID	Chloride (mg/l)	Sulfate (mg/l)	TDS (mg/l)
MW-3	35.1	778	1,130
MW-4	138	846	1,630
MW-12 (background)	29.6	850	1,290
COGCC Allowable Concentration	37.0 ¹	1,062.5 ¹	1,612.5 ¹

¹Allowable concentration is 1.25 times the background concentration
 Bold values exceed allowable concentrations

Background (upgradient) groundwater conditions are represented by well MW-12. Chloride was reported at 29.6 milligrams per liter (mg/l) and TDS at 1,290 mg/l for the background well for this sampling event, similar to previous sampling events. Sulfate was reported at 850 mg/l.

Chloride exceeded the COGCC allowable concentration of 37.0 mg/l (1.25 times the background concentration measured in well MW-12) in well MW-4. Chloride in well MW-4 was reported at 138 mg/l as compared to 46.2 mg/l for the previous sampling event conducted in October 2016. Chloride in well MW-3 decreased from 41.8 mg/l to 35.1 mg/l since the previous sampling event.

TDS was reported at 1,130 mg/l in well MW-3, similar to previous results and below the COGCC allowable limit of 1,612.5 mg/l. TDS in well MW-4 was 1,630 mg/l, slightly above the allowable limit. Sulfate was below the allowable limit for wells MW-3 and MW-4.

Table 4 provides a comparison of chloride concentrations for the two wells with historic chloride concentrations above the COGCC allowable concentration at the site. Chloride has dropped by 97% in well MW-3 and by 91% in well MW-4 since use of the evaporation pit ceased in August 2007.

Table 4 Comparison of Chloride Results for Affected Wells

Well ID	Initial Concentration (mg/l)¹	Current Concentration (mg/l)	Percent Change
MW-3	1,230	35.1	-97%
MW-4	1,470	138	-91%

¹Wells MW-3 and MW-4 were first sampled in October 2007

2.5 Data Quality Review

A data quality review was conducted using the quality assurance report supplied by ESC and standard EPA data validation guidelines. All analyses were conducted within the recommended holding times, and all method blank results were reported as not detected. All Laboratory Control Sample (LCS), surrogate, and Matrix Spike/Matrix Spike Duplicate (MS/MSD) recoveries were within the laboratory control limits.

All results are usable for the intended purposes.

3.0 Reclamation Progress

Inspection of the site and assessment of the reclamation progress was performed on April 24th, 2016. Appendix B provides photographs of the vegetative cover at the site.

The inspection showed that the overall vegetative coverage was similar to the last inspection conducted in October 2016. The vegetative cover was mostly grasses and low-growing forbs, with some low-growing vine weed but little to no active Koshia weed.

Overall coverage was estimated to be about 90-100% on the former wellhead area and the former salt-impacted area. The coverage over the former evaporation pit and process area was about 80-100% in the northern third of the area and 90-100% over the southern two-thirds. No significant bare areas were noted.

4.0 SUMMARY AND RECOMMENDATIONS

4.1 SUMMARY

For the April 2017 sampling event, chloride exceeded the COGCC allowable concentration of 37 mg/l in well MW-4 (138 mg/l). Chloride in well MW-3 decreased from 41.8 mg/l to 35.1 mg/l for this sampling event.

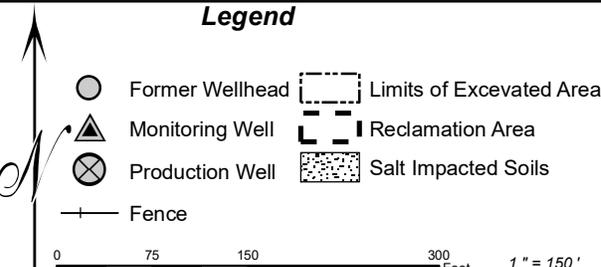
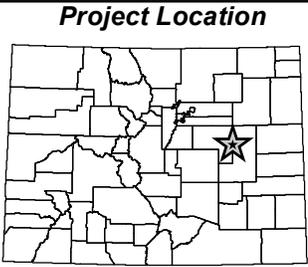
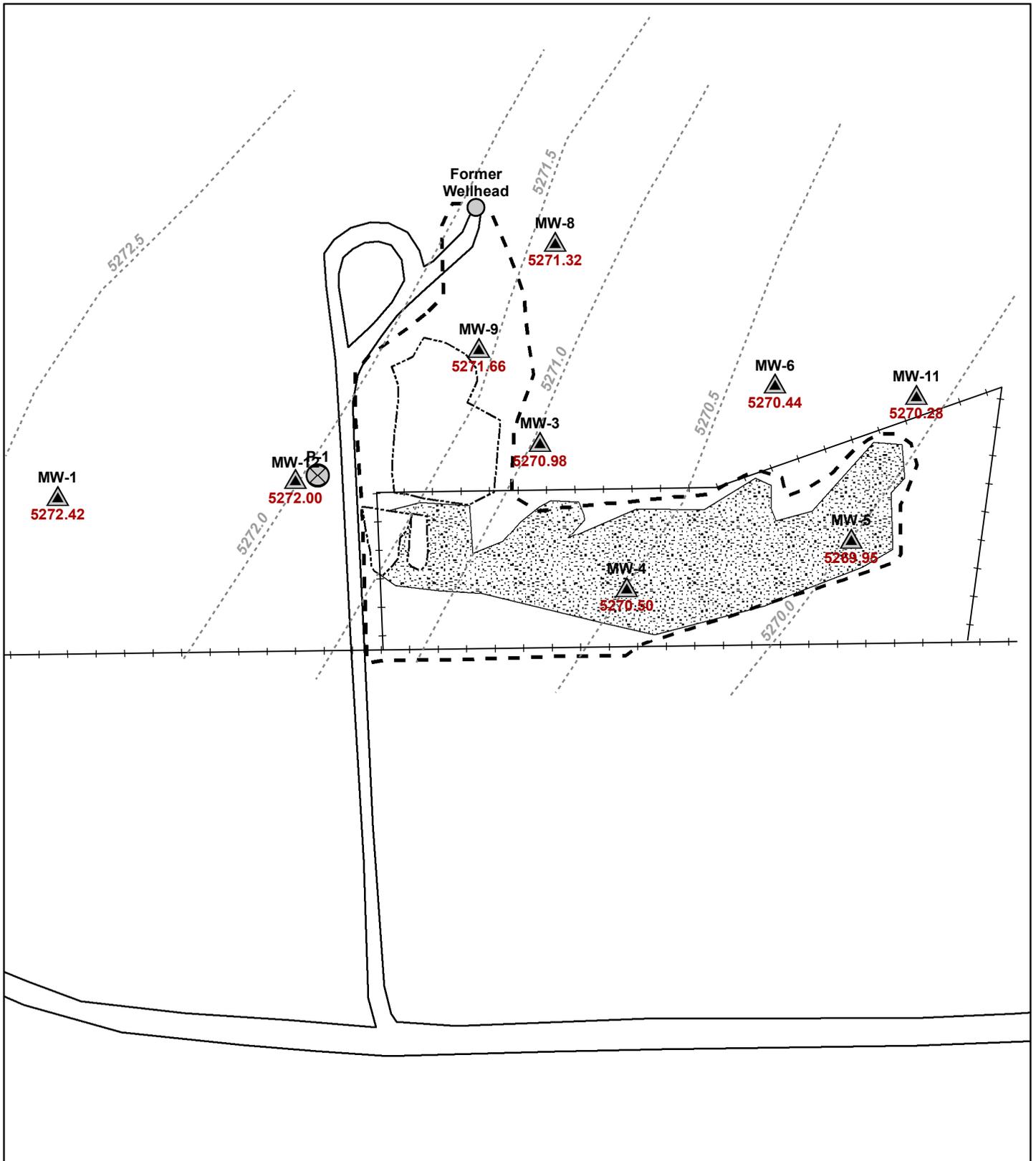
TDS was reported at 1,130 mg/l and 1,630 mg/l in wells MW-3 and MW-4, similar to previous results. The value of 1,630 is slightly above the COGCC allowable limit of 1,612.5 mg/l. Sulfate was below the COGCC allowable concentration of 1,062.5 mg/l for wells MW-3 and MW-4.

Overall vegetative coverage of the site is similar to that observed during the last inspection conducted in October 2016 and consists mainly of grasses and low-growing forbs. Overall coverage ranges from 80-100% with no significant bare areas.

4.2 RECOMMENDATIONS

It is recommended that sampling of the remaining impacted well on site (MW-4), previously impacted well MW-3, and background well MW-12 be continued on a semi-annual basis until chloride concentrations return to levels below the allowable concentration in well MW-4. At that time, sampling would be increased to quarterly until four consecutive quarters of results are below the COGCC allowable concentrations.

Mowing of the site should be conducted in the early summer of 2017 to encourage the continued transition of the vegetative cover to native grasses.

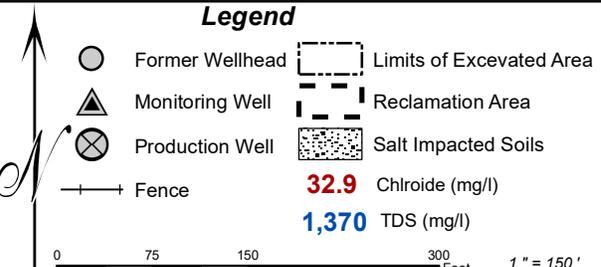
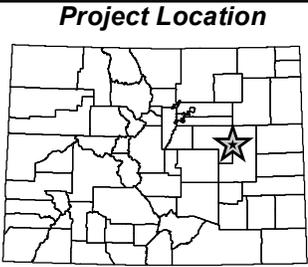
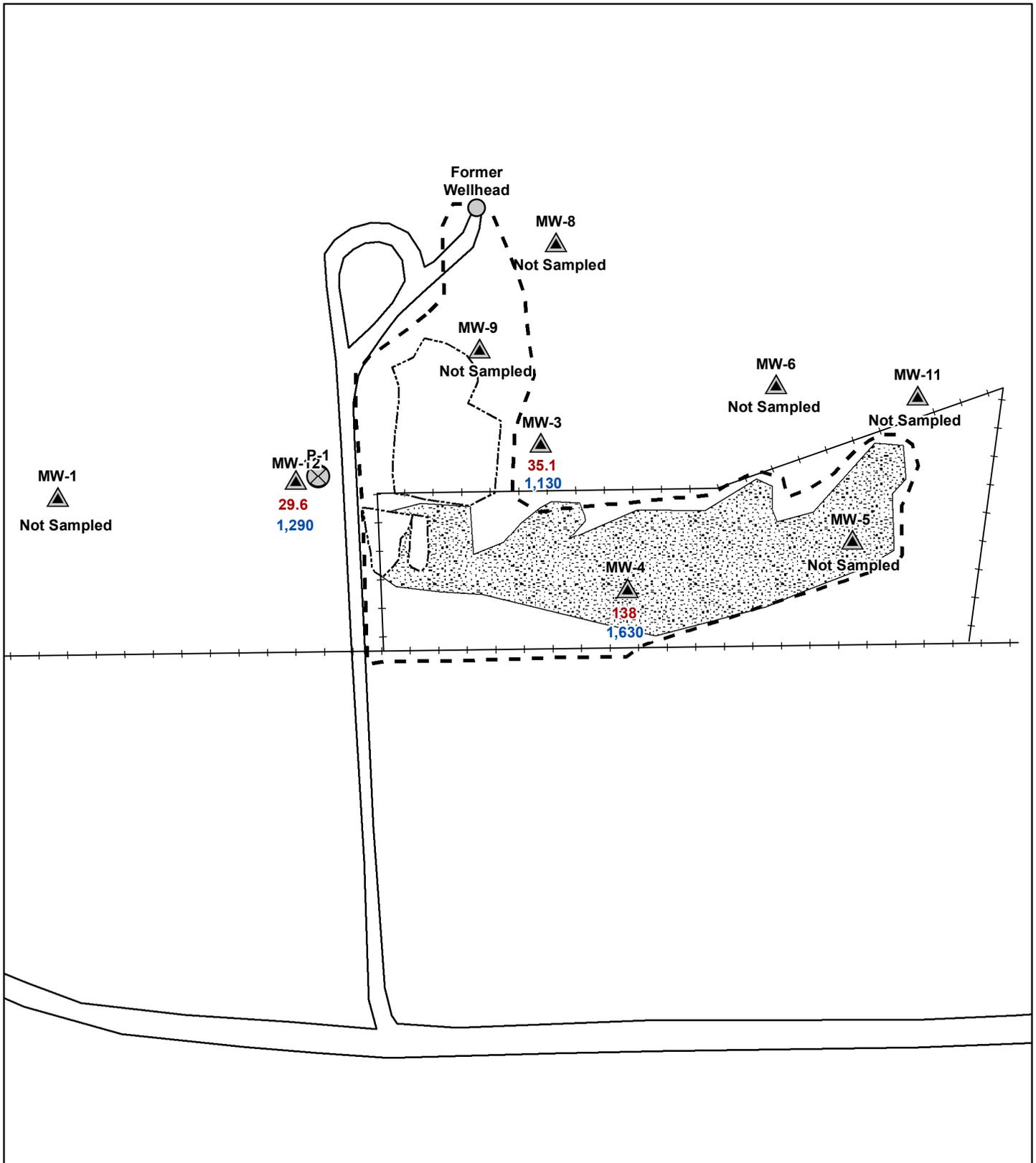


Ritchie Exploration, Inc.

State 1-18 Lease
Groundwater Elevation Map

GeoSolutions
NICHOLSON

Figure 1
April 2017



Ritchie Exploration, Inc.

State 1-18 Lease
Chloride and TDS in Groundwater

GeoSolutions
NICHOLSON

Figure 2

April 2017

APPENDIX A
Laboratory Report

Ritchie Exploration, Inc.- Wichita, KS

Sample Delivery Group: L904819

Samples Received: 04/25/2017

Project Number:

Description: State 1-18

Report To: Dave Nicholson
8100 E. 22th St. North
Wichita, KS 67226

Entire Report Reviewed By:



Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.



¹Cp: Cover Page	1	
²Tc: Table of Contents	2	
³Ss: Sample Summary	3	
⁴Cn: Case Narrative	4	
⁵Sr: Sample Results	5	
MW-3 L904819-01	5	
MW-12 L904819-02	6	
MW-4 L904819-03	7	
⁶Qc: Quality Control Summary	8	
Gravimetric Analysis by Method 2540 C-2011	8	
Wet Chemistry by Method 9056A	9	
⁷Gl: Glossary of Terms	11	
⁸Al: Accreditations & Locations	12	
⁹Sc: Chain of Custody	13	

SAMPLE SUMMARY



MW-3 L904819-01 GW

Collected by
DK Nicholson Collected date/time
04/24/17 11:50 Received date/time
04/25/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Gravimetric Analysis by Method 2540 C-2011	WG974180	1	04/27/17 10:31	04/27/17 11:17	AS
Wet Chemistry by Method 9056A	WG974230	1	04/27/17 15:05	04/27/17 15:05	KCF
Wet Chemistry by Method 9056A	WG974230	20	04/27/17 12:07	04/27/17 12:07	KCF

1
Cp

2
Tc

3
Ss

MW-12 L904819-02 GW

Collected by
DK Nicholson Collected date/time
04/24/17 12:10 Received date/time
04/25/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Gravimetric Analysis by Method 2540 C-2011	WG974180	1	04/27/17 10:31	04/27/17 11:17	AS
Wet Chemistry by Method 9056A	WG974230	1	04/27/17 12:19	04/27/17 12:19	KCF
Wet Chemistry by Method 9056A	WG974230	20	04/27/17 12:30	04/27/17 12:30	KCF

4
Cn

5
Sr

6
Qc

MW-4 L904819-03 GW

Collected by
DK Nicholson Collected date/time
04/24/17 12:40 Received date/time
04/25/17 08:45

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Gravimetric Analysis by Method 2540 C-2011	WG974180	1	04/27/17 10:31	04/27/17 11:17	AS
Wet Chemistry by Method 9056A	WG974230	20	04/27/17 12:42	04/27/17 12:42	KCF

7
Gl

8
Al

9
Sc



All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

- ¹ Cp
- ² Tc
- ³ Ss
- ⁴ Cn
- ⁵ Sr
- ⁶ Qc
- ⁷ Gl
- ⁸ Al
- ⁹ Sc



Gravimetric Analysis by Method 2540 C-2011

Analyte	Result	Qualifier	RDL	Dilution	Analysis date / time	Batch
Dissolved Solids	1130		10.0	1	04/27/2017 11:17	WG974180

1 Cp

2 Tc

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis date / time	Batch
Chloride	35.1		1.00	1	04/27/2017 15:05	WG974230
Sulfate	778		100	20	04/27/2017 12:07	WG974230

3 Ss

4 Cn

5 Sr

6 Qc

7 Gl

8 Al

9 Sc



Gravimetric Analysis by Method 2540 C-2011

Analyte	Result	Qualifier	RDL	Dilution	Analysis date / time	Batch
Dissolved Solids	1290		10.0	1	04/27/2017 11:17	WG974180

1 Cp

2 Tc

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis date / time	Batch
Chloride	29.6		1.00	1	04/27/2017 12:19	WG974230
Sulfate	850		100	20	04/27/2017 12:30	WG974230

3 Ss

4 Cn

5 Sr

6 Qc

7 Gl

8 Al

9 Sc



Gravimetric Analysis by Method 2540 C-2011

Analyte	Result	Qualifier	RDL	Dilution	Analysis date / time	Batch
Dissolved Solids	1630		10.0	1	04/27/2017 11:17	WG974180

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis date / time	Batch
Chloride	138		20.0	20	04/27/2017 12:42	WG974230
Sulfate	846		100	20	04/27/2017 12:42	WG974230

1 Cp

2 Tc

3 Ss

4 Cn

5 Sr

6 Qc

7 Gl

8 Al

9 Sc



Method Blank (MB)

(MB) R3214493-1 04/27/17 11:17

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
Dissolved Solids	U		2.82	10.0

¹ Cp

² Tc

³ Ss

⁴ Cn

⁵ Sr

⁶ Qc

L904819-03 Original Sample (OS) • Duplicate (DUP)

(OS) L904819-03 04/27/17 11:17 • (DUP) R3214493-4 04/27/17 11:17

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
Dissolved Solids	1630	1570	1	3.74		5

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3214493-2 04/27/17 11:17 • (LCSD) R3214493-3 04/27/17 11:17

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
Dissolved Solids	8800	8400	8380	95.5	95.2	85.0-115			0.238	5

⁷ Gl

⁸ Al

⁹ Sc



Method Blank (MB)

(MB) R3214229-1 04/27/17 08:58

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
Chloride	U		0.0519	1.00
Sulfate	U		0.0774	5.00

¹ Cp

² Tc

³ Ss

⁴ Cn

L904816-01 Original Sample (OS) • Duplicate (DUP)

(OS) L904816-01 04/27/17 14:30 • (DUP) R3214229-5 04/27/17 14:42

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
Chloride	60.0	59.9	1	0		15
Sulfate	0.0953	0.000	1	200	P1	15

⁵ Sr

⁶ Qc

L904867-03 Original Sample (OS) • Duplicate (DUP)

(OS) L904867-03 04/27/17 18:00 • (DUP) R3214229-8 04/27/17 18:35

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
Chloride	283	286	10	1		15
Sulfate	314	313	10	0		15

⁷ Gl

⁸ Al

⁹ Sc

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3214229-2 04/27/17 09:10 • (LCSD) R3214229-3 04/27/17 09:21

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
Chloride	40.0	40.0	40.1	100	100	80-120			0	15
Sulfate	40.0	39.0	39.7	98	99	80-120			2	15

L904822-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L904822-01 04/27/17 13:05 • (MS) R3214229-4 04/27/17 13:17

Analyte	Spike Amount	Original Result	MS Result	MS Rec.	Dilution	Rec. Limits	MS Qualifier
Chloride	50.0	63.5	112	97	1	80-120	E



L904865-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L904865-02 04/27/17 16:27 • (MS) R3214229-6 04/27/17 16:50 • (MSD) R3214229-7 04/27/17 17:02

Analyte	Spike Amount mg/l	Original Result mg/l	MS Result mg/l	MSD Result mg/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	<u>MS Qualifier</u>	<u>MSD Qualifier</u>	RPD %	RPD Limits %
Sulfate	50.0	15.4	63.5	63.7	96	96	1	80-120			0	15

¹ Cp

² Tc

³ Ss

⁴ Cn

⁵ Sr

⁶ Qc

⁷ Gl

⁸ Al

⁹ Sc



Abbreviations and Definitions

SDG	Sample Delivery Group.
MDL	Method Detection Limit.
RDL	Reported Detection Limit.
U	Not detected at the Reporting Limit (or MDL where applicable).
RPD	Relative Percent Difference.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Rec.	Recovery.

Qualifier Description

E	The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration (ICAL).
P1	RPD value not applicable for sample concentrations less than 5 times the reporting limit.

¹ Cp

² Tc

³ Ss

⁴ Cn

⁵ Sr

⁶ Qc

⁷ Gl

⁸ Al

⁹ Sc



ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE**.
 * Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Connecticut	PH-0197	North Carolina ¹	DW21704
Florida	E87487	North Carolina ²	41
Georgia	NELAP	North Dakota	R-140
Georgia ¹	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky ¹	90010	South Dakota	n/a
Kentucky ²	16	Tennessee ¹⁴	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas ⁵	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

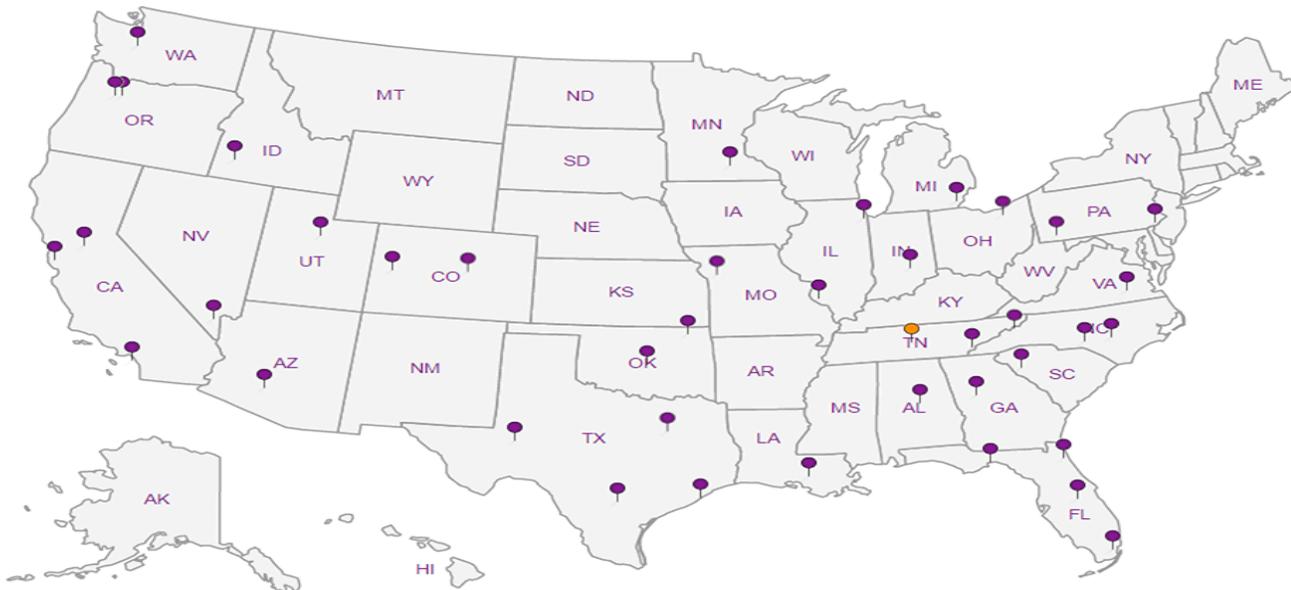
Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC	100789
A2LA – ISO 17025 ⁵	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

¹ Drinking Water ² Underground Storage Tanks ³ Aquatic Toxicity ⁴ Chemical/Microbiological ⁵ Mold ^{n/a} Accreditation not applicable

Our Locations

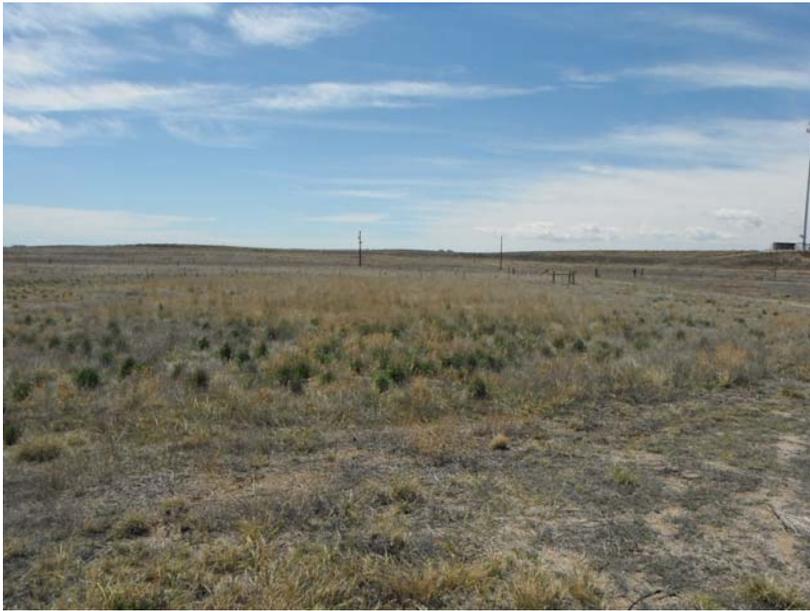
ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



ESC LAB SCIENCES Cooler Receipt Form

Client: BITEXPWAS	SDG#	690489	
Cooler Received/Opened On: 4/25/17	Temperature:	1.7	
Received By: Marina Malone			
Signature: <i>Marina Malone</i>			
Receipt Check List	NP	Yes	No
COC Seal Present / Intact?	/		
COC Signed / Accurate?		/	
Bottles arrive intact?		/	
Correct bottles used?		/	
Sufficient volume sent?		/	
If Applicable			
VOA Zero headspace?			
Preservation Correct / Checked?			

APPENDIX B
Photographs



Former pit area looking southwest



Former pit area looking west



Former wellhead area looking north



Fence between former salt area and undisturbed looking southeast



Former salt-impacted area looking east



Close-up of vegetation species in former salt-impacted area



Former salt-impacted area looking west



Close-up of vegetation species in former salt-impacted area