MAWC – IUP Service Contract
Air Quality Monitoring at Beaver Run Reservoir
Quarterly Report #2

Covering the Period from 11/1/2019 – 1/31/2020

Submitted by

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OUTLINE OF REPORT

I. Scope of Contract

The current contract between the Municipal Authority of Westmoreland County (MAWC) and the Indiana University of Pennsylvania (IUP) started on 1 August 2019 and runs until 31 July 2020. The scope of the contract calls for the contractor, IUP, to perform air quality measurement services at Beaver Run Reservoir (BRR) quarterly.

The air quality measurement services include field sampling, laboratory analyses and reporting as follows: (1) Field Sampling: air quality samples and hand-held sensor readings will be taken at the Mamont compressor station and at the Kuhns, DeArmitt, Hutchinson and Mamont (KDHM) pad sites. Background air quality samples will be taken near the Kuhns pad. (2) Laboratory Analyses: The air samples taken from the pad sites will be monitored for methane concentration and compared to the hand-held sensor readings taken at the pads. The air samples taken from the Mamont compressor station will be monitored for the standard compressor gases of CO, NO_2, SO_2, Benzene, Ethylbenzene, Formaldehyde, n-Hexane, Toluene, Xlenes and 2,2,4 Trimethylpentane. (3) Reporting: A report on the results of the field sampling and analyses will be delivered within six weeks after field sampling. After review and approval of the report results by MAWC, the results will then be posted on an IUP web site for public access.

II. Scope of Report

This report covers the second quarter of the contract. Field samples and hand-held sensor readings were taken at the BRR fracking pad sites on 30 January 2020. A background sample was taken about 200 meters from the edge of the Kuhns pad, as measured using Google Maps. The Carbon Monoxide (CO) monitors and temperature-relative humidity monitor at the Mamont compressor were collected and replaced with new data loggers. Sampling notes and laboratory analyses of the field samples are reported herein.

III. Field Report of Air Quality Sampling

Figure 1 (next page) shows the approximate locations where an air sample was taken or CO monitors were placed at the Mamont compressor station. One air sample was taken at position P7 and the CO data loggers were placed at the positions labeled P7, P1 and P3. Hand-held sensor readings for CO, SO_2, CH_4, NO_2 and CH_2O were taken at position P7. The hand-held sensor readings were taken for 5-minute durations for each gas. A temperature-relative humidity data logger was collected and replaced at position P7.

All of the aerial views shown in this section of the report are taken from Google Maps and do not represent the vegetation or construction in the area on the date of the samples, but instead are intended to show the locations of the air and background samples relative to landmarks around the Mamont compressor and the Kuhns, DeArmitt, Hutchinson, and Mamont (KDHM) pad well sites.

Figure 1. Aerial image of the Mamont compressor station. The red squares labeled P1, P2 and P7 mark the locations where carbon monoxide data loggers were collected and replaced. Air samples and hand-held sensor readings were taken at position P7; the temperature relative-humidity data logger was placed at P7. The aerial image is from Google Maps.

In figure 2, the location of the air sample taken at the Kuhns pad is marked with a red square (■). The location of the background sample taken nearby is marked with a blue square (■) at the upper right of the image. The pathway walked for hand-held CH_4 measurements (Aeroqual Series 500) is shown with the blue line. Moderate winds of variable direction were present during air sampling and hand-held measurements.

Figure 2. Aerial image of the Kuhns pad and nearby vicinity. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey for CH_4. The blue square labeled "bkg" marks the location of the background air sample. The aerial image is from Google Maps.

Figure 3. Aerial image of the DeArmitt pad. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey for CH_4. The aerial image is from Google Maps.

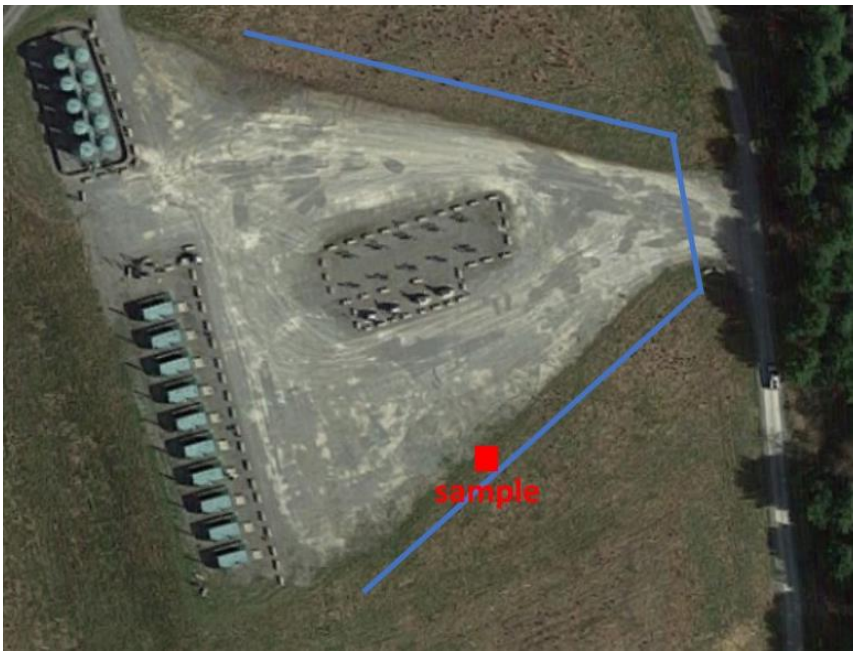

Figure 4. Aerial image of the Hutchinson pad. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey for CH_4. The aerial image is from Google Maps.

Figure 5. Aerial image of the Mamont-South pad. The red square marks the location of the air sample taken. The blue line shows the pathway for the walking survey for CH_4. The aerial image is from Google Maps.

In figure 3, the location of the air sample taken at the DeArmitt pad is marked with a red square (■). During sampling, moderate winds with variable direction were noted. The walked pathway for the handheld monitor survey for CH_4 is shown as a blue line.

In figure 4, the location of the air sample taken at the Hutchinson pad is marked with a red square (■). During sampling, moderate winds with variable direction were noted. The walked pathway for the handheld monitor survey for CH_4 is shown as a blue line.

In figure 5, the location of the air sample taken at the Mamont-South pad is marked with a red square (■). The walked pathway for the handheld monitor survey for CH_4 is shown as a blue line. During sampling, moderate winds with variable direction were noted. Note that the actual Mamont pad is considerably larger than that shown in the figure; the Google Maps image is somewhat outdated. However, the sampling position and walked pathway are fairly accurate.

The results of the field measurements are summarized in table and graphical forms and discussed in the next section.

IV. Results

A. Results of Methane content from air samples at Kuhns, DeArmitt, Hutchinson and Mamont-1 pads and background sampling

i. Air Sample Results

Table 1 below summarizes the results of the methane concentration measurements at the KDHM pads and the background sampling near the Kuhns pad. The sample locations at each pad are shown as the red squares in Figures 2 through 5. Each bag sample was analysed using Fourier-Transform Infrared Spectroscopy for methane presence. When the results are indistinguishable from the atmospheric background (which is approximately 2.0 ppmv), the results are shown as 2.0 ± 1.5 ppmv. Note that the error in this measurement, ± 1.5 ppm, represents the variability of numerous measurements of methane background concentrations.

The methane content of all samples was determined to be indistinguishable from background.

Table 1. Summary of results of methane content analysis from air samples at the Kuhns, DeArmitt, Hutchinson and Mamont pads, including the background measurement taken near the Kuhns pad.

Date	sample	Methane concentration (ppmv)
1/30/2020	Kuhns-1	2.0 ± 1.5
1/30/2020	Dearmitt-1	2.0 ± 1.5
1/30/2020	Hutchinson-1	2.0 ± 1.5
1/30/2020	Mamont-South	2.0 ± 1.5
1/30/2020	background	2.0 ± 1.5

ii. Example walking survey results

The results for the walking survey for Methane at the DeArmitt pad is shown in Figure 6. The pathway walked is shown in Figure 3. The Aeroqual CH_4 monitor has a minimum detectable level of 10 ppm, which is approximately 5x background. As shown in the figure, the sensor reading was about 2-to-3 ppm throughout the entire walked path. This indicates that if there was any methane present, it was at a concentration below the minimum detection limit of the monitor.

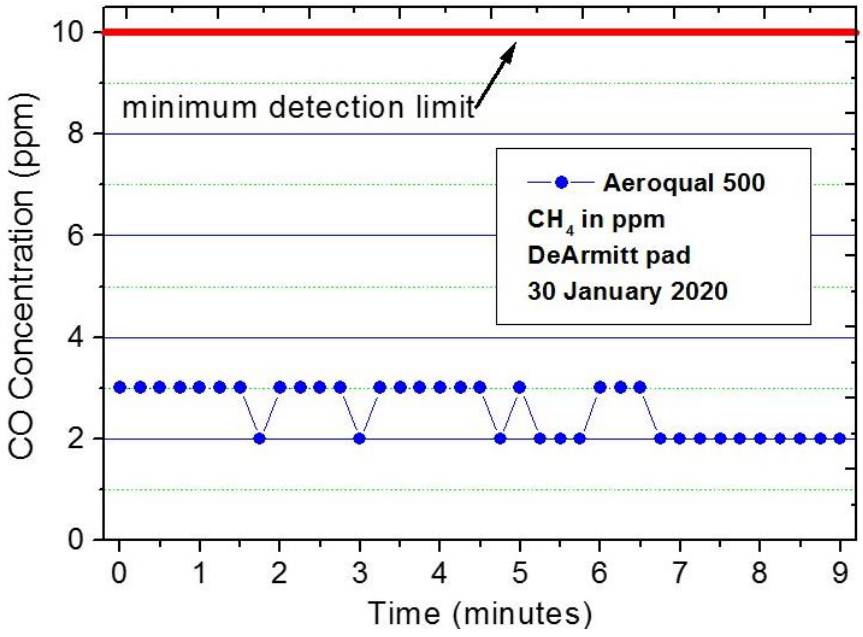

Figure 6. Aeroqual monitor readings for the walking survey about the Kuhns pad on 30 January 2019. The readings show no detected methane concentration above the minimum detectable level of the sensor, 10 ppm.

Very similar results were obtained for the walked paths at the Kuhns, Hutchinson and Mamont-South pads. Because all of the readings are below the minimum detectable concentration of the Aeroqual monitor, results are shown for the DeArmitt pad only.

B. Results of Air Quality Measurements at the Mamont compressor

i. CO logger data results

Figure 7 shows the recorded CO concentration over a 23-day period at the end of the Q2 quarter. Of the three CO data loggers installed on 19 October, two failed. The data logger showed in Figure 7 shows low detected concentrations of CO over the first two-and-a-half weeks, with only a suggestion of the compressor turn-on and turn off cycle. Then starting on January 25, there are 10-12 ppm concentrations detected, but with a smaller than usual on-cycle time. Some of the data during the first two-and-a-half weeks might be attributable to gusting winds. Note also that the winds we noted on 30 January were more moderate and this is consistent with the larger CO concentrations measured starting on 25 January. Note from Figure 1 that position P7 is closest to the compressor and also near a compressor exhaust vent. Although this data looks unusual, there is nothing to suggest that the compressor was not running normally.

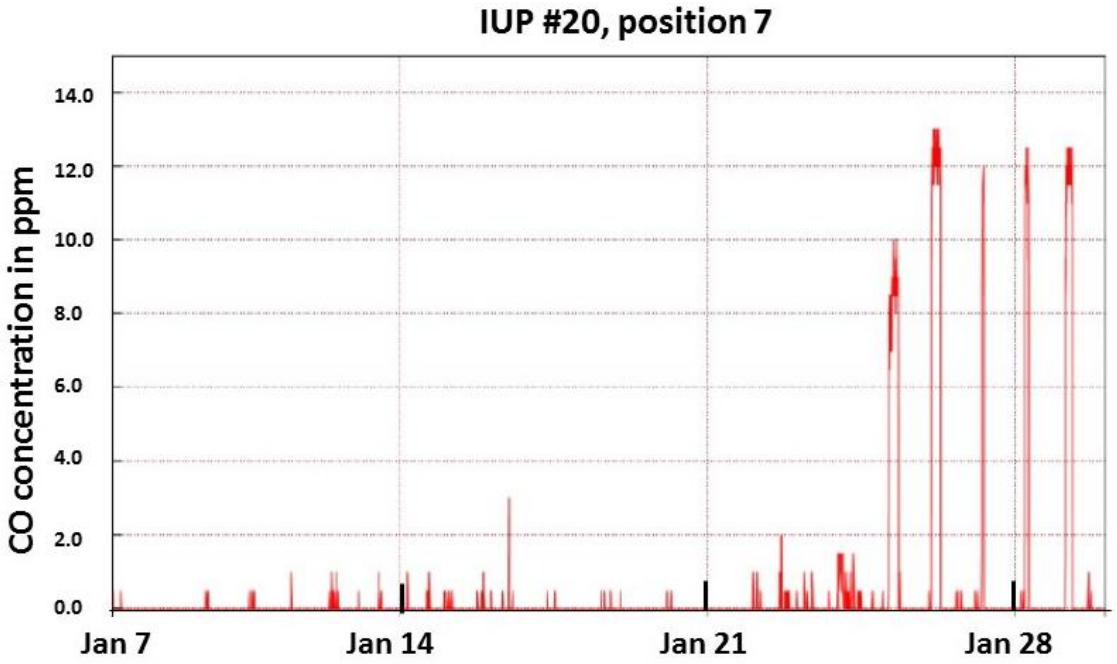

Figure 7. Recorded CO concentration results from data logger #20 at the position P7 (shown in Figure 1) over a 23-day period during Q1.

ii. Aeroqual handheld data

The Aeroqual handheld is a multi-sensor platform. By switching sensor heads, gaseous concentrations of CO, SO_2, NO_2, CH_4, NH_3 and CH_20 at 0.005 to 1.0 ppm

sensitivities are recorded. The handheld sensor has the additional advantage of real-time and mobile measurements. It is useful for gauging the concentration of the other compressor gases in proportion to the CO concentration. Five-minute surveys for each of the compressor gases were taken on 30 January. The compressor was in operation and there was a slight breeze with variable direction at the time of these surveys. The 10.52 ppm concentration reported for carbon-monoxide is the average over the 5-minute survey interval. Note that this average concentration is in modest agreement with the concentration levels in Figure 7, at the far right of the graph, 30 Jan. No concentration above the minimum detectable levels of the instrument were observed for the other compressor gases. The results are summarized in Table 2 below.

Gas	Measured concentration (ppm)	minimum detectable level (ppm)
CO	10.52	0.05
SO_2	0.00	0.04
NO_2	0.000	0.005
CH_4	6	10
NH_3	0.0	0.2
CH_2O	0.00	0.01

Table 2. Summary of results of compressor gas surveys at the Mamont compressor taken on 30 January using the Aeroqual handheld detector and different sensor heads.

V. Summary of Results

The methane content measurements summarized in table 1 indicate methane levels that vary from 0.5 to 3.5 ppmv at the KDHM pads. These levels are totally consistent with the background atmospheric methane level of approximately 2.0 ppmv. The estimated uncertainty of the concentrations of ±1.5 ppmv in table 1 are due to normal fluctuations in background and the accuracy of the FTIR method used.

The compressor gas concentration results summarized in Table 2 indicate that no compressor gases other than carbon monoxide were detected. Figure 7 and Table 2 indicate normal compressor operation.

VI. Contract Status and Notes

On December 20, 2019 John Bradshaw of IUP met with Mr. Brad August (CNX Operational Excellence Department Lead), for safety training. Additionally, Mr. August explained the CNX requirements for conducting air quality sampling at Beaver Run Reservoir. These agreed safety and communication protocols are shown on the next page for reference. In additional to following these protocols, Dr. Bradshaw will always call the George S. Sweeny Water Treatment Plant when arriving at Beaver Run and when leaving after conducting the necessary air sampling and gas monitoring activities.

The agreed safety and communication protocols are shown on the next page for reference.

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December 19, 2019

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Re: CNX site requirements for conducting air quality research

Dear Mr. Bradshaw:

CNX Resources (CNX) understands that Indiana University of Pennsylvania (IUP) has been contracted by the Municipal Authority of Westmoreland County to conduct air quality monitoring at various CNX locations on their property. This letter is to inform you of CNX's safety requirements for continuing to conduct this research at and near our locations. We ask that you review and complete the following:

- Receive CNX Visitor Hazard Training. This training will be good for one year, after which training will need to be obtained again.
- All students must be escorted by someone who has been CNX Hazard trained.
- Provide a courtesy call to the CNX control center at 724-485-3322, 48-hours prior to the date you wish to conduct a site visit. CNX may have an escort available to you.
- Provide another courtesy call to the CNX control center at 724-452-3322, for accountability before and after your site visit.
- The requirement for fire retardant clothing and a 4-gas meter during these visits has been waived.

Should any conditions of the monitoring change, we ask that IUP reach out to CNX to ensure no additional training or requirements are needed. If you have any questions or require any additional information, please do not hesitate to contact me.

Thank You,

Brad August
Operational Excellence Department Lead
CNX Resources Corporation