



November 4, 2021

Wayne Bankert
Laramie Energy LLC
760 Horizon Drive, Suite 101
Grand Junction, CO 81506

**RE: Investigation Report, Baker Canyon Spill
COGCC Facility ID 479751, Remediation Project Number 17836
Garfield County, Colorado**

Mr. Bankert,

Entrada Consulting Group, Inc. (Entrada) was contracted by Laramie Energy (Laramie) to conduct a subsurface investigation including the installation of monitoring wells and collection of soil and water samples at the Baker Canyon Spill (Site) related to the Colorado Oil and Gas Conservation Commission (COGCC) Remediation Project Number 17836. The Site is located in Section 8, Township 7 South, Range 97 West in Garfield County, Colorado. A general site location map is provided as **Figure 1**.

The following report provides a narrative of the monitoring well installation activities and presents the soil and water sample analytical results.

SOIL INVESTIGATION AND MONITORING WELL INSTALLATION ACTIVITIES

On April 29 and 30, 2021 and September 2, 3, and 27, 2021 Entrada provided oversight during the drilling and well installation in ten borings (MW1 through MW10) at the Site.

Soil borings MW2 through MW10 were advanced to provide lateral delineation of petroleum hydrocarbons previously identified. Soil boring MW1 was advanced to characterize native subsurface conditions. Entrada contracted and oversaw Colorado Drilling and Sampling and DA Smith Drilling and to advance the soil borings and install the monitoring wells. The boring locations are shown on **Figure 1**.

The soil borings were advanced with 4.25-inch outside diameter solid stem augers and 6-inch outside diameter hollow stem augers. The borings were driven by Simco and CME-55 drilling rigs. Soil samples were collected at five-foot intervals using split spoon samplers. An Entrada geologist was onsite to describe the lithology of the recovered soil and visually examine for evidence of potential petroleum hydrocarbon impact (e.g., petroleum staining and odor) and field-screened using a photo-ionization detector (PID) to evaluate the presence of volatile organic

compounds (VOCs). Total depth of the borings ranged from 34 ft-bgs to 53 ft-bgs. In general, the lithology observed in the soil borings consisted of sandy and gravelly clay. Bedrock was not observed in any of the borings.

Each soil boring was completed as a 2-inch PVC monitoring well installed to total depth of the boring. In all monitoring wells, silica sand was placed from total depth to above the top of well screen and hydrated bentonite chips were placed from the top of sand to ground surface. Please see the attached boring logs for additional details regarding well construction. The soil boring lithological logs and well construction diagrams are provided in **Attachment 1**.

Entrada previously collected surface samples at the point of release (SS1), the end of the spill path (SS2), and background samples in undisturbed areas on April 20, 2021. The area immediately around the spill, including the SS1 sample location, was excavated and sent to Greenleaf Environmental Services LLC for disposal. Due to SS1 being excavated, it was not directly addressed in this report. The end of the spill path (SS2) was resampled on 10/21/2021 and analytical results are presented on **Table 1K**.

SOIL SAMPLING AND ANALYSIS

Soil samples were collected from each soil boring from various depth intervals for laboratory analysis that are summarized on **Table 1A** through **Table 1K**. In total, 75 samples were submitted for laboratory analysis.

The soil samples were collected into sample containers appropriate for the specified analyses, sealed, labeled, and placed into an ice filled cooler for preservation. Soil samples were submitted to Pace Analytical in Mt. Juliet, Tennessee, following chain of custody procedures and analyzed for the following constituents by the indicated methods:

- Total petroleum hydrocarbons (TPH) as gasoline range organics (GRO) by United States Environmental Protection Agency (EPA) Method 8015D;
- TPH as diesel range organics (DRO) and TPH as oil range organics (ORO) by EPA Method 8015M;
- Benzene, toluene, ethylbenzene, total xylenes, naphthalene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene by EPA Method 8260B;
- Polycyclic aromatic hydrocarbons (COGCC Table 915-1 list plus benzo(k)fluoranthene, phenanthrene, 1-methylnaphthalene, 2-methylnaphthalene, and 2-chloronaphthalene) by EPA Method 8270C-SIM;
- Metals (COGCC Table 915-1 list) by EPA Method 6010B except arsenic and hexavalent chromium, which were analyzed by EPA Method 6020 and EPA Method 7199, respectively;
- Sodium Adsorption Ratio (SAR) by calculation;
- Hot water soluble boron by EPA Method 6010B-NE493 Ch 2;
- pH by EPA Method 9045D; and
- Specific Conductance (EC) by EPA Method 9050A Modified.

SOIL ANALYTICAL RESULTS

The laboratory soil analytical results were compared to the COGCC Table 915-1 Protection of Groundwater Screening Levels (PGWSL). The soil analytical results reported above the COGCC Table 915-1 PGWSL are summarized below.

- Total TPH (GRO+DRO+ORO) was reported above the COGCC Table 915-1 Screening Level in MW3 (25-27 ft-bgs) and MW6 (10-12 ft-bgs). The maximum Total TPH concentration encountered in the subsurface was 1617.7 mg/kg in the 25-27 ft-bgs interval of MW3. The COGCC Table 915-1 Screening Level for Total TPH is 500 mg/kg;
- Benzene was reported above the COGCC Table 915-1 PGWSL in MW3 (8-10 ft-bgs, 15-17 ft-bgs, 20-22 ft-bgs, and 25-27 ft-bgs), MW4 (8-10 ft-bgs, 15-17 ft-bgs, and 25-27 ft-bgs), MW5 (8-10 ft-bgs, 15-17 ft-bgs, 20-22 ft-bgs, 25-27 ft-bgs, and 30-32 ft-bgs), and MW9 (20-27 ft-bgs). The maximum Benzene concentration encountered in the subsurface was 1.36 mg/kg in the 25-27 ft-bgs interval of MW3. The COGCC Table 915-1 PGWSL for Benzene is 0.0026 mg/kg;
- Toluene was reported above the COGCC Table 915-1 PGWSL in MW3 (8-10 ft-bgs, 15-17 ft-bgs, 20-22 ft-bgs, and 25-27 ft-bgs), MW4 (8-10 ft-bgs), and MW5 (8-10 ft-bgs and 25-27 ft-bgs). The maximum Toluene concentration encountered in the subsurface was 37.5 mg/kg in the 25-27 ft-bgs interval of MW3. The COGCC Table 915-1 PGWSL for Toluene is 0.69 mg/kg;
- Ethylbenzene was reported above the COGCC Table 915-1 PGWSL in MW3 (8-10 ft-bgs, 15-17 ft-bgs, and 25-27 ft-bgs) and MW5 (25-27 ft-bgs). The maximum Ethylbenzene concentration encountered in the subsurface was 4.91 mg/kg in the 8-10 ft-bgs interval of MW3. The COGCC Table 915-1 PGWSL for Ethylbenzene is 0.78 mg/kg;
- Total Xylenes were reported above the COGCC Table 915-1 PGWSL in MW3 (8-10 ft-bgs, 15-17 ft-bgs, and 25-27 ft-bgs) and MW5 (25-27 ft-bgs). The maximum Total Xylenes concentration encountered in the subsurface was 76.6 mg/kg in the 8-10 ft-bgs interval of MW3. The COGCC Table 915-1 PGWSL for Total Xylenes is 9.9 mg/kg;
- 1,2,4-Trimethylbenzene was reported above the COGCC Table 915-1 PGWSL in MW3 (8-10 ft-bgs and 15-17 ft-bgs). The maximum 1,2,4-Trimethylbenzene concentration encountered in the subsurface was 1.9 mg/kg in the 8-10 ft-bgs interval of MW3. The COGCC Table 915-1 PGWSL for 1,2,4-Trimethylbenzene is 0.0081 mg/kg;
- 1,3,5-Trimethylbenzene was reported above the COGCC Table 915-1 PGWSL in MW3 (8-10 ft-bgs and 15-17 ft-bgs). The maximum 1,2,4-Trimethylbenzene concentration encountered in the subsurface was 1.82 mg/kg in the 8-10 ft-bgs interval of MW3. The COGCC Table 915-1 PGWSL for 1,3,5-Trimethylbenzene is 0.0087 mg/kg;
- Naphthalene was reported above the COGCC Table 915-1 PGWSL in MW3 (25-27 ft-bgs) and MW5 (25-27 ft-bgs). The maximum Naphthalene concentration encountered in the subsurface was 0.110 mg/kg in the 25-27 ft-bgs interval of MW5. The COGCC Table 915-1 PGWSL for Naphthalene is 0.0038 mg/kg;
- Arsenic in all samples was reported above the COGCC Table 915-1 PGWSL of 0.29 milligrams per kilogram (mg/kg) with concentrations ranging from 2.77 mg/kg to 30.4 mg/kg. However, the arsenic concentrations in all samples with the exception of MW6 (20-22 ft-bgs and 25-27 ft-bgs) are below the maximum concentrations observed in

background soil boring MW1 (8.5-10.5 ft-bgs, 16.4 mg/kg) and are therefore considered compliant with COGCC Table 915-1 standards per footnote 1 of Table 915-1;

- Barium concentrations in all borings where Barium was analyzed were reported above the COGCC Table 915-1 PGWSL of 82 mg/kg with concentrations ranging from 104 mg/kg to 419 mg/kg. Barium was not analyzed in MW1;
- Cadmium was reported above the COGCC Table 915-1 PGWSL of 0.38 mg/kg all samples from MW6, MW7, MW8, MW9 and MW10. Cadmium concentrations in these samples ranged from 0.432 mg/kg to 0.709 mg/kg. Cadmium was not detected in MW2, MW3, MW4, and MW5. Cadmium was not analyzed in MW1;
- Lead was reported above the COGCC Table 915-1 PGWSL in MW6 (10-12 ft-bgs) and MW8 (15-17 ft-bgs). The maximum Lead concentration encountered in the subsurface was 15.7 mg/kg in the 15-17 ft-bgs interval of MW8. The COGCC Table 915-1 PGWSL for Lead is 14 mg/kg; Lead was not analyzed in MW1;
- Selenium was reported above the COGCC Table 915-1 PGWSL in MW3 (30-32 ft-bgs), MW4 (40-42 ft-bgs), MW6 (5-7 ft-bgs, 10-12 ft-bgs, 20-22 ft-bgs, 25-27 ft-bgs and 30-32 ft-bgs), MW7 (all depths), MW8 (all depths), MW9 (10-12 ft-bgs and 15-17 ft-bgs) and MW10 (20-22 ft-bgs and 35-37 ft-bgs). Selenium was also above the COGCC Table 915-1 PGWSL in the surface resample SS2. The maximum Selenium concentration encountered in the subsurface was 2.68 mg/kg in the 30-32 ft-bgs interval of MW8. The COGCC Table 915-1 PGWSL for Selenium is 0.26 mg/kg. Selenium was not analyzed in MW1;
- SAR was reported above the COGCC Table 915-1 upper limit of 6 in MW3 (35-37 ft-bgs and 40-42 ft-bgs), MW4 (40-42 ft-bgs), MW5 (35-37 ft-bgs and 40-42 ft-bgs) and MW6 (5-7 ft-bgs). However, the SARs in all samples are below the maximum values observed in background soil sample BKGND-1 (12-18 in-bgs, 8.87) and are therefore considered compliant with COGCC Table 915-1 standards per footnote 1 of Table 915-1; and
- pH was reported above both the COGCC Table 915-1 upper limit of 8.3 and local background concentration of 8.60 (MW1, 23.5-25.5 ft-bgs and BKGND-4, 12-18 in-bgs) in MW2 (20-22 ft-bgs, 30-32 ft-bgs, 35-37 ft-bgs, 40-42 ft-bgs), MW3 (8-10 ft-bgs, 35-37 ft-bgs, 40-42 ft-bgs), MW4 (30-32 ft-bgs, 35-37 ft-bgs, and 40-42 ft-bgs), MW5 (35-37 ft-bgs and 40-42 ft-bgs) and MW9 (30-32 ft-bgs). pH was reported in twenty-four samples where the values were above the COGCC Table 915-1 upper limit of 8.3 and below the local background concentration of 8.60 and are therefore considered compliant with COGCC Table 915-1 standards per footnote 1 of Table 915-1;

All remaining soil results were reported below the applicable COGCC Table 915-1 standards. The soil analytical results are summarized in **Table 1A** through **Table 1K** and the laboratory analytical report is included in **Attachment 2**.

GROUNDWATER SAMPLING ACTIVITIES

The wells were gauged on the north side of the casing to the nearest 0.01-foot using a water level probe. Groundwater levels were subsequently converted to elevations (feet AMSL). The groundwater elevations were plotted, and a potentiometric groundwater contour map for the most recent sampling event is presented as **Figure 2**. Groundwater depths including surface elevation data is included as **Table 2**. The groundwater flow is generally to the south and the gradient is

0.014 feet/foot as measured from the highest water level elevation in MW1 to the lowest elevation measured at MW8 on October 5, 2021.

Groundwater samples were collected from wells and Conn Creek (SW1) on a bi-weekly basis from May 4, 2021 to October 5, 2021. Three well casing volumes of water were purged at each well before samples were collected. Purged water is disposed of within Laramie's water system at Pond 10. A total of 75 samples were collected. Groundwater samples were collected in sample containers appropriate for the specified analyses, sealed, labeled, and placed into an ice-filled cooler for preservation. Samples were submitted to Pace Analytical in Mt. Juliet, TN and analyzed for the following analyses:

- Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) by EPA Method 8260B;
- Naphthalene, 2,2,4-Trimethylbenzene, and 1,3,5-Trimethylbenzene by EPA Method 8260B;
- Total dissolved solids (TDS) by EPA Method 2540 C-2011;
- Chloride and Sulfate by EPA Method 9056A.

GROUNDWATER ANALYTICAL RESULTS

Groundwater analytical results were reported for 86 groundwater samples during the period from 4/5/2021 to 10/21/2021. Analytical results are summarized in **Table 2** and are compared to COGCC Table 915-1 Concentration Levels. Laboratory analysis reports and chain-of-custody documentation included as an attachment. Groundwater analytical results are summarized below:

- Benzene was reported above the COGCC Table 915-1 Groundwater Screening Level in MW2, MW3, MW4, MW5, and MW9 in at least one sampling event between 4/5/2021 and 10/21/2021. The maximum Benzene concentration encountered was 838 µg/L in MW9 on 10/21/2021. The COGCC Table 915-1 Groundwater Screening Level for Benzene is 5 µg/L.
- Toluene was reported above the COGCC Table 915-1 Groundwater Screening Level in MW5 in one sampling event on 6/11/2021. The Toluene concentration reported in this sample was 741 µg/L. The COGCC Table 915-1 Groundwater Screening Level for Toluene is 560 µg/L.
- Sulfate was reported above the COGCC Table 915-1 Groundwater Screening Level of 250 mg/L in all samples except SW1 (7/23/2021). However, only five samples exceeded the 1.25 X local background concentration. These were MW4 (8/6/2021 and 10/21/2021), MW7 (10/5/2021) and MW8 (9/20/2021 and 10/21/2021). The maximum concentration for Sulfate encountered was 1,140 mg/L.
- TDS was reported above the 1.25 X local background concentration in MW7 (9/7/2021 and 9/20/2021) and MW8 (9/20/2021, 10/5/2021, and 10/21/2021). The maximum concentration for TDS encountered was 3,280 mg/L.

All remaining water results were reported below the applicable COGCC Table 915-1 standards. The water analytical results are summarized in **Table 2** and the laboratory analytical report is included in **Attachment 3**.

CONCLUSIONS / RECOMMENDATIONS

Entrada recommends the of drilling additional monitoring wells to the south for further lateral delineation of impacts from this spill. The plume has been confined and displayed in wells 2, 3, 5, and 9. South of MW9 has not been delineated yet and should be top priority. It is likely that the impacts are staying confined within the pipeline corridor, but additional delineation is required to accurately demonstrate the exceedances noted during sampling events. Entrada also recommends continuing groundwater sampling on a biweekly basis and additional resampling of the SS2 location for Selenium. Entrada believes that this Site would be a viable candidate for enhanced fluid recovery and offsite treatment.

We appreciate the opportunity to assist Laramie Energy. Please contact me at (720) 253-2940 if you have any questions.

Sincerely,

ENTRADA CONSULTING GROUP, INC

A handwritten signature in black ink, appearing to read "Reed Johnson", with a stylized, flowing script.

Reed Johnson, PG
Senior Project Geologist

Attachments:

Figure 1: Site Map

Figure 2: Potentiometric Map

Table 1A-1K: Soil Analytical Results

Table 2: Groundwater Analytical Results

Attachment 1: Boring Log Lithological Logs and Well Construction Diagrams

Attachment 2: Soil Laboratory Analytical Reports

Attachment 3: Water Laboratory Analytical Reports