Overview of Protective Buffers PA's Recommended Setbacks

Unconventional Wells

- Unconventional gas wells shall not be constructed within 3,281 ft of any occupied building or water well, as measured from the edge of the well pad. The property owner shall not be allowed to waive this setback.[1]

- Unconventional gas wells shall not be constructed within 8,202 ft, measured from the edge of the well pad to the edge of the property line of any parcel containing any structure serving vulnerable populations including structures used for education, day care or child care, hospitals, nursing homes and assisted living facilities.[2]

- Unconventional gas wells shall not be constructed within 3,281 ft of any existing water well, surface water intake, reservoir or other water supply extraction point used by a water purveyor, as measured from the edge of the well pad. The water purveyor shall not be allowed to waive this setback.[3]

Compressor Stations

- Natural gas compressor stations that are considered major sources of air pollution requiring a Title V permit shall not be constructed within a distance of 9,843 ft, measured from the edge of the property line of parcel(s) containing the compressor station and related equipment including condensate tanks and dehydrators, to any occupied building.[4]

- Natural gas compressor stations that are not considered major sources of pollution and do not need a Title V permit shall not be constructed within a distance of 3,281 ft, measured from the edge of the property line of the parcel(s) containing the compressor station and related equipment including condensate tanks and dehydrators, to any occupied building.[5]

- Natural gas compressor stations that are not considered major sources of pollution and do not need a Title V permit shall not be constructed within a distance of 8,202 ft measured from the edge of the property line of the parcel(s) containing the compressor station and related equipment including condensate tanks and dehydrators, to the edge of the property line of any parcel containing any structure serving vulnerable populations including structures used for education, day care or child care, hospitals, nursing homes and assisted living facilities.[6]

Ethane Cracker Plants

- Ethane cracker plants shall not be constructed within 9,842 ft, measured from the edge of the property line of the parcel(s) containing the ethane cracker plant, to any occupied building.[7]

Gas-Fired Power Plants

- Natural gas-fired power plants shall not be constructed within 9,842 ft, measured from the edge of the property line of the parcel(s) containing the power plant, to any occupied building.[8]

Natural Gas Processing Plants

- Natural gas processing plants shall not be constructed within 16,404 ft, measured from the edge of the property line of the parcel(s) containing the natural gas processing plant and related equipment including condensate tanks and dehydrators, to any occupied building.[9]

Natural Gas Pipelines

- Natural gas gathering and transmission pipelines that are not providing public utility service and are not under the exclusive jurisdiction of the Federal Energy Regulatory Commission under the Natural Gas Act shall not be permitted within 100 ft beyond the potential impact radius (PIR) of any occupied building. The PIR is calculated using the following formula: PIR= 0.69*(square root of (p*d2)), where ‘r’ is the radius of a circular area in feet surrounding the point of failure, ‘p’ is the maximum allowable operating pressure (MAOP) in the pipeline segment in pounds per square inch and ‘d’ is the nominal diameter of the pipeline in inches.[10]

- Natural gas gathering and transmission pipelines that are not providing public utility service and are not under the exclusive jurisdiction of the Federal Energy Regulatory Commission under the Natural Gas Act shall not be constructed within a distance equal to the potential impact radius (PIR) plus 100 ft of any property containing any structure serving vulnerable populations, measured from the pipeline to the property line of any parcel containing structures serving vulnerable populations (including structures used for education, day care or child care, hospitals, nursing homes and assisted living facilities).[10]

Hazardous Liquid Pipelines

- Hazardous liquid pipelines carrying flammable gases, including refrigerated liquids categorized under Guide 115 of PHMSA’s 2020 Emergency Response Guidebook (e.g., ethane, butane, propane), shall require a minimum setback of at least 2,640 ft (0.5 mile) measured from the pipeline to any occupied building.[11]

- Hazardous liquid pipelines carrying flammable gases, including refrigerated liquids categorized under Guide 115 of PHMSA’s 2020 Emergency Response Guidebook shall not be constructed within 2,640 ft (0.5 mile) of any property containing any structure serving vulnerable populations, measured from the pipeline to the property line of any parcel containing structures serving vulnerable populations (including structures used for education, day care or child care, hospitals, nursing homes and assisted living facilities).[11]

- Hazardous Liquid pipelines carrying flammable liquids, categorized under Guide 128 of PHMSA's 2020 Emergency Response Guidebook (e.g., crude oil, gasoline, fuel oil) shall require a minimum setback of at least 1,000 ft measured from the pipeline to any occupied building.[11]

- Hazardous liquid pipelines carrying flammable liquids categorized under Guide 128 of PHMSA's 2020 Emergency Response Guidebook shall not be constructed within 1,000 ft of any property containing any structure serving vulnerable populations, measured from the pipeline to the property line of any parcel containing structures serving vulnerable populations (including structures used for education, day care or child care, hospitals, nursing homes and assisted living facilities).[11]

Natural Gas Gathering and Transmission Pipelines & Hazardous Liquid Transmission Pipelines

- Pipeline horizontal directional drilling equipment shall not be placed within 250 feet from the edge of any water body, leaving a minimum 250 foot undisturbed buffer extending from the edge of each water body.[12]

Natural Gas Infrastructure and Aquatic Habitats

- The following infrastructure shall not be constructed within 450 ft from the edge of any aquatic habitat, defined as all streams, rivers, seeps, springs, wetlands, lakes, ponds, or reservoirs.[13]
    - Unconventional natural gas well pads
    - Compressor stations
    - Ethane cracker plants
    - Natural gas processing plants
    - Natural gas-fired power plants
    - A pit or impoundment containing drilling cuttings, flowback water, produced water or hazardous materials, chemicals or waste;
    - A tank containing hazardous materials, chemicals, condensate, waste, flowback or produced water
    - Any storage or handling of water, chemicals, fuels, hazardous materials or solid waste on a well site.

Endnotes

1. Janet Currie, Michael Greenstone, Katherine Meckel, (December 2017) "Hydraulic Fracturing And Infant Health: New Evidence From Pennsylvania," Science Advances, https://advances.sciencemag.org/content/3/12/e1603021

Findings: “We found evidence for negative health effects of in utero exposure to fracking sites within 3 km of a mother’s residence, with the largest health impacts seen for in utero exposure within 1 km of fracking sites. Negative health impacts include a greater incidence of low–birth weight babies as well as significant declines in average birth weight and in several other measures of infant health.”

McKenzie, L. M., Witter, R. Z., Newman, L. S., & Adgate, J. L, (May 2012) “Human Health Risk Assessment Of Air Emissions From Development Of Unconventional Natural Gas Resources,” The Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2012.02.018,

Findings: “Residents living ≤½ mile from wells are at greater risk for health effects from NGD (natural gas development) than are residents living >½ mile from wells. Subchronic exposures to air pollutants during well completion activities present the greatest potential for health effects. The subchronic non-cancer hazard index (HI) of 5 for residents ≤½ mile from wells was driven primarily by exposure to trimethylbenzenes, xylenes, and aliphatic hydrocarbons. Chronic HIs were 1 and 0.4. for residents ≤½ mile from wells and >½ mile from wells, respectively. Cumulative cancer risks were 10 in a million and 6 in a million for residents living ≤½ mile and >½ mile from wells, respectively, with benzene as the major contributor to the risk.”

Rabinowitz Pm, Slizovskiy Ib, Lamers V, Trufan Sj, Holford Tr, Dziura Jd, Peduzzi Pn, Kane Mj, Reif Js, Weiss Tr, Stowe Mh, (January 2015) “Proximity To Natural Gas Wells And Reported Health Status: Results Of A Household Survey In Washington County, Pennsylvania,” Environmental Health Perspectives, http://dx.doi.org/10.1289/ehp.1307732.

Findings “The number of reported health symptoms per person was higher among residents living < 1 km (mean ± SD, 3.27 ± 3.72) compared with > 2 km from the nearest gas well (mean ± SD, 1.60 ± 2.14; p = 0.0002). In a model that adjusted for age, sex, household education, smoking, awareness of environmental risk, work type, and animals in house, reported skin conditions were more common in households < 1 km compared with > 2 km from the nearest gas well (odds ratio = 4.1; 95% CI: 1.4, 12.3; p = 0.01). Upper respiratory symptoms were also more frequently reported in persons living in households < 1 km from gas wells (39%) compared with households 1–2 km or > 2 km from the nearest well (31 and 18%, respectively) (p = 0.004).”

Robert B. Jackson, Avner Vengosh, Thomas H. Darrah, Nathaniel R. Warner, Adrian Down, Robert J. Poreda, Stephen G. Osborn, Kaiguang Zhao, and Jonathan D. Karr, (July, 2013) “Increased Stray Gas Abundance in a Subset of Drinking Water Wells Near Marcellus Shale Gas Extraction,” Proceedings of the National Academy of Sciences of the United States of America, https://doi.org/10.1073/pnas.1221635110

Findings: “Horizontal drilling and hydraulic fracturing are transforming energy production, but their potential environmental effects remain controversial. We analyzed 141 drinking water wells across the Appalachian Plateaus physiographic province of northeastern Pennsylvania, examining natural gas concentrations and isotopic signatures with proximity to shale gas wells. Methane was detected in 82% of drinking water samples, with average concentrations six times higher for homes <1 km from natural gas wells (P = 0.0006). Ethane was 23 times higher in homes <1 km from gas wells (P = 0.0013); propane was detected in 10 water wells, all within approximately 1 km distance (P = 0.01).”

Stephen G. Osborn, Avner Vengosh, Nathaniel R. Warner, and Robert B. Jackson, (May 2011) “Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing,” Proceedings of the National Academy of Sciences of the United States of America, https://www.pnas.org/content/pnas/108/20/8172.full.pdf

Findings: “Directional drilling and hydraulic-fracturing technologies are dramatically increasing natural-gas extraction. In aquifers overlying the Marcellus and Utica shale formations of northeastern Pennsylvania and upstate New York, we document systematic evidence for methane contamination of drinking water associated with shale gas extraction. In active gas-extraction areas (one or more gas wells within 1 km), average and maximum methane concentrations in drinking-water wells increased with proximity to the nearest gas well and were 19.2 and 64 mg CH_4 L^{-1} (n ¼ 26), a potential explosion hazard; in contrast, dissolved methane samples in neighboring nonextraction sites (no gas wells within 1 km) within similar geologic formations and hydrogeologic regimes averaged only 1.1 mg L^{-1} ($P < 0.05$; n ¼ 34). Average $\delta^{13}C$-CH_4 values of dissolved methane in shallow groundwater were significantly less negative for active than for nonactive sites (−37 7‰ and −54 11‰, respectively; $P < 0.0001$).”

Avner Vengosh, Robert B. Jackson, Nathaniel Warner, Thomas H. Darrah, and Andrew Kondash, (March 2014) “A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States,” Environmental Science & Technology, 48(15), https://www.researchgate.net/publication/260643891_A_Critical_Review_of_the_Risks_to_Water_Resources_from_Unconventional_Shale_Gas_Development_and_Hydraulic_Fracturing_in_the_United_States

Findings: “Given the different risks to water resources that are associated with shale gas development in the U.S., we consider several plausible solutions that could mitigate some of the identified problems. Previous studies have identified stray gas contamination particularly in drinking water wells located less than 1 km from drilling sites. Enforcing a safe zone of 1 km between new installed shale gas

sites and already existing drinking water wells could reduce the risk of stray gas contamination in drinking water wells in these areas."

2. Janet Currie, Michael Greenstone, Katherine Meckel, (December 2017) "Hydraulic Fracturing And Infant Health: New Evidence From Pennsylvania," Science Advances, https://advances.sciencemag.org/content/3/12/e1603021;

   Findings: "We found evidence for negative health effects of in utero exposure to fracking sites within 3 km of a mother's residence, with the largest health impacts seen for in utero exposure within 1 km of fracking sites. Negative health impacts include a greater incidence of low–birth weight babies as well as significant declines in average birth weight and in several other measures of infant health."

Elaine L.Hill (2018) "Shale Gas Development and Infant Health: Evidence from Pennsylvania," Journal of Health Economics, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6629042/;

Findings: "Using detailed location data on maternal addresses and GIS coordinates of gas wells, this study examines singleton births to mothers residing close to a shale gas well from 2003–2010 in Pennsylvania. The introduction of drilling increased low birth weight and decreased term birth weight on average among mothers living within 2.5 km of a well compared to mothers living within 2.5 km of a future well. Adverse effects were also detected using measures such as small for gestational age and APGAR scores, while no effects on gestation periods were found. These results are robust to other measures of infant health, many changes in specification and falsification tests. In the intensive margin, an additional well is associated with a 7 percent increase in low birth weight, a 5 gram reduction in term birth weight and a 3 percent increase in premature birth. These findings suggest that shale gas development poses significant risks to human health and have policy implications for regulation of shale gas development."

Celia Lewis, Lydia H. Greiner, David R. Brown (2018) "Setback distances for unconventional oil and gas development: Delphi study results," PLoS One, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0202462

Findings: " The goal of this Delphi study was to elicit expert consensus on appropriate setback distances for UOGD from human activity. Three rounds were used to identify and seek consensus on recommended setback distances. The 18 panelists were health care providers, public health practitioners, environmental advocates, and researchers/scientists…Panelists did not reach

consensus on the statement '1–1¼ miles', 50% agreed, 28% were unsure, and 22% disagreed….Panelists reached consensus that additional setback distances should be established for vulnerable populations or settings. Vulnerable groups were defined by the panelists as children, neonates, fetuses, embryos, pregnant women, elderly individuals, those with pre-existing medical or psychological conditions, and those with pre-existing respiratory conditions."

3. Elaine Hill, Lala Ma, (2017) "Shale Gas Development and Drinking Water Quality," American Economic Review: Papers & Proceedings, 107(5): 522–525 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5804812/

   Findings: "We employ a difference-in-differences strategy that compares, for a given CWS, water quality after an increase in the number of drilled well pads to background levels of water quality in the geographic area as measured by the impact of more distant well pads. Our main estimate finds that drilling an additional well pad within 1 km of groundwater intake locations increases shale gas-related contaminants by 1.5–2.7 percent, on average. These results are striking considering that our data are based on water sampling measurements taken after municipal treatment, and suggest that the health impacts of SGD through water contamination remains an open question."

   Environmental Protection Agency (2016) "Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources," https://www.epa.gov/hfstudy

   Findings: "The locations of drinking water resources relative to hydraulically fractured oil and gas production wells influence the potential for activities in the hydraulic fracturing water cycle to impact drinking water resources. With increased proximity, activities in the hydraulic fracturing water cycle have more potential to affect aboveground and belowground drinking water resources… Thirteen of the 151 spills characterized by the EPA were reported to have reached a surface water body (often creeks or streams). Among the 13 spills, reported spill volumes ranged from 28 gallons (105 liters) to 7,350 gallons (27,800 liters). Additionally, Brantley et al. (2014) and Considine et al. (2012) identified fewer than 10 total instances of spills of additives and/or hydraulic fracturing fluids greater than 400 gallons (1,500 liters) that reached surface waters in Pennsylvania between January 2008 and June 2013. Reported spill volumes for these spills ranged from 3,400 gallons (13,000 liters) to 227,000 gallons (859,000 liters)."

4. *Author's note: The Currie study (see endnote 2) demonstrates health effects in fetuses up to 3 km away from unconventional well pads, and the need to establish a minimum setback for vulnerable populations - in this case pregnant women and children. The 3 km*

distance established in the Currie study for health impacts resulting from wells justifies a conservative distance for protecting populations from emissions from larger facilities such as compressor stations, processing plants, cracker plants, and power plants, which emit similar types of pollutants but at larger quantities and on a consistent basis

5. *Author's note: The studies shown in endnote 1 demonstrate the health impacts of unconventional wells at 1km. Since these "minor source" compressor stations emit similar types of pollutants as unconventional wells but at larger quantities on a more consistent basis, a 1km setback is necessary.*

6. *Author's note: The studies shown in endnote 2 demonstrate the health impacts of unconventional wells at distances of 2 km, 2.5 km and 3 km. These "minor source" compressor stations emit less air pollution than those that require a Title V permit. Operators of these minor source compressor stations typically will apply for a general permit (GP-05), which includes strong standards for controlling air pollution. Therefore, these minor source compressor stations can be sited slightly closer to vulnerable populations compared to Title V compressors stations, processing plants, cracker plants, and power plants. The 2.5 km distance is also the middle of the range of distances from the three cited studies.*

7. *Author's note: see endnote 4*

8. *Author's note: see endnote 4 as well as the following study:*

   Agostino Di Ciaula, (2012), "Emergency visits and hospital admissions in aged people living close to a gas-fired power plant," European Journal of Internal Medicine Volume 23, Issue 2, March 2012, https://www.sciencedirect.com/science/article/abs/pii/S0953620511002263

   Findings: "Mean air concentrations of PM10 and NO2 were higher after-than before the start of operation of the plant, with the highest concentrations recorded within 1 km. Although pollutants were below the limits set by the European legislation, in elderly people there was a positive correlation between the number of emergency visits and daily air concentrations of PM10 and NO2, as measured at 1 and 3 km from the plant. In subjects aged 70 years or more, the number of hospital admissions was positively correlated with PM10 levels measured within 3 km from the power plant, whereas in older subjects (≥ 80 year) it was also significantly linked with the lowest air concentration of PM10 (measured at 6 km from the plant)."

9. *Author's note: see footnote 4 as well as the following study*

   David R. Brown, Celia Lewis & Beth I. Weinberger, (2015) "Human exposure to unconventional natural gas development: A public health demonstration of periodic high exposure to chemical mixtures in ambient air," Journal of Environmental Science and

Health, Part A, 50:5, 460-472,
https://www.tandfonline.com/doi/full/10.1080/10934529.2015.992663

Author's note: This study is an air modelling study that was conducted using existing air emissions data and on observed conditions in shale gas development in Washington County, Pennsylvania. The key takeaway point that this study demonstrates is the need for measuring quantitative impact on health when multiple facilities are placed near residences, schools, daycare centers and other locations where people are located, and especially around vulnerable populations. The study was based on a "typical" scenario based on a dataset of 276 households that had "wells 1 km to the west, a compressor station 2 km to the south and a processing station 5 km to the north."

10. Mark J. Stephens, (October 2000) "A Model for Sizing High Consequence Areas Associated With Natural Gas Pipelines", Gas Research Institute and C-FER Technologies, https://pstrust.org/docs/C-FerCircle.pdf

    Author's note: PHMSA uses the Hazard Area Radius formula in Stephens' study to calculate the potential impact radius (PIR) of a natural gas pipeline and determine the location of a high consequence area (HCA). PHMSA defines the PIR as "the distance from a potential explosion at which death, injury or significant property damage could occur." The U.S. Department of Transportation online glossary defines the HCA as "A location that is specially defined in pipeline safety regulations as an area where pipeline releases could have greater consequences to health and safety or the environment." The potential impact radius increases as operating pressure and the diameter of the pipe increase. The PIR is calculated according to the formula used in Stephens' report: PIR= 0.69 (square root of ($p*d^2$)), where 'r' is the radius of a circular area in feet surrounding the point of failure, 'p' is the maximum allowable operating pressure (MAOP) in the pipeline segment in pounds per square inch and 'd' is the nominal diameter of the pipeline in inches.*

11. PHMSA, "2020 Emergency Response Guidebook"
    https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2020-08/ERG2020-WEB.pdf

    Author's note: The minimum setbacks provided are based on PHMSA's public safety guidelines for recommended evacuation distances in the case of large spills. For large spills of substances that fall under Guide 115 (e.g., ethane, butane, propane), the guidelines state, "Consider initial downwind evacuation for at least 800 meters (1/2 mile)" (p.166). For large spills of substances that fall under Guide 128 (e.g., crude oil, gasoline, fuel oil) the guidelines state, "Consider initial downwind evacuation for at least 300 meters (1000 feet)" (p.192).

12. U. S. Fish and Wildlife Service, (July 2009) “Arkansas Best Management Practices For Natural Gas Pipeline Construction And Maintenance Activities In The Fayetteville Shale Area, Upper Little Red River Watershed” https://www.fws.gov/arkansas-es/docs/AR_Natural_Gas_Pipeline_BMPs_ULRR_v1_July_2009.pdf

Author’s note: The U.S. Fish and Wildlife Service recommends the Horizontal Directional Drilling (HDD)best management practice of leaving a minimum 250 ft vegetated buffer from the edge of each stream bank and setting up Horizontal Directional Drilling equipment at least 250 ft away from the stream bank.

13. Raymond D. Semlitsch, J. Russell Bodie (October 2003) “Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles” Conservation Biology 17(5):1219 - 1228, http://www.mctga.org/Stream%20Buffer%20Information/Semlitsch%20and%20Bodie%202003.pdf

    Findings: “We summarize data from the literature on the use of terrestrial habitats by amphibians and reptiles associated with wetlands (19 frog and 13 salamander species representing 1363 individuals; 5 snake and 28 turtle species representing more than 2245 individuals). Core terrestrial habitat ranged from 159 to 290 m for amphibians and from 127 to 289 m for reptiles from the edge of the aquatic site. Data from these studies also indicated the importance of terrestrial habitats for feeding, overwintering, and nesting, and, thus, the biological interdependence between aquatic and terrestrial habitats that is essential for the persistence of populations. The minimum and maximum values for core habitats, depending on the level of protection needed, can be used to set biologically meaningful buffers for wetland and riparian habitats. These results indicate that large areas of terrestrial habitat surrounding wetlands are critical for maintaining biodiversity.”

Maryland Department of the Environment & Maryland Department of Natural Resources, (December 2014) “Marcellus Shale Safe Drilling Initiative Study Part III, Final Report: Findings And Recommendations” https://mde.state.md.us/programs/land/mining/marcellus/documents/final_marcellus_shale_report.pdf

    Findings: “A suite of location restrictions and setbacks will prohibit well pad and permanent surface infrastructure development within high value and sensitive natural resource areas. For example, no well pads will be allowed within 450 feet of streams, rivers, wetlands, lakes, 100 year floodplains and other aquatic habitats.”

Tony Prochaska and Ronald Klauda, Maryland Department of Natural Resources, (July 2014) “Marcellus Shale Safe Drilling Initiative Study Part II, Interim final Best Practices; Appendix G - Justification for Aquatic Habitat Setback from 300 ft. to 450 ft.” https://www.slideshare.net/MarcellusDN/maryland-marcellus-shale-safe-drilling-initiative-interim-best-practices-july-2014

> Findings: “A 450 ft. will provide significant water quality protection… a higher level of protection for biodiversity (with a focus on aquatic biodiversity), ensure sufficient corridor width needed for terrestrial wildlife movement and forest interior dwelling bird species, and reduce the visual, noise, and light impacts of gas extraction operations in close proximity to aquatic habitats.”