



Received 09/11/2014
REM #8633
DOC #2141648

VAQUERO
ENERGY

Sampling and Analysis Results

Vaquero Juhan 26-94

Spill Response

Lands Involved:

SWSW, Section 26, Township 6S Range 94W
Converse County, Wyoming

Prepared for:

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August 27, 2014

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1. INTRODUCTION

On April 17, 2014, an incident occurred at the Vaquero Energy, Inc. (Vaquero) Juhan 26-94 meter run that resulted in a release of approximately 4 bbls produced water with small amounts of associated condensate. A Form 19 Spill Report can be found in **Appendix D**. The well site is located in SWSW Section 26, T6S R94W in Garfield County, CO (**Appendix A**).

Following the release from this incident, ARCADIS US, Inc. (ARCADIS) was contracted to conduct a site investigation using a photoionization detector (PID) to identify volatile organic compounds (VOC's) in the soil. The initial investigation identified high levels of volatile organics. Surficial aeration and natural attenuation methods were employed to increase the rate of volatilization. A second analysis identified high levels of VOC's despite aeration and natural attenuation. ARCADIS determined soil removal and disposal was necessary.

A roustabout crew was brought in to remove all contaminated soils from the impacted area. ARCADIS personnel then sampled the excavation area, waste spoils and non-impacted soil to verify the success of the cleanup. The results of the sampling event can be seen in **Table 1** and in the Lab Report (**Appendix C**). A map of the excavation area and samples can be seen in **Appendix B**.

2. PURPOSE AND SCOPE

ARCADIS, on behalf of Vaquero, has prepared this report in accordance with the State of Colorado Oil and Gas Conservation Commission Amended Rules 900 Series, Exploration and Production Waste Management. Soil cleanup values are taken from the Colorado Department of Public Health and Environment Hazardous Materials and Waste Management Division (CDPHE-HMWMD) Colorado Soil Evaluation Values (December 2007) and USDA Agricultural Handbook 60 method 20B and method 2 for Sodium Adsorption Ratio.

3. EXCAVATION, SAMPLING & RESULTS

On August 5th, 2014, prior to excavation, ARCADIS personnel arrived onsite to assess and photo document the site. A soil background sample was collected away from the contamination area. A roustabout crew then used a skid-steer to excavate the area of contamination, approximately 20 feet wide by 25 feet long, to a maximum depth of 3.5 feet. ARCADIS personnel directed the excavation using a Photoionization Detector (PID). Any soils with a PID reading >100 PPM were removed from the area. The excavated soil was moved to a plastic lined holding area. Upon completion of excavation activities, ARCADIS personnel collected four part composite samples from the bottom of the excavation area and the spoils pile. Field sample sheets are contained in **Appendix C**.

Three soil samples were collected on August 5th, 2014, one background sample labeled RS-BG, one sample from the excavation area floor labeled RS-Comp-Floor, and one waste characterization sample from the spoils pile labeled RS-Comp-WC. See **Table 1** for sample results and **Appendix C** for Lab Report and Chain of Custody documentation. Samples were collected with a stainless steel trowel and sampling

jars provided by Energy Laboratories. All sampling equipment was decontaminated using Alconox, distilled water, and rubbing alcohol solution to minimize the potential for cross contamination. The background sample was a discrete grab sample from a single location and the waste characterization and pit samples were collected as four point grab samples.

The soils visually inspected upon collection and a PID was employed to detect any volatile fumes in the samples. Each sample was assessed for any hydrocarbon or salt stains. ARCADIS personnel also made note of any noticeable soil odor.

Soil samples were submitted to Energy Labs in Casper Wyoming for laboratory analysis of organic compounds (TPH and BTEX), inorganic soil characteristics (Electrical Conductivity-EC, Sodium Adsorption Ratio-SAR, pH) and metals. Energy Labs used testing methods 8015 for TPH, 8260 for BTEX, 8270 for other organic compounds and 8082 for PBC's.

The background sample (RS-BG) was tested for EC, SAR, pH, and total metals. Background EC, SAR and pH were all within normal ranges. Electrical Conductivity was 0.68 mmhos/cm, an important value for comparison to the floor of the excavated pit. Metals in the background samples are all low or non-detectable except for arsenic. Arsenic concentration was measured at 15.8 mg/Kg with a Maximum Contamination Level (MCL) of 0.39 mg/Kg. Natural background arsenic levels in this area are approximately forty (40) times higher than the MCL. Both the excavation area floor and spoils pile samples also exceeds the arsenic MCL.

The excavation area floor sample (RS-Comp-Floor) was tested for EC, SAR, pH, all organic compounds and total metals. The sample showed no signs of major staining or contamination. The sample had a low PID reading of 6.5 PPM and a TPH of 87 mg/Kg. EC was 4.19 mmhos/cm, 0.19 mmhos/cm over the MCL and six times higher than the background soil EC. Arsenic was 16.3 mg/Kg, well over MCL but only 0.5 mg/Kg above the background soil sample. All other metals were well below MCL.

The waste characterization sample (RS-Comp-WC) was tested for TPH, PCB's and total metals. The sample had a very high PID reading of 600 PPM and a TPH result of 1105 mg/Kg. ARCADIS personnel detected an odor within the soil but could not see any visual staining. Arsenic was 10.4 mg/Kg which also exceeded MCL but was lower than the background soil sample. No other metals or PCB's were in exceedance.

Comparison of the three samples shows a high arsenic level native to the soil in the area. All three measured arsenic levels exceed MCL but the highest level was within 0.5 mg/Kg of the background level. The excavation area sample did not exceed any organic MCL's. The only exceedance besides arsenic was EC, which was 4.19 mmhos/cm, (0.19 mmhos/cm above the MCL). The waste spoils pile had a PID reading of 600 PPM, 1105 mg/Kg TPH and an odor detectable by ARCADIS personnel. If left in place, the waste soil would have been well in exceedance of the TPH MCL. The high TPH of the spoils pile and low TPH of the excavation area suggest that the excavation was successful in removing the majority of contaminated soil. Arsenic in the spoils pile was also above MCL but lower than the excavation area and the background. No other tested values exceeded MCL's for any of the samples.

4. CONCLUSIONS

ARCADIS personnel conducted confirmation sampling on the Juhan 26-94 meter run remediation project on August 5th, 2014 following the release of produced water on April 17th, 2014. The impacted area was excavated and removed from the site to a waste disposal facility. Photographic documentation of excavation activities is presented in **Appendix E**. Three samples were collected, a background sample, excavation area sample and spoils pile sample. The samples were analyzed in the field for any staining or volatile gasses. The samples were then sent to Energy Labs for chemical analysis.

The samples all tested positive for arsenic in levels exceeding the state MCL. The high arsenic levels were also present in the background sample suggesting naturally high arsenic levels in the soil. TPH levels in the excavated pit were below MCL and TPH levels were above MCL in the spoils pile. This indicates the contaminated soil were effectively removed from the impacted area.

5. RECOMMENDATION

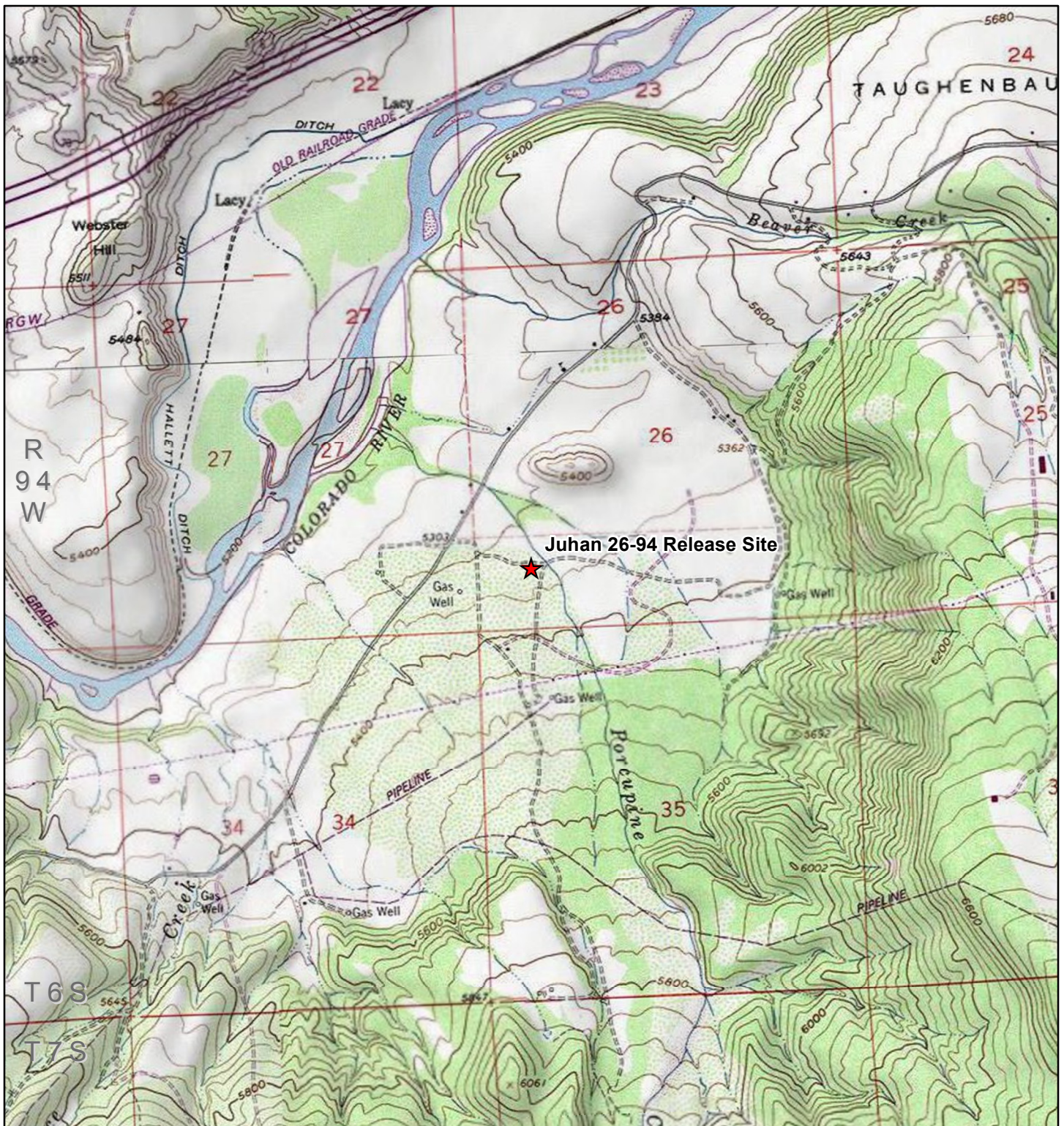
Final review of the analytical data shows no MCL exceedances in the impacted area with the exception of arsenic, which is naturally abundant in the local soils. Reclamation of the site is recommended. The spill site was previously a patch of gravel road, therefore reclamation should include filling the excavation area with clean soil, compacting the area and covering the area in gravel. A Remediation Work Plan (Form 27) is contained in **Appendix D**. It is further recommended that the Colorado Oil and Gas Conservation Commission close Spill Incident No. 2148614.

TABLE 1. LAB RESULTS SUMMARY

Contaminant	MCL	Units	RS-BG	RS-Comp-Floor	RS-Comp-WC
<i>Field Observations</i>					
Sample Type	-	-	Grab	Composite	Composite
PID	-	PPM	0.5	6.5	600
Visual Staining	-	-	No	No	No
Odor	-	-	No	No	Yes
<i>Organics in Soils</i>					
TPH	500	mg/Kg	NS	87	1105
Benzene	0.17	mg/Kg	NS	ND	ND
Toluene	85	mg/Kg	NS	ND	ND
Ethylbenzene	100	mg/Kg	NS	ND	ND
Xylenes	175	mg/Kg	NS	ND	ND
Acenaphthene	1000	mg/Kg	NS	ND	ND
Anthracene	1000	mg/Kg	NS	ND	ND
Benzo(A)anthracene	0.22	mg/Kg	NS	ND	ND
Benzo(B)fluoranthene	0.22	mg/Kg	NS	ND	ND
Benzo(K)fluoranthene	2.2	mg/Kg	NS	ND	ND
Benzo(A)pyrene	0.022	mg/Kg	NS	ND	ND
Chrysene	22	mg/Kg	NS	ND	ND
Dibenzo(A,H)anthracene	0.022	mg/Kg	NS	ND	ND
Fluoranthene	1000	mg/Kg	NS	ND	ND
Fluorene	1000	mg/Kg	NS	ND	ND
Indeno(1,2,3,C,D)pyrene	0.22	mg/Kg	NS	ND	ND
Napthalene	23	mg/Kg	NS	ND	ND
Pyrene	1000	mg/Kg	NS	ND	ND
<i>Inorganics in Soils</i>					
Electrical Conductivity (EC)	<4 or 2x background	mmhos/cm	0.68	4.19	NS
Sodium Adsorption Ratio (SAR)	12		1.5	2.2	NS
pH	6-9		7.5	7.3	NS
<i>Metals in Soils</i>					
Arsenic	0.39	mg/Kg	15.8	16.3	10.4
Barium (LDNR True Total Barium)	15000	mg/Kg	270	251	295
Boron (Hot Water Soluble)	2	mg/l	NS	NS	NS
Cadmium	70	mg/Kg	0.6	0.06	ND
Chromium	120000	mg/Kg	21.7	21.8	24.1
Copper	3100	mg/Kg	NS	NS	NS
Lead (inorganic)	400	mg/Kg	11.6	11.8	16.3
Mercury	23	mg/Kg	ND	ND	ND
Nickel (soluble salts)	1600	mg/Kg	NS	NS	NS
Selenium	390	mg/Kg	ND	6.4	ND
Silver	390	mg/Kg	ND	ND	ND
Zinc	23000	mg/Kg	NS	NS	NS
<i>Liquid Hydrocarbons in Soils</i>					
Liquid Hydrocarbons including condensate and oil	Below Detection Level		NS	NS	NS
ND: No Contaminant Detected			NS: Parameter Not Sampled		

APPENDIX A.

PROJECT LOCATION MAP



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Projection: NAD 1983, UTM Z12N Meters
Source: Esri, DigitalGlobe, GeoEye, i-cubed,
Earthstar Geographics, CNES/Airbus DS, USDA,
USGS, AEX, Getmapping, Aerogrid, IGN, IGP,
swisstopo, and the GIS User Community

Vaquero Juhan 26-94 Spill Response Confirmation Sampling Project Location Map

Garfield County, Colorado



Legend

★ Project Location

0 0.25 0.5 1 Miles



Vaquero Energy, Inc.

Project: WY002589.0001

Date: 8/22/2014

Map By: CAS

Appendix:

A

APPENDIX B.

SAMPLE LOCATION MAP