Health Impacts of Oil and Natural Gas Operations

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VOCs Form Ground-Level Ozone, or Smog, that Harms Human Health

Ozone forms when VOCs and oxides of nitrogen (NOx) react in the presence of heat and sunlight. This process becomes more pronounced in the summertime.

A longstanding body of scientific research, including numerous EPA assessments, demonstrates that exposure to ground-level ozone harms human health. In its 2013 Integrated Scientific Assessment for Ozone, EPA concluded that "a very large amount of evidence spanning several decades supports a relationship between exposure to [ozone] and a broad range of respiratory effects." *2013 Final Report: Integrated Science Assessment of Ozone and Related Photochemical Oxidants* ("ISA") (EPA/600/R-10/076F) at 1-6. These effects range from decreases in lung function among healthy adults to increases in respiratory-related hospital admissions and emergency room visits, to premature death. *Id.* at 6-131 to 6-158, 6-162 to -163.

Multiple studies across various states (California, Georgia, North Carolina), counties (Maricopa County, AZ; Erie County, NY) and cities (Seattle, New York, Newark, Atlanta, Houston, Dallas, San Antonio, Austin, Indianapolis, St Louis) have found that changes in ozone concentrations were associated with higher asthma emergency room visits, most at concentrations below the current standard.[1] It is estimated that up to 11% of all asthma Emergency Room visits in the United States are attributed to ozone.[2] According to the Centers for Disease Control and Prevention, asthma affects 25 million Americans and results in 1.7 million emergency room visits, 9.7 million visits to the physician and 188 thousand hospitalizations. CDC, Most Recent National Asthma Data.[3] Asthma costs the U.S. economy more than $80 billion annually in medical expenses, missed work and school days and deaths.[4]

Ozone pollution is particularly harmful for vulnerable populations, such as children, people with respiratory diseases or asthma, older adults, and people who are active outdoors, especially outdoor workers. *ISA* at 1-8. Children with asthma also face heightened risks from ozone

[1] Stephanie Holm, John Balmes, Ananya Roy, *Human Health Effects of Ozone: The State of Evidence Since EPA's Last Integrated Science Assessment*, EDF 2018.

[2] Susan C. Anenberg, Daven K. Henze, Veronica Tinney, Patrick L. Kinney, William Raich, Neal Fann, Chris S. Malley, Henry Roman, Lok Lamsal, Bryan Duncan, Randall V. Martin, Aaron van Donkelaar, Michael Brauer, Ruth Doherty, Jan Eiof Jonson, Yanko Davila, Kengo Sudo, Johan C.I. Kuylenstierna, *Estimates of the Global Burden of Ambient PM2.5, Ozone, and NO2 on Asthma Incidence and Emergency Room Visits*, Environmental Health Perspectives, 2018; 126 (10): 107004.

[3] *Available at* https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm, last accessed on October 15, 2019.

[4] Tursynbek Nurmagambetov, Robin Kuwahara, Paul Garbe, *The Economic Burden of Asthma in the United States, 2008 – 2013,* Annals of the American Thoracic Society, 2018).

exposure. Many studies have demonstrated that children with asthma experience decrements in lung function and increases in respiratory symptoms when exposed to ozone pollution.[5]

EPA concluded that there is a causal relationship or likely causal relationship between both short- and long-term ozone exposure and a broad range of harmful respiratory effects in humans. *ISA* at 1-5–1-8, Table 1-1. Short-term exposure is defined as hours, days, or weeks, and long-term exposure is measured in months to years. *Id*. at 1-4.

Short-term exposure to ozone can have critical health implications. For instance, there is evidence of an association between out-of-hospital cardiac arrests and short-term exposure to ozone, as reported in Ensor, et al., 2013.[6] Time scales of exposure up to three hours in duration and also at the daily level on the day of the event were significant. Other studies indicate higher rates of stroke in populations following higher exposures to ozone. A study in Pennsylvania that used a time-stratified case-crossover analysis to evaluate the relationships between stroke hospital admissions and ozone, among 26,219 patients in Allegheny County, PA, between 1994 and 2000 found that exposures to ozone on the current day increased the risk of total stroke hospitalization.[7] Another study in Nunces County, Texas evaluated associations with incident stroke and stroke severity with cases identified in the Brain Attack Surveillance in Corpus Christi project between 2000 and 2012 and found elevated risk of having a first stroke with higher ozone concentrations in the preceding 2 days. Effect measure estimates were not changed in a model that included PM2.5.[8] This is supported by two independent meta- analyses of multiple studies.[9,10] This evidence augments the long-standing body of literature demonstrating the serious impacts from short-term exposure to ozone pollution, including the increased risk of premature death. *ISA* at 1-14 (concluding that there is "likely to be a causal relationship between short-term exposures to [ozone] and total mortality"). EPA has recognized that positive associations have been reported between "short-term [ozone] exposures and respiratory mortality, particularly during the summer months." EPA, *National Ambient Air*

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[5] K. Mortimer et al., *The Effect of Air Pollution on Inner-City Children with Asthma*, 19 EUR. RESPIRATORY J. 699 (2002), *ISA*, 6-120–21, 6-160.

[6] Katherine B. Ensor, *et al*., *A Case-Crossover Analysis of Out-of-Hospital Cardiac Arrest and Air Pollution*, 127 CIRCULATION 1192 (2013), https://www.ncbi.nlm.nih.gov/pubmed/23406673.

[7] Xu X, Sun Y, Ha S, Talbott EO, Lissaker CT, *Association between ozone exposure and onset of stroke in Allegheny County, Pennsylvania, USA, 1994-2000I,* Neuroepidemiology, 2013; 41(1):2-6.

[8] Wing JJ, Adar SD, Sánchez BN, Morgenstern LB, Smith MA, Lisabeth LD, *Short-term exposures to ambient air pollution and risk of recurrent ischemic stroke*, Environmental Research, Jan. 2017; 152:304-7.

[9] Shah, Anoop SV, et al., *Short term exposure to air pollution and stroke: systematic review and meta-analysis*, BMJ 350 (2015): h1295.

[10] Yang, Wan-Shui, et al., *An evidence-based appraisal of global association between air pollution and risk of stroke*, International Journal of Cardiology 175.2 (2014): 307-313.

Quality Standards for Ozone, 80 Fed. Reg. 65,292, 65,307 (Oct. 26, 2015); *see also ISA* 6-220 to 6-221.

Long-term exposure likewise has critical health implications. EPA has concluded that there is "likely to be a causal relationship between long-term exposure to [ozone] and respiratory effects." *ISA* at 1-8. Similarly, EPA notes that "recent evidence is suggestive of a causal relationship between long-term [ozone] exposures and total mortality." *Id.* Some longitudinal studies have further demonstrated that "long-term [ozone] exposure influences the risk of asthma development in children." *ISA* at 7-2.

A recent study of almost 61 million Medicare patients conducted nationwide indicates a significant association between short and long term ozone exposure and all- cause mortality, with effects strongest in minorities and those of low socio-economic status. These effects were seen at ozone concentrations well below the current standard of 70 ppb.[11,12]

Health effects other than cardiovascular or respiratory are also likely. A 2017 study suggested that ozone exposure may be linked to approximately 8,000 stillbirths per year.[13] Prolonged exposure to ozone may also accelerate cognitive decline in the early stages of dementia.[14] There is now accumulating evidence that suggests that ozone exposure during pregnancy can result in Autism Spectrum Disorders among children.[15,16]

In 2015, EPA strengthened the national health-based standard for ground-level ozone, lowering the standard from 75 parts per billion ("ppb") to 70 ppb.[17] The record for that rulemaking, however, along with subsequent scientific studies, demonstrates that health effects can occur at much lower levels, especially in sensitive populations. For that reason, EPA's independent scientific advisors recommended that the agency establish the standard in the range of 60–70 ppb. Many health and medical associations suggested that lower standards may be

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[11] Di et al., *Air Pollution and Mortality in the Medicare Population*, NEW ENGLAND J. OF MEDICINE (June 29, 2017)

[12] Di Q, Dai L, Wang Y, Zanobetti A, Choirat C, Schwartz JD, Dominici F, *Association of short-term exposure to air pollution with mortality in older adults*, JAMA (Dec. 26, 2017); 318(24):2446-56.

[13] Mendola et al., *Chronic and Acute Ozone Exposure in the Week Prior to Delivery is Associated with the Risk of Stillbirth*, 14 INT'L J. ENVT'L RESEARCH AND PUB. HEALTH 731 (2017).

[14] Galkina Cleary et al., *Association of Low-Level Ozone with Cognitive Decline in Older Adults*, 61 J. ALZHEIMERS DISEASE 1, 67-78 (2018).

[15] Becerra, Tracy Ann, et al, *Ambient air pollution and autism in Los Angeles county, California*, Environmental Health Perspectives 121.3 (2012) 380-386.

[16] Volk HE, Lurmann F, Penfold B, Hertz-Picciotto I, McConnell R, *Traffic-related air pollution, particulate matter, and autism*, JAMA Psychiatry (Jan. 1, 2013); 70(1):71-7.

[17] EPA, *National Ambient Air Quality Standards for Ozone*, 80 Fed. Reg. 65,292 (Oct. 26, 2015).

appropriate.[18] EPA has issued designations for counties under the 2015 ozone standards. EPA, *Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards*, 82 Fed. Reg. 54,232 (Nov. 16, 2017); Additional Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards, 83 Fed. Reg. 25,776 (June 4, 2018); Additional Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards—San Antonio, Texas Area, 83 Fed. Reg. 35,136 (July 25, 2018).

According to EPA calculations, there are over 120 million people living in ozone non-attainment areas in the U.S[19] and there is evidence that adverse health effects are being seen at lower concentrations too. These unhealthy levels of ozone air quality can result in acute respiratory illness and other damaging health outcomes.

The Oil and Natural Gas Sector Is a Substantial Source of Smog-Forming Emissions

The oil and natural gas sector is a substantial source of smog-forming emissions. According to EPA's most recent National Emissions Inventory (NEI), "Oil and Gas Production" is the largest source of human-caused VOCs nationally.[20] Regional analyses likewise underscore the significant ozone-forming emissions from these sources, including work in the Uinta Basin in Utah,[21] the Barnett Shale in Texas,[22] and in Colorado.[23]

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[18] *Id.* at 65,321-23; 65,355.

[19] https://www3.epa.gov/airquality/greenbook/popexp.html.

[20] Calculation based on EPA, National Emissions Inventory (NEI) Sector Data, *available at* https://edap.epa.gov/public/extensions/nei_report_2014/dashboard.html#sector-db.

[21] Warneke, C. et al., "Volatile organic compound emissions from the oil and natural gas industry in the Uintah Basin, Utah: oil and gas well pad emissions compared to ambient air composition," 14 Atmos. Chem. Phys., 10977–10988 (2014), *available at* www.atmos-chem- phys.net/14/10977/2014/; ENVIRON, "Final Report: 2013 Uinta Basin Winter Ozone Study," (Mar. 2014), *available at* https://deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/06Jun/UBOS2013FinalReport/Title_Contents_UBOS_2013.pdf.

[22] David T. Allen, "Atmospheric Emissions and Air Quality Impacts from Natural Gas Production and Use," Annu. Rev. Chem. Biomol. Eng. 5:55–75 (2014), *available at* http://www.annualreviews.org/doi/abs/10.1146/annurev-chembioeng-060713-035938.

[23] Brantley, et al., "Assessment of volatile organic compound and hazardous air pollutant emissions from oil and natural gas well pads using mobile remote and onsite direct measurements," Journal of the Air & Waste Management Association 1096-2247 (Print) 2162- 2906 (Online) (2015); Pétron, G., et al., "A new look at methane and non-methane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin," 119 J. Geophys. Res. Atmos., 6836–6852 (2014), *available at* http://onlinelibrary.wiley.com/doi/10.1002/2013JD021272/full.

Studies and analyses have linked ozone formation to emissions from oil and gas development. For example, a recent study by NOAA scientists at the Cooperative Institute for Research in Environmental Sciences ("CIRES") found that, on Colorado's Northern Front Range, oil and gas operations contribute roughly 50% to regional VOC reactivity and that these activities are responsible for approximately 20% of all regional ozone production.[24] Another study analyzing ozone impacts associated with unconventional natural gas development in Pennsylvania concluded that "natural gas emissions may affect compliance with federal ozone standards,"[25] and an analysis in the Haynesville Shale in Texas found that emissions associated with projected future production from the oil and gas sector could be responsible for as much as a 5 ppb increase in 8-hour ozone design levels.[26] There are also well-documented connections between oil and gas development and ozone formation in Wyoming's Upper Green River Basin and Utah's Uinta Basin, among others.[27]

EPA's Failure to Adopt Methane Guidelines Allows Substantial Harmful Ozone-Forming Pollution

Analysis completed by Dr. Renee McVay and Hillary Hull found that over 90,000 wells that would be subject to Methane Guideline are located in areas that are not in attainment with the 2015 ozone standard.[28] These wells emit 160,000 tons of VOCs annually.

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[24] McDuffie, E. E., et al. (2016), Influence of oil and gas emissions on summertime ozone in the Colorado Northern Front Range, J. Geophys. Res. Atmos., 121, 8712–8729, doi:10.1002/2016JD025265. http://onlinelibrary.wiley.com/doi/10.1002/2016JD025265/abstract. *See also* Gilman, J. B., B. M. Lerner, W. C. Kuster, and J. A. de Gouw (2013), *Source signature of volatile organic compounds from oil and natural gas operations in northeastern Colorado*, Environ. Sci. Technol., 47(3), 1297–1305, *available at* http://pubs.acs.org/doi/abs/10.1021/es304119a (finding 55% of VOC reactivity in the metro- Denver area is due to nearby O&NG operations and calling these emissions a "significant source of ozone precursors."); Cheadle, LC et al., *Surface ozone in the Colorado northern Front Range and the influence of oil and gas development during FRAPPE/DISCOVER-AQ in summer 2014*, Elementa (2017), *available at* http://doi.org/10.1525/elementa.254 (finding on "individual days, oil and gas O3 precursors can contribute in excess of 30 ppb to O3 growth and can lead to exceedances" of the EPA ozone standards).

[25] Swarthout, R. F., R. S. Russo, Y. Zhou, B. M. Miller, B. Mitchell, E. Horsman, E. Lipsky, D. C. McCabe, E. Baum, and B. C. Sive (2015), *Impact of Marcellus Shale natural gas development in southwest Pennsylvania on volatile organic compound emissions and regional air quality*, Environ. Sci. Technol., 49(5), 3175–3184, doi:10.1021/es504315f, *available at* https://www.ncbi.nlm.nih.gov/pubmed/25594231.

[26] Kemball-Cook, S., A. Bar-Ilan, J. Grant, L. Parker, J. Jung, W. Santamaria, J. Mathews, and G. Yarwood (2010), *Ozone impacts of natural gas development in the Haynesville Shale*, Environ. Sci. Technol., 44(24), 9357–9363, doi:10.1021/es1021137, *available at* https://www.ncbi.nlm.nih.gov/pubmed/21086985.

[27] *See* B. Rappenglück et al., *Strong wintertime ozone events in the Upper Green River basin, Wyoming*, Atmos. Chem. Phys. (2014), *available at* https://doi.org/10.5194/acp-14-4909-2014.

[28] Dr. Renee McVay and Hillary Hull (2019). Assessment of Harm to the Public from a Continued Delay by EPA Promulgating Methane Guidelines for Existing Sources. EDF.

Many Americans live in counties that experience unhealthy levels of ozone pollution. These counties have existing wells that will be able to emit harmful pollution if EPA continues to delay the promulgation of Methane Guidelines. Nationwide, it is estimated that almost 18 million people live within 1 mile of at least one active oil and/or gas site.[29]

Analysis carried out by the Clean Air Task Force found that 2,000 asthma-related emergency room visits and over 600 respiratory related hospital admissions nationally were due to ozone smog resulting from VOC and NOx emissions from oil and gas. Additionally, children miss 500,000 days of school each year due to poor health associated with smog pollution.[30] A recent study published by scientists at EPA found that oil and gas emissions in 2025 could be attributed to cause 1,900 deaths in that year alone.[31]

These impacts can disproportionately affect minority communities living in the vicinity of the oil and gas activity. For example, in Texas, there are over 800,000 Latinos living within half a mile of an oil or gas well, in Colorado nearly 3 out of 10 people living near a well are Latino, and in California 2 out of 5 people living in close proximity to a well are Latino.[32]

EPA's failure to adopt Methane Guidelines will allow additional emissions of smog-forming pollutants in these areas and communities already burdened with unhealthy levels of ozone pollution. This added pollution enhances the risk of near-term harm to children, older adults, those suffering from respiratory diseases such as asthma, low income populations, outdoor workers, and others recreating outdoors.

Oil and Natural Gas Operations Emit Hazardous Air Pollutants like Benzene, a Known Human Carcinogen

Oil and natural gas operations also emit several different hazardous air pollutants ("HAP") from equipment leaks, processing, compressing, transmission and distribution, and storage tanks. HAPs emitted from oil and gas operations include benzene, a known carcinogen. In issuing the New Source Rule, EPA recognized the negative health and welfare consequences of HAPs

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[29] Eliza D. Czolowsk et al., *Toward Consistent Methodology to Quantify Populations in Proximity to Oil and Gas Development: A National Spatial Analysis and Review,* 125 Envtl. Health Perspectives 6, *available at* https://doi.org/10.1289/EHP1535.

[30] Clean Air Task Force, *Gasping for Breath: An analysis of the health effects from ozone pollution from the oil and gas industry* (2016).

[31] Fann, Neal, et al., *Assessing human health PM2. 5 and ozone impacts from US oil and natural gas sector emissions in 2025*, Environmental Science & Technology 52.15 (2018): 8095-8103.

[32] *Latino Communities at Risk: The Impact of Air Pollution from the Oil and Gas Industry*, Clean Air Task Force (CATF), League of United Latin American Citizens (LULAC), National Hispanic Medical Association (NHMA) 2016.

emitted from oil and gas extraction and the health benefits the Rule provides by reducing HAP emissions in addition to methane and VOC emissions.[33]

There is no safe level of human exposure to many of the toxic pollutants released as a result of oil and gas extraction. Exposure to HAPs can cause cancer and seriously impair the human neurological system. For example, EPA has found that benzene, found naturally in oil and gas, is a "known human carcinogen (causing leukemia) by all routes of exposure, and… that exposure is associated with additional health effects, including genetic changes in both humans and animals."[34]

Further, a "number of adverse noncancer health effects including blood disorders, such as preleukemia and aplastic anemia, have also been associated with long-term exposure to benzene."[35] Along with benzene, EPA has also catalogued the harmful effects of other specific air toxics emitted from oil and gas operations, including toluene, carbonyl sulfide, ethylbenzene, mixed xylenes, n-hexane, and other air toxics.[36] Each of these hazardous pollutants is harmful to human health. For example, the serious health effects associated with exposure to toluene range from the dysfunction of the central nervous system to narcosis, with effects "frequently observed in humans acutely exposed to low or moderate levels of toluene by inhalation."[37]

Recently, the Colorado Department of Public Health and Environment and consulting firm ICF released a Quantitative Human Health Risk Assessment based on advanced air pollution modeling.[38, 39]The study estimated exposures from specific oil and gas activities including drilling, fracking, flowback and production, over different time durations (acute/worst case-scenario exposure, multi-day exposure, and long-term chronic exposure over years), from different sized well pads (one, three and five acres), and different basins in the state. Calculated

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[33] EPA*, Regulatory Impact Analysis of the Final Emission Standards for New and Modified Sources in the Oil and Natural Gas Sector Sources* ("EPA RIA")*,* EPA-452/R-16-002, 4-28–4-37 (May 2016), *available at* https://www.regulations.gov/document?D=EPA-HQ-OAR-2010-0505-7630.

[34] EPA RIA at 4-33.

[35] *Id.* at 3-34.

[36] *See id*. 4-33- 4-37.

[37] *Id.*

[38] C. Holder, et al, *Evaluating Potential Human Health Risks from Modeled Inhalation Exposures to Volatile Organic Compounds Emitted from Oil and Gas Operations*, Journal of the Air & Waste Mgmt. Ass'n (Oct. 17, 2019), *available at* https://doi.org/10.1080/10962247.2019.1680459.

[39] Ed Carr, Raga Avanasi, Bill Mendez, Graham Glen, John Hader, Tao Hong, Jess Wignall, YiHua Wei, Belle Guelden, & Chris Holder (ICF); Arsineh Hecobian (Colorado State University). ICF report. Oct 2019. Final Report: Human Health Risk Assessment for Oil & Gas Operations in Colorado. (https://drive.google.com/file/d/1pO41DJMXw9sD1NjR_OKyBJP5NCb-AO0l/view) Accessed 11/25/2019

population exposures were compared against established health-based guideline concentrations (considered safe) at increasing distances from the well pad.

The study found elevated lifetime cancer risk from benzene exposures from production emissions alone, and all activities combined (drilling, fracking, flowback and production), were associated with an increased lifetime risk (above one in a million) of leukemia for the average individual at 500 feet; as well as risks in the most exposed populations (people who live downwind and spend more time outdoors) only dropped below the one-in-a-million risk threshold after a distance of 2000 feet. Nearly 240,000 Coloradoans living within 2000 ft of an oil and gas well pad.

The study also found non-cancer health risks, including that benzene and 2-ethyltoluene emissions resulted in maximal one hour (acute) exposures higher than considered safe for most simulated populations 500 feet away and exposures of benzene were more than 10 times higher than considered safe for this acute exposure and are a risk for blood disorders. Blood disorders could result in anemia, disturbances in clotting or the ability to fight infections, and could manifest as fatigue, nose bleeds or infections. The study also found the potential for neurotoxic effects, such as headaches, blurred vision and dizziness, from combined acute exposures of benzene and 2-ethyltoluene. Risks were seen with acute exposure in every age group assessed. Exposures and risks during the flowback stage were found to be higher than those from other drilling and fracking activities. Specifically, long term exposure to multiple VOCs (n-nonane, benzene, m+p-xylene, and trimethylbenzenes) during prolonged flowback activities in large well sites resulted in elevated risks for neurotoxicity and blood disorders.

Many Americans live in very close proximity to these wells. These Americans will be exposed to additional hazardous air pollutants, increasing their risk of experiencing adverse health outcomes.

Recent Studies Suggest Proximity to Oil and Gas Development Is Associated with Adverse Health Outcomes

In addition to the threats to public health posed by exposure to HAPs and ozone, new studies document associations between proximity to nonconventional oil and gas development and human health effects. While these studies do not evaluate concentrations of specific air pollutants, they document health effects that are consistent with exposure to smog and hazardous air pollutants.

Air pollutants associated with oil and gas operations are known to cause serious health impacts in sensitive populations such as pregnant women, babies, and children. Studies have documented that living near natural gas wells is associated with lower birth weight babies[40] and

[40] *See* Stacy, et al., *Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania*, PLoS ONE (June 3, 2015), *available at* https://doi.org/10.1371/journal.pone.0126425.

preterm birth.[41] Other studies have found an association between oil and gas proximity and congenital heart defects in infants.[42] Congenital heart defects (CHDs) are the leading cause of death due to birth defects.[43] A 2014 Colorado study found that babies whose mothers had large numbers of natural gas wells within a 10-mile radius of their home had an increased risk of birth defects of the heart, compared to babies whose mothers had no wells within 10 miles of their home.[44] A 2019 follow-up study by the same research team fortified these results.[45] Perhaps most notably, a recent study of over 1.1 million births in Pennsylvania demonstrated evidence for negative health effects (including low birth weight) from in utero exposure to fracking sites within 3 kilometers of a mother's residence, with the largest health impacts seen for in utero exposure within 1 kilometer of oil and gas sites.[46]

Other studies also document correlations between proximity to oil and gas drilling and human health effects in otherwise healthy populations. This emerging body of scientific literature includes several new studies documenting negative human health impacts based on proximity to oil and gas wells. For example, a study from 2016 demonstrated that oil and gas well proximity was correlated with an increase in the likelihood of asthma exacerbations, including mild, moderate, and severe asthma attacks.[47] A 2015 study documented increased hospitalization rates in counties with a high density of oil and gas wells.[48] Similarly, other

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[41] Casey et al., *Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA,* Epidemiology (Mar. 2016), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4738074/.

[42] McKenzie et. al., *Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado,* Envtl. Health Perspectives (Jan. 28, 2014) *available at* https://ehp.niehs.nih.gov/1306722/; McKenzie et al., *Congenital Heart Defects and Intensity of Oil and Gas Well Site Activities in Early Pregnancy,* Environment International (July 28, 2019), *available at* https://www.sciencedirect.com/science/article/pii/S0160412019315429.

[43] McKenzie et al., *Congenital Heart Defects and Intensity of Oil and Gas Well Site Activities in Early Pregnancy,* Environment International (July 28, 2019), *available at* https://www.sciencedirect.com/science/article/pii/S0160412019315429.

[44] McKenzie et. al., *Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado,* Envtl. Health Perspectives (Jan. 28, 2014), *available at* https://ehp.niehs.nih.gov/1306722/.

[45] McKenzie et al., *Congenital Heart Defects and Intensity of Oil and Gas Well Site Activities in Early Pregnancy,* Environment International (July 28, 2019), *available at* https://www.sciencedirect.com/science/article/pii/S0160412019315429.

[46] Currie, Janet, et al., *Hydraulic Fracturing and Infant Health: New Evidence from Pennsylvania*, Science Advances, American Association for the Advancement of Science (Dec. 1, 2017), *available at* advances.sciencemag.org/content/3/12/e1603021.

[47] Rasmussen et al, *Association between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations,* 176 J. Am. Med. Assn. Internal Med. 1334-43 (Sept. 2016), *available at* https://www.ncbi.nlm.nih.gov/pubmed/27428612.

[48] Jemielita et al., *Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates,* PLoS ONE (July 15, 2015), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4503720/.

studies, including a 2017 study, have demonstrated an increase in the reporting of nasal, sinus, and migraine headaches, and fatigue symptoms in areas with high volumes of oil and gas drilling.[49]

A 2018 study in Colorado found that communities living in close proximity to oil and gas activity had higher measured exposures to HAPs and face increased risks to their health, including a heightened risk of cancer.[50] The study found that the lifetime cancer risk was 8.3 per 10,000 people for populations living within approximately 500 feet of oil and gas activity, above EPA's allowable risk. The study also found elevated levels of acute and chronic blood system and developmental risks, and acute nervous system risks for the same population. Benzene exposures contributed to 80-95% of risks across the different health effects.

While this literature is developing, it substantiates that people living in close proximity to oil and gas development are exposed to air pollution from these sources and experience acute, adverse, and often near-term health impacts.

Conclusion

As long as EPA fails to issue Methane Guidelines for existing sources in the oil and gas sector, these sources will continue to emit harmful methane, VOC and HAP pollution that would otherwise be abated. Individuals exposed to these emissions face a higher risk of adverse health effects, including acute and immediate respiratory ailments like asthma and enhanced risk of longer term, deleterious health effects associated with toxic pollution exposures.

[49] *See* Tustin et al., *Associations between Unconventional Natural Gas Development and Nasal and Sinus, Migraine Headache, and Fatigue Symptoms in Pennsylvania,* 125 ENV. HEALTH PERSPECTIVES 189 (Feb. 2017), *available at* https://ehp.niehs.nih.gov/EHP281/.

[50] Lisa McKenzie et al., Ambient Non-Methane Hydrocarbon Levels Along Colorado's Northern Front Range: Acute and Chronic Health Risks, forthcoming in Envt'l Sci. & Tech. (Mar. 27, 2018), *available at* https://pubs.acs.org/doi/10.1021/acs.est.7b05983.