Pinyon Environmental, Inc.

Corporate Headquarters
9100 West Jewell Avenue Lakewood, CO 80232
TEL 303 980 5200 FAX 303 980 0089
www.pinyon-env.com

July 18, 2017

Noise Monitoring Adjacent to Waste Connections Well Site June 1, 2017, to June 30, 2017

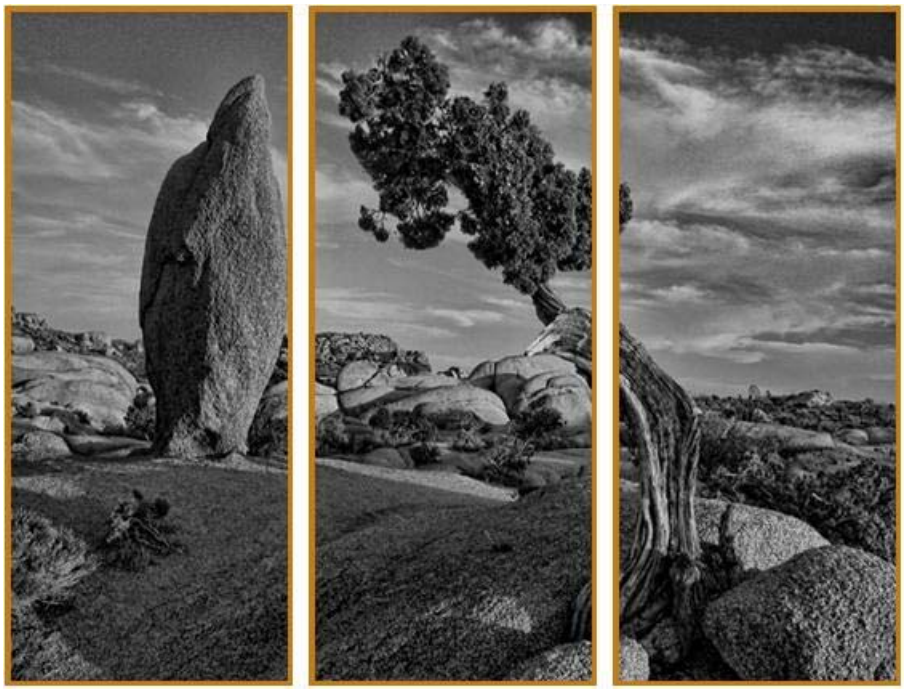
Noise Monitoring of Crestone Peak Resources Operations Erie, Colorado

Prepared For:

Town of Erie
645 Holbrook Street
Erie, CO 80516

Pinyon Project No.:

1/17-695-02.1300



July 18, 2017

Noise Monitoring Adjacent to Waste Connections Well Site June 1, 2017, to June 30, 2017

Noise Monitoring of Crestone Peak Resources Operations Erie, Colorado

Prepared For:

Town of Erie
645 Holbrook Street
Erie, CO 80516

Pinyon Project No.:

I/17-695-02.1300

Prepared by:

Sabrina Williams
Air and Noise Specialist

Reviewed by:

Jill Schlaefer
Air and Noise Specialist

Lauren E. Evans, PE
President

Table of Contents

Tables

Figures

1. Introduction

The Town of Erie (Town) has contracted with Pinyon Environmental, Inc. (Pinyon), to perform noise monitoring near the Crestone Peak Resources (Crestone) Waste Connections well site. Pinyon collected continuous noise measurements at two locations adjacent to the well site (Figure 1). Sampling Site 1 is located approximately 475 feet to the southeast of the well site and collected A-weighted noise measurements. Sampling Site 2 is located near a residential neighborhood approximately 1,400 feet to the southwest of the well site. Both A-weighted and C-weighted noise measurements were collected at Site 2. C-weighted noise was collected at Site 2 only as Site 1 is not located near any occupied structures. Crestone began drilling operations at the Waste Connections well site at approximately 7:00 AM on April 25, 2017, and continued activities at this location throughout the reporting period. Prior to the start of drilling, Pinyon collected baseline noise data from April 14, 2017, to April 25, 2017, that is used to assess how ambient noise levels may change during Crestone's activities during this reporting period. This report details noise measurements collected during drilling and well completion activities, from June 1, 2017, at 7:00 AM through June 30, 2017, at 7:00 PM. The noise monitoring data was analyzed to evaluate noise levels at the two locations during Crestone's well production activities.

Figure 1 Noise Monitoring Locations

2. Methodology

2.1 Noise Monitoring Approach

In accordance with Colorado Oil and Gas Conservation Committee (COGCC) Rule 802, well production facilities may not exceed the maximum permissible noise levels established in accordance to Section 802.b of the rule (Table 2-1). In addition to the maximum permissible A-weighted noise levels, expressed in A-weighted decibels (dBA) (Table 2-1), COGCC Rule 802 specifies that operators may not exceed 65 C-weighted decibels (dBC) measured from the exterior wall of the residence or occupied structure nearest to the noise source at a distance of 25 feet from the structure.

Table 2-1 COGCC Maximum Permissible Noise Levels

Zone	Maximum Permissible Noise Level	
	7:00am to 7:00pm	7:00pm to 7:00am
Residential/Agricultural/Rural	55 dBA	50 dBA
Commercial	60 dBA	55 dBA
Light Industrial	70 dBA	65 dBA
Industrial	80 dBA	75 dBA

dBA A-weighted decibel

Pinyon mobilized to sampling Site 1 and sampling Site 2 and monitored for noise at these locations using 3M Quest SoundPro DL Type 1 datalogging sound level meters. The sound level meters collected continuous measurements of both A-weighted and C-weighted decibels, as applicable to the location. At Sampling Site 1, the sound level meter monitored continuously for A-weighted noise. At sampling Site 2, continuous A-weighted and C-weighted noise measurements were collected. The monitoring period for this report lasted from June 1, 2017, at 7:00 AM through June 30, 2017, at 7:00 PM. Crestone began drilling operations at the well site at approximately 6:00 AM on April 25, 2017 and has continued well drilling and completion activities throughout this reporting period.

The sound level meters are configured with a data logging system that uploads one minute time resolved measurements to a secure online database at 10-minute intervals. The sound level meters are configured with an alert system, that will send a message to Pinyon's noise specialist as soon as the data is uploaded, whenever established noise criteria levels have been exceeded, based on the monitored equivalent continuous noise level (Leq). Leq is the preferred method to describe noise levels that vary over time, resulting in a single decibel value that takes into account the total sound energy over the period of time of interest. The Town and Pinyon agreed to set the alert system at 75 Leq dBA for A-weighted noise at Sampling Site 1, 75 Leq dBA for A-weighted noise at Sampling Site 2 and 70 Leq dBC for C-weighted noise at Sampling Site 2. These noise criteria levels were established based on the COGCC's maximum permissible noise levels, as well as baseline noise monitoring data collected prior to Crestone mobilizing to the well site. The C-weighted noise alert criteria level at Sampling Site 2 is set higher than the COGCC's maximum permissible noise level because baseline noise measurements collected prior to Crestone beginning operations at the well site exceeded this level.

2.2 Noise Monitoring Data Analysis

Pinyon's noise specialist downloaded the noise monitoring data from the online database for this collection period. The data was then formatted into spreadsheets that allowed for analysis of the noise monitoring data. Pinyon utilized statistical methods, as well as graphical representations of the data, to determine baseline noise levels at the two sampling locations during the monitoring period. The baseline analysis of the data indicated

differences in observed noise levels based on day of week; however, statistically significant differences between weekday and weekend noise levels were not observed during this monitoring period. This is likely because Crestone is operating on a seven-day-a-week schedule and not altering their activities on the weekends. COGCC's Rule 802 specifies different maximum permissible noise levels based on time of day (Table 2-1). Therefore, for the statistical analysis of the noise measurements, the monitor data was split into two discrete analytical groups based on time of day:

- Daytime: 7:00 AM—6:59 PM
- Nighttime: 7:00 PM—6:59 AM

The daytime and nighttime analytical groups ended at 6:59 PM and 6:59 AM, respectively, in order to not complete a duplicate analysis of the 7:00 AM and 7:00 PM noise measurements.

To evaluate how noise levels may change over time during Crestone's operations at the well site, the monitoring data was separated into the following discrete analysis periods with each monitoring period then subdivided by time of day:

- April 14th to April 25th, 2017 (Baseline Monitoring Period)
- June 1, 2017, at 7:00 AM to June 8, 2017, at 6:59 PM
- June 8, 2017, at 7:00 PM to June 15, 2017, at 6:59 PM
- June 15, 2017, at 7:00 PM to June 22, 2017, at 6:59 PM
- June 22, 2017, at 7:00 PM to June 30, 2017, at 6:59 PM

Section 3-2 describes how differences in the statistical mean between these monitoring periods were analyzed to confirm the existence of statistically significant increases in average observed noise levels as compared to the baseline monitoring period. To determine the distribution of the noise monitoring data, the statistical mean, median and mode were calculated. The statistical mean, median and mode are used to evaluate the statistical distribution of the noise monitoring data. Large data sets, such as several days of continuous noise monitoring data, tend to follow the normal distribution, which is referred to as the central limit theorem (Shao, 2004). Determining the distribution of the noise monitoring data is important because this distribution is used to determine the appropriate statistical methods for further analysis. The observed relationship between the statistical mean, median and mode for the monitored datasets was determined to follow the normal distribution. The standard deviation for each monitoring periods was also calculated to evaluate the amount of variation in the baseline noise monitoring data and allow for a test of significance in differences between mean noise levels as compared to the baseline monitoring period.

3. Data Analysis Results

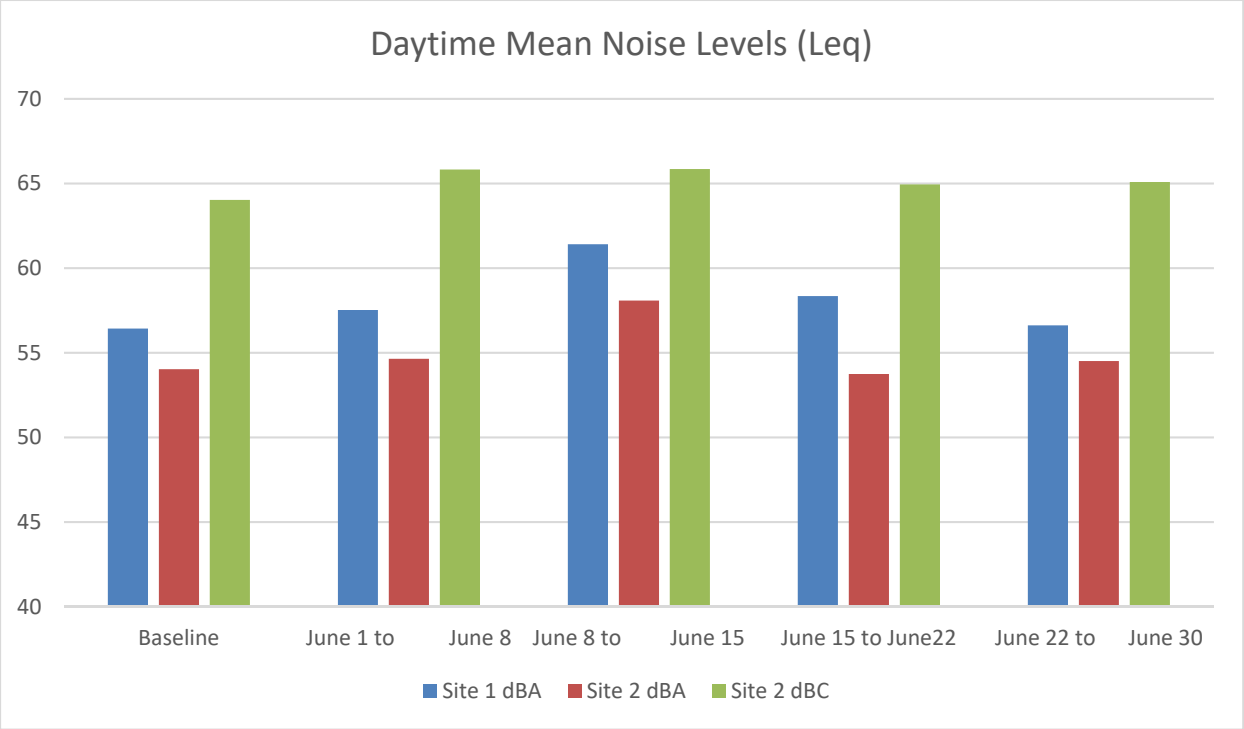
3.1 Graphical Representations of Data

Pinyon evaluated the noise monitoring data and generated several graphs that represented average and maximum noise level conditions during the monitoring periods.

3.1.1 Average Daytime Conditions

The statistical mean for each noise monitoring period was calculated for the daytime hours (7:00 AM to 6:59 PM) (Figure 2). Noise levels were variable between the monitoring periods with the largest increases relative to the baseline observed in A-weighted noise at Site 1 and Site 2.

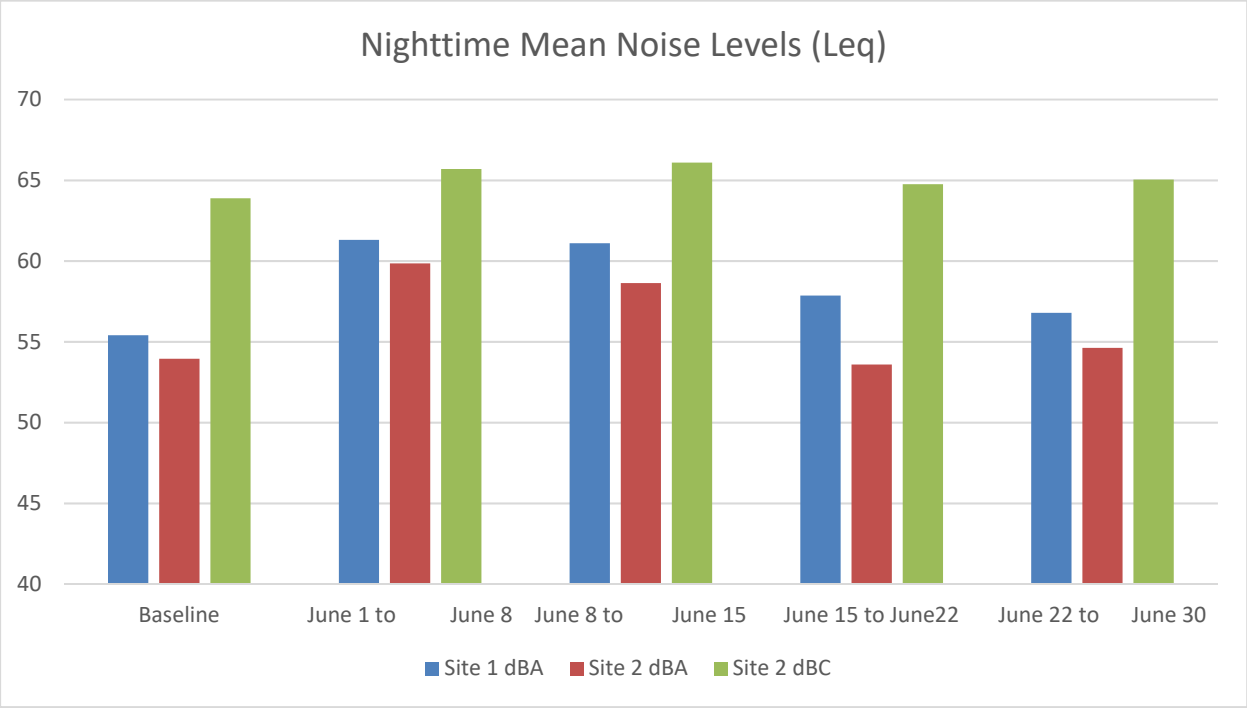
Figure 2 Daytime Mean Noise Levels



3.1.2 Average Nighttime Conditions

Figure 3 shows the statistical mean of noise monitoring data collected during the nighttime period (7:00 PM to 6:59 AM). Large increases in average A-weighted noise levels were observed at Sampling Site 1, which is located closer to the well site than Sampling Site 2. At Sampling Site 2 a large increase in average A-weighted noise was observed from June 8, 2017, to June 15, 2017. During the other monitoring periods, slight increases in A-weighted noise were observed. Only slight increases in average C-weighted noise were observed at Site 2 throughout this reporting period.

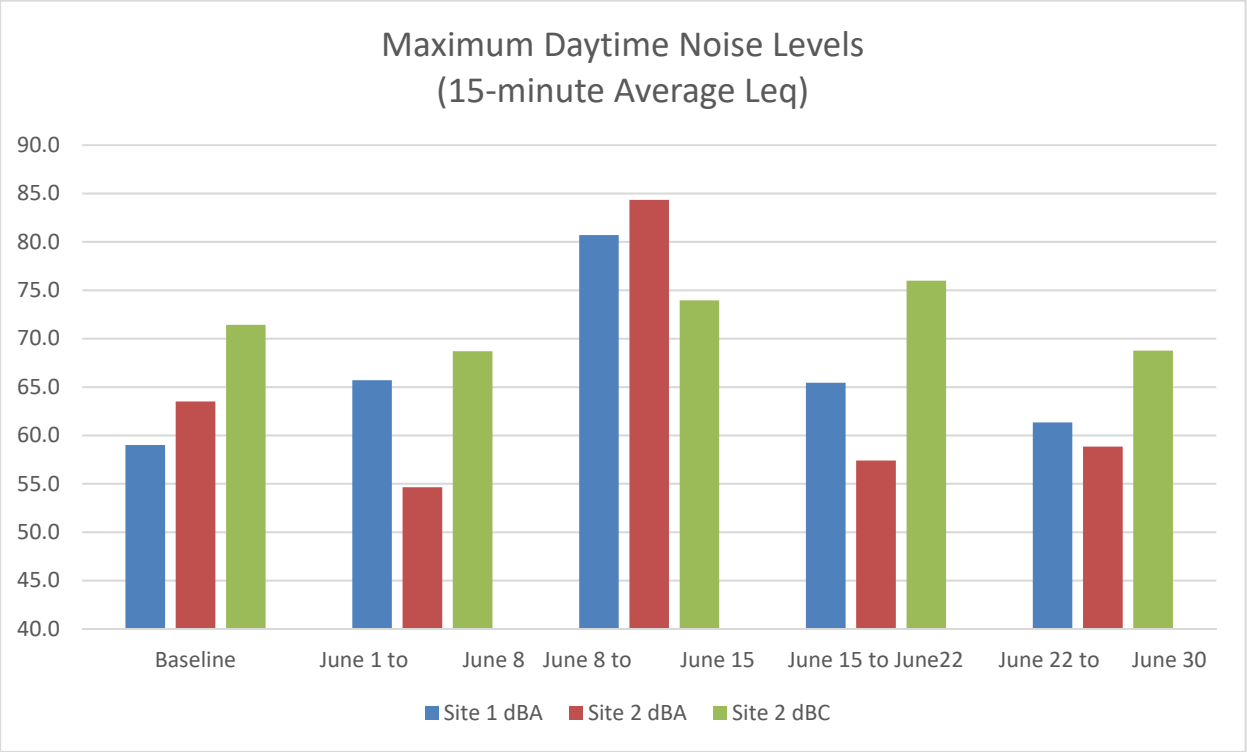
Figure 3 Nighttime Mean Noise Levels



3.1.3 Maximum Observed Daytime Noise Levels

Figure 4 shows the maximum 15-minute average noise measurements collected during the daytime condition during the monitoring periods. The COGCC's maximum permissible noise criteria of 80 dBA were exceeded at Sampling Site 1 and Sampling Site 2 on June 10, 2017. At Sampling Site 1, the maximum permissible noise criteria were exceeded on June 10, 2017, from 4:01 PM to 4:07 PM with a maximum 15-minute average noise measurement of 81 dBA. The maximum permissible noise criteria at Sampling Site 2 was exceeded on June 10, 2017, from 4:01 PM to 4:11 PM with a maximum 15-minute average noise measurement of 84 dBA. The maximum permissible noise criteria for C-weighted noise continued to be above 65 dBC; however, this was also observed during the baseline period prior to Crestone beginning activities at the well site. Pinyon's Noise Specialist notified Town staff of the exceedances in measured A-weighted noise at Site 1 and Site 2 on June 10, 2017. These exceedances were short in duration, lasting a maximum of 10 minutes. The measured exceedance in A-weighted noise was greater at Site 2 and persisted for a longer period of time than Site 1, which is farther away from the Waste Connections well site. Therefore, it is unclear whether the elevated A-weighted noise measurements were attributable to Crestone's activities at the well site or were originating from another noise source in the area.

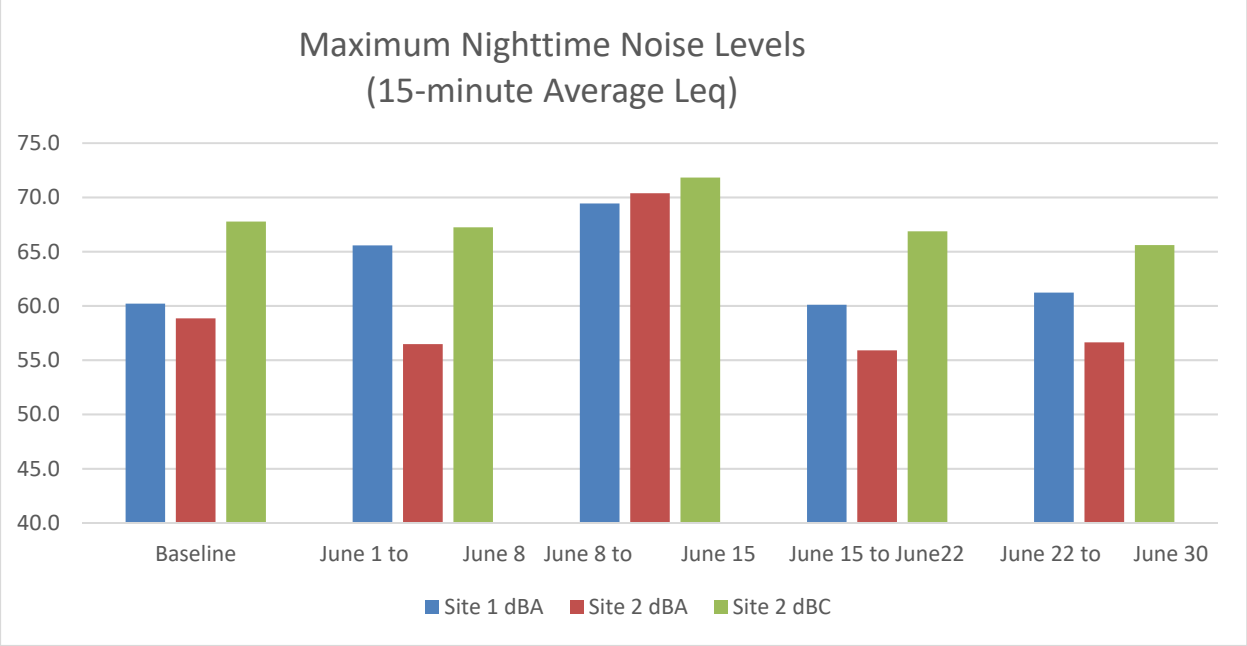
Figure 4 Maximum Daytime Noise Levels



3.1.4 Maximum Observed Nighttime Noise Levels

Figure 5 shows the maximum 15-minute average noise measurements collected during the nighttime monitoring periods. No exceedances of the COGCC's maximum permissible noise criteria were observed for A-weighted noise at Site 1 or Site 2. The maximum permissible noise criteria for C-weighted noise continued to be above 65 dBC; however, this was also observed during the baseline period prior to Crestone beginning activities at the well site.

Figure 5 Maximum Nighttime Noise Levels



3.2 Statistical Analysis of Noise Monitor Data

3.2.1 Increase in Mean Noise Levels as Compared to the Baseline Monitoring Period

Pinyon observed an increase in the statistical mean of the measured noise values from the baseline monitoring period while analyzing the monitoring data. Furthermore, this difference was also observed when generating graphical representations of the measured noise values at the three noise monitors for this reporting period, which was separated into six analysis periods for each monitor. A t-test was performed to determine whether the difference in calculated mean values were statistically significant. A t-test is a statistical method for evaluating the difference in means between two sample groups (Davis, 2003). The higher the t-value the greater the difference between the two means. To assess the level of confidence in the calculated t-value, a p-value is calculated. The p-value is based on the magnitude of the t-value and the total number of samples collected between the two monitoring periods. A p-value of less than or equal to 0.001 means that there is a 99.9% confidence level that the difference between means is statistically significant. The variation in statistical mean, the t-value and the p-value was calculated for the three noise monitors for each analysis period. The calculated p-values were less than 0.001 for all comparisons meaning that the means are statistically significantly different at the 99.9% confidence interval. A 99.9% confidence interval indicates that there is less than a 0.01% likelihood that the calculated differences in statistical mean is insignificant.

At Sampling Site 1 there was a statistically significant increase in A-weighted noise relative to the baseline noise measurements, particularly from June 1, 2017, to June 8, 2017, and from June 8, 2017 to June 15, 2017 (Table 3-1, Table 3-2). This increase is expected at Sampling Site 1, as it is located in close proximity to Crestone's activities, and prior to the start of Crestone's operations there were few other noise sources (e.g., roadways) located within a short distance of the monitor. From June 15, 2017, to June 22, 2017, and from June 22, 2017, to June 30, 2017, a statistically significant increase was still measured; however, the increase in mean noise levels was less than 3 dBA. An increase of 3 dBA or less is considered to be barely perceptible to the human ear.

Table 3-1 Variation in Daytime Statistical Mean for A-weighted Noise at Site 1 LEQ (dBA)

Period	Mean	Change	t-value	p-value
Baseline	56.4	NA	NA	<0.001
June 1 to June 8	61.3	4.9	134.2	<0.001
June 8 to June 15	61.4	5.0	115.6	<0.001
June 15 to June 22	58.3	1.9	69.1	<0.001
June 22 to June 30	56.6	0.2	5.7	<0.001

dBA A-weighted decibels

Table 3-2 Variation in Nighttime Statistical Mean for A-weighted Noise at Site 1 Leq (dBA)

Period	Mean	Change	t-value	p-value
Baseline	55.4	NA	NA	<0.001
June 1 to June 8	61.3	5.9	153.4	<0.001
June 8 to June 15	61.1	5.7	129.7	<0.001
June 15 to June 22	57.9	2.5	72.4	<0.001
June 22 to June 30	56.8	1.4	40.2	<0.001

dBA A-weighted decibels

At Sampling Site 2, there was a statistically significant increase in mean A-weighted noise levels from June 8, 2017, to June 15, 2017 (Table 3-3, Table 3-4). The increase in mean measured noise levels was 4.1 dBA during the daytime period and 4.7 dBA during the nighttime period. This increase is greater than 3 dBA and would be considered perceptible to the human ear. For all other monitoring periods analyzed in this report, the difference in mean A-weighted noise levels was less than 1 dBA, but still statistically significant. A decrease in mean noise levels relative to the baseline monitoring period was observed from June 15, 2017, to June 22, 2017. The decrease in A-weighted noise levels during this analysis period indicates that there were instances of elevated noise measured during the baseline monitoring period coming from sources outside of the well site at Sampling Site 2.

Table 3-3 Variation in Daytime Statistical Mean for A-weighted Noise at Site 2 Leq (dBA)

Period	Mean	Change	t-value	p-value
Baseline	54.0	NA	NA	<0.001
June 1 to June 8	54.6	0.6	29.4	<0.001
June 8 to June 15	58.1	4.1	61.1	<0.001
June 15 to June 22	53.7	-0.3	11.5	<0.001
June 22 to June 30	54.5	0.5	21.8	<0.001

dBA A-weighted decibels

Table 3-4 Variation in Daytime Statistical Mean for A-weighted Noise at Site 2 Leq (dBA)

Period	Mean	Change	t-value	p-value
Baseline	53.9	NA	NA	<0.001
June 1 to June 8	54.6	0.7	33.3	<0.001
June 8 to June 15	58.6	4.7	78.6	<0.001
June 15 to June 22	53.6	-0.4	17.5	<0.001
June 22 to June 30	54.6	0.7	29.0	<0.001

At Site 2 there was a small, but still significant increase in C-weighted noise relative to the baseline noise measurements for all of the monitoring periods (Table 3-5, Table 3-6). The measured increases were less than 3 dBC during the monitoring periods, which is not considered to be perceptible to the human ear.

Table 3-5 Variation in Daytime Statistical Mean for C-weighted Noise at Site 2 Leq (dBC)

Period	Mean	Change	t-value	p-value
Baseline	64.0	NA	NA	<0.001
June 1 to June 8	65.8	1.8	77.0	<0.001
June 8 to June 15	65.8	1.8	59.8	<0.001
June 15 to June 22	64.9	0.9	37.7	<0.001
June 22 to June 30	65.1	1.1	49.1	<0.001

cBC C-weighted decibels

Table 3-6 Variation in Nighttime Statistical Mean for C-weighted Noise at Site 2 Leq (dBC)

Period	Mean	Change	t-value	p-value
Baseline	63.9	NA	NA	<0.001
June 1 to June 8	65.7	1.8	79.7	<0.001
June 8 to June 15	66.1	2.2	81.8	<0.001
June 15 to June 22	64.8	0.9	42.6	<0.001
June 22 to June 30	65.0	1.2	53.7	<0.001

dBC C-weighted decibels

4. Conclusions

Pinyon collected continuous noise measurements at two monitoring locations adjacent to Crestone's Waste Connections well site from June 1, 2017, at 7:00 AM to June 30, 2017, at 7:00 PM. On April 25, 2017, at approximately 6:00 AM, Crestone commenced drilling operations at the well site and has continued activities throughout this reporting period. Prior to the start of Crestone's operations, Pinyon collected baseline data at both locations from April 14, 2017, to April 25, 2017.

An evaluation of the noise measurements collected showed an increase in ambient noise levels that may be attributable to Crestone's activities during this reporting period at both monitoring locations. Analysis of the noise measurements indicated statistically significant differences between observed mean values for the six monitoring periods, which were broken down between daytime and nighttime hours.

During this reporting period, the COGCC's maximum permissible A-weighted noise level was exceeded at Site 1 and Site 2 on June 10, 2017. The maximum permissible A-weighted noise level was exceeded at Site 1 from 4:01 PM to 4:07 PM with a maximum 15-minute average noise level measurement of 81 dBA recorded during this period. The maximum permissible A-weighted noise level was exceeded at Site 2 from 4:01 PM to 4:11 PM with a maximum 15-minute average noise level measurement of 84 dBA recorded during this period. The exceedances at Site 1 and Site 2 were short-term in duration and measured noise was greater at Site 2, which is located farther from the well site than Site 1. Therefore, it is not possible to infer whether this exceedance was attributable to Crestone's activities at the well site or another noise source in the area. Pinyon confirmed with Town staff that they did not receive any noise complaints from residents associated with the period of the measured exceedance.

The COGCC's maximum permissible C-weighted noise levels were exceeded at Site 2 on several occasions. Exceedances of the COGCC's maximum permissible C-weighted noise levels were also observed during the baseline monitoring periods; therefore, a determination cannot be made as to whether elevated C-weighted noise at Site 2 is directly attributable to Crestone's activities at the well site. It is possible that some degree of the increase in C-weighted noise is attributable to activity in the neighborhood adjacent to Site 2.

Pinyon will continue to monitor continuously for noise at Site 1 and Site 2 throughout Crestone's operations at the well site and will compare measured levels of A-weighted and C-weighted noise to baseline levels, in order to assess potential changes in ambient noise levels during various phases of activity and evaluate whether potential exceedances of the COGCC's maximum permissible noise levels are observed.

5. References

Davis, J. 2003. "Statistics and Data Analysis in Geology." Third Edition. Wiley. ISBN: 978-0-471-17275-8

Shao, J. 2004. "Mathematical Statistics." Second Edition. Springer Texts in Statistics. ISBN-13: 978-0387953823