

PETITION TO THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Petition for Listing and Rulemaking Under Section 112 of the Clean Air Act to Establish an Area Source Category for Oil and Gas Production Wells and Associated Equipment and to Set National Emission Standards for Hazardous Air Pollutant Emissions) Submitted via U.S. Mail and) E-mail to the Administrator and) Assistant Administrator of the) Office of Air and Radiation,) U.S. Environmental Protection) Agency

May 13, 2014

EPA MUST LIST OIL AND GAS WELLS AND ASSOCIATED EQUIPMENT AS AN AREA SOURCE CATEGORY AND SET NATIONAL AIR TOXICS STANDARDS TO PROTECT PUBLIC HEALTH

EXECUTIVE SUMMARY

Earthjustice submits this petition on behalf of petitioner organizations listed herein who are concerned about the health effects of toxic air pollution emitted by oil and gas wells on their members and the communities they serve around the United States.

Hazardous air pollutant (“HAP”) emissions from oil and gas wells threaten public health in many areas throughout the United States. The number of oil and gas wells in and near towns and cities has grown swiftly in recent years and is expected to continue to expand. As of 2011, oil and gas wells in the U.S. numbered more than 1.04 million, and as many as 45,000 new wells are expected to be drilled each year through 2035. Technological developments, such as horizontal drilling and hydraulic fracturing techniques, have allowed the industry to reach oil and gas reserves that were previously considered inaccessible. Major oil and gas shale plays – including the Marcellus, Haynesville and Barnett gas plays and the Bakken, Eagle Ford and Monterey oil plays – that were once considered impossible to access, are now expected to produce hundreds of trillions of cubic feet of natural gas and tens of billions of barrels of oil.

This oil and gas expansion has brought drilling activities closer to heavily populated areas, including the Dallas/Fort Worth, Pittsburgh, Denver, and Los Angeles metropolitan regions, placing drill rigs near homes, schools and workplaces and posing an ever increasing threat to public health. If this development continues as predicted, more communities will face greater toxic air emissions and associated harm—most notably from emissions at well sites.

Oil and gas wells and their associated equipment release hazardous air pollutants, including n-hexane, benzene, toluene, ethyl benzene, xylenes, formaldehyde, naphthalene, acetaldehyde, methanol, carbonyl sulfide, ethylene glycol, and 2,2,4-trimethylentane, methylene chloride, among others.¹ Toxic pollution from oil and gas production is emitted not only at the

¹ See section I.C *infra*.

wells during drilling, completion and flaring, but also from compressors, condensate tanks, gas sweetening equipment, storage tanks, produced waste water impoundments, and leaks throughout the process. In addition, hydraulic fracturing uses a number of toxic chemicals that can be released into the air and water, yet many such chemicals and the amounts in which they are used and may be released are undisclosed due to industry's concerns about trade secrets.

The toxic pollutants emitted by these operations present health risks when people are exposed, including increases in cancer risk, heightened risk of developmental disorders in children, and risk of respiratory harm.² As oil and gas development reaches the urban interface, the public health threats are compounded further by exposures to existing industrial toxic pollution. Already, residents living close to oil and gas well facilities have documented health problems in their communities – some of which are consistent with exposures to hazardous air pollutants. Continued, uncontrolled toxic pollution from oil and gas production creates serious health threats in metropolitan areas across the country.

Despite widespread awareness of the rapid expansion in domestic oil and gas production, health concerns about the increased number of wells have not been adequately addressed. Under EPA's current regulations for the oil and gas sector (which do not directly regulate toxic pollution coming from oil and gas wells or set necessary protections for people living near them), it is estimated that less than 10 percent of the industry's total hazardous air pollutant emissions will be reduced. Yet, technology that is available and already in use at some wells can reduce oil and gas well emissions, including green completions, closed loop systems, vapor recovery units, and capping or reductions in flaring.

To protect public health, this petition urgently requests EPA to exercise its authority under the Clean Air Act to list oil and gas wells (and associated equipment) located in the appropriate geographical areas as area sources, and set limits on hazardous air pollutant emissions from oil and gas wells and associated equipment in accordance with 42 U.S.C. §§ 7412(c), (d), (k), and (n)(4)(B). EPA has the authority to establish an area source category "for oil and gas production wells located in any metropolitan statistical area or consolidated metropolitan statistical area with a population in excess of 1 million if the Administrator determines that emissions of hazardous air pollutants from such wells present more than a negligible risk of adverse effects to public health" under section 112(n)(4)(B) of the Act, 42 U.S.C. § 7412(n)(4)(B). This authority embraces not only regulation of wells themselves, but also a broad class of "associated equipment" that EPA has defined to include almost all production-related facilities leading to the point of custody transfer.³

EPA also has a responsibility under the Clean Air Act to protect people from toxic air emissions nationwide, and under section 112(n)(4)(B) it must do so. Indeed, EPA has the authority to take the important and necessary action of designating oil and gas wells as area sources and setting standards to limit toxic pollution released from these facilities, and doing so would be consistent with the Secretary of Energy Advisory Board's recommendations: "Measures should be taken to reduce emissions of air pollutants, ozone precursors, and methane

² *See id.*

³ *See* section II.A *infra*.

as quickly as practicable. The Subcommittee supports adoption of *rigorous* standards for new and existing sources of . . . air toxics, ozone precursors and other air pollutants from shale gas operations.”⁴ In his 2012 State of the Union Address, President Obama promised that his “administration will take every possible action to safely develop this energy . . . without putting the health and safety of our citizens at risk.”

The evidence presented in this petition provides a clear basis for EPA to conclude that the Clean Air Act section 112(n)(4)(B) test is met. Substantial numbers of oil and gas wells exist in section 112(n)(4)(B) areas, emitting large amounts of hazardous air pollutants on a daily basis. People living in the relevant areas need health protection from oil and gas wells because such emissions pose a risk to public health. Some of the documented health effects of the many types of HAPs emitted during oil and gas production include increased risks of cancer, respiratory diseases, and birth defects, among others. HAPs are of particular concern in the areas covered by section 112(n)(4)(B) because now more than ever, people and sources of emissions are concentrated in the same geographic area leading to an increased likelihood of multiple exposures. In addition, children, pregnant women, the elderly and individuals with underlying health problems, such as respiratory and cardiovascular disease, are particularly vulnerable and at risk from exposure to HAPs.

EPA also has a duty to establish robust emission standards for oil and gas production wells and their associated equipment in accordance with Clean Air Act sections 112(c), (d), and (k). For example, such regulation would advance the purposes of sections 112(c)(3) and 112(k), which direct EPA to establish emission standards for sources that account for 90 percent of each of the 30 HAPs that represent the greatest threats to public health in urban areas. To adequately address the health risk of major oil and gas development expansion in section 112(n)(4)(B) areas, and to follow upon EPA precedent in promulgating emission standards for area source categories such as chrome platers, secondary lead smelters and halogenated solvent cleaning, EPA must set HAP standards for oil and gas well area sources pursuant to section 112(d)(2)-(3) by requiring “the maximum degree of reduction in emissions” that EPA “determines is achievable.”

In sum, EPA must act now to protect public health by requiring that oil and gas wells in the covered statistical areas meet limits on the amount of toxic air pollution that they may emit into local communities’ air. Pursuant to the Administrative Procedure Act, 5 U.S.C. § 553(e), and the Clean Air Act, 42 U.S.C. §§ 7412(n)(4)(B), 7412(c), 7412(d), and 7412(k), Petitioners file this Petition for Listing and Rulemaking and respectfully request that EPA exercise its authority to:

- (1) List an area source category of oil and gas production wells (and associated equipment) located in metropolitan statistical areas and consolidated metropolitan statistical areas with a population in excess of one million; and

⁴ SEC’Y OF ENERGY ADVISORY BOARD, SHALE GAS PRODUCTION SUBCOMM., 90-Day Report, 6 (Aug. 18, 2011), http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf [hereinafter *90-Day Report*].

(2) Set emissions standards for oil and gas production wells (and associated equipment) within the newly listed area source category in accordance with 42 U.S.C. §§ 7412(c)(2), 7412(d)(2)-(3), and 7412(k), that require the “maximum achievable” degree of emission reduction.

Petitioners hereby request that EPA take public comment on the issues raised herein and issue a substantive response to this petition within one hundred eighty (180) calendar days. Given the urgent threats to public health posed by unregulated oil and gas well emissions, we urge EPA to give prompt consideration to this petition. In addition to the important protections requested by this Petition, Petitioners urge EPA to put in place comprehensive, clean air protections addressing the full suite of harmful air pollution from the oil and gas sector.

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ARGUMENT

I. FACTS

A. Petitioners

The undersigned Petitioners listed on the final page of this Petition urge EPA to take prompt action on this Petition.

Petitioners are national and local nonprofit organizations with over one million members and supporters who have an interest in securing and strengthening regulatory safeguards to protect communities and ecosystems from the significant toxic pollution emitted by oil and gas development. Petitioners include organizations that have thousands of members who live, work, and enjoy outdoor activities and recreation throughout the United States, including in statistical areas covered by Clean Air Act § 112(n)(4)(B) that contain or are expected to contain oil and gas wells and associated equipment.⁵

B. Thousands of oil and gas production wells are located in the areas covered by section 112(n)(4)(B).

In recent years there has been a surge in oil and gas production across the United States.⁶ The number of oil and gas wells in the U.S. exceeded 1.04 *million* as of 2011⁷ and is projected to grow steadily for at least a few more decades, with increases of around 17,000–35,000 natural gas wells and 9,000–10,000 oil wells expected each year through 2035.⁸ The growth in the industry is so significant that the U.S. Department of Energy’s Energy Information

⁵ For example, this is a sampling of Sierra Club membership in some of the counties that meet the section 112(n)(4)(B) criteria: Fresno County, CA – 1,238 members; Kern County, CA – 932 members; Los Angeles County, CA – 29,877 members; Madera County, CA – 244 members; Weld County, CO – 250 members; Cooke County, TX – 29 members; Dallas County, TX – 2,304 members; Denton County, TX – 578 members; Ellis County, TX – 70 members; Harris County, TX – 3,479 members; Hood County, TX – 51 members; Johnson County, TX – 91 members; Palo Pinto County, TX – 17 members; Parker County, TX – 99 members; Somervell County, TX – 7 members; Tarrant County, TX – 1507 members; Travis County, TX – 3,418 members; Wise County, TX – 33 members; Allegheny County, PA – 3,041 members; Bucks County, PA – 1,481 members; Chester County, PA – 1,572 members; Delaware County, PA – 1,371 members; Montgomery County, PA – 2,453 members; Philadelphia County, PA – 1,999 members; Caddo Parish, LA – 151 members; Belmont County, OH – 31 members; Knox County, OH – 86 members; Licking County, OH – 230 members; Mahoning County, OH – 208 members; Stark County, OH – 370 members; Summit County, OH – 1,015 members.

⁶ See U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., U.S. Crude Oil, Natural Gas and Dry Exploratory and Development Wells Drilled, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=E_ERTW0_XWC0_NUS_C&f=A (the number of crude oil, natural gas, and dry exploratory and developmental wells drilled from 2000-2009 surpassed the number drilled from 1990-1999 by nearly 60 percent).

⁷ See U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., Annual Energy Review 2011, 123, 185 (Sept. 2012) *available at* <http://www.eia.gov/totalenergy/data/annual/> (showing 536,000 producing oil wells and 504,000 producing gas wells)

⁸ See Bob Weinhold, *The Future of Fracking, New Rules Target Air Emissions for Cleaner Natural Gas Production* 120(7) ENVTL. HEALTH PERSPECTIVES A272, A274 (2012), *available at* <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3404676/pdf/ehp.120-a272.pdf> (citing EPA, *Regulatory Impact Analysis: Final New Source Performance Standards and Amendments to the National Emission Standards for Hazardous Air Pollutants for the Oil and Natural Gas Industry* 2-27 tbl. 2-13 (Apr. 2012), Document ID No. EPA-HQ-OAR-2010-0505-4544 [hereinafter *RIA*]).

Administration (“EIA”) projected that the United States would produce more petroleum and natural gas than any other nation in 2013, surpassing Russia and Saudi Arabia.⁹

Recent technological developments in the oil and gas industry—most notably horizontal drilling and hydraulic fracturing, or “fracturing,” techniques—have enabled this growth by allowing companies to extract previously inaccessible oil and gas resources.¹⁰ EIA estimates that overall, due to recently developed techniques, at least 750 trillion cubic feet of shale gas and 23.9 billion barrels of shale oil are now technically recoverable in the United States.¹¹ Thus far, EPA estimates that 11,400 new wells are fractured each year, while 1,400 existing wells are re-fractured to stimulate production.¹² In all, EIA estimates that the total number of potential wells from U.S. shale gas plays alone could number around 410,722, while the total number of potential wells from “tight” (or shale) oil plays could be around 219,729.¹³

Hydraulic fracturing techniques have already led to a noticeable increase in natural gas production, which in 2011 reached record levels.¹⁴ Although there were just over 300,000 wells producing primarily natural gas in 1999, there are now over 500,000 in operation in at least thirty states.¹⁵ Shale gas plays in particular, EIA has predicted, are likely to be the largest contributor to the projected growth in domestic natural gas production, and by 2040 are expected to account for 50 percent of U.S. natural gas production.¹⁶

Similarly notable increases have also occurred in crude oil production, largely due to the use of horizontal drilling and fracturing.¹⁷ Since September 2011, U.S. oil production has increased by more than 900,000 barrels per day.¹⁸ As the EIA recently noted, U.S. crude oil production averaged almost 6.5 million barrels per day in September 2012, the highest volume

⁹ See U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., Today in Energy - U.S. Expected to Be Largest Producer of Petroleum and Natural Gas Hydrocarbons in 2013 (Oct. 4, 2013), <http://www.eia.gov/todayinenergy/detail.cfm?id=13251#>.

¹⁰ U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays, 4 (Jul. 2011) [hereinafter *EIA I*].

¹¹ *Id.*

¹² *RIA*, *supra* note 8, at 3-16, tbl. 3-3.

¹³ U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., Annual Energy Outlook 2012, 58 tbls. 15-16 (Jun. 2012), available at <http://www.eia.gov/forecasts/aeo/pdf/0383%282012%29.pdf>) [hereinafter *EIA II*].

¹⁴ See U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., U.S. Natural Gas Gross Withdrawals, <http://www.eia.gov/dnav/ng/hist/n9010us2a.htm>.

¹⁵ See U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., Number of Producing Natural Gas Wells, http://www.eia.gov/dnav/ng/ng_prod_wells_s1_a.htm (updated Jan. 7, 2013).

¹⁶ U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., Annual Energy Outlook 2013 with Projections to 2040, 79 & tbl. 91 (Apr. 2013), <http://www.eia.gov/forecasts/aeo/pdf/0383%282013%29.pdf>; see also U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, <http://www.eia.gov/analysis/studies/worldshalegas/>.

¹⁷ See U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., Today in Energy - U.S. Monthly Crude Oil Production Reaches Highest Level Since 1998 (Dec. 4, 2012), <http://www.eia.gov/todayinenergy/detail.cfm?id=9030>.

¹⁸ *Id.*

reached in nearly 15 years.¹⁹ This is in part because fracturing techniques have been increasingly applied to conventional wells to boost productivity.

As the U.S. domestic energy outlook transforms, so do landscapes in many areas of the country. People living in heavily populated areas that have been exposed to little, if any, drilling activity in the past are now seeing drilling rigs pop up near their homes, schools, and workplaces, as the locations of shale basins around the country trigger the placement of new oil and gas wells.²⁰ In the U.S., the largest shale gas plays are projected to be the Marcellus in the Northeast (410.3 trillion cubic feet, 55 percent of the total), the Haynesville in the South (74.7 trillion cubic feet, 10 percent of the total), and the Barnett in the Southwest (43.4 trillion cubic feet, six percent of the total).²¹ Map 1 (attached) shows the significant overlap between the approximate locations of shale basins in the lower 48 states and population centers.²² The largest shale oil plays are expected to be the Bakken in North Dakota (3.6 billion barrels), the Eagle Ford in Texas (3.4 billion barrels), and the Monterey Shale in California, which may hold as much as 64 percent of the total shale oil reserves in the continental United States (over 15 billion barrels).²³ Moreover, as illustrated in Map 2 (attached), oil and gas drilling is already occurring in a number of highly populated areas across the country, including many areas covered by CAA § 112(n)(4)(B).²⁴

Examples from around the country illustrate the impact of these numbers on public health. The following examples in the states of California, Colorado, Pennsylvania, Texas, Ohio and Louisiana show large numbers of oil and gas wells, and other sources associated with well activities such as exploration, drilling, flaring, compression and waste water impoundments, emitting hazardous air pollutants very near densely populated communities. People living in these example counties and other statistical areas covered under section 112(n)(4)(B) should receive the full health protection that EPA has authority to provide. Information about oil and gas wells from these example counties, when viewed in light of this petition's subsequent information on the health effects that can be caused by oil and gas well emissions, demonstrates that oil and gas wells pose health risks in such areas (covered by § 112(n)(4)(B)) that are "more than negligible" and that warrant regulation under § 112(d). EPA therefore must regulate such wells as an "area source" category, as authorized by § 112(n)(4)(B) and required by § 112(c)(3). EPA must protect communities in the following areas and all other parts of the country covered

¹⁹ *Id.*

²⁰ See, e.g., Ronald D. White, *Greasing the Wheels of An Urban Oil-Drilling Boom*, L.A. TIMES, Sept. 14, 2012, <http://articles.latimes.com/2012/sep/14/business/la-fi-california-oil-drilling-20120914>; Asher Price, *As Urban Gas Drilling Expands, So Do Health Concerns*, AUSTIN AMERICAN-STATESMAN (June 12, 2010), <http://www.statesman.com/news/news/state-regional-govt-politics/as-urban-gas-drilling-expands-so-do-health-concern/nRtZX/>.

²¹ *EIA I, supra* note 10, at 4.

²² See U.S. Shale Plays and Population Centers (attached as Map 1 in Appendix B); see also U.S. DEP'T OF ENERGY, U.S. ENERGY INFO. ADMIN., *Lower 48 States Shale Plays*, http://www.eia.gov/oil_gas/rpd/shale_gas.pdf.

²³ *EIA I, supra* note 10, at 4.

²⁴ See U.S. Oil and Gas Wells and Population Centers (attached as Map 2 in Appendix B). Section II.A.2 of this Petition describes the statistical areas covered by this provision in more detail.

by CAA § 112(n)(4)(B). As noted in part I.C.2 below, individual states (including some of those identified here) have begun to recognize some of the harmful effects that well emissions pose to surrounding communities by requiring measures to reduce some emissions, but nearly all states have yet to regulate toxic air pollution as needed to protect public health and current national scale oil and gas well standards are not adequate.

1. California

The State of California’s Department of Conservation, Division of Oil, Gas & Geothermal Resources (DOGGR) oversees the drilling, operation, maintenance, plugging and abandonment of oil, natural gas, and geothermal wells in California, which in 2011 produced approximately 200 million barrels of oil and 255 billion cubic feet of gas.²⁵ As of 2011, there were over 54,076 producing oil and gas wells in the state—located in over half of California’s counties—and another 3,081 wells were drilled in 2012.²⁶

As shown in Map 3 (attached), several of the most densely populated areas in California—including Los Angeles County, the most populated county in the U.S.—already have large numbers of oil and gas production wells within their borders.²⁷ Although historically most oil and gas production in California has been from “conventional” sources, oil and gas reservoirs

²⁵ A non-exclusive list of example counties in California that meet the section 112(n)(4)(B) criteria under OMB’s current delineations for MSAs and CSAs includes: Alameda County (6 active wells), Contra Costa County (27 active wells), Fresno County (1,963 active wells), Kern County (42,159 active wells), Los Angeles County (3,751 active wells), Madera County (12 active wells), Monterey County (609 active wells), Orange County (1,036 active wells), Sacramento County (128 active wells), San Benito County (22 active wells), San Bernadino County (18 active wells), San Mateo County (11 active wells), Santa Clara County (13 active wells), Sutter County (299 active wells), Ventura County (1,708 active wells), and Yuba County (1 active well). *See* CAL. DEP’T OF CONSERVATION, DIV. OIL, GAS & GEOTHERMAL RES., *Producing Wells and Production of Oil, Gas, and Water by County – 2011*, ftp://ftp.consrv.ca.gov/pub/oil/temp/NEWS/Producing_Wells_OilGasWater_11.pdf; OFFICE OF MGMT. & BUDGET, EXECUTIVE OFFICE OF THE PRESIDENT, OMB BULLETIN NO. 13 01, REVISED DELINEATIONS OF METROPOLITAN STATISTICAL AREAS, MICROPOLITAN STATISTICAL AREAS, AND COMBINED STATISTICAL AREAS, AND GUIDANCE ON USES OF THE DELINEATIONS OF THESE AREAS (Feb. 28, 2013) [“OMB BULLETIN 13-01”], *available at* <http://www.whitehouse.gov/sites/default/files/omb/bulletins/2013/b13-01.pdf>. Most of these counties would also meet the 112(n)(4)(B) criteria under the delineations in place when the provision was enacted. *See* U.S. CENSUS BUREAU, METROPOLITAN AREAS AND COMPONENTS, 1990 WITH FIPS CODES (June 30, 1990), *available at* <http://www.census.gov/population/metro/files/lists/historical/90mfips.txt> (only Madera and San Benito are not shown as part of an MSA or CMSA).

²⁶ *Producing Wells and Production of Oil, Gas, and Water by County – 2011*, *supra* note 25; CAL. DEP’T OF CONSERVATION, DIV. OIL, GAS & GEOTHERMAL RES., *2012 Preliminary Report of California Oil and Gas Production Statistics 2* (April 2013), ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2012/PR03_PreAnnual_2012.pdf.

²⁷ *See* California: Oil and Gas Wells, Shale Plays and Population Centers (attached as Map 3 in Appendix B); *Producing Wells and Production of Oil, Gas, and Water by County – 2011*, *supra* note 25 (in 2011, Kern County had 42,159 producing wells, Los Angeles County had 3,751 producing wells, and Orange County had 1,036 producing wells).

that require unconventional recovery techniques, such as fracturing, are expected to greatly expand in the state in the near future. According to EIA estimates, the massive Monterey and Santos shale formations, which underlie 1,752 square miles in the San Joaquin and Los Angeles basins in California, are estimated to hold as much as 64% of the nation's shale oil reserves—between 13.7 and 15.4 billion barrels.²⁸ As one industry consultant recently explained, they are “just getting started” with drilling in the Monterey Shale, predicting that, “there will be as much drilling as they possibly can do.”²⁹

Although much information has not been disclosed publicly about the extent of hydraulic fracturing that is taking place in California,³⁰ residents of the state have already expressed a great deal of public concern over its potential health and environmental impacts.³¹ One example is Inglewood Oil Field, located in the Baldwin Hills neighborhood in southwestern Los Angeles County. This more than 1,000-acre oil field is closely surrounded by a community of over 300,000 people.³²

Overall, as the Western States Petroleum Association reports, the number of wells that had been fractured in California as of 2011 was 628,³³ and as of August 2, 2013, a website titled “FracFocus” listed 1,045 wells that have been fractured in California since January 1, 2011.³⁴ These numbers are voluntarily reported by some oil and gas operators. Given the voluntary nature of this reporting, these figures likely underestimate the full extent of hydraulic fracturing in California. Moreover, no number can fully represent the human impacts of additional drilling in such a densely populated state, where many wells are already located in urban areas.³⁵ Some

²⁸ *EIA I, supra* note 10, at 4.

²⁹ Anne C. Mulkern, *Massive Shale Play Predicted to Trigger New ‘Gold Rush’*, E&E PUBLISHING, LLC, ENERGYWIRE, Dec. 5, 2012, http://www.eenews.net/public/energywire/2012/12/05/1?page_type=print (quoting Stephen Harris, a consultant to Occidental Petroleum Corp. and past president of Los Angeles Association of Professional Landmen).

³⁰ On October 16, 2012, four environmental groups [including Petitioner Sierra Club, represented by Earthjustice] filed a state court action alleging that DOGGR has failed to comply with the California Environmental Quality Act (CEQA) in the permitting process for oil and gas operations, including hydraulic fracturing, or “fracking,” in the state. *See Ctr. for Biological Diversity v. Cal. Dep’t of Conservation*, No. RG12652054 (Ca. Super. Ct. Alameda County, filed Oct. 16, 2012).

³¹ *See, e.g.*, CAL. DEP’T OF CONSERVATION, DIV. OIL, GAS & GEOTHERMAL RES., *Hydraulic Fracturing in California*, http://www.conservation.ca.gov/dog/general_information/Pages/HydraulicFracturing.aspx.

³² *See* Baldwin Hills Oil Watch, *Fracking in Culver City*, <http://baldwinhillsoilwatch.org/> (last reviewed July 30, 2013).

³³ John Cox, *Oil Companies Agree to Post Fracking Data*, BAKERSFIELD CALIFORNIAN, May 15, 2012, available at <http://www.bakersfieldcalifornian.com/business/x243433713/Oil-companies-agree-to-post-fracking-data>.

³⁴ FRACFOCUS, Chemical Disclosure Registry, *Find a Well*, <http://www.fracfocusdata.org/fracfocusfind/>.

³⁵ *See, e.g.*, CYRUS RANAGAN & CARRIE TAYMOUR, RESULTS OF 2011 INGLEWOOD OIL FIELD COMMUNITIES’ SURVEY at i-ii (2012), available at <http://ridley-thomas.lacounty.gov/Environment/wp-content/uploads/2012/06/HealthSurvey.pdf>.

conventional wells even operate adjacent to or on school properties, as is the case for the Carson-Gore Academy of Environmental Sciences, where there is an oil well across the street.³⁶

2. Colorado

The Colorado Oil and Gas Conservation Commission (“COGCC”), a division of the Colorado Department of Natural Resources, oversees the development of Colorado’s oil and gas natural resources.³⁷ A state at the forefront of drilling’s new frontier, Colorado has over 51,000 active oil and gas wells located in 43 of its 63 counties.³⁸ The number of horizontal wells in particular has risen dramatically in recent years in Colorado—although horizontal well permits made up only 2.8% of the total oil and gas drilling permits issued in 2009, this number has since risen to 29.3% in 2012, and 61.8% in 2013.³⁹ Colorado has been adding about 2,000 new wells per year for the past nine years, with 2012 production expected to exceed 47 million barrels, and the Colorado Oil and Gas Conservation Commission anticipates that this growth will continue.⁴⁰ Map 4 (attached) shows the significant concentration of oil and gas production in the most populous parts of the state.⁴¹

The number of wells in Colorado is predicted to grow for many years, as new techniques allow companies to drill in the Niobrara shale oil bed located in the northeastern portion of the state. This shale bed, like many across the U.S., lies beneath the homes, schools, and businesses

³⁶ See, e.g., Howard Blume, *Los Angeles School Named after Al Gore*, L.A. TIMES, Sept. 5, 2010, <http://articles.latimes.com/2010/sep/05/local/la-me-gore-school-20100906>.

³⁷ A non-exclusive list of example counties in Colorado that meet the section 112(n)(4)(B) criteria under OMB’s current delineations for MSAs and CSAs includes: Adams County (993 active wells), Arapahoe County (198 wells), Boulder County (321 wells), Broomfield County (97 wells), Denver County (52 wells), Elbert County (72 wells), Jefferson County (6 wells), Park County (1 well), and Weld County (20,794 active wells). See COLORADO OIL AND GAS CONSERVATION COMM’N, *Colorado Weekly and Monthly Oil and Gas Statistics* (Nov. 7, 2013) at 13, <http://cogcc.state.co.us/Library/Statistics/CoWklyMnthlyOGStats.pdf> (last visited Nov. 20, 2013); OMB BULLETIN 13-01 *supra* note 25. Most of these counties would also meet the 112(n)(4)(B) criteria under the delineations in place when the provision was enacted. See U.S. CENSUS BUREAU, *supra* note 25 (only Broomfield, Elbert, and Park are not shown as part of an MSA or CMSA).

³⁸ *Colorado Weekly and Monthly Oil and Gas Statistics, id.*, at 12, 13.

³⁹ COLO. OIL AND GAS CONSERVATION COMM’N, *Staff Report* (Jan. 27, 2014) at 19, available at <http://cogcc.state.co.us> (click “Staff RPT” and select “January 27, 2014”).

⁴⁰ Testimony of Matthew Lepore, Dir., Colorado Oil and Gas Conservation Commission, Colorado Department of Natural Resources, House Committee on Energy & Commerce Subcomm. On Env’t and Economy at 1 (Feb. 15, 2013), <http://democrats.energycommerce.house.gov/sites/default/files/documents/Testimony-Lepore-EE-Protecting-Environment-Under-Law-2013-2-15.pdf>.

⁴¹ See Colorado: Oil and Gas Wells, Shale Plays and Population Centers (attached as Map 4 in Appendix B).

of thousands of people. As one author aptly described the situation in Colorado, wells from the still-emerging oil and gas boom are “completely surrounding the metro area.”⁴²

Yet, even while the oil and gas boom is still emerging, oil and gas production activities have already caused noticeable air quality problems in Colorado. A consortium of authors that included both NOAA and University of Colorado researchers recently conducted an in-depth study to investigate the source of air pollutants at a tower north of Denver, downwind of the Denver-Julesburg Fossil Fuel Basin. The study’s analysis of the tower data, filtered by wind sector, revealed “a strong alkane and benzene signature in air masses coming from northeastern Colorado.”⁴³ Specifically, the authors determined that emissions from oil and gas facilities in the study area were likely responsible for increased levels of hydrocarbons, and benzene in particular, measured at both the stationary and mobile testing sites.⁴⁴

The study also concluded that the available inventories of hydrocarbon emissions from oil and gas facilities in the study area did not correlate with observed atmospheric observations, and were likely underestimates. Specifically, the study found “notable inconsistencies” between monitoring results and state and national emissions inventories, suggesting “that the emissions of the species measured are most likely underestimated in current inventories and that the uncertainties attached to these estimates can be as high as a factor of two.”⁴⁵ A lead author of the study explained: “We found gas operations in the region leaked about twice as much methane into the atmosphere as previously estimated,” adding, “[a]nd the oil and gas infrastructure was leaking other air pollutants, too, including benzene, which is regulated because of its toxicity.”⁴⁶

Subsequent research has confirmed these findings. A more detailed source apportionment study conducted by another team from NOAA and the University of Colorado confirmed the contribution of oil and gas operations to hydrocarbon and benzene emissions, and concluded that oil and gas sector sources emit approximately 55% of the volatile organic

⁴² Kirk Johnson, *Drilling in Fast-Growing Areas Ushers in New Era of Tension*, N.Y. TIMES, October 25, 2011, at A16, available at http://www.nytimes.com/2011/10/25/us/oil-drilling-in-new-areas-ushers-in-era-of-tension.html?_r=0 (“Drilling permits in suburbs, parks and even in lakes have made the local news. Using hydrofracturing technologies—breaking the shale with water, sand and chemicals to release the oil—and horizontal, spiderlike tentacle borers that can spin out beneath communities, the still-emerging boom is bringing energy exploration to some of the fastest-growing counties in the nation, and to places with no experience whatsoever in dealing with it. ‘It’s completely surrounding the metro area,’ said Thom Kerr, the permit and technical services manager at the Colorado Oil and Gas Conservation Commission, which regulates the industry.”).

⁴³ Pétron, G. et al., *Hydrocarbon Emissions Characterization in the Colorado Front Range – A Pilot Study*, 117 J. GEOPHYSICAL RESEARCH D04304 (2012), at 17.

⁴⁴ *Id.* at 8, 13.

⁴⁵ *Id.* at 1, 18.

⁴⁶ COOPERATIVE INSTITUTE FOR RESEARCH IN ENVIRONMENTAL SCIENCES, *Colorado oil and gas wells emit more pollutants than expected* (Mar. 1, 2012), available at http://cires.colorado.edu/news/press/2012/Colorado_oil.html (statement by Gabrielle Pétron, Ph.D., an atmospheric scientist with NOAA’s Earth System Research Laboratory and the Cooperative Institute for Research in Environmental Sciences).

compounds in northeastern Colorado.⁴⁷ The study similarly found that current emission inventories overestimate the contribution of “urban” (essentially, non-oil and gas) hydrocarbon emissions by more than a factor of two.⁴⁸

And a 2014 study provides further evidence that existing emission inventories are significantly underestimating air toxics emissions, particularly benzene.⁴⁹ These findings suggest that the health risk assessments conducted using these inventories are similarly inaccurate and therefore underestimate exposures and health risks. This study used air quality measurements taken from an airplane over Weld County, Colorado to derive estimates of emission rates for benzene and other VOCs. The researchers found that current inventories estimating benzene emissions from oil and gas facilities in the study area underestimated emissions by 7 times and that the difference could be anywhere from 4 to as great as 9 times. The researchers conclude that other HAPs (such as toluene, ethylbenzene, etc.) could similarly be underestimated and that oil and gas sites could be a bigger source of benzene than vehicle emissions, previously thought to be the largest source in the area. The researchers highlight that accurate estimates of emissions from oil and gas production and processing are needed to quantify and reduce threats to air quality and that the sources of benzene and other hazardous air pollutants should be investigated.

The conclusions of these studies are particularly disturbing because the primary source of the air pollutants—the oil and gas facilities that the initial air monitoring tower was downwind of—are located in Weld County, one of Colorado’s most-populated counties. In addition to being Colorado’s main oil and gas producing county, with 20,324 active wells, Weld County is home to over a quarter million people, and is part of the Denver-Aurora Combined Statistical Area, which has a combined population of over three million people.⁵⁰

Yet another recent Colorado study, conducted in Garfield County, sheds light on the public health risks that Colorado residents and countless others across the country will face from the oil and gas drilling boom. Specifically, this study suggests the existence of increased respiratory, neurological, and cancer risks for people in proximity to wells, with benzene as the major contributor to cancer risk.⁵¹ The results of the Garfield County study underscore public health concerns in Weld County, where there is both more oil and gas development activity and more people. There are approximately twice as many active wells in Weld, compared to the

⁴⁷ Gilman, J.B. et al., *Source Signature of Volatile Organic Compounds from Oil and Natural Gas Operations in Northeastern Colorado*, 47 ENVTL. SCI & TECH. 1297, 1303 (2013).

⁴⁸ *Id.* at 1302.

⁴⁹ 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*, accepted for publication, online May 7, 2014, J. GEOPHYSICAL RESEARCH: ATMOSPHERES, available at <http://onlinelibrary.wiley.com/doi/10.1002/2013JD021272/abstract>.

⁵⁰ OMB BULLETIN 13-01 *supra* note 25.

⁵¹ McKenzie, Lisa M., et al., *Human Health Risk Assessment of Air Emissions from Development of Unconventional Natural Gas Resources*, 424 SCI. TOTAL ENV’T 79, 83-86 (2012).

10,337 operating in Garfield,⁵² and Weld County also has over 200,000 additional people living within its borders.

Moreover, the issues noted by the aforementioned Colorado studies are concerning in light of the fact that much of the oil and gas production in the state is taking place in very close proximity to people—often within a range of less than one-half mile—as Colorado law only mandates a 500-foot setback from schools and residential areas for oil and gas wells.⁵³ Further, the Commission is authorized to approve exceptions allowing oil and gas development activities closer to occupied building units.⁵⁴ Indeed, a recent review of active and prospective well data in four northern Colorado counties, researched by Western Resource Advocates, found nearly 200 wells within 2,000 feet of a public school.⁵⁵ According to Western Resource Advocates' research, in Adams, Boulder, Broomfield and Weld counties, each of which is part of one of the areas covered by section 112(n)(4)(B), as further discussed in Part II.A.2 below, there are 87 active and proposed oil and gas wells within 1,000 feet of a public school.⁵⁶ Likewise, a COGCC Staff Report revealed that at least 10 buildings are less than 150 feet from a well spot, 230 are 150 to 300 feet from a well spot, 383 are 350 to 500 feet from a well spot, and 1,211 are within 500 to 1000 feet of a well spot.⁵⁷ COGCC's recent Well to Setback Review also showed that at least two residences are less than two hundred feet from wells in Weld County.⁵⁸

One notable illustration of this proximity is Red Hawk Elementary school, which is located in Erie, CO and is part of the Boulder, Colorado MSA. Host to over 400 students, Red Hawk is located within a 2-mile radius of 66 well pads, including 8 which were recently drilled within 600 yards of the school.⁵⁹

⁵² *Colorado Weekly and Monthly Oil and Gas Statistics*, *supra* note 37.

⁵³ See 2 Colo. Code Regs. § 404-1(604)(a)(1).

⁵⁴ *Id.*

⁵⁵ See WESTERN RESOURCE ADVOCATES, *Fracking*,

<http://www.westernresourceadvocates.org/land/fracking.php> (last accessed Nov. 21, 2013).

⁵⁶ *Id.*

⁵⁷ Staff Report, *supra* note 39, at 20.

⁵⁸ *Id.* at 21.

⁵⁹ See generally, *Federal Regulation: Economic, Job and Energy Security Implications of Federal Hydraulic Fracturing Regulation: Oversight Field Hearing before the H. Subcomm. On Energy and Mineral Resources*, 112th Cong. at 1 (2012) (statement of Jennifer Palazzolo, parent of a Red Hawk Elementary school student),

http://democrats.naturalresources.house.gov/sites/democrats.naturalresources.house.gov/files/2012-05-02_PalazzoloTestimony.pdf. Lighthousesolar, *Fracking at the Erie Elementary School Photo Shoot*, <http://www.lighthousesolar.com/blog/fracking-at-the-erie-elementary-school-photo-shoot/>.



Photo courtesy of Lighthousesolar, *Fracking at the Erie Elementary School Photo Shoot*, available at <http://www.lighthousesolar.com/blog/fracking-at-the-erie-elementary-school-photo-shoot/>.

3. Pennsylvania

The Pennsylvania Department of Environmental Protection, Office of Oil and Gas Management, is responsible for facilitating the exploration and development of Pennsylvania's oil and gas reservoirs. As of 2011, there were over 77,310 producing oil and gas wells in Pennsylvania,⁶⁰ located in a number of areas across the state,⁶¹ as illustrated in the attached Map 5.⁶²

⁶⁰ See Natural Res. Defense Council, *Producing Oil and Gas Wells in the United States, Including Offshore* (Sept. 13, 2011), <http://www.nrdc.org/health/drilling/>.

⁶¹ A non-exclusive list of example counties in Pennsylvania that meet the section 112(n)(4)(B) criteria under OMB's current delineations for MSAs and CSAs includes: Allegheny County (1,169 active wells); Armstrong County (8,783 active wells); Beaver County (282 active wells); Bucks County (1 active well); Butler County (1,541 active wells), Chester County (5 active wells); Fayette County (3,690 active wells); Pike County (2 active wells); Washington County (3,112 active wells); Westmoreland County (6,514 active wells). PA DEP'T OF ENV. PROT., *Operator Well Inventory Report by County*, http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/Operator_Well_Inventory_By_County (On Jan. 9, 2013 a report was generated for each of the counties listed. Wells listed as "regulatory inactive status" are not included in these totals.); see OMB BULLETIN 13-01 *supra* note 25. Most of these counties would also meet the 112(n)(4)(B) criteria under the delineations in place when the provision was enacted. See U.S. CENSUS BUREAU, *supra* note 25 (only Armstrong, Butler, and Pike are not shown as part of an MSA or CMSA).

⁶² See Pennsylvania: Oil and Gas Wells, Shale Plays and Population Centers (attached as Map 5 in Appendix B); see also PA. DEP'T OF ENVTL. PROT., BUREAU OF OIL AND GAS MGMT., *Oil and Gas Permits Issued*, available at www.dep.state.pa.us/dep/deputate/minres/oilgas/photogallery/photo13295/PAOilFieldsmap1.gif (last accessed Jan. 24, 2013).

Pennsylvania has a long history of oil and gas development, but because of new fracturing techniques, such development is now occurring in the state more rapidly and with more extensive impacts than in the past. In 2012 alone, the state issued 4,090 permits for oil and gas wells, and 2,484 (60%) of those permits were for unconventional (or fractured) wells.⁶³ State data show that 2,390 of those permits were active in 2012, including 1,365 (57%) which were for unconventional wells.⁶⁴ With an estimated 60 percent of the state containing the Marcellus Shale formation, the number of wells is growing swiftly. As one report states, “the pace of expansion has been stunning, with 75 percent of all unconventional wells having been drilled just since 2010.”⁶⁵

Recent studies illustrate the risks that shale gas drilling poses to public health in Pennsylvania. One health survey and environmental testing project, conducted by Earthworks Oil and Gas Accountability Project, documented reports of adverse health symptoms experienced by residents living in proximity to oil and gas development and found correlations between these symptoms and air and water contaminants.⁶⁶

Yet, despite these concerns, little has been done to document, investigate, or mitigate the health effects related to oil and gas emissions in Pennsylvania, whether from fractured or traditional wells. In fact, as recently as October 8, 2012, Pennsylvania Governor Tom Corbett signed into law Pennsylvania Senate Bill 367, the “Indigenous Mineral Resources Development Act,” which allows oil and gas development (including hydraulic fracturing) operations on college campuses across the state.⁶⁷

4. Texas

The Texas Railroad Commission, through its Oil and Gas Division, regulates the exploration, production, and transportation of oil and natural gas in Texas. Texas has more producing oil and gas wells than any other state in the U.S., with over 263,096 producing oil and gas wells as of 2009.⁶⁸ Consequently, most of the counties in Texas that meet the CAA §

⁶³ PA. DEP’T OF ENVTL. PROT., WELL PERMITS ISSUED, JAN. – DEC. 2012, at 1(updated Jan. 9, 2013), <http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/OilGasReports/2012/2012Wellspermitted-drilled.pdf>

⁶⁴ *Id.* at 3.

⁶⁵ Nadia Steinzor et al., Earthworks, *Gas Patch Roulette: How Shale Gas Development Risks Public Health in Pennsylvania*, 7 (Oct. 2012).

⁶⁶ *Id.* at 31.

⁶⁷ The Act allows the Department of General Services “to make and execute contracts or leases for the mining or removal of coal, oil, natural gas, coal bed methane and limestone found in or beneath land owned by the state or state system of higher education.” See Indigenous Mineral Resources Development Act, P.L. 1194, No. 147, enacted Oct. 8, 2012, at § 3(a)(1).

⁶⁸ See U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., Distribution of Wells by Production Rate Bracket, http://www.eia.gov/pub/oil_gas/petrosystem/tx_table.html.

112(n)(4)(B) statistical area criteria also have oil and gas wells.⁶⁹ As shown in the attached Map 6, active wells are located all across the state.⁷⁰

In addition to its long history of conventional oil and gas production, Texas has been at the forefront of the recent boom in shale oil and gas drilling, which has brought an expansion of drilling activity in highly populated areas of Texas that have already experienced significant benzene exposures. One example is the Barnett Shale, where nearly 14,000 gas wells have been installed since the late 1990s.⁷¹ As recently as 2010, “[n]early one-fourth of the sites monitored in North Texas’ Barnett Shale natural-gas region had levels of cancer-causing benzene in the air that could raise health concerns...”⁷² The Texas Commission on Environmental Quality (TCEQ) has also measured benzene at levels above 180 parts per billion – TCEQ’S short term, health-based comparison level – at some sites, which it noted as examples of similar problems at other sites that need to be monitored and addressed.⁷³ Data from 2010 Barnett Shale air quality

⁶⁹ A non-exclusive list of example counties in Texas that meet the section 112(n)(4)(B) criteria under OMB’s current delineations for MSAs and CSAs includes: Austin County (197 wells), Bastrop County (360 wells), Bexar County (2,641 wells), Brazoria County (440 wells), Caldwell County (3,179 wells), Chambers County (241 wells), Dallas County (32 wells), Denton County (2,989 wells), Ellis County (74 wells), Fort Bend County (481 wells), Galveston County (146 wells), Grayson County (747 wells), Guadalupe County (1,798 wells), Harris County (481 wells), Hood County (810 wells), Johnson County (3,386 wells), Kaufman County (26 wells), Liberty County (812 wells), Montgomery County (251 wells), Parker County (1,865 wells), Somervell County (95 wells), Tarrant County (3,844 wells), Travis County (19 wells), Waller County (242 wells), Webb County (5,412 wells), Williamson County (60 wells), Wise County (4,991 wells). Well counts include regular producing oil wells and regular producing gas wells. See TEXAS R.R. COMM’N, *Oil Well Counts by County as of September 2013*, (Sept. 4, 2013), http://www.rrc.state.tx.us/data/wells/wellcount/OilWellCt_092013.pdf; TEXAS R.R. COMM’N, *Gas Well Counts by County as of September 2013*, (Sept. 4, 2013), http://www.rrc.state.tx.us/data/wells/wellcount/gaswellct_092013.pdf; OMB BULLETIN 13-01 *supra* note 25. Most of these counties would also meet the 112(n)(4)(B) criteria under the delineations in place when the provision was enacted. See U.S. CENSUS BUREAU, *supra* note 25 (only Austin, Bastrop, Caldwell, Chambers, Hood, Somervell, and Wise are not shown as part of an MSA or CMSA).

⁷⁰ See Texas: Oil and Gas Wells, Shale Plays and Population Centers (attached as Map 6 in Appendix B); see also TEXAS COMM’N ENVTL. QUALITY, *Active Oil and Gas Wells* (2012), http://www.tceq.state.tx.us/assets/public/implementation/barnett_shale/bs_images/txOilGasWells.png.

⁷¹ Charles W. Schmidt, *Blind Rush? Shale Gas Boom Proceeds Amid Human Health Questions*, 119(8) ENV. HEALTH PERSPECTIVES, A348, A350 (2011); see also TEXAS R.R. COMM’N, *Barnett Shale Field Data*, <http://www.rrc.state.tx.us/data/fielddata/barnettshale.pdf> (as of January 23, 2013 there were 16,530 total gas wells on the Barnett Shale field, in addition to 2,457 permitted locations).

⁷² Randy L. Loftis, *High Benzene Levels Found on Barnett Shale*, THE DALLAS MORNING NEWS, Jan. 28, 2010, available at <http://www.dallasnews.com/news/state/headlines/20100128-High-benzene-levels-found-on-Barnett-3021.ece>.

⁷³ TEXAS R.R. COMM’N, *Notice to Oil, Gas & Pipeline Operators Regarding Air Emissions* (March 2010), available at <http://www.rrc.state.tx.us/forms/reports/notices/airemission21010.pdf>. See also Shannon Etheridge, TCEQ, *Emissions from Oil and Gas Operations and Potential Human Health Risk*, 2011 National Air Toxics Monitoring and Data Analysis Workshop Presentation 12-13, 21, 39-40 (Apr. 7, 2011), available at <http://www.epa.gov/ttnamti1/files/ambient/airtox/2011workshop/day4ShannonEtheridgeOilGas.pdf> (discussing monitored benzene concentrations near oil and gas operations in Texas of 370 to 1100 parts

monitoring also found levels of benzene that could contribute to long-term health impacts.⁷⁴ EPA should review and evaluate the air monitoring data that TCEQ is collecting, as well as the point source emission reports from oil and gas wells and associated equipment.⁷⁵

Additionally, concerns about air quality in the town of DISH, Texas, located atop the Barnett Shale, led to a citizen-funded study, which stated:

“Laboratory results confirmed the presence of multiple Recognized and Suspected Human Carcinogens in fugitive air emissions present on several locations tested in the Town of DISH. The compounds identified are commonly known to emanate from industrial processes directly related to the natural gas industrial processes of exploration, drilling, flaring and compression. The laboratory results confirmed levels in excess of TCEQ’s Short Term and Long Term [Effects Screening Levels]. In addition, several locations confirmed exceedances in a chemical identified by TCEQ with the capability for ‘disaster potential.’”⁷⁶

In all, the Texas Railroad Commission estimates that the Barnett Shale extends 5,000 square miles, into parts of at least 21 Texas counties.⁷⁷ Notably, all four of the “Core Counties” it considers most affected by the Barnett Shale (Denton, Johnson, Tarrant and Wise) are located in metropolitan statistical areas.⁷⁸ Moreover, Fort Worth, a fast-growing Texas city of nearly

per billion, in addition to long-term concentrations in excess of TCEQ’s long term health-based comparison level).

⁷⁴ Ethridge, S., TCEQ, Toxicology Div., Ch. Eng’r’s Ofc., Interoffice Memo., Health Effects Evaluation of City of Fort Worth Follow-Up Survey Project, Fort Worth, Texas Area April 19-23, 2010 (July 7, 2010),

http://www.tceq.state.tx.us/assets/public/implementation/barnett_shale/samplingFtWorth/2010.07.07-HealthEffectsFollow-upApril%202010.pdf. See also CAL. EPA OEHHA, *Revised Proposed Reference Exposure Levels for Benzene* (Jan. 22, 2014) (Proposing 8-hour and chronic RELs to be 3 µg/m³ (1 ppb) and 3 µg/m³ (1 ppb) respectively; and noting “These were developed using the latest version of the non-cancer REL guidelines, including application of the revised methodology to protect infants, children and other sensitive subpopulations.”), *draft proposal available at* http://www.oehha.org/air/chronic_rels/012214SRPRev_RELS.html.

⁷⁵ TCEQ, Automated Gas Chromatographs (AutoGCs) Barnett Shale Monitoring Network, http://www.tceq.texas.gov/airquality/monops/agc/agc_barnett.html (last reviewed June 19, 2013); see also TCEQ Point Source Emissions Inventory, 2011, State Summary, <http://www.tceq.texas.gov/airquality/point-source-ei/psei.html>, <http://www.tceq.texas.gov/assets/public/implementation/air/ie/pseisums/2011statesum.xlsx>.

⁷⁶ Chemicals identified include benzene, dimethyl disulfide, methyl ethyl, disulphide, ethyl-methylethyl disulfide, trimethyl benzene, diethyl benzene, methylmethylethyl benzene, tetramethyl benzene, naphthalene, 1,2,4-trimethyl benzene, m&p xylenes, carbonyl sulfide, carbon disulfide, methyl pyridine, and diemethyl pyridine. WOLF EAGLE ENVTL., *Town of DISH, Texas Ambient Air Monitoring Analysis Final Report 6* (2009) (emphasis omitted).

⁷⁷ Al Armendariz, *Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements 2* (2009), http://www.edf.org/sites/default/files/9235_Barnett_Shale_Report.pdf.

⁷⁸ TEXAS R.R. COMM’N, Barnett Shale Information, (updated Nov. 20, 2013), <http://www.rrc.state.tx.us/barnettshale/index.php#counties>.

750,000 people, has been called the epicenter of “urban drilling” in the U.S., as it sits directly atop the Barnett Shale.⁷⁹ EPA has air quality data available on emissions of volatile organic compounds (which include many listed HAPs) in the Dallas Fort Worth area that it should evaluate here, including from the Technical Support Document for the ozone National Ambient Air Quality Standards designation for Dallas Fort Worth.⁸⁰

Another fast-developing shale play impacting communities in Texas is the Eagle Ford, which underlies a crescent-shaped swath of land located between Austin, College Station, Houston, Victoria, Laredo, and San Antonio.⁸¹ The Eagle Ford shale region includes parts of several areas that meet the section 112(n)(4)(B) criteria.⁸² Development in the Eagle Ford is already suspected to be impairing air quality in the San Antonio area,⁸³ and both shale oil and shale gas drilling are rapidly expanding throughout the formation. Gas well permits issued rose from 67 in 2009 to 2,418 in 2013.⁸⁴ Oil wells permitted similarly rose from 40 in 2009 to 2,521 in 2013.⁸⁵ As of March 3, 2014, there were a total of 5,433 permitted oil and gas wells in the Eagle Ford play, with an additional 5,628 oil wells and 2,715 gas wells scheduled to be permitted.⁸⁶ Production at Eagle Ford is expected to continue to grow. The 30 million barrels of

⁷⁹ See Charles W. Schmidt, *supra* note 71, at A350.

⁸⁰ EPA, *Texas: Area Designations for the 2008 Ozone National Ambient Air Quality Standards* at 6-7, available at http://www.epa.gov/glo/designations/2008standards/rec/eparesp/R6_TX_tsd.pdf (reporting that VOC emissions from oil and gas production activities in the 19-county Dallas-Fort Worth ozone nonattainment area totaled 18,383 tons in 2009, according to the TCEQ Barnett Shale Area Special Inventory. Applying EPA’s conversion factor of 0.0377 lb HAP/lb VOC for gas in the production segment (see Document ID No. EPA-HQ-OAR-2010-0505-0084), this inventory translates into approximately 683 tons of HAP emissions).

⁸¹ See TEXAS R.R. COMM’N, WELLS PERMITTED & COMPLETED IN THE EAGLE FORD SHALE PLAY (Mar. 3, 2014), available at <http://www.rrc.state.tx.us/eagleford/images/EagleFordShalePlay030714-lg.jpg>.

⁸² For example, Atascosa & Wilson Counties are located in the San Antonio-New Braunfels MSA; Brazos, Burleson, and Robertson Counties are located in the College Station-Bryan MSA, and Webb County is located in the Laredo MSA. See OMB BULLETIN 13-01 *supra* note 25.

⁸³ See Colin McDonald, *Oil Fields Tied to Pollution*, SAN ANTONIO EXPRESS-NEWS, July 12, 2013, available at <http://www.expressnews.com/news/environment/article/Eagle-Ford-drilling-a-threat-to-San-Antonio-s-air-4660874.php>; Dean Danos, *Impact of the Eagle Ford Shale on South Texas Communities*, 15-18, ALAMO AREA COUNCIL OF GOVERNMENTS, Apr. 13, 2012, available at <http://www.aacog.com/DocumentCenter/Home/View/4208>; Vickie Vaughan, *Shale Play a Worry for Bexar Ozone*, SAN ANTONIO EXPRESS-NEWS, May 23, 2012, available at <http://www.mysanantonio.com/business/article/Shale-play-a-worry-for-Bexar-ozone-3581077.php>; Kate Galbraith, *2011 Proving to be a Bad Year for Air Quality in Texas*, N.Y. TIMES, Dec. 11, 2011, available at <http://www.nytimes.com/2011/12/11/us/2011-proving-to-be-a-bad-year-for-air-quality.html>.

⁸⁴ TEXAS R.R. COMM’N, *Eagle Ford Information*, updated Mar. 7, 2014, available at www.rrc.state.tx.us/eagleford/index.php.

⁸⁵ *Id.*

⁸⁶ TEXAS R.R. COMM’N, *supra* note 81.

oil equivalent it produced in 2011 is expected to rise to 1.2 million barrels of oil equivalent per day by 2015, with new permits issued rising to 25,000 per year.⁸⁷

5. Ohio

Ohio's Department of Natural Resources, Division of Oil and Gas Resources Management is responsible for the regulation of the state's oil and gas drilling operations. As of 2012, Ohio had 64,481 active oil and gas wells, as illustrated in the attached Map 7.⁸⁸ Many counties in Ohio meet the section 112(n)(4)(B) criteria, including six of the top ten counties with the most active drilling activity.⁸⁹

Ohio drilling operator Chesapeake Energy has confirmed that its activities potentially release a number of air pollutants from well sites and compressor stations, including formaldehyde.⁹⁰

A pilot study conducted by West Virginia University and the Wheeling-Ohio County Health Department monitored air quality and threats to public health around Marcellus Shale gas drilling sites in Ohio County, West Virginia, which is located on the Ohio border. Beginning in December 2012, air quality monitors were set up throughout the region, including on the property of residents living adjacent to well pads, to survey toxic exposures.⁹¹ This program demonstrates both that heightened public concerns exist over continued oil and gas development

⁸⁷ Keith Schaefer, *Investing in the Eagle Ford Shale Oil Play*, OIL AND GAS INVESTMENTS BULLETIN, May 25, 2012, available at <http://oilandgas-investments.com/2012/investing/investing-in-the-eagle-ford-shale-oil-play/>.

⁸⁸ See Ohio: Oil and Gas Wells, Shale Plays and Population Centers (attached as Map 7 in Appendix B); see also OHIO GEOLOGICAL SURVEY, Oil & Gas Interactive Web Map (2013), <http://www.dnr.state.oh.us/Website/Geosurvey/oilgas/viewer.htm>; OHIO DEPT. OF NAT. RES., DIV. OF OIL AND GAS RES. MGMT., 2011 Ohio Oil and Gas Summary (2011) at 1, <http://www.ohiodnr.com/portals/11/publications/pdf/oilgas11.pdf>

⁸⁹ A non-exclusive list of example Ohio counties that meet the section 112(n)(4)(B) criteria under OMB's current delineations for MSAs and CSAs and the number of new wells drilled there in 2011 includes: Ashtabula County (5 wells), Belmont County (26 wells), Cuyahoga County (14 wells), Geauga County (8 wells), Jefferson County (2 wells), Knox County (32 wells), Lake County (1 well), Licking County (18 wells), Mahoning County (21 wells), Medina County (2 wells), Morrow County (7 wells), Pickaway County (4 wells), Portage County (14 wells), Stark County (40 wells), Summit County (11 wells), Trumbull County (11 wells), and Washington County (2 wells). See OMB BULLETIN 13-01 *supra* note 25; OHIO DEPT. OF NAT. RES., DIV. OF OIL AND GAS RES. MGMT., *id.*, at 5. Most of these counties would also meet the 112(n)(4)(B) criteria under the delineations in place when the provision was enacted. See U.S. CENSUS BUREAU, *supra* note 25 (only Ashtabula and Morrow are not shown as part of an MSA or CMSA).

⁹⁰ See Tyler Reynard, *Effects on Air Quality Studied*, THE INTELLIGENCER/ WHEELING NEWS-REGISTER, Dec. 10 2012, <http://www.theintelligencer.net/page/content.detail/id/578434/Effects-on-Air-Quality-Studied.html?nav=515>.

⁹¹ Jamie Ward, *Researchers Begin to Study Air Quality Near Ohio County Drilling Sites*, 7-WTRF.com, Dec. 7, 2012, <http://www.wtrf.com/story/20290295/researchers-begin-to-study-air-quality-near-ohio-county-drilling-sites>. See also notes 211-12, *infra*, and accompanying text (summarizing the final report from this study).

expansion and the need for EPA to evaluate and act on the available information about toxic exposures and public health impacts.

6. Louisiana

Louisiana has a long history of oil and gas drilling, and has been subject to an influx of new drilling activity recently due to the presence of the Haynesville Shale in the northwest portion of the state. Several parishes in Louisiana that have oil and gas wells meet the section 112(n)(4)(B) criteria.⁹² All of these areas are increasingly affected by shale gas drilling, as shown in Map 8 (attached).⁹³ For example, a recent study modeled the impact of oil and gas development in the Haynesville Shale region and found that hydrocarbon emissions from projected Haynesville Shale development will affect air quality in Shreveport.⁹⁴

C. Emissions from oil and gas wells pose more than a negligible risk of adverse effects to public health.

1. Oil and gas wells, and associated equipment, emit significant toxic air emissions.

EPA estimated in 2011 that hazardous air pollutant emissions from the oil and gas industry were roughly 127,000 tons per year.⁹⁵ The annual emissions of benzene, toluene, ethyl benzene, and xylenes (“BTEX compounds”) from the industry are between 8,600 and 21,800 tons per year, depending on the source of their emission.⁹⁶ Emissions of eight HAPs make up a large percentage of the total HAP emissions by mass from the oil and gas sector: toluene,

⁹² A non-exclusive list of example Louisiana parishes that meet the section 112(n)(4)(B) criteria under OMB’s current delineations for MSAs and CSAs includes: Bossier Parish (136 wells), Caddo Parish (343 wells), De Soto Parish (1,299 wells), and Webster Parish (5 wells). *See* OMB BULLETIN 13-01 *supra* note 25; LA. DEP’T. OF NATURAL RES., *Haynesville Shale Wells Scout Reports* (updated Nov. 14, 2013), *available at*

<http://dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=442&pnid=0&nid=186>.

Many of these counties would also meet the 112(n)(4)(B) criteria under the delineations in place when the provision was enacted. *See* U.S. CENSUS BUREAU, *supra* note 25 (only De Soto and Webster are not shown as part of an MSA or CMSA).

⁹³ *See* Louisiana: Oil and Gas Wells, Shale Plays and Population Centers (attached as Map 8 in Appendix B); *see also* LA. DEP’T OF NATURAL RES., *Haynesville Shale Gas Play Activity Map* (2013), http://dnr.louisiana.gov/assets/OC/haynesville_shale/haynesville.pdf.

⁹⁴ Susan Kemball-Cook et. al., *Ozone Impacts of Natural Gas Development in the Haynesville Shale*, 44 ENVTL. SCI. TECH., 9357, 9361-2 (2010) (finding that projected oil and gas development in the Haynesville Shale would likely increase ozone design values for monitors in the region by up to 5 ppb).

⁹⁵ *See* EPA, *Proposed Air Rule Fact Sheet 2* (using EPA estimate that a reduction of 38,000 tons per year of HAPs that would be achieved by the proposed rule represents “a reduction of nearly 30 percent”), *available at* <http://www.epa.gov/airquality/oilandgas/pdfs/20110728factsheet.pdf>. This shows that EPA estimates a total of about 127,000 tons per year of HAPs from these sources.

⁹⁶ *Id.* at 1; Memorandum from Heather P. Brown, P.E., EC/R Incorporated, to Bruce Moore, EPA, *Re: Composition of Natural Gas for use in the Oil and Natural Gas Sector Rulemaking* 10 Tbl. 6, 12 Tbl. 9 (July 28, 2011), Document ID No. EPA-HQ-OAR-2010-0505-0084 [hereafter *Gas Composition Memo*] (using production and well completion weight ratios of BTEX:VOC against total annual VOC emissions).

hexane, benzene, mixed xylenes, ethylene glycol, methanol, ethyl benzene, and 2,2,4-trimethylpentane.⁹⁷ Some major HAPs of concern from the oil and natural gas sector include: benzene, toluene, carbonyl sulfide, ethyl benzene, mixed xylenes, and n-hexane, and the state-specific section above describes some of the air monitoring data, including the 2014 Petrón study, illustrating the major HAP emissions coming from oil and gas operations.⁹⁸

However, based on EPA figures for HAP emissions per facility and the count of facilities nationwide, EPA's 2011 estimate appears to underestimate oil and gas sector HAP emissions. EPA's data on the HAP emissions per individual facility show that a typical natural gas production facility (*i.e.*, wellpad) will leak HAPs at a rate of 0.671 tons per year.⁹⁹ With around a half million gas wells in the United States,¹⁰⁰ this suggests over 100,000 tons of HAP pollution just from wellpad leaks, even with a conservative assumption that the average wellpad has three wells. If the number of wells per wellpad is in fact lower than two, this figure would exceed 150,000 tons of HAPs just from wellpads. Typically venting emissions of natural gas from wellpads are larger than leaking emissions from wellpads,¹⁰¹ and therefore venting emissions of HAPs from wellpads will be as high or higher than the leaking emissions of HAPs. In addition, the average gathering and boosting facility leaks 3.10 tons of HAPs per year, and the average storage facility leaks 0.33 tons of HAPs per year.¹⁰² Moreover, a recent review of emission events (*i.e.*, emissions from events such as malfunctions and other upsets) reported in the Texas Commission on Environmental Quality's ("TCEQ's") Emissions Event database shows that individual compressors and fractionators can emit as much as 25.76 and 41.28 tons of HAPs per year, respectively.¹⁰³

This Texas review sheds light on another important issue—that the industry releases a significant amount of air pollution from emissions events alone.¹⁰⁴ In fact, between 2009 and 2011, Texas-wide emissions events from components in the natural gas industry for which data

⁹⁷ *RIA*, *supra* note 8, at 4-13 to 4-14.

⁹⁸ *Id.* at 4-14; *supra* Part I.B.

⁹⁹ Memorandum from Bradley Nelson & Heather Brown, EC/R Incorporated, to Greg Nizich & Bruce Moore, EPA, *Re: Equipment Leak Emission Reduction and Cost Analysis for Well Pads, Gathering and Boosting Stations, and Transmission and Storage Facilities Using Emission and Cost Data from the Uniform Standards* 6 Tbl. 2 (April 17, 2012), Document ID No. EPA-HQ-OAR-2010-0505-4496 [hereafter *Equipment Leak Memo*].

¹⁰⁰ *See supra* note 15.

¹⁰¹ Carbon Limits, *Quantifying Cost-effectiveness of Systematic Leak Detection and Repair Programs Using Infrared Cameras*, 11 Fig. 5, CL report CL-13-27 (March 2014), available at http://www.catf.us/resources/publications/files/Carbon_Limits_LDAR.pdf.

¹⁰² *Equipment Leak Memo*, *supra* note 99, at 6 Tbl. 2.

¹⁰³ *See generally* Environmental Integrity Project, *Accident Prone: Malfunctions and "Abnormal" Emission Events at Refineries, Chemical Plants, and Natural Gas Facilities in Texas, 2009-2011* App. A: Natural Gas HAPs (TPY) p. 21 (compressor leaking 25.76 tons of HAPs), 22 (individual fractionator leaking 41.28 tons of HAPs) (2012) [hereinafter *Accident Prone*], available at http://www.environmentalintegrity.org/news_reports/07_18_2012.php. Because many HAPs are VOCs, this report, which provides data on VOC releases, serves as an indicator of HAP emissions from natural gas production facilities.

¹⁰⁴ *Id.* at 1-4.

was available released a total of 779.01 tons of HAPs, with 633.39 tons of HAP emissions reported in 2011 alone.¹⁰⁵

This review of the TCEQ Emissions Event database also illustrates the extent to which HAP emissions are underestimated.¹⁰⁶ As explained above, these data are limited to “emissions events” occurring in Texas, which are releases that occur *in addition to* a facility’s normal operations. These releases tend to be caused by malfunctions, power outages, startup and shutdown activities, and maintenance, and manifest themselves as venting, leaks, and flares.¹⁰⁷ Because the TCEQ data is based on industry reporting, which often underreports the releases or aggregates the releases under the heading of “natural gas” or “VOCs,” the data are inherently incomplete.¹⁰⁸

2. Significant toxic emissions from oil and gas wells are uncontrolled.

Although EPA recently finalized a new set of air pollution regulations that address part of the oil and gas sector (the “2012 Rule”),¹⁰⁹ only some of the new standards cover any wells at all, and there are still a number of hazardous air pollution sources at oil and gas wells that remain largely unregulated or receive an exemption under those standards. For example, as Table 1 (attached) shows, the new source performance standards EPA finalized in 2012 under CAA § 111 regulate only completion emissions from certain new and refractured gas wells.¹¹⁰ Completion emissions from fractured oil and condensate-producing wells, and equipment leaks from all types of new and existing wells remain completely unregulated under both § 111 and § 112 despite a high rate of leaks. Moreover, the area source category that EPA established under CAA § 112 in 2007 for oil and gas production does not cover any wells—it only includes glycol

¹⁰⁵ *Id.* at App. A: Natural Gas HAPs (TPY) at 22.

¹⁰⁶ *See generally Accident Prone*, *supra* note 103.

¹⁰⁷ *Id.* at 1-4.

¹⁰⁸ Among other underestimations, industry reporters often provide emission event numbers on the basis of formulas, which understate leak rates from sources such as storage tanks. *Id.* at 8. In fact, a study followed up on a chemical plant’s reporting with actual monitoring based on differential absorption light detection and ranging (“DIAL”) and found that the actual emissions were greater by an order of magnitude or more. For example, the DIAL measurements found that benzene emissions from storage tanks were 93 times greater than reported, and VOC emissions from other tanks were 132 times greater than reported. *Id.* at 8 Tbl. 5.

¹⁰⁹ EPA, Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews; Final Rule, 77 Fed. Reg. 49,490 (Aug. 10, 2012) (revising 40 C.F.R. Part 60, subpt. OOOO (New Source Performance Standards or “NSPS”); 40 C.F.R. Part 63, subpt. HH (National Emissions Standards for Hazardous Air Pollutants or “NESHAP”)) [hereinafter “2012 Rule”].

¹¹⁰ *See* Table 1 – NSPS V. NESHAP Coverage Comparison: Regulation of Wells and Associated Equipment (attached as Table 1 in Appendix A); *see also* 2012 Rule, 77 Fed. Reg. at 49,492 (summarizing coverage of wells).

dehydrators.¹¹¹ And the major source rules EPA has issued under CAA § 112 do not set any standards for wells or their associated equipment, so there are no HAP-specific controls in place at all for these sources.¹¹² EPA’s own analysis of the 2012 Rule confirms the limited impact the new standards will have on HAP emissions. EPA estimates that the new standards will reduce emissions of HAPs by only 12,000-20,000 tons per year, leaving the vast majority of the industry’s over 100,000 tons of HAP emissions uncontrolled.¹¹³

Table 1 and Table 2 (attached) confirm that significant gaps remain in the regulation of HAP emissions from oil and gas production. This analysis of available data (mainly for the gas sector) shows that at least 64,935 tons of HAP emissions are left uncontrolled, of which about 27,149 tons (42%) come from wells.¹¹⁴

Although some individual states have begun to recognize the harmful effects that well emissions pose to their surrounding communities by requiring measures to reduce some emissions,¹¹⁵ nearly all states have yet to regulate toxic air pollution as needed to protect public health and current national scale oil and gas well standards are not adequate. EPA has a responsibility under the Clean Air Act to protect people from toxic air emissions nationwide, and to do so under section 112(n)(4)(B). It is especially important for these emissions to be regulated on the federal level to ensure equal, national, and effective health protection for all communities affected by oil and gas pollution, without delay. EPA should consider the work being done in some states, like Colorado, particularly around emission control technologies, as the agency addresses this petition and considers the need for strong national protection from toxic oil and gas well air pollution nationwide.

¹¹¹ EPA, National Emission Standards for Hazardous Air Pollutants: National Emission Standards for Hazardous Air Pollutants for Source Categories from Oil and Natural Gas Production Facilities, 72 Fed. Reg. 26, 28 (Jan. 3, 2007) [hereinafter “2007 Oil and Gas Area Source NESHAP”] (defining “the affected source” as “each TEG dehydration unit located at an area source oil and natural gas production facility,” and excluding all “[o]ther types of dehydration units or other emission points (e.g., equipment leaks) at area source oil and natural gas production facilities”).

¹¹² See 2012 Rule, 77 Fed. Reg. at 49,492 (summarizing revisions to NESHAP regulations).

¹¹³ See 2012 Rule, 77 Fed. Reg. at 49,533-34; section I.C.1 *supra*.

¹¹⁴ Table 2 - Oil and Gas Sector Summary: Comparison of Emissions Controlled by EPA’s Final Rule (“Controlled”) vs. Emissions that Could Have Been Controlled by EPA’s Final Rule But Were Not (“Not Controlled”) (attached as Table 2 in Appendix A).

¹¹⁵ See, e.g., *RIA, supra* note 8, at 3-15 (discussing EPA’s assumptions regarding state-level emissions control requirements for gas well completions); see also Colo. Dep’t of Pub. Health and Environment Air Quality Control Commission, Unofficial Draft Regulations Adopted Feb 23, 2014, at <http://www.colorado.gov/cs/Satellite/CDPHE-AQCC/CBON/1251647985820> (requiring leak detection and repair and other controls to limit emissions from oil and gas operations); Ohio EPA, General Permit 12.1(C)(5)(c)(2), 12.2(C)(5)(c)(2), at <http://www.epa.state.oh.us/dapc/genpermit/genpermits.aspx> (click on “Recently Issued Model General Permits”) (requiring leak detection and repair).

3. Oil and gas drilling poses particular concerns regarding HAP emissions because of the toxic constituents it causes to be released into the air.

In the face of the rapid growth of oil and gas production discussed above, the toxic constituents of natural gas released during well completions, production, and flaring pose added public health concerns. In a recent memorandum regarding the composition of natural gas, EPA drew from a number of sources and estimated the components of gas—and specifically the HAPs and VOCs—produced and released by oil and gas operations.¹¹⁶ On this basis, EPA determined representative compositions for natural gas during production, as well as during completions and recompletions.¹¹⁷ Because the relative composition likely varies considerably depending on the geology of each play, and the impacts in some locations may therefore be more severe,¹¹⁸ the broad array of HAP emission sources at or near well sites (described in detail below) must be included in any area source listing of wells and their “associated equipment” to ensure the public is adequately protected from the health threats posed by these significant sources of HAP emissions.

a. Emissions During Production at Oil and Gas Wells

From EPA’s analysis of gas composition during production, a few of the pollutants applicable to this area source listing were, in order of presence and with volume and weight percentages:

- n-Hexane: 0.09 percent volume, 0.39 percent weight;
- Benzene: 0.022 percent volume, 0.083 percent weight;
- Toluene: 0.016 percent volume, 0.074 percent weight;
- Ethylbenzene: 0.00090 percent volume, 0.0047 percent weight;
- Xylenes (m-, p-, and o-): 0.0041 percent volume, 0.021 percent weight.¹¹⁹

b. Well Completions and Recompletions

From EPA’s analysis of gas composition for natural gas well completions and recompletions specifically, a few of the pollutants applicable to this area source listing were, by volume:

- n-Hexane: 0.155 percent volume;
- Benzene: 0.005 percent volume;
- Toluene: 0.003 percent volume;
- Xylenes: 0.001 percent volume.¹²⁰

¹¹⁶ *Gas Composition Memo*, *supra* note 96 at 1.

¹¹⁷ *Id.* at 1-2, 9.

¹¹⁸ *E.g., id.* at 5 Tbl. 3 (showing variations in n-Hexane composition from 88.7 to 2783 ppmv).

¹¹⁹ *Id.* at 8 Tbl. 5.

¹²⁰ *Id.* at 11 Tbl. 8.

EPA also estimated pollutant volumes for oil well completions and recompletions:

- n-Hexane: 0.0052 percent volume
- Benzene: 0.0062 percent volume
- Toluene: 0.0002 percent volume
- Ethylbenzene: 0.0004 percent volume¹²¹

c. Flaring at Oil and Gas Wells

For the purposes of determining the composition of natural gas constituents after flaring, the Ventura County Air Pollution Control District developed HAP emission factors for natural gas fired power plants in 2001 based on EPA data.¹²² By the factors' estimation, toxic pollutants are released in the following proportions during flaring, in pounds per million cubic feet of natural gas.

- Benzene: 0.159
- Formaldehyde: 1.169
- Naphthalene: 0.011
- Acetaldehyde: 0.043
- Acrolein: 0.010
- Toluene: 0.058
- Xylenes: 0.029
- Ethylbenzene: 1.444
- Hexane: 0.029.¹²³

Toxic air emissions via flaring are notable due to their prevalence, their significance, and their data concerns. For example, the Energy Information Administration has estimated that, as of 2010, roughly 0.62 percent of all natural gas in the U.S.—or 166 billion cubic feet—is vented or flared.¹²⁴ Both this amount and the proportion of production that is flared have been increasing over the past decade. In 2002, for example, only 99 billion feet of natural gas were vented or flared, or 0.41 percent of the total gas produced.¹²⁵ EPA recently performed a study on flare efficiency that identified several factors that can degrade flare performance, potentially

¹²¹ *Id.*

¹²² Ventura County Air Pollution Control District, *AB 2588 Combustion Emission Factors 1* (2001) [hereinafter *Flaring Emission Factors*], available at <http://www.vcapcd.org/pubs/Engineering/AirToxics/combem.pdf>.

¹²³ *Id.*

¹²⁴ U.S. DEP'T OF ENERGY, U.S. ENERGY INFO. ADMIN., *Natural Gas Annual 2010* at 1 Tbl. 1 (Dec. 2011) [hereinafter *Natural Gas Annual 2010*].

¹²⁵ GAO, *Natural Gas Flaring and Venting: Opportunities to Improve Data and Reduce Emissions* 17 Tbl. 2 (2004).

leading to the release of much higher amounts of toxic air emissions than EPA has assumed for years.¹²⁶

The impacts of this trend are clearer in light of the Ventura County Air Pollution Control District HAP emission factors for flaring discussed above. Because the emissions factors are based on the composition of processed gas used at power plants and not the raw gas found at production sites and because flaring likely produces fewer toxic emissions than venting, applying these factors to the estimated 2010 venting or flaring of 166 billion cubic feet of gas produces a conservative estimate of HAP emissions:

- Benzene: 26,383 lbs.
- Formaldehyde: 193,970 lbs.
- Naphthalene: 1,825 lbs.
- Acetaldehyde: 7,135 lbs.
- Acrolein: 1,659 lbs.
- Toluene: 9,624 lbs.
- Xylenes: 4,812 lbs.
- Ethylbenzene: 239,600 lbs.
- Hexane: 4,812 lbs.¹²⁷

The emissions described above become significant when considered in the context of the ongoing boom in oil and gas production and the concentration of that development in certain areas, as shown on the attached maps. Having multiple wells concentrated near one another exposes a single community to emissions from many oil and gas sources.

d. Equipment Leaks

An analysis of the data provided with the 2012 Rule suggests that equipment leaks total at least 23,228 tons per year.¹²⁸ However, this appears to be a substantial underestimate. As previously stated, based on EPA data, the equipment at an average well facility leaks HAPs at a rate of 0.671 tons per year.¹²⁹ This is not a measured average value; rather, it is the emissions rate for a “model” wellpad with an assumed count of connectors, valves, open-ended lines, and pressure reducing valves, all emitting at the rate predicted by GRI/EPA emission factors. However, the 0.671 tons per year estimate is striking, in that, if it is accurate, natural gas well facilities alone would emit at least 100,000 tons per year of HAPs just from leaks, even if we conservatively assume that there are an average of three wells per wellpad.¹³⁰ In addition, EPA’s data suggest that the average rate of leakage from valves, pressure relief devices, and other

¹²⁶ See EPA, Parameters for Properly Designed and Operated Flares 1-2 to 1-3 (2012) [hereinafter *EPA Flare Parameters*]. Although this study focused on flares used at refineries and chemical plants, EPA concluded that some of the factors it found to affect flare performance would also apply to other types of flares. See *id.* at 1-3.

¹²⁷ *Flaring Emission Factors*, *supra* note 122, at 1; *Natural Gas Annual 2010*, *supra* note 124, at 1 Tbl. 1.

¹²⁸ See Table 2 - Oil and Gas Sector Summary (Appendix A).

¹²⁹ *Equipment Leak Memo*, *supra* note 99 at 6 tbl. 2.

¹³⁰ See section I.C.1 *supra*.

equipment at gathering and boosting operations is 3.10 tons of HAPs per year, and similar equipment in the storage component leaks an average of 0.33 tons of HAPs per year.¹³¹

e. Other Equipment at or Associated with Oil and Gas Wells

In addition to the sources discussed above, certain other pieces of oil and gas production equipment are also sources of hazardous air pollutant emissions:

- Condensate tanks: The liquid mixture of hydrocarbons and aromatic hydrocarbons that is removed from the gas stream and collected in tanks during production includes BTEX compounds.¹³²
- Glycol dehydrators: Most dehydrators use glycols for water absorption, including the HAP ethylene glycol.¹³³
- Gas sweetening: The amine solution process is the most common gas sweetening technique, and one of the amines used is the HAP diethanolamine.¹³⁴ Sweetening removes hydrogen sulfide, and the recovered hydrogen sulfide gas stream may be vented, flared, incinerated, or sold as elemental sulfur.¹³⁵ Moreover, BTEX compounds are readily absorbed by the amine solution, and sweetening may therefore be a “significant source” of BTEX emissions if the byproducts are released at the end of the process.¹³⁶
- Storage tanks: Vessels are used for storage and other activities throughout natural gas processing, and they therefore hold a variety of different toxic chemicals and mixtures thereof. Emissions from the vessels are accordingly significant. For example, in the 2012 Rule, EPA estimated an average reduction of 2.88 tons per year of HAPs from each regulated vessel.¹³⁷
- Produced water ponds: As described in more detail in the next section, these open “frack pits” are a significant source of toxic emissions because they hold fracturing fluids,

¹³¹ *Equipment Leak Memo*, *supra* note 99 at 6 tbl. 2.

¹³² EARTHWORKS, *Sources of Oil and Gas Air Pollution*, http://www.earthworksaction.org/issues/detail/sources_of_oil_and_gas_air_pollution (last visited Nov. 21, 2013).

¹³³ U.S. DEP’T OF ENERGY, U.S. ENERGY INFO. ADMIN., *Natural Gas Processing: The Crucial Link Between Natural Gas Production and Its Transportation to Market* 4 (2006), available at http://www.eia.gov/pub/oil_gas/natural_gas/feature_articles/2006/ngprocess/ngprocess.pdf.

¹³⁴ *RIA*, *supra* note 8, at 2-3, 2-8; DOW CHEMICAL CO., *Gas Sweetening: Product Specifier 1* (1998), available at http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_0039/0901b803800391f8.pdf?filepath=gastreating/pdfs/noreg/170-01395.pdf&fromPage=GetDoc.

¹³⁵ See *RIA*, *supra* note 8, at 2-8; EPA, *Stationary Point and Area Sources* 5.3-1 (5th ed. 1995), available at <http://www.epa.gov/ttn/chief/ap42/ch05/index.html>.

¹³⁶ Skinner, F.D., et al., *Absorption of BTEX and Other Organics and Distribution Between Natural Gas Sweetening Unit Streams*, 37881 SOC’Y OF PETROLEUM ENG’RS 17, 17 (1997), available at <http://www.onepetro.org/mslib/app/Preview.do?paperNumber=00037881&societyCode=SPE>.

¹³⁷ *RIA*, *supra* note 8, at 3-12 Tbl. 3-2 (estimating number of regulated vessels), 3-20 Tbl. 3-4 (providing total emission reductions from regulated storage vessels). The 2.88 tpy per regulated vessel estimate comes from dividing the total emissions from regulated storage vessels, 876 tpy, by the total number of regulated storage vessels, 304.

including flowback water and produced water, and are typically open to the air allowing toxics such as BTEX compounds, hydrogen sulfide, and methanol escape into the air. EPA itself has even identified produced water ponds as a “potentially significant source of emissions” for which additional data needs to be collected.¹³⁸

- **Compressors:** The TCEQ Emissions Event database shows that individual compressors and fractionators emit as much as 25.76 and 41.28 tons of HAPs per year, respectively.¹³⁹ Analysis of available data in the 2012 Rule record also shows that compressors emit a total of about 9,091 tons of HAPs that are uncontrolled.¹⁴⁰
- **Pneumatic controllers:** Analysis of data in the 2012 Rule record shows that pneumatic devices emit approximately 4,667 tons of HAPs that are uncontrolled.¹⁴¹

4. Hydraulic fracturing raises unique concerns regarding toxic air emissions because this technique uses many additional toxic chemicals as inputs.

Currently nine out of ten natural gas wells use hydraulic fracturing and its associated processes.¹⁴² According to industry responses to a 2011 House Committee investigation, between 2005 and 2009, hydraulic fracturing companies used at least 595 products containing 24 different hazardous air pollutants as components of fracturing fluids.¹⁴³ In fact, the most widely used chemical component in hydraulic fracturing during this time period—methanol, which appears in 342 products—is a listed HAP.¹⁴⁴ In all, toxic chemicals appeared in over a quarter of the total products used in fracturing fluids.¹⁴⁵ A few particular chemicals of note are hydrogen fluoride and lead. As the House Committee Report explains, hydrogen fluoride—which is in two products of which one hydraulic fracturing company used 67,222 gallons from 2008 to 2009—“is a hazardous air pollutant that is a highly corrosive and systemic poison that causes severe and sometimes delayed health effects due to deep tissue penetration. Absorption of substantial

¹³⁸ EPA, Proposed Rule, Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 76 Fed. Reg. 52,738, 52,756 (Aug. 23, 2011) [hereinafter “2011 Proposed Rule”].

¹³⁹ See *Accident Prone*, *supra* note 103, at App. A: Natural Gas HAPs (TPY) at 21-22 (providing data from individual sources).

¹⁴⁰ See Table 2 - Oil and Gas Sector Summary (Appendix A).

¹⁴¹ See *id.*

¹⁴² OMB WATCH, *The Right to Know, The Responsibility to Protect: State Actions Are Inadequate to Ensure Effective Disclosure of the Chemicals Used in Natural Gas Fracking 2* (2012) (citing PROPUBLICA, *What Is Hydraulic Fracturing?*, <http://www.propublica.org/special/hydraulic-fracturing-national>).

¹⁴³ Minority Staff, Committee on Energy and Commerce, U.S. House of Representatives, *Chemicals Used in Hydraulic Fracturing* 11 (April 2011) [hereafter *House Committee Report*], available at <http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic-Fracturing-Chemicals-2011-4-18.pdf>.

¹⁴⁴ *Id.* at 6.

¹⁴⁵ *Id.* at 5 (oil and gas service companies reported using more than 2,500 hydraulic fracturing products), 8 (652 of these products contained toxic chemicals).

amounts of hydrogen fluoride by any route may be fatal.”¹⁴⁶ Other HAPs commonly used in fracturing operations include ethylene glycol, naphthalene, formaldehyde, and BTEX compounds.¹⁴⁷

Excerpt from Table 3 from page 8 of *House Committee Report* showing hydraulic fracturing chemical components of concern that are listed hazardous air pollutants (also listing carcinogens and Safe Drinking Water Act-regulated chemicals):

Chemical Component	Chemical Category	No. of Products
Methanol (Methyl alcohol)	HAP	342
Ethylene glycol (1,2-ethanediol)	HAP	119
Naphthalene	Carcinogen, HAP	44
Xylene	SDWA, HAP	44
Hydrogen chloride (Hydrochloric acid)	HAP	42
Toluene	SDWA, HAP	29
Ethylbenzene	SDWA, HAP	28
Diethanolamine (2,2-iminodiethanol)	HAP	14
Formaldehyde	Carcinogen, HAP	12
Benzyl chloride	Carcinogen, HAP	8
Cumene	HAP	6
Dimethyl formamide	HAP	5
Phenol	HAP	5
Benzene	Carcinogen, SDWA, HAP	3
Di (2-ethylhexyl) phthalate	Carcinogen, SDWA, HAP	3
Acrylamide	Carcinogen, SDWA, HAP	2
Hydrogen fluoride (Hydrofluoric acid)	HAP	2
Phthalic anhydride	HAP	2
Acetaldehyde	Carcinogen, HAP	1
Acetophenone	HAP	1
Ethylene oxide	Carcinogen, HAP	1
Lead	Carcinogen, SDWA, HAP	1
Propylene oxide	Carcinogen, HAP	1
p-Xylene	HAP	1
Number of Products Containing a Component of Concern		652

Another listing of the chemicals used by the industry in fracturing fluids was created by the New York Department of Environmental Conservation as part of its environmental impact statement on the development of Marcellus shale in the state.¹⁴⁸ To compile the list, the state

¹⁴⁶ *Id.* at 11 (citing HHS, Agency for Toxic Substances and Disease Registry, *Medical Management Guidelines for Hydrogen Fluoride* (online at www.atsdr.cdc.gov/mhmi/mmg11.pdf) (accessed Nov. 22, 2013)).

¹⁴⁷ *Id.* at 8.

¹⁴⁸ See N.Y. DEP’T OF ENV. CONSERVATION, *Revised Draft Supplemental Generic Environmental Impact Statement, On the Oil, Gas and Solution Mining Regulatory Program: Well Permit Issuance for*

agency drew on Material Safety Data Sheets (“MSDS”) provided by the industry. The agency’s listing of chemicals included (in part) the following HAPs:

- 1, 4 Dioxane
- Acrylamide
- Benzene
- Ethyl Benzene
- Ethylene oxide
- Formaldehyde
- Hydrochloric Acid
- Methanol
- Naphthalene
- Toluene
- Xylene¹⁴⁹

Most obvious sources of emissions from the oil and gas industry come from processing at wells and from natural gas constituents. Yet a large quantity of emissions also results from the open “frack pits” (also known as “produced water ponds”) and other such impoundments that hold fracturing fluids, including flowback water and produced water, as well as from leaks, venting, and evaporative loss from the tanks that may also hold these substances.¹⁵⁰ As the pits, in particular, are typically open to the air, the volatile chemicals contained in the fluids—such as BTEX compounds and hydrogen sulfide—will inevitably evaporate and escape into the air.¹⁵¹ For obvious reasons, data on these emissions are developing, but the data available and extent of chemicals involved in the fluids give some idea of the emissions involved as well as the related health risks.

As a general matter, EPA stated in proposing the 2012 Rule that it “believes that produced water ponds are . . . a potentially significant source of emissions,” and specifically sought comments on control options for such ponds.¹⁵² This produced water can emit significant amounts of VOCs, and EPA’s own research has demonstrated that such open-air impoundments can emit HAPs such as the BTEX compounds and methanol.¹⁵³

Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs (2011) [*N.Y. DEC Revised DSGEIS*], available at <http://www.dec.ny.gov/energy/75370.html>.

¹⁴⁹ *Id.* at 5-55 to 5-63, Tbl. 5.7.

¹⁵⁰ See *Sources of Oil and Gas Air Pollution*, *supra* note 132; see also ATSDR, *Exposure Investigation. Natural Gas Activities Ambient Air Monitoring Initiative: Marcellus Shale—Washington County, PA*, 4, 6-7 (June 1, 2012) (discussing emissions from oil and gas wastewater impoundments).

¹⁵¹ *Id.*

¹⁵² 2011 Proposed Rule, 76 Fed. Reg. at 52,756.

¹⁵³ See Sierra Club et al., *Comments on National Emission Standards for Hazardous Air Pollutants: Oil and Natural Gas Sector, Review and Proposed Rule for 40 C.F.R. Part 63* at 16-17 (Nov. 2011) (Document ID No. EPA-HQ-OAR-2010-0505-4457) [hereinafter *Sierra Club NESHAP Comments*]; Dr. Ranajit Sahu, *Technical Report and Comments on EPA’s Proposed NESHAP Rule for Oil and Natural*

The New York Department of Environmental Conservation has also gathered data on such emissions and concluded that the impoundments could be significant sources of methanol:

Analysis of air emission rates of some of the compounds used in the fracturing fluids in the Marcellus Shale reveals potential for emissions of hazardous air pollutants (HAPs), in particular methanol, from the recovered (flowback) water stored in central impoundments. This methanol is present as a major component of the surfactants, cross-linker solutions, scale inhibitors and iron control solutions used as additives in the frac water. Current field experience indicates that an approximately 25% recovery of fracturing water from Marcellus shale wells may be expected. Thus, using a 25% recovery factor of a nominal 5,000,000 gallons of frac water used for each well, an estimated 6,500 pounds (3.25 tons) of methanol will be contained in the flowback water. Since methanol has a relatively high vapor pressure, its release to the atmosphere could possibly occur within only about two days after the recovered water is transferred to the impoundment. Based on an assumed installation of ten wells per wellsite in a given year, an annual methanol air emission of 32.5 tons (i.e., “major” quantity of HAP) is theoretically possible at a central impoundment.¹⁵⁴

5. Toxic air emissions from oil and gas production threaten public health

In EPA’s analysis for the 2012 Rule, the agency flagged the following as “the main HAP[s] of concern”: benzene, toluene, ethylbenzene, xylenes, carbonyl sulfide, and n-hexane.¹⁵⁵ As described in part below, these HAPs are known to cause significant harmful effects to human health.

- **Benzene:** EPA has described benzene as one of two “key pollutants that contribute most to the overall cancer risks” nationwide.¹⁵⁶ It is a known human carcinogen “by all routes of exposure”—specifically causing leukemia—and also has serious non-cancer effects, such as preleukemia, aplastic anemia, and “the depression of the absolute lymphocyte

Gas Production and Natural Gas Transmission and Storage Source Categories at 10 (Nov. 2011) (attached in addenda to *Sierra Club NESHAP Comments*); Eben Thoma, *Measurement of Emissions from Produced Water Ponds: Upstream Oil and Gas Study #1* (2009), available at <http://permanent.access.gpo.gov/lps120786/600r09132.pdf>.

¹⁵⁴ N.Y. DEP’T OF ENV. CONSERVATION, *Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Program* at 6-56 to 6-57 (2009). The Department’s recent revised environmental impact statement, as cited above, has deleted this statement, not on the basis of its veracity, but rather on the grounds that “[t]he Department was informed in September 2010 that operators would not routinely propose to store flowback water either in reserve pits on the well pad or in centralized impoundments” and therefore the Department opted not to address such practices in the revised draft. See *N.Y. DEC Revised DSGEIS*, *supra* note 148, at 1-2.

¹⁵⁵ *RIA*, *supra* note 8, at 4-14.

¹⁵⁶ *Id.* at 4-9.

count in blood.”¹⁵⁷ Though most of these non-cancer effects result from long-term exposure, recent research has found “that biochemical responses are occurring at lower levels of benzene exposure than previously known.”¹⁵⁸ Benzene has also been listed by the state of California to cause developmental toxicity. A 2001 California EPA (“CalEPA”) review of the literature concluded that “there is evidence that benzene exposure early in life elicits a stronger carcinogenic response than equivalent exposures of working-age adults.”¹⁵⁹ This increased susceptibility is not accounted for in the dose-response values used by the US EPA or CalEPA and thus standards or assessments based on these values “may underpredict the risk from early life exposures” and “would not be adequately protective of children.”¹⁶⁰ Studies of human biological tissues which found benzene detected in fetal cord blood at levels equal to or greater than that of maternal blood and in breast milk¹⁶¹ indicate the potential for increased exposures during prenatal development and infancy.

- Toluene: While there is not yet adequate information to classify toluene as a human carcinogen, it is known to cause serious neurological and developmental effects.¹⁶² For example, central nervous system (“CNS”) dysfunction and narcosis have been “frequently observed” in humans acutely exposed to toluene by inhalation, even in low levels.¹⁶³ In more chronic exposures with high levels of toluene, CNS depression has occurred, resulting in symptoms such as “ataxia, tremors, cerebral atrophy, nystagmus (involuntary eye movements), and impaired speech, hearing, and vision.” Chronic inhalation has also caused non-CNS effects such as “irritation of the upper respiratory tract, eye irritation, dizziness, headaches, and difficulty with sleep.”¹⁶⁴ And developmental effects have occurred in the children of women who have abused toluene during pregnancy.¹⁶⁵ In studies of occupational exposures to toluene, “neurological effects (i.e., impaired color vision, impaired hearing, decreased performance in neurobehavioral analysis, changes in motor and sensory nerve conduction velocity, headache, and dizziness) [were] the most sensitive endpoint.”¹⁶⁶
- Ethylbenzene: In acute exposure in humans, ethylbenzene has been found to result in respiratory effects such as throat irritation and chest constriction, as well as neurological effects such as dizziness.¹⁶⁷ In cases of chronic exposure, ethylbenzene “may cause eye

¹⁵⁷ *Id.* at 4-15.

¹⁵⁸ *Id.*

¹⁵⁹ CAL. EPA, OEHHA, *Chemical Summary: Benzene. Prioritization of Toxic Air Contaminants – Children’s Environmental Health Protection Act 19* (2001).

¹⁶⁰ *Id.*

¹⁶¹ EPA, *Benzene: TEACH Chemical Summary: U.S. EPA Toxicity and Exposure Assessments for Children’s Health 4* (Feb. 27, 2009), http://www.epa.gov/teach/chem_summ/BENZ_summary.pdf.

¹⁶² *RIA*, *supra* note 8, at 4-16.

¹⁶³ *Id.*

¹⁶⁴ *Id.*

¹⁶⁵ *Id.*

¹⁶⁶ *Id.*

¹⁶⁷ *Id.* at 4-17.

and lung irritation, with possible adverse effects on the blood.”¹⁶⁸ Although there is not yet ample human evidence to demonstrate the carcinogenic and developmental effects of ethylbenzene, animal studies have found both, and the International Agency for Research on Cancer has classified ethylbenzene as “possibly carcinogenic” to humans based on animal studies.¹⁶⁹

- Xylenes: Although EPA has found xylenes to be “not classifiable with respect to human carcinogenicity,” effects via acute inhalation include “irritation of the nose and throat, nausea, vomiting, gastric irritation, mild transient eye irritation, and neurological effects.”¹⁷⁰ Chronic effects via inhalation include nervous system effects such as “headaches, dizziness, fatigue, tremors, and impaired motor coordination.”¹⁷¹
- n-Hexane: Exposure to n-hexane includes a variety of effects to the nervous system, which is the chemical’s primary target via inhalation.¹⁷² Effects via acute exposure include “dizziness, giddiness, slight nausea, and headache,” and effects via chronic exposure include “numbness in the extremities, muscular weakness, blurred vision, headache, and fatigue.”¹⁷³ As with xylenes, EPA has classified n-hexane as “not classifiable as to human carcinogenicity” due to limited human data.¹⁷⁴

The IRIS reports for each of these pollutants are incorporated here and attached in the Appendix. Additional HAPs also warrant considerable attention from EPA.

- Formaldehyde: Along with benzene, formaldehyde is one of two “key pollutants” that EPA has determined “contribute most to the overall cancer risks.”¹⁷⁵ Formaldehyde is also a potent respiratory irritant that is “associated with decrements in lung function and elevated respiratory symptoms in children.”¹⁷⁶
- Mercury: Mercury is a potent neurotoxin that is particularly hazardous to the developing brain. Once released into the environment in elemental form, it is converted to methylmercury which bioaccumulates in the food chain. Therefore, even low emission levels can pose significant harm to human health. Mercury content in natural gas has been reported up to 5,000 $\mu\text{g}/\text{m}^3$, but concentrations are highly variable among specific regions and deposits.¹⁷⁷ Most authors agree that all natural gas deposits contain some

¹⁶⁸ *Id.*

¹⁶⁹ *Id.* at 4-17 to 4-18.

¹⁷⁰ *Id.* at 4-18.

¹⁷¹ *Id.*

¹⁷² *Id.* at 4-18.

¹⁷³ *Id.* at 4-19.

¹⁷⁴ *Id.*

¹⁷⁵ *Id.* at 4-9.

¹⁷⁶ CAL. EPA, OEHHA, *Chemical Summary: Formaldehyde. Prioritization of Toxic Air Contaminants – Children’s Environmental Health Protection Act 13* (2001).

¹⁷⁷ Olsen, S.D., *Literature Study Concerning Mercury and Arsenic Distribution in Petroleum and Geothermal Systems, Rogaland Research. Report RF-98/032Olson*, 20 Tbl. 1 (1998).

mercury.¹⁷⁸ A figure for “typical” mercury concentrations in natural gas that is often cited is 1-200µg/m³.¹⁷⁹

- Polycyclic Aromatic Hydrocarbons (PAH): Animal studies have found that ingestion of PAHs during pregnancy results in much greater genetic damage in the fetus compared to the mother.¹⁸⁰ Human children exposed prenatally to PAHs have statistically significant increases in DNA aberrations in specific chromosomes, low birth weight, intrauterine growth restriction, and reduced IQ.¹⁸¹
- Arsenic: Arsenic is a known carcinogen, a persistent toxin, and has also been listed by the state of California as known to cause developmental toxicity.¹⁸² A 2001 CalEPA review of the literature concluded that, “there is evidence that infants and children may be more susceptible to arsenic exposure than adults.”¹⁸³ According to a 2003 evaluation conducted by the EPA Office of Water, “[a]rsenic, and/or its metabolites, is a chemical that bioaccumulates in tissues of aquatic organisms.”¹⁸⁴
- Methylene Chloride: Methylene chloride is a carcinogen and can also have cardiovascular and neurological impacts. A 2001 CalEPA review determined that

¹⁷⁸ E.g., Bingham, M.D., *Field Detection and Implications of Mercury in Natural Gas*, 5(2) SPE PRODUCTION ENGINEERING 120-124 (1990).

¹⁷⁹ *Id.* at 120; Abu El Ela, M., et al., *Egyptian Gas Plant Employs Absorbents for Hg Removal*, 104(46) OIL & GAS J. 52–58 (Dec. 11, 2006).

¹⁸⁰ Harper, BL, et al., *Micronucleus Formation by Benzene, Cyclophosphamide, Benzo(a)pyrene, and Benzidine in Male, Female, Pregnant Female, and Fetal Mice*, 9(4) TERATOGENESIS, CARCINOGENESIS, AND MUTAGENESIS 239-252 (1989).

¹⁸¹ Choi, H, et al., *International Studies of Prenatal Exposure to Polycyclic Aromatic Hydrocarbons and Fetal Growth*, 114(11) ENVTL. HEALTH PERSPECTIVES 1744-1750 (2006); Dejmek, J, et al., *The Impact of Polycyclic Aromatic Hydrocarbons and Fine Particles on Pregnancy Outcome*, 108(12) ENVTL. HEALTH PERSPECTIVES 1159-1164 (2000); Orjuela, M.A., et al., *Prenatal PAH Exposure Is Associated with Chromosome-Specific Aberrations in Cord Blood*, 703(2) MUTATION RESEARCH/GENETIC TOXICOLOGY AND ENVIRONMENTAL MUTAGENESIS 108-114 (2010); Perera, F, et al., *DNA Damage from Polycyclic Aromatic Hydrocarbons Measured by Benzo[a]pyrene-DNA Adducts in Mothers and Newborns from Northern Manhattan, The World Trade Center Area, Poland, and China*, 14 CANCER EPIDEMIOLOGY, BIOMARKERS & PREVENTION 709-714 (2009); Perera, F., et al., *Prenatal Airborne Polycyclic Aromatic Hydrocarbon Exposure and Child IQ at Age 5 Years*, 124(2) PEDIATRICS e195-e202 (Aug. 2009).

¹⁸² CAL. EPA, *Safe Drinking Water And Toxic Enforcement Act of 1986: Chemicals Known To The State To Cause Cancer Or Reproductive Toxicity* (2011), http://www.oehha.ca.gov/prop65/prop65_list/files/P65single052011.pdf.

¹⁸³ CAL. EPA, OEHHA, *Prioritization of Toxic Air Contaminants - Children’s Environmental Health Protection Act: Arsenic and Arsenic Compounds* 7 (2001).

¹⁸⁴ EPA, *Technical Summary of Information Available on the Bioaccumulation of Arsenic in Aquatic Organisms* 2 (2003), Document ID No. EPA-822-R-03-032.

through its metabolism to carbon monoxide in the body methylene chloride can have an increased toxicity for infants which is not accounted for in the dose-response values.¹⁸⁵

- Acrolein: Acrolein is a powerful respiratory irritant and there is substantial evidence that it exacerbates asthma. Due to the high rates of asthma among children, the CalEPA has prioritized acrolein as a toxic air contaminant of particular concern for children and added a 10 fold factor to the derivation of dose-response values to account for this increased vulnerability.¹⁸⁶

6. Scientific research provides significant support for the determination that oil and gas wells pose more than a negligible risk to public health.

EPA has an abundance of evidence upon which it should base its section 112(n)(4)(B) determination. For example, local, state, and national health agencies have been examining the potential health impacts that HAP emissions from oil and gas facilities pose, including the Center for Disease Control and Prevention (CDC) Agency for Toxic Substances and Disease Registry (ATSDR),¹⁸⁷ Association of Occupational and Environmental Clinics (AOEC) Pediatric Environmental Health Specialty Unit (PEHSU),¹⁸⁸ and the Colorado Health Department.¹⁸⁹ The Secretary of Energy Advisory Board, Shale Gas Production Subcommittee (SEAB) has also weighed in on the subject, recommending the adoption of rigorous standards to reduce emissions from shale gas operations.¹⁹⁰ Many researchers and groups of concerned residents in communities across the county have also conducted their own studies of toxic air emissions from oil and gas production, and the elevated levels of HAP emissions detected in these and other studies raise serious concerns about increased health risks—including cancer, respiratory and

¹⁸⁵ CAL. EPA, OEHHA, *Chemical Summary: Methylene Chloride. Prioritization of Toxic Air Contaminants – Children’s Environmental Health Protection Act 1* (2001).

¹⁸⁶ CAL. EPA, OEHHA, *Prioritization of Toxic Air Contaminants - Children’s Environmental Health Protection Act: Acrolein 6* (2001); CAL. EPA, OEHHA, *Acrolein Reference Exposure Levels 56* (2008).

¹⁸⁷ ATSDR, *Health Consultation: Public Health Implications of Ambient Air Exposures to Volatile Organic Compounds as Measured in Rural, Urban, and Oil & Gas Development Areas Garfield County, Colorado* (2008) [hereinafter *ATSDR 2008*].

¹⁸⁸ PEHSU, *Information on Natural Gas Extraction and Hydraulic Fracturing for Health Professionals* (2011).

¹⁸⁹ Witter R., et al., *Draft Health Impact Assessment for Battlement Mesa, Garfield County Colorado* (2010), <http://www.garfield-county.com/public-health/documents/1%20%20Complete%20HIA%20without%20Appendix%20D.pdf>.

¹⁹⁰ *90-Day Report*, supra note 4, at 2 (emphasis added).

neurological toxicity—for residents living near oil and gas facilities.¹⁹¹ This and other research provides important information showing that oil and gas wells and their associated equipment pose more than a negligible risk to public health.

One recent exploratory study of particular note was designed to assess air quality and explore the presence of volatile chemicals in a rural western Colorado area “where residences and gas wells co-exist.” The study involved weekly sampling for one year—before, during, and after the drilling and hydraulic fracturing of a new natural gas well pad.¹⁹² Development during this time included drilling, hydraulic fracturing, and production operations. This study reached a number of conclusions that EPA must consider.

- The report found that methylene chloride, a listed HAP and a toxic solvent not reported in products used in drilling or hydraulic fracturing, was detected 73% of the time; several times in high concentrations.¹⁹³ As the report states regarding these findings: “Methylene chloride stood out due to the extremely high concentrations in some of the samples, including one reading of 1730 ppbv, and three other readings more than 563 ppbv (the cutoff value for spikes) during the period of well development. In contrast, after activity on the pad came to an end and the wells went into production, the highest level of methylene chloride detected was 10.6 ppb. . . . Given that methylene chloride was found in such high concentrations in air samples in the present study, its source and potential exposure scenarios should be explored with respect to exposure of individuals working on the pads and living nearby.”¹⁹⁴
- The report also found that selected polycyclic aromatic hydrocarbons (PAHs), some of which are listed HAPs, were at concentrations greater than those at which prenatally exposed children in urban studies had lower developmental and IQ scores.¹⁹⁵

¹⁹¹ See, e.g. WOLF EAGLE ENVTL., *supra* note 76; EASTERN RESEARCH GROUP, INC., City of Fort Worth Natural Gas Air Quality Study (2011), *available at* http://fortworthtexas.gov/uploadedFiles/Gas_Wells/AirQualityStudy_final.pdf; ATSDR 2008, *supra* note 187, at 1 (the ATSDR 2008 investigation was spurred by health complaints including that some Garfield County residents are experiencing health effects that they believed may have environmental causes. Community concerns ranged from mild complaints such as dizziness, nausea, respiratory problems, and eye and skin irritation to more severe concerns including cancer.); GLOBAL COMMUNITY MONITOR, *GASSED! Citizen Investigation of Toxic Air Pollution from Natural Gas Development 19-21* (2011), <http://www.gcmonitor.org/downloads/gassedreport.pdf> (this investigation found elevated cancer risk at one site and recommended further investigation into HAP emissions and risks.).

¹⁹² Colborn, T., et al., *An Exploratory Study of Air Quality near Natural Gas Operations*, TEDX, The Endocrine Disruption Exchange, Paonia, CO (p. 2 of manuscript, peer-reviewed and accepted for publication by HUMAN AND ECOLOGICAL RISK ASSESSMENT (November 9, 2012)).

¹⁹³ *Id.* at 2.

¹⁹⁴ *Id.* at 10 (citations omitted).

¹⁹⁵ *Id.* at 2.

- The report concluded, “[t]he human and environmental health impacts of the [nonmethane hydrocarbons], which are ozone precursors, should be examined further given that the natural gas industry is now operating in close proximity to human residences and public lands.”¹⁹⁶
- Finally, the study recommended that “[i]n order to determine how to reduce human exposure for both those who work on the well pads and those living nearby, systematic air quality monitoring of natural gas operations must become a regular part of permitting requirements.”¹⁹⁷

Other notable studies that EPA must examine offer further evidence of the “more than negligible risk to public health” that oil and gas wells pose. For example:

- *A new look at methane and non-methane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin*, summarized in the Colorado section above.¹⁹⁸
 - This article assessed ambient air data for benzene and various volatile organic compounds and found an average emission rate of 173 kg/hr of the carcinogen benzene in the air above an oil and gas producing region, which corresponds to annual emissions of nearly 1,700 tons for Weld County, Colorado, alone. This county has a population of close to 264,000 people and is part of the Denver-Aurora Combined Statistical Area, where more than three million people live. The findings of this study support the need for new measures nationwide to adequately characterize and reduce air contaminants, including benzene and other HAPs from oil and gas development, which can be associated with significant public health threats.
- *Natural gas operations from a public health perspective*, a review of over 600 known chemicals used in natural gas operations.¹⁹⁹
 - This report concluded that many of the chemicals used in natural gas operations could have long-term health impacts, including on skin, eyes, and kidneys, and respiratory, gastrointestinal, brain/nervous, immune, endocrine, and cardiovascular systems, as well as causing cancer and mutations.²⁰⁰

¹⁹⁶ *Id.*

¹⁹⁷ *Id.* at 12.

¹⁹⁸ Petróñ et al., *supra* note 49.

¹⁹⁹ Colborn, T., et al., *Natural Gas Operations From a Public Health Perspective*, 17 HUMAN & ECOLOGICAL RISK ASSESSMENT 1039 (2011).

²⁰⁰ *Id.* at 1039.

- *Maternal Exposure to Ambient Levels of Benzene and Neural Tube Defects among Offspring: Texas, 1999–2004*, a study in Texas linking benzene exposure (from various sources’ emissions) to birth defects.²⁰¹
 - Among other things, the report stated that “maternal exposure to ambient levels of benzene is associated with the prevalence of spina bifida among offspring.”²⁰²
- *Impacts of Gas Drilling on Human and Animal Health*, a report documenting cases in which animals (both livestock and pets) exposed to natural gas operations and related toxic substances suffered negative health impacts and even death.²⁰³
 - This report concludes that complete evidence regarding health impacts of gas drilling cannot be obtained due to incomplete testing and disclosure of chemicals and nondisclosure agreements, and notes that “[w]ithout rigorous scientific studies, the gas drilling boom sweeping the world will remain an uncontrolled health experiment on an enormous scale.”²⁰⁴
- *The Potential Near-Source Ozone Impacts of Upstream Oil and Gas Industry Emissions*, a study of air emissions on the Barnett Shale in Texas.²⁰⁵
 - “Our findings suggest that improved regulation of the upstream oil and gas industry in nonattainment areas should include reporting of emission events, and more aggressive deployment of control strategies, such as vapor recovery to avoid flaring, and the use of oxidation catalysts on stationary engines. The control of formaldehyde emissions is especially desirable both from an air toxics perspective, and with regard to attainment of the federal ozone standard in surrounding or nearby urban areas.”²⁰⁶

²⁰¹ Lupo, Philip J., et al., *Maternal Exposure to Ambient Levels of Benzene and Neural Tube Defects among Offspring: Texas, 1999–2004*, 119(3) ENVTL. HEALTH PERSPECTIVES 397 (2011), available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3060005/pdf/ehp-119-397.pdf>; see also Matthew Tresaugue, *Study Links Texas Birth Defects to Benzene Levels*, HOUSTON CHRONICLE, Oct. 27, 2010, available at <http://www.chron.com/news/houston-texas/article/Study-links-Texas-birth-defects-to-benzene-levels-1702259.php%20/>.

²⁰² Lupo, *id.*, at 401.

²⁰³ Bamberger, Michelle E. & Oswald, Robert E., *Impacts of Gas Drilling on Human and Animal Health* 22(1) NEW SOLUTIONS 51 (2012), available at http://ia700801.us.archive.org/1/items/ImpactsOfGasDrillingOnHumanAndAnimalHealth/Bamberger_Oswald_NS22_in_press.pdf.

²⁰⁴ *Id.* at 51.

²⁰⁵ Olaguer, Eduardo P., *The potential near-source ozone impacts of upstream oil and gas industry emissions*, 62:8 J. AIR & WASTE MGMT. ASS’N 966 (2012).

²⁰⁶ *Id.* at 976.

- “Based on the modeling exercise discussed earlier, we conclude that oil and gas activities can have significant near-source impacts on ambient ozone, through either regular emissions or flares and other emission events associated with process upsets, and perhaps also maintenance, startup, and shutdown of oil and gas facilities. Besides flares, candidate facilities that have the potential to emit large amounts of formaldehyde and/or [highly reactive VOCs] as well as NO_x in transient events include compressor or drill rig engines, and glycol or amine reboilers used in gas dehydration or sweetening.”²⁰⁷
- “Major metropolitan areas in or near shale formations will be hard pressed to demonstrate future attainment of the federal ozone standard, unless significant controls are placed on emissions from increased oil and gas exploration and production.”²⁰⁸
- *The Rush to Drill for Natural Gas: A Public Health Cautionary Tale*, a commentary in the American Journal of Public Health.²⁰⁹
 - This article discusses fracturing, arguing that “it would be prudent to invoke the precautionary principle before further degradation and damage to the public’s health and the environment occur.”²¹⁰
 - This article summarizes other recent research including: one “study based on Pennsylvania Department of Environmental Protection and the Susquehanna River Basin Commission Material Safety Data Sheets for 41 products used in fracturing operations, which assessed the chemicals used in fracturing and found that 73% of the products had between 6 and 14 different adverse health effects including skin, eye, and sensory organ damage; respiratory distress including asthma; gastrointestinal and liver disease; brain and nervous system harms; cancers; and negative reproductive effects. . . . Some of the negative health effects appeared fairly immediately after exposure whereas others appeared months or years later, as was the case with some cancers, harm to the reproductive system, or developmental effects. Of concern is that endocrine-disrupting chemicals may alter developmental pathways, manifesting decades after exposure or even transgenerationally by altering epigenetic pathways.”²¹¹

²⁰⁷ *Id.*

²⁰⁸ *Id.* at 966.

²⁰⁹ Finkel, Madelon L. & Law, Adam, *The Rush to Drill for Natural Gas: A Public Health Cautionary Tale*, 101(5) AM. J. OF PUBLIC HEALTH 784 (2011), available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3076392/>.

²¹⁰ *Id.* at 785.

²¹¹ *Id.* (citing Diamanti-Kandarakis, E, et al., *Endocrine-Disrupting Chemicals: an Endocrine Society Scientific Statement*, 30(4) ENDOCRINE REVS. 293 (2009)).

- *Human Health Risk Assessment of Air Emissions from Development of Unconventional Natural Gas Resources*, a recent Colorado study on the public health risks from oil and gas drilling.²¹²
 - This study suggests the existence of increased respiratory, neurological, and cancer risks for people in proximity to wells, with benzene as the major contributor to cancer risk.²¹³
- *Air, Noise, and Light Monitoring Results for Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations*, a study conducted at the behest of the West Virginia Department of Environmental Protection.²¹⁴
 - Measurements in this study found benzene concentrations “above what the CDC calls the ‘the minimum risk level for no health effects.’ This is a concern for potential health effects that might arise due to these exposures over a long time.”²¹⁵
- *Potential Public Health Hazards, Exposures and Health Effects from Unconventional Natural Gas Development*, a review of the literature on public health impacts and threats posed by gas drilling sites and related infrastructure.
 - This review identified 15 different sources and processes which present a chemical exposure hazard via the emission of air pollutants and summarized risk assessment findings that air exposures could result in acute, subchronic, and elevated cancer risk.²¹⁶
- *Birth Outcomes and Maternal Residence Proximity to Natural Gas Development in Rural Colorado*
 - Researchers found that babies whose mothers lived in close proximity to multiple oil and gas wells were 30% more likely to be born with defects in their heart than babies born to mothers who did not live close to oil and gas wells. Although the study does not include exposure monitoring, the

²¹² McKenzie, Lisa M., et al., *supra* note 51.

²¹³ *Id.* at 83-86.

²¹⁴ Michael McCawley, *Air, Noise, and Light Monitoring Results for Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations* (May 3, 2013), available at <http://wvri.org/wp-content/uploads/2013/10/A-N-L-Final-Report-FOR-WEB.pdf>.

²¹⁵ *Id.* at 2.

²¹⁶ Adgate, John L., et al., *Potential Public Health Hazards, Exposures and Health Effects from Unconventional Natural Gas Development*, ENVTL. SCI. & TECH. (Feb. 2014), available at <http://pubs.acs.org/doi/abs/10.1021/es404621d>.

study authors suggest that exposures to air pollutants, including benzene, could be a possible cause.²¹⁷

These studies demonstrate that air toxics emitted by oil and gas well site activity threaten human health, and provide a strong basis for EPA to take action under section 112(n)(4)(b).

7. The real-world health impacts of oil and gas well emissions are likely greater even than current data illustrate.

EPA must also consider the cumulative impacts of emissions, the uncertainties in current emissions inventories, the greater vulnerability of children to health impacts from air toxics, and the numerous oil and gas well safety and drilling violations in making its determination. As explained below, these factors amplify the risks that well emissions pose, and when properly considered, provide further evidence that the risk to public health easily meets the section 112(n)(4)(B) threshold.

a. EPA must consider and account for the fact that children are more vulnerable to toxic air emissions and exposed at a greater rate, leading to greater health impacts from early life exposure.

The science on the greater vulnerability and exposure of children to toxic air pollution—and the need to better protect minority and low-income children in particular from pollution—is robust, and must be considered by EPA both when deciding whether oil and gas wells pose more than a negligible risk to public health and when deciding what emission limits to set on oil and gas wells. As discussed below, relevant studies are available from the National Academy of Sciences, the Office of Children’s Health Protection, the U.S. Children’s Health Protection Advisory Committee, scientists in the EPA Office of Research and Development who focus on children’s and community health (such as experts in the National Center for Environmental Research), and the California EPA’s Office of Environmental Health Hazard Assessment (OEHHA). In addition, Executive Order 13045 requires that EPA “ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.”²¹⁸

It is well-established that biological differences in the developing child and fetus can result in increased cancer and non-cancer risk due to both increased exposure and increased vulnerability.²¹⁹ The most recent review of EPA risk assessment practices by the National

²¹⁷ McKenzie, Lisa M., et al., *Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado*, ENVTL. HEALTH PERSPECTIVES 122:412–417 (Apr. 2014), available at <http://dx.doi.org/10.1289/ehp.1306722>.

²¹⁸ The President, Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks, 62 Fed. Reg. 19,885, 19,885 (Apr. 23, 1997) (Sec. 1-101(b)).

²¹⁹ See AM. ACAD. PEDIATRICS, *Policy Statement—Chemical-Management Policy: Prioritizing Children’s Health*, 127 PEDIATRICS 983, 983 (2011); see generally also NAT’L ACAD. SCIENCES, *Science and Decisions: Advancing Risk Assessment* (2009); NAT’L ACAD. SCIENCES, *Pesticides in the Diets of Infants and Children* (1993).

Academy of Sciences (NAS) highlights the need to more fully address children's health and vulnerability in EPA health risk assessments, including through the use of default or uncertainty factors.²²⁰

As EPA noted in its 2008 *Child-Specific Exposure Factors Handbook*, “[i]n terms of risk, children may also differ from adults in their vulnerability to environmental pollutants because of toxicodynamic differences (e.g., when exposures occur during periods of enhanced susceptibility) and/or toxicokinetic differences (i.e., differences in absorption, metabolism, and excretion).”²²¹ As EPA explained, environmental contaminants may have longer half-lives in young children, due to the immaturity of metabolic enzyme systems and clearance mechanisms, and the cellular immaturity of children and the ongoing growth processes account for elevated risk.²²² Thus, “[t]oxic chemicals in the environment can cause neurodevelopmental disabilities, and the developing brain can be particularly sensitive to environmental contaminants.”²²³ For example, the Handbook states that “elevated blood lead levels and prenatal exposures to even relatively low levels of lead can result in behavior disorders and reductions of intellectual function in children,” and “exposure to high levels of methylmercury can result in developmental disabilities among children.”²²⁴

In addition to EPA's 2008 Handbook, the agency's 2011 *Exposure Factors Handbook* should help guide the analysis of children's vulnerability to emissions from oil and gas production.²²⁵ EPA's 2011 Handbook states that while the risks due to bioaccumulative HAPs might be lower in an urban setting, the combined exposures from multiple sources and multiple persistent chemicals could potentially be much greater, as soil contaminants are a particular risk to children due to play activities and behaviors, such as increased hand to mouth and object to mouth frequency, which increase their exposures via incidental ingestion.²²⁶

To account for real-world risk to children, EPA must use age-dependent adjustment factors for all carcinogens. This would be consistent with the NAS recommendations and with the scientific approach developed by OEHHA.²²⁷

EPA should also use a 10X default factor to account for cancer risk created by in-utero exposure. The NAS identified the lack of accounting for “*in utero* periods” of exposure as a

²²⁰ NAS, *Science and Decisions: Advancing Risk Assessment* Ch. 6: Selection and Use of Defaults (2009) [hereinafter *NAS 2009*].

²²¹ EPA, *Child-Specific Exposure Factors Handbook* 1-2 (2008), EPA/600/R-06/096F (citation omitted).

²²² *Id.* (citations omitted).

²²³ *Id.*

²²⁴ *Id.* (citations omitted).

²²⁵ See EPA, *Exposure Factors Handbook* at 1-11 (2011), EPA/600/R-09/052A.

²²⁶ *Id.*

²²⁷ *NAS 2009*, *supra* note 220, at 112, 196 (2009) (Tbl. 6-3 - Examples of “Missing” Defaults in EPA “Default” Dose-Response Assessments); CAL. EPA, OEHHA, *Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures* 3-4, 50-51 (May 2009) [hereinafter *OEHHA TSD for Cancer Potency Factors*], available at http://www.oehha.ca.gov/air/hot_spots/2009/TSDCancerPotency.pdf, and http://oehha.ca.gov/air/hot_spots/tsd052909.html.

major omission in EPA's 2005 cancer guidelines.²²⁸ OEHHA conducted its own review of the scientific literature to account for pre-natal susceptibility and exposures, which EPA should also consult and use.²²⁹ It has also developed methods and adjustment factors to account for pre-natal susceptibility and exposures that EPA should use.²³⁰ In its new risk assessment guidelines, OEHHA includes procedures for exposure assessment during fetal development, which EPA should evaluate.²³¹ OEHHA specifically discusses the use of a 10X adjustment factor for cancer risk due to pre-natal to age 2 exposures, and EPA should consider using at least this same factor.²³²

At least until the IRIS values fully account for the increased risk caused by early-life exposure to an emitted pollutant, EPA should use the OEHHA child-specific reference doses or benchmarks available to assess chronic non-cancer health risk from ingestion for certain pollutants.²³³ OEHHA has generated these child-specific reference values based on the latest science to take into account children's greater exposure and greater vulnerability.

Until EPA has child-specific or child-based reference values available for a given pollutant, EPA should apply a default or uncertainty factor of at least 10 to account for increased risk from early-life exposures for non-cancer risk assessments. This would be consistent with the NAS recommendation on the need for EPA to use default factors to account for greater risk,²³⁴ with the science developed and considered by OEHHA, and with the 10X factor enacted

²²⁸ *NAS 2009, id.*, at 112 (observing that "EPA treats the prenatal period as devoid of sensitivity to carcinogenicity"); *see also id.* at 196 (noting that it is a "missing" default that EPA recognizes in utero carcinogenic activity, but fails to take account of it or calculate any risk for it).

²²⁹ *See OEHHA TSD for Cancer Potency Factors, supra* note 227, at 3-4, 50-51; *id.* App. J "In Utero and Early Life Susceptibility to Carcinogens: The Derivation of Age-at-Exposure Sensitivity Measures" – conducted by OEHHA's Reproductive and Cancer Hazard Assessment Branch," http://oehha.ca.gov/air/hot_spots/2009/AppendixJEarly.pdf.

²³⁰ *Id.* at App. J at 7-8 & tbl. 1.

²³¹ *See* CAL. EPA, OEHHA, *Air Toxics Hot Spots Program Risk Assessment Guidelines, Technical Support Document for Exposure Assessment and Stochastic Analysis*, Technical Support Document for Exposure Assessment and Stochastic Analysis at 1-6 to 1-7 (Aug. 27, 2012) [hereinafter *OEHHA 2012 Guidelines*], http://www.oehha.org/air/hot_spots/tsd082712.html.

²³² *See id.*

²³³ A full list, with links to each scientific determination document, is available here: OEHHA, Table of all Child-chRDs Finalized to Date (updated 06/22/09),

http://oehha.ca.gov/public_info/public/kids/chrtable.html.

²³⁴ *NAS 2009, supra* note 220, at 190-93, 203.

by Congress in the Food Quality Protection Act.²³⁵

b. To protect public health, EPA must consider and account for the cumulative health impacts of oil and gas well emissions for people exposed to more than one well or production facility.

EPA has a responsibility to consider the *cumulative* impacts of oil and gas well emissions when determining whether those emissions pose a risk to public health that exceeds the low threshold stated in section 112(n)(4)(B) and when determining the emission limitations to impose on these facilities. Cumulative risk assessments include “aggregate exposures by multiple pathways, media and routes over time, plus combined exposures to multiple contaminants from multiple sources.”²³⁶ In authorizing the listing and regulation of wells, section 112(n)(4)(B) explicitly states that EPA may do so if “emissions of hazardous air pollutants *from such wells* present more than a negligible risk of adverse effects to public health.”²³⁷ Although section 112(n)(4)(A) generally bars aggregation of emissions under section 112, section 112(n)(4)(B) creates a specific exception that reflects the reality of oil and gas production’s concentration in areas where those resources are available.

Thus, EPA must consider the combined risk from multiple wells in this analysis, and not just look at the impact of a single well, in isolation. Further, section 112(c) confirms that listing is appropriate where an area source category presents a threat of adverse health effects “individually or in the aggregate,” again recognizing that EPA must consider the combined impact of such sources as part of its listing decision.²³⁸

Both EPA and the National Academy of Sciences have highlighted the importance of including cumulative impacts and risk in risk assessments and risk-based decision making. As EPA has previously noted, it “understands the potential importance of considering an individual’s total exposure to HAP,” and is “interested in placing source category and facility-wide HAP risks in the context of total HAP risks from all sources combined in the vicinity of

²³⁵ 21 U.S.C. § 346a(b)(2)(C) (requiring that, in establishing, modifying, leaving in effect, or revoking a tolerance or exemption for a pesticide chemical residue, for purposes of ensuring “that there is a reasonable certainty that no harm will result to infants and children from aggregate exposure . . . an additional tenfold margin of safety for the pesticide chemical residue and other sources of exposure shall be applied”); *see also* EPA Sci. Adv. Bd., *Review of EPA’s draft entitled, “Risk and Technology Review (RTR) Risk Assessment Methodologies: For Review by the EPA’s Science Advisory Board with Case Studies – MACT I Petroleum Refining Sources and Portland Cement Manufacturing”*, EPA-SAB-10-007, at 34 (May 2010) [hereinafter *SAB May 2010*] (citing CAL. EPA, OEHHA, *Technical Support Document for the Derivation of Noncancer Reference Exposure Levels* (June 2008), available at http://www.oehha.ca.gov/air/hot_spots/2008/NoncancerTSD_final.pdf).

²³⁶ EPA, *Concepts, Methods, and Data Sources for Cumulative Health Risk Assessment of Multiple Chemicals, Exposures and Effects: A Resource Document*, at xxxii (2007), EPA/600/R-06/013F.

²³⁷ 42 U.S.C. § 7412(n)(4)(B).

²³⁸ *Id.* § 7412(c)(3).

each source.”²³⁹ Moreover, as the most recent National Academy of Sciences report on risk assessment states, “it is difficult to imagine any risk assessment in which it would not be important to understand the effects of coexposures to agents or stressors that have similar [Modes of Action].”²⁴⁰

The Science Advisory Board also has urged EPA to consider cumulative risks. As the Board stated regarding Risk and Technology Reviews, “[it] will be most useful to decision makers and communities if results are presented in the broader context of aggregate and cumulative risks, including background concentrations and contributions from other sources in the area.”²⁴¹ The Board explained, “[a] residual risk analysis that does not add exposures to baseline contamination to the estimates of on-going contamination may vastly underestimate the hazard quotient at the site and incorrectly conclude that the on-going releases pose risks at less than threshold levels.”²⁴²

c. EPA must consider and account for environmental justice and the need for greater protection for communities overburdened by toxic air pollution from oil and gas wells.

Unregulated oil and gas well emissions implicate concerns regarding environmental justice. As EPA has noted, “urban air toxics . . . have a potential to elevate health risks among particular urban subpopulations, including children, the elderly, and persons with existing illnesses.”²⁴³ Additionally, “the prevalence of minority and low-income communities in urban industrial and commercial areas, where concentrations of air toxics may be greatest, increases the likelihood of elevated exposures among these subpopulations.”²⁴⁴

Moreover, as EPA’s recent review found for the oil and natural gas production, transmission, and storage sectors, there are disparities attributable to this sector for several demographic groups. In particular, racial minorities and people below the poverty level face increased cancer risk from this sector at a greater rate than their representation in the U.S. population.²⁴⁵ EPA found the following disproportionate exposure to cancer risk at or above 1-in-1 million from oil and gas sources (and facilities that include such sources as well as other source categories) for the following demographic groups:

²³⁹ EPA, Proposed Rule, National Emissions Standards for Hazardous Air Pollutants: Secondary Lead Smelting, 76 Fed. Reg. 29,032, 29,047 (May 19, 2011).

²⁴⁰ *NAS 2009*, *supra* note 220, at 219.

²⁴¹ *SAB May 2010*, *supra* note 235, at ii.

²⁴² *Id.* at 41.

²⁴³ EPA, RISK ASSESSMENT AND MODELING - AIR TOXICS RISK ASSESSMENT REFERENCE LIBRARY VOL. 1 – TECH. RES. MANUAL, Part I Background, at 1-2 (2003), http://www.epa.gov/ttn/fera/risk_atra_vol1.html.

²⁴⁴ *Id.*

²⁴⁵ 2011 Proposed Rule, 76 Fed. Reg. at 52,778-79 tbl. 4, 52,782 tbl. 5.

Oil & Natural Gas Production (ONGP)²⁴⁶

Demographic group	% of U.S. population as a whole	% with increased cancer risk due to exposure to a facility that includes ONGP	% with increased cancer risk due to exposure to oil and gas source covered by the ONGP NESHAP
Minority (non-white)	25%	39%	38%
Other/multi-racial	12%	30%	25%
Hispanic	14%	34%	22%
Below the poverty level	13%	19%	14%

In sum, even if considering only those parts of the oil and gas sector covered by the NESHAP, EPA’s own data indicate significant concerns regarding the environmental justice impact of oil and gas activities. EPA must take this into account when determining the significance of the health risks posed by oil and gas well emissions.

d. EPA must consider and account for the numerous oil and gas well safety and drilling violations which lead to higher toxic air emissions.

EPA also must consider the many oil and gas well safety and drilling violations that occur each year, as these violations further exacerbate the risk that well emissions pose to public health. Recently, an Earthworks report that examined in detail the current state of oil and gas enforcement in several states concluded that “[t]he U.S. faces a crisis in the enforcement of rules governing the oil and gas industry,” adding that “states are dangerously unprepared to oversee current levels of extraction, let alone increased drilling activity from the shale boom.”²⁴⁷ As the report explains,

“Based on their own data, every state we studied fails to adequately enforce regulations on the books. Among our findings:

- Every year hundreds of thousands of oil and gas wells – 53 to 91% of wells in the states studied (close to 350,000 active wells in the six states in 2010) – are operating with no inspections to determine whether they are in compliance with state rules.
- When inspections do uncover rule violations, the violations often are not formally recorded – and the decision whether or not to record a violation is often left to the discretion of the individual inspector.
- When violations are recorded, they result in few penalties.

²⁴⁶ *Id.*

²⁴⁷ EARTHWORKS, *Breaking All the Rules—The Crisis in Oil and Gas Regulatory Enforcement: States Are Betraying the Public by Failing to Enforce Oil and Gas Development Rules* 8 (Sept. 2012), available at <http://www.earthworksaction.org/files/publications/FINAL-US-enforcement-sm.pdf>.

- When penalties are assessed, they provide little incentive for companies to not offend again.²⁴⁸

A subsequent report examining the impacts of drilling in Texas’s Eagle Ford shale play contrasts the growth in “emission events” at oil and gas production facilities with the decline in TCEQ’s enforcement resources. Since 2009, “unplanned toxic air releases associated with oil and gas production” have increased 100 percent statewide, but the state legislature “has cut the TCEQ’s budget by a third since the Eagle Ford boom began, from \$555 million in 2008 to \$372 million in 2014.”²⁴⁹ Similarly, the report notes that “[t]he number of employees in the TCEQ’s Office of Compliance and Enforcement, which conducts investigations and performs air monitoring and other health-related duties, has fallen 13 percent since 2010.”²⁵⁰

These issues pose potentially serious threats to public health, as those living near wells risk significant HAP exposure from excess emission events caused by mechanical malfunctions and operator errors—exposures that could be minimized by setting stronger standards and compliance requirements through an area source listing.

Additionally, a recent report prepared by the Democratic Staff of the House Natural Resources Committee discusses the failure to oversee drilling on public lands and how this endangers health and the environment. In all, 2,025 safety and drilling violation notices were issued to 335 companies drilling on public lands in seventeen states between February 1998 and February 2011.²⁵¹ Of these, 27 percent were classified by Committee staff as a major environmental or safety violation.²⁵²

There were many violations that could endanger health and safety of workers and the environment. An evaluation of the data found many examples of major environmental or safety violations reported during this period, including a 2008 blowout of a well in North Dakota that was not immediately reported to the DOI; an operator in Mississippi that did not install a blowout preventer or any other safety equipment to control the well in the event of a blowout; and an improper casing and cement job in Wyoming that led to leaks of water and gas through the cement of the well.²⁵³

Another example of health risks posed by a lack of regulation and oversight in the oil and gas industry recently made headlines in Texas, where high levels of benzene were documented

²⁴⁸ *Id.*

²⁴⁹ Jim Morris et al., *Big Oil, Bad Air: Fracking the Eagle Ford Shale of South Texas* (Feb 18, 2014), at <http://eagleford.publicintegrity.org/>.

²⁵⁰ *Id.*

²⁵¹ DEMOCRATIC STAFF OF THE HOUSE NATURAL RESOURCES COMMITTEE, *Drilling Dysfunction - How the Failure to Oversee Drilling on Public Lands Endangers Health and the Environment*, 4 (Feb. 8, 2012), available at http://democrats.naturalresources.house.gov/sites/democrats.naturalresources.house.gov/files/2012-02-08_RPT_DrillingDysfunction_0.pdf.

²⁵² *Id.*

²⁵³ *Id.*

on the Barnett Shale. At one well site in particular, “[b]enzene was one of 35 airborne chemicals leaking at the well in amounts above the environmental commission’s level for short-term effects, signaling the potential for health problems with only brief exposure. The benzene level at the well, 15,000 parts per billion, was more than 83 times the short-term effects level of 180 ppb.”²⁵⁴

e. EPA must consider and account for the data gaps that exist in current emissions inventories and fracturing chemical disclosures.

The risks well emissions pose to public health are likely much greater than current studies show because emissions estimates and inventories are not complete. As some Petitioners requested in their petition to EPA for reconsideration of the 2012 NESHAP for the oil and gas sector, the agency must collect current data on the amount of toxic air emissions from oil and gas operations, including wells.²⁵⁵ A 2013 report from EPA’s Inspector General (“IG”) reiterates the need for EPA to strengthen the quantity and quality of data it has on the entire oil and gas sector, including wells.²⁵⁶ As the IG found, “EPA has limited directly-measured air emissions data for air toxics and criteria pollutants for several important oil and gas production processes and sources, including well completions and evaporative ponds,” and its emission factors are of “questionable quality.”²⁵⁷ As a result of these problems, and the fact that the national emission inventory includes so little data, the IG found that the emission inventory “likely underestimates oil and gas emissions.”²⁵⁸ Further, as the aforementioned study published by a consortium of authors from NOAA and the University of Colorado found, the available inventories of hydrocarbon emissions from oil and gas facilities in the study area did not correlate with observed atmospheric observations and were likely underestimates.²⁵⁹ Additionally, a report by the Central States Regional Air Partnership (“CENRAP”) identified the need to improve the oil and gas area source inventories for the CENRAP region, with a focus on the states of Texas, Louisiana, Oklahoma, Arkansas, Kansas and Nebraska.²⁶⁰ Remarks made in both citizen petitions and comments related to the oil and gas production industry have also noted this issue

²⁵⁴ Loftis, *supra* note 72.

²⁵⁵ Sierra Club et al., Petition for Reconsideration of Oil and Natural Gas Sector: National Emission Standards for Hazardous Air Pollutants Reviews; Final Rule, 77 Fed. Reg. 49,490 (Aug. 16, 2012), 40 C.F.R. Part 63, Subparts HH and HHH, Dkt. ID No. EPA-HQ-OAR-2010-0505-4591 at 35 (Oct. 15, 2012).

²⁵⁶ EPA, INSPECTOR GEN., *EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sector*, Report No. 13-P-0161 (Feb. 20, 2013).

²⁵⁷ *Id.* (executive summary).

²⁵⁸ *Id.*

²⁵⁹ Pétron, *supra* note 43, at 1 (This study was conducted in Weld County, CO. It took a regional approach, using data collected over 3 years by both fixed and mobile sampling equipment looking for sources and mixing ratios of methane and benzene and several other non-methane hydrocarbons.).

²⁶⁰ ENVIRON, *Recommendations for Improvements to the CENRAP States’ Oil and Gas Emissions Inventories* at ES-1 (2008), http://www.wrapair.org/forums/ogwg/documents/2008-11_CENRAP_O&G_Report_11-13.pdf.

in greater detail.²⁶¹ As such, EPA should take a comprehensive approach to address the data gaps on the oil and gas sector for wells and all other parts of the sector, in response to this petition and the Sierra Club *et al.* petition for reconsideration of the 2012 oil and gas sector NESHAP.

Additional data gaps exist in fully evaluating potential health effects caused by emissions from hydraulically fractured wells. Many of the chemicals used by these wells (and their associated HAP emissions) are unknown, in part due to a “trade secret” exemption to the chemical disclosure process that drilling companies frequently utilize.²⁶² EPA’s decision to perform a study on hydraulic fracturing and its human health effects on drinking water shows that EPA must also perform a full assessment to evaluate the ways in which fracturing affects air toxics in areas near wells, starting by collecting emission test data.²⁶³

Although EPA should gather additional data to further evaluate the health effects and promulgate an appropriate regulatory response, EPA must not delay in listing well facilities as area sources. There is ample existing evidence referenced in and attached to this Petition demonstrating that these sources pose more than a negligible risk to public health, thereby warranting an immediate area source designation.

D. Existing technology is available to reduce oil and gas wells’ toxic emissions.

Technology that is available and is already in use in some places can reduce oil and gas well emissions, showing that HAP reductions have been achieved and are achievable. These technologies have been demonstrated throughout well facilities.

- Well completion: EPA’s regulation of some wells in the New Source Performance Standards for the oil and gas sector shows that green completions and other reduced VOC emission requirements are available and effective.²⁶⁴ These techniques can also be applied to oil-producing wells, which are currently not subject to the New Source Performance Standards, but are a rapidly growing source of HAP emissions in light of

²⁶¹ See *Sierra Club NESHAP Comments*, *supra* note 153 at 22 (“Other HAPs are also likely to be emitted that EPA did not capture due to its lack of emission test data. Both EPA and the public need more information about oil and gas chemicals used in the United States today for hydraulic fracturing, because many are either not disclosed, or the public has limited or no information about the health risks associated with them.”); see also Earthjustice et al., *Citizen Petition under TSCA Regarding the Chemical Substances and Mixtures Used in Oil and Gas Exploration or Production* (Aug. 4, 2011).

²⁶² See *House Committee Report*, *supra* note 143, at 2 (“Between 2005 and 2009, the companies used 94 million gallons of 279 products that contained at least one chemical or component that the manufacturers deemed proprietary or a trade secret.”).

²⁶³ See EPA, *EPA’s Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources*, at <http://www.epa.gov/hfstudy/> (last updated Nov. 15, 2013).

²⁶⁴ See EPA, *Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution, Background Technical Support Document for the Proposed Rules* (“TSD”) at § 4.4 (July 2011) (Document ID No. EPA-HQ-OAR-2010-0505-0045).

major shale oil reservoir development expansion in Texas' Eagle Ford and California's Monterey shale reserve, among others.²⁶⁵

- Flares: Flaring can be reduced or capped except when necessary to avoid emergencies.²⁶⁶ Emissions from flares also can be reduced with the use of enclosed combustion devices.²⁶⁷ As EPA's own research shows, flaring also can be made more effective by implementing better flare monitoring programs, requiring operators to justify each time they flare, and requiring operators to ensure efficient flare operation.²⁶⁸
- Plunger lifts for liquids unloading: Emissions released from liquids unloading and other well cleanup activities can be reduced or eliminated with the use of plunger lifts.²⁶⁹ Emissions from liquids unloading are not controlled by EPA's new source performance standards.
- Compressors: Gas leakage and emissions from wellhead compressors (which are not subject to the NSPS) can be substantially reduced using centrifugal compressors

²⁶⁵ See, e.g., 2 Colo. Code Regs. § 404-1(805)(b)(3)(A) (requiring green completions on both oil and gas wells "where reservoir pressure, formation productivity, and wellbore conditions are likely to enable the well to be capable of naturally flowing hydrocarbon gas in flammable or greater concentrations at a stabilized rate in excess of five hundred (500) MCFD to the surface against an induced surface backpressure of five hundred (500) psig or sales line pressure, whichever is greater"); WYOMING DEP'T OF ENVTL. QUALITY, *Oil and Gas Production Facilities Chapter 6, Section 2 Permitting Guidance* at 15, 20 (2010) [hereinafter *Wyoming Guidance*], available at <http://deq.state.wy.us/aqd/oilgas.asp>; Clean Air Council et al., Petition for Reconsideration of Oil and Natural Gas Sector New Source Performance Standards, Dkt. ID No. EPA-HQ-OAR-2010-0505-4575 at 10-14 (Oct. 15, 2012) (discussing growth in oil production and recent data showing significant emissions from co-producing oil and gas wells).

²⁶⁶ See Chad A. Wocken et al., *End-Use Technology Study – An Assessment of Alternative Uses for Associated Gas* at 90 (Apr. 2013), available at http://www.undeerc.org/bakken/pdfs/CW_Tech_Study_April-2013.pdf (concluding that natural gas liquid removal and distributed power generation "hold near-term promise" for reducing flaring by putting non-traditional natural gas to productive uses).

²⁶⁷ Cindy Copeland and Megan Williams, *Methane Related Comments on EPA's "Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews," Proposed Rule 22-23* (Nov. 29, 2011), Document ID No. EPA-HQ-OAR-2010-0505-4460-0017.

²⁶⁸ See, e.g., *EPA Flare Parameters*, *supra* note 126, at 1-1 to 1-2 (listing factors that can impair flare efficiency); *id.* at 8-1 (explaining the monitoring equipment needed to ensure efficient flare operation); see also, e.g., Bay Area Air Quality Mgmt. Dist., Regulation 12, Rules 11 & 12 (Flare Monitoring at Petroleum Refineries and Flares at Petroleum Refineries).

²⁶⁹ See, e.g., Methane to Markets, Oil & Gas Subcommittee Technology Transfer Workshop, *Reduced Emission Completions/Plunger Lift and Smart Automation*, 26-27 (Nov. 5, 2008), https://www.globalmethane.org/documents/events_oilgas_20090127_techtrans_day2_robinson1_en.pdf (describing successful plunger lift projects); BP, *Plunger Well Vent Reduction Project*, 18 (2006), www.epa.gov/gasstar/documents/desaulniers.pdf (describing "great success" with plunger lifts).

equipped with tandem dry seal systems.²⁷⁰ Emissions from compressor turbines also can be reduced if driven by electric motors.

- Storage vessels/Produced water ponds: Storage vessels already are achieving 98% emissions reductions in jurisdictions such as Wyoming through the use of certain types of vapor recovery units.²⁷¹ This level of emission reduction exceeds the 95% control efficiency required for certain new storage vessels under the NSPS. Similarly rigorous controls could be applied to existing storage vessels at area sources, which are currently not subject to NSPS or NESHAP. Measures addressing emissions from similar impoundments, pits, sumps, and well cellars include prohibitions against organic liquid storage in well cellars and on primary sumps, requirements to cover vessels/pits with VOC impervious material, and replacing open pits with liquid storage tanks equipped with a vapor recovery unit.²⁷²
- Leak Detection and Repair: LDAR programs should apply to wellheads, compressors and storage vessels and related components and equipment, requiring highly sensitive monitoring systems, use of leakless components, frequent monitoring and low leak detection thresholds of 100 ppm for valves in gas/vapor/light liquid services, and 500 ppm for pumps in light liquid service, and prompt repair requirements with no loopholes.²⁷³ Currently, the NSPS and NESHAP for oil and gas facilities only require LDAR at natural gas processing plants and for certain types of closed vent systems on storage vessels located at major sources.

Requirements to implement these technologies and practices at oil and gas wells and their associated equipment will achieve significant toxic pollution reductions not accomplished by the 2012 Rule. As discussed above, among other loopholes, the NSPS only applies to new wells, leaving the entire fleet of existing wells unregulated, and it exempts oil producing wells from regulation.

²⁷⁰ EPA Natural Gas STAR, *Lessons Learned: Replacing Wet Seals with Dry Seals in Centrifugal Compressors*, 1 (Oct. 2006), www.epa.gov/gasstar/documents/ll_wetseals.pdf; see also EPA, *Methane Savings from Compressors and VRUs*, 11-14 (July 27, 2006), epa.gov/gasstar/documents/savings.pdf (showing low emissions from dry seals and concluding that such seals “often used in tandem” are profitable to install in many circumstances).

²⁷¹ Copeland and Williams, *supra* note 267, at 52; See also *Wyoming Guidance*, *supra* note 265, at 5, 11, 18 (requiring such controls).

²⁷² Ventura County Air Pollution Control Dist. Rule 71.4(B), (C)(1)(c); So. Coast Air Quality Mgmt. Dist. Rule 1148.1(d)(1)-(3), (6); Santa Barbara County Air Pollution Control Dist. Rules 344(D)(1)-(3), 325(D); San Joaquin Valley Air Pollution Control Dist. Rule 4402(5).

²⁷³ See generally Bay Area Air Quality Mgmt. Dist. Regulation 8, Rule 18; Carbon Limits AS, *Quantifying Cost-Effectiveness of Systematic Leak Detection and Repair Programs Using Infrared Cameras* 6 (prepublication draft Dec. 24, 2013), at http://www.catf.us/resources/publications/files/CATF-Carbon_Limits_Leaks_Interim_Report.pdf (finding that abatement costs for LDAR programs at well sites range from \$0 to \$300 per ton of VOC emissions eliminated); ICF International, *Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries* 4-11 to 4-13 (Mar. 2014), at www.edf.org/content/ifc-methane-report (showing cost-effectiveness of HAP reductions achieved through control measures at oil and gas facilities, including LDAR programs).

II. BASED ON THE NEED TO PROTECT PUBLIC HEALTH, THE ADMINISTRATOR MUST LIST AN AREA SOURCE CATEGORY FOR OIL AND GAS PRODUCTION WELLS AND ASSOCIATED EQUIPMENT LOCATED IN THE SECTION 112(n)(4)(B) AREAS.

A. EPA has authority to list oil and gas wells and their associated equipment and to regulate their toxic air emissions.

Section 112(c)(3) of the CAA directs EPA to list “each category or subcategory of area sources which the Administrator finds presents a threat of adverse effects to human health or the environment (by such sources individually or in the aggregate)” warranting regulation under section 112.²⁷⁴ EPA listed oil and natural gas production as an area source category after EPA identified it in the Urban Air Toxics Strategy as warranting regulation in part because of benzene emissions.²⁷⁵ However, EPA has not yet regulated toxic air emissions from oil and gas wells under section 112.²⁷⁶

EPA has the authority to regulate these sources pursuant to section 112(n)(4)(B), which provides an exception to what is otherwise a prohibition on listing oil and gas wells and associated equipment as an area source category under section 112(c).²⁷⁷ This provision authorizes EPA to list oil and gas production wells and their associated equipment²⁷⁸ located in “any metropolitan statistical area” or “a consolidated metropolitan statistical area with a

²⁷⁴ 42 U.S.C. § 7412(c). An “area source” is “any stationary source of hazardous air pollutants that is not a major source.” *Id.* § 7412(a)(2).

²⁷⁵ See EPA, National Emission Standards for Hazardous Air Pollutants: Oil and Natural Gas Production and National Emission Standards for Hazardous Air Pollutants: Natural Gas Transmission and Storage, 64 Fed. Reg. 32,610 (June 17, 1999); 2007 Oil and Gas Area Source NESHAP, 72 Fed. Reg. 26. EPA had previously listed oil and natural gas production as a major source category in 1992. EPA, Initial List of Categories of Sources Under Section 112(c)(1) of the Clean Air Act Amendments of 1990, 57 Fed. Reg. 31,576 (July 16, 1992) [hereinafter “Initial Listing Rule”]. EPA explicitly excluded oil and gas wells (and associated equipment) from the source category. EPA, *Documentation for Developing the Initial Source Category List*, EPA-450/3-91-030 at A-25 (July 1992).

²⁷⁶ See 40 C.F.R. § 63.760 (applicability and designations of affected sources for oil and gas production NESHAP). EPA’s area source standards regulate only glycol dehydrators at oil and gas production facilities above certain thresholds, with differing regulation depending upon proximity to populated areas. *See id.*

²⁷⁷ 42 U.S.C. § 7412(n)(4)(B).

²⁷⁸ Although section 112(n)(4)(B) does not repeat the clarifying parenthetical, “(with its associated equipment)” when directing EPA to “establish an area source category for oil and gas production wells,” 42 U.S.C. § 7412(n)(4)(B), nothing in the Act compels the irrational interpretation that an area source category covering oil and gas wells must apply standards to the wells exclusively, and not also the equipment used in the production operations that occur at those wells. The term “associated equipment” is not defined in the Act, but EPA has interpreted it to include “all equipment from the wellbore to the point of custody transfer, except glycol dehydration units and storage vessels.” *See* 40 C.F.R. § 63.761; *cf.* 40 C.F.R. § 63.765 (glycol dehydration unit process vent standards); 40 C.F.R. § 63.766 (storage vessel standards).

population in excess of one million” as area sources if EPA determines that emissions of hazardous air pollutants from such wells present “more than a negligible risk” of adverse effects to public health.²⁷⁹ As explained below, this test is met and EPA action is urgently needed to make this determination.²⁸⁰

1. The best available evidence shows EPA must find wells pose “more than a negligible risk of adverse effects to public health.”

In order for EPA to exercise its authority under section 112(n)(4)(B), it must make a determination that oil and gas well emissions pose “more than a negligible risk of adverse effects to public health.”²⁸¹ The plain meaning of “negligible” makes clear that this was intended to be a low threshold.

According to Webster’s dictionary, “negligible” means “so small or unimportant or of so little consequence as to warrant little or no attention.”²⁸² Under a faithful reading of this phrase, for EPA to regulate oil and gas wells, they just need to pose a health risk that is not unimportant or inconsequential. This is a low threshold that is easily met by the evidence presented in this Petition.

As described in Part I above and shown by sources listed in the Appendix, studies have found pollutants emitted by oil and gas wells (and associated equipment) cause cancer and other kinds of dangerous chronic and acute health impacts. Substantial numbers of oil and gas wells and associated equipment (such as nearby compressors, waste water impoundments, condensate and storage tanks, and drilling equipment), exist in section 112(n)(4)(B) areas and emit hazardous air pollutants on a daily basis. People living in the relevant areas need health protection from oil and gas well facilities. Toxic air pollutants are of particular concern in the areas covered by section 112(n)(4)(B) because now more than ever, people and sources of emissions are concentrated together in the same geographic area.²⁸³ For people living near current and potential wells, the increased likelihood of cancer, neurological harm, birth defects, trouble breathing, nausea, and other impacts is certainly “more than a negligible” health threat, and EPA should so find and list this new area source category.

²⁷⁹ 42 U.S.C. § 7412(n)(4)(B).

²⁸⁰ In addition, EPA defined the oil and natural gas production source category as a whole to include “equipment leaks, storage tanks, power generating equipment, wastewater treatment, and process vents.” EPA, *Documentation for Developing the Initial Source Category List*, *supra* note 275, at A-25 (including “the processing and upgrading of crude oil prior to entering the petroleum refining process and natural gas prior to entering the transmission line”). Thus, in addition to listing and regulating oil and gas wells and associated equipment, EPA must fulfill its responsibility to regulate the full, listed area source category (not just TEG dehydration units or glycol dehydrators), as required by section 112(c)(5) and (d)(1). 42 U.S.C. § 7412(c)(5), (d)(1) (requiring EPA to set standards under § 112(d) to control emissions from each listed source category within 2 years after listing the source category, or by November 15, 2000, whichever is later).

²⁸¹ 42 U.S.C. § 7412(n)(4)(B).

²⁸² WEBSTER’S NEW COLLEGIATE DICTIONARY 769 (1974 ed.).

²⁸³ EPA, RISK ASSESSMENT AND MODELING, *supra* note 243, Part I Background, at 1-2.

a. Cancer risk is more than negligible.

The fact that these sources emit pollutants that create cancer risk, as described in Part I, above, requires listing. No level of exposure to cancer-causing pollutants and no level of cancer risk is insignificant or negligible. In enacting section 112 of the Act, Congress made this clear, stating that “Federal Government health policy since the mid-1950s has been premised on the principle that there is no safe level of exposure to a carcinogen and, unless all of the sources in the category are so remote that no human exposure occurs (a circumstance unclaimed for any source category at this time), standards should be imposed and the discretion not to act would be inappropriate.”²⁸⁴

In addition, EPA should fully evaluate this source category to assess the real-world cancer risk that it causes. Available data suggest that residents living near well pads face an estimated lifetime excess cancer risk well above one-in-one million, which is at least “more than negligible.”²⁸⁵ Congress has repeatedly recognized this level of cancer risk as problematic under CAA § 112.²⁸⁶ For example, under section 112(c)(9), EPA may not delete any source category from the list of area sources if it poses a cancer risk “greater than one in one million” to the most exposed person.²⁸⁷ This prohibition on delisting shows that Congress believed cancer risk above that level is, at least, more than negligible. As another example, in defining the requirement for health risk standards under section 112(f)(2), Congress directed that if lifetime cancer risk for the most-exposed person has not been reduced to “less than one in one million, the Administrator shall promulgate standards” under section 112(f).²⁸⁸ Because the statute triggers regulation at that level, it, at minimum, also shows a congressional concern for cancer risk at that level, indicating that it is, at least, more than negligible.

Consistent with Congress’s approach, the D.C. Circuit has also recognized that preventing cancer risk above one-in-one million is an “aspirational goal” established by section 112(f)(2).²⁸⁹ Similarly, EPA has found that cancer risk of one in one million or more contributes

²⁸⁴ S. REP. NO. 101-228, at 175 (1989), 1990 U.S.C.C.A.N. 3385, 3560.

²⁸⁵ See, e.g., Witter, *supra* note 189, at 24-25.

²⁸⁶ As discussed in section I.C.7 above, current data likely underestimates the total risk, and to account for this, EPA must evaluate the real-world health risk for children and overburdened communities. For example, EPA must use children’s health (i.e., age-dependent adjustment factors) to assess risk from all carcinogens (as Cal. EPA OEHHA does); EPA must use an in-utero (children’s health) exposure factor of 10X to assess cancer risk (as OEHHA does); EPA must apply child-health reference doses where they have been developed (including those created by OEHHA); EPA must evaluate the cumulative impacts of exposure to multiple pollutants, from multiple sources, through multiple pathways; EPA must use additional factors to account for uncertainty and vulnerability, including based on environmental justice impacts. Petitioners have provided EPA with information on these issues and will be glad to provide additional information at EPA’s request.

²⁸⁷ 42 U.S.C. § 7412(c)(9)(B)(i).

²⁸⁸ *Id.* § 7412(f)(2)(A).

²⁸⁹ *NRDC v. EPA*, 529 F.3d 1077, 1082 (D.C. Cir. 2008). The court also found that 1-in-200,000 or 5-in-1 million was “sufficient to support standing,” demonstrating that this level could not be negligible. *NRDC v. EPA*, 464 F.3d 1, 7 (D.C. Cir. 2006).

to a “determination of [the] unacceptability” of health risk created by an air toxics source category.²⁹⁰

b. Non-cancer chronic and acute health risks are more than negligible.

The threat of other non-cancer health impacts from wells’ toxic air emissions is also important and shows the need for listing. As described above, oil and gas wells can emit many pollutants that are associated with non-cancer chronic and acute health risks. And, as an example, one community health risk assessment found acute and chronic non-cancer risk well above the level at which harmful health impacts can occur.²⁹¹ Moreover, similar to the one in one million cancer risk threshold discussed above, the fact that EPA may not delist a source category under section 112(c)(9) unless no source’s emissions “exceed a level which is adequate to protect public health with an ample margin of safety and no adverse environmental effect will result from emissions from any source ([or group of sources]),” indicates that Congress considered that level of health risk to be, at least, more than negligible for pollutants that may result in adverse effects other than cancer.²⁹² Because oil and gas wells emit HAPs that cause acute and chronic (non-cancer) health impacts, EPA has information showing that it must list oil and gas wells as an area source.

c. Listing oil and gas wells would serve the objectives of § 112(c)(3) and would be consistent with EPA’s past area source listings.

CAA § 112(c)(3) directs EPA to list each area source category “which the Administrator finds presents a threat of adverse effects to human health or the environment (by such sources individually or in the aggregate) warranting regulation.”²⁹³ This test is similar to the “more than negligible risk” test enacted in § 112(n)(4)(B). In each instance, as EPA has recognized, all that is required is a “threat” of harm.²⁹⁴

EPA has interpreted the Act as not creating a “bright line” rule for what is required to list and regulate area sources, but directing a consideration of various relevant factors, including “the number of sources in a category, the quantity of emissions from sources individually or in aggregate, the toxicity of the HAP emissions, the potential for individual and population exposures and risks, and the geographical distribution of sources.”²⁹⁵ EPA has evaluated cancer

²⁹⁰ EPA, National Emissions Standards for Hazardous Air Pollutants from Secondary Lead Smelting, 77 Fed. Reg. 556, 563 (Jan. 5, 2012).

²⁹¹ Witter, *supra* note 189, at 23-24 (finding hazard index of 40 for acute risks and of 2 for chronic non-cancer risks); McKenzie, *supra* note 51, at 83-86 (suggesting the existence of increased respiratory, neurological and cancer risks for people in proximity to wells).

²⁹² 42 U.S.C. § 7412(c)(9)(B)(ii).

²⁹³ *Id.* § 7412(c)(3).

²⁹⁴ Initial Listing Rule, 57 Fed. Reg. at 31,586-87 (finding § 112(c)(3) requires a “threat of adverse effect, not a demonstration of the adverse effect, per se”).

²⁹⁵ Initial Listing Rule, 57 Fed. Reg. at 31,587; *Accord* EPA, National Emission Standards for Hazardous Air Pollutants from Secondary Lead Smelting, Final Rule, 60 Fed. Reg. 32,587, 32,591 (June 23, 1995) [hereinafter “Secondary Lead Smelting Rule”].

and other kinds of health threats, including “carcinogenicity, mutagenicity, teratogenicity, neurotoxicity, reproductive dysfunction and other acute and chronic effects.”²⁹⁶ Regarding cancer risk, the agency has also noted that:

In making area source listing determinations, the EPA strives to provide maximum feasible protection against risks to health from HAP’s by: (1) Protecting the greatest number of persons possible to an individual lifetime cancer risk level of no higher than approximately 1 in 1 million and (2) limiting to no more than 1 in 10,000 the estimated cancer risk to the hypothetical maximum exposed individual.²⁹⁷

Listing oil and gas wells would be consistent with that approach for area sources because these sources have cancer risk above the level of one-in-one million, and also cause other kinds of health threats identified by EPA, as described in Part I.

Further, listing oil and gas wells and associated equipment would be consistent with EPA’s listings of other specific categories of area sources, including glycol dehydrators at oil and gas production facilities.²⁹⁸ Oil and gas wells (and associated equipment) emit similarly dangerous pollutants, cause similarly harmful health risks (including a risk of cancer), and are affecting populated communities, as EPA found for other listed area sources.²⁹⁹

d. Listing oil and gas wells would fulfill the objectives of the Area Source Program under 112(k).

EPA also must list oil and gas wells to meet the objectives of the Area Source Program and CAA § 112(k), as well as § 112(n)(4)(B). As Congress found in establishing the Area Source Program of the Clean Air Act, “emissions of hazardous air pollutants from area sources may individually, or in the aggregate, present significant risks to public health in urban areas.”³⁰⁰ Further, “[c]onsidering the large number of persons exposed and the risks of carcinogenic and other adverse health effects from hazardous air pollutants,” Congress determined that “ambient concentrations characteristic of large urban areas should be reduced to levels *substantially below* those currently experienced.”³⁰¹

Benzene is one of the 30 pollutants EPA included in the Urban Air Toxics Strategy under CAA § 112(k)(3)(B)(i), “which, as the result of emissions from area sources, present the greatest

²⁹⁶ Initial Listing Rule, 57 Fed. Reg. at 31,586.

²⁹⁷ Secondary Lead Smelting Rule, 60 Fed. Reg. at 32,591.

²⁹⁸ See *supra* notes 275-76, and accompanying text.

²⁹⁹ For example, EPA listed secondary lead smelters as an area source category because of their cancer and non-cancer risk. Secondary Lead Smelting Rule, 60 Fed. Reg. at 32,591. In other area source determinations, EPA listed sources due to their combination of health risks, including cancer. Initial Listing Rule, 57 Fed. Reg. at 31,588-80 (describing findings for commercial sterilizers using ethylene oxide, chromium electroplaters and anodizers, halogenated solvent cleaners, and asbestos processing).

³⁰⁰ 42 U.S.C. § 7412(k)(1).

³⁰¹ *Id.*

threat to public health in the largest number of urban areas.”³⁰² This provision requires EPA to “assure that sources accounting for 90 [percent] or more of the aggregate emissions of each of the 30 identified hazardous air pollutants are subject to standards pursuant to subsection (d) of [section 112].”³⁰³ EPA identified certain pieces of equipment in the oil and gas production sector as an area source requiring regulation as part of the Strategy, in part because they contributed 47 percent of the national urban benzene emissions from area sources.³⁰⁴ Oil and gas wells are also a significant source of benzene in urban areas covered by § 112(n)(4)(B), as well as formaldehyde and other listed pollutants, and they likely will become even more significant sources with the continued expansion of oil and gas development at the urban interface. EPA should therefore regulate them to fulfill the directives of § 112(k) and 112(c) and its outlined objectives for the Area Source Program.

2. EPA must protect all communities covered by CAA § 112(n)(4)(B) from the health risk created by oil and gas wells.

Substantial areas of the United States are included in the geographical areas to which section 112(n)(4)(B) applies. Part I, above, has provided many examples of these areas that have oil and gas wells, and many additional areas are slated for potential shale development, requiring urgent EPA action.

Section 112(n)(4)(B) authorizes EPA to list oil and gas wells as area sources in any “metropolitan statistical area” (“MSA”) or “consolidated metropolitan statistical area with a population in excess of one million” (“CMSA”).³⁰⁵ This covers both metropolitan areas (including counties connected to cities) and larger, consolidated areas (of multiple cities and counties). It is consistent with the purposes of the Clean Air Act, including the protection of public health and welfare and pollution prevention³⁰⁶ and the objectives of the air toxics program in section 112 to ensure that EPA effectively regulates dangerous air toxics,³⁰⁷ to interpret the relevant statistical area terms to cover as many affected communities as possible.

As an initial matter, the “population in excess of 1 million” requirement in § 112(n)(4)(B) applies only to consolidated metropolitan statistical areas. The statute extends coverage under

³⁰² *Id.* § 7412(k)(3)(B)(i); EPA, National Air Toxics Program: The Integrated Urban Strategy, 64 Fed. Reg. 38,706, 38,715 tbl. 1 (July 19, 1999).

³⁰³ 42 U.S.C. § 7412(k)(3)(B)(ii).

³⁰⁴ 2007 Oil and Gas Area Source NESHAP, 72 Fed. Reg. at 28. However, in setting area source standards for oil and gas production, EPA only restricted the emissions of glycol dehydrators (TEG dehydration units), and did so based on a cut-off and geographical distinctions, so that it did not even regulate all of these sources, or apply the same standard. *Id.* at 28-29.

³⁰⁵ 42 U.S.C. § 7412(n)(4)(B).

³⁰⁶ 42 U.S.C. § 7401(b)(1), (c).

³⁰⁷ *See, e.g., Sierra Club v. Jackson*, 2011 WL 181097, at *1 (D.D.C. Jan. 20, 2011) (“The purpose of these revisions was to ‘entirely restructure the existing law, so that toxics might be adequately regulated by the Federal Government.’” (quoting S. REP. NO. 101-228, at 128 (1989), 1990 U.S.C.C.A.N. 3385, 3513); *see also NRDC v. EPA*, 489 F.3d 1364, 1368 (D.C.Cir.2007). In setting standards under § 112, “maximum protection of human health shall be the objective test.” S. REP. NO. 101-228, at 168 (1989), 1990 U.S.C.C.A.N. 3385, 3553.

this provision to sources in “any metropolitan statistical area or consolidated metropolitan statistical area with a population in excess of 1 million,”³⁰⁸ not “any metropolitan statistical area with a population in excess of 1 million or consolidated metropolitan statistical area with a population in excess of 1 million.” The “rule of last antecedent”³⁰⁹ confirms that the population requirement applies only to CMSAs. Under this rule, relative or modifying phrases such as “with a population in excess of 1 million” are to be applied only to words immediately preceding them—here, “consolidated metropolitan statistical areas”—and are not to be construed as extending to more remote phrases, such as “metropolitan statistical areas.”

Although it is clear that the population threshold in section 112(n)(4)(B) applies only to CMSAs, neither section 112, nor the rest of the Clean Air Act provides a specific definition of the terms MSA and CMSA. Elsewhere in some places, the Act refers to the definitions “established by the Bureau of the Census” or “the Office of Management and Budget.”³¹⁰ These references reflect the shifting responsibility within the federal government for identifying MSAs and CMSAs. Formerly, the Census Bureau used MSA and CMSA delineations created by the Department of Commerce, but now OMB establishes these delineations.³¹¹

At the time of the 1990 Clean Air Act Amendments, the standards defining the terms MSA and CMSA for use by the Census Bureau were issued in 1980 by the Office of Federal

³⁰⁸ 42 U.S.C. § 7412(n)(4)(B).

³⁰⁹ See generally *Barnhart v. Thomas*, 540 U.S. 20, 26 (2003) (explaining that according to the grammatical “rule of the last antecedent,” a limiting clause or phrase should ordinarily be read as modifying only the noun or phrase that it immediately follows, and that while this rule is not an absolute and can be overcome by other indicia of meaning, construing a statute in accord with the rule is “quite sensible as a matter of grammar”).

³¹⁰ See, e.g., 42 U.S.C. § 7407(d)(4)(A)(iv) (referring to “a metropolitan statistical area or consolidated metropolitan statistical area (as established by the Bureau of the Census),” and expanding ozone and carbon monoxide nonattainment areas to include the entire MSA or CMSA within which they are located); *id.* § 7511a(h)(1) (referring to “a Metropolitan Statistical Area or, where one exists, a Consolidated Metropolitan Statistical Area (as defined by the United States Bureau of the Census),” and addressing “rural transport areas” for ozone); *id.* § 7512a(b)(3)(A) (referring to “the Consolidated Metropolitan Statistical Area (as defined by the United States Office of Management and Budget) (CMSA)” and if the area is not located in a CMSA, the Metropolitan Statistical Area (as defined by the United States Office of Management and Budget),” and addressing requirements for oxygenated gasoline). The following CAA provisions also use these terms, like § 112(n)(4)(B), without reference to the Census Bureau or OMB: 42 U.S.C. §§ 7511c(a) (ozone transport regions), 7545(m)(2) (oxygenated gasoline in CO nonattainment areas), 7554(c)(2)(A) (low-polluting fuel requirement for urban buses in MSAs or CMSAs with a 1980 population of 750,000 or more).

³¹¹ See U.S. CENSUS BUREAU, *About Metropolitan and Micropolitan Statistical Areas*, <http://www.census.gov/population/metro/about/>; U.S. CENSUS BUREAU, *Metropolitan and Micropolitan Statistical Areas Main*, <http://www.census.gov/population/metro/>. See also OMB, *Alternative Approaches to Defining Metropolitan and Nonmetropolitan Areas*; Notice, 63 Fed. Reg. 70,526, 70,527-31 & tbl.1 (Dec. 21, 1998) (describing the history of these terms); OMB, *Statistical Programs and Standards: Metropolitan Statistical Areas*, at http://www.whitehouse.gov/omb/inforeg_statpolicy#pr; OMB, *Statistical Programs and Standards, cont'd. Metropolitan Statistical Areas, cont'd: Background Documents*, at http://www.whitehouse.gov/omb/regulatory_affairs/inforeg_msa_backgrd/.

Statistical Policy and Standards (Department of Commerce).³¹² The Department of Commerce then defined the term “metropolitan statistical area” to mean an area that includes a city with a population of at least 50,000, or an urbanized area with a population of at least 50,000 and a total MSA population of at least 100,000.³¹³ A typical MSA included central counties (with the main population concentration) and “outlying counties which have close economic and social relationships with the central counties,” including commuting ties, and a certain level of population density.³¹⁴ At that time, CMSAs were areas that included over 1 million population, with more than one MSA with a large urbanized county or county cluster and “very strong internal economic and social links.”³¹⁵ Each term also included both urban areas and less-populated areas related to them, including some territory “where the population density is less than 1,000 persons per square mile.”³¹⁶

In the intervening decades, OMB has made several adjustments to the criteria governing metropolitan area delineations.³¹⁷ OMB issued its most recent interpretation of these terms in 2010.³¹⁸ OMB currently defines the term “metropolitan statistical area” to mean: at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties.³¹⁹ The term “urbanized area” means: “A statistical geographic entity delineated by the Census Bureau,

³¹² See Dep’t of Commerce, Ofc. of Fed. Statistical Policy & Standards, Metropolitan Statistical Area Classification, 45 Fed. Reg. 956 (Jan. 3, 1980) [hereinafter “1980 Standards”]. While Congress was considering the 1990 amendments to the Clean Air Act, OMB issued revised standards for delineating MSAs and CMSAs. See OMB, Revised Standards for Defining Metropolitan Areas in the 1990’s, 55 Fed. Reg. 12,154 (Mar. 30, 1990). However, the OMB standards did not take effect until after the 1990 Clean Air Act amendments were enacted. See *id.* at 12,154 (explaining that the 1980 standards “remain in effect until the list of metropolitan areas [meeting the new standards] is issued in June 1992”).

³¹³ 1980 Standards, 45 Fed. Reg. at 956, 959.

³¹⁴ *Id.* at 956. In New England, MSAs include cities and towns instead of whole counties. *Id.*

³¹⁵ *Id.* (the 1980 statistical area definitions that the 1990 delineations were based on defined consolidated metropolitan statistical areas as follows: “In areas with over 1 million population . . . primary metropolitan statistical areas may be identified. These areas consist of a large urbanized county, or cluster of counties, that demonstrates very strong internal economic and social links, in addition to close ties to neighboring areas. When primary metropolitan statistical areas are defined, the large area of which they are component parts is designated a consolidated metropolitan statistical area.”).

³¹⁶ *Id.* at 957.

³¹⁷ See, e.g., OMB, Revised Standards for Defining Metropolitan Areas in the 1990’s, 55 Fed. Reg. 12,154 (Mar. 30, 1990); OMB, Standards for Defining Metropolitan and Micropolitan Statistical Areas, 65 Fed. Reg. 82,228 (Dec. 27, 2000); OMB, 2010 Standards for Delineating Metropolitan and Micropolitan Statistical Areas, 75 Fed. Reg. 37,246 (June 28, 2010). OMB’s most recent list of these areas is from 2013 (based on the 2010 census). OMB BULLETIN 13-01, *supra* note 25.

³¹⁸ See OMB, 2010 Standards for Delineating Metropolitan and Micropolitan Statistical Areas, 75 Fed. Reg. 37,246 (June 28, 2010) [hereinafter “2010 Standards”].

³¹⁹ 2010 Standards, 75 Fed. Reg. at 37,252 (defining metropolitan statistical area as: “A Core Based Statistical Area associated with at least one urbanized area that has a population of at least 50,000. The Metropolitan Statistical Area comprises the central county or counties containing the core, plus adjacent outlying counties having a high degree of social and economic integration with the central county or counties as measured through commuting.”).

consisting of densely settled census tracts and blocks and adjacent densely settled territory that together contain at least 50,000 people.”³²⁰

The other term in section 112(n)(4)(B), “Consolidated Metropolitan Statistical Area,” is not currently in use by OMB. In 2000, OMB ended use of that term, and created a new term called “Combined Statistical Area” (“CSA”).³²¹ The term CSA currently means the following: “A geographic entity consisting of two or more adjacent Core Based Statistical Areas with employment interchange measures of at least 15.”³²² A combined statistical area may include two or more areas that are either metropolitan or micropolitan.³²³ The most recent list of cities and counties within MSAs and CSAs was published by OMB in 2013, applying the 2010 OMB Standards.³²⁴

The Census Bureau’s and OMB’s treatment of these terms can provide guidance as to their meaning in section 112(n)(4)(B). Consistent with OMB’s evolving approach, EPA should substitute the term CSA for CMSA in applying § 112(n)(4)(B). This would fulfill Congressional intent to capture not only MSAs, but also certain combined geographical areas that share social and economic ties and have a population of one million or more. In sum, based on the current OMB guidance, the coverage of section 112(n)(4)(B) includes all MSAs and all CSAs that meet the population requirement. However, at a minimum, the provision applies to all metropolitan statistical areas and all consolidated metropolitan statistical areas with a population of more than 1 million that would meet the standards in effect when the section 112(n)(4)(B) was enacted.

In Part I, above,³²⁵ this Petition describes a number of areas that meet the section 112(n)(4)(B) criteria based on the 1980 standards and OMB’s most recent delineations in 2013. A more complete, but not exhaustive, list of the areas covered by MSAs and CSAs (with a population in excess of 1 million) is attached.³²⁶ Generally, areas that would have been covered under the 1980 standards continue to be covered, and some additional areas would now be covered under the 2010 standards. EPA should also interpret the statutory terms in section 112(n)(4)(B) to include areas that later became covered by the OMB’s new delineations of these terms, in view of the fact that Congress should be presumed aware of the ongoing evolution of

³²⁰ *Id.*

³²¹ See OMB, Standards for Defining Metropolitan and Micropolitan Statistical Areas, 65 Fed. Reg. 82,228 (Dec. 27, 2000) [hereinafter “2000 Standards”].

³²² 2010 Standards, 75 Fed. Reg. at 37,251; see also 2000 Standards, 65 Fed. Reg. at 82,238.

³²³ The core based statistical area referred to in the definition of a CSA is either a metropolitan statistical area, or a micropolitan statistical area. 2010 Standards, 75 Fed. Reg. at 37,252 (defining micropolitan statistical area as: “A Core Based Statistical Area associated with at least one urban cluster that has a population of at least 10,000, but less than 50,000.”).

³²⁴ See OMB BULLETIN 13-01, *supra* note 25, at 116 (List 6, showing counties designated in each state and level of designation).

³²⁵ See, e.g., *supra* notes 25, 38, 61, 69, 89 and 92.

³²⁶ See Table 3 – Metropolitan Statistical Areas (MSAs) with Active Oil and Gas Wells (Appendix A); Table 4 – Combined Statistical Areas (CSAs) with Population Greater than 1 Million and Active Oil and Gas Wells (Appendix A); Table 5 – Presence of Active Oil and Gas Wells in -- (1) Combined Statistical Areas (CSAs) with population greater than 1 million and (2) Metropolitan Statistical Areas (MSAs) not located in such a CSA (Appendix A).

these terms. For years before 1990, the terms Congress chose to use had been updated at various points in time, so it is reasonable to assume that Congress would expect this to continue to occur.³²⁷

The lists of states, counties and corresponding statistical areas given in this petition are provided as examples (and not intended to be an exclusive account of the areas that would be covered by an area source listing under section 112(n)(4)(B)). These examples of significant numbers of communities affected by oil and gas production and resulting toxic air emissions illustrate that a substantial number of people in the U.S. - *i.e.*, over 150 million - live in an area covered by section 112(n)(4)(B).³²⁸ However the terms in section 112(n)(4)(B) are interpreted, the examples given in this petition illustrate that significant numbers of oil and gas wells are also located in areas covered by section 112(n)(4)(B). To ensure adequate air pollution safeguards in the many areas impacted by drilling, EPA must evaluate and act on this Petition without delay.

B. The Administrator has a duty to establish robust emissions standards for the oil and gas well area source category.

Upon listing oil and gas wells as an area source category, EPA has a duty to set emissions standards for oil and gas production wells and their associated equipment in accordance with Clean Air Act sections 112(c), (d), and (k).³²⁹ EPA must set standards under section 112(d) for a listed area source category within two years of listing.³³⁰

Under section 112(d), EPA may set emission standards for area sources either pursuant to section 112(d)(2)-(3) (*i.e.*, “MACT” standards), or section 112(d)(5) (*i.e.*, “GACT” standards). MACT standards promulgated pursuant to section 112(d)(2) require “the maximum degree of reduction in emissions” of the hazardous air pollutants subject to section 112 of the Clean Air Act, including a prohibition on such emissions, where achievable, that EPA, “taking into consideration the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements, determines is achievable.”³³¹ The statute directs that “[t]he maximum degree of reduction in emissions that is deemed achievable for new sources. . . shall not be less stringent than the emission control that is achieved in practice by the best controlled similar source.”³³² For existing sources, emission standards “shall not be less stringent, and may be more stringent than – the average emission limitation achieved by the best performing 12 percent of the existing sources (for which the Administrator has emissions information).”³³³ Alternatively, GACT standards “provide for the use of generally available

³²⁷ See sources cited *supra* note 311.

³²⁸ See sources cited *supra* note 326; Tables 3-5, Appendix.

³²⁹ 42 U.S.C. §§ 7412(c), (d), & (k).

³³⁰ *Id.* §§ 7412(c)(2) & (5).

³³¹ *Id.* § 7412(d)(2).

³³² *Id.* § 7412(d)(3).

³³³ *Id.* §§ 7412(d)(3)(A) (setting emission floor requirements), (B) (also providing that if there are fewer than 30 sources, the floor must be “the average emission limitation achieved by the best performing 5 sources”).

control technologies or management practices by such sources to reduce emissions of hazardous air pollutants.”³³⁴

Public health warrants strong regulations for oil and gas wells, under § 112(d)(2)-(3). EPA must set MACT standards for these oil and gas wells (and associated equipment), because of the significant health concerns that they pose. Doing so would be consistent with the Congressional findings in the Clean Air Act that “emissions of hazardous air pollutants from area sources may individually, or in the aggregate, present *significant* risks to public health in urban areas”³³⁵ and that “[c]onsidering the large number of persons exposed and the risks of carcinogenic and other adverse health effects from hazardous air pollutants, ambient concentrations characteristic of large urban areas should be reduced to levels *substantially* below those currently experienced.”³³⁶

Once listed, the oil and gas well area source category will contribute to EPA’s urban air toxics strategy, through which EPA must reduce cancer and other health risks from emissions by area sources.³³⁷ The stated purpose of this program is “to achieve a substantial reduction in emissions of hazardous air pollutants from area sources and an equivalent reduction in the public health risks associated with such sources including a reduction of not less than 75 per centum in the incidence of cancer attributable to emissions from such sources.”³³⁸ This program includes both a national strategy and area-wide activities.³³⁹

As the Secretary of Energy Advisory Board stated in a recent report: “Measures should be taken to reduce emissions of air pollutants . . . as quickly as practicable. The Subcommittee supports adoption of *rigorous* standards for new and existing sources of . . . air toxics, ozone precursors and other air pollutants from shale gas operations.”³⁴⁰ Moreover, in his 2012 State of the Union Address, President Obama promised that his “administration will take every possible action to safely develop this energy . . . without putting the health and safety of our citizens at risk.”³⁴¹

It would be consistent with EPA’s past action on other area sources to set MACT standards for oil and gas wells. As EPA explained in regulating area sources in the halogenated solvents source category, “[a]rea sources are regulated with a MACT standard, unless there is

³³⁴ *Id.* § 7412(d)(5).

³³⁵ *Id.* § 7412(k)(1) (emphasis added).

³³⁶ *Id.* (emphasis added).

³³⁷ *Id.* §§ 7412(k)(3)-(4).

³³⁸ *Id.* § 7412(k)(1).

³³⁹ *See id.* § 7412(k)(3)-(4).

³⁴⁰ *90-Day Report*, *supra* note 4, at 2 (emphasis added).

http://www.shalegas.energy.gov/resources/081811_90_day_report_final.pdf (emphasis added).

³⁴¹ President Barack Obama, Remarks by the President in State of the Union Address (Jan. 24, 2012), *available at* <http://www.whitehouse.gov/the-press-office/2012/01/24/remarks-president-state-union-address>.

justification for regulating them under GACT.”³⁴² Here, there is no valid justification not to set strong MACT standards.

Rather, key reasons that EPA has given for setting MACT standards for area sources in prior rules are also present here. Oil and gas wells emit HAPs that can cause serious health effects, including increased cancer risks, and their emissions implicate environmental justice concerns. As EPA has explained in other area source rulemakings, such as its rule for secondary lead smelters, emissions of dangerous HAPs like carcinogens and environmental justice concerns, considering sources operate in disproportionately minority and low-income communities, direct the use of MACT (not GACT) standards.³⁴³ Here, benzene, n-hexane, formaldehyde, toluene, and ethylbenzene (among other hazardous air pollutants that oil and gas wells emit) are extremely toxic. Likewise, since oil and gas development also implicates environmental justice concerns (as discussed in Part I, above), a reduction in emissions from these sources would help advance the objectives of both the CAA and the Executive Order on Environmental Justice, No. 12,898.³⁴⁴

Finally, EPA should set area source standards that apply Title V requirements to oil and gas wells and their associated equipment. Title V is an important program that allows affected communities the opportunity to review and comment on proposed permits and facilitates enforcement and compliance with emission standards by requiring monitoring and reporting.³⁴⁵

III. CONCLUSION

The swift expansion of oil and gas development in the United States—particularly development utilizing new drilling techniques—continues to bring oil and gas wells closer to homes, schools, and businesses nationwide, often in areas of the country that are home to large numbers of people. Because only a small set of emission points related to oil and gas production is currently subject to any air toxics regulation under section 112, increased development means that large numbers of people are now being exposed to more and more toxic air emissions on a steady, daily basis. With oil and gas companies poised to add tens of thousands of additional wells across the country annually, public health threats posed by this development will only increase unless EPA acts to list oil and gas wells as a source category and set emission standards to limit their toxic air emissions.

Oil and gas well emissions pose a “more than negligible” risk to public health, as shown by the data cited in and attached to this Petition. Based on available health studies, EPA has a duty to list oil and gas wells as an area source category pursuant to section 112(n)(4)(B), and it

³⁴² EPA, National Emission Standards for Hazardous Air Pollutants: Halogenated Solvent Cleaning, 59 Fed. Reg. 61,801, 61,801 (Dec. 2, 1994).

³⁴³ Secondary Lead Smelting Rule, 60 Fed. Reg. 32,587, 32,591-92 (June 23, 1995).

³⁴⁴ See The President, Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations, 59 Fed. Reg. No. 32 (Feb. 16, 1994). Moreover, as described in section I.D above, the majority of HAP emissions from wells and associated equipment can be controlled by existing technologies already in use in the industry.

³⁴⁵ See generally 42 U.S.C. § 7661a; 40 C.F.R. §§ 70.1-70.12.

must do so now to protect the health of communities across the United States that are already facing emissions from massive oil and gas expansions.

For more information and to provide a timely response to this petition within 180 days, as requested above, please contact us at your earliest convenience. For your reference, please find the tables, maps, and major sources cited in the Appendix, and also provided on an accompanying CD-ROM.

Thank you for your time and prompt consideration of this petition.

Sincerely,

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SUBMITTED ON BEHALF OF THE FOLLOWING UNDERSIGNED PETITIONERS:

California:

California Communities Against Toxics
California Kids IAQ
California Safe Schools
Center on Race, Poverty & the Environment
Citizens Coalition for a Safe Community
Clean Water & Air Matter
Coalition For A Safe Environment
Comite Pro Uno
Communities for a Better Environment
Community Dreams
Esperanza Community Housing Corporation
Physicians for Social Responsibility - Los Angeles
Tri-Valley CAREs

Colorado:

Citizens for Clean Air
Colorado Citizens Lobby
Douglas County Green Party
Sheep Mountain Alliance
Sierra Club Rocky Mountain

Chapter (CO)

The Question Alliance
Western Colorado Congress
Western Slope Conservation Center
What the Frack?! Arapahoe

Connecticut:

Mitchell Environmental Health Associates

Louisiana:

Louisiana Bucket Brigade
Louisiana Environmental Action Network
Sierra Club Delta Chapter (Louisiana)

New York:

Catskill Citizens for Safe Energy
Catskill Mountainkeeper
Citizens' Environmental Coalition
Concerned Health Professionals of New York
Riverkeeper, Inc.

Ohio:

Athens County Fracking Action Network
Buckeye Forest Council

Pennsylvania:

Berks Gas Truth
Breathe Easy Susquehanna County(BESC)
Lehigh Valley Gas Truth
Pennsylvania Forest Coalition
Sierra Club Pennsylvania Chapter
Clean Air Council

Texas:

Air Alliance Houston
Downwinders At Risk
Sierra Club Lone Star Chapter (TX)
Texas Campaign for the Environment

Wyoming:

Clark Resource Council
Pavillion Area Concerned Citizens
Powder River Basin Resource Council

National and Regional:

Alliance of Nurses for Healthy
Environments
Center for Biological Diversity
Center for Effective Government
Center for Health, Environment and Justice
Clean Air Taskforce
ClimateMama
Delaware Riverkeeper Network
Earthworks
EcoFlight
Environmental Defense Fund
Global Community Monitor
Greenpeace
Natural Resources Defense Council
Physicians Scientists & Engineers for
Healthy Energy
SafeMinds
Sierra Club Beyond Natural Gas Campaign
Sierra Club Beyond Oil Campaign
TEDX, The Endocrine Disruption Exchange
The Mothers Project, Inc.
U.S. Climate Plan
Western Environmental Law Center
WildEarth Guardians

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Table 1 - NSPS V. NESHAP COVERAGE COMPARISON: REGULATION OF WELLS AND ASSOCIATED EQUIPMENT

NSPS		NESHAP		NOT COVERED BY NSPS OR NESHAP
REGULATED	NOT REGULATED	REGULATED	NOT REGULATED	
<ul style="list-style-type: none"> New or reconstructed facilities that are covered; and Covered facilities that undergo modification. Modification: any physical change in, or change in the method of operation of, a facility which increases the amount of any air pollutant emitted or results in the emission of any air pollutant not previously emitted. <p>42 U.S.C. § 7411(a)(2); 40 C.F.R. pt. 60 subpt. OOOO (§§ 60.5360 - 60.5430).</p>	<p>Existing oil and gas wells (and associated equipment) that have not undergone modification since Aug. 23, 2011.</p> <p>In 2009 there were an estimated 1.02 million onshore oil and natural gas wells in the United States, split roughly evenly between the two types.</p> <p>Significant sources of emissions that not regulated under the NSPS include:</p> <ul style="list-style-type: none"> Most pneumatic controllers Most well completions Some storage vessels Many compressors Liquids unloading Produced water ponds 	<p>New and existing covered facilities, which include: glycol dehydrators and storage vessels at oil and natural gas production facilities, and certain equipment leaks at natural gas processing plants, if located prior to the point of custody transfer at a major source.</p> <p>Only glycol dehydrators and storage vessels can be aggregated to determine major source status.</p> <p>40 C.F.R. Part 63 subpart HH (oil & natural gas production: §§ 63.760 to 63.779)</p>	<p>Everything else at well sites and production facilities located prior to the point of custody transfer, including oil and gas wells (unless they meet the 10 tpy single HAP/25 tpy total HAP threshold, which seems to be few or none).</p> <p>Additional exemptions:</p> <ul style="list-style-type: none"> * Black oil facilities. * A major source facility, prior to the point of custody transfer, with a facility-wide actual annual average natural gas throughput less than 18.4 thousand standard cubic meters per day and a facility-wide actual annual average hydrocarbon liquid throughput less than 39,700 liters per day. 	<ol style="list-style-type: none"> Oil wells (new and existing) Conventional gas wells (new and existing) Existing hydraulically fractured gas wells (unless modified) New hydraulically fractured gas wells that are exempted from the NSPS Most equipment associated with wells, including: many storage vessels, pneumatic controllers, compressors, and equipment leaks. All equipment is unregulated (except certain large TEG glycol dehydrators, which are subject to area source standards, if not major source standards) if located at facilities that do not meet major source threshold due to aggregation prohibition (42 USC § 112(n)(4)(A)). <p>Note: coverage under both NSPS and NESHAP depends largely on whether a piece of associated equipment is located “prior to the point of custody transfer.” <i>See</i> 40 C.F.R. §§ 60.5365, 5430; 40 C.F.R. §§ 63.1270-71, 760-761.</p>

Table 2 - Oil and Gas Sector Summary			
Comparison of Emissions Controlled by EPA's Final Rule ("Controlled") vs. Emissions that Could Have Been Controlled by EPA's Final Rule But Were Not ("Not Controlled")*			
Emission Type	Emissions (tons/year) in 2012		
	Methane	VOC	HAP
New Natural Gas Wells Drilled and Completed using Hydraulic Fracturing	1,589,622	215,559	16,844
New Wild Cat Exploration, Delineation, and Low Pressure Wells Routed to Control Device During Completion Operations	218,323	29,606	2,313
Gas Wells Refractured	224,665	30,466	2,381
Wells Subtotal	2,032,611	275,630	21,538
Oil and Gas Production Segment: Pneumatic controllers >6 scfh installed after 8-23-11.	90,685	25,210	952
Gas Processing Plant Segment: All pneumatic controllers in installed after 8-23-11.	225	63	2
Pneumatic Controllers Subtotal	90,910	25,273	954
New Gas Production (Gathering & Boosting) Reciprocating Compressors	1,437	400	15
New Gas Processing Plant Reciprocating Compressors	3,892	1,082	41
New Gas Processing Plant Centrifugal Compressors	2,810	254	9
Compressors Subtotal	8,139	1,736	65
New Storage Vessels >6 tpy VOC	6,490	29,746	68
Storage Vessels Subtotal	6,490	29,746	68
New Gas Processing Plants	1,490	415	16
Equipment Leaks Subtotal	1,490	415	16
Subtotal of Emissions Controlled by EPA's Final Rule	2,139,640	332,800	22,641
Gas Well Venting - Liquids Unloading (Existing Wells)	2,464,800	359,614	26,127
Gas Well Venting - Liquids Unloading (New Wells) (Note 1)	96,440	14,071	1,022
Wells Subtotal	2,561,240	373,685	27,149
Oil and Gas Production and Gas Processing Plant Segments: Convert existing high-bleed devices to low-bleed devices.	439,432	122,248	4,626
Transportation and Storage Segments: Convert existing high-bleed devices to low-bleed devices.	43,520	1,210	41
Transportation and Storage Segments: Require low-bleed pneumatic controllers installed after 8-23-11.	212	6	0.2
Pneumatic Controllers Subtotal	483,164	123,464	4,667
New Wellhead Reciprocating Compressors	20,520	3,131	114.9
New Transmission Reciprocating Compressors	423	12	0.3
New Storage Reciprocating Compressors	87	2	0.1
New Transmission and Storage Centrifugal Compressors	1,546	43	1
Existing Oil and Gas Reciprocating Compressors	1,108,432	169,120	6,240
Existing Oil and Gas Centrifugal Compressors	416,416	73,537	2,734
Compressors Subtotal	1,547,424	245,845	9,091
Existing Storage Vessels > 6tpy	76,312	366,783	801
Vessels Subtotal	76,312	366,783	801
New Well Pads; Control of Valves Only	63,412	17,572	665
New Gathering & Boosting Facilities; Control of Valves Only	7,040	1,955	74
New Transmission & Storage Facilities; Control of Valves Only	3,403	94	3
Existing Oil & Gas Sector Equipment Leaks	2,141,568	595,356	22,486
Equipment Leaks Subtotal	2,215,423	614,977	23,228
Subtotal of Emissions Not Controlled by EPA's Final Rule	6,883,563	1,724,755	64,935

Source: Table created by Susan Harvey, Harvey Consulting LLC, M.S., Environmental Engineering, Univ. Alaska-Anchorage; B.S., Petroleum Engineering, Univ. of Alaska-Fairbanks. Note: Annual emission estimate as of Year 5.

Table 3 - Metropolitan Statistical Areas (MSAs) with Active Oil and Gas Wells

MSA Code	MSA Name	State	Population	No. of Oil and Gas Wells*	% of the MSA Area with wells**	Part of a CSA >1 million population
11260	Anchorage, AK Metro Area	AK	380,821	13	< 1	
13820	Birmingham-Hoover, AL Metro Area	AL	1,128,047	631	3	X
26620	Huntsville, AL Metro Area	AL	417,593	1	< 1	
33660	Mobile, AL Metro Area	AL	412,992	271	4	
46220	Tuscaloosa, AL Metro Area	AL	219,461	1,992	19	
19460	Decatur, AL Metro Area	AL	153,829	4	< 1	
30780	Little Rock-North Little Rock-Conway, AR Metro Area	AR	699,757	6	< 1	
22220	Fayetteville-Springdale-Rogers, AR-MO Metro Area	AR-MO	463,204	155	1	
22900	Fort Smith, AR-OK Metro Area	AR-OK	298,592	3,034	18	
31100	Los Angeles-Long Beach-Santa Ana, CA Metro Area	CA	12,828,837	889	4	X
41860	San Francisco-Oakland-Fremont, CA Metro Area	CA	4,335,391	130	1	X
40140	Riverside-San Bernardino-Ontario, CA Metro Area	CA	4,224,851	21	< 1	X
40900	Sacramento--Arden-Arcade--Roseville, CA Metro Area	CA	2,149,127	492	2	X
41940	San Jose-Sunnyvale-Santa Clara, CA Metro Area	CA	1,836,911	39	< 1	X
23420	Fresno, CA Metro Area	CA	930,450	521	2	X
12540	Bakersfield-Delano, CA Metro Area	CA	839,631	2,830	9	
37100	Oxnard-Thousand Oaks-Ventura, CA Metro Area	CA	823,318	437	5	X
44700	Stockton, CA Metro Area	CA	685,306	158	3	
33700	Modesto, CA Metro Area	CA	514,453	3	< 1	
42220	Santa Rosa-Petaluma, CA Metro Area	CA	483,878	6	< 1	X
47300	Visalia-Porterville, CA Metro Area	CA	442,179	68	< 1	
42060	Santa Barbara-Santa Maria-Goleta, CA Metro Area	CA	423,895	510	3	
41500	Salinas, CA Metro Area	CA	415,057	75	< 1	
46700	Vallejo-Fairfield, CA Metro Area	CA	413,344	348	10	X

Table 3 - Metropolitan Statistical Areas (MSAs) with Active Oil and Gas Wells

MSA Code	MSA Name	State	Population	No. of Oil and Gas Wells*	% of the MSA Area with wells**	Part of a CSA >1 million population
42020	San Luis Obispo-Paso Robles, CA Metro Area	CA	269,637	73	1	
32900	Merced, CA Metro Area	CA	255,793	8	< 1	
17020	Chico, CA Metro Area	CA	220,000	28	< 1	
49700	Yuba City, CA Metro Area	CA	166,892	277	6	X
25260	Hanford-Corcoran, CA Metro Area	CA	152,982	158	3	
31460	Madera-Chowchilla, CA Metro Area	CA	150,865	47	1	X
19740	Denver-Aurora-Broomfield, CO Metro Area	CO	2,543,482	1,554	5	X
22660	Fort Collins-Loveland, CO Metro Area	CO	299,630	156	1	
14500	Boulder, CO Metro Area	CO	294,567	208	7	X
24540	Greeley, CO Metro Area	CO	252,825	4,316	27	X
24300	Grand Junction, CO Metro Area	CO	146,723	468	3	
33100	Miami-Fort Lauderdale-Pompano Beach, FL Metro Area	FL	5,564,635	2	< 1	
15980	Cape Coral-Fort Myers, FL Metro Area	FL	618,754	11	< 1	
37860	Pensacola-Ferry Pass-Brent, FL Metro Area	FL	448,991	91	1	
34940	Naples-Marco Island, FL Metro Area	FL	321,520	41	< 1	
26980	Iowa City, IA Metro Area	IA	152,586	3	< 1	
16580	Champaign-Urbana, IL Metro Area	IL	231,891	3	< 1	
44100	Springfield, IL Metro Area	IL	210,170	100	2	
19500	Decatur, IL Metro Area	IL	110,768	82	3	
16980	Chicago-Joliet-Naperville, IL-IN-WI Metro Area	IL-IN-WI	9,461,105	16	< 1	X
26900	Indianapolis-Carmel, IN Metro Area	IN	1,756,241	57	< 1	X
23060	Fort Wayne, IN Metro Area	IN	416,257	27	< 1	
21140	Elkhart-Goshen, IN Metro Area	IN	197,559	2	< 1	
14020	Bloomington, IN Metro Area	IN	192,714	67	1	
45460	Terre Haute, IN Metro Area	IN	172,425	179	3	
11300	Anderson, IN Metro Area	IN	131,636	7	< 1	X
34620	Muncie, IN Metro Area	IN	117,671	20	1	
33140	Michigan City-La Porte, IN Metro Area	IN	111,467	10	< 1	X

Table 3 - Metropolitan Statistical Areas (MSAs) with Active Oil and Gas Wells

MSA Code	MSA Name	State	Population	No. of Oil and Gas Wells*	% of the MSA Area with wells**	Part of a CSA >1 million population
21780	Evansville, IN-KY Metro Area	IN-KY	358,676	1,831	19	
43780	South Bend-Mishawaka, IN-MI Metro Area	IN-MI	319,224	48	1	
48620	Wichita, KS Metro Area	KS	623,061	2,165	13	
45820	Topeka, KS Metro Area	KS	233,870	144	1	
31740	Manhattan, KS Metro Area	KS	127,081	18	< 1	
29940	Lawrence, KS Metro Area	KS	110,826	70	4	
30460	Lexington-Fayette, KY Metro Area	KY	472,099	8	< 1	
14540	Bowling Green, KY Metro Area	KY	125,953	540	16	
21060	Elizabethtown, KY Metro Area	KY	119,736	19	1	X
36980	Owensboro, KY Metro Area	KY	114,752	631	17	
31140	Louisville/Jefferson County, KY-IN Metro Area	KY-IN	1,283,566	314	2	X
35380	New Orleans-Metairie-Kenner, LA Metro Area	LA	1,167,764	2,655	9	X
12940	Baton Rouge, LA Metro Area	LA	802,484	974	6	
43340	Shreveport-Bossier City, LA Metro Area	LA	398,604	3,771	35	
29180	Lafayette, LA Metro Area	LA	273,738	654	15	
26380	Houma-Bayou Cane-Thibodaux, LA Metro Area	LA	208,178	2,537	18	
29340	Lake Charles, LA Metro Area	LA	199,607	1,529	13	
33740	Monroe, LA Metro Area	LA	176,441	1,883	31	
10780	Alexandria, LA Metro Area	LA	153,922	220	3	
25180	Hagerstown-Martinsburg, MD-WV Metro Area	MD-WV	269,140	3	< 1	
19060	Cumberland, MD-WV Metro Area	MD-WV	103,299	44	1	
19820	Detroit-Warren-Livonia, MI Metro Area	MI	4,296,250	504	3	X
24340	Grand Rapids-Wyoming, MI Metro Area	MI	774,160	220	2	X
29620	Lansing-East Lansing, MI Metro Area	MI	464,036	171	2	
22420	Flint, MI Metro Area	MI	425,790	18	1	X
11460	Ann Arbor, MI Metro Area	MI	344,791	18	1	X
28020	Kalamazoo-Portage, MI Metro Area	MI	326,589	160	2	
26100	Holland-Grand Haven, MI Metro Area	MI	263,801	107	2	X

Table 3 - Metropolitan Statistical Areas (MSAs) with Active Oil and Gas Wells

MSA Code	MSA Name	State	Population	No. of Oil and Gas Wells*	% of the MSA Area with wells**	Part of a CSA >1 million population
40980	Saginaw-Saginaw Township North, MI Metro Area	MI	200,169	44	1	
34740	Muskegon-Norton Shores, MI Metro Area	MI	172,188	115	2	X
27100	Jackson, MI Metro Area	MI	160,248	66	2	
35660	Niles-Benton Harbor, MI Metro Area	MI	156,813	7	< 1	
33780	Monroe, MI Metro Area	MI	152,021	12	< 1	X
12980	Battle Creek, MI Metro Area	MI	136,146	189	7	
13020	Bay City, MI Metro Area	MI	107,771	146	6	
41180	St. Louis, MO-IL Metro Area	MO-IL	2,812,896	350	1	X
28140	Kansas City, MO-KS Metro Area	MO-KS	2,035,334	1,272	4	X
41140	St. Joseph, MO-KS Metro Area	MO-KS	127,329	2	< 1	
27140	Jackson, MS Metro Area	MS	539,057	300	2	
25060	Gulfport-Biloxi, MS Metro Area	MS	248,820	54	1	
25620	Hattiesburg, MS Metro Area	MS	142,842	182	3	
13740	Billings, MT Metro Area	MT	158,050	143	1	
10740	Albuquerque, NM Metro Area	NM	887,077	377	1	
42140	Santa Fe, NM Metro Area	NM	144,170	1	< 1	
22140	Farmington, NM Metro Area	NM	130,044	6,666	30	
15380	Buffalo-Niagara Falls, NY Metro Area	NY	1,135,509	850	9	X
40380	Rochester, NY Metro Area	NY	1,054,323	249	1	X
45060	Syracuse, NY Metro Area	NY	662,577	101	1	
46540	Utica-Rome, NY Metro Area	NY	299,397	18	< 1	
13780	Binghamton, NY Metro Area	NY	251,725	20	< 1	
27060	Ithaca, NY Metro Area	NY	101,564	4	< 1	
21300	Elmira, NY Metro Area	NY	88,830	30	2	
17460	Cleveland-Elyria-Mentor, OH Metro Area	OH	2,077,240	1,944	12	X
18140	Columbus, OH Metro Area	OH	1,836,536	1,575	10	X
19380	Dayton, OH Metro Area	OH	841,502	2	< 1	X
10420	Akron, OH Metro Area	OH	703,200	2,165	58	X
45780	Toledo, OH Metro Area	OH	651,429	57	1	
15940	Canton-Massillon, OH Metro Area	OH	404,422	2,074	53	

Table 3 - Metropolitan Statistical Areas (MSAs) with Active Oil and Gas Wells

MSA Code	MSA Name	State	Population	No. of Oil and Gas Wells*	% of the MSA Area with wells**	Part of a CSA >1 million population
44220	Springfield, OH Metro Area	OH	138,333	1	< 1	X
31900	Mansfield, OH Metro Area	OH	124,475	81	4	
30620	Lima, OH Metro Area	OH	106,331	5	< 1	
41780	Sandusky, OH Metro Area	OH	77,079	35	1	
17140	Cincinnati-Middletown, OH-KY-IN Metro Area	OH-KY-IN	2,130,151	17	< 1	X
49660	Youngstown-Warren-Boardman, OH-PA Metro Area	OH-PA	565,773	3,996	57	
44600	Steubenville-Weirton, OH-WV Metro Area	OH-WV	124,454	40	2	
36420	Oklahoma City, OK Metro Area	OK	1,252,987	10,002	45	X
46140	Tulsa, OK Metro Area	OK	937,478	13,287	51	
30020	Lawton, OK Metro Area	OK	124,098	357	8	
38900	Portland-Vancouver-Hillsboro, OR-WA Metro Area	OR-WA	2,226,009	56	< 1	
38300	Pittsburgh, PA Metro Area	PA	2,356,285	3,727	17	X
42540	Scranton--Wilkes-Barre, PA Metro Area	PA	563,631	6	< 1	
21500	Erie, PA Metro Area	PA	280,566	1,628	26	
44300	State College, PA Metro Area	PA	153,990	296	7	
27780	Johnstown, PA Metro Area	PA	143,679	194	7	
11020	Altoona, PA Metro Area	PA	127,089	1	< 1	
48700	Williamsport, PA Metro Area	PA	116,111	9	< 1	
34980	Nashville-Davidson--Murfreesboro--Franklin, TN Metro Area	TN	1,589,934	57	< 1	X
28940	Knoxville, TN Metro Area	TN	698,030	20	< 1	X
34100	Morristown, TN Metro Area	TN	136,608	1	< 1	X
16860	Chattanooga, TN-GA Metro Area	TN-GA	528,143	1	< 1	
17300	Clarksville, TN-KY Metro Area	TN-KY	273,949	159	2	
28700	Kingsport-Bristol-Bristol, TN-VA Metro Area	TN-VA	309,544	28	< 1	
19100	Dallas-Fort Worth-Arlington, TX Metro Area	TX	6,371,773	5,738	15	X
26420	Houston-Sugar Land-Baytown, TX Metro Area	TX	5,946,800	4,957	12	X
41700	San Antonio-New Braunfels, TX Metro Area	TX	2,142,508	2,637	9	

Table 3 - Metropolitan Statistical Areas (MSAs) with Active Oil and Gas Wells

MSA Code	MSA Name	State	Population	No. of Oil and Gas Wells*	% of the MSA Area with wells**	Part of a CSA >1 million population
12420	Austin-Round Rock-San Marcos, TX Metro Area	TX	1,716,289	710	4	X
32580	McAllen-Edinburg-Mission, TX Metro Area	TX	774,769	1,309	21	
18580	Corpus Christi, TX Metro Area	TX	428,185	2,919	30	
15180	Brownsville-Harlingen, TX Metro Area	TX	406,220	75	1	
28660	Killeen-Temple-Fort Hood, TX Metro Area	TX	405,300	5	< 1	
13140	Beaumont-Port Arthur, TX Metro Area	TX	388,745	1,295	13	
31180	Lubbock, TX Metro Area	TX	284,890	455	6	
29700	Laredo, TX Metro Area	TX	250,304	3,864	29	
11100	Amarillo, TX Metro Area	TX	249,881	1,716	12	
47380	Waco, TX Metro Area	TX	234,906	29	1	
17780	College Station-Bryan, TX Metro Area	TX	228,660	2,879	34	
30980	Longview, TX Metro Area	TX	214,369	2,853	39	
46340	Tyler, TX Metro Area	TX	209,714	701	18	
10180	Abilene, TX Metro Area	TX	165,252	3,851	35	
48660	Wichita Falls, TX Metro Area	TX	151,306	4,629	43	
36220	Odessa, TX Metro Area	TX	137,130	2,165	60	
33260	Midland, TX Metro Area	TX	136,872	2,607	72	
43300	Sherman-Denison, TX Metro Area	TX	120,877	551	14	X
47020	Victoria, TX Metro Area	TX	115,384	3,271	29	
41660	San Angelo, TX Metro Area	TX	111,823	2,324	22	
45500	Texarkana, TX-Texarkana, AR Metro Area	TX-AR	136,027	322	5	
41620	Salt Lake City, UT Metro Area	UT	1,124,197	99	< 1	X
41100	St. George, UT Metro Area	UT	138,115	14	< 1	
25500	Harrisonburg, VA Metro Area	VA	125,228	1	< 1	
49020	Winchester, VA-WV Metro Area	VA-WV	128,472	20	< 1	X
42660	Seattle-Tacoma-Bellevue, WA Metro Area	WA	3,439,809	2	< 1	X
28420	Kennewick-Pasco-Richland, WA Metro Area	WA	253,340	3	< 1	
13380	Bellingham, WA Metro Area	WA	201,140	1	< 1	
16620	Charleston, WV Metro Area	WV	304,284	4,301	42	

Table 3 - Metropolitan Statistical Areas (MSAs) with Active Oil and Gas Wells

MSA Code	MSA Name	State	Population	No. of Oil and Gas Wells*	% of the MSA Area with wells**	Part of a CSA >1 million population
34060	Morgantown, WV Metro Area	WV	129,709	297	7	
26580	Huntington-Ashland, WV-KY-OH Metro Area	WV-KY-OH	287,702	1,123	16	
37620	Parkersburg-Marietta-Vienna, WV-OH Metro Area	WV-OH	162,056	2,582	46	
48540	Wheeling, WV-OH Metro Area	WV-OH	147,950	117	3	
16940	Cheyenne, WY Metro Area	WY	91,738	203	2	
16220	Casper, WY Metro Area	WY	75,450	777	4	
	Totals		136,469,278	156,322		
*	Due to claims of proprietary information, precise well locations are unavailable in all states. The numbers in this table are taken from a publically available map which identified those quarter mile square cells where at least one active oil or gas well was located. Therefore, the numbers in this column reflect the lower bounds of the true range because there may be more than one well within the quarter mile square cells.					
**	This column represents the percent of the designated area that is covered by quarter mile square cells containing at least one active oil or gas well.					
Sources	US Census Data (2010) and Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado, <i>available at</i> http://catalog.data.gov/dataset/oil-and-gas-exploration-and-production-in-the-united-states-shown-as-quarter-mile-cells .					

Table 4 - Combined Statistical Areas (CSAs) with Population Greater than 1 Million and Active Oil and Gas Wells

CSA Code	CSA Name	State	Population	No. of Oil and Gas Wells*	% of the CSA Area with wells**	No. of MSAs included in CSA
142	Birmingham-Hoover-Cullman, AL CSA	AL	1,208,453	632	3	1
348	Los Angeles-Long Beach-Riverside, CA CSA	CA	17,877,006	1,347	1	3
260	Fresno-Madera, CA CSA	CA	1,081,315	569	2	2
488	San Jose-San Francisco-Oakland, CA CSA	CA	7,468,390	523	1	6
472	Sacramento--Arden-Arcade--Yuba City, CA-NV CSA	CA-NV	2,461,780	769	2	2
216	Denver-Aurora-Boulder, CO CSA	CO	3,090,874	6,078	12	3
548	Washington-Baltimore-Northern Virginia, DC-MD-VA-WV CSA	DC-MD-VA-WV	8,572,971	20	< 1	3
176	Chicago-Naperville-Michigan City, IL-IN-WI CSA	IL-IN-WI	9,686,021	26	< 1	3
294	Indianapolis-Anderson-Columbus, IN CSA	IN	2,080,782	86	< 1	3
350	Louisville/Jefferson County--Elizabethtown--Scottsburg, KY-IN CSA	KY-IN	1,427,483	333	2	2
406	New Orleans-Metairie-Bogalusa, LA CSA	LA	1,214,932	2,672	8	1
266	Grand Rapids-Muskegon-Holland, MI CSA	MI	1,321,557	799	3	3
220	Detroit-Warren-Flint, MI CSA	MI	5,218,852	553	2	4
476	St. Louis-St. Charles-Farmington, MO-IL CSA	MO-IL	2,878,255	350	1	1
312	Kansas City-Overland Park-Kansas City, MO-KS CSA	MO-KS	2,104,853	1,296	4	1
332	Las Vegas-Paradise-Pahrump, NV CSA	NV	1,995,215	38	< 1	1
160	Buffalo-Niagara-Cattaraugus, NY CSA	NY	1,215,826	1,507	10	1
464	Rochester-Batavia-Seneca Falls, NY CSA	NY	1,149,653	815	4	1
184	Cleveland-Akron-Elyria, OH CSA	OH	2,881,937	5,642	22	2
198	Columbus-Marion-Chillicothe, OH CSA	OH	2,071,052	2,228	9	1
212	Dayton-Springfield-Greenville, OH CSA	OH	1,072,891	6	< 1	2
178	Cincinnati-Middletown-Wilmington, OH-KY-IN CSA	OH-KY-IN	2,172,191	17	< 1	1
416	Oklahoma City-Shawnee, OK CSA	OK	1,322,429	11,163	44	1
430	Pittsburgh-New Castle, PA CSA	PA	2,447,393	3,865	17	1
314	Knoxville-Sevierville-La Follette, TN CSA	TN	1,055,086	105	1	2

Table 4 - Combined Statistical Areas (CSAs) with Population Greater than 1 Million and Active Oil and Gas Wells

CSA Code	CSA Name	State	Population	No. of Oil and Gas Wells*	% of the CSA Area with wells**	No. of MSAs included in CSA
400	Nashville-Davidson--Murfreesboro--Columbia, TN CSA	TN	1,670,890	57	< 1	1
206	Dallas-Fort Worth, TX CSA	TX	6,731,317	9,814	17	2
288	Houston-Baytown-Huntsville, TX CSA	TX	6,051,363	5,921	12	1
126	Austin-Round Rock-Marble Falls, TX CSA	TX	1,759,039	710	3	1
482	Salt Lake City-Ogden-Clearfield, UT CSA	UT	1,744,886	107	< 1	2
500	Seattle-Tacoma-Olympia, WA CSA	WA	4,199,312	2	< 1	4
Totals			107,234,004	58,050		
*	Due to claims of proprietary information, precise well locations are unavailable in all states. The numbers in this table are taken from a publically available map which identified those quarter mile square cells where at least one active oil or gas well was located. Therefore, the numbers in this column reflect the lower bounds of the true range because there may be more than one well within the quarter mile square cells.					
**	This column represents the percent of the designated area that is covered by quarter mile square cells containing at least one active oil or gas well.					
Sources	US Census Data (2010) and Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado, <i>available at</i> http://catalog.data.gov/dataset/oil-and-gas-exploration-and-production-in-the-united-states-shown-as-quarter-mile-cells .					

**Table 5 - Presence of Active Oil and Gas Wells in
(1) Combined Statistical Areas (CSAs) with population greater than 1 million and
(2) Metropolitan Statistical Areas (MSAs) not located in such a CSA**

Code	Name	State	Population	No. of Oil and Gas Wells*	% of Census Area with Wells**	Census Designation
11260	Anchorage, AK Metro Area	AK	380,821	13	< 1	MSA
142	Birmingham-Hoover-Cullman, AL CSA	AL	1,208,453	632	3	CSA
26620	Huntsville, AL Metro Area	AL	417,593	1	< 1	MSA
33660	Mobile, AL Metro Area	AL	412,992	271	4	MSA
46220	Tuscaloosa, AL Metro Area	AL	219,461	1,992	19	MSA
19460	Decatur, AL Metro Area	AL	153,829	4	< 1	MSA
30780	Little Rock-North Little Rock-Conway, AR Metro Area	AR	699,757	6	< 1	MSA
22220	Fayetteville-Springdale-Rogers, AR-MO Metro Area	AR-MO	463,204	155	1	MSA
22900	Fort Smith, AR-OK Metro Area	AR-OK	298,592	3,034	18	MSA
348	Los Angeles-Long Beach-Riverside, CA CSA	CA	17,877,006	1,347	1	CSA
488	San Jose-San Francisco-Oakland, CA CSA	CA	7,468,390	523	1	CSA
260	Fresno-Madera, CA CSA	CA	1,081,315	569	2	CSA
12540	Bakersfield-Delano, CA Metro Area	CA	839,631	2,830	9	MSA
44700	Stockton, CA Metro Area	CA	685,306	158	3	MSA
33700	Modesto, CA Metro Area	CA	514,453	3	< 1	MSA
47300	Visalia-Porterville, CA Metro Area	CA	442,179	68	< 1	MSA
42060	Santa Barbara-Santa Maria-Goleta, CA Metro Area	CA	423,895	510	3	MSA
41500	Salinas, CA Metro Area	CA	415,057	75	< 1	MSA
42020	San Luis Obispo-Paso Robles, CA Metro Area	CA	269,637	73	1	MSA
32900	Merced, CA Metro Area	CA	255,793	8	< 1	MSA
17020	Chico, CA Metro Area	CA	220,000	28	< 1	MSA
25260	Hanford-Corcoran, CA Metro Area	CA	152,982	158	3	MSA
472	Sacramento--Arden-Arcade--Yuba City, CA-NV CSA	CA-NV	2,461,780	769	2	CSA
216	Denver-Aurora-Boulder, CO CSA	CO	3,090,874	6,078	12	CSA
22660	Fort Collins-Loveland, CO Metro Area	CO	299,630	156	1	MSA
24300	Grand Junction, CO Metro Area	CO	146,723	468	3	MSA
548	Washington-Baltimore-Northern Virginia, DC-MD-VA-WV CSA	DC-MD-VA-WV	8,572,971	20	< 1	CSA

**Table 5 - Presence of Active Oil and Gas Wells in
(1) Combined Statistical Areas (CSAs) with population greater than 1 million and
(2) Metropolitan Statistical Areas (MSAs) not located in such a CSA**

Code	Name	State	Population	No. of Oil and Gas Wells*	% of Census Area with Wells**	Census Designation
33100	Miami-Fort Lauderdale-Pompano Beach, FL Metro Area	FL	5,564,635	2	< 1	MSA
15980	Cape Coral-Fort Myers, FL Metro Area	FL	618,754	11	< 1	MSA
37860	Pensacola-Ferry Pass-Brent, FL Metro Area	FL	448,991	91	1	MSA
34940	Naples-Marco Island, FL Metro Area	FL	321,520	41	< 1	MSA
26980	Iowa City, IA Metro Area	IA	152,586	3	< 1	MSA
16580	Champaign-Urbana, IL Metro Area	IL	231,891	3	< 1	MSA
44100	Springfield, IL Metro Area	IL	210,170	100	2	MSA
19500	Decatur, IL Metro Area	IL	110,768	82	3	MSA
176	Chicago-Naperville-Michigan City, IL-IN-WI CSA	IL-IN-WI	9,686,021	26	< 1	CSA
294	Indianapolis-Anderson-Columbus, IN CSA	IN	2,080,782	86	< 1	CSA
23060	Fort Wayne, IN Metro Area	IN	416,257	27	< 1	MSA
21140	Elkhart-Goshen, IN Metro Area	IN	197,559	2	< 1	MSA
14020	Bloomington, IN Metro Area	IN	192,714	67	1	MSA
45460	Terre Haute, IN Metro Area	IN	172,425	179	3	MSA
34620	Muncie, IN Metro Area	IN	117,671	20	1	MSA
21780	Evansville, IN-KY Metro Area	IN-KY	358,676	1,831	19	MSA
43780	South Bend-Mishawaka, IN-MI Metro Area	IN-MI	319,224	48	1	MSA
48620	Wichita, KS Metro Area	KS	623,061	2,165	13	MSA
45820	Topeka, KS Metro Area	KS	233,870	144	1	MSA
31740	Manhattan, KS Metro Area	KS	127,081	18	< 1	MSA
29940	Lawrence, KS Metro Area	KS	110,826	70	4	MSA
30460	Lexington-Fayette, KY Metro Area	KY	472,099	8	< 1	MSA
14540	Bowling Green, KY Metro Area	KY	125,953	540	16	MSA
36980	Owensboro, KY Metro Area	KY	114,752	631	17	MSA
350	Louisville/Jefferson County--Elizabethtown--Scottsburg, KY-IN CSA	KY-IN	1,427,483	333	2	CSA
406	New Orleans-Metairie-Bogalusa, LA CSA	LA	1,214,932	2,672	8	CSA
12940	Baton Rouge, LA Metro Area	LA	802,484	974	6	MSA
43340	Shreveport-Bossier City, LA Metro Area	LA	398,604	3,771	35	MSA

**Table 5 - Presence of Active Oil and Gas Wells in
(1) Combined Statistical Areas (CSAs) with population greater than 1 million and
(2) Metropolitan Statistical Areas (MSAs) not located in such a CSA**

Code	Name	State	Population	No. of Oil and Gas Wells*	% of Census Area with Wells**	Census Designation
29180	Lafayette, LA Metro Area	LA	273,738	654	15	MSA
26380	Houma-Bayou Cane-Thibodaux, LA Metro Area	LA	208,178	2,537	18	MSA
29340	Lake Charles, LA Metro Area	LA	199,607	1,529	13	MSA
33740	Monroe, LA Metro Area	LA	176,441	1,883	31	MSA
10780	Alexandria, LA Metro Area	LA	153,922	220	3	MSA
25180	Hagerstown-Martinsburg, MD-WV Metro Area	MD-WV	269,140	3	< 1	MSA
19060	Cumberland, MD-WV Metro Area	MD-WV	103,299	44	1	MSA
220	Detroit-Warren-Flint, MI CSA	MI	5,218,852	553	2	CSA
266	Grand Rapids-Muskegon-Holland, MI CSA	MI	1,321,557	799	3	CSA
29620	Lansing-East Lansing, MI Metro Area	MI	464,036	171	2	MSA
28020	Kalamazoo-Portage, MI Metro Area	MI	326,589	160	2	MSA
40980	Saginaw-Saginaw Township North, MI Metro Area	MI	200,169	44	1	MSA
27100	Jackson, MI Metro Area	MI	160,248	66	2	MSA
35660	Niles-Benton Harbor, MI Metro Area	MI	156,813	7	< 1	MSA
12980	Battle Creek, MI Metro Area	MI	136,146	189	7	MSA
13020	Bay City, MI Metro Area	MI	107,771	146	6	MSA
476	St. Louis-St. Charles-Farmington, MO-IL CSA	MO-IL	2,878,255	350	1	CSA
312	Kansas City-Overland Park-Kansas City, MO-KS CSA	MO-KS	2,104,853	1,296	4	CSA
41140	St. Joseph, MO-KS Metro Area	MO-KS	127,329	2	< 1	MSA
27140	Jackson, MS Metro Area	MS	539,057	300	2	MSA
25060	Gulfport-Biloxi, MS Metro Area	MS	248,820	54	1	MSA
25620	Hattiesburg, MS Metro Area	MS	142,842	182	3	MSA
13740	Billings, MT Metro Area	MT	158,050	143	1	MSA
10740	Albuquerque, NM Metro Area	NM	887,077	377	1	MSA
42140	Santa Fe, NM Metro Area	NM	144,170	1	< 1	MSA
22140	Farmington, NM Metro Area	NM	130,044	6,666	30	MSA
332	Las Vegas-Paradise-Pahrump, NV CSA	NV	1,995,215	38	< 1	CSA
160	Buffalo-Niagara-Cattaraugus, NY CSA	NY	1,215,826	1,507	10	CSA

**Table 5 - Presence of Active Oil and Gas Wells in
(1) Combined Statistical Areas (CSAs) with population greater than 1 million and
(2) Metropolitan Statistical Areas (MSAs) not located in such a CSA**

Code	Name	State	Population	No. of Oil and Gas Wells*	% of Census Area with Wells**	Census Designation
464	Rochester-Batavia-Seneca Falls, NY CSA	NY	1,149,653	815	4	CSA
45060	Syracuse, NY Metro Area	NY	662,577	101	1	MSA
46540	Utica-Rome, NY Metro Area	NY	299,397	18	< 1	MSA
13780	Binghamton, NY Metro Area	NY	251,725	20	< 1	MSA
27060	Ithaca, NY Metro Area	NY	101,564	4	< 1	MSA
21300	Elmira, NY Metro Area	NY	88,830	30	2	MSA
184	Cleveland-Akron-Elyria, OH CSA	OH	2,881,937	5,642	22	CSA
198	Columbus-Marion-Chillicothe, OH CSA	OH	2,071,052	2,228	9	CSA
212	Dayton-Springfield-Greenville, OH CSA	OH	1,072,891	6	< 1	CSA
45780	Toledo, OH Metro Area	OH	651,429	57	1	MSA
15940	Canton-Massillon, OH Metro Area	OH	404,422	2,074	53	MSA
31900	Mansfield, OH Metro Area	OH	124,475	81	4	MSA
30620	Lima, OH Metro Area	OH	106,331	5	< 1	MSA
41780	Sandusky, OH Metro Area	OH	77,079	35	1	MSA
178	Cincinnati-Middletown-Wilmington, OH-KY-IN CSA	OH-KY-IN	2,172,191	17	< 1	CSA
49660	Youngstown-Warren-Boardman, OH-PA Metro Area	OH-PA	565,773	3,996	57	MSA
44600	Steubenville-Weirton, OH-WV Metro Area	OH-WV	124,454	40	2	MSA
416	Oklahoma City-Shawnee, OK CSA	OK	1,322,429	11,163	44	CSA
46140	Tulsa, OK Metro Area	OK	937,478	13,287	51	MSA
30020	Lawton, OK Metro Area	OK	124,098	357	8	MSA
38900	Portland-Vancouver-Hillsboro, OR-WA Metro Area	OR-WA	2,226,009	56	< 1	MSA
430	Pittsburgh-New Castle, PA CSA	PA	2,447,393	3,865	17	CSA
42540	Scranton--Wilkes-Barre, PA Metro Area	PA	563,631	6	< 1	MSA
21500	Erie, PA Metro Area	PA	280,566	1,628	26	MSA
44300	State College, PA Metro Area	PA	153,990	296	7	MSA
27780	Johnstown, PA Metro Area	PA	143,679	194	7	MSA
11020	Altoona, PA Metro Area	PA	127,089	1	< 1	MSA
48700	Williamsport, PA Metro Area	PA	116,111	9	< 1	MSA
400	Nashville-Davidson--Murfreeshboro--Columbia, TN CSA	TN	1,670,890	57	< 1	CSA

**Table 5 - Presence of Active Oil and Gas Wells in
(1) Combined Statistical Areas (CSAs) with population greater than 1 million and
(2) Metropolitan Statistical Areas (MSAs) not located in such a CSA**

Code	Name	State	Population	No. of Oil and Gas Wells*	% of Census Area with Wells**	Census Designation
314	Knoxville-Sevierville-La Follette, TN CSA	TN	1,055,086	105	1	CSA
16860	Chattanooga, TN-GA Metro Area	TN-GA	528,143	1	< 1	MSA
17300	Clarksville, TN-KY Metro Area	TN-KY	273,949	159	2	MSA
28700	Kingsport-Bristol-Bristol, TN-VA Metro Area	TN-VA	309,544	28	< 1	MSA
206	Dallas-Fort Worth, TX CSA	TX	6,731,317	9,814	17	CSA
288	Houston-Baytown-Huntsville, TX CSA	TX	6,051,363	5,921	12	CSA
41700	San Antonio-New Braunfels, TX Metro Area	TX	2,142,508	2,637	9	MSA
126	Austin-Round Rock-Marble Falls, TX CSA	TX	1,759,039	710	3	CSA
32580	McAllen-Edinburg-Mission, TX Metro Area	TX	774,769	1,309	21	MSA
18580	Corpus Christi, TX Metro Area	TX	428,185	2,919	30	MSA
15180	Brownsville-Harlingen, TX Metro Area	TX	406,220	75	1	MSA
28660	Killeen-Temple-Fort Hood, TX Metro Area	TX	405,300	5	< 1	MSA
13140	Beaumont-Port Arthur, TX Metro Area	TX	388,745	1,295	13	MSA
31180	Lubbock, TX Metro Area	TX	284,890	455	6	MSA
29700	Laredo, TX Metro Area	TX	250,304	3,864	29	MSA
11100	Amarillo, TX Metro Area	TX	249,881	1,716	12	MSA
47380	Waco, TX Metro Area	TX	234,906	29	1	MSA
17780	College Station-Bryan, TX Metro Area	TX	228,660	2,879	34	MSA
30980	Longview, TX Metro Area	TX	214,369	2,853	39	MSA
46340	Tyler, TX Metro Area	TX	209,714	701	18	MSA
10180	Abilene, TX Metro Area	TX	165,252	3,851	35	MSA
48660	Wichita Falls, TX Metro Area	TX	151,306	4,629	43	MSA
36220	Odessa, TX Metro Area	TX	137,130	2,165	60	MSA
33260	Midland, TX Metro Area	TX	136,872	2,607	72	MSA
47020	Victoria, TX Metro Area	TX	115,384	3,271	29	MSA
41660	San Angelo, TX Metro Area	TX	111,823	2,324	22	MSA
45500	Texarkana, TX-Texarkana, AR Metro Area	TX-AR	136,027	322	5	MSA
482	Salt Lake City-Ogden-Clearfield, UT CSA	UT	1,744,886	107	< 1	CSA

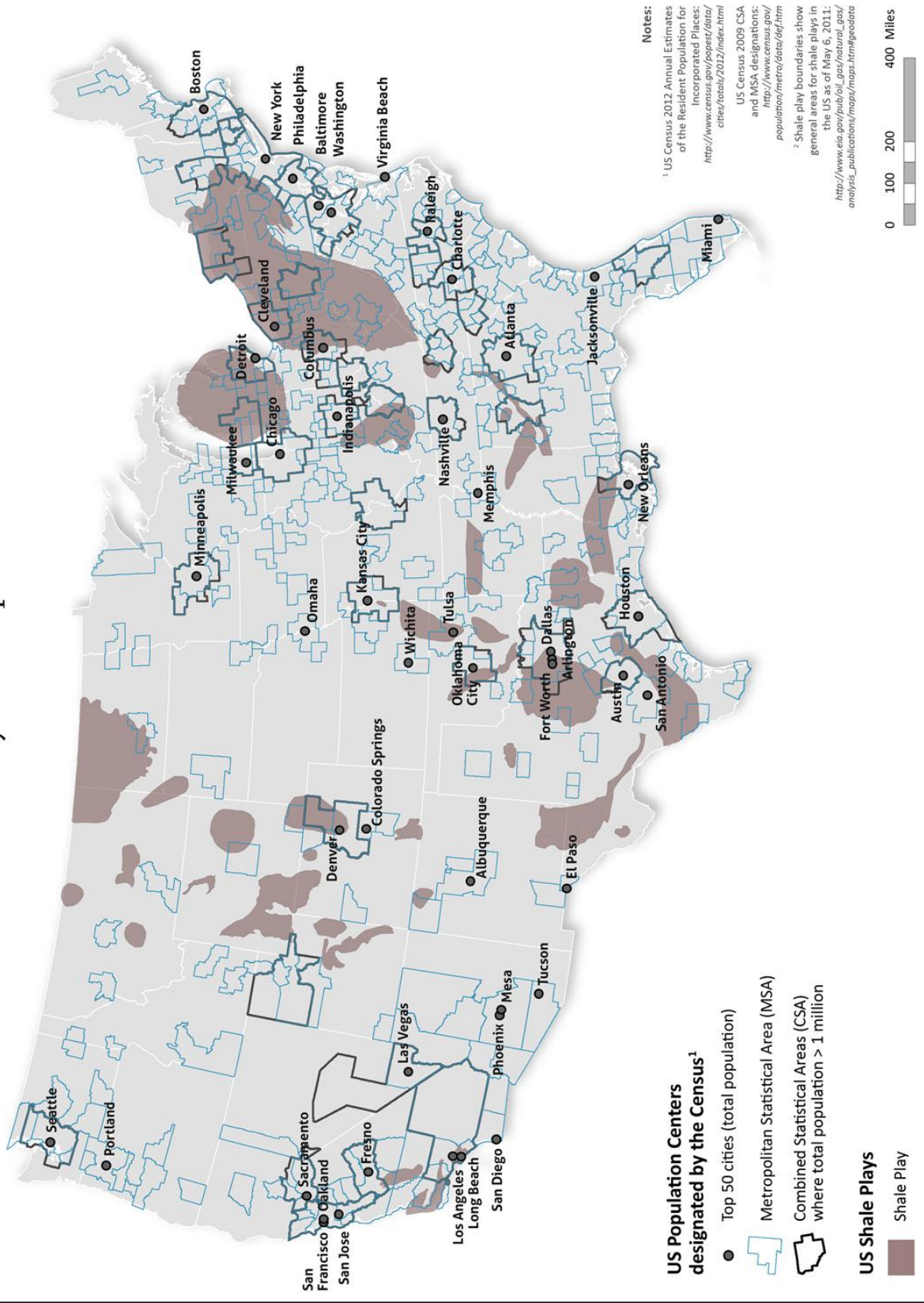
**Table 5 - Presence of Active Oil and Gas Wells in
(1) Combined Statistical Areas (CSAs) with population greater than 1 million and
(2) Metropolitan Statistical Areas (MSAs) not located in such a CSA**

Code	Name	State	Population	No. of Oil and Gas Wells*	% of Census Area with Wells**	Census Designation
41100	St. George, UT Metro Area	UT	138,115	14	< 1	MSA
25500	Harrisonburg, VA Metro Area	VA	125,228	1	< 1	MSA
500	Seattle-Tacoma-Olympia, WA CSA	WA	4,199,312	2	< 1	CSA
28420	Kennewick-Pasco-Richland, WA Metro Area	WA	253,340	3	< 1	MSA
13380	Bellingham, WA Metro Area	WA	201,140	1	< 1	MSA
16620	Charleston, WV Metro Area	WV	304,284	4,301	42	MSA
34060	Morgantown, WV Metro Area	WV	129,709	297	7	MSA
26580	Huntington-Ashland, WV-KY-OH Metro Area	WV-KY-OH	287,702	1,123	16	MSA
37620	Parkersburg-Marietta-Vienna, WV-OH Metro Area	WV-OH	162,056	2,582	46	MSA
48540	Wheeling, WV-OH Metro Area	WV-OH	147,950	117	3	MSA
16940	Cheyenne, WY Metro Area	WY	91,738	203	2	MSA
16220	Casper, WY Metro Area	WY	75,450	777	4	MSA
	Total		151,032,896	166,075		
*	Due to claims of proprietary information, precise well locations are unavailable in all states. The numbers in this table are taken from a publically available map which identified those quarter mile square cells where at least one active oil or gas well was located. Therefore, the numbers in this column reflect the lower bounds of the true range because there may be more than one well within the quarter mile square cells.					
**	This column represents the percent of the designated area that is covered by quarter mile square cells containing at least one active oil or gas well.					
Sources	US Census Data (2010) and Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado, <i>available at</i> http://catalog.data.gov/dataset/oil-and-gas-exploration-and-production-in-the-united-states-shown-as-quarter-mile-cells .					

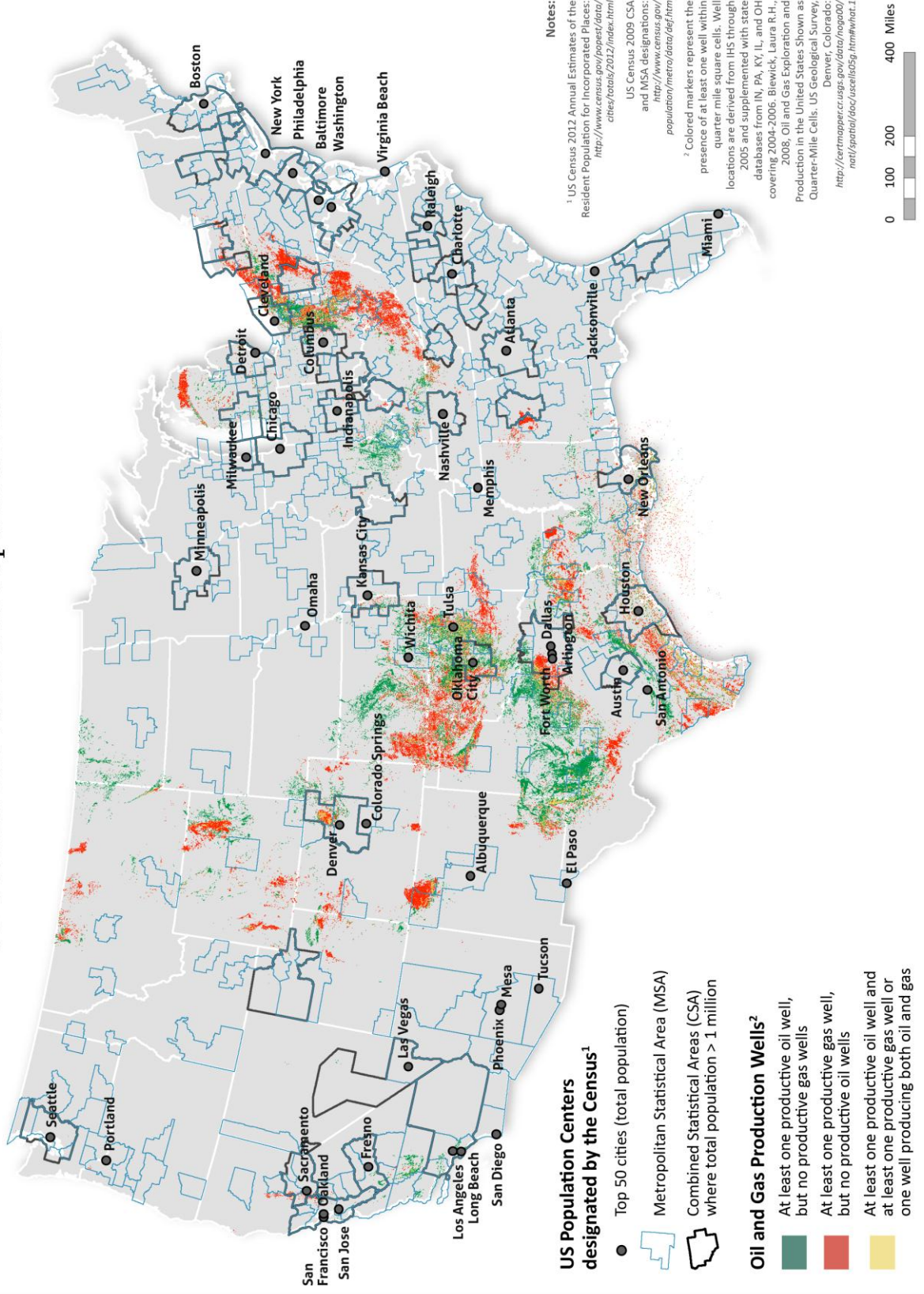
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US Shale Plays and Population Centers



US Oil and Gas Wells and Population Centers



CALIFORNIA

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

- Cities where total population > 250,000
- Ⓜ Metropolitan Statistical Area (MSA)
- Ⓜ Combined Statistical Areas (CSA)
where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well,
but no productive gas wells
- At least one productive gas well,
but no productive oil wells
- At least one productive oil well and
at least one productive gas well or
one well producing both oil and gas

Shale Plays³

- Shale Play

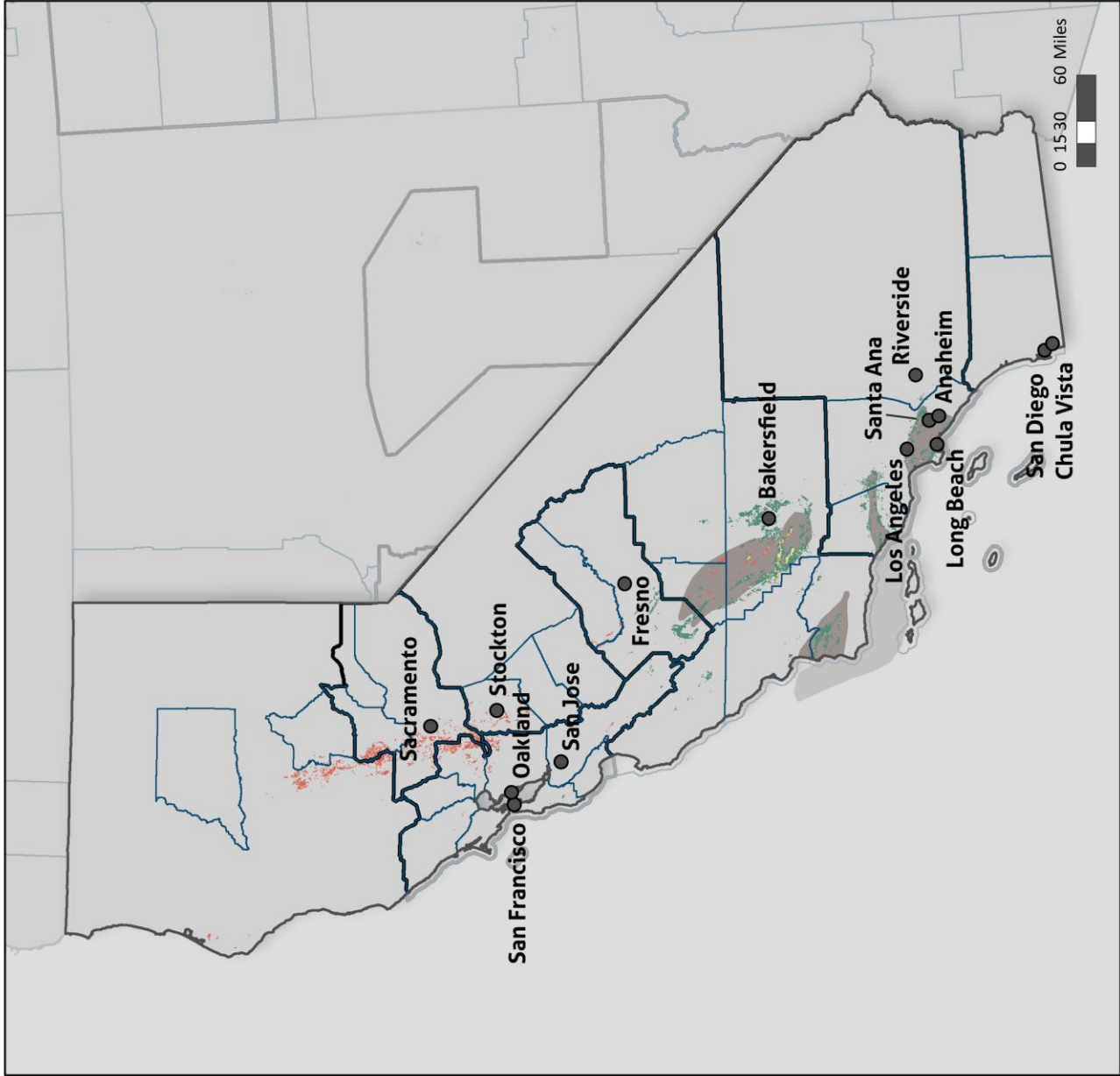
Notes:

¹ US Census 2012 Annual Estimates of the Resident Population for Incorporated Places:
<http://www.census.gov/popest/data/cities/totals/2012/index.html>

US Census 2009 CSA and MSA designations:
<http://www.census.gov/population/metro/data/def.html>

² Colored markers represent the presence of at least one well within quarter mile square cells. Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Blewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells; U. S. Geological Survey, Denver, Colorado. http://xertmapper.cr.usgs.gov/data/mogad07_natl/spatial/doc/usefile05g.htm#what.1

³ EIA 2011, Lower 48 Shale Plays:
http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm#geodata



COLORADO

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

- Cities where total population > 250,000
- Metropolitan Statistical Area (MSA)
- Combined Statistical Areas (CSA)
where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well,
but no productive gas wells
- At least one productive gas well,
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at least one productive gas well or
one well producing both oil and gas

Shale Plays³

- Shale Play

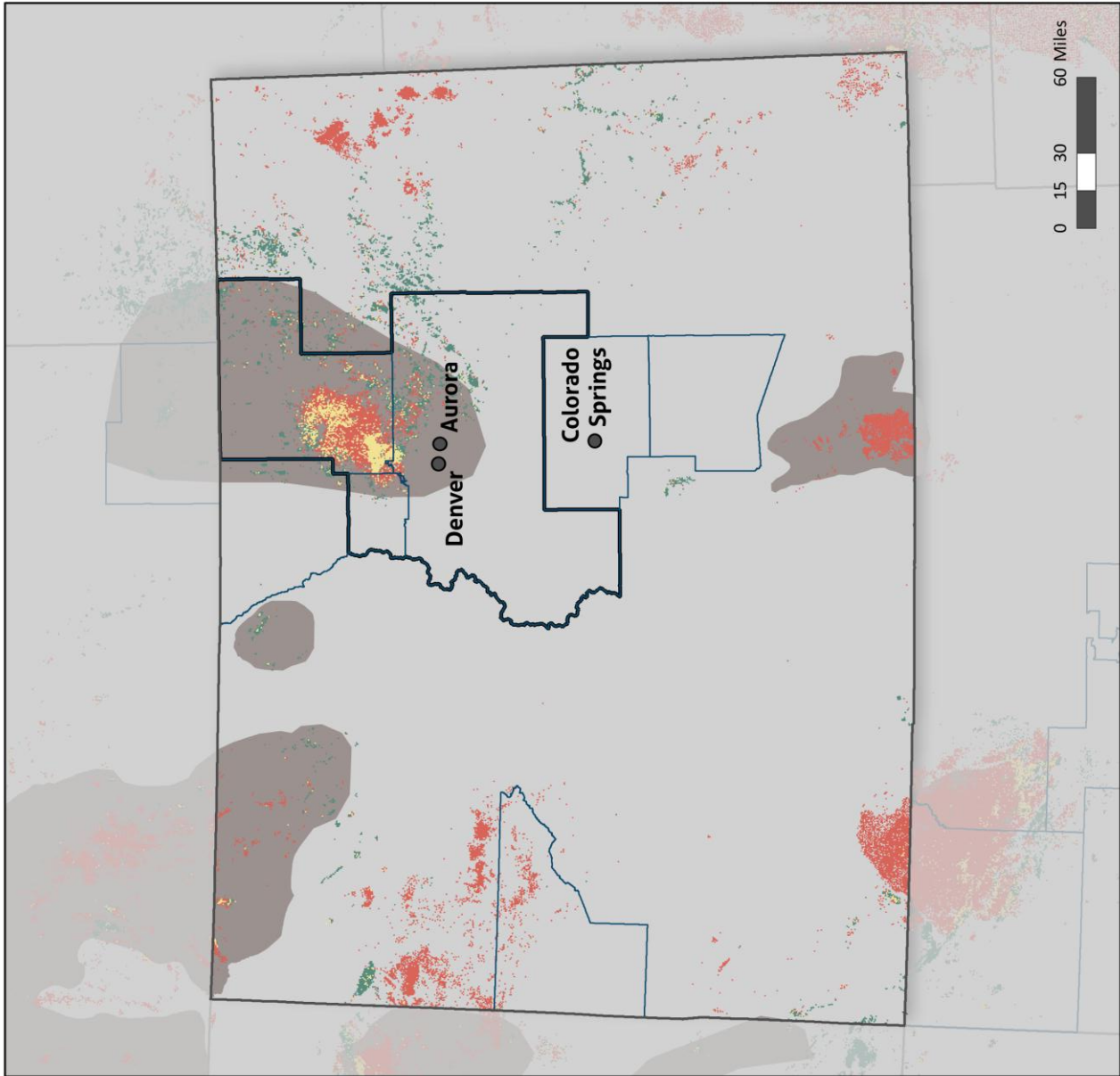
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¹ US Census 2012 Annual Estimates of the Resident Population for Incorporated Places: <http://www.census.gov/popest/data/cities/totals/2012/index.html>

US Census 2009 CSA and MSA designations: <http://www.census.gov/population/metro/data/def.html>

² Colored markers represent the presence of at least one well within quarter mile square cells. Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado. <http://ceetmapper.cr.usgs.gov/data/nogad00/natl/spatial/doc/uscell505g.html#what.1>

³ EIA 2011. Lower 48 Shale Plays: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.html#geodata



PENNSYLVANIA

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

- Cities where total population > 250,000
- ⬜ Metropolitan Statistical Area (MSA)
- ⬜ Combined Statistical Areas (CSA)
where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well,
but no productive gas wells
- At least one productive gas well,
but no productive oil wells
- At least one productive oil well and
at least one productive gas well or
one well producing both oil and gas

Shale Plays³

- Shale Play

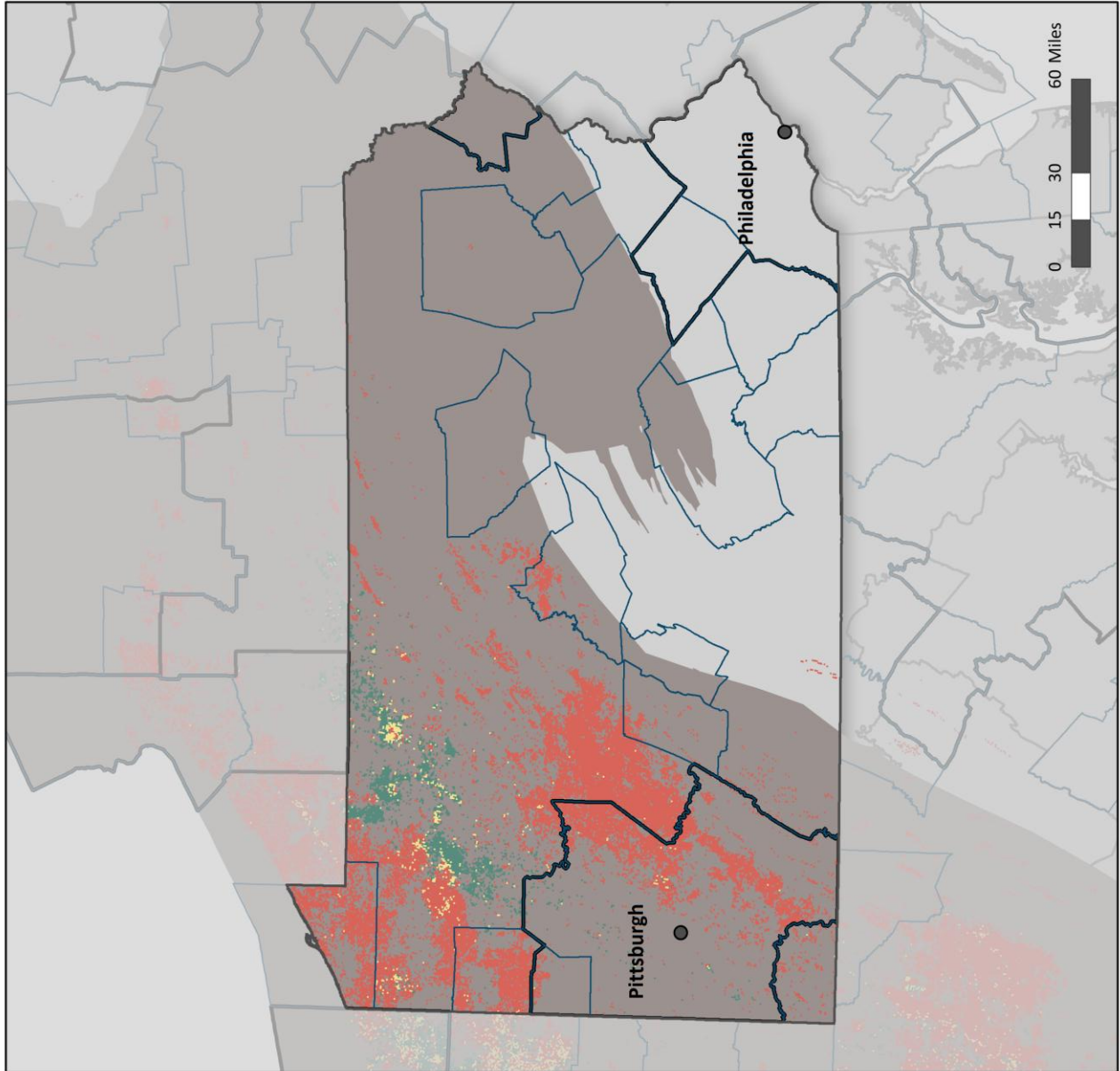
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¹ US Census 2012 Annual Estimates of the Resident Population for Incorporated Places: <http://www.census.gov/popest/data/cities/totals/2012/index.html>

US Census 2009 CSA and MSA designations: <http://www.census.gov/population/metro/data/def.html>

² Colored markers represent the presence of at least one well within quarter mile square cells. Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008. Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U.S. Geological Survey, Denver, Colorado. <http://cermapper.cr.usgs.gov/data/nagooq/na01/spatial/doc/uscel105g.html#vrat.1>

³ EIA 2011. Lower 48 Shale Plays: http://www.eia.gov/pub/oi/gas/natural_gas/analysis_publications/maps/maps.html#geodata



TEXAS

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

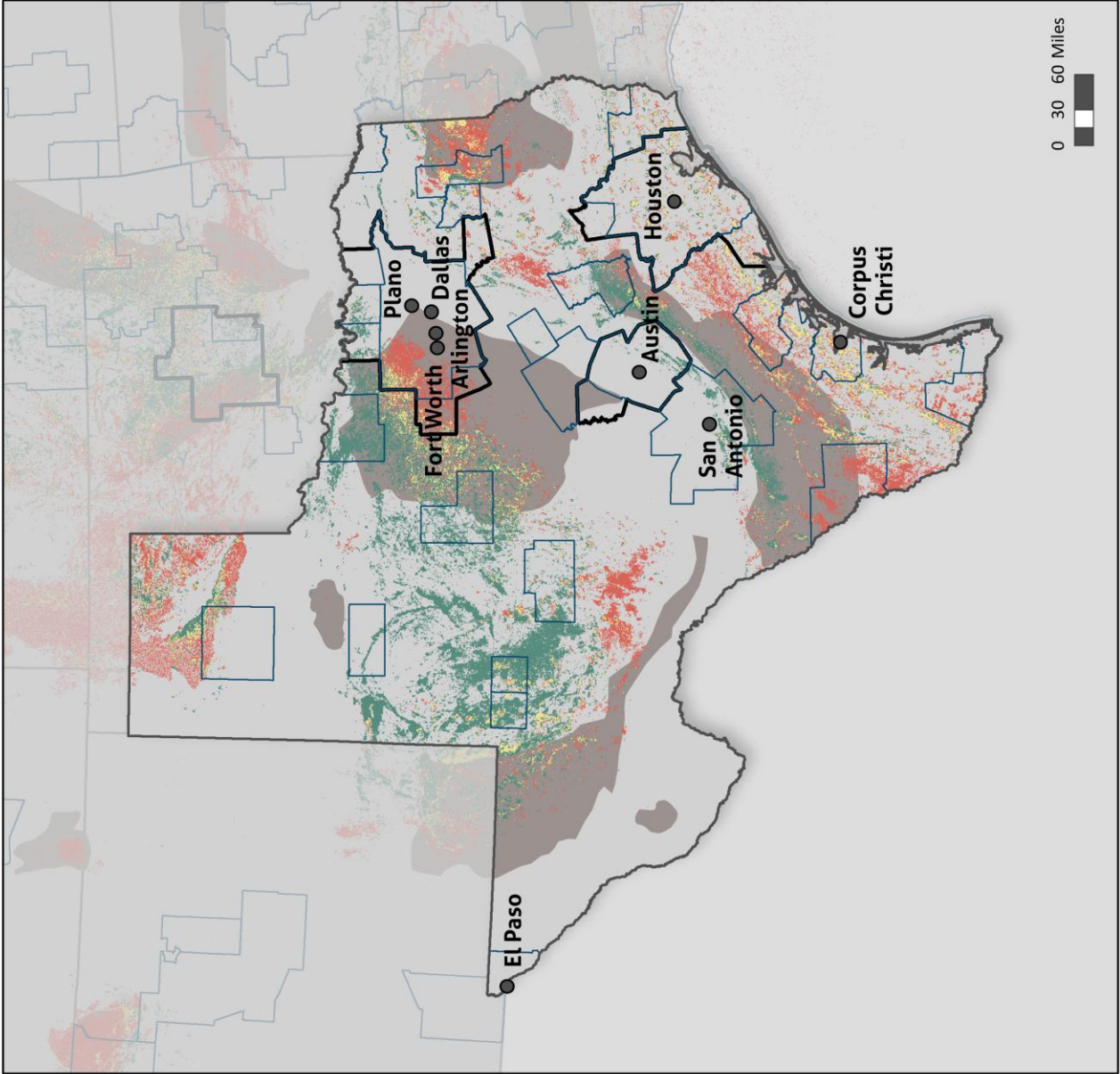
- Cities where total population > 250,000
- ⬜ Metropolitan Statistical Area (MSA)
- ⬜ Combined Statistical Areas (CSA) where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well, but no productive gas wells
- At least one productive gas well, but no productive oil wells
- At least one productive oil well and at least one productive gas well or one well producing both oil and gas

Shale Plays³

- Shale Play



Notes:

¹ US Census 2012 Annual Estimates of the Resident Population for Incorporated Places: <http://www.census.gov/popest/data/cities/totals/2012/index.html>

US Census 2009 CSA and MSA designations: <http://www.census.gov/population/metro/data/def.html>

² Colored markers represent the presence of at least one well within quarter mile square cells. Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006; Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado. http://ceirmapper.cr.usgs.gov/data/hoq007_natl/spatial/doc/uscell505g.htm#what.1

³ EIA 2011, Lower 48 Shale Plays: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.html#goodata

OHIO

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

- Cities where total population > 250,000
- Metropolitan Statistical Area (MSA)
- Combined Statistical Areas (CSA)
where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well,
but no productive gas wells
- At least one productive gas well,
but no productive oil wells
- At least one productive oil well and
at least one productive gas well or
one well producing both oil and gas

Shale Plays³

- Shale Play

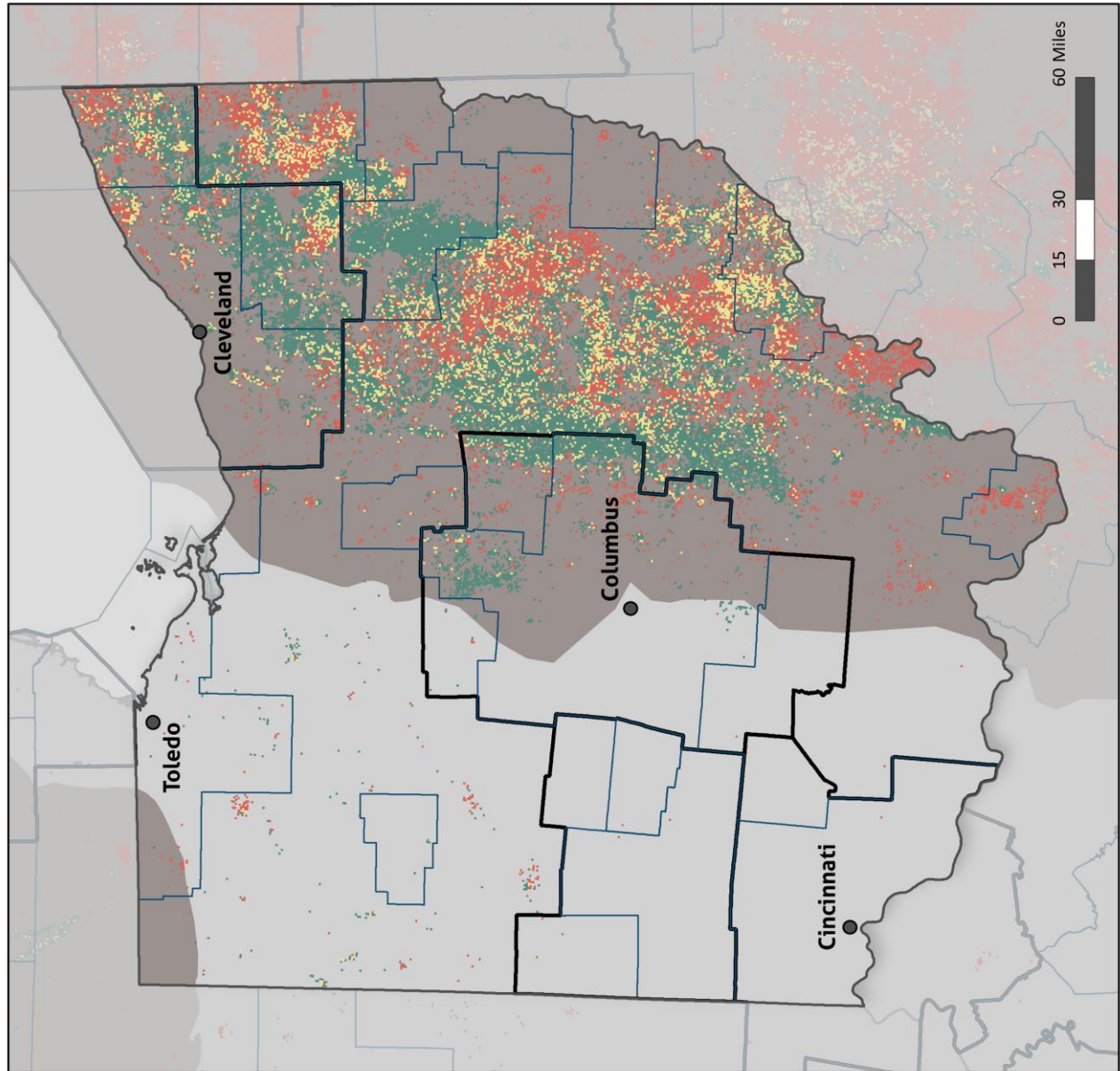
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US Census 2009 CSA and MSA designations: <http://www.census.gov/population/metro/data/def.html>

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³ EIA 2011, Lower 48 Shale Plays: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.html#geodata



LOUISIANA

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

- Cities where total population > 250,000
- Metropolitan Statistical Area (MSA)
- Combined Statistical Areas (CSA)
where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well,
but no productive gas wells
- At least one productive gas well,
but no productive oil wells
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at least one productive gas well or
one well producing both oil and gas

Shale Plays³

- Shale Play

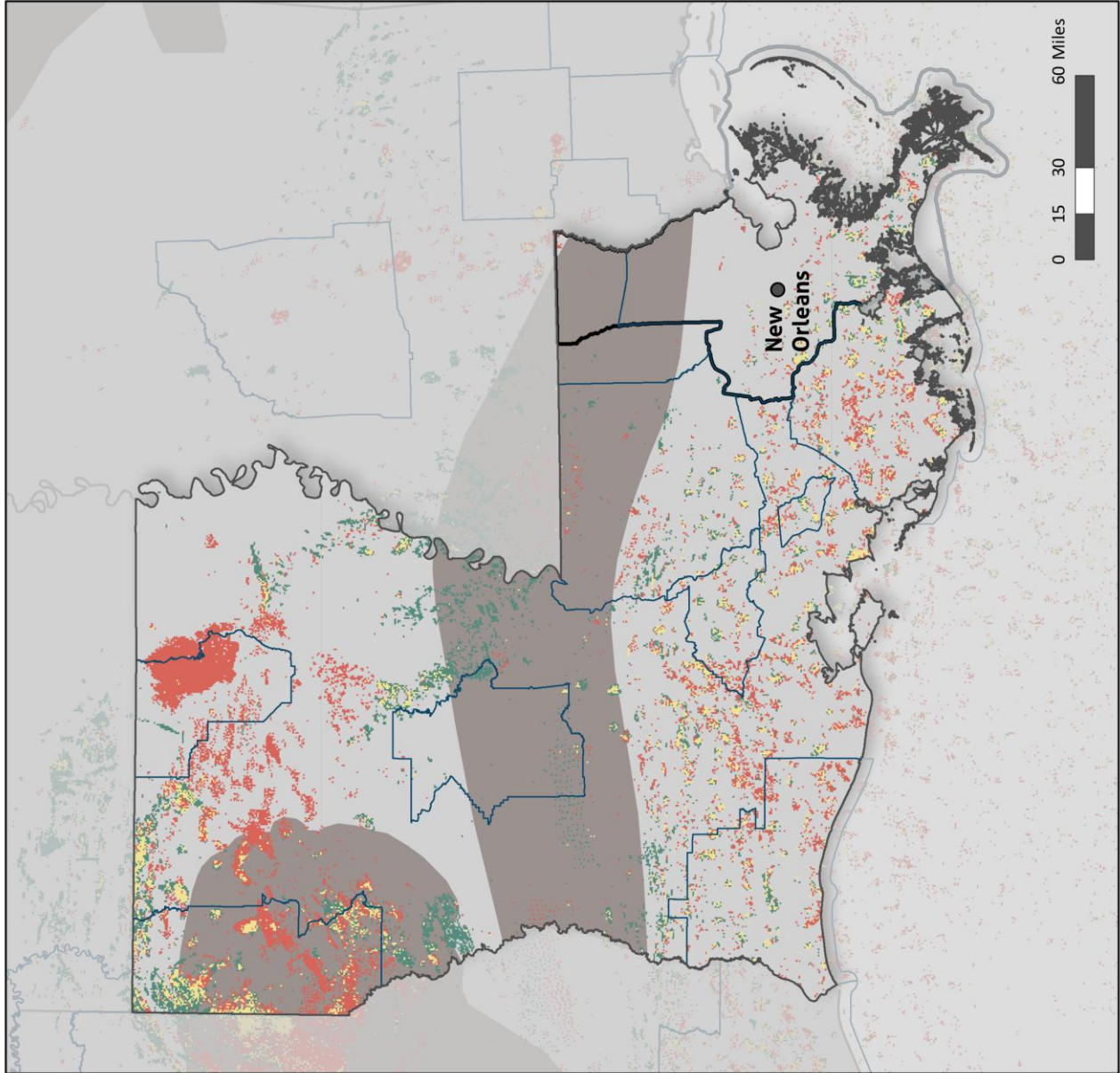
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¹ US Census 2012 Annual Estimates of the Resident Population for Incorporated Places: <http://www.census.gov/popest/data/cities/totals/2012/index.html>

US Census 2009 CSA and MSA designations: <http://www.census.gov/population/metro/data/def.html>

² Colored markers represent the presence of at least one well within quarter mile square cells. Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado. <http://ceetmapper.cr.usgs.gov/data/nogad00/natl/spatial/doc/uscell505g.html#what-1>

³ EIA 2011, Lower 48 Shale Plays: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.html#geodata



MICHIGAN

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

- Cities where total population > 250,000
- Metropolitan Statistical Area (MSA)
- Combined Statistical Areas (CSA)
where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well,
but no productive gas wells
- At least one productive gas well,
but no productive oil wells
- At least one productive oil well and
at least one productive gas well or
one well producing both oil and gas

Shale Plays³

- Shale Play

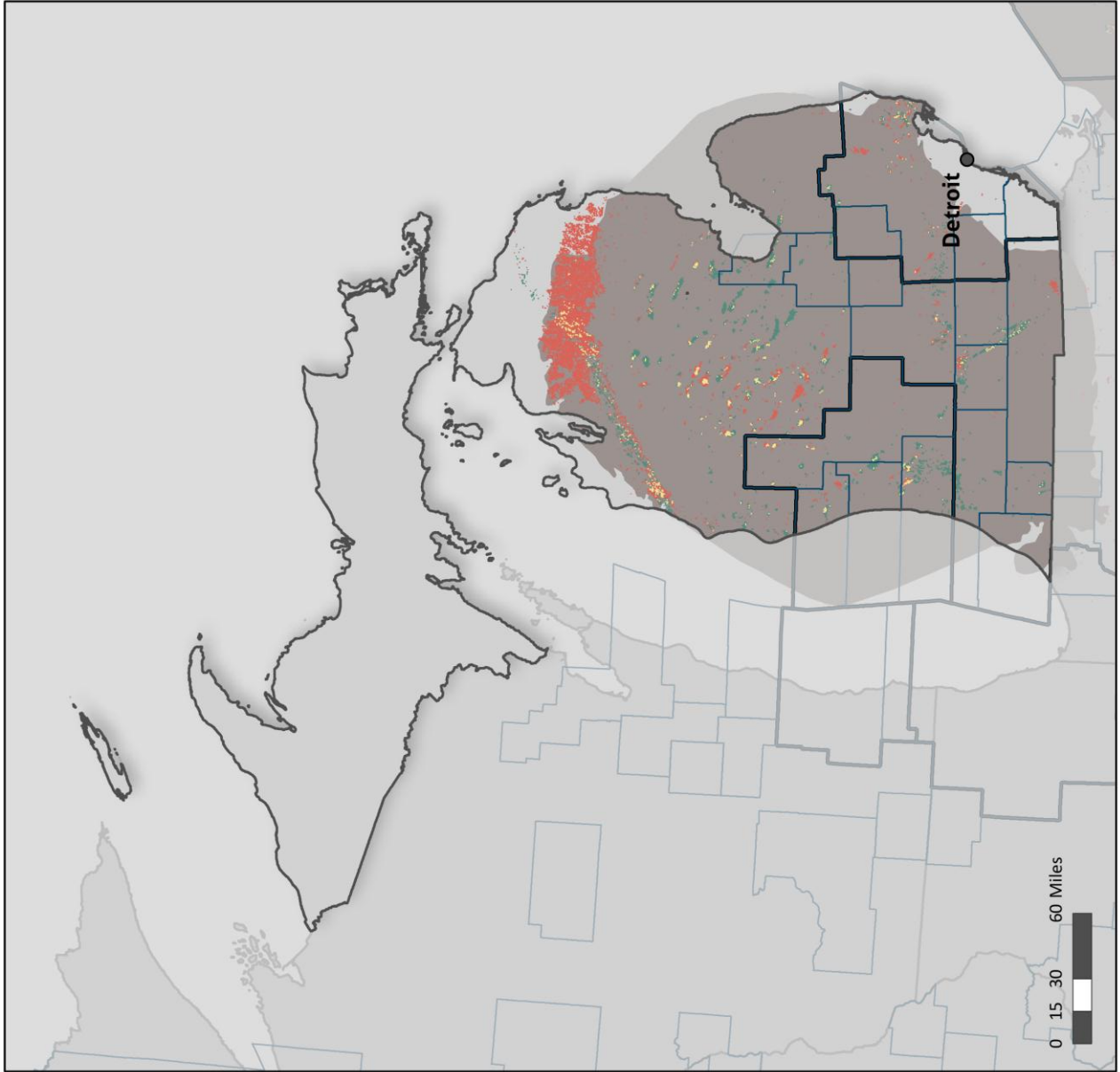
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¹ US Census 2012 Annual Estimates of the Resident Population for Incorporated Places: <http://www.census.gov/popest/data/cities/totals/2012/index.html>

US Census 2009 CSA and MSA designations: <http://www.census.gov/population/metro/data/09.html>

² Colored markers represent the presence of at least one well within quarter mile square cells. Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado. <http://ceetmappercr.usgs.gov/data/nogad00/natl/spatial/doc/uscell505g.html#what.1>

³ EIA 2011. Lower 48 Shale Plays: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.html#geodata



NEW YORK

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

- Cities where total population > 250,000
- ⊔ Metropolitan Statistical Area (MSA)
- ⊔ Combined Statistical Areas (CSA)
where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well,
but no productive gas wells
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at least one productive gas well or
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Shale Plays³

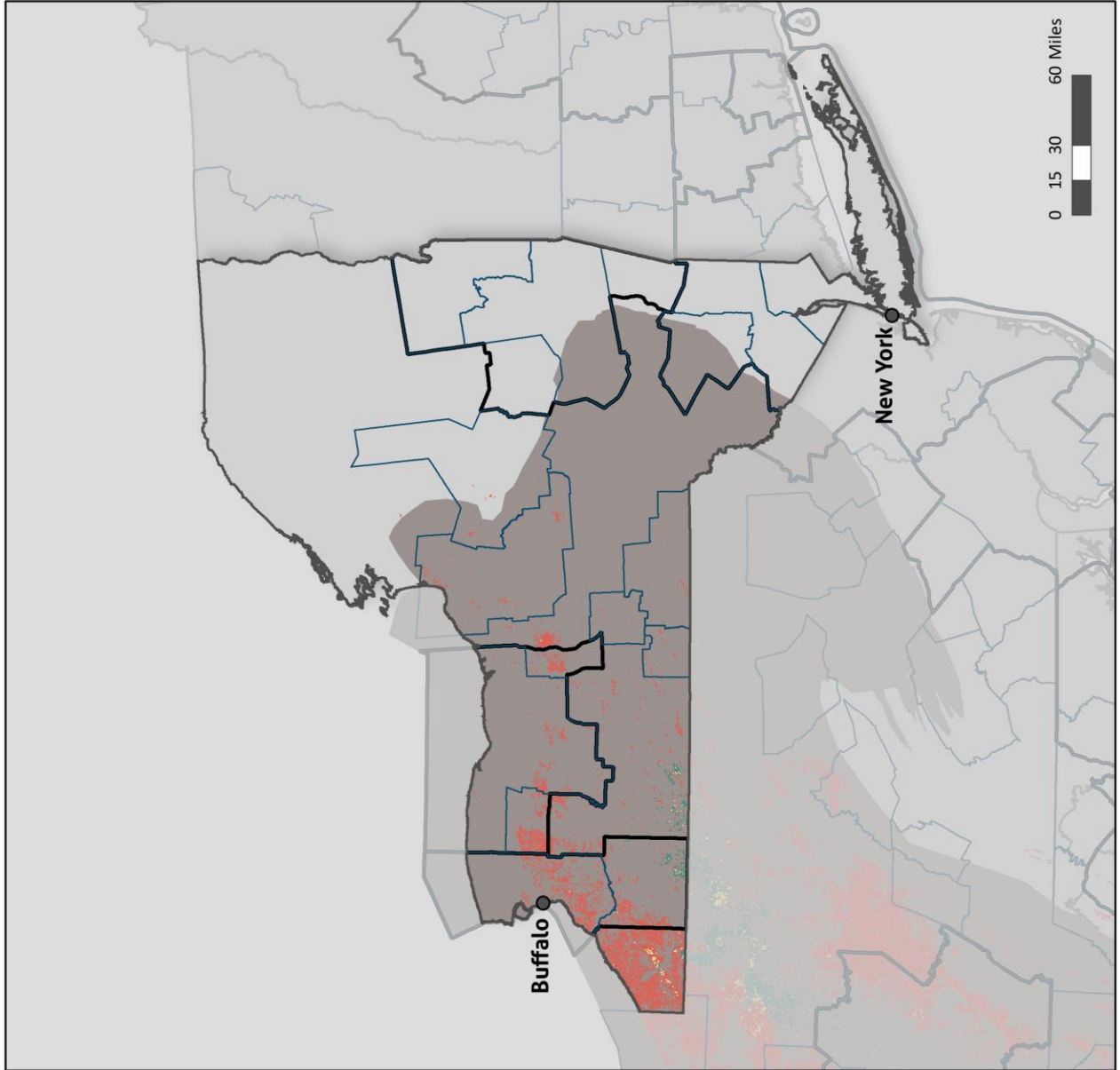
- Shale Play

Notes:

¹ US Census 2012 Annual Estimates of the Resident Population for Incorporated Places: <http://www.census.gov/popest/data/cities/totals/2012/index.html>

² Colored markers represent the presence of at least one well within quarter mile square cells. Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado. http://certmapper.cr.usgs.gov/data/nogad07_natl/spatial/doc/uscells05g.html#what.1

³ EIA 2011. Lower 48 Shale Plays: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.html#geodata



OKLAHOMA

Oil and Gas Wells, Shale Plays and Population Centers

US Population Centers designated by the Census¹

- Cities where total population > 250,000
- Metropolitan Statistical Area (MSA)
- Combined Statistical Areas (CSA) where total population > 1 million

Oil and Gas Production Wells²

- At least one productive oil well, but no productive gas wells
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Shale Plays³

- Shale Play

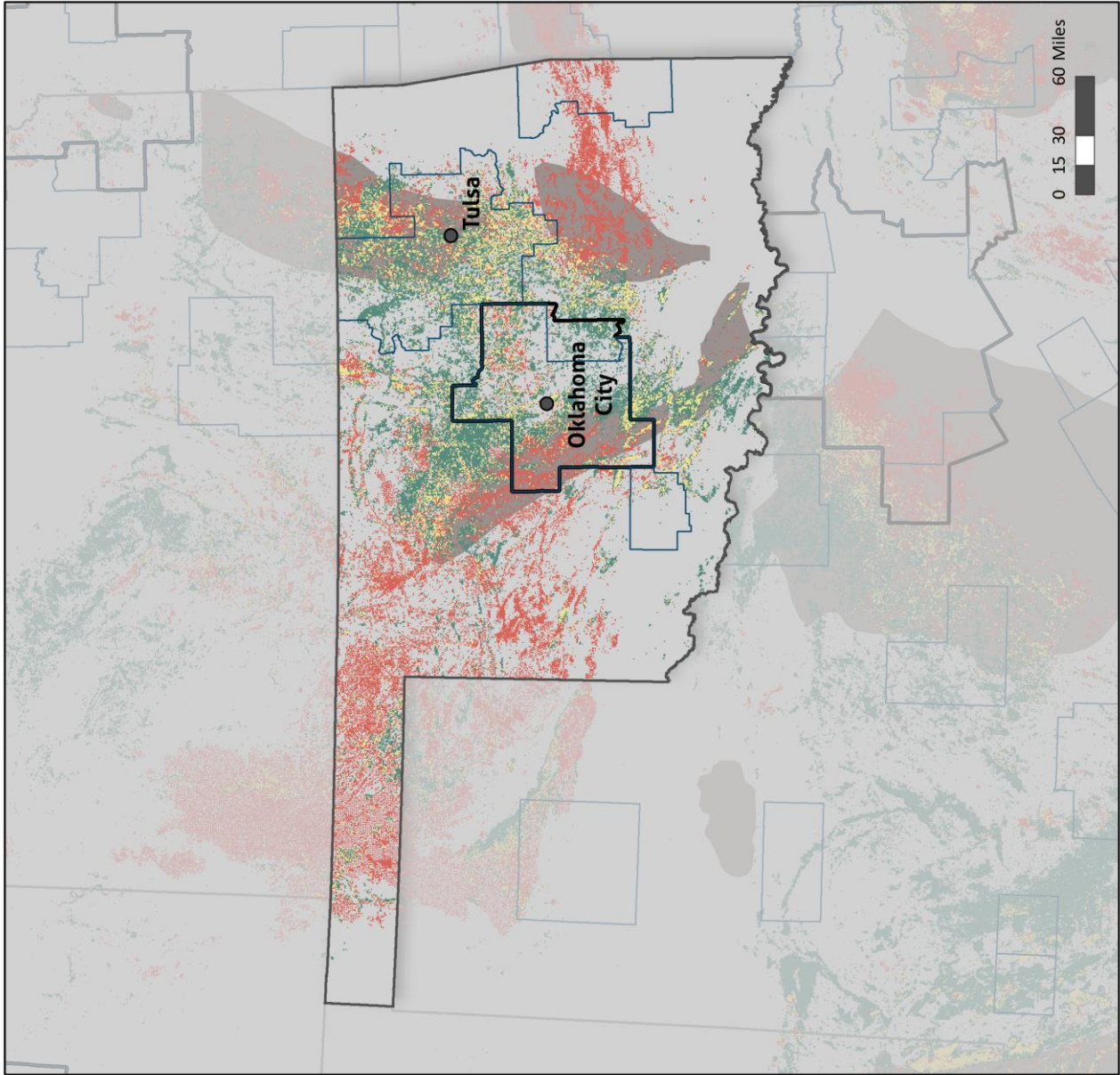
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¹ US Census 2012 Annual Estimates of the Resident Population for Incorporated Places: <http://www.census.gov/popest/data/cities/totals/2012/index.html>

US Census 2009 CSA and MSA designations: <http://www.census.gov/population/metro/data/def.html>

² Colored markers represent the presence of at least one well within quarter mile square cells. Well locations are derived from IHS through 2005 and supplemented with state databases from IN, PA, KY, IL, and OH covering 2004-2006. Biewick, Laura R.H., 2008, Oil and Gas Exploration and Production in the United States Shown as Quarter-Mile Cells: U. S. Geological Survey, Denver, Colorado. <http://cermapper.cr.usgs.gov/data/noag00/natl/spatial/doc/uscell50g.htm#what-1>

³ EIA 2011, Lower 48 Shale Plays: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.html#gendata



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190. Also attached are the summaries for each of the following pollutants available from EPA's Integrated Risk Information System ("IRIS"), available at: <http://www.epa.gov/iris/>, or EPA's TTN website.
- Acetaldehyde (last updated 08/09/2012)
 - Acetophenone (last updated 08/09/2012)
 - Acrolein (last updated 08/09/2012)
 - Acrylamide (last updated 08/09/2012)
 - Arsenic (last updated 08/09/2012)
 - Benzene (last updated 01/24/2013)
 - Benzyl chloride (last updated 08/09/2012)
 - Carbon disulfide (last updated 08/09/2012)
 - Carbonyl sulfide (last updated 08/09/2012)
 - Cumene (last updated 08/09/2012)
 - 1, 4 Dioxane (last updated 10/21/2013)
 - Di (2-ethylhexyl) phthalate (Bis (2-ethylhexyl) phthalate) (last updated 08/09/2012)
 - Dimethyl formamide (N, N-Dimethylformamide) (last updated 08/09/2012)
 - Ethylbenzene (Ethyl benzene) (last updated 08/09/2012)
 - Ethylene glycol (1,2-ethanediol) (last updated 08/09/2012)
 - Formaldehyde (last update 08/09/2012)
 - Hexane (n-Hexane) (last updated 08/09/2012)
 - Hydrogen chloride (Hydrochloric acid) (last updated 08/09/2012)
 - Hydrogen fluoride (Hydrofluoric acid) (1992, revised Jan. 2000)
 - Lead (last updated 01/24/2013)
 - Mercury (last updated 08/09/2012)
 - Methylene chloride (dichloromethane) (last updated 08/09/2012)
 - Methanol (Methyl alcohol) (last updated 09/30/2013)
 - Naphthalene (last updated 08/09/2012)
 - Phenol (last updated 08/09/2012)
 - Phthalic anhydride (last updated 08/09/2012)
 - Propylene oxide (last updated 08/09/2012)
 - Toluene (last updated 04/01/2013)
 - 2,2,4-trimethylpentane. (last updated 08/09/2012)
 - Xylenes (last updated 08/09/2012)