Order Code RL32948

Air Quality Issues and Animal Agriculture: A Primer

June 10, 2005

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Summary

From an environmental quality standpoint, much of the public and policy interest in animal agriculture has focused on impacts on water resources, because animal waste, if not properly managed, can harm water quality through surface runoff, direct discharges, spills, and leaching into soil and groundwater. A more recent issue is the contribution of emissions from animal feeding operations (AFOs), enterprises where animals are raised in confinement, to air pollution. This report provides background on the latter issue. It will be updated as warranted.

AFOs can affect air quality through emissions of gases such as ammonia and hydrogen sulfide, particulate matter, volatile organic compounds, hazardous air pollutants, and odor. These pollutants and compounds have a number of environmental and human health effects.

Agricultural operations have been treated differently than other businesses under numerous federal and state laws. Some environmental laws specifically exempt agriculture from regulatory provisions, and some are designed so that farms escape most, if not all, of the regulatory impact. The primary regulatory focus on environmental impacts has occurred under the Clean Water Act. In addition, AFOs that emit large quantities of air pollutants may be subject to Clean Air Act regulation. Some livestock operations also may be regulated under the release reporting requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Emergency Planning and Community Right-to-Know Act (EPCRA). Questions about the applicability of these laws to livestock and poultry operations have been controversial and have drawn congressional attention.

Enforcement of federal environmental laws requires accurate measurement of emissions to determine whether regulated pollutants are emitted in quantities that exceed specified thresholds. Two reports by the National Research Council evaluated the current scientific knowledge base and approaches for estimating air emissions from AFOs as a guide for future management and regulatory efforts.

Stakeholders may find little agreement on these issues, with the exception of agreeing on a need for research to estimate, measure, and characterize emissions, and to develop and evaluate technologies to mitigate and control emissions.

In an effort to collect scientifically credible data on air emissions, in January 2005 the Environmental Protection Agency (EPA) announced a plan negotiated with segments of the animal agriculture industry. Called the Air Compliance Agreement, it is intended to produce air quality monitoring data on AFO emissions, while at the same time protecting participants through a "safe harbor" from liability under certain provisions of federal environmental laws. Issues related to this agreement, which has been controversial with environmental advocates, state and local air quality officials, and some industry groups, are discussed separately in CRS Report RL32947, *Air Quality Issues and Animal Agriculture: EPA's Air Compliance Agreement.*

Contents

List of Figures

List of Tables

Air Quality Issues and Animal Agriculture: A Primer

Introduction

Animal agriculture is a $100 billion per year industry in the United States. Livestock and poultry are raised on an estimated 1.3 million farms throughout the nation. About 238,000 of these farms are considered animal feeding operations (AFOs) — agriculture enterprises where animals are kept and raised in confinement. An estimated 95% of these are small businesses: most AFOs raise fewer than 300 animals. Very large AFOs, housing 300 or more animals such as cows (or equivalent numbers of other animals species), are defined as concentrated animal feeding operations, or CAFOs. For more than two decades, organizational changes within the industry to enhance economic efficiency have resulted in larger confined production facilities that often are geographically concentrated. Increased facility size, greater numbers of animals being raised at large feedlots, and regional concentration of livestock and poultry operations have, in turn, given rise to concerns over the management of animal wastes from these facilities and potential impacts on environmental quality.

From an environmental quality standpoint, much of the public and policy interest in animal agriculture has focused on impacts on water resources, because animal waste, if not properly managed, can adversely impact water quality through surface runoff and erosion, direct discharges to surface waters, spills and other dry-weather discharges, and leaching into soil and groundwater. However, animal feeding operations can also result in emissions to the air of particles and gases such as ammonia, hydrogen sulfide, and volatile organic chemicals (VOCs). At issue today are questions about AFOs' contribution to total air pollution and corresponding ecological and possible public health effects. Resolving those questions is hindered by a lack of adequate, accurate, scientifically credible data on air emissions from AFOs, data that are needed to gauge possible adverse impacts and subsequent implementation of control measures.

This report provides background on these issues.[1] It first reviews the types of air emissions from livestock and poultry operations and their human health and environmental impacts. It then discusses provisions of several federal laws concerned with environmental impacts, beginning with the Clean Water Act, because

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[1] This report focuses on the animal production segment of agriculture. Other types of production agriculture also can generate air emissions, such as land preparation and crop harvest activities, prescribed burning, and other farming practices, or emissions associated with storage and use of mobile source fuels and operation of farm vehicles, engines, and equipment. While some of these types of emissions may contribute to air quality problems, especially in agriculture-dominated regions, they are outside the scope of this report.

protecting water resources has been the primary regulatory focus regarding livestock and animal operations. The Environmental Protection Agency (EPA) has authority to address AFO air emissions under several laws — the Clean Air Act, Comprehensive Environmental Response, Compensation, and Liability Act, and the Emergency Planning and Community Right-to-Know Act — which are next discussed. Questions about the applicability of these laws to livestock and poultry operations have been controversial in several arenas and have drawn congressional attention. Studies by the National Research Council concerning air emissions are reviewed, as are relevant activities of the states and the U.S. Department of Agriculture. Finally, the report identifies a number of key research questions needed to characterize and evaluate animal agriculture emissions.

In January 2005, EPA announced a plan called the Air Compliance Agreement that would produce air quality monitoring data on animal agriculture emissions from a small number of farms, while at the same time protecting all participants (including farms where no monitoring takes place) through a "safe harbor" from liability under certain provisions of federal environmental laws. Some industry sectors involved in negotiating this agreement, notably pork and egg producers, strongly support it, but other industry groups that were not involved in the discussions have concerns and reservations. State and local air quality officials and environmental groups oppose the agreement. Issues related to the Air Compliance Agreement are discussed separately in CRS Report RL32947, *Air Quality Issues and Animal Agriculture: EPA's Air Compliance Agreement.*

Air Emissions from Livestock and Poultry: Sources and Impacts

AFOs can affect air quality through emissions of gases (ammonia and hydrogen sulfide), particulate matter (PM), volatile organic compounds (VOCs), hazardous air pollutants, microorganisms, and odor. AFOs also produce gases (carbon dioxide and methane) that are associated with climate change. The generation rates of odor, manure, gases, particulates, and other constituents vary with weather, time, animal species, type of housing, manure handling system, feed type, and management system (storage, handling, and stabilization).

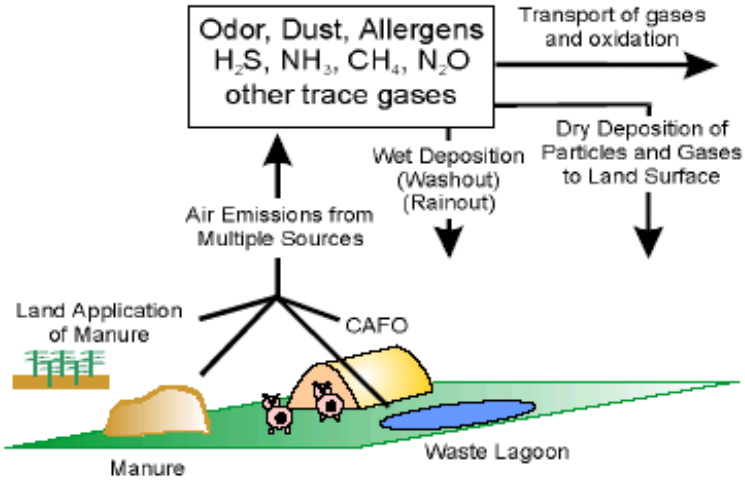
Emission sources include barns, feedlot surfaces, manure storage and treatment units, silage piles, animal composting structures, and other smaller sources, but air emissions come mostly from the microbial breakdown of manure stored in pits or lagoons and spread on fields. Each emission source will have a different profile of substances emitted, with rates that fluctuate through the day and the year. The sources, fate, and transport of AFO emissions are illustrated in **Figure 1**.

Health and Environmental Impacts

Pollutants associated with AFOs have a number of environmental and human health impacts. Most of the concern with possible health effects focuses on

ammonia, hydrogen sulfide, and particulate matter, while major ecological effects are associated with ammonia, particulates, methane, and oxides of nitrogen.[2]

Figure 1. Fate and Transport of Air Emissions Associated with Animal Feeding Operations



Source: The University of Iowa and The University of Iowa Study Group, *Iowa Concentrated Animal Feeding Operations Air Quality Study, Final Report*, 2002, p. 87.

The nitrogen in animal manure can be converted to **ammonia** (NH_3) by a combination of processes. Ammonia released from the surface of liquid manure storage structures rapidly adheres to particles in the air, due to its cohesive properties, thus contributing to the formation of ambient particulate matter, specifically ammonium nitrate and ammonium sulfate. These particles form to a varying degree in the presence of ammonia and oxides of nitrogen or sulfur (see below). Once emitted, ammonia also is re-deposited back to earth in rainfall that can harm surface waters and aquatic life in lakes and streams. Ammonia aerosols in rainfall contribute to oxygen depletion of aquatic systems and excessive growth of algae, as well as acidification of the environment. It is estimated that emissions from animal waste account for about one-half of the total natural and anthropogenic ammonia emitted in the United States annually. Ammonia has a strong, sharp, characteristic odor that disperses rapidly in the air. Health effects at low concentrations include eye, nose and throat irritation; exposure at very high short-term concentrations can be lethal.

Particles are highly complex in size, physical properties, and composition. For regulatory purposes, airborne particulate matter (PM) is commonly considered as coarse particles (those less than 10 microns in diameter, referred to as PM_{10}), or fine particles, those less than 2.5 microns in diameter (referred to as $PM_{2.5}$). Agriculture is a major direct source of PM_{10}, which is essentially dust raised from unpaved roads,

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[2] The following discussion is drawn primarily from National Research Council, *Air Emissions from Animal Feeding Operations, Current Knowledge, Future Needs*, 2003, pp. 65-71 (hereafter cited as NRC 2003 AFO Report); and David R. Schmidt et al., National Center for Manure and Animal Waste Management, North Carolina State University, *Air Quality and Emissions from Livestock and Poultry Production/Waste Management Systems*, Aug. 12, 2002.

grain mills or storage facilities, feeding equipment, and particles generated in other mechanical processes. In contrast, $PM_{2.5}$ is a different class of particles, resulting more from evaporation and atmospheric chemical processes than direct emissions. Fine particles are formed in the atmosphere through the interaction of gases such as sulfur oxides, nitrogen oxides, and VOC.

AFOs can contribute directly to particulate matter through several mechanisms, including animal activity, animal housing ventilation units, and particles of mineral and organic material from soil and manure that adhere to air molecules. As described above, particulate matter can contribute indirectly to fine particle formation by emissions of ammonia, nitrogen oxides, and hydrogen sulfide, which are converted to aerosols through reactions in the atmosphere. Particle formation is highly dependent on atmospheric temperature, humidity, concentrations of the precursor compounds, and other factors, so the particle formation is variable and difficult to predict. Particles of differing sizes have been linked to health effects. Larger particles tend to be deposited in the upper airways of the respiratory tract, whereas small particles have both health and environmental effects: they can be deposited in the smallest airways in the lungs and, while still airborne, also play an important role in formation of regional haze. Populations with long-term exposure to heavier loads of particles have higher rates of mortality from major cardiovascular diseases, as well as increased rates of morbidity. The primary environmental and ecological effects of particles are related to haze and decreased visibility, which is caused by the suspended aerosols that both absorb and scatter light.

Hydrogen sulfide (H_2S) is a colorless gas with a strong and generally objectionable rotten egg odor. It is produced in anaerobic (oxygen-deprived) environments from the microbial reduction of sulfate in water and the decomposition of sulfur-containing organic matter in manure. Acute human health effects include respiratory and cardiovascular irritation, as well as headaches. H_2S may have local effects of concern — especially odor — and may contribute to the atmospheric sulfur burden of regions with a high density of AFOs, but few other sources.

Methane and **nitrous oxide** are known to contribute to global warming. An estimated one-half of global methane comes from manmade sources, of which agriculture is the largest source, with livestock production being a major component within the sector. EPA estimates that 25% of the nation's methane emissions come from livestock. Agricultural methane is produced by ruminant animals, but also is emitted during microbial degradation of organic matter under anaerobic conditions. Nitrous oxide forms via the microbial processes of nitrification and denitrification. In the United States, animal waste accounts for about 6% of nitrous oxide emissions.

Many of the complaints about AFOs are generated by **odor**. Odor from AFOs is not caused by a single substance, but is rather the result of a large number of contributing compounds, including ammonia, VOCs, and hydrogen sulfide. As classes of compounds, odor and VOCs can be considered together. VOCs (also referred to as reactive organic compounds, or ROGs) vaporize easily at room temperature and include a large number of constituents, such as volatile fatty acids, sulfides, amines, alcohols, hydrocarbons, and halocarbons. In terms of their health and environmental effects, some VOCs may irritate the skin, eyes, nose, and throat. They also can be precursors to the formation of $PM_{2.5}$ and ozone (smog).

Adverse effects of ozone include lung damage and exacerbated respiratory disease, as well as diminished visibility. Ozone in the troposphere, the lowest layer of the atmosphere which is closest to the Earth, has both natural and anthropogenic sources. It can damage forests, crops, and manmade materials, and harm respiratory tissue through inhalation. Ozone that occurs naturally at ground-level is generally at low concentrations that are not believed to threaten human health or the environment. Ozone that is a byproduct of human activity is formed through the interaction of sunlight with VOCs, nitrogen oxides, and other substances and adds to the total atmospheric burden of the pollutant.

Effects of these pollutants occur on a variety of scales, as shown in **Table 1.**

Table 1. Potential Importance of AFO Emissions at Different Spatial Scales

Emissions	Global, National, and Regional	Local (Property Line or Nearest Dwelling)	Primary Effects of Concern
NH_3 (ammonia)	Major	Minor	Atmospheric deposition, haze
N_2O (nitrous oxide)	Significant	Insignificant	Global climate change
NO_x (the sum of nitric oxide and nitrogen dioxide)	Significant	Minor	Haze, atmospheric deposition, smog
CH_4 (methane)	Significant	Insignificant	Global climate change
VOCs (volatile organic compounds)	Insignificant	Minor	Quality of human life
H_2S (hydrogen sulfide)	Insignificant	Significant	Quality of human life
PM_{10} (coarse particulate matter)	Insignificant	Significant	Haze
$PM_{2.5}$ (fine particulate matter)	Insignificant	Significant	Health, haze
Odor	Insignificant	Major	Quality of human life

Source: National Research Council, *Air Emissions from Animal Feeding Operations, Current Knowledge, Future Needs*, 2003, Table ES-1, p. 5. Rank order from high to low importance is major, significant, minor, and insignificant. Emissions from non-AFO sources may have different rankings. For example, VOCs and NO_x play important roles in the formation of tropospheric ozone, however, the role of AFOs is likely to be insignificant compared to other sources.

Control Strategies

Manure management varies widely across animal species, region, and farm type, depending on climate, soil productivity, farm size, and other factors. Systems and strategies now in wide use by farmers are those that have proved the most cost-effective and reliable at achieving their design objectives. Land application has been

and remains the predominant method for disposing of manure and recycling its nutrient and organic content. For the most part, design objectives for managing manure do not include minimization of emissions of ammonia, methane or other gaseous compounds, but rather focus on odor and dust control, avoidance of direct discharge to surface water, and land application at rates that are beneficial to growing crops.[3]

As noted above, emissions of odors, gases, and dust from livestock production facilities arise from buildings, manure storage, and land application. Eliminating emissions from one of these sources will likely not eliminate emissions entirely, as control technologies often address only one of the three sources. Many of the available technologies reduce emissions; none eliminates them.[4] Some technologies have been evaluated to the point of demonstrating efficacy, but most have not been evaluated systematically.

Emissions from buildings can be reduced by inhibiting contaminant generation, or by capturing and treating the air as it leaves the building (e.g., by using biofilters to treat ventilation air, or wet or dry scrubbing of air as it passes through evaporative pads before release). Frequent manure removal is one of the best ways of reducing contaminant generation within the building. Other methods that can be used inside buildings include using bedded solid manure (i.e., manure mixed with bedding that creates a solid stack of material), chemical additives on animal litter, and diet manipulation.

There are four general types of manure storage: deep pits, outdoor slurry storage, anaerobic lagoons, and solid stacks. Outdoor storage is the most apparent source of odors. Controls that have been shown to be effective when managed properly include various types of covers (permeable and impermeable, natural such as straw or cornstalks, and synthetic). Techniques to manipulate the manure to minimize emissions also exist but have certain limitations. For example, separating solids from liquid manure reduces the load on anaerobic lagoons, but also creates a second waste stream to manage which may be detrimental to overall air quality. Proper aeration will eliminate odors from outdoor storage, but it is expensive in a liquid system. Anaerobic digesters reduce odors, but they are also not economically feasible.[5]

Emission control during land application is best done by direct injection of liquid manure below the soil surface. Solid manure is generally less odorous than liquid, but because it cannot be injected, rapid incorporation into the soil by plowing or similar techniques is the best method to minimize odors.

While many treatment technologies are available that may be important in mitigating emissions, the effectiveness of most of them is not well quantified.

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[3] NRC 2003 AFO Report, pp. 46-47.

[4] Iowa State University and The University of Iowa Study Group, *Iowa Concentrated Animal Feeding Operations Air Quality Study, Final Report*, February 2002, p. 203. Hereafter cited as Iowa CAFO Air Quality Study.

[5] Ibid., p. 207.

Extensive research programs are underway in the United States and Europe, and many options of varying cost and effectiveness are being evaluated. Livestock emission mitigation research is being performed by the University of California at Davis, California State University Fresno, Purdue University, Texas A&M University, and others, and information on available control measures and strategies for agricultural sources of air pollution is being presented.[6] Experts believe that cost, increased management requirements, and a lack of economic or regulatory incentives to encourage or require their use are the primary reasons that more poultry and livestock producers have not adopted technologies to reduce emissions.[7]

Environmental Statutes and Regulation of Animal Feeding Operations

The animal sector of agriculture has undergone major changes in the last several decades, a fact that has drawn the attention of policymakers and the public. In the United States there are an estimated 238,000 animal feeding operations where livestock and poultry are confined, reared, and fed, according to the U.S. Department of Agriculture's 1997 Census of Agriculture.

Organizational changes within the industry to enhance economic efficiency have resulted in larger confined production facilities that often are geographically concentrated. The driving forces behind structural change in livestock and poultry production are no different than those that affect many other industries: technological innovation and economies of scale.[8] From 1982 to 1997, the total number of U.S. operations with confined livestock fell by 27%. At the same time, the number of animals raised at large feedlots (generally confining 300 animals or more) increased by 88%, and the number of large feedlots increased by more than 50%.[9] The traditional image of small farms, located in isolated, rural locales, has given way to very large farming operations, some on the scale of industrial activities. Increased facility size and regional concentration of livestock and poultry operations have, in turn, given rise to concerns over the management of animal wastes from these facilities and potential impacts on environmental quality.

Agricultural operations often have been treated differently than other types of businesses under numerous federal and state laws. In the area of environmental

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[6] For example, the California Air Pollution Control Officers Association maintains a website to assist agricultural operators, local air districts, and others with information on air pollution reduction techniques. See [http://www.capcoa.org/AgClearinghouse.htm].

[7] Ibid., p. 209.

[8] Marc Ribaudo et al, U.S. Department of Agriculture, Economic Research Service, *Manure Management for Water Quality: Costs to Animal Feeding Operations of Applying Manure Nutrients to Land*, June 2003, Agricultural Economic Report 824, 87 pp.

[9] U.S. Department of Agriculture, Natural Resources Conservation Service, *Manure Nutrients Relative to the Capacity of Cropland and Pastureland to Assimilate Nutrients: Spatial and Temporal Trends for the United States*, Publication no. nps00-0579, December 2000, p. 18. Hereafter cited as USDA 2000 Manure Nutrients report.

policy, one observer noted that agriculture is "virtually unregulated by the expansive body of environmental law that has developed in the United States in the past 30 years."[10] Some laws specifically exempt agriculture from regulatory provisions, and some are structured in such a way that farms escape most, if not all, of the regulatory impact. The Clean Water Act (CWA), for example, expressly exempts most agricultural operations from the law's requirements, while under the Clean Air Act (CAA), most agricultural sources escape that law's regulatory programs because the majority of them do not meet the CAA's minimum emission quantity thresholds. Moreover, in implementing environmental laws, federal and state regulators have traditionally focused most effort on controlling the largest and most visible sources of pollution to the water, air, and land — factories, waste treatment plants, motor vehicles — rather than smaller and more dispersed sources such as farms.

Nevertheless, certain large animal feeding operations are subject to environmental regulation. The primary regulatory focus on environmental impacts has been on protecting water resources and has occurred under the Clean Water Act. In addition, facilities that emit large quantities of air pollutants may be regulated under the Clean Air Act. Some livestock operations may also be subject to the release reporting requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (the Superfund law) and the Emergency Planning and Community Right-to-Know Act. The following sections describe relevant provisions of these laws.

Clean Water Act

The Clean Water Act (CWA, 33 U.S.C. §§1251-1387) provides one exception to policies that generally exempt agricultural activities — and specifically the livestock industry — from environmental rules. The law protects water quality by a combination of ambient water quality standards established by states, limits on effluent discharges, and permits.[11] The regulatory structure of the CWA distinguishes between point sources (e.g., manufacturing and other industrial facilities which are regulated by discharge permits) and nonpoint sources (pollution that occurs in conjunction with surface erosion of soil by water and surface runoff of rainfall or snowmelt from diffuse areas such as farm and ranch land). Most agricultural activities are considered to be nonpoint sources, since they do not discharge wastes from pipes, outfalls, or similar conveyances. Pollution from nonpoint sources is generally governed by state water quality planning provisions of the Act.

However, the CWA defines large animal feeding operations that meet a specific regulatory threshold number of animals (termed concentrated animal feeding operations, or CAFOs; they are a small percentage of all animal feeding operations) as point sources and treats CAFOs in a manner similar to other industrial sources of

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[10] J. B. Ruhl, "Farms, Their Environmental Harms, and Environmental Law," *Ecology Law Quarterly*, vol. 27, no. 2 (2000), p. 265.

[11] For additional information on the Clean Water Act, see CRS Report RL30798, *Environmental Laws: Summaries of Statutes Administered by the Environmental Protection Agency*, pp. 29-38.

pollution. They are subject to the Act's prohibition against discharging pollutants into waters of the United States without a permit. In 2003, EPA revised regulations that were first promulgated in the 1970s defining the term CAFO for purposes of permit requirements and specifying effluent limitations on pollutant discharges from regulated feedlots.

These regulations are intended to address the concern that animal waste, if not properly managed, can adversely impact the environment through several possible pathways, including surface runoff and erosion, direct discharges to surface waters, spills and other dry-weather discharges, leaching into soil and groundwater, and releases to air (including subsequent deposition back to land and surface waters). The primary pollutants associated with animal wastes are nutrients (particularly nitrogen and phosphorus), organic matter, solids, pathogens, and odorous/volatile compounds. Data collected for the EPA's 2000 National Water Quality Inventory identify agriculture as the leading contributor to water quality impairments in rivers and lakes. Animal feeding operations are only a subset of the agriculture category, but 29 states specifically identified animal feeding operations as contributing to water quality impairment.[12]

Scientists recognize that actions taken to mitigate harmful water quality impacts of managing animal waste can have implications for air quality, in complex ways that are not perfectly understood. Production of some emissions is directly related to the quantity of waste the type of waste management system used, and the temperature and moisture of the waste. For example, manure that is handled as a liquid or in anaerobic management systems tends to produce more methane, while manure that is handled as a solid or in aerobic management systems produces little methane. Thus, liquid manure that is stored in covered lagoons, in order to contain surface runoff, can generate gases associated with climate change, such as methane. Similarly, some farmers utilize compost operations that add organic material to waste piles to aid in decomposition of the waste, which could otherwise be subject to runoff. Compost operations liberate more methane than unagitated stockpiles, in part because the compost windrows are turned regularly.

The 2003 clean water rule applies to approximately 15,500 of the largest animal feeding operations that confine cattle, dairy cows, swine, sheep, chickens, laying hens, and turkeys, or about 6.5% of all animal confinement facilities in the United States. The rule details requirements for permits, annual reports, and development of plans for handling manure and wastewater. The rule contains a performance standard which prohibits discharges from regulated CAFOs except in the event of wastewater or manure overflows or runoff from an exceptional 25-year, 24-hour rainfall event. Parts of the rule are intended to control land application of animal manure and wastewater.[13]

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[12] U.S. Environmental Protection Agency, *National Water Quality Inventory, 2000 Report*, August 2002, EPA-841-R-02-001, 1 vol.

[13] For additional information, see CRS Report RL31851, *Animal Waste and Water Quality: EPA Regulation of Concentrated Animal Feeding Operations (CAFOs)*, by Claudia Copeland.

Clean Air Act

The Clean Air Act (CAA, 42 USC §§7401-7671q) provides a complex and comprehensive framework for regulating stationary and mobile sources of air pollution.[14] The law emphasizes controlling "major sources" that emit more than threshold quantities of regulated pollutants. Air emissions from farms typically do not exceed the specified thresholds, thus they generally escape most CAA regulatory programs. However, livestock producers and other agricultural sources are not exempt from the statute, and for any whose emissions meet statutory or regulatory definitions of "major," provisions of the Act could apply.

Under the CAA framework, EPA designates criteria air pollutants that may reasonably be anticipated to endanger public health or welfare, and then establishes nationally uniform ambient air quality standards for those pollutants (NAAQS).[15] EPA has identified six criteria pollutants, two of which (particulate matter and nitrogen dioxide) are directly associated with AFO emissions. In addition, AFOs and other sources emit a number of substances (VOCs and nitrogen oxide compounds) which are precursors of ozone, another criteria pollutant. The CAA also regulates hazardous air pollutants (HAPs). HAPs are identified in a statutory list that can be modified by EPA regulation; EPA currently regulates 188 HAPs, including volatile organic compounds (VOCs) which are emitted by livestock facilities. Precursors of ozone (reactive VOCs) and $PM_{2.5}$ (ammonia), both emitted by livestock facilities, are regulated air pollutants, even though they are not listed as criteria pollutants or HAPs. (See **Table 2**.)

States play an important role in carrying out CAA provisions and assuring that state air quality meets federal air quality standards. The State Implementation Plan (SIP), prepared by the state (or local) air pollution control agency, translates national ambient standards into emission limitations and other control measures that govern individual sources of air pollution; the SIP is enforceable as both state and federal law. The CAA details the basic content of SIPs: enforceable emission limitations, other control measures, monitoring requirements, and schedules for compliance. The provisions of the SIP govern individual facilities through two types of state permitting programs. The preconstruction permit applies to major new sources or major modifications of an existing source, and it describes proposed air pollution abatement systems, allowable emission rates, and other requirements. In addition, most major stationary sources are required to obtain operating permits which specify each source's emission limitations and standards, compliance schedule, reporting requirements, and other conditions.

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[14] For additional information on the Clean Air Act, see CRS Report RL30798, *Environmental Laws: Summaries of Statutes Administered by the Environmental Protection Agency*, pp. 7-28.

[15] Under the Act, EPA establishes primary ambient air quality standards at a level sufficient to protect the public health. EPA also is authorized to establish secondary ambient air quality standards designed to protect the public welfare.

Table 2. CAA Classification of Substances in AFO Emissions

Substance	Criteria Pollutant	Hazardous Air Pollutant	Regulated Air Pollutant
Ammonia [a]			X
Nitrogen oxides	X		X
VOCs [b]		X	X
Hydrogen sulfide [c]			X
PM_{10} [d]	X		X
$PM_{2.5}$	X		X
Odor [e]			X

Source: National Research Council, *Air Emissions From Animal Feeding Operations, Current Knowledge, Future Needs*, 2003, table 1-1, p. 16.

[a] Ammonia is not a criteria pollutant but is a precursor for secondary $PM_{2.5}$, which is a criteria pollutant.

[b] Some but not all VOCs are listed as hazardous air pollutants. VOCs contribute to the formation of ozone, a criteria pollutant.

[c] Hydrogen sulfide is not listed as a criteria pollutant or a hazardous air pollutant. However, it is a regulated pollutant because it is listed as having a New Source Performance Standard which EPA establishes for facilities that contribute significantly to air pollution.

[d] Prior to 1987, particulate matter (PM) was a criteria pollutant and regulated as total suspended particulate (TSP). Currently, the PM fractions listed as criteria pollutants are PM_{10} and $PM_{2.5}$.

[e] Odor is a regulated pollutant in some states.

The CAA threshold determination of whether a source — including a livestock or poultry operation — is subject to these requirements depends on whether it is defined as "major." That definition differs based on the region in which the source is located and whether that region is attaining and maintaining national ambient air standards. The Act classifies nonattainment areas based on the extent to which the NAAQs is exceeded, and it specifically creates five classes of ozone nonattainment (from least to most polluted: marginal, moderate, serious, severe, and extreme). More stringent control requirements are imposed in areas with worse pollution. Generally, a major source is a stationary source that emits, or has potential to emit, 100 tons per year or more of any pollutant. However, regulated sources of HAPs that emit more than 10 tons per year of an individual hazardous pollutant, or sources in the most serious nonattainment areas that emit as little as 10 tons per year of VOCs or $NO_{x,}$ are defined as major sources and would be subject to these CAA requirements.

A state's SIP provisions must be at least as stringent as federal requirements, but beyond the core CAA framework, states have latitude in adopting requirements to achieve national ambient air quality standards. States, for example, may regulate additional categories of sources or may define major sources more stringently than do federal programs.

Most agricultural operations are believed to be minor sources of air pollution, and few have been required to comply with the Act's permit requirements. Some environmental advocates have argued that many large livestock facilities emit more than 100 tons per year of regulated pollutants (especially ammonia) and should be regulated as major sources under federal law. However, federal and state officials generally have placed a low priority on regulating agricultural sources, and, further, a lack of adequate air quality monitoring data hampers the ability of regulators to answer key questions. Agricultural air pollution has become more of an issue as EPA implements revised NAAQS for particulates that were issued in 1997, and as nonattainment areas look to reduce pollutants from more sources as they strive to come into attainment. As discussed previously, emissions of ammonia and several other AFO pollutants are precursors that transform in the atmosphere to form secondary particulate matter. Aside from ammonia, other agriculture pollutants include dust that contributes to PM_{10}, diesel emissions from farm equipment, and emissions from specialized activities such as crop burning.[16]

A lawsuit brought in federal court by environmentalists in 2004 argued that feedlots must be regulated under the Clean Air Act and must obtain a CAA "permit to construct" under provisions of the Idaho SIP. The company, intending to construct a large feedlot, had argued that the SIP did not require a permit for key pollutants from agricultural sources, including ammonia and hydrogen sulfide. In September 2004, the court ruled that the state's plan did not allow such exemptions, indicating that any agricultural facility in the state with sufficient emissions levels would have to obtain a permit. The case was settled early in 2005 when the parties to the lawsuit agreed to request that the Idaho Department of Environmental Quality conduct a rulemaking to establish a process for CAA permitting of dairies in the state (*Idaho Conservation League v. Adrian Boer*, D.Id.,Civ. No. 1:04-cv-00250-BLW, Feb. 1, 2005). Industry officials say the case has limited implications, because it refers specifically to the Idaho SIP, but environmentalists involved in the case believe it could have significance nationally because of the mutual agreement by the parties on emissions factors for ammonia that trigger CAA thresholds for dairies.

In calculating emissions to determine major sources, fugitive emissions are not counted; however, they do count for purposes of demonstrating attainment with NAAQS. Fugitive emissions are defined in regulation as "those emissions which could not reasonably pass through a stack, chimney, vent or other functionally equivalent opening." (40 CFR §51.165(a)(1)(ix)). EPA has issued a number of interpretive memoranda and guidance documents discussing how fugitive emissions should be accounted for in evaluating such industries as landfills, printing, and paint manufacturing. No such guidance with respect to animal confinement systems has been issued, but some groups, who believe that agricultural air pollution should be more vigorously controlled, have in the past expressed concern that EPA might make a determination that emissions from waste lagoons and barns are fugitive, thus excluding those types of AFO emissions from applicable CAA requirements. In a 2003 letter to EPA, state and local air program administrators said that such a policy,

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[16] For additional information, see CRS Report 97-670, *Agriculture and EPA's New Air Quality Standards for Ozone and Particulates*, by James E. McCarthy and Jeffrey A. Zinn.

if pursued, would create inequities in CAA application between similar operations in some sectors but not others.

> Since barns and lagoons are the dominant sources of emissions from the CAFO industry, such a policy would exempt most agricultural operations from many provisions of the Clean Air Act. The result would be an evisceration of states' and localities' ability to address air quality problems emanating from agricultural operations.[17]

CAA Regulation in California. Some of the interest in agriculture's impact on air quality derives from events in California and that state's progress in implementing the permit and SIP provisions of the Clean Air Act. The state's air pollution problems are diverse and, in some areas, severe. Throughout the state, emission controls have become increasingly more stringent on currently regulated sources of air pollution, such as factories and cars. State officials believe that, to meet state and federally mandated requirements to improve air quality, emissions from all air pollution sources must be reduced, whether they are large or small, industrial or agricultural.

With regard to agriculture, air quality improvement efforts have focused primarily on two regions which represent California's most challenging air quality problems for ozone and particulate matter pollution. The South Coast (Los Angeles) Air Basin and the San Joaquin Valley Air Basin are designated in extreme nonattainment for the federal health-based 1-hour standard for ozone. In addition, the South Coast Basin and the San Joaquin Valley Basin are designated in severe and serious nonattainment, respectively, for the more protective federal 8-hour ozone standard. In these two areas, all sources of air pollution produce air quality impacts and have some level of significance, and virtually all emission sources, even very small ones, are regulated. Both areas have large concentrations of confined animal feeding operations; agriculture is the San Joaquin Valley Basin's most important industry and a significant source of its air emissions. Thus, agricultural sources have been a particular focus of efforts to implement the federal and state laws in both regions.[18]

For more than 30 years, California law specifically exempted existing major for livestock production or equipment used in crop growing from all environmental permitting requirements. In 1994, EPA notified the state that the agriculture exemption was a defect in the state's clean air program that prevented California from fully regulating all air pollution sources. That notification and settlement of a lawsuit by citizen groups seeking to force EPA to impose air pollution controls on California's agriculture industry finally led EPA in October 2002 to withdraw federal approval of the state's program. Pursuant to the Clean Air Act, EPA was then required to implement a federal program while the state addressed the cited

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[17] Lloyd L. Eagan (President of State and Territorial Air Pollution Program Administrators) and Ellen Garvey (President of Association of Local Air Pollution Control Officials), letter to Christine Todd Whitman (EPA Administrator), April 7, 2003, p. 2.

[18] Ten areas of the state have been designated in nonattainment for the 1-hour federal ozone standard.

deficiencies. Following that action, and during the time it temporarily had responsibility for the California program, EPA evaluated ways to administer the law, while minimizing significant new permitting requirements on thousands of existing agricultural sources in the state. A major concern was recognition that there was insufficient scientific information about agricultural air emissions to immediately issue permits to sources or mandate pollution control requirements.

EPA considered various regulatory options, but did not actually issue any permits in California before its responsibility for the state program ended in August 2003. The state re-assumed responsibility after the legislature enacted a measure (California SB 700) that removed the long-standing exemption for agriculture and set timelines for existing facilities to apply for clean air permits and install control technologies. SB 700 regulates crop growers, dairies, poultry farms, cattle ranches, food-processing operations, and other agriculture-related businesses in the state. As of January 1, 2004, it made these sources subject to air quality permitting and specified emission mitigation requirements. Deadlines and requirements differ, depending on the size of facilities, level of emissions, and the attainment status of the region where the source is located.

The state and its local air quality management districts (in California, the state sets overall rules and policies, and 35 local agencies have primary day-to-day responsibility) are now implementing SB 700. By July 2005, the state Air Resources Board is mandated to review scientific information and adopt a definition of large confined animal facilities, which will be used by local air districts to begin issuing permits to facilities and adopting various regulations to control emissions. The district rules, to be adopted by July 1, 2006, must require facilities to obtain permits and to reduce emissions to the extent feasible. For severe and extreme ozone nonattainment areas, the law requires best available retrofit control technology (BARCT). In moderate and serious areas, regulated facilities will need to use reasonably available control technology (RACT). In federal ozone attainment areas where air quality problems are less significant, districts must adopt a rule requiring existing large confined animal facilities to reduce air contaminants to the extent feasible unless the district makes a finding that such facilities will not contribute to a violation of any state or federal standard. Regulated facilities must prepare emission mitigation plans and must comply with them by July 1, 2008.

The definition of "regulated facility" being developed by the state board seeks to include the majority of emissions, or animals, which are in the larger livestock facilities in the state. By focusing on large facilities and excluding smaller farms, dairies and other operations, the board expects to obtain the most air quality benefit while regulating the fewest number of facilities. Under the approach being considered, agricultural operations in areas designated in nonattainment for the federal 1-hour ozone standard will be defined as large confined animal facilities based on specified numbers of animals at the facility (for example, facilities with 1,000 or more milk-producing cows or 650,000 egg-laying chickens). In areas with less significant air quality problems — those designated as in attainment for the

federal 1-hour ozone standard — less stringent definitions will apply (e.g., 2,000 milk-producing cows or 1.3 million egg-laying chickens).[19]

Even before the state board defines which existing facilities face new requirements, some local air quality control districts have moved ahead with permitting and emission reduction requirements. For example, the San Joaquin Valley district has adopted rules to reduce PM emissions from general crop-based agricultural operations and dairies with 500 or more cows, and in the South Coast district, dairies with 50 or more cows are required to reduce emissions. Industry contends that the state board should first establish how much pollution comes from livestock operations before any permitting requirements are implemented, but the local districts interpreted SB 700 as requiring permits by January 1, 2005. The local districts have attempted to provide flexibility (such as by allowing for permit modifications after the state board completes its rules), but the overall situation has created substantial confusion for the farm community in California. Farmers in the state have resisted efforts to implement federal and state laws to regulate emissions from agriculture. Some in industry contend that agriculture emissions are not major sources of pollution and that any regulation should await completion of federal and state studies that are examining the industry's contribution to air pollution.

While California SB700 focuses on existing agricultural sources, by lifting the long-standing exemption for such operations from the state Health & Safety Code, new and modified agriculture sources in the state had previously been subject to permit and regulatory requirements of the California State Implementation Plan (SIP). New or modified sources located in nonattainment areas which may emit air pollution must obtain New Source Review permits that require installation of best available control technology (BACT) and require purchase of "offsets" or "emission reduction credits" from other sources in the same nonattainment area, in a relation determined by the severity of the air pollution problem. Local district rules implement these federal and state requirements. For example, San Joaquin Valley District Rule 2201 requires a new or modified stationary source, including agriculture sources, to install BACT when the potential to emit VOC exceeds 2 pounds per day and to purchase offsets for VOC when the source's potential to emit exceeds 10 tons per year.

As agriculture operations continue to locate in areas of the state that already are highly industrialized by agriculture, their compliance with these environmental requirements is being scrutinized. For example, a large dairy under construction in Tulare County (San Joaquin Valley) has been sued by local citizen groups for Clean Air Act violations stemming from constructing a major stationary source without a New Source Review permit.[20]

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[19] State of California, California Environmental Protection Agency, Air Resources Board, *Staff Report: Initial Statement of Reasons for Rulemaking, Public Hearing to Consider the Large Confined Animal Facility Definition*, May 6, 2005, 102 pp.

[20] *Association of Irritated Residents, et al, v. Fred Schakel Dairy,* E.D.Ca., No. 05-707, filed June 1, 2005.

Other States' Regulatory Activities. In terms of geographic impact, every state has agricultural operations in which animals are raised in confinement, according to the U.S. Department of Agriculture. States with high livestock populations, and with significant numbers of large operations (i.e., with more than 300 animal units), include several West Coast, Southwest, and Northwest states (Washington, Oregon, California and Arizona); the whole of the Midwest, from the Dakotas, Minnesota and Wisconsin south through Texas; sweeping across the southeast to the coastal states of Georgia, the Carolinas, Virginia, Maryland, and Pennsylvania; and north through New York and Vermont.[21]

The issue of evaluating and managing the health and environmental impacts of emissions from animal agriculture facilities has largely been left up to states. Air quality has not been the driving force behind state government action on AFOs, but has emerged out of long-standing concern to protect water resources. Several states have recognized a need to regulate air emissions from agricultural operations, but many states have not yet directly adopted or enacted programs affecting AFO emissions.

State programs, under statutes and regulations, both implement and supplement federal CAA requirements. That is, in some cases, state programs have been adopted to ensure state compliance with requirements of the federal law and to implement SIPs, such as facility permits that apply to construction and operation of livestock operations. In other cases, states have enacted more comprehensive laws and regulations calling for air emission testing and monitoring, manure management to abate pollutant emissions, inspections, and testing. Some states have regulatory programs or ambient air standards for odor and/or certain AFO pollutants, such as hydrogen sulfide, for which no NAAQS apply. In states with significant animal production, facility management statutes often govern construction and operation of AFOs, primarily for purposes of protecting water quality, with incidental provisions for air quality. For example, facility management statutes often contain setback requirements for confinement buildings and waste impoundments that may help to reduce air emissions by avoiding or minimizing odor nuisances.

A recent survey of seven states[22] identified a number of measures to govern air emissions from livestock facilities, but no comprehensive regulatory systems. States have used varied techniques to control air emissions from AFOs. State programs set emission limits, require use of best management practices, and impose other pre-operational and operational requirements. Hydrogen sulfide and odor emissions from AFOs have received significant attention, but there is little or no standardization of approach. For example:

- Minnesota requires feedlots and manure storage areas to acquire construction and operating permits and also requires air emission plans for large livestock facilities. The state has adopted an ambient

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[21] USDA 2000 Manure Nutrients report, pp. 28-29.

[22] Jody M. Endres and Margaret Rosso Grossman, "Air Emissions from Animal Feeding Operations: Can State Rules Help?" *Pennsylvania State Environmental Law Review*, vol. 13, fall 2004, pp. 1-51.

air quality standard for hydrogen sulfide which applies to emissions from AFOs as well as other sources.

- Iowa also has adopted a health effects-based ambient air quality standard for hydrogen sulfide that will be used in a three-year AFO field study to measure levels of H_2S, ammonia and odor to determine if material adverse health effects exist.
- Missouri regulations set odor emission limitations and require large AFOs to submit odor control plans. In addition, the state's CAA permit program includes operational requirements for AFOs to prevent air pollution. Missouri's CAA contains a hydrogen sulfide emission standard that does not refer to AFOs or other agricultural operations specifically, nor does it exempt AFOs. Missouri also has an ambient acceptable level (AAL) for ammonia.
- In Texas, a consolidated program governs water and air quality general permits. Its requirements control the emission of odors and other air contaminants from AFOs, although its does not have a specific air emission threshold for odors. Like Missouri, Texas has a hydrogen sulfide emission standard that makes no specific reference to, or exception for, animal agriculture.
- Illinois has implemented a facility statute that relies in part on setback distances to control odor emissions. Like Missouri, Illinois has established a numerical "objectionable odor nuisance" standard (that is, when odor is detectable in ambient air adjacent to residential or similar structures after dilution with a specific volume of odor-free air) and has enforced the limitation against AFOs.
- Colorado water quality rules help to control air emissions through provisions that govern the construction and operation of facilities that treat animal wastes. A separate regulation establishes an odor emissions standard for swine feeding operations and requires that anaerobic waste impoundments be covered.
- North Carolina, like Colorado, has focused its regulatory efforts on odor emissions from swine operations. All AFOs must use management practices that control odors, and some swine operations must submit odor management plans, although it does not require control technology (e.g., covers) unless best management practices fail. North Carolina does not have air emission standards for H_2S, ammonia, or odor.

A separate survey done by the Nebraska Department of Environmental Quality found that more than half of the states have standards for hydrogen sulfide. States base standards on a variety of issues, including odor or nuisance, welfare effects, and health effects. Consequently, standards vary considerably from as low as 0.7 parts per billion (ppb) for a yearly average (New York) and 5 ppb averaged over 24 hours (Pennsylvania), to standards based on nuisance, such as Minnesota's 50 ppb not to be exceeded for one-half hour twice per year and measured at the AFO property line.[23]

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[23] Iowa CAFO Air Quality Study, p. 189.

CERCLA and EPCRA

Both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund, 42 USC §§9601-9675) and the Emergency Planning and Community Right-to-Know Act (EPCRA, 42 USC §§11001-11050) have reporting requirements that are triggered when large quantities of certain substances are released to the environment, including ambient air.[24] Both laws utilize information disclosure in order to increase the information available to the government and citizens about the sources and magnitude of chemical releases to the environment. At issue today is how the reporting requirements of these laws apply to poultry and livestock operations.

CERCLA authorizes programs to remediate uncontrolled or abandoned hazardous waste sites and assigns liability for the associated costs of cleanup when a responsible party cannot be identified. Section 103(a) of CERCLA requires that the person in charge of a facility that releases a "reportable quantity" of certain hazardous substances must provide notification of the release to the National Response Center.

EPCRA establishes requirements for emergency planning and notifications to communities about storage and release of hazardous and toxic chemicals. Section 304(a)(1) of EPCRA requires a facility owner or operator to report to state and local authorities any releases greater than the reportable quantity of substances deemed hazardous under CERCLA or extremely hazardous under EPCRA. Under CERCLA, the definition of "release" applies to discharges of substances to water and land that are regulated under other federal environmental laws, such as the Clean Water Act and the Safe Drinking Water Act, and also applies to emissions into the air that are subject to a permit or control regulation under the Clean Air Act. Under EPCRA, the term "release" includes emitting any hazardous chemical or extremely hazardous substance into the environment. CERCLA excludes the "normal application of fertilizer" from the definition of release, and EPCRA excludes from the definition of hazardous chemicals any substance "used in routine agricultural operations or is a fertilizer held for sale by a retailer to the ultimate customer."

The CERCLA definition of "hazardous substance" triggers reporting under both laws. Among the reportable substances released by livestock facilities are hydrogen sulfide and ammonia. The reportable quantity for both of these substances is 100 pounds per day, or 18.3 tons per year.

CERCLA and EPCRA Enforcement Against AFOs. EPA has enforced the CERCLA and EPCRA reporting requirements against AFO release of hazardous air pollutants in a single case, involving the nation's second largest pork producer, Premium Standard Farms (PSF) and Continental Grain Company. In November 2001, EPA and the Department of Justice announced an agreement resolving numerous claims against PSF concerning principally the Clean Water Act, but also

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[24] For additional information on CERCLA and EPCRA, see CRS Report RL30798, *Environmental Laws: Summaries of Statutes Administered by the Environmental Protection Agency*, pp. 68-80 and pp. 81-86, respectively.

the Clean Air Act, CERCLA, and EPCRA. Among other actions under the settlement, PSF and Continental were to monitor air emissions for PM, VOCs, H_2S, and ammonia, and if monitoring levels exceed CAA thresholds for any regulated pollutant, the companies would apply to the State of Missouri for any necessary CAA permits. The companies also agreed to fund a $300,000 supplemental environmental project (SEP) to reduce air emissions and odors from swine barns. Results of the required air monitoring and status of the SEP are unknown.

Both CERCLA and EPCRA include citizen suit provisions that have been used to sue poultry producers and swine operations for violations of the laws. In two cases, environmental advocates claimed that AFO operators have failed to report ammonia emissions, putting them in violation of CERCLA and EPCRA. In both cases, federal courts have supported broad interpretation of key terms defining applicability of the laws' reporting requirements.

In one case, a federal district court in Oklahoma initially ruled in 2002 that a farm's individual barns, lagoons, and land application areas are separate "facilities" for purposes of CERCLA reporting requirements, rather than aggregating multiple emissions of pollutants across the entire site. This court held that CERCLA's reporting requirements would only apply if emissions for *each individual facility* exceed 100 pounds per day. However, the district court's ruling was reversed on appeal (*Sierra Club v. Seaboard Farms*, 387 F.3d 1167 (10th Cir. 2004)). Contrary to the lower court, the court of appeals ruled that the whole farm site is the proper regulated entity for purposes of CERCLA reporting and determining if emissions of regulated hazardous substances meet minimum thresholds.

In a second case, a federal district court in Kentucky similarly ruled in 2003 that the term "facility" should be interpreted broadly, including facilities operated together for a single purpose at one site, and that the whole farm site is the proper regulated entity for purposes of the CERCLA and EPCRA reporting requirements (*Sierra Club v. Tyson Foods, et al*, 299 F.Supp. 2d 693, (W.D.Ky. 2003)). While CERCLA provides that a continuous release is subject to reduced reporting requirements and EPCRA provides an exemption for reporting releases when the regulated substance is used in routine agricultural operations or is used on other farms for fertilizer, the court found that those provisions do not apply to the facts of this case. The ruling was not appealed.

EPA was not a party in either of these lawsuits. The U.S. Court of Appeals for the 10th Circuit invited EPA to file an *amicus* brief in the *Seaboard Farms* case, in order to clarify the government's position on the issues, but EPA declined to do so within the timeframe specified by the court. The net result of these lawsuits is growing concern by the agriculture community that other legal actions will be brought and that the courts will continue to hold that the CERCLA and EPCRA reporting requirements apply to whole farm sites, thus potentially exposing more of these operations to enforcement under federal law.

Congressional Interest. The court rulings on applicability of CERCLA and EPCRA to poultry and livestock operations have led to some congressional interest in these issues. For example, in March 2004, a number of senators wrote to the EPA Administrator to ask the agency to clarify the reporting requirements of the two laws

so as to limit their impact on poultry operations. The senators' letter said that because of unclear regulations and a lack of scientific information about emissions, farmers are uncertain about the laws' requirements and are vulnerable to enforcement actions.[25] In report language accompanying EPA's FY2006 appropriations, the House Appropriations Committee similarly urged EPA to address the issues:[26]

> The Committee continues to be concerned that unclear regulations, conflicting court decisions, and inadequate scientific information are creating confusion about the extent to which reporting requirements in [CERCLA] and [EPCRA] cover emissions from poultry, dairy, or livestock operations. Producers want to meet their environmental obligations but need clarification from the Environmental Protection Agency on whether these laws apply to their operations. The committee believes that an expeditious resolution of this matter is warranted.

Also in 2004, some in Congress considered proposing legislation that would amend the definition provision in CERCLA to clarify that the reporting requirements do not apply to releases from biological processes in agricultural operations and to amend EPCRA to exclude releases of hazardous chemicals produced through biological processes in routine agricultural operations. For some time, there were indications that an amendment containing these statutory changes would be offered during Senate debate on FY2005 consolidated appropriations legislation, but this did not occur.[27]

National Research Council Reports on Air Emissions from AFOs

During the time that EPA was developing the revised Clean Water Act CAFO rules that it promulgated in 2003 (discussed above), the issue of air emissions from CAFOs received some attention. The Clean Water Act requires EPA to consider non-water quality environmental impacts, such as air emissions, when it sets effluent limitations and standards. EPA recognized that certain animal waste management practices can either increase or decrease emissions of ammonia and/or hydrogen sulfide and that some regulatory options intended to minimize water discharges (such as anaerobic lagoons and waste storage ponds) have the potential to result in higher air emissions than other options, due to volatilization of ammonia in the waste. Likewise, emissions of nitrous oxide are liberated from land application of animal waste on cropland when nitrogen applied to the soil undergoes nitrification and denitrification.[28] Some environmental groups had urged EPA to address or restrict

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[25] Senator Blanche L. Lincoln et al., letter to Michael Leavitt, EPA Administrator, March 12, 2004.

[26] U.S. Congress, House Committee on Appropriations, *Report accompanying H.R. 2361, Department of the Interior, Environment, and Related Agencies Appropriation Bill, 2006*, H.Rept. 109-80, 109th Cong., 1st sess., p. 87.

[27] "Spending Bill Excludes Proposal for Farms; Craig Plans Separate Legislation Next Year," *Daily Environment Report*, Nov. 23, 2004, p. A-10.

[28] Nitrification and denitrification are biological processes that, respectively, oxidize (continued...)

feedlot air emissions as part of the water quality rule. In the proposed rule and the 2003 final revised rule, EPA generally evaluated air emissions impacts of the rule, but it said that insufficient data exist to fully analyze all possible compounds and the significance of air emissions from feedlot operations.

In part because of this lack of information, in 2001 EPA asked the National Research Council (NRC) of the National Academy of Sciences for a report evaluating the current scientific knowledge base and approaches for estimating air emissions from AFOs. EPA asked the NRC to identify critical short- and long-term research needs and provide recommendations on the most promising science-based approaches for estimating and measuring emissions. USDA joined EPA in the request for the study. At the time, EPA was under a court order to issue the water quality rules and hoped that the NRC report would help assure that rules aimed at improving water quality would not have negative impacts on air emissions.

In an interim report released in 2002, the NRC responded to several of the EPA questions.[24] Nitrogen emissions from production areas are substantial, the committee found, and control strategies aimed at decreasing emissions should be designed and implemented now. It recommended developing improved approaches to estimating and measuring emissions of key air pollutants from AFOs and initiating long-term coordinated research by EPA and USDA with the goal of eliminating release of undesirable air emissions. The committee said that implementation of feasible management practices that are designed to decrease emissions, such as incorporating manure into soil, should not be delayed while research on mitigation technologies proceeds. This report focused particularly on the suitability of an approach for estimating air emissions from AFOs presented in a 2001 draft EPA report. In that report, EPA attempted to develop a set of model farms, based on manure management systems typically used by large AFOs, and identify emissions factors that could be associated with each element of the model farm. In the absence of actual data from extensive monitoring, EPA hoped that emission factors could be applied to model farms to estimate annual mass emissions.[25]

An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of the pollutant. The emission factor approach is based on measuring emissions from a set of defined AFOs to obtain an average emission per unit (per animal unit, or per production unit process, such as manure storage piles and lagoons, stall areas, and feed storage areas), then multiplying the emission factor by the number of units and period of time (e.g, annually). The current method of estimating cow, chicken, swine, or any other livestock animal emissions is generally expressed in terms of

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[28] (...continued)
ammonia to nitric acid, nitrous acid, or any nitrate or nitrite; and reduce nitrates or nitrites to nitrogen-containing gases.

[24] National Research Council, *The Scientific Basis for Estimating Air Emissions from Animal Feeding Operations, Interim Report* (Washington, D.C.: National Academies Press, 2002).

[25] U.S. Environmental Protection Agency, *Emissions from Animal Feeding Operations (Draft)*, EPA Contract No. 68-D6-0011, Washington, D.C., August 15, 2001, 414 pp.

emissions per head, per year. Using this method, facility emissions are directly proportional to the number of animals at the facility.

The NRC recognized that direct measurements of air emissions at all AFOS are not feasible. However, it found that the model farm construct described by EPA cannot be supported because of weaknesses in the data needed to implement it, which fail to consider variations in many factors (geography, climate, management approaches) that could affect annual amounts and temporal patterns of emissions from an individual AFO. Alternatively, the NRC recommended that EPA consider a more complex process-based approach to focus on activities that determine the movement of nutrients and other substances into, through, and out of each component of the farm enterprise.

The NRC expanded on these recommendations in its final report, issued in 2003.[26] Overall, it found that scientifically sound protocols for measuring air concentrations, emission rates, and fates are needed for the elements, compounds, and particulate matter associated with AFOs. Similarly, standardized methodology for odor measurement should be developed in the United States, the NRC said. The report noted that emission factor approaches should be broadened to integrate animal and crop production systems both on and off the AFO (i.e., imported feeds and exported manure) in order to represent the full environmental effects of animal production systems. Such a systems analysis should include impacts of best management practices (BMPs) aimed at mitigating AFO air emissions on other parts of the entire system.

The Role of USDA

The U.S. Department of Agriculture (USDA) manages a diverse range of programs involving food, forests, rural development, agricultural trade, and conservation of natural resources. Several USDA agencies have conservation responsibilities that may involve livestock and their environmental effects. For example, the Natural Resources Conservation Service (NRCS) provides technical assistance and information, as well as financial assistance, to landowners and agricultural producers to implement conservation systems and practices, such as developing Comprehensive Nutrient Management Plans to control AFO runoff.

The Agricultural Research Service (ARS) is the in-house research agency of USDA and conducts a wide range of research activities. Among those related to livestock production are national programs directed to air quality (focusing on particulates, agriculturally emitted ammonia, and odor) and manure and by-product utilization (focusing on nutrient management and atmospheric emissions). A second USDA agency is the Cooperative State Research, Education, and Extension Service (CSREES). Like ARS, CSREES has projects related to livestock production, such as an animal waste management program aimed at educating producers and increasing the use of best management practices through training for AFO operators.

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[26] NRC 2003 AFO Report.

USDA cooperates with EPA when issues concern both agriculture and the environment. Notably, the two collaborated on a Unified National Strategy for Animal Feeding Operations, issued in 1999, intended to minimize public health and environmental impacts of runoff from AFOs. That strategy consisted of multiple elements and was based on a national performance expectation that all AFO owners and operators would develop and implement site-specific Comprehensive Nutrient Management Plans by 2009 to protect water quality and public health.

The importance of relationships between air quality and agriculture has received increased recognition at USDA in recent years. One direct result was enactment of a provision in the 1996 Federal Agriculture Improvement and Reform Act (P.L. 104-127), the 1996 farm bill, requiring USDA to create an Agricultural Air Quality Task Force. One finding in Section 391 of the statute stated that USDA should lead efforts to determine accurate measures of agriculture's role in air pollution and in the development of cost-effective approaches to reduce pollution. Several provisions of the 2002 farm bill (the Farm Security and Rural Investment Act, P.L. 107-171) specifically addressed air quality issues in the context of USDA conservation programs.

The Agricultural Air Quality Task Force is an advisor to the Secretary of Agriculture. Its chairman is the chief of the NRCS, and its members represent USDA, EPA, industry, and basic and applied science. It is charged with ensuring sound data quality and interpretation, so that policy recommendations made by federal or state agencies to address air pollution problems related to agriculture are based on accurate scientific findings, peer review, and economic feasibility.

In 2000, the task force issued a white paper on air quality and concentrated animal feeding operations (CAFOs). It recommended a program of accelerated research, education, technology transfer, technical training, and financial assistance to address CAFO air quality problems. According to the white paper, current funding levels for air quality research are "elusive" and cannot be separately identified from all animal waste-related research. It recommended that USDA and EPA develop enhanced long-term funding packages and programs for agricultural air quality research and technology transfer that specifically address CAFOs. The task force recommended that at least $12.8 million per year be spent by USDA (NRCS, ARS, and CSREES) for coordinated, integrated research and technical assistance programs for animal agriculture air quality, but USDA's response is unknown.[27]

Research Priorities

In debates over controversial and complex public policy questions, stakeholders who hold differing perspectives at times may find little common ground. Sometimes the only point of agreement is the need for more and better research to resolve key

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[27] USDA Agricultural Air Quality Task Force, *Air Quality Research and Technology Transfer White Paper and Recommendations for Concentrated Animal Feeding Operations*, July 19, 2000. Text available at [http://aaqtf.tamu.edu/Archives/2000/Policy/CAFO.htm]. Hereafter cited as AAQTF CAFO White Paper.

questions — and each side hopes that research findings will support its own perspectives on the issues at hand. With regard to questions about AFO emissions and the possible need to implement control strategies, there is little dispute about the need for more research. Research on a wide range of topics currently is being supported by federal agencies, a number of individual states, academic institutions, and industry, but there is no apparent coordination or unified strategy. The monitoring study that EPA proposes as part of the Air Compliance Agreement is intended to answer some questions. However, in view of the critiques of the study discussed above, doubts exist about the study's utility. Some critics of the Air Compliance Agreement fault EPA for planning only to measure emissions, but not also using the monitoring study as an opportunity to research mitigation techniques.

In its 2003 report, the National Research Council addressed these issues and recommended "substantial research efforts in both the short term and the long term." Research in the short term (four to five years), the NRC said, can significantly improve the capability of scientifically sound modeling approaches for measuring and estimating air emissions, especially for process-based modeling that the NRC recommends be developed by EPA and USDA. A long-term research program (20-30 years) that encompasses overall impacts of animal production on the environment can have substantial results in decreasing overall impacts on the environment, while sustaining production at a high level. For the long term, coordinated research is needed to determine which emissions are most harmful to the environment and human health and to develop technologies to decrease their releases into the environment[28]

Priority research needs identified by the NRC, USDA's Agricultural Air Quality Task Force,[29] and others fall into two broad categories: fundamental research to estimate, measure, and characterize emissions; and technology research (including technology transfer).

- Foremost is the need to produce scientifically sound, standardized methodology as a basis for measuring and estimating gaseous and particulate emissions and odor, from AFOs on local, regional, and national scales. The science for estimating air emissions from individual AFOs should be strengthened, along with models to understand the totality of AFO processes, including dispersion, transformation, and deposition of emissions. This information is needed in order to assess relationships between emissions, potential health indicators, and candidate regulatory and management programs.
- A related concern is that much more needs to be understood about community-level impacts from exposure to AFO emissions. Occupational health studies have documented adverse health effects among AFO workers, such as acute and chronic respiratory diseases, but experts agree that occupational health risks cannot be extrapolated to community health risks. Peer reviewed studies of

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[28] NRC 2003 AFO Report, pp. 11, 174-175.

[29] AAQTF CAFO White Paper, p. 5.

health impacts on residents in the vicinity of livestock operations are limited. These findings support a conclusion that AFO air emissions constitute a public health hazard, deserving of public health precautions as well as larger, well controlled, population-based studies to more fully ascertain adverse health outcomes and their impact on community health.[30]

- With regard to technology, there is a need to develop standardized measurement technologies for pollutants and odorous compounds emitted by AFOs and effective, practical, and economically feasible technologies to reduce and control odors and pollutants. Experts believe that there is a need to develop and evaluate innovative treatment processes for each of the major sources of AFO emissions, confinement buildings, manure storage areas, and land application. Research further should include programs to provide for transfer of economically viable technologies to all producers.

In its 2003 report, the National Research Council observed that EPA and USDA have not devoted the necessary technical or financial resources to estimate air emissions and develop mitigation technologies, and it criticized both for failing to address this deficiency in defining high-priority research programs. The report said, "Each has pursued its regulatory and farm management programs under the assumption that the best currently available information can be used to implement its program goals." It concluded that a change in research priorities in both agencies is needed if air emissions are to be addressed with an adequate base of scientific information.[31]

Congressional attention to the issues discussed in this report has been limited, with the result that developments are proceeding largely by administrative and some judicial actions, not through legislative policymaking. As described previously, one aspect that has attracted some congressional interest is questions about the applicability of CERCLA and EPCRA to livestock and poultry operations. However, as of May 2005, no legislation regarding this issue had been introduced. Finally, there appears to be wide agreement among stakeholder groups on the need for more research on a large number of related issues, but congressional interest in supporting or funding more federal participation in research activities is unclear.

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[30] Iowa CAFO Air Quality Study, p. 138.

[31] NRC 2003 AFO Report, pp. 13, 153.