RULE 303.a.(5) CUMULATIVE IMPACTS ANALYSIS: ALAMOSA 5-64 6-1

Prepared for

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Date Plan Finalized: March 24, 2022

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ACRONYMS AND ABBREVIATIONS

APCD	Air Pollution Control Division
BMP	Best Management Practice
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CI	Cumulative Impacts
CDPHE	Colorado Department of Public Health and Environment
COGCC	Colorado Oil and Gas Conservation Commission
EPA	United States Environmental Protection Agency
FLDP	Fluid Leak Detection Plan
HAP	Hazardous Air Pollutant
LED	Light-Emitting Diode
MOVES	Motor Vehicle Emission Simulator
WMP	Waste Management Plan

EXECUTIVE SUMMARY

Crestone Peak Resources ("Crestone") developed this Cumulative Impacts ("CI") analysis for the proposed Alamosa 5-64 6-1 Well Site[1] ("Well Site") pursuant to Colorado Oil and Gas Conservation Commission ("COGCC" or "Commission") Rule 303.a.(5). This Well Site is a proposed oil and natural gas development location in Arapahoe County, Colorado. As part of the development of the Well Site, this CI analysis was developed to address resource impacts to the following six topics:

- Air resources;
- Public health;
- Water resources;
- Terrestrial and aquatic wildlife resources and ecosystems;
- Soil resources; and
- Public welfare.

The aim of the CI is two-fold to identify: i) the potential impacts the Well Site will have on a specific region; and ii) ways the operator can avoid, minimize, or mitigate impacts. The operator of the Well Site, Crestone, has addressed CI for the six resources within this report and detailed further in the submitted interim Form 2B.

Crestone has implemented many strategies to reduce CI in and around the Well Site. One of the most notable is the consolidation of new wells into one well pad. Specifically, under the original proposal, there were three locations proposed: Alamosa 5-64 6-1, Alamosa 5-64 5-6 1AH was planned for the NE4NE4 of Section 5, of T5S-R64W (hereafter "Alamosa North"), and Alamosa 5-64 6-5 4CH was planned for the SW4SE4 of Section 6, T5S-R64W (hereafter "Fountain"). Under Crestone's revised proposal, only Alamosa will be developed. The obvious benefits of consolidating the operations from three to one location is detailed throughout this report. In addition, Crestone owns the vast majority of the oil and natural gas mineral rights in the area including directional spacing units consisting of: i) Sky Ranch 4-65 9-10, ii) Prosper Farms 4-65 11-12, iii) Lone Tree 4-65 15-16, iv) Prosper Farms 4-65 13-14, and v) Sunset-Grimm Motocross 4-65 23-24. Thus, essentially restricting other oil and natural gas development in the surrounding area. Crestone refers to the large continuous leasehold as Watkins Field.

[1] COGCC 100 Series Rules: "**WELL SITE** shall mean the areas that are directly disturbed during the drilling and subsequent operation of, or affected by production facilities directly associated with, any oil well, gas well, or injection well and its associated well pad."

Due to Crestone's unique continuous leasehold and ability to drill longer lateral wellbores and larger side-sails than the previous operators, Crestone was able to consolidate approved drilling locations. This consolidation resulted in the elimination of:

- Two approved well pads (Alamosa North and Fountain) consisting of 16 wells combined;
- Two access roads for the Alamosa North and Fountain well pads; and
- Certain operational redundancies that contribute to CI.

The potential CI are minimized in multiple ways, such as:

- Using electric drill rigs when line power is available;
- Using drilling fluid that does not contain benzene, toluene, ethylbenzene, and xylene ("BTEX") and is virtually odor-free; and
- Reducing the time between when wells are completed and product is delivered to flowlines.

When CI impacts cannot be eliminated or minimized, Crestone works to mitigate issues through strategies such as:

- Isolating noisy equipment with individual sound walls;
- Sending fugitive emissions from drilling to a combustor; and
- Utilizing its own community relations hotline to address citizen complaints in a timely manner.

Examples of the measured and estimated reductions of environmental impacts due to the proposed best management practices ("BMPs") are as follows:

Topic	Estimated Measurable Reduction
Total disturbed acreage	65%
Total VOC emissions	53%
Total water use	40% (drilling and completions)
Ecological impacts	Eliminate impacts to wetlands, streams, drainages, riparian areas
Construction, drilling and completion	Over 264 days

A spreadsheet with the calculations for the reductions above is in **Attachment A**. Crestone strives to continually improve its operations, listen to its stakeholders, and increase transparency on relevant topics.

INTRODUCTION

SLR International Corporation (SLR) was retained by Crestone to develop a CI analysis of the Well Site pursuant to COGCC Rule 303.a.(5) ("the Rule"). This CI analysis addresses resource impacts including:

- Air resources;
- Public health;
- Water resources;
- Terrestrial and aquatic wildlife resources and ecosystems;
- Soil resources; and
- Public welfare.

Additionally, the Form 2B addresses "Surrounding Oil and Gas Impacts and Other Industrial Impacts" pursuant to Rule 305.a.(5)C and D.

1.1 Purpose

As stated in the Rule, this analysis:

> [I]s intended to provide data for the COGCC's cumulative impacts data evaluation repository. The [COGCC] intends to use the data, in cooperation with CDPHE and other partners, to undertake basin-wide, statewide, and other studies to evaluate and address cumulative impacts to relevant resources at appropriate scales pursuant to Rules 304.c.(19) or 904.[2]

This report will provide data to evaluate contributions to CI and, "any measures the Operator will take to avoid, minimize, or mitigate any adverse impacts."

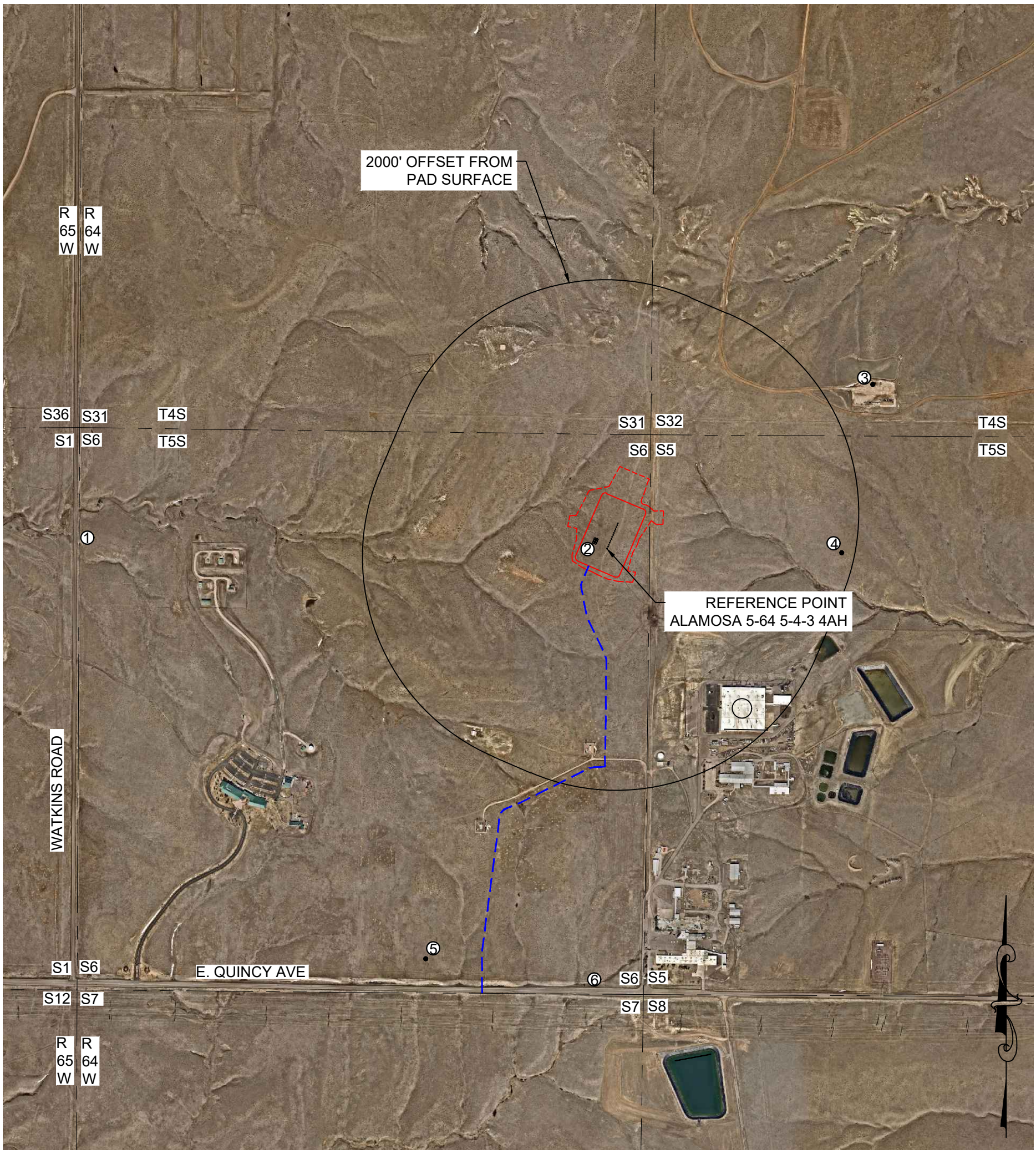
1.2 Well Site Background

The proposed Well Site is in Arapahoe County surrounded by mostly undeveloped shrub and farmland. A site location map is provided in Figure 1. Within one mile of the Well Site, there are two abandoned well sites to the east and southwest and one shut in well site to the northeast. A proposed access road will drop south and slightly west from the Well Site for approximately 0.8 miles till it intersects with E. Quincy Avenue. The next closest public road is Watkins Road located approximately ½ mile due west of the Well Site.

Since the Well Site is a new location, there are currently no pipelines in place and no existing power and water resources. However, a gas pipeline is planned to be in place prior to completing

[2] Colorado Oil and Gas Conservation Commission, 2021. Rules – Permitting Process 300 Series. January 15, 2021.

Figure 1 - Site Location Map



LEGEND

- OIL AND GAS LOCATION
- WORKING PAD SURFACE
- PROPOSED ACCESS ROAD
- SECTION LINE
- OIL/GAS WELL

SCALE: 1" = 1000'

DISTURBANCE DURING CONSTRUCTION = ±19 ACRES
PERMANENT DISTURBANCE AFTER INTERIM RECLAMATION = ± 15 ACRES

REFERENCE POINT: ALAMOSA 5-64 5-4-3 4AH
LAT: 39.648991°
LONG: -104.586126°
UNGRADED GROUND ELEVATION: 5994.55'

NOTE: BEARING & DISTANCES N/A FOR FEATURES LOCATED WITHIN THE OIL & GAS LOCATION

#	FEATURE	BEARING	DISTANCE
1	WATKINS ROAD	WEST	2960'±
2	MINION TANKS	N/A	N/A
3	TEBO 32 3H (SHUT IN)	NE	2975'±
4	ALAMOSA 5-64 5 2V (ABANDONED)	EAST	2205'±
5	ALAMOSA 5-64 6-5 4CH (ABANDONED)	SW	4210'±
6	QUINCY AVENUE	SOUTH	4125'±

CRESTONE PEAK RESOURCES
ALAMOSA 5-64 6-1 1BH, 2AH, 2BH, 3AH, 3BH, 4AH, 4BH,
5-4-3 1AH, 1BH, 2AH, 2BH, 3AH, 3BH, 4AH
SECTION 6, T5S, R64W, 6TH P.M.
ARAPAHOE COUNTY, COLORADO

DRAWN BY: KMG | DATE DRAWN: 06-24-2021
LOCATION DRAWING

Westwood
10333 E DRY CREEK RD.
SUITE 240
ENGLEWOOD , CO 80112
TEL: 720.482.9526
Westwoodps.com
Westwood Professional Services, Inc.

the Alamosa wells. The closest above-ground utility is approximately 0.85 miles south of the Well Site.

The original planned development to drill for the minerals in Watkins Field, as agreed to with Arapahoe County, included:

- The development of a new well pad (Alamosa North) with 8 wells; and,
- The development of a new well pad (Fountain) with 8 wells.

Crestone consolidated these locations into a single Well Site with 14 planned wells. Crestone received local permit approval for the Alamosa 5-64 6-1. Therefore, the need to build operations at Alamosa North and Fountain for mineral development have been eliminated.

1.3 Cumulative Impacts

The CI of this development is detailed in the following sections of this report and in the submitted Form 2B. Specific strategies to reduce CI through avoiding, minimizing, or mitigating impacts on resources are detailed in each section. However, the development plan as developed by Crestone, contains some overarching reductions to CI as detailed below.

Crestone has purchased the oil and natural gas mineral rights in the Watkins Field. This, among other benefits, reduces the CI to the area by streamlining operations that might be otherwise redundant and greatly reduces the likelihood of future well pads built in the area.

Through consolidation, as stated in Section 1.2, Crestone has eliminated:

- The Alamosa North well pad (including a haul road);
- Potential impacts to local drainage features south of the Alamosa North well pad;
- The Fountain well pad (including a haul road);
- Potential impacts to local drainage features south of the Fountain well pad; and,
- Certain operational redundancies that contribute to CI.

This consolidation reduces the amount of disturbed acreage, including impacts to vegetative communities and potentially threatened and endangered species habitat, as well as reductions in VOC emissions and water use. Crestone has a community relations hotline to promptly address citizen complaints and an incident on-call system to put in mitigation measures as needed. This system alerts Crestone to public welfare issues and provides a vehicle to respond to specific citizen complaints.

RESOURCE IMPACTS

2.1 Air Resources

Crestone is committed to meeting or exceeding Colorado air quality requirements and deploys a series of industry-leading technologies and management practices intended to protect public health and the environment for all Coloradans. The efforts to reduce air emissions is focused on continual improvement.

2.1.1 Emission Increases

Pre-production activities and the first year of production at the Well Site will result in emissions from both stationary and mobile sources. Below is a summary of the emissions and all values are in tons per year ("tpy").

TABLE 1 – AIR RESOURCES EMISSIONS

Period	NO_x	CO	VOC	CH_4	C_2H_6	CO_2	N_2O
Pre-Production	154.7	86.5	73.8	24.82	12.0	18,905.2	0.2
Production (Year 1)	17.0	31.7	44.3	49.7	28.4	13,084.7	0.1

Note 1: oxides of nitrogen ("NO_x"), carbon monoxide ("CO"), volatile organic compounds ("VOCs"), methane ("CH_4"), ethane ("C_2H_6"), carbon dioxide ("CO_2"), and nitrous oxide ("N_2O").
Note 2: Emission estimates include both stationary and mobile sources of emissions, including tailpipe emissions

Pre-Production

Pre-production values were calculated using US Environmental Protection Agency's ("EPA's") Motor Vehicle Emission Simulator ("MOVES"). Pad construction specifically includes: i) bulldozing, ii) truck dumping, iii) compacting, and iv) motor grading as activities that will occur during pad construction. Drilling includes boilers and drill rig engines. Fracturing and completions includes frac engines, cement and mortar mixers, generator sets, and pumps. Emission factors were retrieved from AP-42 or EPA Emissions Facts, EPA420-F-08-027. The length of operational time was based on the project development schedule provided in Form 2A.

Production – First Year

The first year of production was calculated using proposed equipment, representative analyses, ProMax simulation models, agency approved emission factors and manufacturer's emission factors. Specifically, emissions were calculated for the equipment in the following table.

Topic	Description
Condensate	A representative analysis was used in a ProMax model to estimate flashing, working, and breathing emissions. Total emissions from the condensate tanks were reduced to one pound of VOCs per barrel ("lb/bbl") of condensate produced.

Topic	Description
	Enclosed combustors with a destruction efficiency of 95% were included to calculate controlled emissions.
Produced Water Tanks	A representative flash liberation analysis was utilized along with 95% destruction efficiency from the enclosed combustors.
Truck Loadout	To be conservative, truck loadout emissions are assumed for the first year of production. An emission factor in lb/bbl was determined using AP-42: Section 5.2 methodology. Emissions from the truck loadout will be routed to the enclosed combustors for a 95% destruction efficiency.
Separator Heater	Emissions are based on maximum heat input in MMBtu/hr and AP-42 Section 1.4 emission factors.
Fugitive Emissions	Emissions from leaks are based on a representative component count of another Crestone facility ratioed by the equipment proposed for this pad. Emission factors from EPA Protocol for Equipment Leak Emission Estimates EPA-453R-95-017 Table 2.8 were used to estimate emissions.
Natural Gas Venting	Venting associated with equipment blowdowns (e.g., compressor blowdowns for maintenance) were conservatively estimated based on event counts for similar existing facilities. All pneumatic devices and pumps will operate on instrument air.
Generator and Compressor Engines	Emissions are based on maximum fuel usage and horsepower ("hp") and both manufacturers guaranteed emissions and AP-42 Section 3.2 emission factors. The use of non-selective catalytic reduction to CDPHE and federal New Source Performance Standard emission limitations was included.

2.1.2 Measures Taken to Avoid, Minimize, or Mitigate Impacts

The consolidation efforts detailed in Section 1.2 included:

- Eliminating construction of two additional pads and haul road; and
- Reducing the total number of new planned wells from 30 to 14 wells.

These efforts resulted in a reduction of emissions by 53% for most air constituents. The operations at the Well Site are designed to minimize and mitigate CI of air emissions including the following practices.

Category	Details and Description
Monitoring	Per CDPHE Regulation 7, continuous emissions monitoring will be performed for baseline air quality and monitoring during all pre-production operations through six-months of initial production. (Project Canary) Conducting weekly forward looking infrared ("FLIR") camera evaluation of completions operations to minimize leaks
Prevention	Piping fugitive emissions during drilling to a combustor Construction of facility prior to flowback operations

Category	Details and Description
	Enclosed flowback equipped with vapor recovery units piped into sales line Gas during flowback will be connected to a combustor (green completion) and production (no flaring of production gas during pipeline downtime). Once available, transferring production oil offsite via lease automated custody transfer ("LACT") unit. Use of instrument air driven pneumatic controllers and pumps. Use Vapor Recovery Towers (VRTs) to reduce storage tank emissions.
Control	Use of certain control equipment such as enclosed combustors for tank and loadout control and non-selective catalytic control for engines.

The following sections provide more detail on key practices and technologies mentioned above.

Continuous Monitoring and Air Quality Testing

Crestone monitors wells during each operational phase through its FLIR camera program to verify that sites are operating correctly and in compliance with regulations. Additionally, Crestone adopted a real-time, continuous air quality monitoring program using technology from Project Canary at its horizontal well sites, representing about 80% of total production. Crestone will implement continuous monitoring at the Alamosa facility per CDPHE Regulation 7. The monitoring will follow all CDPHE requirements. Monitors will be located based on the prevailing winds determined during the baseline monitoring period as well as to avoid sound walls and equipment. They will continuously monitor for methane, total VOCs, particulate matter, and meteorological conditions.

Pipelines and Gathering Facilities

Crestone utilizes pipelines and central gathering facilities to minimize the footprint of well pads, helping reduce truck traffic and eliminating storage tanks and emissions sources.

'Tanklite' Production Facilities

Facilities are smaller in footprint and utilize pipelines for removing oil from a well site. This eliminates long-term storage and decreasing truck traffic. Design requirements include:

- Vapor Recovery Towers ("VRTs") and Vapor Recovery Units ("VRUs") to capture flash gas; and
- Grid-powered instrument air skids, which remove natural gas-actuated pneumatic controllers, a potential emissions area.

Enclosed Flowback Operations

Crestone's company practice is to direct gas from the well to a combustor during the completions process.

2.2 Public Health

In 2019, Crestone hired a third-party expert, CTEH, to design and perform studies to characterize the short-term impacts on local air quality and public health from discrete operational phases at four oil and natural gas well pads being developed in Weld County, Colorado.[3] It is important to note that Crestone is using the same technologies and practices for the Alamosa Well Site as was used in the four locations in Weld County. See **Attachment B** for the finalized report.

The specific goals of this project were to:

- Collect a high-resolution data set of chemical concentrations in air near the well pad and the surrounding communities; and
- Evaluate the impact on risks to public health, if any, from the release of oil and gas-related compounds into the air during specific operational phases of well development.

CTEH conducted real-time air monitoring for total VOCs, hydrogen sulfide, particulate matter, and specific VOCs (such as benzene), simultaneously with other measurements. More than 5,000 total measurements were collected in real-time by CTEH personnel over a period of 26 days.

These data, combined with corresponding documented wind directions, suggest that oil and natural gas-related analytes that may come from the four well pads studies, are not migrating to the surrounding communities to any significant extent. The report included the following statement: "Thus, the real-time and analytical data indicate no adverse health risks to nearby communities, including sensitive individuals, from cumulative exposures to VOCs that may be emitted from pre-production and production activities at Crestone well pads." Since Crestone is planning to use the same practices, technologies, and practices for the Alamosa Well Site as was used in the four locations in Weld County, we are assuming the same conclusion can be relied upon.

2.2.1 Emission Increases

Pre-production activities and the first year of production at the Well Site will result in emissions from both stationary and mobile sources. Below is a summary of the emissions in pounds per year ("lbs/year").

[3] Community Exposure and Health Risk Assessment: Real-Time Air Monitoring and Air Sampling, Crestone Peak Resources, Weld County, CO, written by CTEH, The Science of Ready, dated December 11, 2019.

TABLE 2 – PUBLIC HEALTH EMISSIONS

Period	B	T	EB	X	n-Hexane	2,2,4-TMP	H_2S	HCOH	Methanol	Total HAP
Pre-Production	1,794.5	238.3	6.9	115.5	8,583.9	24.6	<0.01	800.6	<0.01	11,564.2
Production (Year 1)	481.7	162.6	11.0	36.7	2,385.0	1.2	<0.01	1,979.7	294.5	5,352.5

Note 1: benzene ("B"), toluene ("T"), ethylbenzene ("EB"), xylene ("X"), 2,2,4-trimethylpentane (2,2,4-TMP), hydrogen sulfide ("H_2S"), formaldehyde ("HCOH"), total hazardous air pollutants ("Total HAPs").
Note 2: Emission estimates include both stationary and mobile sources of emissions, including tailpipe emissions

Calculations for the above compounds were performed as specified in Section 2.1.1. Production during the first year was calculated using representative gas analyses and agency approved emission factors. Apart from engines and tailpipe emissions, the other HAP emissions are based on the percent weight ("%wt") of a representative gas stream. HAP emissions from the engines were calculated based on maximum fuel usage and AP-42 emission factors. Tailpipe emissions were calculated based on operating hours, AP-42 Section emission factors, and emission factors from US EPA Emissions Facts, EPA420-F-08-027, as applicable.

2.2.2 Potential Acute or Chronic, Short- or Long-Term Public Health Impacts

This section summarizes the impacts found by CTEH. The full report can be found in **Attachment B.** Continuous air quality concentrations were monitored around four well pads over a period of 26 days and during the following operational phases of well pad development:

- Kugel Pad (Loc ID #336435) – drilling
- Bighorn Pad (Loc ID #440933) – hydraulic fracturing
- Bighorn Pad (Loc ID #440933) – flowback
- Cosslett Pad (Loc ID #332117) – production
- Echevarria Pad (Loc ID #459170) – production

The continuous monitoring consisted of total volatile organic compounds (VOCs), hydrogen sulfide (H_2S), nitrogen dioxide (NO_2), and particulate matter ($PM_{2.5}$ and PM_{10}). Of these, only H_2S is specifically regulated under COGCC Rule 314.e.(10).B. Total VOC can be used to inform the levels of individual VOCs that are listed in the rule.

A summary of the applicable continuous air monitoring results is provided in Table 3 below.

TABLE 3 – SUMMARY OF CONTINUOUS AIR MONITORING RESULTS

Analyte	# of Readings	# of Detections	Range [1]
Total VOC	1308	1	18 ppb
H_2S	212	0	< 0.1 ppm

[1] If no detections were observed, the instrument detection limit preceded by a "<" is listed. The detection limit for total VOC is 1 part per billion (ppb).

No H_2S concentrations were detected. The single detected total VOC concentration of 18 ppb was observed over a single 1-minute period. While there is no Health Guideline Value (HGV) for total VOC, the total VOC results can be used as a surrogate for the individual VOCs that are subject to the rule. The CDPHE's approved acute HGVs for individual VOCs reflect intermittent exposures that could occur repeatedly for a few hours to up to 14 days.

Since all other 1-minute total VOC readings collected during the CTEH study were less than the instrument detection level of 1 ppb, it is not possible for any acute HGV to have been exceeded for any individual VOC subject to the rule.

Additional analytical air sampling was conducted at four fixed locations in the community. This sampling was performed during the flowback phase, which has been identified by the CDPHE as an operational phase that may produce higher emissions than other phases. Air samples were collected using whole air canisters in accordance with U.S. EPA Method TO-15. The air samples were collected for 24-hour periods over five consecutive days.

A summary of the whole air canister results is provided in Table 4 below.

TABLE 4 – SUMMARY OF WHOLE AIR CANISTER AIR MONITORING RESULTS

Analyte	# of Samples	# of Detections	Range of Detections (ppb)	ATSDR Acute HGV (ppb) [1]
Benzene	20	19	0.207 - 0.896	9
Ethylbenzene	20	2	0.295 - 0.38	5000
m,p-xylenes	20	8	0.429 - 1.22	2000
o-xylene	20	3	0.214 - 0.66	2000
Toluene	20	20	0.358 - 13.1	2000

[1] The Agency for Toxic Substances and Disease Registry (ATSDR) HGVs are approved by CDPHE and represent exposure durations of one to 14 days.

All detections for each analyte were below their respective HGV.

For more details on the CTEH study, please see Attachment B.

2.2.3 Disproportionately Impacted Community

This Well Site is not located in a "disproportionately impacted community" as determined by Census Bureau data on the COGCC GIS map. There is one building located approximately 1,407 feet from the edge of the Working Pad Surface. There are no other buildings or sensitive receptors within 2,000 feet of the Working Pad Surface for the Well Site.

The Well Site is located in a rural area with relatively sparse ranches that can be categorized as on the upper range of values for homes in Colorado. Higher density housing that could be considered disproportionally impacted communities is located more than 1 mile from the Well Site and will not be affected by the oil and natural gas development activities.

2.2.4 Measures Taken to Avoid, Minimize, or Mitigate Impacts

Similar measures used to reduce CI to Air Resources are used for Public Health. See Section 2.1.2 for details of these measures.

2.3 Water Resources

Water is a critical resource and Crestone takes responsible water use seriously. Water safety and conservation are priorities during operations – from drilling a new well and producing natural gas or oil, to the treatment and disposal of water. Each phase of operations has unique water requirements and challenges. Crestone adapts its water management approach to each well based on geological factors, local water resources, stakeholder feedback and operational needs. Protection of water sources starts with proper design and construction of drilling sites and steadfast field inspection and logging to maintain the integrity of all components throughout its lifespan. Crestone strives to act as good stewards through a continued commitment to improving processes.

2.3.1 On-Location Storage Volume Evaluation

Planned on-location storage volume (measured in barrels ["bbls"]) of the following are provided below in Table 5: i) oil; ii) condensate; iii) produced water; and iv) other volumes of stored hydrocarbons, chemicals, or exploration and production ("E&P") waste fluids. Storage of any of these materials are done in state-approved containment with a focus on preventing spills or releases. If a spill or release occurs, Crestone works to minimize the extent of the spill and mitigate any impacts.

TABLE 5 - ON-LOCATION STORAGE AT PROPOSED ALAMOSA PAD

Phase	Est. Oil and Condensate (bbls)	Est. Produced Water (bbls)	Other Storage (bbls)
Drilling	0	0	0
Completion	0	0	0
Production	4,500	1,000	48 (See Note 1)

Note 1: 12 bbls each of corrosion inhibitor, paraffin inhibitor, H2S scavenger, methanol

On-location water is stored for use in drilling and completions and produced water is stored prior to disposal or recycling or reuse in Crestone's operations. For drilling, a mixture of clay and water is used to carry rock chips or cuttings to the surface, cool and lubricate the drill bit, and maintain pressure in the wellbore (or drilled hole) During completions, a combination of water, sand and a small amount of additives is injected at high pressure through the well to the target rock formation deep underground. This injected fluid creates small cracks in the rock, allowing natural gas and oil to flow to the surface.

2.3.2 Potential Contaminant Migration Pathways

There are four (4) NHD/NWI stream/riverine features and one (1) NWI freshwater pond mapped within ½ mile of the Well Site; however, all are greater than 1000 feet from the Well Site and do not pose a constraint to the project.

There is one unmapped potential wetland approximately 550 feet southeast of the proposed Working Pad Surface (approximately 440 feet east-southeast of the proposed Site boundaries); no impacts to this feature are expected to occur and no chemical/fuel storage will occur within 500 feet of it. No other potential wetlands or waters were observed around the Site.

The Well Site is not located within a Federal Emergency Management Agency (FEMA)-mapped 100-year floodplain. The closest mapped 100-year floodplain is greater than one mile from the Well Site. Also, there are no springs or irrigation ditches within one mile of the Well Site.

The Well Site sits on a narrow ridge with elevations decreasing to both the east and west of the Well Site. Therefore, stormwater is assumed to flow away from the Well Site toward the riverine features located in both directions (Deacon Run drainage to the east and Kersten Gully drainage to the west). However, Crestone works to implement BMPs for stormwater at the Well Site to mitigate potential contamination migration pathways.

Groundwater may also be impacted by changes to stormwater patterns that occur during the development of a pad. However, BMPs at the Well Site are implemented to reduce impact to stormwater drainage and infiltration to groundwater resources. Arapahoe County is the relevant local government for the Well Site and requires an approved Grading, Erosion and Sediment

Control Plan ("GESC") prior to construction of the pad. Crestone has an approved GESC for the Well Site. Finally, the soil is classified as well-drained silty loam.

Spills and releases are potential sources of contaminants that could reach a migration pathway. Crestone works to prevent spills and release from occurring and mitigates impacts if a spill or release occurs. Crestone has and follows a strong spill prevention and management program.

In addition, another potential migration pathway is through the wellbore. As an important component of Crestone's operations, water protection starts with an effective wellbore design and the proper execution of wellbore construction procedures. Every natural gas or oil well has an engineered steel casing system that is cemented externally to prevent any fluids from moving from the wellbore to groundwater aquifers. A casing and cementing program is designed for all types of Crestone drilling. The proper wellbore design, with layers of protective casing, protects groundwater throughout the development process and the life of the well. Crestone constructs and operates its wells in accordance with state requirements to protect potential contamination of soil and groundwater from its wellbores.

2.3.3 Potential Impact to Public Water System Intakes

There are no Public Water System intakes within one mile of the Well Site.

2.3.4 Surface Water and Groundwater Usage

Crestone sources its water from leased water rights, municipal sources, and recycling. The company works to establish closed-loop systems when appropriate and feasible. For this Well Site, produced water will be disposed of in state-approved disposal wells, until a closed loop system may be established.

Water use is estimated based on the number of wells proposed. Water usage considers the water used to drill and fracture a well. The water usage calculations assume that the water use occurs within the first two weeks of drilling and production. The volume of water used for drilling a well is assumed to be equal to the wellbore fluid volume (400 bbls/well).

The fracture water use calculations assume that the water usage is approximately 2.7 million gallons per well, the average reported water usage for fracturing per well in the Wattenberg Sandstone in Colorado[4], resulting in an estimate of 38 million gallons of water used. It is estimated that approximately 20 to 40% of initial fracturing fluid volume will be recovered as flowback water.

[4] Goodwin, S., Carlson, K., Douglas, C., & Knox, K. (2012). Life Cycle Analysis of Water Use and Intensity of Oil and Gas Recovery in Wattenberg Field, Colo. *Oil and Gas Journal, 110*(5), 48-59.

Water for drilling operations will be sourced from a fresh-water hydrant from Rangeview Metropolitan District near the intersection of 6th Avenue and N. Hayesmount Road. Fresh water used for completion operations will be transported by a temporary water line ("Layflat"). The temporary Layflat will be fed from Rangeview Metropolitan District's Sky ranch and Lowry Storage.

Farmers Reservoir and Irrigation Company (FRICO) will be a secondary or supplemental water source. FRICO and Crestone Peak Resources Operating LLC have an operating plan for delivery of non-potable water from Barr Lake. Water from Barr Lake is transferred via Layflat to the Well Site location. All water coming from FRICO is fresh water.

Crestone estimates that the Alamosa Pad location will consume approximately 7,500,000 to 8,500,000 bbls of water. Daily consumption will be approximately 96,600 bbls per day.

Crestone's primary measure to reduce the usage of fresh water is to utilize Reg 84 - Reclaimed Water for frac operations, pending availability. In addition, if on-going operations are necessary, Crestone will re-evaluate the ability to use water from producing wells in the area. Currently this area produces less than 500 BBL so water from the existing wells would displace only 30,000 bbls of fresh water.

Once the 14 wells are operational at the Well Site, approximately 933,338 bbl/yr of produced water will be generated the Well Site. In the future, Crestone will evaluate whether the produced water can be recycled in its operations.

2.3.5 Impacts of Consolidation on Water Resources

The consolidation detailed in Section 1.2 minimizes CI impacts to Water Resources. Specifically, the consolidation will:

- Reduce the total estimated produced water generated by approximately 1.07 MMbbl/yr;
- Reduce water usage by approximately 5,400,000 bbl during drilling and completions;
- Potential impacts to local drainage features south of the Alamosa North and Fountain well pads; and,
- Reduce stormwater discharges from Well Sites by eliminating two well pads.

In addition to these reductions, Crestone plans to take product away from the Well Site via trucks. The Well Site will have spill containment around oil and produced water storage tanks. The engineered SWMP requires that stormwater flow is directed to a single outlet which is engineered to include oil removal from stormwater and allows for visual inspection to work to prevent oil from leaving the location in the event of soil staining. This mitigates potential contamination of soil, groundwater and surface water from spills.

2.3.6 Measures Taken to Avoid, Minimize, or Mitigate Impacts to Water Resources

In addition to water use reduction measures, Crestone take measures to prevent spills. Specifically, Crestone's Fluid Leak Detection Plan ("FLDP") provides details on Crestone's actions to prevent and manage leaks and releases. Crestone is committed to safe and environmentally responsible management to all COGCC rules governing environmental impact prevention and fluid leak detection. We use numerous BMPs and strategies to enhance fluid leak detection and minimize spills.

Below are a few examples of the BMPs and strategies used during drilling and completions:

Phase of Operation	Best Practices and Strategies
Drilling	Inspections occur twice a day on all fluid equipment and logged into a data system General secondary containment is placed under equipment Portable containers are stored inside portable containment Double-walled tanks are installed where available Closed loop drilling systems are used Continuous monitoring on equipment occurs
Completions	Inspections occur twice a day on key equipment and the results into data management system There are frequent routine inspections during operation General secondary containment is placed under equipment Portable containers are stored inside portable containment Double-walled tanks are installed where available Continuous monitoring on equipment occurs
All	For leak prevention, Crestone conducts: • Weekly facility inspections • Annual SPCC inspections • Equipment integrity inspections • Flowline and pipeline pressure testing Training is provided to Crestone employees and expected for all contractors and subcontractors working for Crestone

In addition, Crestone operates under a Waste Management Plan ("WMP") tailored to each location. Crestone's WMP provides guidelines and minimum requirements for waste management according to the Waste Management Corporate Standard, Crestone's Management, and state and federal laws. The guide is designed to reduce the impact of company operations on the environment and maintain compliance with company policy and regulatory requirements for waste management. By detailing handling practices and waste minimization and recycling information, Crestone works to minimize impacts associated with waste management.

2.4 Terrestrial and Aquatic Wildlife Resources and Ecosystems

2.4.1 High Priority Habitats

There are no high priority habitats within one mile of the Well Site. There is no suitable habitat for Threatened, Endangered or Candidate Species on the Well Site. There is suitable habitat for nesting raptors (including bald eagles) within ½ mile of the Well Site and for burrowing owls within ¼ mile of the Well Site; however, no activity has been recorded on the Well Site. The Well Site is not located within any CPW-mapped High Priority Habitats. There are Aquatic Native Species Conservation Waters over 5,280 feet from the Well Site, and no impacts are anticipated.

2.4.2 Acreage of New or Expanded Surface Disturbance

The total acreage of surface disturbance during construction will be 13.00 acres. After reclamation, permanent disturbance will be 9.50 acres. Current land use of the 13.00 acres is made up of undeveloped rangeland used for grazing. Within a one-mile radius of the Well Site, approximately 1660 acres are in undeveloped rangeland and 594 acres are subdivided for industrial use.

2.4.3 Measures Taken to Avoid, Minimize, or Mitigate Impacts

The consolidation detailed in Section 1.2 minimizes CI impacts to terrestrial and aquatic wildlife resources and ecosystems. Specifically, these changes:

- Eliminate the Alamosa North well pad;
- Eliminate the Fountain well pad;
- Eliminate potential impacts to local drainage features south of the Alamosa North and Fountain well pads; and,
- Eliminate operational redundancies that contribute to cumulative impacts.

2.5 Soil Resources

2.5.1 Topsoil and Vegetative Communities Impacts

New construction at the Alamosa Well Site will result in the stripping of approximately 10,487 cubic yards of topsoil (estimate based on six inches of topsoil stripping). Undeveloped rangelands will be the primary ecological and vegetative communities disturbed by the development.

2.5.2 Measures Taken to Avoid, Minimize, or Mitigate Impacts

The consolidation detailed in Section 1.2 minimizes CI impacts to soil resources. Specifically, these changes:

- Eliminate the Alamosa North well pad;
- Eliminate the Fountain well pad;

- Eliminate potential impacts to local drainage features south of the Alamosa North and Fountain well pads; and,
- Eliminate operational redundancies that contribute to cumulative impacts.

Additionally, of the 13.00 acres planned to be disturbed by the expansion of the Well Site, 3.50 acres will be reclaimed shortly after development activities for a working surface disturbance of 9.50 acres.

2.6 Public Welfare

Crestone strives to minimize the temporary and ongoing potential impacts oil and gas operations have on neighboring communities. We monitor for and deploy a number of mitigation strategies to minimize any potential public welfare impacts associated with our operations. Table 6 summarizes the number of buildings within one mile of the Well Site which could be impacted by Well Pad construction and operation.

TABLE 6 - NUMBER OF BUILDINGS POTENTIALLY IMPACTED BY WELL SITE DEVELOPMENT

Building Unit Type	0-2000 ft	2001-5280 ft
Residential Building Units	0	0
High Occupancy Building Units	0	0
School Facilities	0	0
Child Care Centers	0	0

The closest residential building unit, high occupancy building unit, designated outdoor activity area, school, and childcare facility are more than one mile from the Working Pad Surface of the Well Site.

There are potential sources of short-term and long-term impacts related to the following noise, light, odor, dust, and recreational and scenic values. These potential sources include those in the following table:

Topic	Description
Noise	During periods of drilling and hydraulic fracturing, noise may exceed COGCC Noise Limits at the residential building units without proper abatement. Additionally, intermittent noise from vehicular traffic on roads and from heavy equipment during construction will occur. To mitigate these impacts, during production, compressors and generators will operate onsite and vehicular traffic will travel on roadways.

Topic	Description
Light	No night work and no permanent lighting will be installed on the Well Site during pre-production activities. The development of the project will require work operations to be performed 24-hours a day during drilling, completion, drill-out, and flowback stages, requiring the use of temporary lighting and lights permanently affixed to development equipment (e.g., drill rig).
Odor	Odors from typical oil and natural gas development and production emission sources are expected.
Dust	Dust will be generated based on vehicle trips to and from the Well Site on dirt haul roads, by equipment operating at the site, and site activities such as use of proppant used during completions.
Recreation and Scenic Values	There are no State Parks, State Trust Lands, State Wildlife Areas, Designated Outdoor Activity Areas, or mapped trails that support outdoor recreational activities within one mile of the Well Site.

2.6.1 Measures Taken to Avoid, Minimize, or Mitigate Impacts

This Well Site is physically distant from most receptors. Pad construction, drilling, hydraulic fracturing, and well completion activities will likely occur in a time frame prior to substantial development in the area. However, Crestone is committed to decreasing public welfare impacts in the area. These measures include the following measures to mitigate potential impacts to noise, light, odor, dust, and recreation and scenic values.

Noise Mitigation

Noise impacts during pre-production activities will be during the construction, drilling and completions phases. The closest main road is 4,718' south of the location and the surrounding areas are all industrial or rangeland. There are no residential building units within 1 mile of the Well Site. Receptors of noise impacts could be industrial operations.

Light Mitigation

The drill rig will be equipped with tinting around the rig derrick, lights will be tinted and downward and inward pointing. Other lights are also shrouded to further reduce light pollution. Additionally, as part of the consolidation, lighting of two additional pads have been eliminated.

Light pollution Best Management Practices (Lighting BMPs) will also be used to minimize light pollution during all phases of the project's proposed operations. Oil and gas facilities and equipment shall be operated in such a manner that lighting does not constitute a nuisance or hazard to public welfare and will be minimized throughout all phases to the maximum extent practicable. All lighting shall conform to nationally recognized industry and federally mandated safety standards.

Odor Mitigation

Crestone utilizes a new high-performance drilling fluid, NeoFlo™, that is virtually odor-free, non-toxic and readily biodegradable. Other benefits of using this fluid include:

- Reduced drilling time, meaning less time on location;
- Minimal aromatic content and intrinsically cleaner when compared to conventional fluids such as diesel and straight run gas oil; and
- Low vapors, reducing the impact on health and safety of the nearby community and the on-site team.

Also, mud chillers are used to reduce odors from mud as it is removed from the wellbore and drill pipe is wiped down during tripping events to prevent odors from formation cuttings. Crestone consistently monitors operations and is committed to improving and adjusting operations as needed to minimize the impact on nearby properties.

Dust Mitigation

Crestone will follow its fieldwide fugitive dust suppression plan. This plan includes:

- Application of freshwater or magnesium chloride for suppression;
- Use of high-quality construction materials for roads;
- Reestablishment of vegetation;
- Establishment of speed limits; and
- Limiting or stopping work during high wind conditions.

Additionally, as part of the consolidation, elimination of two additional pads and associated haul roads will reduce dust impacts.

Mitigation for Recreation and Scenic Values

Crestone plans to construct visual mitigation berms using spoil piles on the NW corner of the pad for visual mitigation. There are no recreational areas (parks, trails, etc.) within a one-mile radius of the Well Site, so recreation impacts are negligible.

ATTACHMENT A: MEASURED AND ESTIMATED REDUCTIONS OF ENVIRONMENTAL IMPACTS

Civitas Resources Inc.
Alamosa Consolidated Well Pad
Cumulative Impacts Analysis
Attachment A - Measured and Estimated Reduction of Environmental Impacts

Disturbed Acreage - Original Plan vs Consolidated Plan			
Site Name	**Original Acres**	**Consolidated Acres**	**Acres Eliminated**
Alamosa Mega	13.0	13.0	0.0
Alamosa North	11.6	0.0	11.6
Fountain	17.7	0.0	17.7
Alamosa Mega Haul Road	7.0	7.0	0.0
Alamosa North Haul Road	3.0	0.0	3.0
Fountain Haul Road	4.1	0.0	4.1
Totals	**56.4**	**20.0**	**36.4**

VOC Emissions - Pre-Production Through 1 Years of Production			
Original Plan vs Consolidate Plan			
Site Name	**Original Emissions (tpy)**	**Consolidated Emissions (tpy)**	**% Reduction**
Alamosa Mega	118.1	118.1	**53.4%**
Alamosa North	67.7	0.0	
Fountain	67.7	0.0	
Totals	**253.5**	**118.1**	

Drilling and Completions Water Use - Original Plan vs Consolidated Plan			
Site Name	**Original Water Use (mm gal)**	**Consolidated Water Use (mm gal)**	**% Reduction**
Alamosa Mega	8,000,000	8,000,000	**40.3%**
Alamosa North	2,700,000	0.0	
Fountain	2,700,000	0.0	
Totals	**13,400,000**	**8,000,000**	

Construction, Drilling, and Completion Time			
Estimated Original Plan vs Consolidated Plan			
Site Name	**Original Time Frame (days)**	**Consolidated Time Frame (days)**	**Reduction (days)**
Alamosa Mega	259	259	**264**
Alamosa North	132	0.0	
Fountain	132	0.0	
Totals	**523**	**259**	

ATTACHMENT B:
SCREENING LEVEL HEALTH RISK EVALUATION OF COMMUNITY AIR MONITORING AND SAMPLING STUDY

THE SCIENCE OF READY℠

SCREENING LEVEL HEALTH RISK EVALUATION OF COMMUNITY AIR MONITORING AND SAMPLING STUDY

Prepared on Behalf of:

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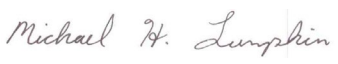
Reviewed by:	Michael Lumpkin, PhD, DABT		12/11/2019

Executive Summary

CTEH, LLC (CTEH) was requested by Crestone Peak Resources (Crestone) to design and perform studies to characterize the short-term impacts on local air quality and public health from discrete operational phases at four oil and gas wellpads being developed in Weld County, Colorado: Big Horn, Cosslett, Echevarria, and Kugel wellpads. The specific goals of this project were to: (1) collect a high-resolution data set of chemical concentrations in air near the wellpad and the surrounding communities, and (2) evaluate the impact on risks to public health, if any, from the release of oil and gas-related compounds into the air during specific operational phases of well development.

To address these goals, CTEH staff conducted real-time air monitoring for total volatile organic compounds (VOCs), hydrogen sulfide (H_2S), particulate matter ($PM_{2.5}$ and PM_{10}), and specific VOCs such as benzene with simultaneous observations of odors, wind direction, and wind speed relative to the wellpad. CTEH also collected discrete air samples around the perimeter of the wellpads to be analyzed by a certified analytical laboratory. These samples were analyzed for VOCs, including benzene, toluene, ethylbenzene and xylenes (BTEX compounds). The study focused on collecting data during activities that may produce the greatest emissions for each phase of operations. This approach uses a robust and widely accepted method for characterizing potential public health risks. This report provides the data and health risk evaluations from real-time air monitoring and analytical sampling (BTEX compounds) conducted in the communities surrounding the wellpads during the various phases of operations to date. Findings contained in this report include the drilling phase at Kugel wellpad, hydraulic fracturing and flowback phases at Big Horn wellpad and the production phases at the Cosslett and Echevarria wellpads.

More than 5,000 total measurements were collected in real-time by CTEH personnel in the communities surrounding the wellpads over a period of 26 days. Additionally, 20 analytical samples were collected from four locations around the Bighorn wellpad to evaluate potential community exposures over 5 days of flowback activities. Approximately 99% of the real-time VOC measurements recorded in the communities were non-detections, which means that VOCs were not present or that VOC concentrations were less than the instrument detection limit of 1 ppb for VOCs. This detection limit is well below the federal (ATSDR) health guideline level for short-term adverse health effects for benzene (9 ppb). Of the over 1,500 measurements collected for benzene specifically or VOCs in general, just one reading was at a detectable level but did not exceed public health guideline values for the BTEX compounds. No H_2S was ever detected, and just one of over 1,500 readings taken for PM, taken on along a dirt road, was higher than typical background values. In the 20 analytical air samples collected in the surrounding community during flowback, the maximum measured concentrations for BTEX compounds were also all 10 to 13,000-times lower than their respective federal acute health guideline values.

These data, combined with corresponding documented wind directions, suggest that oil and gas-related analytes that may come from the wellpads are not migrating to the surrounding communities to any significant extent. Thus, the real-time and analytical data indicate no adverse health risks to nearby communities, including sensitive individuals, from cumulative exposures to VOCs that may be emitted from pre-production and production activities at Crestone wellpads.

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1.0 Introduction

In the State of Colorado, concerns have been raised by government, non-government, and individual stakeholders regarding the impact of air quality on public health at regional and local (i.e., neighborhood, city/town, county) levels from oil and gas drilling and completion activities. Based on these stakeholder concerns, CTEH, LLC (CTEH) was requested by Crestone Peak Resources (Crestone) to design and perform studies to characterize the short-term impacts on local air quality and public health from discrete operational phases at four wellpads being developed in Weld County, Colorado: the drilling phase at Kugel wellpad, hydraulic fracturing and flowback phases at Big Horn wellpad and the production phases at the Cosslett and Echevarria wellpads.

CTEH is an environmental and human health consulting firm specializing in health risk assessment and regulatory compliance, as well as responding to hazardous materials emergencies and chemical releases.

Specific Goals: CTEH designed and executed a study of the Crestone wellpads with the specific goals of (1) collecting a high-resolution data set of chemical concentrations that have potential for public health impacts in air near the wellpad and the surrounding communities, and (2) evaluating the impact on short-term risks to public health, if any, from the release of oil and gas-related compounds into the air during specific operational phases of well development and production.

The specific analytes evaluated in this study were selected based on their association with oil and gas operations and their potential for public health impact. For example, multiple studies conducted during all phases of natural gas well development, both on-site and in residential communities near oil and gas sites, including studies conducted by the Colorado Department of Public Health and Environment (CDPHE), have shown that benzene has the greatest potential to cause short-term and long-term health effects and therefore, is considered a risk driver.[1][2][3][4]

This report provides an overview and a screening level analysis of data collected by CTEH during real-time air monitoring and air sampling (during flowback) in communities surrounding the Crestone wellpads.

[1] https://www.colorado.gov/pacific/cdphe/oil-and-gas-community-investigations
[2] McMullin, T.S., Bamber, A.M., Bon, D., and VanDyke, M. (2018). Exposures and Health Risks from Volatile Organic Compounds in Communities Located near Oil and Gas Exploration and Production Activities in Colorado (U.S.A.). International Journal of Environmental Research and Public Health. Jul 16; 157 (7). DOI: 10.3390/ijerph15071500
[3] Collett, J.; Ham, J.; Hecobian, A. North Front Range Oil and Gas Air Pollutant Emission and Dispersion Study; Colorado State University: Fort Collins, CO, USA, 2016.
[4] Collett, J.; Ham, J.; Hecobian, A. Characterizing Emissions from Natural Gas Drilling and Well Completion Operations in Garfield County, Co; Colorado State University: Fort Collins, CO, USA, 2016.

1.1 Site Descriptions

The four Crestone wellpads around which CTEH performed monitoring and sampling (Big Horn, Cosslett, Echevarria, and Kugel) are in Longmont, Weld County, Colorado. Monitoring and sampling occurred from September 2, 2019 to October 21, 2019

Table 1: Wellpad Descriptions

Wellpad	Phase	Monitoring Dates	Location	Site Description
Big Horn	Hydraulic Fracturing and Flowback	September 9, 2019 to September 13, 2019 October 16, 2019 to October 21, 2019	North of County Road 20	Bordered by agricultural land on three sides, residential neighborhood on the west side and nearby production wells on private land
Cosslett	Production (Hub)	September 16, 2019 to September 20, 2019	West of Interstate 25 and south of Erie Parkway (County Road 8)	Surrounded by primarily agricultural land
Echevarria	Production (Tank Light)	September 23, 2019 to September 27, 2019	South of Co road 26 and west of Co Rd 21 ½	Rural area
Kugel	Drilling	September 2, 2010 to September 6, 2019	South of Sable Ave (Co Rd 22) and west of Frontier St (Co Rd 15)	Residential properties surrounding the wellpad on three sides with a more densely-developed residential subdivision to the north and drilling/production activities to the west

1.2 Operations Description

Data were collected during four operational phases: drilling, hydraulic fracturing, flowback and production. Table 2 lists best management practices (BMPs) in place to address potential sources of emissions for each phase of operation.

Table 2: Description of Best Management Practices

Phase	BMPs
Drilling	• Class III Drilling Fluid - oil based mud (odorless, no BTEX) • Mud Chillers - used to control cuttings odor while drilling through hydrocarbon bearing zones • Rotary steerable unit that reduces drilling time on-site • Local electrical power for drill rig - reduces air emissions, NOx • All equipment is on impermeable ground liners during drilling and completions
Flowback	• Vapor Recovery Units are used during flowback operations and initial year of production • Closed-top oil tanks - used during flowback operations and drill out • Combustor used for tank vapors during flowback and drill out
Production	• Hub facility - a central gathering facility serving several well sites which allows for smaller wellpads and fewer emission sources • Tank-lite facilities - Use of Lease Automatic Custody Transfer (LACT) units for custody transfer of oil, reduces the need to open tanks • Electric permanent production equipment - no gas actuated pneumatics
Completions	• Completions fleet fuel substitution – use compressed natural gas to reduce use of diesel fuel; up to 50% replacement when possible • Low-noise completion fleets – utilizing insulated engine housing and hospital grade mufflers

2.0 Methods

CTEH combined analytical sampling with real-time monitoring to provide a comprehensive set of data from which to assess short-term health risks in addition to public welfare impacts, such as odors. Real-time monitoring can capture near-instantaneous and short-term, transient changes in air quality while analytical sampling provides information about specific airborne compounds in the air over a longer period. The strategy for real-time air monitoring and analytical sampling used for this study is like that used routinely by CTEH during chemical emergency responses at accidental releases as well as support of regulatory compliance at numerous sites in North America, including petroleum-related industrial facilities and their neighboring communities.

This report describes the real-time air monitoring results conducted by CTEH personnel using hand-held instruments throughout the communities surrounding the Big Horn, Cosslett, Echevarria and Kugel

wellpads. This report also describes the analytical data collected in the community during flowback operations at the Big Horn wellpad.

2.1 Real-Time Air Monitoring

The objective of the real-time monitoring was to measure analyte levels in the communities with respect to specific wellpad operations CTEH staff targeted the surrounding communities with an emphasis on locations downwind of the pad using handheld instruments to monitor the ambient air quality at breathing zone level.

Real-time air monitoring for each wellpad was performed for at least 48 continuous hours followed by 12-hour shift monitoring over the subsequent three days. The duration of phase-specific data capture representative of normal operating activities (Table 1). Real-time air monitoring was conducted during the drilling phase at Kugel wellpad, hydraulic fracturing and flowback phases at Big Horn wellpad and during the production phases at the Cosslett and Echevarria wellpads. Measurements were collected at various distances from the pads ranging from the fence line to approximately one mile from wellpad operations. Maps of the specific location of each real-time measurement are provided in Appendix A.

Real-time air monitoring was conducted according to the CTEH site-specific sampling and analysis plan. Measured analytes included hydrogen sulfide (H_2S), particulate matter with a mean diameter of 2.5 microns ($PM_{2.5}$) and 10 microns (PM_{10}), nitrogen dioxide (NO_2), total non-methane volatile organic compounds (VOCs) and benzene, toluene, xylene, and hexane using hand-held instruments (Table 1). CTEH personnel used handheld instruments including TSI SidePak aerosol monitors, Gastec GV-100 pumps with chemical-specific, colorimetric detector tubes, and Honeywell/RAE Systems ppbRAEs, UltraRAEs, and MultiRAEs. Instruments were calibrated daily at a minimum and according to manufacturer specifications.

Table 3: Airborne analytes measured using real-time monitoring and/or analytical sampling

Analyte	Justification
Total volatile organic compounds (VOCs)	Assesses for the presence of elevated total non-methane VOCs compared to background.
Benzene	Multiple studies conducted during all phases of natural gas well development, both on-site and in residential communities near oil and gas sites, have repeatedly shown that of all measured VOCs, benzene has the highest potential to cause short-term and long-term health effects and therefore, is considered a risk driver
Toluene	Frequently detected during historical monitoring of oil and gas activities and responses to untended releases, represents a petroleum constituent that has relatively low health screening guideline values, indicating higher potential for adverse effects.
Ethylbenzene	
***m,o,p*-Xylenes**	

Analyte	Justification
Hydrogen Sulfide	Although studies have shown that hydrogen sulfide levels are generally negligible during oil and gas operations in Colorado, its low odor threshold combined with community concern warrants monitoring.
Particulate Matter ($PM_{2.5}$/PM_{10})	Measurement of airborne particulate matter (PM2.5 and PM10) is also proposed because it is frequently cited as a concern from community members that live near oil and gas sites. The main source of PM, if any, is likely to come from dust entrained from vehicular activity or diesel fuel-powered combustion engines.
Nitrogen Dioxide	Nitrogen dioxide is a by-product of gasoline/diesel engine combustion. It has relatively low health screening guideline value, indicating higher potential for adverse effects.

During real-time air monitoring, CTEH personnel also recorded simultaneous observations of odors, wind direction and speed relative to the wellpad, and observed activities or potential odor sources in the community. Fixed locations in the community(s) were monitored at regular intervals (i.e., once per hour) to provide concentration averages that may be observed and analyzed for trends over time within the community. Locations that provide upwind (background) and downwind characterization of compounds were selected, with a primary focus on measuring at locations that were generally downwind of the wellpad in adjacent communities. Wind rose plots of wind direction and wind speed can be provided upon request. This approach was intended to capture the highest number of analyte measurements relevant to potential public health risks in a community. CTEH personnel entered readings from handheld instruments, observations of wind direction and speed, presence of odors, and GPS coordinates of their reading locations into a CTEH smartphone application, which saves the data to a CTEH server. All real-time data were reviewed and underwent an in-house QA/QC process to verify that the concentration values reflected the analytes being measured, data were entered correctly and accurately characterized the environment in which they are being measured.

2.2 Community Analytical Air Sampling

In addition to real-time air monitoring, analytical air samples were collected at four discrete locations away from the work area and in the community during the flowback phase at the Bighorn wellpad. A map of the sample locations is provided in Appendix A.

Samples were collected using 1.4-liter evacuated canisters with 24-hour flow controllers. These samples were deployed for 24-hour periods, which represents a conservative estimate of potential exposures from which to compare to federally established short term health guideline values. All samples were sent under chain-of custody to Pace Analytical, a NELAP-accredited laboratory, and analyzed for a suite of VOCs in accordance with the United States Environmental Protection Agency (US EPA) method TO-15, plus tentatively identified compounds (TICs). A formal QA/QC evaluation of the laboratory data was conducted by Environmental Standards, Inc.

For the initial screening evaluation of potential for community health risks for further decision making, this assessment evaluated acute (short-term) exposures during the flowback phase. BTEX compounds (benzene, toluene, ethylbenzene, and xylene) were selected as high priority compounds of potential concern (COPCs) related to oil and gas activities for this initial evaluation.

Acute toxicity values (called health guideline values) for comparison with the air sampling data were selected following CDPHE memo[1]: FA2019 HGVs (updated acute and chronic health guideline values for use in preliminary risk assessments). For BTEX, all health guideline values were from the Agency for Toxic Substances and Disease Registry (ATSDR). According to ATSDR, an acute MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over for up to 14 days of exposure. ATSDR states, "These substance-specific estimates, which are intended to serve as screening levels, are used by ATSDR health assessors and other responders to identify contaminants and potential health effects that may be of concern at hazardous waste sites. It is important to note that MRLs are not intended to define clean up or action levels for ATSDR or other Agencies."[2].

3.0 Results

3.1 Real-time Air Monitoring

More than 5,000 readings were collected in real-time by CTEH personnel in the communities surrounding the Crestone wellpads over 26 days. A cumulative summary of off-pad real-time monitoring measurements is provided in Table 4. Summaries of real-time air monitoring measurements by phase are provided in tables 5 through 9.

Table 4: Cumulative Community Real-Time Air Monitoring Summary (All Phases)

Analyte	Instrument	# of Readings	# of Detections	Range*
H_2S	MultiRAE Pro	212	0	< 0.1 ppm
NO_2	MultiRAE	1283	0	< 0.1 ppm
PM_{10}	AM510/AM520/DustTrak	1297	1297	0.00 - 0.790 mg/m^3
$PM_{2.5}$	AM510/AM520/DustTrak	1299	1299	0.001 - 0.080 mg/m^3
VOCs	MultiRAE	1	0	< 0.1 ppm
	ppbRAE	1308	1	18 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

[1] https://drive.google.com/file/d/1P2KEvu0MFiyzQAOQtjQUclqR-WGh1bEX/view
[2] https://www.atsdr.cdc.gov/mrls/index.asp

Table 5: Community Real-Time Air Monitoring Summary for Kugel Drilling Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
NO_2	MultiRAE	228	0	< 0.1 ppm
PM_{10}	AM510	238	238	0.005 - 0.046 mg/m^3
$PM_{2.5}$	AM520	238	238	0.005 - 0.049 mg/m^3
VOCs	ppbRAE	237	0	< 1 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Table 6: Community Real-Time Air Monitoring Summary for Big Horn Hydraulic Fracturing Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
NO_2	MultiRAE	269	0	< 0.1 ppm
PM_{10}	AM510	272	272	0.005 - 0.049 mg/m^3
$PM_{2.5}$	AM520	273	273	0.004 - 0.062 mg/m^3
VOCs	ppbRAE	271	0	< 1 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Table 7: Community Real-Time Air Monitoring Summary for Big Horn Flowback Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
H_2S	MultiRAE Pro	212	0	< 0.1 ppm
NO_2	MultiRAE	245	0	< 0.1 ppm
PM_{10}	AM520/DustTrak	245	245	0.001 - 0.790 mg/m^3
$PM_{2.5}$	AM510/DustTrak	247	247	0.001 - 0.08 mg/m^3
VOCs	ppbRAE	257	1	18 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Table 8: Community Real-Time Air Monitoring Summary for Cosslett Production Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
NO_2	MultiRAE	272	0	< 0.1 ppm
PM_{10}	AM510	273	273	0.005 - 0.052 mg/m^3
$PM_{2.5}$	AM520	272	272	0.003 - 0.039 mg/m^3
VOCs	MultiRAE	1	0	< 0.1 ppm
	ppbRAE	274	0	< 1 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Table 9: Community Real-Time Air Monitoring Summary for Echevarria Production Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
NO_2	MultiRAE	269	0	< 0.1 ppm
PM_{10}	AM510	269	269	0.003 - 0.045 mg/m^3
$PM_{2.5}$	AM520	269	269	0.002 - 0.027 mg/m^3
VOCs	ppbRAE	269	0	< 1 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Over 99.9% of all total VOC real-time measurements were non-detects (< 1 ppb) in surrounding communities over the duration of all pre-production and production activities. One (1) out of 1,308 total VOC measurements was above the detection limit of 1 ppb. This detection occurred on October 18, 2019 and measured a one-minute sustained detection of 18 ppb total VOC approximately 4,000 feet northeast of the Bighorn wellpad during the flowback phase of operations. At that time, CTEH personnel noted that they were downwind of site and observed a "manure-like" odor. They also noted that there was livestock nearby. No other odors were noted in the community during real-time monitoring, even during conditions when the VOCs were detected or when transient odors were reported on the wellpad. There were no exceedances of the 20ppb action-level set for VOCs in the community, therefore, no chemical specific measurements were taken for benzene, toluene, xylene or hexane.

No H_2S concentrations were detected. Of the approximately 1,500 readings for PM, only one was higher than typical background values. This reading was recorded on a dirt road at the entrance to the site.

3.2 Off-Pad Analytical Air Sampling

Because flowback phase has been identified by CDPHE as an operational phase that may product higher emissions that other phases, additional analytical air sampling was conducted at four fixed locations in the community over five consecutive days during the flowback phase at the Bighorn Wellpad. A total of 20 samples were deployed for 24-hour periods over five days. As an initial screening level assessment, the air sampling data for selected VOCs were compared to their respective health guideline values that are used by CDPHE to evaluate the potential for short-term health impacts (Table 10). A full summary of lab results is provided in Appendix B.

All detections for each analyte were below their acute health guideline value established by the federal Agency for Toxic Substances and Disease Registry (ATSDR). Acute guideline values were consulted because the analytical data represent potential 5-day (acute) airborne exposures in the surrounding community, and ATSDR acute guideline values are designed to protect even sensitive persons for continuous, 24-our exposures of up to 14 days. The highest concentration of benzene (0.896 ppb) was reported on October 16 (BHCO1016MC005). This sample was collected at AS05 which is located approximately 500 yards northwest of the wellpad. On October 18, when the real-time detection of 18 ppb total VOCs was recorded

northeast of the wellpad, the corresponding analytical sample (BHCO1018MC008) reported a concentration of 0.785 ppb benzene. This sample was collected at AS08, which is approximately 470 yards northeast of the wellpad. These detections, including the maximum measured benzene concentration, were from 10 to over 13,000-times lower than their respective acute health guideline values.

Table 10: Analytical Air Sampling Summary for Big Horn Flowback Phase

Analyte	# of Samples	# of Detections	Range of Detections (ppbv)	ATSDR Acute Health Guideline Value (ppb)[1]
Benzene	20	19	0.207 - 0.896	9
Ethylbenzene	20	2	0.295 - 0.38	5,000
m,p-xylenes	20	8	0.429 - 1.22	2,000
o-xylene	20	3	0.214 - 0.66	2,000
Toluene	20	20	0.358 - 13.1	2,000

[1] https://drive.google.com/file/d/1P2KEvu0MFiyzQAOQtjQUclqR-WGh1bEX/view

4.0 Impact on Public Health

The real-time air monitoring data and analytical BTEX samples did not indicate any potential increase in adverse health risks to in nearby communities from potential exposures to VOCs that may be emitted by oil and gas wellpad activities at Crestone wellpads. Approximately 99% of the total VOC real-time measurements in the community were non-detects, which means the VOC concentrations were not present or less than 1 ppb total VOCs. Additionally, real-time data indicate no adverse health risks to nearby communities, including sensitive individuals, from exposures to VOCs, H_2S or PM that may be emitted from the operations associated with well development at the various wellpad sites. Corresponding continuous analytical air samples of BTEX were well below their federally established acute health guideline levels.

5.0 Conclusions

CTEH designed and performed a study of air monitoring and sampling to characterize potential for short-term (acute) adverse health impacts to nearby communities resulting from oil and gas activities at Crestone wellpads in Weld County, Colorado. To accomplish this, CTEH collected over 5,000 real-time measurements, along with 20 analytical samples, in communities around multiple Crestone wellpads. Findings from this dataset indicate:

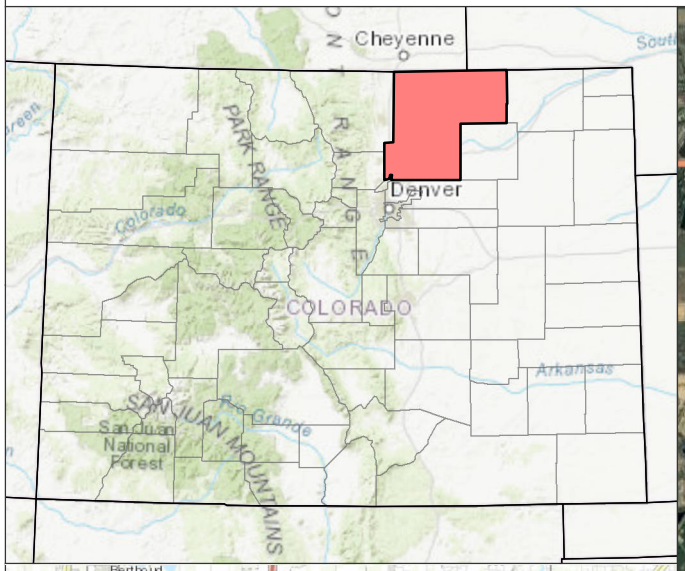
- Pre-production and production activities on Crestone wellpads occurring during the time of these monitoring studies did not result in off-pad migration of VOCs, including benzene, in the nearby community areas at levels expected to cause acute adverse health effects.
- During flowback phase, the maximum detected levels of BTEX in the air in surrounding communities were below their acute health guideline values established by the federal Agency for Toxic Substances and Disease Registry (ATSDR).
- Total VOCs and BTEX concentrations measured during this study were not likely to impact the health of a maximally exposed hypothetical individual living at each of the sampling locations in nearby communities.

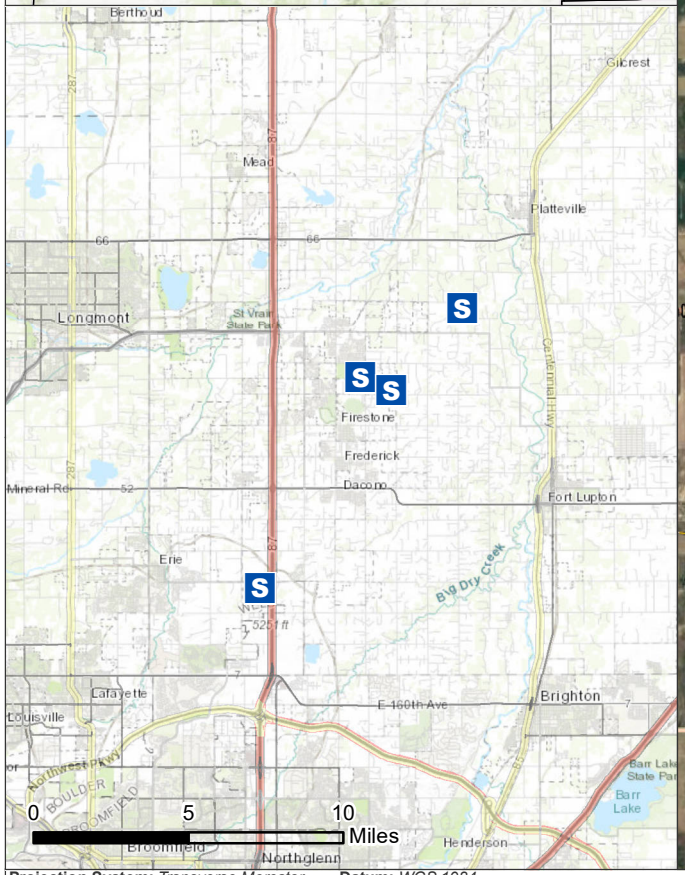
Appendix A

Maps

Crestone Peak Resources Well Pad Monitoring
Pad Locations

Project: 111976
Client: Crestone
City: Longmont, CO
County: Weld





Projection System: *Transverse Mercator* **Datum:** *WGS 1984*

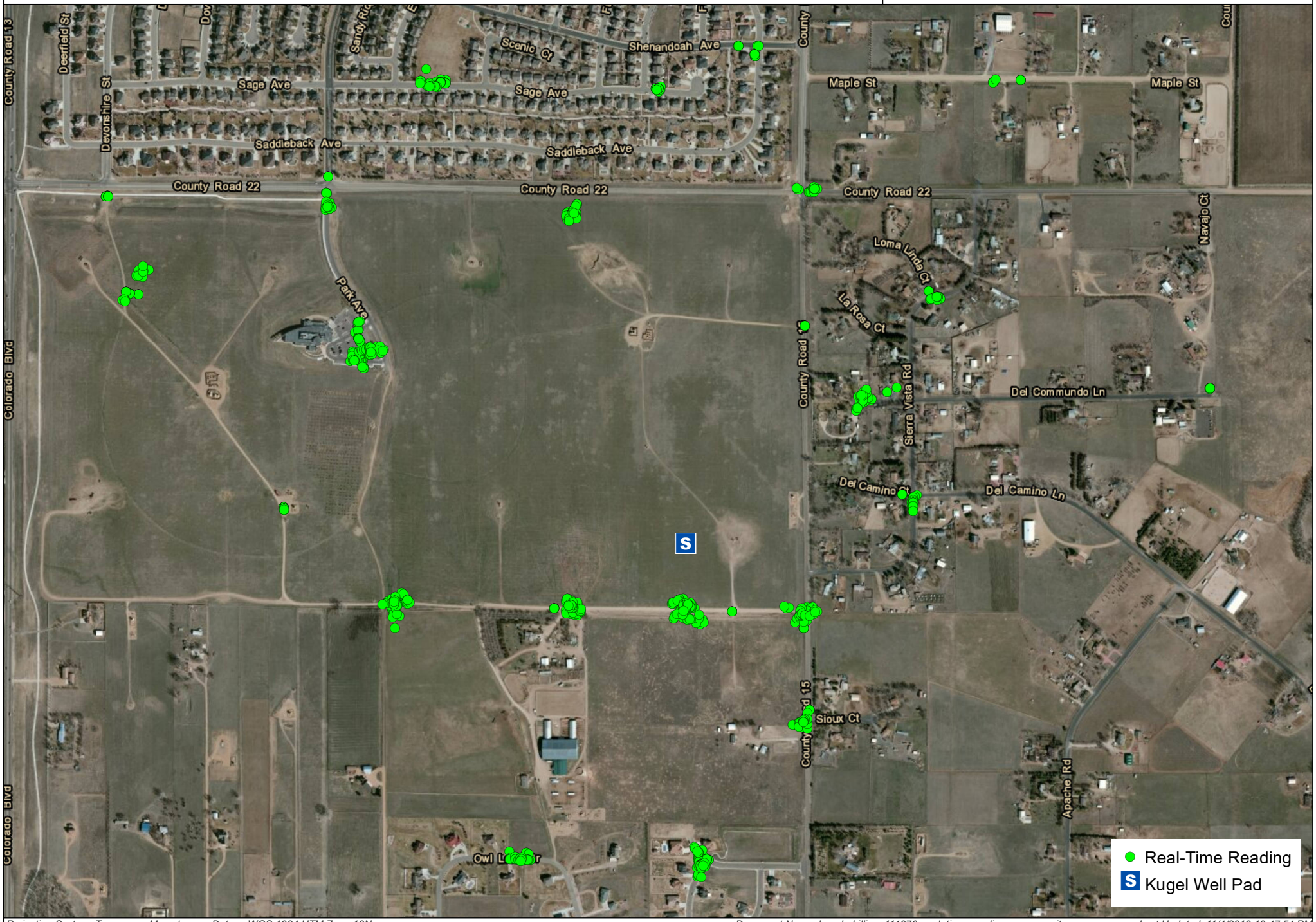
Document Name: site_location **Last Updated:** *11/20/2019 3:28:14 PM*

Crestone Peak Resources Kugel Well Pad Drilling Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

0 500 1,000 Feet

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld



Projection System: Transverse Mercator Datum: WGS 1984 UTM Zone 13N Document Name: kugel_drilling_111976_real_time_readings_community Last Updated: 11/4/2019 12:47:54 PM

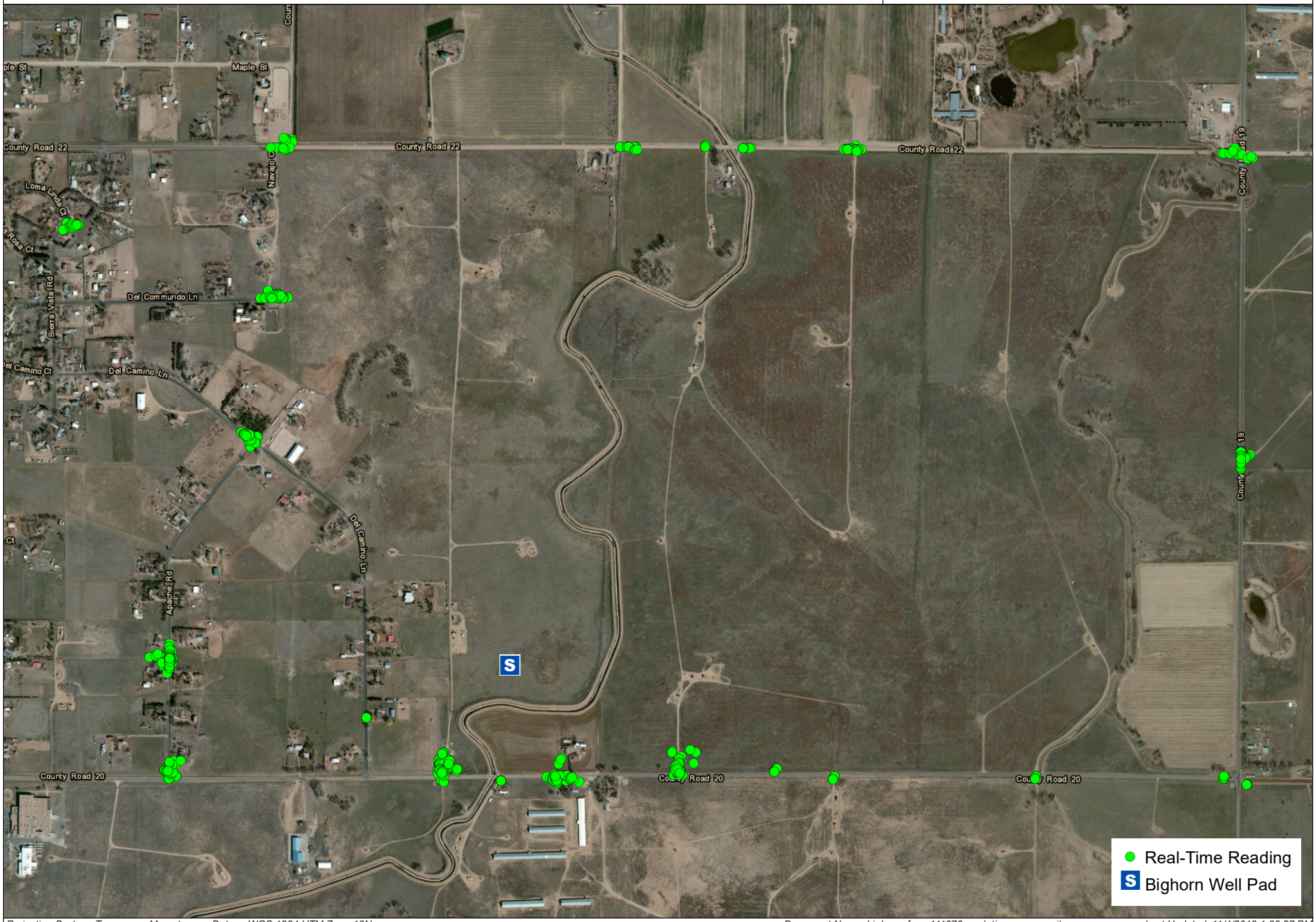
*GPS Coordinates are Approximate

Crestone Peak Resources Bighorn Well Pad Hydraulic Fracturing Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld

0 700 1,400 Feet



Projection System: Transverse Mercator Datum: WGS 1984 UTM Zone 13N Document Name: bighorn_frac_111976_real_time_community Last Updated: 11/4/2019 1:00:27 PM

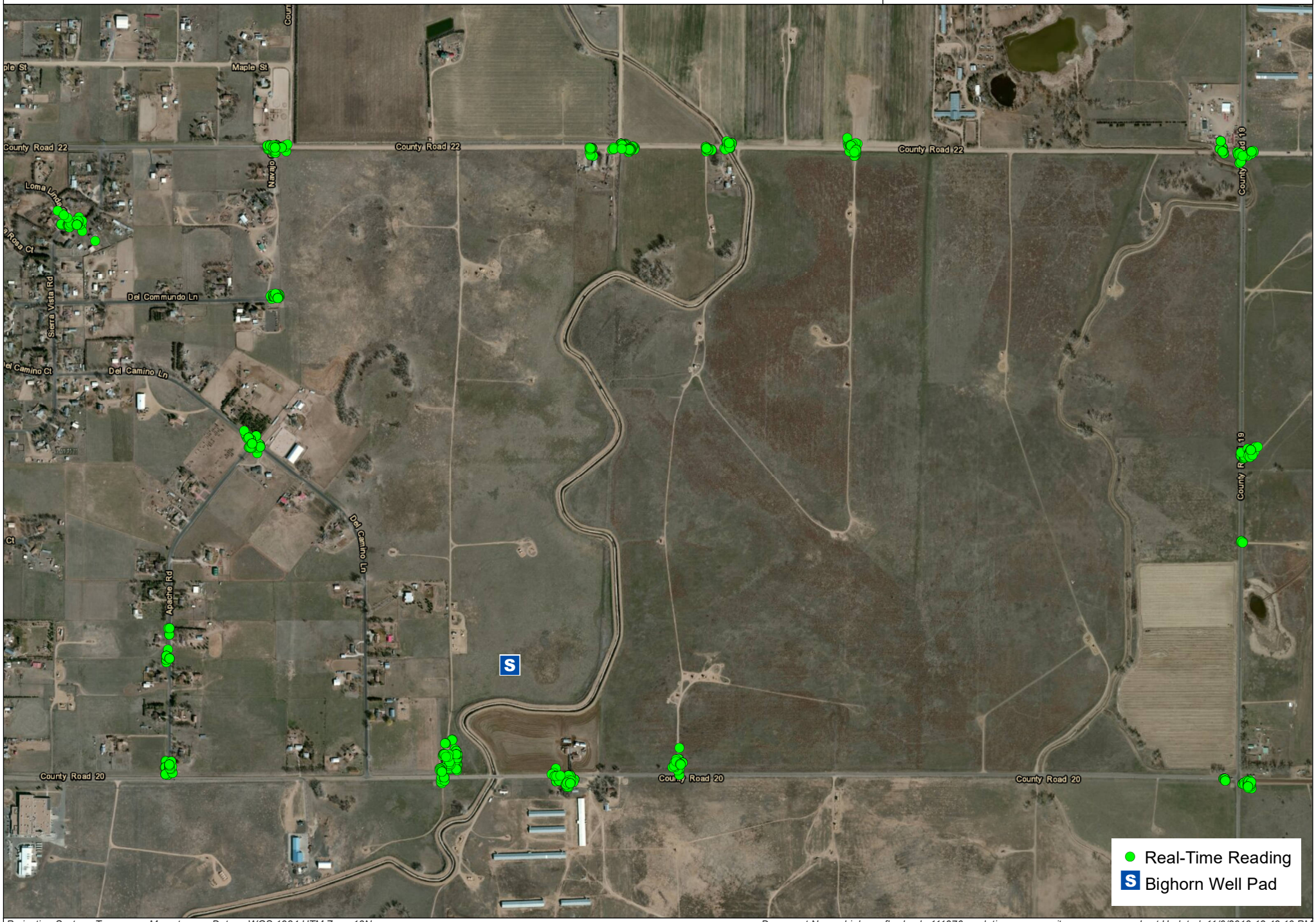
*GPS Coordinates are Approximate

Crestone Peak Resources Bighorn Well Pad Flowback Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld

0 700 1,400 Feet



Projection System: Transverse Mercator Datum: WGS 1984 UTM Zone 13N Document Name: bighorn_flowback_111976_real_time_community Last Updated: 11/6/2019 12:49:10 PM

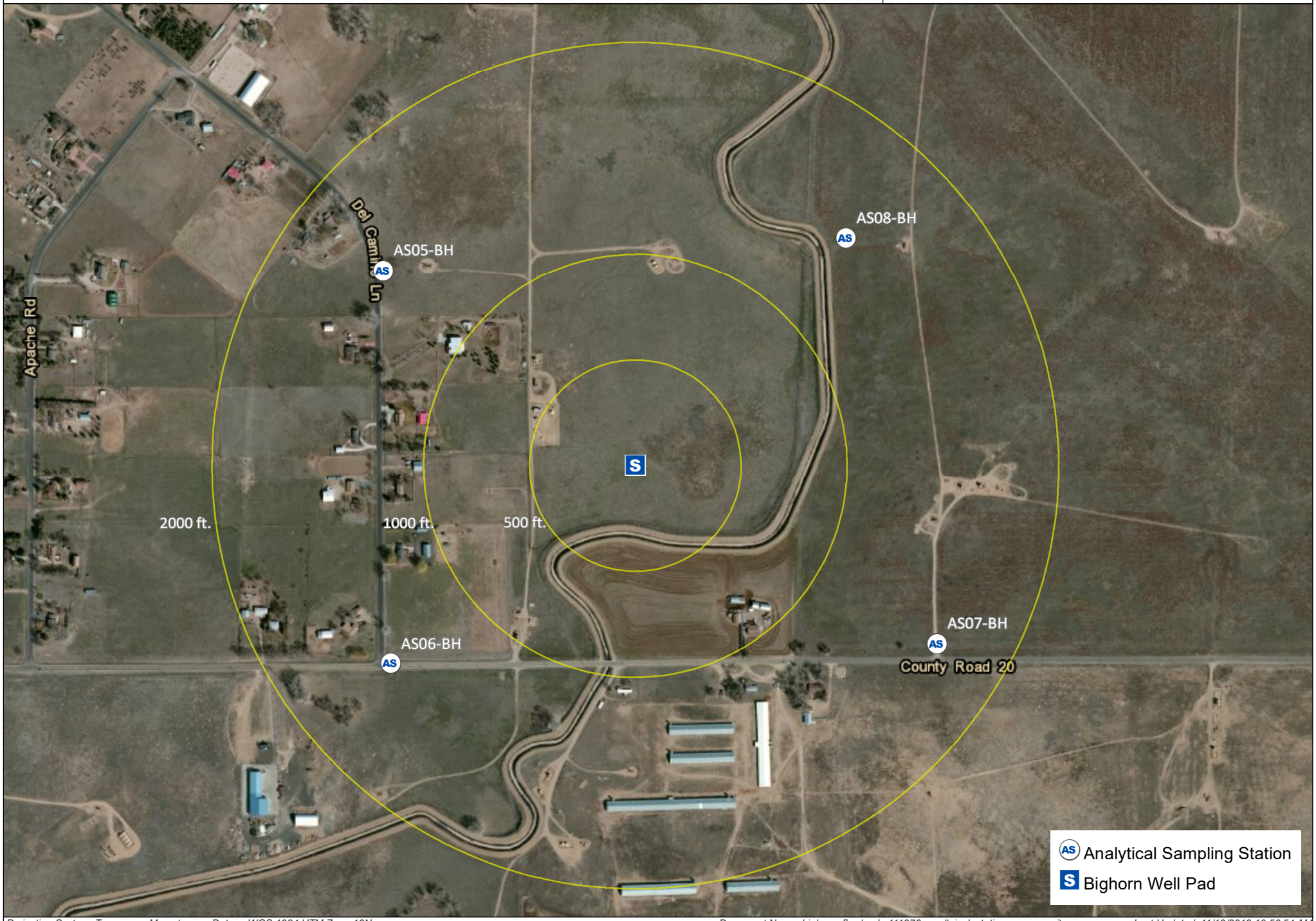
*GPS Coordinates are Approximate

Crestone Peak Resources Bighorn Well Pad Flowback Phase

Analytical Sampling Stations | Community

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld

0 400 800 Feet



Projection System: Transverse Mercator Datum: WGS 1984 UTM Zone 13N Document Name: bighorn_flowback_111976_analtyical_stations_community Last Updated: 11/19/2019 10:56:54 AM

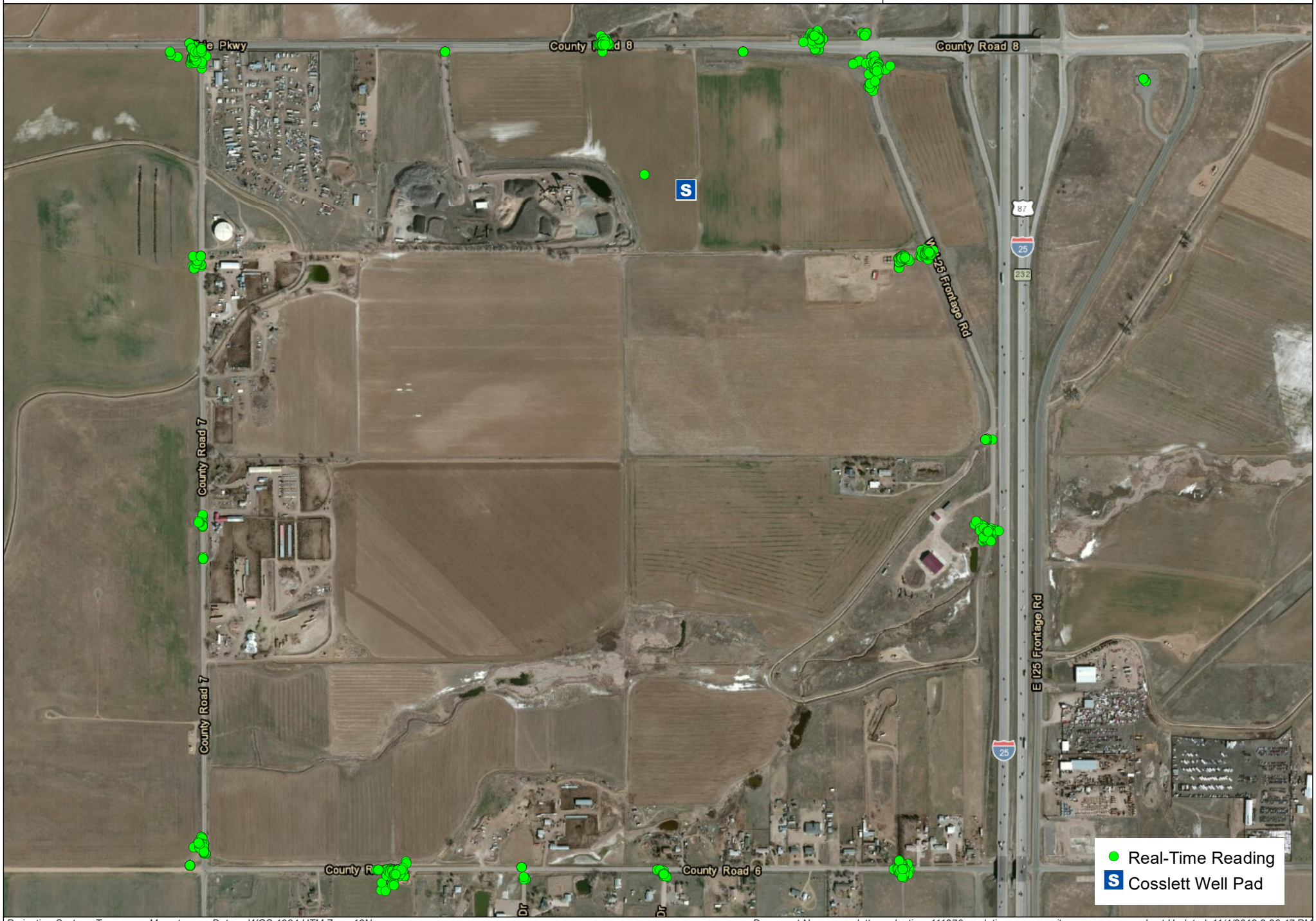
*GPS Coordinates are Approximate

Crestone Peak Resources Cosslett Well Pad Production Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

0 500 1,000 Feet

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld



Projection System: Transverse Mercator Datum: WGS 1984 UTM Zone 13N Document Name: cosslett_production_111976_real_time_community Last Updated: 11/4/2019 2:26:47 PM

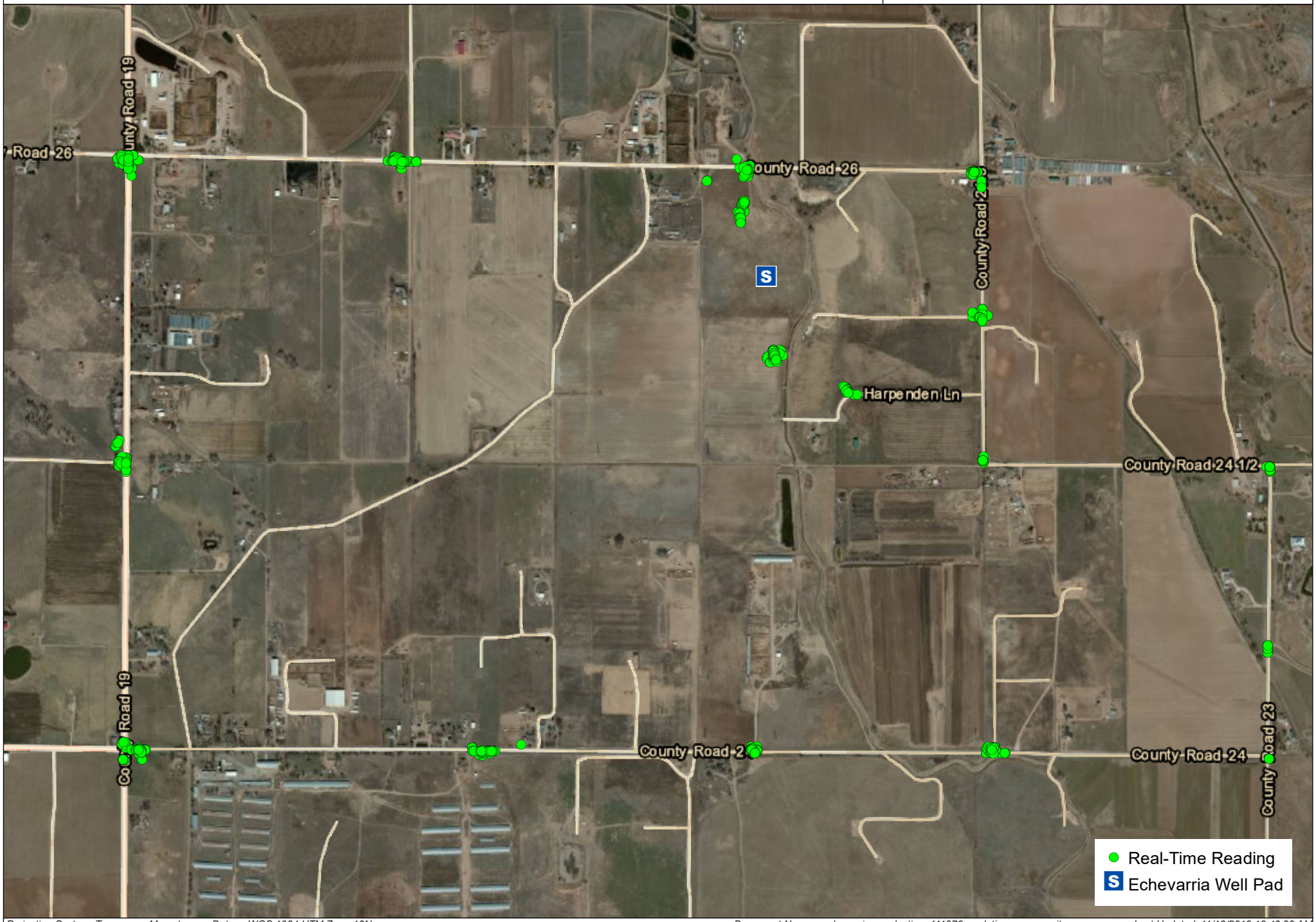
*GPS Coordinates are Approximate

Crestone Peak Resources Echevarria Well Pad Production Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld

0 750 1,500 Feet



Projection System: Transverse Mercator Datum: WGS 1984 UTM Zone 13N Document Name: ecchevarrie_production_111976_real_time_community Last Updated: 11/13/2019 10:49:22 AM

*GPS Coordinates are Approximate

Appendix B

Analytical Summary Table

Analtyical Results BTEX | Crestone Peak Resources

Bighorn Pad - Flowback Phase

Last updated: 12/4/2019 3:25:15 PM

			AS05-BH					AS06-BH				
			Approx. 520 yds NW of well pad					Approx. 510 yds SW of pad				
			October 16, 2019	October 17, 2019	October 18, 2019	October 19, 2019	October 20, 2019	October 16, 2019	October 17, 2019	October 18, 2019	October 19, 2019	October 20, 2019
			BHCO1016MC005	BHCO1017MC005	BHCO1018MC005	BHCO1019MC005	BHCO1020MC005	BHCO1016MC006	BHCO1017MC006	BHCO1018MC006	BHCO1019MC006	BHCO1020MC006
Analysis Method	**Result Type**	**Analyte**										
EPA TO-15 + TICs	Target Analyte	BENZENE	0.896 ppbv	0.543 ppbv	0.353 ppbv	0.438 ppbv	0.260 ppbv	0.615 ppbv	0.467 ppbv	0.544 ppbv	0.265 ppbv	0.253 ppbv
		ETHYLBENZENE	0.295 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv
		M,P-XYLENES	1.080 ppbv	0.505 ppbv	< 0.095 ppbv	< 0.095 ppbv	< 0.095 ppbv	0.459 ppbv	0.502 ppbv	< 0.095 ppbv	< 0.095 ppbv	< 0.095 ppbv
		O-XYLENE	0.361 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv
		TOLUENE	3.510 ppbv	1.490 ppbv	1.180 ppbv	1.080 ppbv	0.433 ppbv	1.430 ppbv	1.620 ppbv	0.947 ppbv	0.681 ppbv	0.457 ppbv

[1]Laboratory non-detections are reported as less than ("<") the laboratory method detection limit.

Detection Color Legend

Detection

Non-detect

Analtyical Results BTEX | Crestone Peak Resources

Bighorn Pad - Flowback Phase

Last updated: 12/4/2019 3:25:15 PM

			AS07-BH					AS08-BH				
			Approx. 530 yds SE of well pad					Approx. 470 yds NE of well pad				
			October 16, 2019	October 17, 2019	October 18, 2019	October 19, 2019	October 20, 2019	October 16, 2019	October 17, 2019	October 18, 2019	October 19, 2019	October 20, 2019
			BHCO1016MC007	BHCO1017MC007	BHCO1018MC007	BHCO1019MC007	BHCO1020MC007	BHCO1016MC008	BHCO1017MC008	BHCO1018MC008	BHCO1019MC008	BHCO1020MC008
Analysis Method	**Result Type**	**Analyte**										
EPA TO-15 + TICs	Target Analyte	BENZENE	0.419 ppbv	0.600 ppbv	0.343 ppbv	0.313 ppbv	0.207 ppbv	0.787 ppbv	0.705 ppbv	0.785 ppbv	0.348 ppbv	< 0.046 ppbv
		ETHYLBENZENE	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	< 0.051 ppbv	0.380 ppbv	< 0.051 ppbv	< 0.051 ppbv
		M,P-XYLENES	0.512 ppbv	< 0.095 ppbv	< 0.095 ppbv	< 0.095 ppbv	< 0.095 ppbv	0.583 ppbv	0.429 ppbv	1.220 ppbv	< 0.095 ppbv	< 0.095 ppbv
		O-XYLENE	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	< 0.063 ppbv	0.214 ppbv	< 0.063 ppbv	0.660 ppbv	< 0.063 ppbv	< 0.063 ppbv
		TOLUENE	1.480 ppbv	1.130 ppbv	0.606 ppbv	0.876 ppbv	0.741 ppbv	1.600 ppbv	1.330 ppbv	13.100 ppbv	0.699 ppbv	0.358 ppbv

[1]Laboratory non-detections are reported as less than ("<") the laboratory method detection limit.

Detection Color Legend

Detection

Non-detect