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December 13, 2021

Town of Erie Board of Trustees
645 Holbrook St.
P.O. Box 750
Erie, CO 80516

Re: Letter in Opposition to the Proposed Ordinance that Repeals and Reenacts
Section 10-6-14 of the Town of Erie (“Erie”) Municipal Code.

Dear Trustees:

Our firm represents Rieder Homeplace, LLC (“Rieder Homeplace”), the owner of property located at 3490 County Road 12, Erie, Colorado. For the reasons discussed below, Rieder Homeplace asks the Erie Board of Trustees (the “Board”) to vote against the proposed repeal and reenactment of Section 10-6-14 of the Erie Municipal Code (the “Proposed Blanket Setbacks”).

1. Preliminary Statement

The Proposed Blanket Setbacks are overly broad and fail to accomplish their stated goal of protecting the health and safety of Erie’s citizens while allowing Erie to develop and responsibly grow. Accordingly, the Board should vote against the Proposed Blanket Setbacks. If the Board determines repealing Section 10-6-14 is necessary, any subsequent reenactment should be based on current data, science, and technology and should allow Erie to *increase or decrease* setback requirements on an individual basis depending on the measurable emissions of the subject oil and gas location.

Importantly, Rieder Homeplace does not assert that development in proximity to oil and gas facilities should be *unregulated*. Instead, Rieder Homeplace contends that any legislation

considered by the Board should only be enacted after due diligence and consideration of relevant information and data.

2. Discussion

Any legislation passed by the Board should allow Erie to develop new residential, commercial, or other property for human occupancy while protecting the health and safety of Erie's citizens. Therefore, legislation that allows development but fails to protect Erie's citizens is intolerable. Conversely, any legislation that unnecessarily restricts development and fails to provide *added protection* to Erie's citizens is unacceptable. The Board should vote against the Proposed Blanket Setbacks because (1) the Proposed Blanket Setbacks are unnecessarily restrictive, and (2) Erie's goals of promoting thoughtful development while protecting Erie's citizens are better achieved by allowing Erie to increase or decrease setbacks on an individual basis.

I. **A blanket setback is unnecessarily restrictive for protecting the health and safety of Erie citizens.**

Blanket setbacks (setbacks that apply equally to all oil and gas facilities regardless of emissions) would be logical if all oil and gas facilities posed a consistent risk of harm within a given setback's radius. This, however, is not the case. The Proposed Blanket Setbacks require a 500-foot setback from any oil and gas location for any new residential lot, occupied structure, park, sports field, or playground. See Proposed Blanket Setbacks, at § C. Data from nearby oil and gas production sites suggests that a 500-foot setback is arbitrary.

The Colorado Department of Public Health and Environment ("CDPHE") develops (and continuously modifies) health guideline values ("HGVs") to determine acceptable rates of emissions most commonly emitted from oil and gas operations. See generally Colo. Dep't of Pub.

Health and Env't, Updated Acute and Chronic Health Guideline Values for Use in Preliminary Risk Assessments (2019), attached hereto as Exhibit 1. Benzene, one of the potential substances emitted from oil and gas operations, can cause acute or chronic health issues at relatively low concentrations. According to the CDPHE, the acute HGV for Benzene is nine parts per billion (ppbV), and the chronic HGV is nine and three ppbV. See id., at p. 3. In other words, the acceptable rate of emission for Benzene before causing a statistical risk of acute health issues is nine ppbV. In comparison, Benzene's acceptable rate of emission before causing a statistical risk of chronic health issues is 9 and 3 ppbV.

The Mae J Production Site and the Papa Jo-Yellowhammer Production Site (located near Erie) emit Benzene at levels far below those that pose a health and safety risk. See generally Montrose Air Quality Services, Air Quality Report Mae J Production & Air Quality Report Papa Jo-Yellowhammer Production, attached hereto as Exhibit 2 (collectively, the "Reports"). Occidental, the company that operates the Mae J Production Site and the Papa Jo-Yellowhammer Production Site, works with Montrose Air Quality Services, LLC ("Montrose") to monitor the Mae J Production Site's and Papa Jo-Yellowhammer Production Site's emissions. See id. Montrose monitors emissions in compliance with Occidental's air monitoring plan, which the CDPHE approved. Montrose places air monitors approximately 200-300 feet away from emission sources to measure emissions. The Reports show that the Mae J Production Site and the Papa Jo-Yellowhammer Production Site emit *less than 1 ppbV of Benzene when measured 200-300 feet away from the sites*. Put differently, the amount of Benzene emitted from these production sites at 200-300 feet is less than one-tenth the amount CDPHE determined to be hazardous.

If the Board passes the Proposed Blanket Setbacks, Erie will inevitably prevent potential development that poses no measurable risk to Erie's citizens. It is worth noting that Erie has the

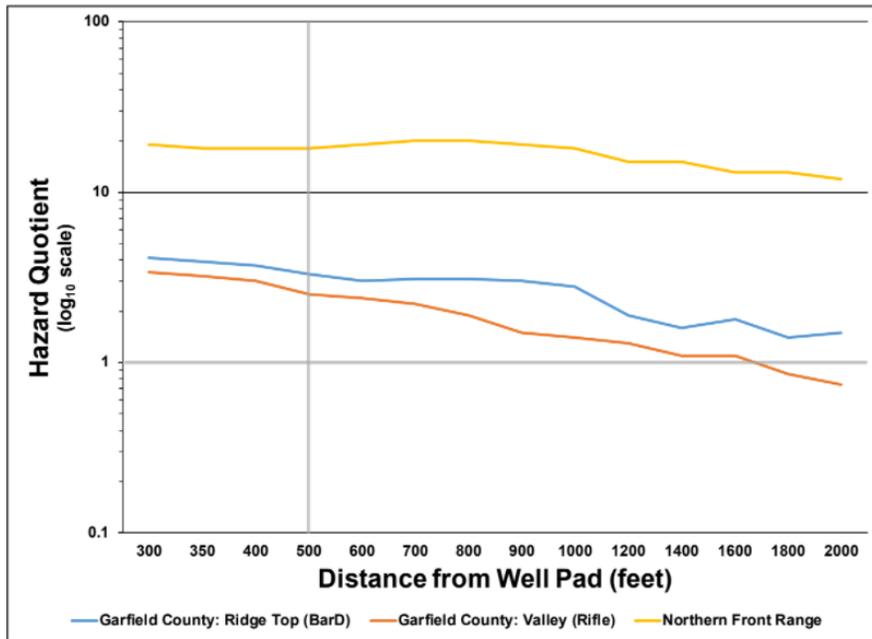
capability of collecting similar data. Erie possesses ten (10) air monitors capable of measuring emissions from different oil and gas locations. Before concluding that a 500-foot blanket setback is necessary, the Board should do its due diligence to determine emission rates from different oil and gas locations and compare said data to the HGVs provided by the CDPHE. In brief, any blanket setback is arbitrary and fails to strike an appropriate balance between limiting development and protecting the health and safety of Erie's citizens.

II. If the Board determines it is necessary to amend existing setbacks, any reenactment should allow *increasing or decreasing* setbacks based on actual emissions of individual oil and gas locations.

Striking the appropriate balance between protecting the health and safety of Erie citizens and allowing responsible development is better achieved by legislation that will enable Erie to measure emissions before determining an appropriate setback. This flexible approach is more favorable as emissions can vary greatly depending on the geographic location of an oil and gas facility, the technology used at an oil and gas facility, and the type of facility at issue. Finally, the Proposed Blanket Setbacks contain similarly flexible provisions when applied to *plugged and abandoned wells*.

a. Oil and gas emissions vary based on geographic location.

In 2019, the CDPHE released the Human Health Risk Assessment for Oil and Gas Operations in Colorado. In the study, the CDPHE analyzed data released to the public by Colorado State University in 2016. See Colo. Dep't of Pub. Health and Env't, Final Report: Human Health Risk Assessment for Oil and Gas Operations in Colorado, (Oct. 17, 2019), at p. 1. The risk assessment compiled data from Garfield County: Ridge Top, Garfield County: Valley, and the Northern Front Range. As you can see, the "Hazard Quotient" varies considerably based on the geographic location of oil and gas facilities:

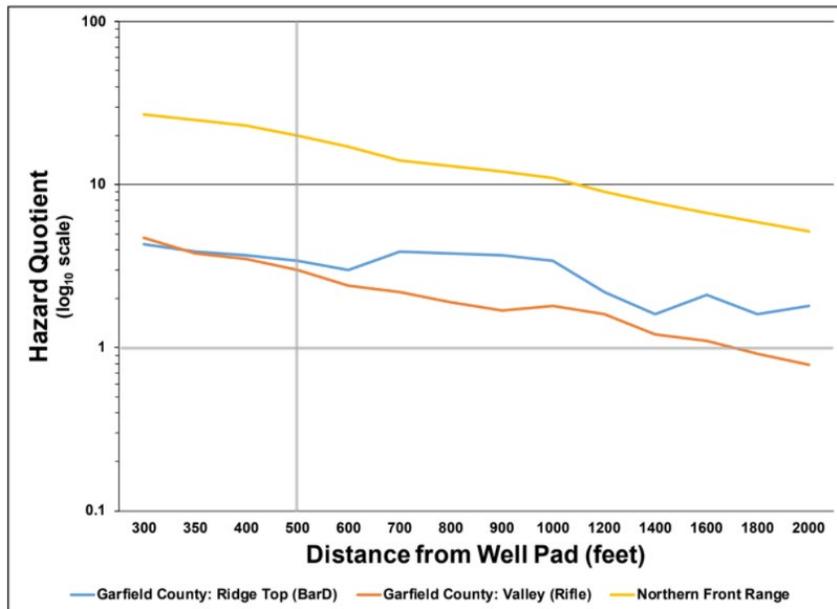


Notes: X-axis is not to scale. The y-axis is in logarithm base 10 scale while the values plotted are not transformed. Thick lines emphasize hazard quotient=1 and the 500-foot distance. Corresponds to ages 17 and younger (results for other age groups are nearly identical).

log10 = logarithm base 10.

Figure 5-6. Largest Acute Non-cancer Hazard Quotients for Benzene, for the Highest Exposed Hypothetical Individuals at Various Distances from the 3-acre Well Pad during Flowback Activities

Id., p. 138.



Notes: X-axis is not to scale. The y-axis is in logarithm base 10 scale while the values plotted are not transformed. Thick lines emphasize hazard quotient=1 and the 500-foot distance. Corresponds to ages 17 and younger (results for other age groups are nearly identical).

log10 = logarithm base 10

Figure 5-2. Largest Acute Non-cancer Hazard Quotients for Benzene, for the Highest Exposed Hypothetical Individuals at Various Distances from the 1-acre Well Pad during Flowback Activities

Id., at p. 147.

The data exemplifies that setbacks in Garfield County would not be appropriate or adequate in the Northern Front Range. Notably, at further distances from oil and gas well pads, the same setbacks *within Garfield County* may not be appropriate. Because geographic location can impact emissions, a flexible approach to setback requirements is more logical.

b. Oil and gas emissions vary depending on the technology used at an oil and gas facility.

It is essential to remember that the CDPHE's 2019 Human Health Risk Assessment for Oil and Gas Operations in Colorado relied on data and information collected between 2014 and 2016.

See id. Technology in the oil and gas industry has changed significantly since then:

Several of the innovations that have occurred along Colorado's Front Range include but are not limited to: tankless production, low-bleed pneumatics, electric powered drill rigs, electric pumping engines, fence line and community air monitoring, water recycling, beneficial water reuse with industrial partners, solar PV and battery storage for monitoring and small pump operations, increased pipeline usage to reduce truck traffic, light mitigation, noise barriers, quiet hydraulic fracturing equipment, as well as community coordination to identify, plug, and reclaim old verticals wells to reduce cumulative emissions. These innovations and other emerging applications, while not possible in all circumstances, can improve operational efficiency and provide significant emission reductions that would otherwise lead to regional ozone formation and global climate change.

Colorado Oil and Gas Association, Colorado: Oil and Natural Gas Resource Guide, (2020), at p. 28, attached hereto as Exhibit 3.

Much of this new technology is what accounts for the low emission rates at the Mae J Production Site and the Papa Jo-Yellowhammer Production Site. See generally Occidental, New Energy Development, attached hereto as Exhibit 4. To minimize its impact, Occidental is utilizing noise mitigation, light mitigation, tankless oil and gas development, advanced leak detection and repair, and groundwater protection. Id.

The Proposed Blanket Setbacks will unintentionally punish good actors who have proactively utilized technology to minimize emissions. In other words, the Proposed Blanket Setbacks treat oil and gas companies and developers that do the bare minimum the same as oil and gas companies and developers who go above and beyond what is required to ensure the safety of their community. The technology used at different oil and gas locations varies greatly – such variation further justifies a flexible approach when determining setbacks.

c. Oil and gas emissions vary based on the type of facility.

The Proposed Blanket Setbacks fail to adequately distinguish between different types of oil and gas facilities:

- a. Where a Form 2 or Form 2A has been submitted to the COGCC for an oil and gas location, but the oil and gas well has not reached completion, no external boundary of a new residential lot, structure that requires a certificate of occupancy, park, sports field, or playground shall be located less than two thousand (2,000) feet from *the oil and gas location*.
- b. No new residential lot, occupied structure, park, sports field, or playground shall be located less than five hundred (500) feet from an existing *oil and gas location*.
- c. No street, sidewalk, or trail shall be located less than one-hundred-fifty (150) feet from an existing *oil and gas location*.
- d. Any structure that is not required to obtain a certificate of occupancy shall be located in at least twenty-five (25) feet from an *existing oil and gas location*.

The Proposed Blanket Setbacks, at § C. “Oil and gas location,” however, is only defined as “a definable area where an operator has disturbed or intends to disturb the land’s surface to locate an oil and gas facility.” *Id.*, at § A.

Blanket provisions like the one above fail to account for the extent to which different oil and gas facilities emit substances. Emissions will differ for an oil and natural gas well site when compared to a central tank battery. Emissions will differ for a pipeline pump station when compared to an underground natural gas storage facility. As discussed above, these differences are compounded by the fact that different technology is being utilized by different companies. The

Proposed Blanket Setbacks simply apply a broad stroke to all “oil and gas locations” without considering the extent to which emissions may vary.

- d. *Section C(3)(f) of the Proposed Blanket Setbacks could serve as a model for setback flexibility as it contains a provision that allows setbacks to be adjusted for development near plugged and abandoned wells.*

While most setback requirements contained in the Proposed Blanket Setbacks are fixed, section C(3)(f) of the Proposed Blanket Setbacks allows setbacks to be adjusted if certain criteria are met:

- e. The reciprocal setbacks required in subsections a. and b. hereof may be reduced, on a case by case basis, if the Town finds, based on information submitted by the applicant at the applicant’s sole cost in a plugging and abandonment summary report, which shall include, to the extent available, the following information:
 - i. The plugged and abandoned well has been located to a certainty not less than five (5) feet horizontally;
 - ii. A third party, approved by the Town, has confirmed that there is no hydrocarbon contamination within the subject oil and gas location in which the plugged and abandoned well is located, or that such hydrocarbon contamination has been remediated to background levels; and
 - iii. A report reviewing the records on file with the COGCC and certifying in writing that the well has been plugged in accordance with the COGCC Rules current at the time of the certification, or the well is re-plugged in accordance with the COGCC Rules current at the time of the application

The Proposed Blanket Setbacks, at § C(3)(f).

This provision is important for two reasons. First, it demonstrates that the Planning Commission, in one context, considers flexible setback requirements appropriate. Second, the above provision provides a template to which flexible setbacks could be applied to oil and gas locations, flowlines, crude oil transfer lines, and gathering lines. If the Board decides to amend existing setbacks, it could require a third party to analyze data regarding rates of emissions (using

Erie's air monitors) and compare said emissions to the CDPHE's HGVs. *Based on the data*, the Board could make an informed decision on whether increasing or decreasing the relevant setback is appropriate.

A flexible approach allows Erie to strike a more precise balance protecting its citizens health and safety *and* allowing Erie's citizens to make productive use of their land.

3. Conclusion

Too often, the discussion around oil and gas regulations is framed as "the people" versus the "oil and gas companies." The reality is more nuanced. More than any other factor, the Proposed Blanket Setbacks will impact how *Erie citizens* utilize their land. Erie citizens who own developable land or purchased land to develop it are unfairly affected by the Proposed Blanket Setbacks. This is especially true because the Proposed Blanket Setbacks are not narrowly tailored. The Board should foster its citizens' ability to develop their land so long as it does not negatively impact other citizens' safety. The Board should vote against the Proposed Blanket Setbacks because they fail to accomplish this goal.

Respectfully,

ALDERMAN BERNSTEIN LLC



Josh T. Mangiagli

ALDERMAN BERNSTEIN LLC



Jody Harper Alderman

cc: Kendra Carberry (*via email*)



Dedicated to protecting and improving the health and environment of the people of Colorado

Date: September 20, 2019 (effective September 20, 2019)
To: Interested Parties
From: Oil and Gas Health Information Response Program, Toxicology and Risk Assessment Section, Colorado Department of Public Health and Environment (CDPHE)

Re: Updated acute and chronic health guideline values for use in preliminary risk assessments (referred to as “FA2019 HGVs”)

Health guideline values (HGVs) were reviewed in the fall of 2019 based on the previously published¹ tiered approach (Table 1). These new values will be used in preliminary risk assessments starting September 20, 2019 and referred to as “FA2019 HGVs” where necessary for clarity. Previous HGVs will not be used after September 20, 2019 without approval from CDPHE’s state toxicologist. All chemicals associated with oil and gas operations are not included in this memo. Rather, the chemicals included here are those most commonly identified to be emitted from oil and gas operations¹.

HGVs are determined by the US Environmental Protection Agency and/or similar federal and state agencies for both acute and chronic exposures to volatile organic compounds (VOCs). A health guideline value is defined by the US Environmental Protection Agency as the exposure level that is likely to be without appreciable risk of adverse non-cancer health effects in an exposed population, including sensitive individuals (Table 2). Acute or short-term exposures represent intermittent exposures that could occur repeatedly for a few hours to a few days. Chronic or long term exposures assume a person is breathing the air continuously (24 hours per day, 365 days per year) for a lifetime (i.e. 70 years).

In order to estimate the risk of developing cancer from VOCs, the US Environmental Protection Agency develops inhalation unit risk factors. We compare each inhalation unit risk factor to an exposure concentration in order to estimate excess cancer risk from exposure to that concentration over a lifetime. The US Environmental Protection Agency typically considers risks below 1×10^{-6} to be so small as to be negligible and uses a cancer risk of one in a million (1×10^{-6}) as a regulatory goal. In general, risk levels below one in ten thousand (100 in one million; 1×10^{-4}) are considered low risk and within the US Environmental Protection Agency’s “acceptable” excess cancer risk range. VOCs with inhalation unit risk factors, as well as the air concentrations associated with various risks, are shown in Table 3.

Risk assessment is complicated and requires experience with the application and interpretation of these values and related calculations. Please strongly consider consulting either with us or with a professional risk assessor. Please contact us at cdphe_oghealth@state.co.us with additional questions or to request assistance.

¹ McMullin TS, Bamber AM, Bon D, Vigil DI, Van Dyke 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.). *Int. J. Environ. Res. Public Health* 15(7), 1500: 1-19. doi.org/10.3390/ijerph15071500

Table 1. Tiered selection approach for health guideline values used in a preliminary risk assessment.

Acute	Chronic
1. ATSDR Acute Inhalation MRL	1. US EPA IRIS Chronic RfC or IUR
2. CalEPA Acute Inhalation REL	2. ATSDR Chronic Inhalation MRL
3. TCEQ Acute AMCV	3. PPRTV
4. DOE Protective Action Criteria	4. CalEPA Chronic Inhalation REL or IUR
5. Surrogate	5. TCEQ Chronic AMCV
	6. Surrogate

US EPA (US Environmental Protection Agency); ATSDR (US Agency for Toxic Chemicals and Disease Registry); PPRTV (US EPA Provisional Peer Reviewed Toxicity Values); CalEPA (California Office of Environmental Health Hazard Assessment); TCEQ (Texas Commission on Environmental Quality); DOE (Department of Energy); ppbV (parts per billion by volume); MRL (Minimum Risk Level); REL (Reference Exposure Level); AMCV (Air Monitoring Comparison Values); RfC (Reference Concentration); IUR (Inhalation Unit Risk Factor); "--" (no value has been established).

Table 2. List of substances and non-cancer acute and chronic health guideline values.

Substance (Synonym)	CAS #	Health Guideline Values (ppbV)			
		Acute	Source	Chronic	Source
1-Butene	106-98-9	27,000	TCEQ	2,300	TCEQ
1-Hexene	592-41-6	500	TCEQ	50	TCEQ
1-Pentene	109-67-1	12,000	TCEQ	560	TCEQ
1,2,3-Trimethylbenzene	526-73-8	3,000	TCEQ	12.2	US EPA
1,2,4-Trimethylbenzene	95-63-6	3,000	TCEQ	12.2	US EPA
1,3,5-Trimethylbenzene	108-67-8	3,000	TCEQ	12.2	US EPA
2-Methyl-2-butene	513-35-9	12,000	TCEQ	560	TCEQ
2-Methylheptane	592-27-8	4,100	TCEQ	380	TCEQ
2-Methylhexane	591-76-4	8,300	TCEQ	2,200	TCEQ
2-Methylpentane	107-83-5	5,400	TCEQ	190	TCEQ
2,2-Dimethylbutane	75-83-2	5,400	TCEQ	190	TCEQ
2,2,4-Trimethylpentane	540-84-1	4,100	TCEQ	380	TCEQ
2,3-Dimethylbutane	79-29-8	5,400	TCEQ	190	TCEQ
2,3-Dimethylpentane	565-59-3	8,300	TCEQ	2,200	TCEQ

(continued)

Substance (Synonym)	CAS #	Health Guideline Values (ppbV)			
		Acute	Source	Chronic	Source
2,3,4-Trimethylpentane	565-75-3	4,100	TCEQ	380	TCEQ
2,4-Dimethylpentane	108-08-7	8,300	TCEQ	2,200	TCEQ
3-Methylheptane	589-81-1	4,100	TCEQ	380	TCEQ
3-Methylhexane	589-34-4	8,300	TCEQ	2,200	TCEQ
3-Methylpentane	96-14-0	5,400	TCEQ	190	TCEQ
Acetylene	74-86-2	25,000	TCEQ	2,500	TCEQ
Benzene	71-43-2	9	ATSDR	9 and 3	US EPA and ATSDR ¹
cis-1,3-dimethylcyclohexane	638-04-0	4,000	SU ²	400	SU ²
cis-2-Butene	590-18-1	15,000	TCEQ	700	TCEQ
cis-2-Pentene	627-20-3	12,000	TCEQ	560	TCEQ
Cyclohexane	110-82-7	1,000	TCEQ	1,743	US EPA
Cyclopentane	287-92-3	5,900	TCEQ	590	TCEQ
Ethane	74-84-0	Simple Asphyxiant	-	-	-
Ethylbenzene	100-41-4	5,000	ATSDR	230	US EPA
Ethylcyclohexane	108-87-2	4,000	SU ²	400	SU ²
Ethylene	74-85-1	500,000	TCEQ	5,300	TCEQ
Isobutane	75-28-5	33,000	TCEQ	10,000	TCEQ
Isopentane (2-methylbutane)	78-78-4	68,000	TCEQ	8,100	TCEQ
Isoprene	78-79-5	1,400	TCEQ	140	TCEQ
Isopropylbenzene (cumene)	98-82-8	510	TCEQ	81.4	US EPA
m-Diethylbenzene	141-93-5	450	TCEQ	45	TCEQ
m-Ethyltoluene	620-14-4	250	TCEQ	25	TCEQ

(continued)

Substance (Synonym)	CAS #	Health Guideline Values (ppbV)			
		Acute	Source	Chronic	Source
m-Xylene/p-Xylene	108-38-3/106-42-3	2,000	ATSDR	23	US EPA
Methanol	67-56-1	21,400	CalEPA	15,300	US EPA
Methylcyclohexane	108-87-2	4,000	TCEQ	400	TCEQ
Methylcyclopentane	96-37-7	750	TCEQ	75	TCEQ
n-Butane	106-97-8	92,000	TCEQ	10,000	TCEQ
n-Decane	124-18-5	1,000	TCEQ	190	TCEQ
n-Dodecane	112-40-3	1,720	DOE	3.8	SU ³
n-Heptane	142-82-5	8,300	TCEQ	97.6	PPRTV
n-Hexane	110-54-3	5,400	TCEQ	198.6	US EPA
n-Nonane	111-84-2	3,000	TCEQ	3.8	PPRTV
n-Octane	111-65-9	4,100	TCEQ	380	TCEQ
n-Pentane	109-66-0	68,000	TCEQ	338.9	PPRTV
n-Propylbenzene	103-65-1	510	TCEQ	51	TCEQ
n-Undecane	1120-21-4	550	TCEQ	55	TCEQ
o-Ethyltoluene (2-ethyltoluene)	611-14-3	250	TCEQ	25	TCEQ
o-Xylene	95-47-6	2,000	ATSDR	23	US EPA
p-Diethylbenzene (1,4-diethylbenzene)	105-05-5	450	TCEQ	45	TCEQ
p-Ethyltoluene (4-ethyltoluene)	622-96-8	250	TCEQ	25	TCEQ
Propane	74-98-6	Simple Asphyxiant	-	-	-
Propylene (propene)	115-07-1	Simple Asphyxiant	-	1,743	CalEPA
Styrene	100-42-5	5,000	ATSDR	234.8	US EPA

(continued)

Substance (Synonym)	CAS #	Health Guideline Values (ppbV)			
		Acute	Source	Chronic	Source
Toluene	108-88-3	2,000	ATSDR	1,327	US EPA
trans-1,2-dimethylcyclohexane	6876-23-9	4,000	SU ²	400	SU ²
trans-1,3-dimethylcyclohexane	2207-03-6	4,000	SU ²	400	SU ²
trans-2-Butene	624-64-6	15,000	TCEQ	700	TCEQ
trans-2-Pentene	646-04-8	12,000	TCEQ	560	TCEQ

US EPA (US Environmental Protection Agency); ATSDR (US Agency for Toxic Chemicals and Disease Registry); PPRTV (US EPA Provisional Peer Reviewed Toxicity Values); CalEPA (California Office of Environmental Health Hazard Assessment); TCEQ (Texas Commission on Environmental Quality); SU = Surrogate; DOE (Department of Energy); ppbV (parts per billion by volume); "--" (no value has been established). ¹Both the US EPA inhalation reference concentration and the ATSDR inhalation minimum risk level will be considered when evaluating this substance to best protect human health from non-cancer effects. ²Value surrogated from methylcyclohexane as described in previously published tiered approach because no chronic value was available. ³Value surrogated from n-nonane chronic PPRTV because no chronic value was available.

Table 3. List of substances and measured concentrations for each cancer risk level.

Substance	CAS #	Inhalation Unit Risk Factor (per $\mu\text{g}/\text{m}^3$) (Source)	Cancer Risk Estimate		
			Air Concentration at 1 in a million (ppbV)	Air Concentration at 10 in a million (ppbV)	Air Concentration at 100 in a million (ppbV)
Benzene	71-43-2	7.8×10^{-6} (US EPA)	0.040	0.40	4.0
Ethylbenzene	100-41-4	2.50×10^{-6} (CalEPA)	0.092	0.92	9.2
Isoprene	78-79-5	2.20×10^{-8} (TCEQ)	16	163	1631

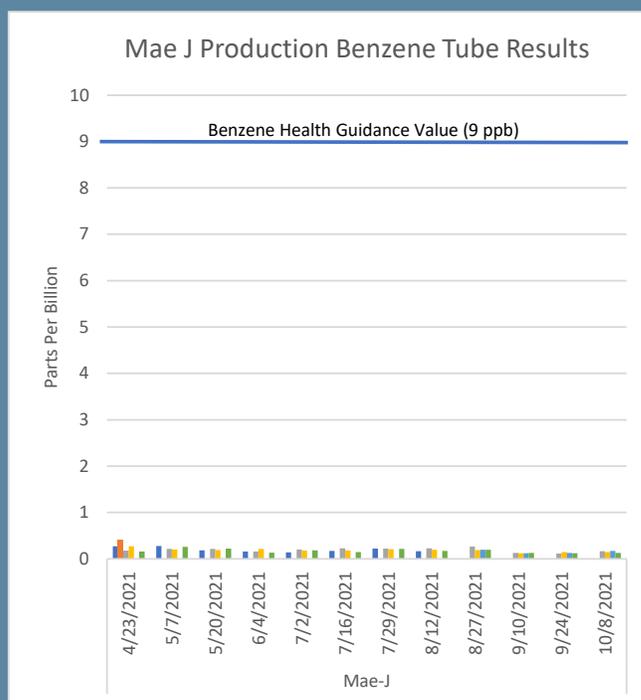
A one in a million cancer risk (1×10^{-6}) is considered a minimal cancer risk. A 100 in a million cancer risk (1×10^{-4}) is considered the upper limit of the EPA "acceptable" range. Risk estimates were determined by using each inhalation unit risk factor. US EPA (US Environmental Protection Agency); CalEPA (California Office of Environmental Health Hazard Assessment); TCEQ (Texas Commission on Environmental Quality); ppbV (parts per billion by volume).

Air Quality Report Mae J Production



Montrose Air Quality Services, LLC

- We conduct air quality monitoring in accordance with Occidental's air monitoring plan which is approved by the Colorado Department of Public Health and Environment (CDPHE)
- Results from validated air samples consisting of carbon desorption tubes and SUMMA® canisters are included in the graphs below



Health Guidance Values

Benzene – 9 ppb; Toluene – 2,000 ppb; Ethylbenzene – 5,000 ppb; M-, O-, and P-Xylenes – 2,000 ppb

Conclusion

All air samples taken during the reporting period were well below the established Health Guidance Values (HGVs) compiled by [CDPHE](#)

Additional Resources

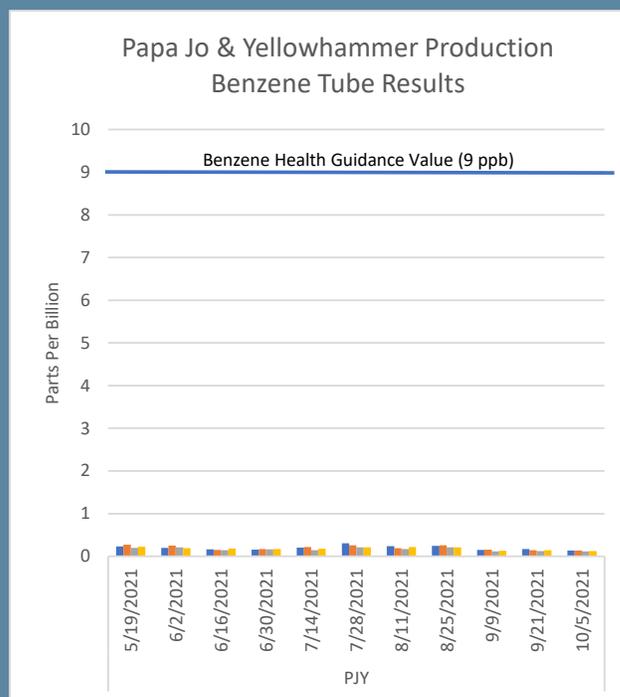
- [Colorado Oil and Gas Association](#) – Climate, Emissions, Ozone
- [Colorado Department of Public Health and Environment](#) – Oil and Gas and your health

Air Quality Report Papa Jo-Yellowhammer Production



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Additional Resources

- [Colorado Oil and Gas Association](#) – Climate, Emissions, Ozone
- [Colorado Department of Public Health and Environment](#) – Oil and Gas and your health

EXHIBIT 3

COLORADO:

Oil & Natural Gas Resource Guide



COLORADO
OIL & GAS
ASSOCIATION

2020



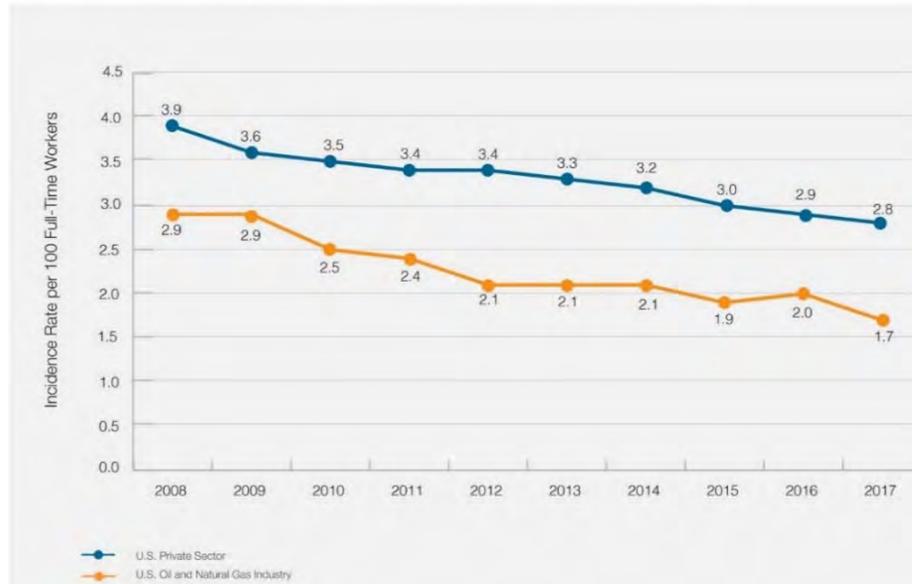
Safety

Colorado oil and natural gas operators are an integral part of one of the safest industries in the country.

The [U.S. Bureau of Labor Statistics](#) found that working in the oil and natural gas industry is on average, safer than the construction and manufacturing industries, hospitality, educational and health services, and even state government.

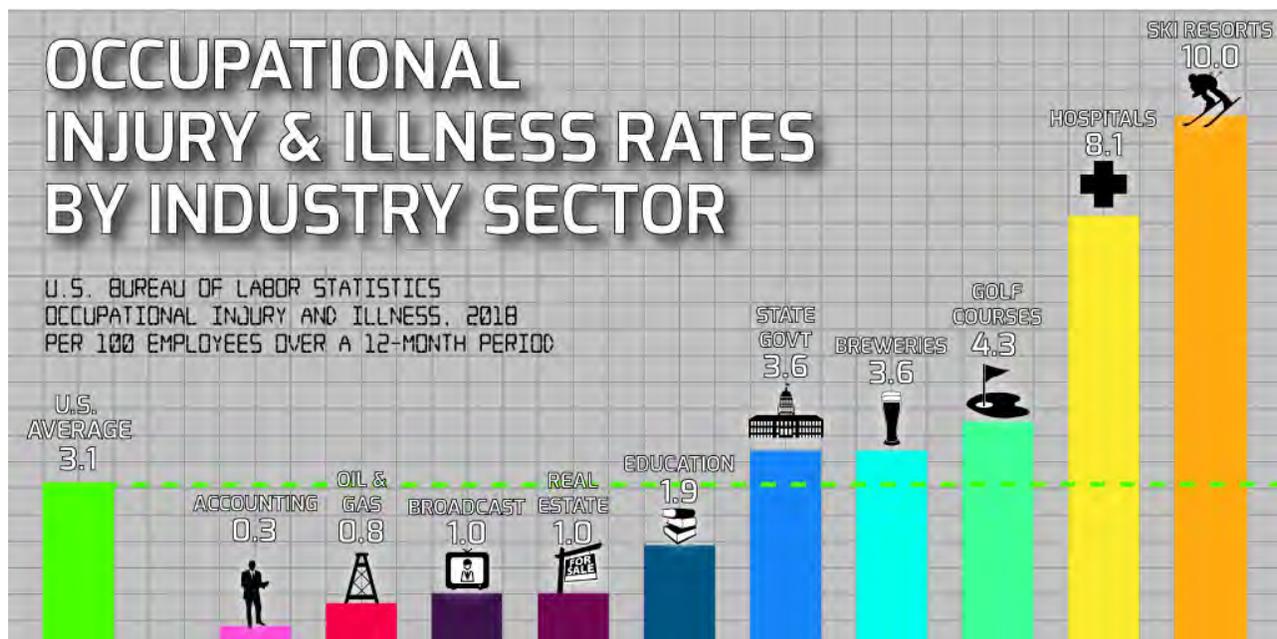
In 2017, the rate of job-related injuries and illnesses for the oil and natural gas industry was 1.7 per 100 full-time workers compared to a rate of 2.8 for the entire [U.S. private sector](#). Even as the U.S. average occupational incident rate rose to 3.1 in 2018, the oil and natural gas industry rates [dropped to 0.8](#) per 100 full-time workers, and have [continued to decline year over year](#).

U.S. Oil and Natural Gas Industry vs. U.S. Private Sector (2008-2017)
Injuries and Illnesses Incidence Rates



Incidence Rates of Occupational Injuries by Industry

The [Survey of Occupational Injuries and Illnesses \(SOII\)](#) presents estimates of counts and incidence rates of employer-reported workplace injuries and illnesses by industry and type of case, as well as detailed estimates of case circumstances and worker characteristics for cases that resulted in days away from work. According to the BLS Report, there were 2.8 million nonfatal workplace injuries and illnesses reported in the United States by private industry employers in 2018, unchanged from 2017.





Industry’s Commitment to Safety

- **Prevention**

- ✓ Operations are intentionally designed to reduce the risk of injury and incident.
- ✓ Many operations are monitored 24/7 and are designed to automatically shut in remotely, further preventing risk of injuries and incidents.
- ✓ Anyone who comes on an active site has stop-work authority if they see anything unsafe occurring.

- **Training**

- ✓ Colorado employees attend regular, mandatory safety training sessions.
- ✓ Operators conduct spontaneous safety drills in coordination with local responders to ensure everyone has the skills and confidence to effectively respond to a situation.

- **Industry Collaboration**

- ✓ Through innovation, applied learnings and tailoring operations in ways that benefit communities and improve the safety of employees.
- ✓ Applying best safety practices and train employees on incident prevention.
- ✓ Serving as a resource to community first responders on incident responses.
- ✓ Engaging in active campaigns like Colorado811 to educate excavators and the general public on the industry’s underground infrastructure of pipelines to avoid incident and injury.



Goal of zero injuries and incidents



Continuously monitored operations



Automatic, remote shut-in capabilities



Stop-work authority at all active sites



Regular, mandatory safety training for employees



Active safety drills in collaboration with local first responders

Additional Resources & Information

Sources

American Petroleum Institute (API) | www.api.org
 United States Department of Labor (BLS) | www.bls.gov



On October 17, 2019, the Colorado Department of Public Health and Environment (CDPHE) released an oil and natural gas health effects [study](#) titled, *Human Health Risk Assessment for Oil & Gas Operations in Colorado*. This study follows CDPHE’s 2017 *Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado*. That earlier [study](#) reviewed more than 10,000 air samples in regions of Colorado where people are living near oil and natural gas development. It concluded that all measured air concentrations were below short- and long-term safe levels.

Measurements are an important tool for understanding actual health risks, which is why CDPHE continues to collect air samples. In fact, an additional [5,000 samples](#) near well pads and communities have been taken by the state’s state-of-the-art mobile monitoring lab in the past few years. Similar to the CDPHE 2017 study, not one of the mobile lab measurements were at a level that could cause short- or long-term health effects to nearby residents.

CDPHE’s 2019 health study took a different approach and reviewed data from Colorado State University’s emission study, taken from 2013-2016. Authors then developed an air dispersion model to make thousands of predictions of air concentrations and hypothetical exposures to populations living between 150 to 2,000 feet from a well pad under worst-case conditions.

Chronic Results

The model found all simulated long-term, chronic exposures to individual substances (like benzene) at 500 feet or more from production operations, which can continue for up to 30 years, were below health guideline levels. The study says, “chronic exposures during production operations were below guideline levels at the 500-ft distance in all scenarios.” This result confirms there are no anticipated long-term health impacts, including cancer, for people living near oil and natural gas development.

Acute Results

The model predicted in isolated scenarios that benzene, toluene, and ethyltoluenes, at smaller well pads during flowback activities, could exceed short-term, acute exposure health guideline levels at short distances.

North Front Range – The model used to simulate oil and natural gas operations in the North Front Range predicted infrequent, worst-case scenarios where the highest one-hour exposures exceeded health guideline values for benzene during flowback.

Western Slope – The model used to simulate oil and natural gas operations on the Western Slope predicted infrequent, worst-case scenarios where the highest short-term exposures exceeded health guideline values for benzene during flowback, as well as ethyltoluene and toluene for some other pre-production phases.

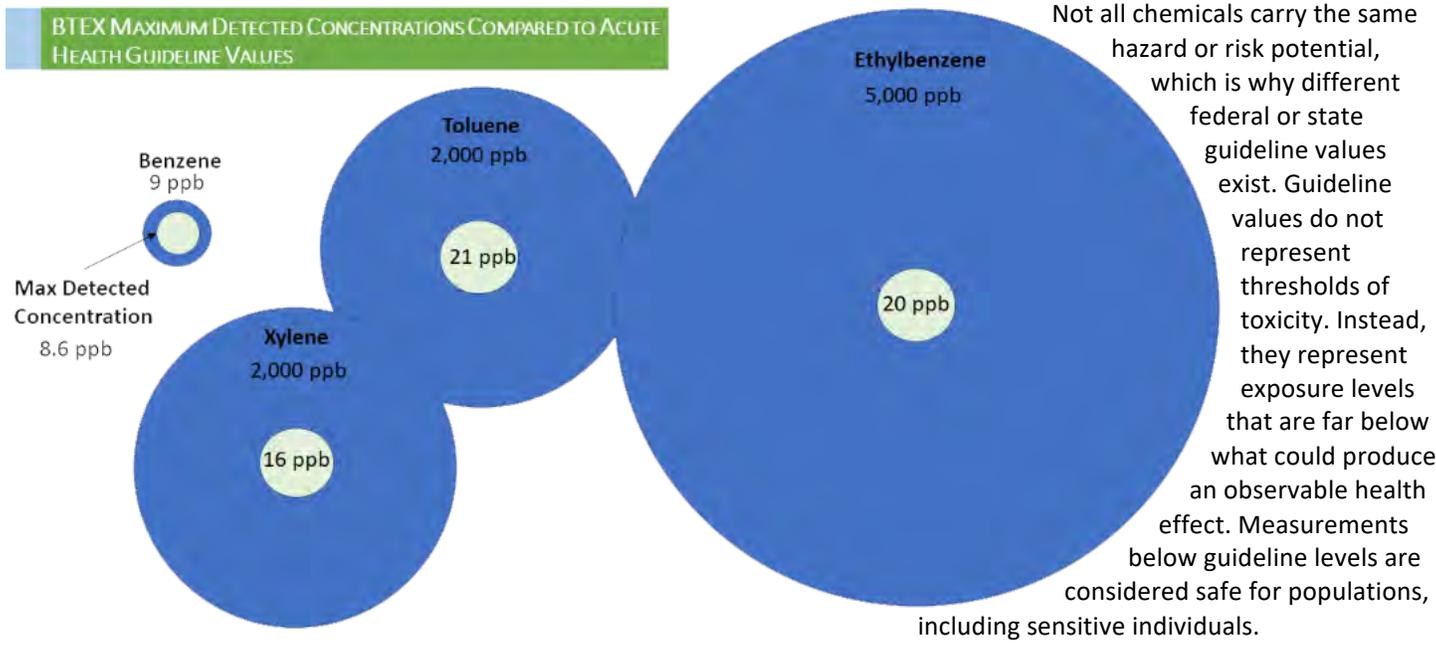
Authors of the study emphasize that modeling was “highly conservative, in that these highest-estimated exposures occur when the highest chemical emissions are highly concentrated by ‘worst-case’ meteorological conditions onto a hypothetical person who is outdoors or in a highly ventilated area, which might happen only rarely.” By using thousands of simulations, the study suggests “acute (short-term) health risk can be exaggerated when applying an air dispersion model to the improbable coincidence of the highest emission-release rate with worst-case meteorological conditions.”

In summation, under worst-case, hypothetical scenarios involving acute exposures only, the study determined that the potential for health risks could occur. However, even in those extremely rare situations, according to federal risk assessment guidelines, none of those worst-case modeled results were at levels that might produce observable health impacts. More information about those guideline levels is below.

Industry Practices

The 2019 CDPHE health study specifically identified the pre-production flowback stage as an area of potential concern under worst-case scenarios for acute exposure only, not chronic exposure. Current industry practices during flowback are significantly different than when the measurements were taken (2013-2016) to inform the model. Techniques at the time included open-air tanks, and in some cases “[green completions](#).” Today, open-air tanks for flowback are not used in urban areas and green completions are commonplace. In some cases, operators have moved to enhance green completions and have a variety of best practices to further reduce emissions from this phase of development.

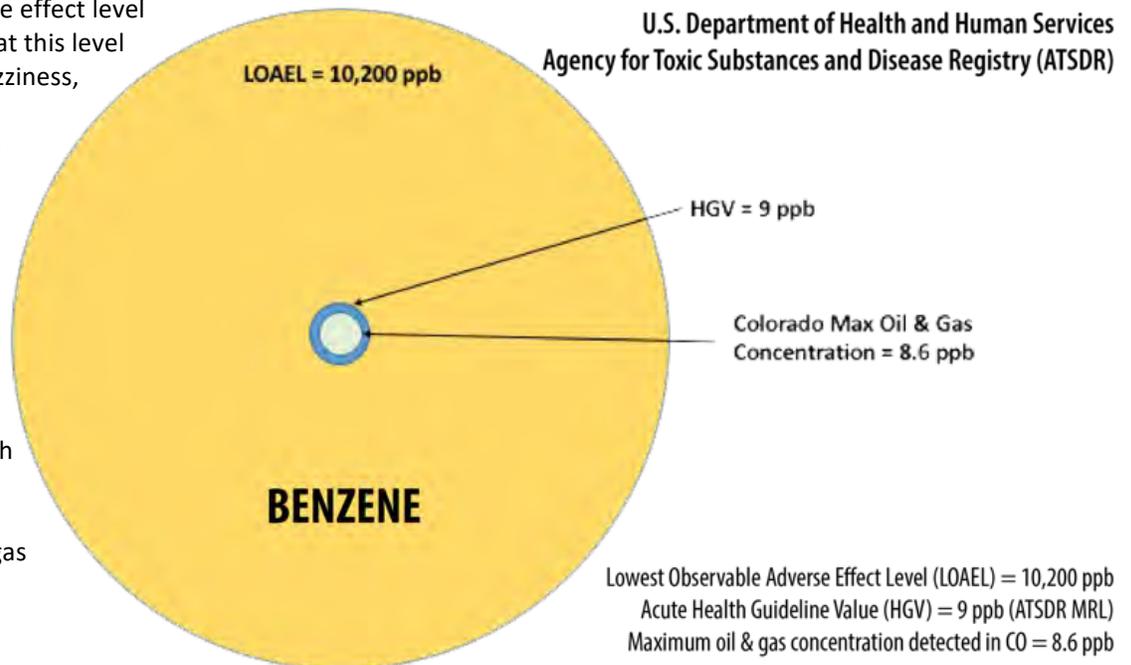
Health Guideline Values



In the chart above, adhering to Colorado’s 500-foot setback distance, the highest confirmed measurement of chemicals commonly associated with oil and natural gas development have all been below health guideline values. Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) are the chemicals most often monitored and measured. The chart shows the maximum confirmed detection of each chemical taken in Colorado (green circle) and the corresponding federal health guideline value from the Agency for Toxic Substances and Disease Registry (ATSDR) used to evaluate health risk (blue circle).

There is a big difference between health guideline values and the actual concentrations that may produce observable effects. The chart below illustrates these differences in benzene concentrations. Drawing from known toxicology studies, the U.S. Department of Health and Human Services’ Agency for Toxic Substances and Disease Registry (ASTDR) was able to determine the lowest observable adverse effect level (LOAEL). Benzene exposures at this level (10,200 ppb) could lead to dizziness, headaches, nose and throat irritation. The ATSDR’s health guideline value is set much lower at 9 ppb, to be highly conservative.

Measurements of benzene in Colorado at distances of 500 feet or greater have been near that health guideline value, which is much lower than the 200 ppb that someone may be exposed to while filling up their car at a gas station.



STUDIES OF OIL AND GAS EMISSIONS

Hess et al., “Assessing Agreement in Exposure Classification between Proximity-Based Metrics and Air Monitoring Data in Epidemiology Studies of Unconventional Resource Development,” *Int J Environ Res Public Health*, 2019 ([study link](#)). This study was conducted by a research team at Shell. This peer-reviewed study, published in the *International Journal of Environmental Research and Health*, tested the assumption that oil and gas well activity can be used as a reasonable proxy for exposure to air pollution. The researchers concluded: “The question we essentially asked was, if [Pennsylvania] monitoring sites were instead a sample of epidemiology study subjects’ homes with monitors placed outside the front door, how well does the categorization of exposure agree between the two methods? We found that they did not agree well at all with the same exposure quartile assigned in roughly one in four observations, and the opposite category assigned for roughly 25%.”

Leken et al. “The climate and health effects of a USA switch from coal to gas electricity generation,” *Elsevier B.V.*, 2016 ([study link](#)). This Carnegie Mellon University peer-reviewed study found that increased use of natural gas would result in further sulfur dioxide (SO₂) reductions from current levels of 90 percent and 60 percent for nitrogen oxide (NO_x), reducing national annual health damages by \$20-\$50 billion annually.

National Bureau of Economic Research. “Can Natural Gas Save Lives? Evidence from the Deployment of a Fuel Delivery System in a Developing Country,” 2016 ([study link](#)). This study examines the relationship between an increase in natural gas use and adult and elderly mortality rates. The study finds, “the expansion of natural gas services has caused significant reductions in the both the adult and the elderly mortality rates.” The paper focuses on 81 Turkish provinces, 71 of which have switched from a coal-based fuel delivery system to natural gas over the last two decades. The study shows that when a natural gas network is deployed in a province, air quality improves compared to those provinces without an access to natural gas, and subsequently the rates of mortality go down for all age groups including infants, adults, and the elderly. Furthermore, the study finds that the mortality gains are primarily driven by reductions in cardio-respiratory deaths, which are more likely to be due to conditions caused or exacerbated by air pollution.

Bunch et al. “Evaluation of impact of shale gas operations in the Barnett Shale region on volatile organic compounds in air and potential human health risks,” *Science of the Total Environment*, 2013 ([study link](#)). This peer-reviewed study of air emissions across the Barnett Shale, conducted by ToxStrategies, concluded that “shale gas activities have not resulted in VOC levels that pose a health concern.” The study found that VOCs associated with shale gas were all below health-based CVs and VOCs associated with shale gas showed acceptable chronic risk and hazard. The study’s abstract states, “The analyses demonstrate that, for the extensive number of VOCs measured, shale gas production activities have not resulted in community-wide exposures to those VOCs at levels that would pose a health concern.” The study’s conclusions were based on Texas Commission on Environmental Quality (TCEQ) data.

Tanaka et al. “Asserting the climate benefits of the coal-to-gas shift across temporal and spatial scales,” Nature Climate Change, 2019 ([study link](#)). The study used a “multimetric approach” to analyze both short-term and long-term climate impacts and found that “a recent synthesis study gave a leakage estimate of 2.3% for the United States...CH₄ measurements and inventory data are concentrated in the United States, leaving the leakage estimates in the other parts of the world more uncertain. Leakage rates outside of the United States could be high due to fewer regulatory oversights on environmental issues, among other factors.” The study also discussed the climate benefits of shifting from coal to gas stating, “We found that the coal-to-gas shift is consistent with climate stabilization objectives for the next 50-100 years. Our finding is robust under a range of leakage rates and uncertainties in emissions data and metrics. It becomes conditional to the leakage rate in some locations only if we employ a set of metrics that essentially focus on short-term effects. Our case for the coal-to-gas shift is stronger than previously found...”

Vaught et al. “Temporal variability largely explains top-down/bottom-up difference in methane emission estimates from a natural gas production region,” Proceedings of the National Academy of Sciences of the United States of America, 2018 ([study link](#)). The study was a response to a finding that suggested methane emissions rates were 60 percent higher than what federal data showed, but the PNAS study showed that could be the result of how top-down aircraft measurements are extrapolated to annual averages. “Study area total emissions exhibited significant variability throughout the day. On both days of the study period, modeled emissions peaked during mid-afternoon hours due to MLUs performed and recorded by production facility operators,” the study said.

Barkley et al. “Quantifying methane emissions from natural gas production in northeastern Pennsylvania,” U.S. Department of Energy, 2017 ([study link](#)). The study was funded by the Department of Energy and conducted by researchers at Penn State University. It found that methane leakage rates from natural gas wells and other infrastructure in the Northeast Marcellus shale are roughly 0.4 percent of production. 3.2 percent is the threshold for natural gas to maintain its climate benefits. The study said, “Using the model optimization technique presented in this study, we find a weighted mean natural gas emission rate from unconventional production and gathering facilities of 0.36% of production with a 2 σ confidence interval from 0.27 to 0.45% of production. This emission rate is supported by four mass balance calculations, which produce a mean of 0.40% and a 2 σ confidence interval of 0.08–0.72% of production. Applied to all the wells in our study region, this mean rate results in a leakage rate of 20MgCH₄ h⁻¹ for the year 2015.” Additionally, an EID review of EPA data shows that U.S. natural gas systems had a methane leakage rate of only 1.2 percent in 2015.

Lan et al. “Long-Term Measurements Show Little Evidence for Large Increases in Total U.S. Methane Emissions Over the Past Decade,” National Oceanic and Atmospheric Administration, University of Colorado at Boulder, 2019 ([study link](#)). The study shows that previous estimates of methane emissions were greatly overstated. The study stated, “Our estimated increases in North American ONG CH₄ emissions (on average $\sim 3.4 \pm 1.4$ % yr⁻¹ for 2006-2015, $\pm\sigma$) are much smaller than estimates from some previous studies and below our detection threshold for total emissions increases at the east coast sites that are sensitive to U.S. outflows. We also find an increasing trend in ethane/methane emission ratios which has resulted

in major overestimation of oil and gas emissions trends in some previous studies.” The study suggests that methane emissions may have been overestimated by as much as 10 times.

Nisbet et al. “Rising atmospheric methane: 2007–2014 growth and isotopic shift,” Department of Earth Sciences at Royal Holloway, University of London, 2016 ([study link](#)). The study showed the rising methane emissions rates around the world wasn’t due to oil and natural gas production, but rather because of tropical wetlands and agriculture. The study’s lead author said, “Our results go against conventional thinking that the recent increase in atmospheric methane must be caused by increased emissions from natural gas, oil, and coal production. Our analysis of methane’s isotopic composition clearly points to increased emissions from microbial sources, such as wetlands or agriculture.” The study also stated the data analyzed found “both the majority of this methane increase and the isotopic shift are biogenic.”

Schwietzke et al. “Improved Mechanistic Understanding of Natural Gas Methane Emissions from Spatially Resolved Aircraft Measurements,” National Oceanic and Atmospheric Administration, University of Colorado at Boulder, 2017 ([study link](#)). This study finds that emission estimates reported in a series of studies used to justify federal methane regulations may have been significantly exaggerated because of the time that measurements were taken: “O/NG emissions are systematically higher during daytime hours when TD and BU measurements have been made, and lower at night”

EID, Colorado Health Officials Debunk Lung Association’s Ozone Report Card (May 6, 2015), ([study link](#)). CDPHE Air Pollution Control Division Director Will Allison revealed that the ALA’s 2015 report card on air quality in Colorado ignored a full year of air quality data from 2014, which shows ozone levels getting better, not worse. Colorado’s response to ALA also wasn’t unique to Colorado. Widespread criticism of the ALA reports poured in from across the country in recent years from the Pittsburgh Post-Gazette’s editorial board, as well as government agencies and regulators like EPA Region 7, the Indiana Department of Environmental Management, Maryland Department of the Environment, Texas Commission on Environmental Quality and Hamilton County Department of Environmental Services.

EID, Latest EPA Data Show U.S. Greenhouse Gas Emissions at Lowest Levels Since 1992 (Apr. 16, 2019), ([study link](#)). According to April 2019 EPA GHG Inventory, total U.S. greenhouse gas emissions in 2017 reached their lowest levels since 1992. Total U.S. GHG emissions fell by 12 percent and total GHG emissions from fossil fuel combustion decreased nearly 15 percent between 2005 and 2017. Meanwhile, U.S. oil and natural gas production increased more than 80 percent and 51 percent, respectively, and natural gas consumption increased 23 percent, according to the Energy Information Administration.

McDuffie et al., “Influence of Oil and Gas Emissions on Summertime Ozone in the Colorado Northern Front Range,” 2016 ([study link](#)). A 2016 study conducted by NOAA and the University of Colorado demonstrates that the oil and natural gas industry accounts for just a small portion of total ozone in Colorado’s northern Front Range. The study found that on high ozone days, when ozone levels reach to approximately 70 ppb, 17 ppb of that ozone is produced locally (the remainder is from regional background sources or residual ozone produced locally during previous days) and that on average, oil and gas emissions account for about 3 ppb or 17 percent of the daily infusion of VOCs that create ground-level ozone.

Michael A. Levi, Revisiting a Major Methane Study, Council on Foreign Relations (Oct. 12, 2012), ([study link](#)). Discussing research published in the Journal of Geophysical Research on why NOAA's 2012 estimates on methane rates from oil and gas production in the Denver-Julesburg basin were unsupportable and explaining that methane leakage rates—even prior to the 2014 landmark rulemaking—were most likely between 1 and 2 percent.

EID, Let's Take a Closer Look at the Boulder Air Quality Study (Jan. 18, 2019), ([study link](#)). Analyzing Detlev Helmig's air monitoring data drawing connections between high ozone levels in the region and oil and gas development east of the city in Weld County. According to Professor Helmig, the monitoring did not actually include “ozone production modeling” or “a study that would attribute ozone to particular sources.” In fact, the monitoring “did not even include ozone.”

EID, Ethane Study Pushes Alarmist Claims on Ground-Level Ozone, Methane Emissions (Jun. 20, 2016), ([study link](#)). Detailed analysis of Detlev Helmig's 2016 research on methane and ozone levels using ethane as a tracer gas.

EID, U.S. Natural Gas Leads all Energy Sources in Carbon Emission Reductions (Nov. 19, 2019), ([study link](#)). The shift in the United States to building more natural gas power plants has led to the reduction of more than 2.8 million metric tons of carbon dioxide emissions since 2005, making it the largest source of energy-related carbon savings, according to recent data from the Energy Information Administration.

Bamber et al., “A Systematic Review of the Epidemiologic Literature Assessing Health Outcomes in Populations Living near Oil and Natural Gas Operations: Study Quality and Future Recommendations,” Int J Environ Res Public Health, 2019 ([study link](#)). A comprehensive and systematic literature review by the CDPHE and the Pennsylvania Department of Health of existing epidemiological studies on the health effects of unconventional oil and gas development (20 epidemiological studies with 32 health outcomes), concluded that “(s)tudies of populations living near ONG operations provide limited evidence (modest scientific findings that support the outcome, but with significant limitations) of harmful health effects including asthma exacerbations and various self-reported symptoms.”

McMullin et al., “Exposures and Health Risks from Volatile Organic Compounds in Communities Located near Oil and Gas Exploration and Production Activities in Colorado (U.S.A.) ,” Int J Environ Res Public Health , 2018 ([study link](#)). A CDPHE conducted risk assessment. The researchers identified 56 VOCs emitted from oil and gas industry operations while reviewing 47 air monitoring datasets in 34 regions in Colorado. The report concluded that measured ambient air data collected at distances greater than 500 feet around oil and gas development activities did not exceed EPA health guidance values for either long-term or short-term exposures

Long et al., “Synthesis and Health-Based Evaluation of Ambient Air Monitoring Data for the Marcellus Shale Region,” Journal of the Air * Waste Management Association, 2019 ([study link](#)). The objective of this research effort was to publish the findings of an evaluation of the growing number of ambient air monitoring data collected in the Marcellus Shale region. The data were evaluated to determine if there was evidence of potential community-level air quality-related health concerns. The ambient air data evaluated indicate that pollutants in the Marcellus

shale region are found in concentrations that are typically below health-based air comparison values. Where there were exceedances, they were sporadic and not focused on any specific chemical, time, or site and could have been the result of non-industry emission sources

McCallum et al., “Health Impact Assessment of an Oil Drilling Project in California,” Int J Occup Med Environ Health, 2016 ([study link](#)). A Health Impact Assessment was conducted to evaluate potential health effects in community where a proposed oil development product project in Hermosa beach , California. The authors concluded that the project would have no substantial effects on the community’s health.



2020

Oil & Natural Gas Resource Guide



www.coga.org



EXHIBIT 4

New Energy Development



About Occidental

- We are committed to conducting our business in a manner that safeguards our employees, protects the environment, benefits neighboring communities and strengthens local economies.
- In 2020, Occidental set a target to reach net-zero emissions associated with its operations by 2040 and an ambition to reach net-zero emissions with the use of its products by 2050.
- Our Stakeholder Relations team is available Monday through Friday, 7a.m. to 4p.m. Please leave a message at 866.248.9577 or email us at ColoradoStakeholder@oxy.com, and we'll get right back to you.

Location and Timeline



Location	Pad Build	Drilling	Hydraulic Fracturing and Completion	Facility Built	Site Reclamation
MAE J	9/2019	10/2019 - 4/2020	2/2021 - 3/2021	4/2021	9/2021
PAPA JO	10/2017	10/2017 - 1/2018	3/2021 - 4/2021	3/2021	10/2021
YELLOWHAMMER	10/2017	10/2017 - 1/2018	3/2021 - 4/2021	3/2021	10/2021

- Two community meetings were held in the fall of 2017. In addition to all required notices, we have sent seven different courtesy notifications throughout the development process. We also continue to provide bi-weekly email updates to residents upon request.

Facts about developing near Erie

- For projects near Erie, our water-on-demand system will eliminate an estimated 46,800 truck trips.
- Although operations are conducted 24/7, at night, we aim to minimize all non-essential work.
- We contract with an environmental air quality expert to perform continuous air monitoring during the drilling and hydraulic fracturing phases.

Wellsite Mitigation



We have developed a rigorous process for analyzing and mitigating surface impacts at each of our locations. For each new well pad we select technologies and advancements to reduce noise, light, odor, and dust.

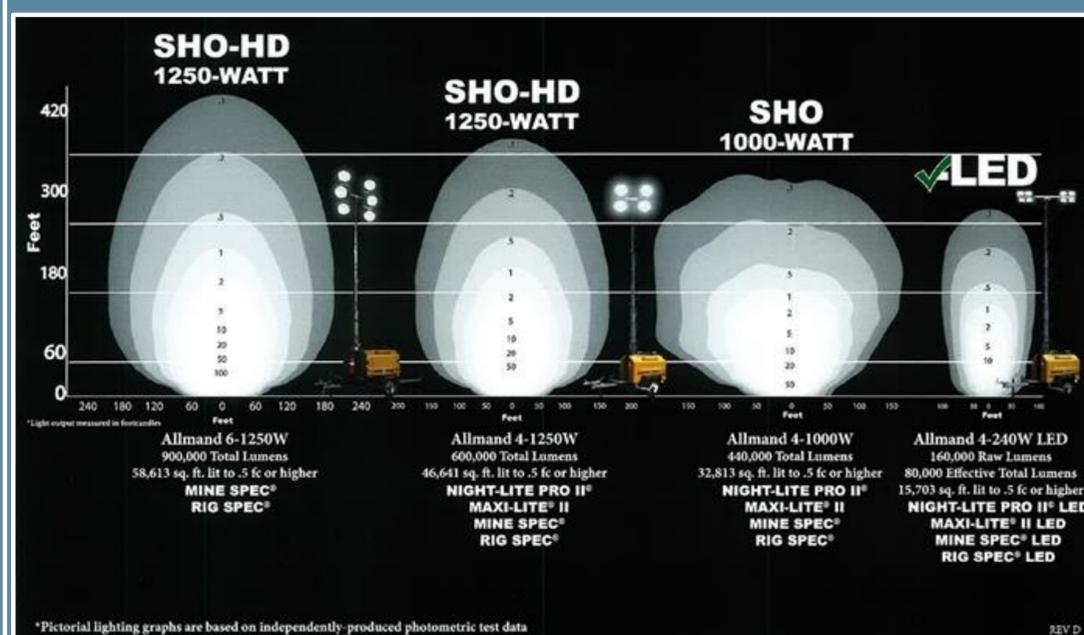
For the pads near Erie, this includes a quiet completions fleet, sound walls, our water-on-demand system, performing continuous air quality monitoring and paved access roads.

NOISE – SOURCE MITIGATION



- Examples of modified completions equipment includes a quiet completions fleet with enclosed pump trucks and blender

LIGHT – SOURCE MITIGATION



- LED light plants
- Strategic orientation

NOISE - MECHANICAL MITIGATION



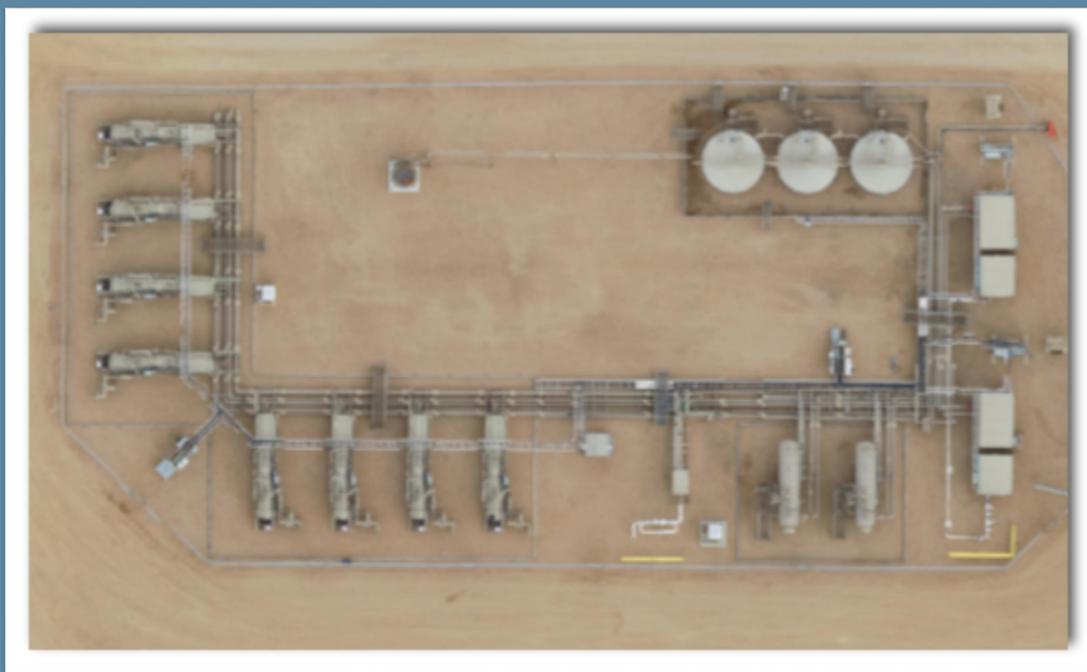
- Sound walls on-site

LIGHT – MECHANICAL MITIGATION



- Sound panels installed on the south side of CR 10 to mitigate light from truck traffic.

Reducing Impacts & Emissions



Innovative design reduces impacts:

- Tankless means eliminating oil storage tanks, which are the largest source of potential emissions
- Because oil flows off-site through a pipeline, there is no need for trucks to transport oil
- Our tankless design also reduces the footprint of the disturbance area, reducing the overall impact on the community

Leak Detection and Repair:

- Every facility is inspected using an infrared camera
- We use additional infrared camera equipped drones
- Audio/visual/olfactory inspections
- Daily facility inspections
- Integrated Operations Center in Platteville staffed 24/7



Groundwater Protection:

- Baseline water-quality sampling
- Double-walled produced water sumps
- Secondary containment for operations
- Automation
 - Fluid level monitors / high-level shutoff
 - Sensors between walls of water sumps
 - Ability to shut-in wells remotely



Community Resources



Monday to Friday, 7 a.m. to 4 p.m.:

After-Hours and emergencies:

1.970.506.5980



Colorado Response Line



1.866.248.9577

ColoradoStakeholder@oxy.com

Integrated Operations Center



- Staffed 24 hours per day, seven days per week, 365 days per year by personnel who have been trained in the Occidental response practices and procedures.
- Enables real-time monitoring of the majority of our wells, water tanks, and pipeline system pressures. Additionally, the system allows us to monitor personnel locations and surrounding features, including sensitive areas, bodies of water, habitats, and communities.
- Company vehicles are equipped with tracking devices in order to quickly deploy resources.
- Enables employees to shut-in many of our wells remotely.
- Enhances collaboration with local emergency response agencies.

Phases of Energy Development



1 PAD CONSTRUCTION



- Standard equipment prepares the well site.
- A wall or straw bales may be installed to reduce or minimize noise and light during future operational phases.

DAYS
10 - 20
Per Pad

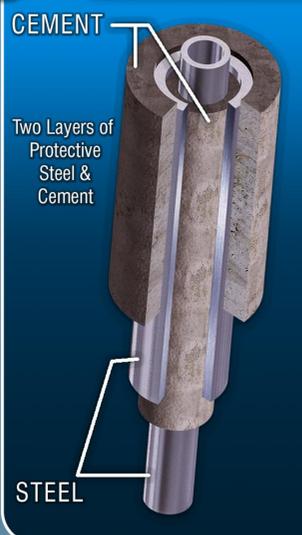
4 HYDRAULIC FRACTURING



- Hydraulic pumps send water and sand down the wellbore to cause a hairline fracture in the rock so that oil and natural gas can be produced.
- 95% of wells in the U.S. require fracking to produce oil and natural gas.
- For more information [click to visit Coloradans for Responsible Energy Development](#)

DAYS
2 - 4
Per Well

2 SURFACE CASING SET



- A drilling rig begins the underground construction process by installing steel pipe and cement (surface casing) to protect groundwater.
- Surface casing is set below the Fox Hills aquifer, which is ~1,000' below the surface.

DAYS
1 - 2
Per Well

5 PRODUCTION FACILITY CONSTRUCTION



- Production facilities are constructed adjacent to the wells to collect and separate the oil, natural gas and water that are produced.
- A majority of our wells are monitored via remote automation.

DAYS
30 - 45
Per Pad

3 HORIZONTAL DRILLING



- A production rig arrives and drills to a depth of 7,000 to 8,000 feet.
- The horizontal portion of the wellbore can extend more than 2 miles.

DAYS
4 - 10
Per Well

6 RECLAIMED WELL SITE



- Once development phases are complete, the pad is reclaimed to match the existing landscape.
- Each well will produce energy for decades to come.

Hydraulic Fracturing



Hydraulic Fracturing is a highly engineered technology developed in the 1940s to enhance production of oil and natural gas from tight rock formations more than a mile below the earth's surface.



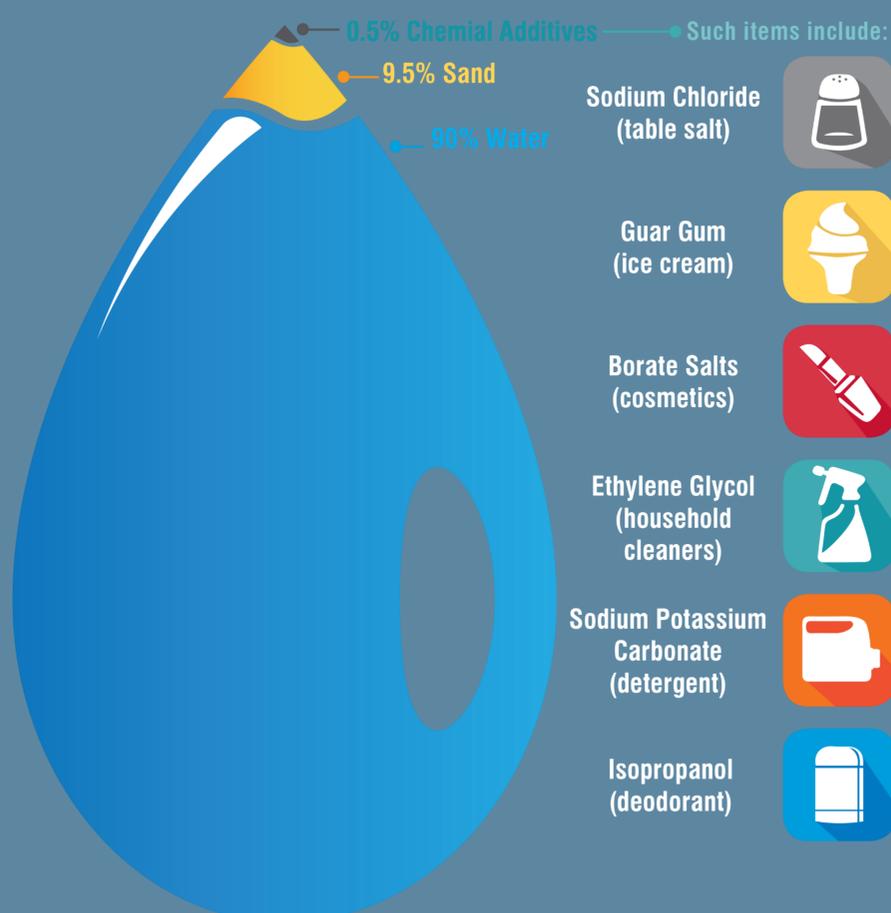
Engineer monitoring operations on-site



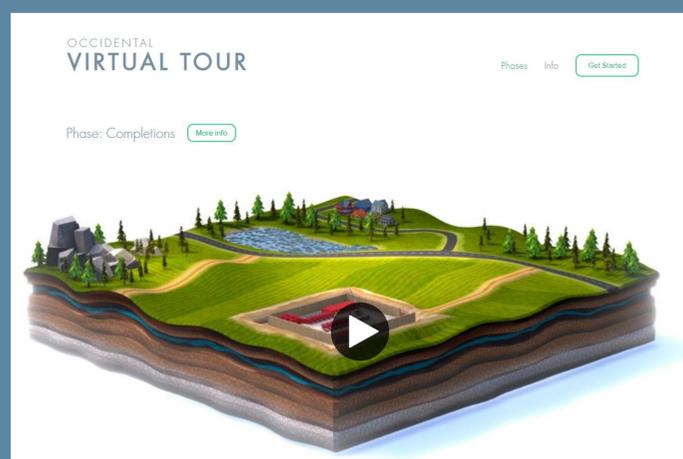
Hydraulic fracturing site

How Does It Work? A mixture of water, sand and additives are pumped under high pressure down the wellbore to create hairline fractures in the rocks over a mile below the earth's surface. The sand props open the fractures to allow for oil and natural gas to flow to the wellbore, while the additives – like ones commonly found in ice cream, gum, etc. – reduce friction and prevent bacteria formation and build up.

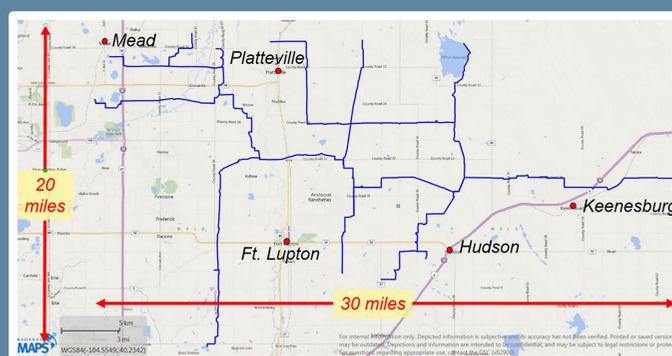
Additives Used in Hydraulic Fracturing



Source: Groundwater Protection Council, API



To learn more about this process, [click here to take a 3D Interactive Tour](#)



We transport the water used in fracturing through our innovative “Water- On-Demand” pipeline system. Since its inception in 2012, this technology has enabled us to eliminate more than 25 million miles of truck traffic in Weld County.