



SUMMARY

Executive Summary

Energy In Depth examined publicly available health data in Weld County, Colo., during a time frame of significant oil and natural gas activity expansion (2002-2015). The data show that rates of death for cancer, heart disease and chronic lower respiratory disease in Weld County decreased over this period. The population increased by nearly 43 percent during this time frame, while the number of residents 65 years of age or older nearly doubled—a notable statistic since cancer, heart disease, and chronic lower respiratory disease are listed by the Center for Disease Control and Prevention (CDC) as the leading causes of death for persons in that age group. ¹

Further, a review of 10,000 air samples by the Colorado Department of Public Health and Environment (CDPHE) found the air quality to be "safe" even for sensitive populations, while concentrations of most substances likely emitted from oil and gas operations were between four and 10,000 times lower than standard short and long-term health based reference levels for non-cancer effects. CDPHE scientists also reviewed existing studies on 27 different health effects and did not find any "substantial" or "moderate" evidence of health risks.

Major Findings

- As oil and natural gas production in Weld County increased by 12 times and three times respectively, and well counts more than doubled, the rates of death for cancer, respiratory illness and heart disease decreased by 1.9 percent, 9.1 percent and 21.4 percent, respectively.
- Between 2002 to 2015, the elderly population in the county nearly doubled. The CDC lists cancer, lower respiratory disease and heart disease as the leading causes of death for those 65 and older.
- A CDPHE report that analyzed more than 10,000 air samples in the areas of the state where "substantial" oil and natural gas operations occurred found that levels of emissions were "safe," even for sensitive populations.
- The CDPHE scientists also reviewed 12 relevant epidemiological studies covering 27 different health effects and found "no substantial or moderate evidence for any health effects."
- Of the recent studies that purported to find a link between oil and natural
 gas activity and adverse health effects, CDPHE ranked a majority "low quality,
 primarily due to limitations of the study designs that make it difficult to establish
 clear links between exposures to substances emitted directly from oil and gas and
 the outcomes evaluated."

This report examines:

- Death statistics data available through the Colorado Department of Public Health and Environment²
- "Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado," a 2017 report by CDPHE³
- "Screening Assessment of Potential Exposures and Health Effects," an air sample report from CDPHE's 2017 Assessment⁴
- Oil and Gas Health Information Reports from CDPHE 5
- Weld County oil and natural gas production figures from the Colorado Oil and Gas Conservation Commission

Background

Colorado is the nation's seventh⁶ largest producer of oil, and its fifth⁷ largest producer of natural gas, thanks in large part to the abundance of shale⁸ resources located in the Denver-Julesburg (D-J) Basin. In recent years, the state has been the focus of several health studies⁹ to assess the impact of hydraulic fracturing on human health. Some of these studies suggest that there is an association between fracking and adverse human health impacts. However, association does not translate into causation. Regardless, environmental activists have seized upon these studies, citing them as proof as to why oil and natural gas development should be banned or significantly restricted, in Colorado and elsewhere.

This report reviews publicly available but previously underreported data compiled by the Colorado Department of Public Health and Environment (CDPHE), including epidemiological health studies and air sample studies for Weld County, Colo. Weld County was chosen for analysis due to the high concentration of oil and natural gas activity in the region, and the county's vast expansion of production levels since the turn of the century.

From 2002 to 2015, natural gas production in the county increased three-fold, and oil production increased by more than 12 times. The county, which is located to the northeast of Denver, delivered nearly 90 percent of Colorado's oil production in 2015. As is to be expected, Weld County also has the highest number of active wells in the state with nearly 24,000 as of Feb. 1, 2018. That number is close to outnumbering the next five largest counties' aggregate active well count in the state combined.

Denver-Julesburg Basin

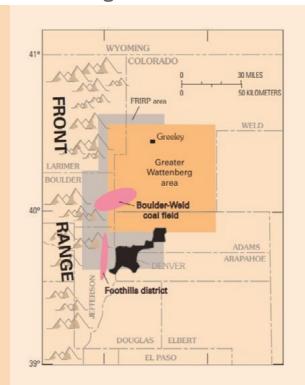
The D-J Basin has a long history of oil and natural gas development dating back to 1901, when the first gas

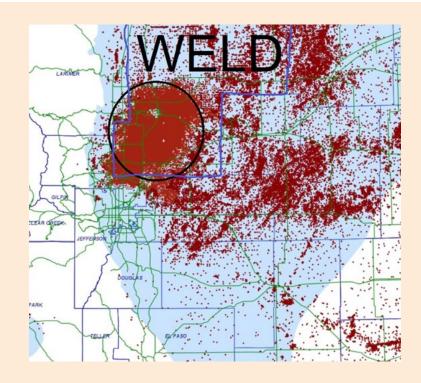
- 2 "Colorado Health and Environmental Data," Colorado Department of Public Health and Environment (CDPHE), 2017.
- 3 "Oil and gas health assessment," CDPHE, 2017.
- 4 Ibid.
- 5 "Oil and gas community investigations," CDPHE.
- 6 "Rankings: Crude Oil Production," U.S. Energy Information Administration, November 2017.
- 7 "Rankings: Natural Gas Marketed Production," U.S. Energy Information Administration, 2016.
- 8 "Fast Facts: The Niobrara," Colorado Oil and Gas Association (COGA).
- 9 "Childhood hematologic cancer and residential proximity to oil and gas development," PLOS One, February 15.

well was drilled in the basin in Boulder County. In 2010¹⁰, after more than a century of vertical development, operators began to use directional and horizontal drilling more often. This shifted the focus of development primarily to Weld County.

Today, Colorado produces more than 115 million barrels of oil and 1.7 trillion cubic feet of natural gas annually out of the Niobrara Shale and Wattenberg Field. Forty-three percent (more than 23,000) of all active wells in the state are located in Weld County.¹¹

Wattenberg Field:





Source: USGS¹²

D-J basin in blue, with Wattenberg field circled, Weld County in blue outline. Red dots indicate oil or natural gas wells. Source: COGCC¹³

Weld County Oil and Natural Gas Production

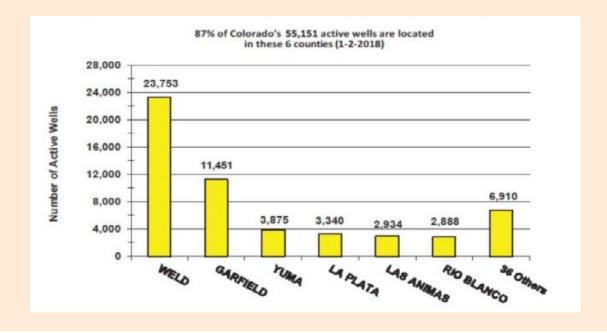
From 2002 to 2015, natural gas production¹⁴ in Weld County increased from 184 million to 552 million cubic feet annually – a three-fold increase. Oil production¹⁵ increased nearly 12.3 times from 8.9 million to 109.3 million barrels per year. Weld County delivered nearly 90 percent of all oil production (114 million barrels) in the state of Colorado in 2015 (as compared to 45 percent in 2002¹⁶). The county's 2015 natural gas

- 10 "The D-J Basin, Reinvented," Oil and Gas Investor, August 29, 2016
- 11 Weld County Oil and Gas
- 12 "Planning for the Conservation and Development of Infrastructure Resources in Urban Areas—Colorado Front Range Urban Corridor," U.S. Geological Survey, 2002
- 13 "GIS Online," Colorado Oil and Gas Conservation Commission (COGCC)
- 14 "COGCC Reports Portal: Monthly Production Reports," COGCC.
- 15 Ibid
- 16 "FY 2002-2003 REPORT TO THE WATER QUALITY CONTROL COMMISSION and WATER QUALITY CONTROL DIVISION of THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT," COGCC, November, 2003.

production was roughly one-third of the approximately 1.7 trillion cubic feet produced.

More recent numbers hint at Weld County's share of oil and natural gas production increasing, however modestly, to new highs. At the end of the third quarter of 2017, Weld County accounted for 90.4 percent of all oil produced in Colorado. The county also led the state in natural gas production, according to the county's records, with 39 percent of the state's natural gas production through the end of the third quarter, up slightly from 38 percent in 2016, the last full year of data available. For comparison, in 2002, Weld County produced just 21 percent of the state's natural gas.

Weld County's total producing well counts more than doubled between 2002 and 2015, from 12,481 to 27,063. There are currently 23,753 active wells in Weld County (through February 1, 2018), or approximately 43 percent of the state total (up from 38.2 percent in 2006), and the county's number of active wells nearly outnumbers the next five largest Colorado counties — Garfield, Yuma, La Plata, Las Animas, and Rio Blanco — combined.



Source: Weld County Department of Planning and Zoning: Oil and Gas¹⁹

Weld County accounted for 38 percent of the state's total permitting for oil and natural gas drilling in 2002,²⁰ but by 2015, the number of drilling permits for Weld County had increased to 62 percent of the state's total. Weld County received 63 percent²¹ of Colorado's drilling permits for 2017, with 68 percent of the state's well starts through the same time frame.

If there were clear links between health risks an oil and natural gas development, then it is reasonable to expect that residents in Weld County would experience the highest rates of those health impacts. But publicly available health data from the Colorado Department of Public Health and Environment, based on a variety of health indicators, show the opposite is happening.

17 "Weld County Oil & Gas Update February 2018," Weld County Department of Planning and Zoning.

18 Ibid.

19 Ibid.

20 "FY 2002-2003 REPORT," COGCC.

21 "Weld County Oil & Gas Update February 2018," Weld County.

Weld County Profile

Weld County²² is the third largest county in the state of Colorado, covering approximately 4,000 square miles, or twice the size of Delaware. Weld County is also the most agriculturally productive county in Colorado, according to the U.S. Department of Agriculture.²³

The county population grew 39.7 percent between 2000 and 2010, and was the fastest growing county in the United States between 2000 and 2004. Weld County has the ninth largest population of the state's 64 counties, and outpaced the state's overall growth, climbing 40 percent between 2000 and 2015, while the state population overall increased by 26 percent. The county has outpaced the state's average growth every year since 2000, and local officials expect the county to experience a 3.75 percent compounded growth rate each year from 2015 to 2035, more than double the expected annual compounded growth rate for Colorado overall.

The number of county residents employed in oil and gas jumped 160 percent between 2009 and 2016, from 1,870 to 4,870 workers, according to the Colorado Department of Local Affairs.

Death Statistics

In order to better understand what impacts, if any, oil and gas development may be having in the D-J Basin, Energy In Depth analyzed death statistics from 2002 through 2015 in counties located within the basin. This led to a focus on the county where the greatest intensity of production has occurred: Weld County.

Here is a chart compiling the publicly available data from CDPHE²⁴ and COGCC.²⁵

Weld County, Colo. Health Indicators	2002	2015	Percent Change
Total population	198,975	284,876	+43.2 %
Population 65+	17,492	32,557	+86.1 %
Percentage of population	8.8%	11.4%	+29.5%
Rates of death for all causes	616.7	614	-0.4 %
Rates of death for:			
All cancers	131.7	129.2	-1.9 %
All heart diseases	143.7	113	-21.4 %
All chronic lower respiratory diseases	45.2	41.1	-9.1 %
Oil and gas wells	12,481 (COGCC)	27,063 (COGCC)	+116.8%

The total population of Weld County grew by more than 43 percent, or nearly 86,000 residents, from 2002 to 2015. The number of residents 65 years of age or older nearly doubled in the same time period, a 29.5 percent increase in the percentage this age group represents in the total population, as it grew from 8.8 percent to 11.4 percent of the total county population. This is especially notable given the fact the Centers for Disease Control and Prevention (CDC) lists heart disease, cancer, and lower respiratory disease as the leading causes of death for persons age 65 and over.²⁶

^{22 &}quot;The Weld County Population & Development Report," Weld County, September 26, 2016.

²³ Ibid.

^{24 &}quot;Colorado Health and Environmental Data," CDPHE.

^{25 &}quot;GIS Online," COGCC.

^{26 &}quot;Older Persons' Health," National Center for Health Statistics, U.S. Centers for Disease Control and Prevention.

Despite this population growth, there was a decrease for every major negative health indicator in Weld County. In fact, for the leading cause of death in individuals 65 and older – heart disease – the death rate decreased by 21.4 percent, even as the population of this age group nearly doubled. Cancer death rates dropped nearly two percent, and chronic lower respiratory disease death rates dropped more than nine percent.

In other words, despite a growing elderly population that nearly doubled in just 13 years, every major health indicator appeared to improve at the same time oil and natural gas production was rapidly expanding across Weld County. This, while the number of productive wells in the county increased nearly 117 percent, from 12,481 by the end of calendar year 2002 to 27,063 by the same time in 2015, according to data compiled by COGCC.

Results of Colorado Death Dataset Query

Counties: WELD Zip Codes: None Selected Census Tracts: None Selected Race: All Races Ethnicity: Not selected

Gender: Male and Female Age: All
Underlying Causes of Death: CANCERS: ALL CANCERS ---Heart Diseases-all ---Chronic low. resp. diseases-all
Start Year: 2002 End Year: 2015

	Total Deaths	al Deaths Total Population	Total Crude Death Rate	CANCERS: ALL CANCERS		Heart Diseases-all		Chronic low.	resp. diseases-all
				N	Crude Rate	N	Crude Rate	N	Crude Rate
RECORD YEAR									
2002	638	198,975	320.6	262	131.7	286	143.7	90	45.2
2003	654	207,157	315.7	256	123.6	300	144.8	98	47.3
2004	646	214,069	301.8	281	131.3	284	132.7	81	37.8
2005	679	223,432	303.9	290	129.8	311	139.2	78	34.9
2006	658	231,283	284.5	275	118.9	287	124.1	96	41.5
2007	637	238,279	267.3	268	112.5	269	112.9	100	42.0
2008	692	244,116	283.5	301	123.3	287	117.6	104	42.6
2009	675	248,959	271.1	344	138.2	237	95.2	94	37.8
2010	683	254,240	268.6	332	130.6	251	98.7	100	39.3
2011	739	258,629	285.7	328	126.8	309	119.5	102	39.4
2012	728	264,052	275.7	299	113.2	324	122.7	105	39.8
2013	758	270,175	280.6	350	129.5	296	109.6	112	41.5
2014	817	276,089	295.9	380	137.6	319	115.5	118	42.7
2015	807	284,876	283.3	368	129.2	322	113.0	117	41.1
All	9,811	3,414,331	287.3	4,334	126.9	4,082	119.6	1,395	40.9

Rates are per 100,000 population.

Population figures are most current year estimates from State Demography Office, Colorado Department of Local Affairs.

Source: CDPHF²⁷

These findings are consistent with data obtained in other areas of the country. For example, a 2011 analysis²⁸ examining the effects of natural gas development in Denton County, Tex., concluded that "even as natural gas development expanded significantly in the area over the past several years, key indicators of health improved" across multiple categories studied. A separate analysis²⁹ found a decline in mortality rates from lower respiratory disease in some of the largest natural gas producing counties in the Marcellus Shale region of Pennsylvania.

CDPHE Report:

'Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado'

In February 2017, the CDPHE released a health assessment³⁰ based upon more than 10,000 air samples in areas of the state where "substantial" oil and gas operations occurred. The study came as a result of the state's 2014-15 blue-ribbon oil and gas task force recommendations.³¹

Dr. Mike Van Dyke, CDPHE's head of environmental epidemiology, occupational health, and toxicology, spoke to³² the comprehensive nature of the CDPHE study that looked at both air emissions and relevant scientific studies, and found "no chemicals or substances that exceeded those safe levels":

"Our current report has two pieces. The first part is essentially all the air samples that we could find that were taken in areas near oil and gas, and we really, in a conservative way, took the max concentration and the max average concentration from those datasets, and compared them to what would be called 'safe' levels by the U.S. EPA, or by other states if the EPA did not have a value.

"Those values are really based on all the studies that have been done on those particular chemicals, and safety factors have been applied to the levels in those studies. The way people interpret those results are that they are conservative estimates to protect nearly all people from health effects.

"What we found was that based on these data, there were no chemicals or substances that exceeded those safe levels."

-Dr. Van Dyke of CDPHE (emphasis added)

^{28 &}quot;Data Show Public Health Impacts from Natural Gas Production Overstated," Energy In Depth, October 19, 2011.

^{29 &}quot;New Report Finds Marcellus Shale Development Unrelated To Pa. Mortality Rates," Energy In Depth Health & Safety, December 12, 2017

^{30 &}quot;Oil and gas health assessment," CDPHE, 2017.

³¹ Ibid.

^{32 &}quot;Q&A: Why the Colorado health department says fracking's risk to health is 'low,' The Colorado Independent.

PART 1: Air Sample Analysis

The report³³ looked at air samples collected "near oil and gas operations" and possible exposure to residents:

"Sixty-two substances that are likely emitted, though not exclusively, from oil and gas operations were identified as priority substances for analysis. More than 10,000 air samples that measured these substances in regions of Colorado that have substantial oil and gas operations were combined to estimate potential air exposures to people living near oil and gas operations (defined as 500 feet or greater from an oil and gas site). These exposures were compared to standard short- and long-term health-based reference values related to cancer and non-cancer effects."

"This isn't cherry-picked air sampling data," Van Dyke said at an oil and gas forum³⁴ in Broomfield, Colo. "This is all air sampling data."

The report's conclusions found that levels of emissions were "safe," even for sensitive populations. "All measured air concentrations of [sic] were below short- and long-term 'safe' levels of exposure for non-cancer health effects, even for sensitive populations," CDPHE's Oil and Gas Health Information and Response Program authors wrote.

The authors also found that "concentrations of a small number of substances (benzene, formaldehyde, acetaldehyde) in the air surrounding oil and gas operations were 4-5 times lower than standard short- and long-term health-based reference levels for non-cancer effects," and that "concentrations of the other substances are 5-10,000 times lower than the standard short- and long-term health-based reference values for non-cancer effects."

Furthermore, "Cancer risks for all substances were within the 'Acceptable Risk' range established by the U.S. EPA," the authors wrote.

"Overall, available air monitoring data *suggest low risk of harmful health effects* (emphasis added) from combined exposure to all substances," the CDPHE report found.

"Based on currently available air monitoring data, the risk of harmful health effects is low for residents living [near] (sic) oil and gas operations," with the authors concluding that "[a]t this time, results from exposure and health effect studies do not indicate the need for immediate public health action."

PART 2: Analysis of Existing Epidemiological Studies

In the second portion of the report, CDPHE researchers identified 12 studies that met their criteria of "an observational human health epidemiologic study evaluating the potential health effects associated with living near oil and gas operations" (emphasis in original). The researchers' objective: to determine the level of scientific evidence for the findings of the studies to answer the question they posed:

"Do substances emitted into the air from oil and gas operations result in exposures to Coloradans living near oil and gas operations at levels that may be harmful to their health?"

The CDPHE scientists' review of the relevant epidemiological literature of 27 different health effects found "no substantial or moderate evidence for any health effects."

^{33 &}quot;Oil and gas health assessment," CDPHE.

^{34 &}quot;Colorado Town Hall Meeting Offers Opportunity for Constructive Dialogue and Fact-Based Discussion," Energy In Depth, February 21, 2017.

The researchers then rated the quality of individual findings from each study, with each rated as having "a low, medium or high quality of evidence based on the strengths and limitations of that study." After grouping together similar health-effects, the findings were then assessed for overall strength of evidence.

Evidence Level	Definition
Substantial	Strong scientific findings that support an association between oil and gas exposure and the outcome, with no credible opposing scientific evidence.
Moderate	Strong scientific findings that support an association between oil and gas exposure and the outcome, but these findings have some limitations.
Limited	Modest scientific findings that support an association between oil and gas exposure and the outcome, but these findings have significant limitations.
Mixed	Both supporting and opposing scientific findings for an association between oil and gas exposure and the outcome, with neither direction dominating.
Failing to show an association	Body of research failing to show an association - indicates that the topic has been researched without evidence of an association; is further classified as a limited, moderate or substantial body of research failing to show an association.
Insufficient	The outcome has not been sufficiently studied.

CDPHE examined a wide range of epidemiological studies by health effect: birth outcomes and birth defects; respiratory (eye, nose and throat, lung); neurological (migraines, dizziness); cancer; skin (irritation, rashes); psychological (depression, sleep disturbances); cardiovascular (heart); gastrointestinal (nausea, stomach pain); musculoskeletal (joint pain, muscle aches); and blood/immune system. Studies included effects like hospitalizations for a majority of health effects categories (8 of 11).

The state health department's findings are summarized in the following table (Table 2). Only two studies found a "limited" or modest association, but with significant limitations, according to CDPHE. Of the remaining health effects examined, 11 were "mixed," with neither outcome dominating, three were "failing to show an association," and another 11 were designated as "insufficient."

Strength of evidence findings

Table 2. Summary of overall strength of evidence for epidemiological studies by health effect

Health Effects Of Categories Studio		Health Effects	Evidence	
	4	Preterm birth ^{9,10,11,12}	Mixed	
Birth outcomes		Low APGAR ^{10,11}	Mixed	
		Small for gestational age 10,11,12	Mixed	
		Birth weight (LBW & mean)9,10,11,12	Mixed	
0	1	Congenital heart defects	Insufficient	
Birth Defects		Oral Clefts'	Insufficient	
		Neural tube defects	Insufficient	
Respiratory (eye, nose and throat (ENT) and lung)	6	Multiple, self-reported symptoms 13,14,15	Mixed	
		Hospitalizations 17,18	Failing to show an association	
(Asthma exacerbations ¹⁶	Limited	
Neurological (migraines, dizziness)	5	Hospitalizations 17,18	Mixed	
		Multiple, self-reported ¹⁴	Insufficient	
		Migraine/severe headache ^{13,14,15}	Mixed	
	4	Overall childhood cancer incidence 19	Insufficient	
Cancer		Childhood Hematological (Blood) Cancers ^{19,20}	Mixed	
		Childhood CNS tumors ¹⁹	Insufficient	
		Hospitalizations ^{17,18}	Mixed	
Skin (irritation, rashes)	2	Multiple, self-reported ^{14,15}	Limited	
Psychological (depression, sleep disturbances	4	Multiple, self-reported ^{13,14,15}	Failing to show an association	
		Hospitalizations ¹⁷	Insufficient	
Cardiovascular	2	Hospitalizations ¹⁷	Insufficient	
(heart)		Multiple, self-reported ¹⁴	Insufficient	
Gastrointestinal	3	Hospitalizations ¹⁷	Insufficient	
(nausea, stomach pain)		Multiple, self-reported ^{14,15}	Failing to show an association	
Musculoskeletal	2	Hospitalizations ¹⁷	Insufficient	
(joint pain, muscle aches)		Multiple, self-reported ¹⁵	Mixed	
Blood/Immune	2	Hospitalizations 17,18	Mixed	

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Source: CDPHF35

"There is limited evidence that exacerbation of existing asthma and self-reported dermal symptoms are associated with exposure to substances emitted from oil and gas operations," CDPHE wrote in their conclusions. "There is a lack of evidence or, in some cases, conflicting evidence concerning the relationship between other health outcomes and oil and gas operations."

The authors ranked a majority of the findings in the 12 studies as "low quality, primarily due to limitations of the study designs that make it difficult to establish clear links between exposures to substances emitted directly from oil and gas and the outcomes evaluated."

CDPHE's analysis noted that an individual's total exposure "may reflect multiple substances from both oil and gas and non-oil and gas sources from indoor and outdoor environments. For example, VOCs can be emitted from a variety of sources including oil and gas, other industrial operations, vehicle traffic and everyday consumer products such as nail polish, detergents, sealants, aerosol antiperspirants and deodorants."

"Studies of populations living near oil and gas operations provide limited evidence of the possibility for harmful health effects. This needs to be confirmed or disputed with higher quality studies," CDHPE concluded.

A CDPHE study on "health-risk assessment specific to oil and gas emissions" using data from Colorado State University is expected³⁶ in 2018.

CDPHE's health study review³⁷ and review methodology³⁸ (Appendices 2A-2C)can be found in CDPHE's oil and gas health assessment.³⁹

The conclusions reached in the CDPHE report disputed research that attempted to link oil and gas development to cancer, for example.

In an extended interview with the Colorado Independent⁴⁰, Dr. Van Dyke from CDPHE said that the often-cited leukemia study⁴¹ by University of Colorado professor and researcher Lisa McKenzie had "significant limitations" and constituted "research that suggests more research needs to be done, not research that definitively links oil and gas exposure to cancers in this age group."

CDPHE Executive Director and Chief Medical Officer Dr. Larry Wolk told⁴² the *Denver Business Journal (DBJ)* that McKenzie's conclusions were "misleading." "Based on this study and other studies/data/information we have to date, we find no increased risk for childhood leukemia, especially when considering the current setbacks [of a minimum 500-foot buffer between oil and gas wells and homes]," Wolk wrote to the DBJ upon the report's release last February.

Wolk said CDPHE saw "no increases in leukemia in oil and gas developed counties vs those that don't and vs the statewide expected average." While he welcomed studies that explore public health effects, "The study questions a possible association between oil and gas operations and childhood leukemia; it does not prove or establish such a connection," Wolk concluded.

The CDPHE report also confirmed previous research. Notably:

- A study that found hydraulic fracturing presented⁴³ little risk to the City of Fort Collins.
- 36 "Oil and gas health assessment," CDPHE.
- 37 "Section 2: Systematic Review of Human Health Effect Studies," CDPHE.
- 38 "Appendix 1A," CDPHE.
- 39 "Oil and gas health assessment," CDPHE.
- 40 "Q&A: Why the Colorado health department says fracking's risk to health is 'low,'" The Colorado Independent.
- 41 Ibid.
- 42 "Colorado health chief, researcher tangle over oil and gas cancer impact," The Denver Business Journal, February 15, 2017
- 43 "New Reports Find Fracking Poses Little Risk to Fort Collins' Air or Water Quality," Energy In Depth, June 4, 2015.

- CDPHE's own analysis⁴⁴ of ground-level ozone data that refuted American Lung Association claims that Colorado's background ozone levels were deteriorating, rather than improving.
- A study⁴⁵ by the Cooperative Institute for Research in Environmental Sciences (CIRES) at University of Colorado Boulder and the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory Chemical Sciences Division that found that oil and natural gas development along Colorado's northern Front Range as having a "small" impact on ozone formation.
- Colorado State University data⁴⁶ delivered to the Colorado Air Quality Control Commission that indicated low methane emissions near oil and gas operations, and benzene levels near production sites to be "much smaller than background concentrations," with Front Range emissions indicating no "urgent health, safety, or welfare concern."

Need for Unbiased Research

Battles at the Ballot Box

Between 2012 and 2014, five Colorado cities⁴⁷ passed bans, moratoria, and other restrictions on oil and gas operations, citing health and environmental concerns. Two cities, Fort Collins and Longmont, were sued by the Colorado Oil and Gas Association. In May 2016, the Colorado State Supreme Court ruled in each case that Fort Collins' voter-approved five-year moratorium on fracking and Longmont's voter-approved fracking ban were "preempted by state law and therefore... invalid and unenforceable."

Defeat at the state's highest court, however, was not the end of the campaign to shut down energy development. Environmentalists and teenage activists filed a lawsuit⁴⁸ against the Colorado Oil and Gas Conservation Commission in 2014, following the agency's denial of the petitioners' 2013 request to suspend oil and gas permitting unless the planned drilling "does not adversely impact human health and does not contribute to climate change." The Colorado Court of Appeals agreed with the teenagers who brought the suit, and in March 2017, ruled⁴⁹ that the COGCC implement as "a condition that must be fulfilled" the proposal sought by the activists, preventing new drilling permits:

"unless the best available science demonstrates, and an independent third party organization confirms, that drilling can occur in a manner that does not cumulatively, with other actions, impair Colorado's atmosphere, water, wildlife, and land resources, does not adversely impact human health and does not contribute to climate change."

Colorado Attorney General Cynthia Coffman (R) announced in May 2017 that she would appeal⁵⁰ the case to the Colorado State Supreme Court, along with the COGCC. In January 2018, the Colorado Supreme Court agreed⁵¹ to review the case.

- 44 "Colorado Health Officials Debunk Lung Association's Ozone 'Report Card,'" Energy In Depth, May 6, 2015.
- 45 "NOAA Study Finds 'Small' Ozone Impact from Front Range Oil & Gas Development," Energy In Depth, August 8.
- 46 "CSU Finds Low Emissions Levels along Colorado's Front Range," Energy In Depth, September 16, 2016.
- 47 "Colorado Supreme Court rules on local fracking bans," The Denver Business Journal, May 2, 2016.
- 48 "Key Colorado Voices Support AG's Decision to Appeal 'Kids' Anti-Fracking Lawsuit," Energy In Depth, May 26, 2017.
- 49 "Colorado appeals court says state must protect health and environment before allowing oil and gas drilling," The Denver Post, March 24, 2017
- 50 "Statement from Attorney General Cynthia H. Coffman on the Appeal to the Colorado Supreme Court in the COGCC v. Martinez Case,"
 Office of Colorado Attorney General Cynthia H. Coffman, May 18, 2017
- 51 "Xiuhtezcatl Martinez Talks Music, Politics and Suing the Government," Westword, February 5, 2018.

Statewide attempts to ban fracking and oil and gas development, meanwhile, have not fared well. In 2014, two measures to increase setbacks for drilling rigs and add an environmental bill of rights were pulled⁵² at the last minute, just as signatures for the ballot measures were due to the Colorado Secretary of State's office. Governor John Hickenlooper (D) orchestrated a compromise that led to a one-year statewide oil and gas task force⁵³ review to tackle concerns about oil and gas development, including health and environmental impacts.

Attempts in 2016 to resurrect the oil and gas restrictions through setbacks, fracking bans, or environmental bill of rights failed, with nine out of 11⁵⁴ ballot measures eventually being dropped by their sponsors, and the final two failing⁵⁵ to gain enough valid voter signatures to reach the ballot box that November. Those measures⁵⁶ would have allowed local governments to ban oil and gas development, and would have instituted a statewide 2,500 foot setback requirement.

The same groups who brought forth related ballot measures in the past have come back with yet another ballot measure attempt in 2018. Ballot measure #97,57 which includes similar provisions, has been filed with the Colorado Secretary of State and is currently moving through the ballot measure approval process.

CDPHE Finds Anti-Oil and Gas Reports Mischaracterize Data

Claims of negative health-related impacts cited by opponents of oil and gas development prompted the Colorado Department of Public Health and Environment (CDPHE) to examine its available health data, particularly in Weld County. Dr. Wolk said⁵⁸ of the department's research: "People should do their own research before making assumptions. I want to make sure people aren't presuming there's a health hazard. We wanted to make sure the public wasn't unnecessarily misled."

There is no apparent health risk, Wolk said, and despite alleged claims of oil and gas development causing health risk, Colorado's health department found that oil and gas development has not adversely affected the health of Weld County's 285,000 residents.

Indeed, based on the state's data, it appears certain groups have mischaracterized or poorly presented the findings of health reports to the public. Examples include Dr. Van Dyke's analysis of the McKenzie cancer study⁵⁹ that he said had "significant limitations." The 2017 CDPHE report's findings restate that based on currently available agency data "there were no chemicals or substances that exceeded those [Environmental Protection Agency] safe levels." The CDPHE report argues against presenting the data out of context or erroneously presenting the conclusions of reports to the public.

CDPHE's analysis found that⁶⁰ despite Weld County producing 90 percent of Colorado's oil and having 70 percent more active wells than other counties in the northern part of the state, it does not have more health issues. Bill Jerke, executive director of Fostering Unity and Energizing Leadership (FUEL) Colorado told⁶¹ the Greeley Tribune in 2016,

- 52 "Hickenlooper compromise keeps oil and gas measures off Colorado ballot," The Denver Post, August 4, 2014.
- 53 "The Campaign Goes On: 'Ban Fracking' Groups Target New Colorado Task Force," Energy In Depth, August 28, 2014.
- 54 "Despite Dropping More Initiatives, Activists Haven't Given Up on 'Full-Fledged Ban' on Fracking, Energy In Depth, February 25, 2016.
- 55 "Anti-Fracking Measures Fail to Make Colorado Ballot —... 'Potentially Forged' Signatures," Energy In Depth, August 29, 2016.
- 56 "Energy measures fail to make... ballot...No. 75 and 78 fall short," Office of Colorado Sec. of State Wayne W. Williams, August 29, 2016.
- 57 <u>"2017-2018 #97 FINAL," January 5, 2018</u>
- 58 "Weld County health incidents level with rest of state, despite more oil and gas development," The Greeley Tribune
- 59 "Q&A: Why the Colorado health department says fracking's risk to health is 'low,' The Colorado Independent.
- 60 "Weld County health incidents level with rest of state, despite more oil and gas development," *The Greeley Tribune.*

61 lbid.

"We've had at least 10,000 wells or more in Weld County for about 30 years or more and with that number of wells, we clearly have been the canary in the mine. It's obvious that there would be health effects if indeed oil and gas was causing health issues that would take us out of the normal range. If it was going to be a problem, it should have shown up long ago, but it hasn't."

Wolk told the Tribune there is not a causal relationship between development and chronic diseases.

"We want to make sure that we stay very much objective and neutral and just report the facts," he said.

"It says that there's no reason to believe that there is a causal relationship between oil and gas operations and chronic diseases or cancers. That plays out in the end numbers."

As the Greeley Tribune reported⁶² in 2016:

"The numbers, which were reported in two-year increments between 2008 and 2012, show that **Weld does not have** significantly more, and in many cases, it has fewer, instances of asthma, cancer, birth defects, infant mortality and low birth weights than other Front Range counties." (Emphasis added) CDPHE Executive Director and Chief Medical Officer Larry Wolk noted that despite alleged claims of oil and natural gas development causing health risk, Colorado's health department found that development has not adversely affected the health of Weld County's 285,000 residents. "There's no reason to believe that there is a causal relationship between oil and gas operations and chronic diseases or cancers," he told the Greeley Tribune in 2016.

Broader Analysis of Colorado Communities: CDPHE's Oil and Gas Health Information Reports

The CDPHE issued a FY 2016-17 status report⁶³ for the Colorado State Legislature Joint Budget Committee on Nov. 1, 2017. Led by Tami McMullin, Oil and Gas Health Information and Response (OGHIR) Program Manager and Toxicologist, and Greg Harshfield, Air Quality Monitoring Unit Supervisor, the report tracked health concerns reported by Colorado residents, with 50 percent of the self-reported concerns in the state originating in Weld County.

Responding to stakeholders, air sampling was conducted and reports provided for 6 Tier III responses.

- "Six Tier III community investigations, which included community air sampling, accounted for 65% of reported concerns," according to OGHIR. Five of the six reports included Weld County sampling data.
- "OGHIR deployed the Colorado Air Monitoring Mobile Laboratory (CAMML) to three of the investigations, resulting in approximately 500 sampling hours. Each hourly sample includes about 1000 individual data points," the authors explained.
- "In general, the data collected from air sampling investigations have shown low risk for short- and long-term health effects to people in communities reporting concerns," the authors found.

^{63 &}quot;Colorado Department of Public Health and Environment Request for Information 03 Oil and Gas Health Information and Response Program," CDPHE, November 1, 2017.

The first⁶⁴ of six investigations, dated May 4, 2017, examined reported health concerns near Firestone, Colo. The air samples collected found a methane level of 1.86 parts per million, lower than the measured global background levels (1.99 ppm), and below the concentrations observed in Denver (2.30 ppm) and Platteville (3.05 ppm) air toxics monitoring sites on the Front Range, for comparison.

The authors described the purpose of the health concern evaluations:

"A health concern evaluation was performed by comparing the air data collected by the resident with short-term and long-term health screening levels established by federal and state agencies for each substance. These screening levels represent the concentrations at or below which no appreciable health effects are likely to occur to individuals (including sensitive individuals) for the specified exposure period. As the sample collected represents a short-term or peak exposure from a self-reported 'odor event,' this evaluation focused on the potential for health effects due to short-term exposures to the detected substances."

"Based on the limited air sampling data available, there is a low potential for health effects due to this shortterm exposure," the CDPHE report concluded. Though the report conceded "[a]dditional sampling would be helpful to reduce the uncertainty in our assessment and better characterize exposures from these shortterm events," it also indicated that it would continue to monitor the area.

A May 26, 2017 report⁶⁵ on the Triple Creek oil and gas site screened for VOCs in ambient air sampling, CDPHE's McMullin found air concentrations "were below short and long term health-based reference values and approximately the same or below the average air concentrations along the Front Range."

"The purpose of this assessment was to estimate the risk of short or long term health effects of inhalation of the measured air concentrations of volatile organic compounds (VOCs). These measurements were compared to health based reference levels set by federal and state agencies to estimate the potential for short and long-term health risks to residents."

"Of the 60 substances analyzed, isoprene was the only substance that slightly exceeded (2.8ppb) its long-term health based reference level (2.0ppb). Isoprene is primarily emitted from vegetation and humans. Published information indicates that isoprene is not emitted at significant amounts from oil and gas operations and therefore, it is unlikely that Triple Creek oil and gas operation would be the main source of this substance. The results for the other 59 substances analyzed indicated that all air concentrations of individual and combined VOC's were below short and long term health-based reference values and approximately the same or below the average air concentrations along the Front Range."

A separate investigation⁶⁶ of Waste Connections, dated July 31, 2017, found, once again, "the measured levels of all VOCs were well below health guideline levels which suggests a very low risk of harmful health effects." The measurements identified the previously excluded isoprene, and benzene, saying, "All air concentrations of individual and combined VOCs were below long-term non-cancer health guideline values," adding that "[a] Il other benzene air concentrations were 10–100 times lower than the short and long-term health guideline values."

Among the limitations noted by the OGHIR Waste Connections report, the authors added an inability to discern outside factors. "Whether the VOCs in the air will have a harmful effect on an individual's health

depends upon many factors that are not all measured in this risk assessment. These include non-chemical factors such as age, family traits (i.e. genetics), and lifestyle behaviors," OGHIR wrote.

"Using currently available measurement technology and risk assessment methods, OGHIR is unable to document conditions that suggest an ongoing health hazard at this time. However, although the air measurements identified a large number of chemicals related to oil and gas emissions, there may be other chemicals that were not measured that may contribute to the respiratory irritation and odor concerns reported by residents. Furthermore, it is important to make the distinction that our risk assessment methods take into account short and long-term health effects, but do not necessarily reflect the risk for reversible health symptoms due to odors."

A November 3, 2017 OGHIR report⁶⁷ on the Pratt oil and gas site, also in Erie, Colo., found similar results as the Waste Connections investigation. "The measured levels of all VOCs were well below federal or state health guideline values, which suggest a low risk of harmful health effects," OGHIR wrote, with the same caveats on health symptoms due to odors it discovered near the Waste Connections site.

The final Weld County OGHIR report⁶⁸, also prepared by McMullin, focused on reports of VOC inhalation near Erie, Colo..

"Based on the large volume of ongoing health concerns, OGHIR deployed the Colorado Air Monitoring Mobile Laboratory (CAMML) on March 7-8 and March 20-23, to measure volatile organic compounds (VOCs) in the air where residents have reported health symptoms and odors. These measurements were compared to health based reference levels set by federal and state agencies to estimate the potential for short and long term health risks to residents living in the vicinity of these oil and gas sites. The evaluation indicated that all air concentrations of individual and combined VOCs were below non-cancer health-based reference values. Cancer risks estimates for benzene, ethylbenzene, and the two VOCs combined were less than one in one hundred thousand, which is generally considered to be within the acceptable risk range."

"In conclusion, using currently available measurement technology and risk assessment methods, OGHIR is unable to document conditions that suggest an ongoing health hazard at this time," the report concluded.

As of February 2018, the report is under review.

Outside of Weld County, health concern reports in Dolores and Montezuma counties in the southwest part of the state initiated an air sampling investigation, following citizen complaints from November 2015 to October 2016. OGHIR issued a follow up report⁶⁹ on August 18, 2017.

"Based on the results from this preliminary air sampling investigation, there appears to be a low risk for harmful health effects due to exposures from VOCs or H2S," the report stated. The report also found that no additional health concern reports were made by local residents after October 2016, leading OGHIR to close the investigation.

"Importantly, the original intent of this investigation was to conduct follow-up sampling at a later date based on additional reports from residents near the site. As OGHIR has not heard from any of the residents voicing concerns since October 2016 and has not received new concerns we are closing the investigation with this report. OGHIR will continue to monitor

^{67 &}quot;Investigation of Reported Health Concerns near Pratt Oil and Gas Site in Erie," CDPHE, November 3, 2017.

^{68 &}quot;Health Risk... Inhalation of VOCs in Ambient Air Near Woolley-Sosa and Erie Champlin Oil and Gas Sites," CDPHE, May 23, 2017.

^{69 &}quot;Investigation of Reported Health Concerns near Doe Canyon, Cow Canyon and Yellowjacket Carbon Dioxide Facilities in Colorado," CDPHE, August 18, 2017.

health concerns in the vicinity of these three facilities. Individuals with new or ongoing health concerns are encouraged to contact OGHIR."

In an unrelated study⁷⁰ in Colorado's Garfield County released in January 2018, county health officials told county commissioners that air quality impacts from new oil and gas operation suggest "little risk."

"On Monday, Garfield County Environmental Specialist Morgan Hill presented some of the county's first findings, indicating minimal risk in any of the samples," the *Post Independent* wrote.

"According to the data, all air concentrations of individual and combined volatile organic compounds (VOCs) were below long-term, non-cancer health guideline values established by state and federal agencies," the report found.

Forthcoming Human Health Risk Assessment

Expected to be finalized by the end of summer 2018, the OGHIR "Human Health Risk Assessment Project" uses new data from CSU [Colorado State University] studies that measured substances emitted directly from O&G [oil and gas] operations to understand human health risks," according to the authors.

"The Project uses CSU emission data collected in Garfield County and the Front Range," the report said.

Conclusion

This report reviewed publicly available data compiled by the Colorado Department of Public Health and Environment regarding death statistics, relevant epidemiological studies of health effects, and air sample studies for Weld County, Colo., the state's most active oil and gas producing county. The results of this review suggest that even with a significant increase in both number of active wells and overall oil and natural gas production levels, rates of death for cancer, heart disease and chronic lower respiratory disease did not increase, but in fact decreased. CDPHE's review of 10,000 air samples found "safe" air quality levels for sensitive populations, with likely oil and gas emissions much lower than both short and long-term reference levels for expected non-cancer effects. Also, CDPHE's analysis of relevant, peer-reviewed epidemiological studies covering 27 health effects did not find any "substantial" or "moderate" evidence of health risks. In fact, CDPHE ranked a majority of the studies as "low quality, primarily due to limitations of the study designs that make it difficult to establish clear links between exposures to substances emitted directly from oil and gas and the outcomes evaluated."

Finally, air quality tests conducted at the request of local residents throughout the state consistently reported measured emissions near oil and gas producing sites "below short and long term health-based reference values" suggesting a "very low risk of harmful health effects." In one example from Weld County, the CDPHE Oil and Gas Health Information report "indicated that all air concentrations of individual and combined VOCs were below non-cancer health-based reference values."

In conclusion, despite claims of harmful effects from oil and gas development, CDPHE's data and literature analysis does not support those interpretations.