CESSPOOLS OF SHAME

How Factory Farm Lagoons and Sprayfields Threaten Environmental and Public Health

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The Clean Water Network is an alliance of over 1,000 organizations that endorse its platform paper, the *National Agenda for Clean Water*. The *Agenda* outlines the need for strong clean water safeguards in order to protect public health and the environment. The Clean Water Network includes a variety of organizations representing environmentalists, family farmers, commercial fishermen, recreational anglers, surfers, boaters, faith communities, environmental justice advocates, tribes, labor unions, and civic associations.

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Animal waste from large factory farms is threatening our health, the water we drink and swim in, and the future of our nation's rivers, lakes, and streams. This report documents the public health and environmental risks associated with the use of the lagoon and sprayfield system, which is commonly used by many types of factory farms to dispose of animal waste. The problems with lagoons and sprayfields described in this report are documented through scientific studies, records of pollution events, and victims' accounts of their experiences.

Lagoons and Sprayfields of the Largest Companies Pollute the Environment

Multi-million dollar corporations control many factory farms. The factory farms owned or controlled by these corporations are plagued with pollution problems. Lagoons at many of these operations have broken, failed, or overflowed, leading to major fish kills and other pollution incidents. Operators have sprayed waste in windy and wet weather, on frozen ground, or on land already saturated with manure. More and more, local communities and environmental groups are looking to the courts to remedy environmental violations.

Lagoons and Sprayfields Threaten Public Health

People living near factory farms are placed at risk. Hundreds of gases are emitted by lagoons and the irrigation pivots associated with sprayfields, including ammonia (a toxic form of nitrogen), hydrogen sulfide, and methane. The accumulation of gases formed in the process of breaking down animal waste is toxic, oxygen consuming, and potentially explosive, and farm workers' exposure to lagoon gases has even caused deaths. People living close to hog operations have reported headaches, runny noses, sore throats, excessive coughing, respiratory problems, nausea, diarrhea, dizziness, burning eyes, depression, and fatigue.

The pathogenic microbes in animal waste can also infect people. Water contaminated by animal manure contributes to human diseases such as acute gastroenteritis, fever, kidney failure, and even death. Nitrates seeping from lagoons and sprayfields have contaminated groundwater used for human drinking water. Nitrate levels above 10 mg/l in drinking water increase the risk of methemoglominemia, or blue baby syndrome, which can cause deaths in infants, and contamination from manure has also been linked to spontaneous abortions. Moreover, the practice of feeding huge quantities of antibiotics to animals in subthereapeutic doses to promote growth has contributed to the rise of bacteria resistant to antibiotics, making it more difficult to treat human diseases. Scientists recently found bacteria with antibiotic resistant genes in groundwater downstream from hog operations.

The Lagoons and Sprayfields Harm Water Quality

Lagoons and sprayfields pose a grave danger to the water we use for drinking and swimming. Lagoons filled with manure have spilled and burst, dumping thousands and often millions of gallons of waste into rivers, lakes, streams, and estuaries. In addition, the impact of runoff from sprayfields can be severe over time since manure is often over-applied or misapplied to cropland and pastures. There are also often cumulative effects from sprayfield runoff within local watersheds because multiple large-scale feedlots cluster around slaughterhouses. Watersheds as far as 300 hundred miles away are also affected by the atmospheric deposition of ammonia that is emitted from lagoons and sprayfields.

Lagoons and sprayfields are often located in close proximity to waterways and floodplains, which increases the likelihood of ecological damage. Lagoon spills and leaks and runoff from sprayfields have killed fish, depleted oxygen in water, contaminated drinking water, and threatened aquatic life. In many cases, lagoons leak because they are not lined, but leakage may even occur with the use of clay liners, with seepage rates as high as millions of gallons per year. How much a lagoon or sprayfield seeps depends, in part, upon where it is sited. In many places, lagoons and sprayfields have been permitted for places where groundwater can be threatened, such as over alluvial aquifers and in locations with shallow groundwater tables. The lagoon system also depletes groundwater supplies by using large quantities of water to flush the manure into the lagoon and spray it onto fields.

Alternative Approaches to the Lagoon and Sprayfield System Exist but Are Rarely Used by Factory Farms

A wide range of alternatives to the lagoon and sprayfield system currently exist, which illustrates that it is not the lack of other options that is driving factory farms to rely almost exclusively on the lagoon and sprayfield system. Instead, factory farms continue to use this polluting system because they have been allowed to use farmland, rural waterways, and air as disposal sites for untreated wastes. Alternative approaches include sustainable agriculture practices that prevent pollution, such as management intensive rotational grazing, hoop houses, and composting. Alternative technologies that treat the wastewater, including anaerobic digestion, wetlands treatment, and sequencing batch reactors also mitigate some of the risks to surface water, groundwater, air, and public health.

Recommendations

Despite the growing body of evidence that the lagoon and sprayfield system pollutes the environment in numerous ways, the Environmental Protection Agency's (EPA) proposed technology rules under the Clean Water Act would allow the riskiest lagoons to continue to operate and also allow new lagoons to be built. Instead, EPA should ban new lagoons and sprayfields from being built, and phase-out existing systems. The agency should encourage new concentrated animal feeding operations to use sustainable animal production systems. In addition, EPA's final regulations should include controls that address all air, surface water, and groundwater pollution that can contaminate our lakes, streams, and coastal waters, including ammonia, bacteria, viruses, heavy metals, salt, antibiotics, and other toxins.

FACTORY FARM POLLUTION IS A GROWING PROBLEM

American livestock production has changed dramatically over the past sixty years. Like other agricultural enterprises, raising animals has been influenced by new technologies and scientific advancements. But the forces that have had the greatest impact on the business are intensive confinement and the conglomeration of small farms into large corporations. These two changes have had grave impacts on the ecosystems and human communities that surround livestock farms.

Intensive livestock operations first appeared in the 1940s with poultry production.[1] In the egg production segment of the industry, the shift went from chicken houses with bedding to bird confinement in cages. In the swine industry, farmers made a shift from pasture-based and open-lot or production systems to totally controlled confinement. The dairy industry replaced stanchions with free-stall barns. All of these moves to greater confinement decreased or eliminated the need for bedding. While this reduction in bedding materials reduced production costs, it created new problems in disposing manure. To address this problem, producers began adding water to manure and handling it like it was a liquid or pumpable slurry.

It is now common for intensive livestock operations to raise thousands–and sometimes even hundreds of thousands–of animals that produce enormous quantities of manure. A single hog produces two to four times the amount of waste as a human produces, while a dairy cow produces 23 times the waste of a human. In total, these animals generate 220 billion gallons of waste each year. (See Table 1-1.) In our country, 130 times more animal waste is produced than human waste.[2]

Currently, most swine and many dairy and egg-laying poultry concentrated animal feeding operations (CAFOs) in the United States collect the waste produced by their animals with scrapers, flushing systems, or gravity flow gutters, and then store the wet livestock manure in vast open-air pits. Producers use a variety of lagoon systems for liquid manure, including anaerobic lagoons, aerobic lagoons, and temporary storage bins.[3] These lagoons have a size as great as six to seven-and-a-half acres and can contain as much as 20 to 45 million gallons of wastewater.[4] In North Carolina, a facility of 2,500 swine may generate 26 million gallons of lagoon liquid, close to one million gallons of lagoon sludge, and 21 million gallons of slurry. (See Table 1-2.) The operation of the lagoon system may differ depending upon the type of animal waste placed in the lagoon. For example, dairy waste may contain fibrous bedding and grit that is separated before the waste and flush water are placed in the lagoon.[5] For swine manure, such separation is not customary.

TABLE 1-1
Animal Waste Summary in the United States

Animal Type	Number of Head	Waste Amount Tons/Year	Waste Volume Gallons/Year	Amount of Pounds/Year	Nitrogen Lost to Atmosphere Pounds/Year
Hogs	57.5 million	110 million	27 billion	1.3 billion	960 million
Cattle	99.3 million	750 million	180 billion	8.2 billion	4.1 billion
Poultry	1.3 billion	50 million	12 billion	1.3 billion	530 million
Sheep	7.6 million	3 million	730 million	64 million	46 million
TOTAL	1.5 billion	910 million	220 billion	11 billion	5.7 billion

National totals are compiled using 1997 Census of Agriculture data.
Source: Environmental Defense, Animal Waste Summary, http://www.hogwatch.org/maps/index_wherethehogsare.html; Pollution Locator, Animal Waste, http://www.scorecard.org/env-releases/aw/us.tcl#summary (visited May 15, 2001).

Liquid manure stored in a lagoon is typically sprayed untreated on cropland or pastures through a large sprinkler system. This land-application practice is known as the sprayfield system. While the nutrients in manure can help build and maintain soil fertility when applied at agronomic rates, CAFOs often overapply animal waste. Excess manure can harm crop growth, contaminate soils, cause surface and groundwater pollution, and waste valuable nutrients.

The trend towards confinement as an animal production method has been coupled with domination of the nation's animal production system by large, corporate entities. About 50 large pork producers are responsible for about 45 percent of the industry's product.[6] Industry officials predict that their market domination will rise to 75 percent within the next few years.[7] The trend in industrialized animal production has meant that more animals are being raised in fewer operations. In the pork industry, for example, the number of hog farms has fallen from 600,000 to less than 100,000 over the past fifteen years, while the number of hogs produced has stayed about the same.[8] In Iowa, the nation's number one hog producing state, from 1998 to 1999, 17 percent of the hog producers exited from the business.[9]

EPA NOW HAS THE OPPORTUNITY TO MOVE BEYOND THE LAGOON AND SPRAYFIELD SYSTEM

For more than twenty years, the Clean Water Act has specified that CAFOs are industrial point sources of pollution that must obtain Clean Water Act permits before discharging into lakes, rivers, and streams. However, EPA has failed to implement and enforce these statutory requirements. For example, according to EPA, approximately 13,000 operations should be permitted under existing EPA regulations, yet only an estimated 2,520 CAFOs (19 percent) are actually covered under either a general or an individual permit.[10]

The Clean Water Act also specifies that dischargers must meet technology standards, known as effluent guidelines, for their discharges. Effluent guidelines specify wastewater treatment technology, monitoring, and discharge requirements for specific industrial sources.

TABLE 1-2

Average Swine Waste Generated Annually by Different Types of North Carolina Facilities with 2,500 Swine[i]

Production Unit[ii]	Animal Unit	Animal Unit Equivalent Live Weight (pounds)	Lagoon Liquid[i] (gallons per animal unit/year)	Lagoon Sludge[iv] (gallons per animal unit/year)	Slurry[v] (gallons per animal unit/year)
Feeder-to finish	Per head capacity	135	2,317,500	82,500	1,877,500
Farrow-to weanling	Per active sow	433	8,007,500	195,000	6,595,000
Farrow-to feeder	Per active sow	522	9,652,500	235,000	7,950,000
Farrow-to finish	Per active sow	1,417	26,202,500	955,000	21,585,000

i. Swine feeding operations with 2,500 swine weighing over 55 pounds each are considered to be CAFOs (if they also meet the other operational requirements of the Clean Water Act). Many CAFOs are significantly larger.
ii. Assumes 400-pound sow or boar on limited feed, 3-week old weanling, 50 pound feeder pig, 220 pound market hog, and 20 pigs/sow/year.
iii. Estimated total lagoon liquid included total liquid waste plus average annual rainfall surplus falling on lagoon.
iv. Net solids removal prior to lagoon input.
v. Six month accumulation of waste, urine excess water usage; does not include fresh water for flushing or lot runoff.
Figures were derived from Table 3-1, *Average Swine Waste Generation Values for Different Production Units*, North Carolina Cooperative Extension Service, College of Agriculture and Life Sciences, North Carolina State University, Certification Training for Operators of Animal Waste Management Systems, AG-538 (April 1996), and were based upon a model by Nicolette Hahn, Water Keeper Alliance.
Note: Citing these figures does not imply endorsement. Instead they are being used for illustrative purposes.

The current effluent guidelines applicable to CAFOs are 25 years old and severely outdated. However, pursuant to a consent decree in settlement of litigation with the Natural Resources Defense Council, EPA has agreed to issue new technology standards by the end of 2002. EPA has authority to consider non-water quality impacts (such as air pollution) as well as water quality concerns in setting technology standards. The NRDC-EPA agreement requires that EPA evaluate a range of non-lagoon systems for CAFOs and study the effects on surface water, groundwater, air quality, and public health of any technology the agency recommends. It also requires the new rules to cover not only manure storage, but also the land application of manure.[11]

These rules provide the best opportunity on the national level in over twenty years to ensure that factory farms protect the environment and public health. In its new effluent guidelines, EPA has the opportunity to require that CAFOs adopt a technology different than the lagoon and sprayfield system. In fact, EPA has a legal obligation to require the best technology economically achievable. The question remains whether EPA will fully account for the environmental and economic harm caused by the present manure storage and application system and recommend an approach that better protects the environment.

CHAPTER 2

The Lagoons and Sprayfields of the Largest Corporations

In 1999, almost 20 percent of the hogs sold in the United States were produced by four corporations: Smithfield Foods, Inc., Contigroup (Continental Grain and Premium Standard Farms), Seaboard Corporation, and Prestage Farms.[1] These companies operate feedlots themselves or under contracts with producers. The contracts state that the corporation owns the animals, but under most state permit programs, the contractor owns the waste. Thus, the contract system allows corporate owners to avoid responsibility for the waste. These corporations have no responsibility to contribute financially to clean-up or pollution control. Many of the largest corporations have taken advantage of the contract system; facilities under their control have had numerous pollution problems, but the companies have often been able to evade responsibility.

SMITHFIELD FOODS, INC.

Smithfield Foods, Inc. is the nation's largest pork producer, with sales of $3.8 billion in 1999, ownership of about 700,000 sows (four times more than the company's biggest competitor), and the capacity to produce 12 million hogs per year.[2] The company processes pork, contracts with smaller producers to raise hogs, and also produces hogs on its own factory farms and those of the company's subsidiaries: Brown's of Carolina, Inc., Carroll's Foods, Inc., Carroll's Foods of Virginia, Inc., Quarter M Farms, and Murphy Family Farms, Inc.[3] There have been numerous pollution problems from slaughterhouses the company operates in North Carolina and Virginia. The company was fined $12.6 million for dumping pollutants from a Virginia slaughterhouse into the Pagan River–a fine that, as of 1997, was the largest ever imposed under the Clean Water Act.[4] A Smithfield slaughterhouse in North Carolina has polluted the Cape Fear River nearly 40 times.[5] However, the company, its subsidiaries, and contractors have also been responsible for many pollution problems attributed to lagoon spills, polluted runoff from sprayfields, and general mishandling of liquid hog waste. Even when actual discharges have not occurred, practices such as overfilling lagoons ("inadequate freeboard") present a substantial risk that a discharge could occur and also indicate problems with operator error and the generation of too much liquid waste. Some of the incidents are listed below.

August 1995: Two million gallons of liquid hog waste from a Brown's Inc. lagoon in New Hanover County spilled into a tributary of the Cape Fear River in North Carolina.[6]

1996: One million gallons of liquid hog waste from a Smithfield hog factory spilled into the Trent River in Jones County, North Carolina.[7] Also, at a Brown's of Carolina facility in Bladen County, North Carolina, inspectors found ponding of waste on fields, indicating that wastewater had been overapplied, and that waste had been applied when the ground was wet or frozen.[8]

1997: Smith Farms, a finishing operation for Brown's of Carolina, flooded over an acre of wetlands bordering the New River with hog waste from its Onslow County, North Carolina operation.[9]

July 1997: North Carolina inspectors found that a lagoon or lagoons had been overfilled at a Brown's of Carolina facility in Bladen County ("inadequate freeboard"). Also in July 1997, state inspectors found that areas around the dikes at the facility might erode if improvements were not made.[10]

September 1998: State inspectors from North Carolina noted that the waste management system of a Brown's of Carolina facility in Jones County was in disrepair.[11]

March 1998: Inspectors from the state of North Carolina found trash floating in the lagoons and inadequate lagoon storage capacity at a Brown's of Carolina facility in Jones County.[12]

March and May 1998: At a facility in Duplin County under contract with Smithfield Foods, North Carolina inspectors found numerous deficiencies including ponding of animal waste in sprayfields that indicated over-application, lagoon seepage, and the pointing of a spray mechanism towards a ditch that led to a waterway.[13]

April 1999: A hole in a lagoon at a Murphy Family Farms factory farm in Duplin County, North Carolina spilled 1.5 million gallons of manure and urine into a swamp adjoining the Persimmon Branch, a tributary of the Northeast Cape Fear River.[14]

Operators of a hog factory farm dumped waste into this stream in Duplin County, North Carolina. This stream leads to the Cape Fear River. This was discovered and reported by a local citizen activist.

Rick Dove

June 1999: At two Brown's of Carolina facilities in Bladen County, North Carolina, inspectors found that the discharge pipes that carried waste from the confinement buildings to the storage pond or lagoons were not functioning properly.[15]

September 1999: A state inspection of a Brown's of Carolina facility in Jones County, North Carolina found that the lagoon storage capacity was inadequate.[16]

October 1999: At a facility under contract with Smithfield Foods in Duplin County, North Carolina, inspectors found that animal waste had been discharged to navigable waters during flooding. In July of that year, the overfilling of lagoons had been identified as a problem by inspectors.[17]

November 1999: A Duplin County, North Carolina factory farm owned and operated by Murphy Family Farms,[18] spilled 5,000 gallons of hog waste into wetlands, and then into a tributary of Persimmon Branch. Whether the problem originated from waste applied to saturated fields or a lagoon leak was unclear. This same facility spilled 1.5 million gallons of manure in April of the same year.[19]

December 1999: A Carroll's Foods lagoon in Sampson County, North Carolina spilled nearly 200,000 gallons of hog waste into Turkey Creek and a nearby swamp. The waste spill was caused by a pump that was left running overnight between a lagoon and a field where waste was applied. By the time the pump was shut down, the four-acre lagoon had dropped by two inches.[20]

1999-2000: At a Brown's of Carolina facility in Bladen County, North Carolina, inspectors found insufficient storage levels at lagoons three times.[21]

February 2000: Inspectors from the state of North Carolina found trash floating in the lagoons, evidence of over-application of waste, ponding, and inadequate lagoon storage capacity at a Brown's of Carolina facility in Jones County.[22]

March and July 2000: Neighbors saw waste coming from pipes at a Brown's of Carolina facility and entering into White's Creek, a tributary of the Cape Fear River. At other times, neighbors had reported the spraying of waste in windy and wet weather.[23]

March 2000: At a facility under contract with Smithfield in Duplin County, the Riverkeepers documented discharges of waste from the waste management system into a waterway.[24] During that same month, North Carolina inspectors noted that waste had been sprayed into woods and near the edge of a forest close to a waterway.[25]

April, May, September 2000: At four separate times, North Carolina inspectors found inadequate lagoon storage capacity at a Brown's of Carolina facility in Bladen County.[26]

May 2000: The Riverkeepers documented that swine waste coming from a facility under contract with Smithfield Foods in Duplin County was flowing into woods next to a waterway.[27] Later that month, North Carolina inspectors found on several occasions that wastewater from sprayfields was flowing into woods and waterways. In August of the same year, inspectors observed excessive ponding in fields and woods near the facility.[28]

August 2000: Smithfield agreed to convert its existing open-air lagoon systems on company-owned farms in North Carolina to "environmentally superior technologies" within five years.[29] Several non-lagoon technologies have already been identified for installation under the terms of the agreement, including constructed wetlands treatment and a sequencing batch reactor.[30] (See Chapter Five.) However, this agreement does not apply to the hundreds of thousands of sows raised at hog farms in South Carolina, Virginia, Utah, Colorado, Texas, Oklahoma, South Dakota, Missouri, Illinois, Mexico, and Brazil.[31]

December 2000 and February 2001: Water Keeper Alliance, supported by environmental, family farm, and animal welfare organizations, launched a legal campaign against the hog industry, sending notice-of-intent-to-sue letters to Smithfield producers in North Carolina and Missouri, filing two lawsuits in North Carolina federal court based on company violations of the federal Clean Water Act and Resource Conservation and Recovery Act, a lawsuit in North Carolina state court based on public nuisance and the public trust doctrine, and a lawsuit in Florida federal court based on violations of the Racketeer Influenced and Corrupt Organizations law (RICO).[32]

SEABOARD CORPORATION

Seaboard Corporation is currently the third largest pork producer in the United States,[33] despite the fact that, as of 1989, the company did not own a single hog.[34] According to *Time Magazine*, the growth of the company has been achieved, in part, through $150 million in economic incentives the company received from federal, state, and local governments from 1990 to 1997, including various types of financial assistance to its poultry and hog processing plants in the U.S.[35] Despite all that support, Seaboard continues to violate environmental laws.

February 1999: A Seaboard factory farm in Texas County, Oklahoma sprayed effluent in the air during a windy day. The facility was later fined $5,000 by the state.[36]

October 1999: Seaboard Farms' Dorman Sow Farm had three manure spills in one month. In one spill, over-application of manure onto already over-saturated fields resulted in one pool of manure that was 250 feet by 100 feet and over six feet deep. In another incident, a hole was punched in the irrigation line creating a pool 150 feet long by six feet wide and a foot deep. The final incident that month occurred when an underground pipeline failed and produced a waste stream that ran almost a mile and ended within 300 feet of the Beaver River Wildlife Sanctuary in Oklahoma.[37]

February 2000: The Sierra Club filed a notice of intent to sue Seaboard for 12 separate violations of the Clean Water Act at the Dorman Sow Farm. Violations cited include pouring waste directly into streams, over-applying waste to the land, and being unable to properly store manure.[38]

November 2000: The Sierra Club filed another notice of intent to sue Seaboard's Dorman Sow Farm under the Superfund law for its failure to report ammonia emissions. The

Superfund law Comprehensive, Environmental Response, Compensation, and Liability Act) provides that any site that releases more than 100 pounds of ammonia per day is required to report its releases.[39]

The facility's record of violations is of a particular concern because of its close proximity to the 23 square-mile Beaver River Wildlife Management Area, home to pheasants, quail, turkeys, rabbits, deer, and other animal life.[40] The decision by the state of Oklahoma to grant an operating license to Seaboard is the subject of a lawsuit by adjacent landowners and the Oklahoma Department of Wildlife Conservation (operator of the Beaver River Wildlife Management Area). The suit charges that a license to operate the facility should never have been issued in the first place, because of the risk to the Beaver River and wildlife.[41]

PRESTAGE FARMS

Prestage Farms is the nation's fourth largest hog corporation.[42] The company's facilities in Mississippi have raised concerns among neighbors. One facility in particular in Oktibbeha County, a 7,040-head operation under contract with Prestage, has been the focus of controversy because of its location adjacent to the Noxubee Wildlife Refuge, home to many endangered species and a local tourist attraction. Neighbors believe that polluted runoff from a manure lagoon or from fields sprayed with liquid hog manure could foul adjacent Browning Creek and ultimately the Noxubee River, which runs through the wildlife refuge. Despite community objections, the state granted the facility a permit and the facility has been in full operation since October 1997.[43] Odor and contaminants from the facility were the subject of a $10 million lawsuit brought by a neighbor–a father who claimed that the pollutants aggravated his teenager's asthma.[44] In 1997, a chancery court judge ruled that because of the particulate air pollution emitted from the facility, the state was obligated to issue an air quality permit to the contract farm. However, the Mississippi Department of Environmental Quality has not enforced the decision.[45] This ruling prompted the state's legislature to exempt hog farms from air quality standards, but allowed local governments to establish local controls.[46] Since the establishment of the original facility two years ago, more facilities have requested permits to establish operations near the refuge.[47] Fifty-two counties established rules for CAFOs, but Prestage Farms sued the six counties in which the company had facilities. Concerned about the expenses of litigation, five of the counties eliminated their ordinances. One county, Monroe County, defended its ordinance and won the legal challenge. Then a state moratorium on the building of new CAFOs was established until January 2000. After the Health Department decided to take a cautionary approach regarding possible health impacts of these facilities, the moratorium was extended. The factory farms in Mississippi controlled by Prestage produce 300,000 hogs per year. If the moratorium is lifted, the corporation plans to establish 33 more facilities.[48]

November 1994: In Lowndes County, Mississippi, several discharges from over-application of manure onto the land from Prestage Farms into James Creek resulted in a $15,000 state fine that was then reduced to $6,375.[49]

January 2000: Over 500 neighbors of Prestage Farms hog factory farms, processing plants, and meat packers in Chicksaw and Clay counties in Mississippi filed a $75 million class action lawsuit claiming that air pollution from the facilities has led to unusually high levels of asthma, migraines, and other illnesses. The families that have brought the lawsuit have the backing of the Sierra Club.[50]

CONTIGROUP COMPANIES/PREMIUM STANDARDS FARMS

Contigroup, formerly Continental Grain, became a top hog producer and processor when it acquired a majority interest in Premium Standard Farms in 1998.[51] As of 1999, Contigroup was the second largest pork producer in the United States.[52] Prior to its acquisition, Premium Standard Farms was itself ranked in the top five pork producers,[53] and the company has facilities in Missouri, North Carolina, and Texas.[54]

1995: Six spills at Premium Standard Farms facilities killed more than 268,000 fish. One spill resulted in the loss of all aquatic life in an 11-mile stretch of Mussel Fork Creek in Missouri.[55]

March 1997-July 1998: Premium Standard Farms facilities in Missouri were responsible for 20 spills of liquified feces and urine totaling over a quarter-million gallons.[56]

July 1999: A valve was left open on spraying equipment at a Premium Standard Farms facility in Missouri resulting in about 2,000 gallons of manure spilling into Raccoon Creek.[57]

Throughout 1999: Twenty-five animal waste spills from Premium Standards Farms facilities in Missouri caused the discharge of over 224,000 gallons of manure, wastewater, and liquids from dead animals.[58]

Ongoing Legal Action Against Premium Standard Farms: In 1997 and 1998, the Citizens Legal Environmental Action Network (CLEAN) filed legal action against Premium Standard Farms and Continental Grain. CLEAN's lawsuit alleged Premium Standard Farms violated the Clean Water Act by discharging animal wastes into waterways, violated the Clean Air Act by failing to obtain permits, and failed to report releases of hazardous substances in violation of the Comprehensive Enviornmental Response, Compensation, and Liability Act.[59] EPA intervened in the suit in 1999, taking the citizens' position against Premium Standard Farms. Also in 1999, the Missouri attorney general filed a lawsuit against Premium Standard Farms for manure spills and other environmental violations; the settlement agreement on the case resulted in a $1 million fine and a commitment by the company to invest $25 million in new technology to reduce pollution.[60] In late April 2000, EPA issued a Notice of Violation under the Clean Air Act against seven Premium Standard Farms facilities in Missouri stating that the facilities "emit, in addition to odors, regulated pollutants such as particulate matter and hydrogen sulfide."[61]

DECOSTER EGG FARMS

With the production of 12 to 14 million eggs a week from 3.5 million chickens and with $40 million in sales, DeCoster Egg Farms of Turner, Maine, is one of the largest egg producers in the United States. The firm also has facilities in Iowa, Ohio, and Minnesota, some of which produce pork.[62]

DeCoster has been the subject of numerous federal fines and legal actions for workplace and civil rights violations from 1988-2000. In 1988, the company was fined $46,250 for 184 workplace violations. Eight years later, a fine of $3.6 million was levied for bad working and housing conditions. This second fine prompted Labor Secretary Robert Reich to say that conditions at DeCoster are "as dangerous and oppressive as any sweatshop we have ever seen." In 1997, the company agreed to pay $2 million in fines for a range of health and safety violations. The company was set back $24,000 for failing to pay workers on time and failing to compensate workers for overtime hours in 1999. In 2000 DeCoster agreed to pay $850,000 in worker overtime claims dating from 1991 through 1997.[63] The company's civil rights violations have included restrictions on visitors to the company-owned trailer park that housed Hispanic migrant workers (1992) and the use of force by supervisors against worker-tenants living on DeCoster's property (1995).[64]

The company, which has used lagoons to store manure, has also had environmental violations.

September 1996: State inspectors found evidence of faulty construction at 19 DeCoster hog farms in north-central Iowa. Lagoons at many of the sites were below the water table, lagoon walls had eroded, and many of the operations were built in sandy soil that is unsuitable for manure lagoons. The Iowa Department of Natural Resoures threatened to shut down a 16,000 hog nursery in north-central Iowa after a state inspection found part of the lagoon sat more than 20 feet below the groundwater level.[65]

July 1997: The Maine Board of Environmental Protection levied a $75,000 fine against DeCoster for installing a wastewater disposal system at a 77-acre Leeds site without first obtaining the required state approvals.

November 1997: The Maine Board of Environmental Protection approved a consent agreement drafted by the Department of Environmental Protection (DEP) and signed by the Attorney General's Office and DeCoster president Austin "Jack" DeCoster. The 13-page consent agreement, which carries a $68,500 fine, acknowledges wrongdoing by the company at its egg-processing plants in Turner, Maine. According to the consent agreement, the company had built a large uncovered manure pit without approval, stored septage material in unapproved tanks in unapproved locations, and installed a mobile home and septic system without approval.[66]

Related Action, June, 2000: In a settlement agreement with the state of Iowa over DeCoster's operation of hog CAFOs in Iowa, DeCoster agreed to pay a $150,000 fine and build additional manure storage facilities to settle two pending environmental cases. The fine is the largest ever assessed against a livestock producer for violating environmental laws. DeCoster had previously been fined $69,000 for three previous violations and accrued enough environmental violations to be designated as a "habitual offender" under Iowa law– the first such designation in Iowa history. It prohibits DeCoster from expanding or building a new hog confinement operation for five years and puts the company's current operations under increased regulatory scrutiny.[67]

DAIRY OPERATIONS

Presently most dairy operations are not controlled by large corporations through contract arrangements. Instead, many operate within cooperatives, like Land O Lakes. Ten cooperatives produced half of the nation's milk in 1998.[68] However, when pollution incidents occur, the operator, rather than the cooperative to which the facility is a part, is held responsible. Thus, it is difficult to identify pollution incidents that happen in multiple states attributed to a single cooperative. Moreover, despite the increasing power of the cooperatives, many independent dairies continue to operate in many states. There are numerous examples of pollution problems from dairies attributed to the lagoon system, the application of liquid manure to the land, and liquid manure systems generally. A few examples are noted below.

March 1998: In the first imposition of jail time for dairy water pollution, Pete Hetinga of the 3H Dairy Farm in Oakdale, California was sentenced to 90 days of jail time, 90 days of home confinement, and four years probation for Clean Water Act violations. Hetinga also had to pay a $100,000 fine and make $101,000 of improvements on his farm. The defendant admitted that over a four-year period, he discharged wastewater polluted with cow urine, feces, and wash water into streams that flow into the Tuolumne River and the Sacramento Delta.[69]

Spring 1998: In the state of Washington, two dairy feedlot operators reported catastrophic lagoon failures. Each of the spills dumped the contents of an entire lagoon. One spill dumped 1.3 million gallons of waste, while the other dumped 700,000 gallons. Within one week of each other, both spills polluted the Yakima River. Meager fines of $2,000 and $3,000 respectively, were levied by the state.[70]

March and April 1999: Inspection by Washington state inspectors found spills at a dairy near Little Rock. The fecal coliform bacteria in the water in one of the facility's drainage swales was 23,000 colonies per 100 ml; another one registered at 130,000 colonies per 100 ml. (The state water quality standard is 100 colonies per 100 ml of water.) Liquid dairy waste was also observed covering a road, pooled in ditches surrounding the property, and seeping on to a neighbor's property.[71]

March 2000: A Washington state inspection of a dairy operation in Orting identified five streams of manure and wastewater entering Horse Haven Creek from the dairy. Manure was running off the confinement areas and over the top of a manure storage lagoon. Also, a pipe from field drainage tiles surrounding the manure storage lagoon was discharging wastewater directly into the creek.[72]


Karen Hudson

In February 2001, Inwood Dairy, LLC, near Elmwood, Illinois, pumped and dumped waste via long hoses across fields into a ditch from a lagoon.

February 2001: Inwood Dairy, near Elmwood, Illinois, pumped two million gallons of cattle waste into a nearby ravine.[73] Earthen dams along the ravine failed to retain the waste, which killed fish in a nearby pond and drained into Kickapoo Creek. At the time, the dairy was under a court-ordered injunction to keep its 8.3-acre, 40-million-gallon lagoon from overflowing. The Illinois attorney general sought the injunction after state inspectors found dairy employees sandbagging the berm of the lagoon and applying wastewater onto saturated fields to stop the lagoon from overflowing.[74]

March 2001: NRDC filed a lawsuit in Florida state court on behalf of three environmental groups and a Florida activist against the Florida Department of Environmental Protection (DEP). The civil action alleges that DEP has failed to require large-scale dairies to obtain permits mandated by the Clean Water Act and Florida law.[75] The groups are concerned that attempts at voluntary compliance by the unpermitted dairies are not preventing water pollution. Under Florida law, citizens have the power to sue the state to compel the agency to enforce its laws and regulations designed to protect surface and groundwater.[76] Florida's failure to regulate large-scale dairies is one example of a regulatory shortfall prevalent in many states across the country.

The litany of violations by these large hog, egg, and dairy producers provides an indication of the environmental harm caused by industrial livestock productions through the use of the lagoon and sprayfield system. Every year, millions of gallons of waste spills from lagoons into rivers and wetlands, is sprayed into waterways, and kill countless fish. Yet, despite the ample financial resources of the largest corporations, lagoons continue to be constructed poorly and waste management systems are not adequately maintained.

CHAPTER 3

HEALTH EFFECTS OF LAGOONS AND SPRAYFIELDS

Lagoons are a common feature of the growing number of factory-sized animal operations located in more than 30 states across the United States. Hundreds of gases from these lagoons can pollute the air around the operation. Researchers indicate that feedlot odor may contain 170 separate chemical substances.[1] A report released by the Minnesota Pollution Control Agency (MPCA)[2] indicates that lagoon emissions contain toxic constituents and greenhouse gases, including hydrogen sulfide, ammonia, and methane.[3] Large scale feedlots also emit particulate matter from confinement buildings. In late April 2000, EPA issued a Notice of Violation under the Clean Air Act against seven Premium Standard Farm factory farms in Missouri stating that the facilities "emit, in addition to odors, regulated pollutants such as particulate matter and hydrogen sulfide."[4] Pathogens, including bacteria, viruses, and parasites from ruptured, overflowing, and leaching lagoons, are a major concern when they flow into streams, rivers, and bays, and poison drinking water supplies.

Another threat associated with lagoons comes from sprayfields. Once manure is stored in open-air lagoons, it is periodically pumped out to be sprayed on fields surrounding the factory farm, ostensibly to be used as fertilizer. The spray emits the same gases as lagoons. Spraying the wastes increases evaporation and volatilization of pollutants into the air.

Manure applied to crops is helpful as a fertilizer; however, factory farms often produce too much manure for the amount of land available to use it. Manure is often over-applied and misapplied to land, which causes it to run off the fields, polluting our rivers and streams with pathogens and leaching into groundwater and poisoning our drinking water supplies. This poses a problem even if the manure is applied in dry form; however, the likelihood of runoff increases when the manure is in liquid form as it is with the sprayfield system.

AIR EMISSIONS

Studies consistently show that lagoons emit toxic airborne chemicals that can result in human health problems through inflammatory, immunologic, irritant, neurochemical, and psychophysiologic mechanisms.[5] The emissions are the result of the decomposition of liquid manure by anaerobic bacteria during storage and treatment. This process releases 400 volatile organic compounds,[6] including hydrogen sulfide, ammonia, dusts, endotoxins,[7] and methane.

Ammonia. Up to 80 percent of a lagoon's nitrogen may change from a liquid into a gas in the process known as ammonia volatilization.[8] This process also causes a sprayfield's nitrogen to be lost to the atmosphere.[9] In contrast, dry manure systems lose 15 to 40 percent of their nitrogen to the atmosphere.[10] Once the ammonia is volatilized, it may be redeposited onto land and water as far away as 300 miles.[11]

Although ammonia can cause eye irritation or even death at high levels, ammonia emissions associated with the lagoon system may not be at levels as toxic as other gases emitted. Nonetheless, European studies have found that reducing ammonia levels reduces the levels of odors across-the-board.[12] Ammonia may adsorb dust particles that may be then carried into the lungs.[13]

Hydrogen Sulfide. Among the many feedlot emissions, hydrogen sulfide is one of the most threatening.[14] Hydrogen sulfide is a gas that can cause eye, nose, and throat irritation, diarrhea, hoarseness, sore throat, cough, chest tightness, nasal congestion, heart palpitations, shortness of breath, stress, mood alterations, sudden fatigue, headaches, nausea, sudden loss of consciousness, comas, seizures, and even death.[15] Even when exposure is at a low level, health impacts can be irreversible.[16] A recent study by the Minnesota Pollution Control Agency (MPCA) revealed that manure storage methods appear to affect the amount of hydrogen sulfide emitted into the air. Earthen lagoons had the greatest hydrogen sulfide emissions, with averages greater than 30 parts per billion, while stockpiling manure had a rating of 20 parts per billion.[17] Another study by the same agency evaluated hydrogen sulfide emissions from 42 animal feedlots that used lagoons and cement pits in a nine-township area targeted for hog-farm expansions. The study found that concentrations of hydrogen sulfide, estimated by using a standard EPA approach to model emissions, exceeded the state standard significantly, even as far away as 4.9 miles.[18]

Air quality monitoring by the Minnesota Department of Health affirmed that toxic gas emanating from the manure lagoon of ValAdCo in Renville County, one of the state's largest operations for finishing hogs for market, posed a potential threat to human health. After two years of testing the swine facility, the state found hydrogen sulfide levels far exceeding the state standard (50 parts per billion), 53 times in 1998, and 271 times in 1999 and 2000. The violations in 2000 occurred despite a 1999 settlement between the company and state pollution officials designed to reduce odor and prevent health problems. The latest violations have prompted a new agreement between the company and state officials, which includes a penalty of $125,000, new technology to cover fourteen lagoons, additional air quality monitoring, and more expeditious resolutions of odor problems. The facility is already required to install covers over some of its lagoons under the 1999 settlement agreement.[19] For most of the violations that have occurred over the last two years, the hydrogen sulfide reading was 90 parts per billion. In 2000, Kathy Norlien of the Health Department's Health Risk Assessment stated that "without delay, actions should be taken to reduce the emissions for the protection and well-being of human health."[20] The monitoring was done under a 1997 law by the Minnesota legislature that required the MPCA to monitor hydrogen sulfide emissions from feedlots.

MINNESOTA HOG FARM SICKENS CHILDREN

When the poison control center official spoke to Julie Jansen, his words were shocking: "Ma'am, the only symptoms of hydrogen sulfide poisoning you're not experiencing are seizures, convulsions, and death. Leave the area immediately." Panic-stricken, Jansen grabbed her six children and her friends' two children and drove away from her home.

Jansen first thought the 11-year-old, home-based day care center she owned in Olivia, Minnesota had been hit by a flu bug. In the spring of 1995, 17 children ranging in age from newborn to 13 shared a long list of symptoms–diarrhea, nausea, headaches, vomiting, teary eyes, and stuffy noses. She soon noticed that it only happened when the wind blew from the south. Two factory-scale hog farms had recently located not more than a mile and a half away. It turned out the hog operations were poisoning the air with toxic wastes.

As a result, Jansen fought with state politicians and officials, helped pass a law to ensure that the state's air quality standards for hydrogen sulfide were applied to factory farms, and forced the Minnesota Pollution Control Agency to monitor the air quality of neighboring hog factories. In 1998, a massive hog operation in Renville was cited for 46 violations of air quality standards and was ordered to improve the way it stored hog manure.[21] In 1999, an agreement with state pollution authorities for violations required the company to install covers over many of its lagoons, and demanded the payment of a $32,000 fine. However, the violations have continued, resulting in a new agreement with state officials in June 2001.[22]

Carbon Dioxide. Organic matter in livestock manure is converted to carbon dioxide and methane during the anaerobic decomposition process that occurs in lagoons. The most abundant gas produced during this process is carbon dioxide,[24] although oceans, plants and soils are constantly absorbing it from the atmosphere.[24] Carbon dioxide is not highly toxic itself, but contributes to oxygen deficiency, or asphyxiation.[25] Health problems associated with elevated levels of carbon dioxide include respiratory problems, eye irritation, and headaches.[26] Carbon dioxide is also a greenhouse gas.[27]

Methane. Methane generated during anaerobic decomposition is released from lagoons into the air. Methane is toxic at high levels, levels that typically are not found surrounding open-air lagoons, but which may be found at the top of unventilated areas such as closed manure pits. Moreover, persons exposed to toxic amounts may be unaware of the danger because methane is colorless, odorless, and tasteless.[28] In August 2000, three farm workers in Canada died after they climbed into a liquid manure tank used to spread manure on a farm field; police believe that the cause of the deaths was inhalation of the methane gas.[29] In high temperatures, the methane in the air can be highly combustible and thus extremely dangerous.[30] The level of methane concentration along a waste lagoon's berm is greater than that at a surface coal mine.[31] Methane is also a potent greenhouse gas implicated in global climate change. EPA estimated that nearly 13 percent of the total U.S. methane emissions was from livestock manure in 1998.[32] Methane emissions from manure management activities increased 53 percent from 1990 to 1998 and EPA attributes the increase in methane emissions to the growing number of large hog and dairy operations and their use of liquid manure systems.[33] EPA claims that liquid manure systems produce conditions that result in large quantities of methane emissions.[34]

STUDIES FIND PHYSICAL AND MENTAL HEALTH OF NEIGHBORS AFFECTED BY LARGE-SCALE LIVESTOCK OPERATIONS

Steven Wing and Susanne Wolf of the University of North Carolina at Chapel Hill's School of Public Health conducted a detailed survey of residents in three eastern North Carolina communities. One community was located close to a 6,000-head hog factory farm with a lagoon, another community lived close to two large dairy operations with two lagoons, and the third community served as the control group because there were no intensive livestock operations nearby. More than half of the respondents living within two miles of the intensive swine operation with an open lagoon reported not being able to open windows or go outside even in nice weather because of the noxious smell. Also, the people living close to the hog operation reported headaches, runny noses, sore throats, excessive coughing, diarrhea, and burning eyes significantly more often than the other groups in the study.[35]

Another study, led by Kendall Thu, former associate director of the University of Iowa's Center for Agricultural Safety and Health, evaluated the health of 18 neighbors living within a two-mile radius of a 4,000-head hog confinement facility. Their physical and mental health was compared to a random sample of comparable rural residents who did not live near livestock facilities. Neighbors reported respiratory problems similar to those of workers on factory farms. Of greatest frequency among the neighbors surrounding the hog facility were symptoms that indicated bronchitis and hyperactive airways, including coughing, shortness of breath, wheezing, and chest tightness. Other common symptoms among this group of residents were nausea, weakness, dizziness, and fainting. Symptoms that were less statistically significant but still mentioned among the neighbors were headaches, burning eyes, runny noses, and scratchy throats.[36]

Finally, a study by Dr. Susan Schiffman from the Duke University Department of Psychiatry study found significantly higher levels of tension, depression, anger, and fatigue among North Carolina residents who lived near large swine factory farms as compared to rural residents located away from these facilities.[37] This study used a standardized scale to quantify objectively the moods of people exposed to odors near large-scale hog operations. According to the study, investigating mood in persons exposed to odors is an important health issue because a negative mood can affect immunity and can influence susceptibility to disease.[38]

HOW PATHOGENS FROM MANURE CAUSE HUMAN DISEASES

As the number of CAFOs increase around the country, scientists and policymakers are becoming more concerned about the presence of pathogens–microorganisms which are a potential source of infection for animals and humans–in livestock waste and wastewater. One of the reasons that pathogens pose a significant concern is that within the next decade, one in five persons will fit into a category considered vulnerable to the impacts of pathogens and chemical pollutants–infants, the elderly, or persons with compromised immune systems.[39] Home drinking water wells near animal waste application sites may become contaminated by pathogens or other pollutants.[40]

Until recently, the microbial quality of feedlot wastewater was not a regulatory issue or research focus. Vincent R. Hill and Mark D. Sobsey of the University of North Carolina at Chapel Hill, one of the few health research teams studying CAFOs, found that a number of the pathogenic microbes in swine and poultry wastes can infect people. These researchers also found that the "bacterial indicator levels in swine lagoon effluents are much higher than allowed for municipal wastewater effluents discharged to land or water." Thus, the land application of swine-lagoon effluent could pose a risk to communities that rely on groundwater for drinking water and could also degrade the microbial quality of nearby surface waters.[41] According to EPA, "bacteria and viruses such as *E. Coli*, salmonella, and giardia found in dairy waste can contaminate drinking water, cause acute gastroenteritis and fever, kidney failure, and even death."[42] Scientist Jeffrey C. Burnham also concludes that water contaminated by animal manure significantly contributes to the occurrence of human disease, especially from water-borne infections.[43] Burnham contends that infectious diseases from manure can result from direct contamination of water, a change in the levels of nutrients found in the environment, or the transfer of drug-resistant pathogens infecting the human population (resistance to antibiotics). Burnham reports that the following contaminants cause dangerous human health problems.

Water contaminated by animal manure significantly contributes to the occurrence of human disease, especially from water-borne infections.

1. *E. Coli*, which is found in the intestines and feces of both animal and humans, is extremely virulent.[44] A recent case, in May 2000, occurred in Walkerton, Ontario, where 1,300 cases of gastroenteritis occurred and six people died. The Ontario Ministry of Health and Long-Term Care determined that the likely source was cattle manure runoff from a farm adjacent to a drinking water supply well.[45]
2. *Cryptosporidium* poses a real problem to manure and wastewater processing because it is resistant to most treatment protocols. In healthy individuals, *cryptosporidiosis* lasts for a few days, causing diarrhea, vomiting, stomach cramps, and fever.
3. *Pfiesteria piscicida* results from an increase in nutrients in water sources. The toxic dinoflagellate causes lesions in fish and neurological damage in infected humans.

Cryptosporidium can cause death in persons with compromised and weak immune systems. It is estimated that five to ten percent of all AIDS patients may have *cryptosporidial* infections each year. In the United States, there have been six outbreaks of *cryptosporidiosis* from drinking water. One of these occurred in Milwaukee in 1993, left 400,000 persons ill,[46] and resulted in $37 million in lost wages and productivity.[47] In

LIFE NEXT DOOR TO A HOG FARM

Neil Julian Savage, Bladen County, North Carolina

"I am a farmer and I have lived with my wife Charlotte on our farm here in Bladen County since 1952. Originally,… this land belonged to my father. Things began to change for my family and me when a large corporate hog farm opened up operations on the property adjoining mine. This took place about 1991…The hog farm, which is owned by Brown's of Carolina (Brown's 91-Smithfield), has a lagoon, ten barns, and multiple sprayfields which are directly connected to my property in many places. Often times, even when they are not spraying hog waste, the smell from the barns and lagoon gets so bad I can smell it in my house with all the doors and windows shut. During these times, it is impossible to stay outside for even short periods. When Brown's is spraying hog waste on the fields, especially when it is near my property, living here is almost impossible.

"The overall situation has been so bad that I have not been able to farm my land for some time and I am forced to live on what little savings I have put aside over the years. My wife and I have been made sick by the rancid odors that are forced upon us. If Brown's is spraying near my house I cannot stand to be outside for more than a few minutes. It makes me so sick that I have fallen to the ground and had to crawl back to the house on several occasions. The same thing has happened to my wife. Sometimes it is so bad that my wife and I feel like giving up. We are getting old and this situation is very difficult to handle….

"Often times, when Brown's is spraying hog waste, they spray within just a few feet of my front yard. Some of the sprayers are so close that the hog waste is sprayed on my property. This happens when the wind blows it over in my direction. Sometimes on windy days, when the hog waste being sprayed, a mist of hog waste gets all over my house, vehicles, equipment, and land. During those times, my family and I are forced to breathe that hog waste into our lungs."[48]

Milwaukee, the likely sources of the infection were cattle manure upstream of the city, slaughterhouses, or human sewage.[49] A Canadian study of the presence of *Cryptosporidium* at ten swine farms found the parasite in liquid swine manure storage structures, surface drain water, and subsurface tile drainage water. Thirty-seven percent of the samples taken of swine liquid manure structures contained the parasite, demonstrating that "conditions in a typical swine liquid manure storage are not such that there is a complete die-off of *Cryptosporidium* oocysts."[50] Forty-four percent of the 32 water samples tested positive for *Cryptosporidium.*[51]

Michael Mallin and JoAnn Burkholder studied the effects of lagoon spills on the surface waters of North Carolina and found that there are high counts of fecal coliform–indicating the presence of bacteria–even 61 days after a spill. Natural or man-made disturbance of contaminated water re-suspend potentially dangerous amounts of bacteria and other microbes back into the water column for weeks after a spill.[52]

Waste can enter surface and groundwater supplies even in dry weather through spills or leaks from lagoons and from over-spraying manure onto croplands. The U.S. Fish and

Wildlife Service reported that elevated levels of fecal coliforms and fecal streptocolli were found on fields on which animal manure was applied.[53] The problem is exacerbated when there is extensive rain and hurricanes resulting in flooding–a problem common to North Carolina and states along the Mississippi River. For example, when Hurricane Floyd hit North Carolina in 1999, at least five manure lagoons burst and approximately 47 lagoons were completely inundated–allowing manure to flow out with the flood waters.[54]

Rick Dove

Brown's 5 & 6, a wholly-owned Smithfield hog factory, lost the contents of one of its cesspools to floodwaters caused by Hurricane Floyd. This factory is located along the Trent River above New Bern, North Carolina.

A study completed by the Centers for Disease Control of nine large Iowa confinement sites found chemical pollutants and pathogens, metals, bacteria, nitrates, and parasites in lagoons and other sites including agricultural drainage wells, tile line inlets, tile line outlets, lagoon monitoring wells, underground water, and a river.[55] Samples from the earthen lagoons contained the highest levels of chemical pollutants and pathogens. Their findings suggest that both chemical pollutants and microbial pathogens may move through soil from the site of the lagoon and flow over the land away from where the manure was applied.[56] The study called for additional research to accurately determine the potential level of risk to human health, possible pathways of exposure, and critical control points to avoid any potential exposure.

NITRATES IN WATER SUPPLIES CAN HARM HUMAN HEALTH

Nitrates above 10 mg/l in drinking water can cause human health risks, especially to children younger than five years old, the elderly, and people with suppressed immune systems. For example, infants who drink nitrate-contaminated water may be at risk of methemoglobin-emia, or baby-blue syndrome, which can cause developmental deficiencies or even death. In 1996, the Centers for Disease Control linked the high nitrate levels in Indiana well water near feedlots to spontaneous abortions in humans.[57] Increased levels of nitrates may be the result of lagoon seepage, lagoon spills or leaks, or the over- or misapplication of manure onto the land. Manure contains nitrogen which changes into nitrates in the soil. After that step, the nitrates may move through the soil and accumulate in water supplies.[58]

Infants who drink nitrate-contaminated water may be at risk of methemoglobin-emia, or baby-blue syndrome, which can cause developmental deficiencies or even death.

A survey of domestic drinking-water wells in nine Midwestern states by the Centers for Disease Control found that 32 percent of the 5,500 samples taken were above the 3 mg/l level for nitrates (assumed to be the background level); 13 percent were above the drinking water maximum contaminant standard of 10 mg/l. The study compared the contamination rates of samples from wells that, in the past five years, had manure applied within 100 feet of the wellhead to the rates of samples where no applications had occurred. This analysis found that the use of manure doubled the likelihood of an elevated nitrate level.[59]

EPA ISSUES EMERGENCY ORDER TO HOG FARMS CONTAMINATING DRINKING WATER

On June 7, 2001, EPA Region 6 exercised rarely used emergency powers under the federal Safe Drinking Water Act to compel five hog operations in Kingfisher and Major Counties in Oklahoma to provide area residents with safe drinking water.

In March and May 2001, EPA sampled drinking-water supply wells and found nitrate concentrations as high as 15.7 mg/l, where the acceptable level is 10 mg/l. Nitrates from the hog operations contaminated the surficial aquifer, which serves as an underground source of drinking water for four nearby households. EPA warned one area resident, a pregnant woman, to drink only bottled water, when an investigation team visited her home on May 30, 2001.

The hog facilities continue to contaminate the surficial aquifer by spraying waste and/or leaking waste lagoons. EPA's order clearly states, "[n]itrate contamination in the soil and ground water at the facility and in the vicinity will continue to threaten human health and the environment until the source of the contamination is removed and the site is remediated."

EPA issued the Emergency Order to Seaboard Farms, Inc., Shawnee Funding Limited Partnership, and PIC International Group, Inc. The order requires the companies to deliver an emergency supply of water for human consumption to area residents and hog farm employees. In addition, the companies must sample and test wells to determine the presence of nitrate, ammonia, bacteria, and other contaminants.[60]

ANTIBIOTICS IN LAGOONS MAY CONTRIBUTE TO ANTIBIOTIC RESISTANCE

Antibiotic resistance poses a major public health concern. Many antibiotics can no longer effectively fight infectious diseases because bacteria resistant to them. Exposure of the elderly, children, and immune-compromised individuals to antibiotic-resistant bacteria can be deadly. Even for healthy adult-human populations, antibiotic resistance makes it take longer to treat an infection and increases the cost of treatment.

Low doses of antibiotics are routinely added to livestock feed and water to promote growth and prevent disease in crowded conditions. The Union of Concerned Scientists estimated that livestock producers in the United States use 24.6 million pounds of antimicrobials each year for nontherapeutic purposes, compared to just 3 million pounds used by humans to treat diseases.[61] Recognizing the increasingly serious public health threat caused by bacterial resistance, the American Medical Association (AMA) passed a resolution in June 2001 opposing nontherapeutic uses of antibiotics in agriculture. The resolution states, the "AMA is opposed to the use of antimicrobials at nontherapeutic levels in agriculture or as pesticides or growth promoters and urges that non-therapeutic use in animals of antimicrobials (that are also used in humans) should be terminated or phased out."[62]

“THE SMELL ALMOST KNOCKS YOU OVER”

Rolf Christen, family farmer who raises cattle, chickens, and various crops in Green City, Missouri

“I moved from Switzerland in 1983 to my part of Missouri because of the wide-open spaces and clean environment. When Premium Standard Farms purchased 4,000 acres next to my farm in 1993, I knew nothing about the company. But when I heard about the type of hog facility that they were intending to build there, I immediately opposed them. The facility next to my property has a 80,000 hog head capacity, which is replaced 2.8 times a year. This facility and others nearby generate so much waste that they have turned our land into waste handling facilities, which is an immoral and unethical way to use the land.

“I can’t describe how terrible the odor from the lagoons, sprayfields, and barns often is. We can’t keep our windows open, and sometimes you can even smell the odor through the shut windows. You open the door and the smell almost knocks you over. One of the worst parts of it is that the odor hits at unpredictable times so it is a constant threat. Breathing in such a terrible stench makes you feel desperate. One time I was planting soybeans on a field and I got so sick to my stomach that I had to stop planting. My wife has allergies which are aggravated by the odor. She is in the health field, and she believes that many of her patients are also suffering from worse allergies from the hog odor. A year or so ago, I went on vacation to a beautiful national park; when I entered my house upon my return and smelled the terrible odor, I broke down and cried.”[63]

According to EPA’s National Research Exposure Laboratory, “in some cases as much as 80 percent of antibiotics administered orally pass through the animal unchanged into bacteria-rich waste lagoons and is then spread on croplands as fertilizer leaving antibiotics available for entry into groundwater and runoff into surface waters carrying both the drugs and resistant bacteria or genetic material to other bacteria in soils and waterways.”[64]

The Centers for Disease Control study of nine large Iowa confinement sites found antibiotics in the lagoons and other sites including agricultural drainage ditches, agricultural drainage wells, tile line inlets, tile line outlets, lagoon monitoring wells, underground water, and a river.[65] Examples of the antibiotics identified included tetracyclines, beta lactams, and macrolides. Researchers from the University of Illinois have found bacteria resistant to tetracycline in soil and groundwater near two hog facilities that use antibiotics as growth promoters.[66] The research team concluded that, “the presence of the tetracycline resistance genes is due to seepage and movement of groundwater underlying the lagoon,” and cautioned, “the occurrence of antibiotic resistance genes in drinking water provides a possible way for antibiotic resistance to enter the animal and food chain.”[67]

According to Environmental Defense, effluents from German sewage treatment works and groundwater/surface waters were found to contain antibiotics in the microgram per liter range.[68] Given that CAFO effluents undergo even less treatment than human waste, these effluents also are likely to contain antibiotics. Even if the antibiotics have short half-lives,

MANURE LAGOONS KILL

In December 1999, a man drowned in a six-acre, 25 foot-deep, Murphy farm manure lagoon in Ellis County, Oklahoma. The man was transferring pig effluent from a malfunctioning lift station near the hog facility when he and his truck went over the bank of the lagoon and fell in. It took 18 days for the body to be recovered. A jury in a federal civil trial found Murphy Farms to be negligent and awarded the man's widow close to $2 million.[69]

In another incident, a farm worker entered a lagoon to make a repair. When he attempted to climb out, he was overcome and fell to the bottom. His 15-year-old nephew went into the lagoon to try to rescue him and collapsed. The boy's father, his cousin, and his grandfather, the owner of the operation, entered the lagoon one by one and, tragically, all five family members died. In August 1992, two separate instances took the lives of four men. Two men were overcome, fell into the lagoon and died of hydrogen sulfide poisoning. Another two men died from asphyxiation. In both cases, one man fell in the lagoon while making repairs or removing obstructions and the second man died in rescue attempts.[70]

the supply is replenished and thus they may continue to contaminate the environment, kill susceptible bacteria, and allow resistant bacteria to multiply, potentially exposing people who boat, swim, or drink water.

WORKER DEATH AND INJURY

Nineteen people have died due to hydrogen sulfide emissions from manure pits.

According to the National Institute for Occupational Safety and Health (NIOSH) of the Centers for Disease Control, manure pit and lagoon systems always hold the potential to kill farm workers, particularly in the hot summer months. In 1998, the National Institute of Health notes that some 19 people died due to hydrogen sulfide emissions from manure pits.[71] NIOSH warns that the accumulation of gases formed in the process of breaking down the waste are toxic, oxygen-consuming, and explosive.[72] Though NIOSH has issued warnings to workers, no Occupational Safety and Health Administration standard exists for work around manure pits.[73]

There are four dangerous gases emitted from lagoons of concern to farm workers:

Methane: Usually found at the top of the pit, this gas is highly flammable and explosive at concentrations of five to 15 percent. At high concentrations, methane can displace enough oxygen to suffocate a worker.[74] In addition to concerns about methane from lagoons, methane-related deaths have been attributed to entering liquid manure tanks used to spread manure on farm fields.[75]

Hydrogen Sulfide: This highly toxic gas usually settles at the bottom of a pit and, at low concentrations, can cause severe eye irrititation, dizziness, headache, nausea, and irritation of the respiratory tract. At high concentrations, the gas can result in unconsciousness, respiratory failure, and death within minutes. The gas is also explosive at concentrations ranging from 4.3 to 46 percent by volume.[76]

Carbon Dioxide: Carbon dioxide, an odorless gas, can settle at the bottom of the pit. A worker exposed to low concentrations of this gas can have headaches, labored breathing, and drowsiness. At high levels of concentration, this gas will displace oxygen and suffocate a worker.[77]

Ammonia: This gas can result in severely irritated eyes, nose, throat, and lungs and, in high concentrations, can be fatal.[78]

Because of the hazards posed to workers, NIOSH recommends that a number of precautionary steps be taken, including alerting workers to the possible dangers.

Water Quality Impacts of the Lagoon and Sprayfield System

There are multiple ways that the lagoon and sprayfield system causes water pollution, kills fish, degrades aquatic habitats, and threatens drinking water supplies. Lagoons can break, spill, or fail, sending wastewater into streams, lakes, rivers, or estuaries. Liquid waste can be over-applied or inappropriately applied to farm fields through irrigation pivots with resulting runoff into lakes, rivers, and streams or seepage into groundwater. Lagoon linings can allow liquefied manure to seep into groundwater, and cracks in the linings can make the problem worse. Pipes and hoses connecting to lagoons or sprayfields may fail or leak. Finally, ammonia emissions from lagoons and sprayfields may result in atmospheric deposition, which sends a toxic form of nitrogen through the air miles away, where it is then deposited in waterways.

Siting and cumulative effects are particular concerns with the lagoon and sprayfield system. States and the federal government have allowed lagoons and sprayfields to be located in places where environmental harm is likely, such as in floodplains and wetlands, near water bodies, and on sandy soils, agricultural drainage wells, and karst topography that provide direct access to groundwater sources. Additionally, when multiple sprayfields cluster around slaughterhouses, as is common, their runoff causes cumulative effects within local watersheds.

The pollution from animal waste can harm waterways, human health, and aquatic life. The primary pollutants of concern for water quality purposes are the nutrients nitrogen and phosphorus. At a 2,500 hog operation in North Carolina, the slurry, which is the liquid from the lagoon that will be land applied, can contain between 58,000 and 700,000 pounds of nitrogen and 41,000 and 475,000 pounds of phosphorus depending upon the live weight of the pigs raised at the facility.[1]

While nutients are essential for plant, animal, and human life, excessive amounts can be harmful. Impacts include drinking water contamination; toxic and nontoxic algal blooms that impair recreational waters and kill fish; climatic changes from greenhouse gas increases (due to the process in which nitrates are converted to nitrous oxide); changes to coastal marine fisheries; acidification of soils and terrestrial and aquatic ecosystems; and increases in ozone and particulate matter that may harm human health and the productivity of crops and forests.[2] Nutrient pollution fosters the growth of a type of algae known as *Pfiesteria piscicida*, which has been implicated in the death of more than one billion fish in coastal waters in North Carolina.[3] The nation's primary expert on *Pfiesteria*, Dr. JoAnn Burkholder from North Carolina State University, has stated that one of the sources of pollution respon-

A CREEK THE COLOR OF HOG WASTE

Neil Julian Savage, Bladen County, North Carolina

“There is a little creek called Whites Creek that runs alongside of the Brown’s hog farm, then downstream to my farm. It eventually goes into Hammonds Creek and the Cape Fear River. The creek has a wide spot next to my property. It is a special place, a place that my family and I used to be able to enjoy. Before the hog farm opened next to us, my family would go there to sit and recreate in many different ways. It was a wonderful place for the family to get together, but not any more. Since the hog farm opened it has become nearly impossible to enjoy this family treasure…

“What has happened to Whites Creek is one of our major concerns. Since the hog farm began operating, I have seen changes in this creek which are not good. Now the creek often clogs up with vegetative growth that was not seen prior to when the farm was there. The look and smell of the water has changed for the worst. There is nothing else I can think of that would account for the changes in the condition of the creek besides the Brown’s hog farm. Much of the sprayfield areas at the Brown’s hog farm are on a downward slope towards the creek. It is a very bad situation so far as the creek is concerned. Since I live downstream on this creek, I have been directly and adversely impacted by the degradation of Whites Creek.

“On Sunday, March 19, 2000…as I walked back to the Whites Creek and up that creek to where the hog farm was located, I could see that the creek had turned the color of hog waste. There was a strong smell coming from the creek. It was the smell of hog waste. As I continued to walk along the creek, I saw many places where Brown’s had put pipes at the end of their sprayfields. These pipes were carrying hog waste from the fields, through an earthen berm, and discharging that waste directly across the land to Whites Creek. At the end of the pipes, which were connected to the sprayfields, I could see hog waste puddled and ponded as deep as 5 or 6 inches. There was a lot of hog waste ponded up everywhere…

“In some places, there was so much hog waste on the ground that it had washed out of the earthen bern and was running across the ground and into Whites Creek… On Sunday night, they sprayed again. I know this because I could hear the pumps running all night. On Monday morning, I walked around and the whole back field next to Whites Creek was heavily ponded with hog waste. It was ponded much worse than the day before. As I looked around, I found several places where it was running into the creek.

“On July 20 and 21, 2000, I heard the pumps once again running all night. On the morning of the 21st, the wind was blowing right, and I took a chance by taking a look at what was taking place. I saw two pipes connected to the lagoon. The pipes ran into the woods. I saw where the hog waste had run through the pipes and into the creek.

“On several occasions, Brown’s has over-sprayed so much hog waste next to my property that, during heavy rains, the rainwater and the waste that was carried in it actually ran, in large amounts, right onto my land. A number of times this waste has ponded in my front yard. The waste has come up to my front porch, surrounded my drinking well, and run past my house on to what used to be my farm fields. I have complained to Brown’s, but they have done little to correct the problems. We are afraid to drink the water from our well.”[4]

sible for the outbreaks is hog waste in coastal areas.[5] Nitrogen also causes the eutrophication of lakes and estuaries, which in turn harms fish and is likely to result in species changes, since plants–and the animals and microorganisms that depend upon them–that are tolerant of low nitrogen conditions diminish while nitrophilous plant species increase.[6]

According to EPA's 1998 National Water Quality Inventory, 30 percent of surveyed rivers, 44 percent of surveyed lakes, and 23 percent of surveyed estuaries suffer from nutrient pollution. The impairment is sufficient to make it unsafe to use the waterbody for the purpose for which it is designated–fishing, swimming, and other activities.[7] Nutrients caused severe pollution problems in 44 of the coastal areas examined by the National Academy of Sciences' National Research Council, including Washington, California, Louisiana, Texas, Florida, North Carolina, Maryland, New York, and Massachusetts.[8] The U.S. Fish and Wildlife Service estimates that in 1995, manure contributed 37 percent of all nitrogen and 65 percent of all phosphorus inputs to watersheds in the central United States.[9] Another example of impairment is the Dead Zone located in the Gulf of Mexico, up to 7,000 square miles of oxygen-deprived water where no aquatic life exists, that is the result of agricultural and municipal wastewater runoff.[10] According to the Committee of Environment and Natural Resources of the White House Office of Science and Technology Policy, animal manure alone contributes 15 percent of the nitrogen to the Gulf of Mexico, while industrial and municipal point sources together contribute only 11 percent.[11]

Rick Dove

Pfiesteria-like sores appearing on fish taken from the Neuse River in North Carolina. In the fall of 2000, nearly 100 percent of the menhaden swimming in a 40-square mile area of the Neuse River below New Bern had these sores. A very high percentage died.

SALT AND HEAVY METALS

Manure may contain trace elements of arsenic, copper, selenium, zinc, cadmium, molybdenum, nickel, lead, iron, manganese, aluminum, and boron. Some of these elements are added to animal feed as growth stimulants, others are present in pesticides applied to livestock to rid the animals of insects. Salts may also be in the manure, passed through the animals in undigested feed.[12] Heavy metals and salts are transported to the environment via wastewater. Additionally, heavy metals accumulate in the solid sludge in the bottom of lagoons, reaching toxic levels until they are emptied out every five to fifteen years, or abandoned after ten or twenty years.[13]

Trace elements of metals and salts from animal manure present risks to human health and ecosystems. Excessive salt can impact ecosystems, making drinking water undrinkable, making irrigation water unusable, and increasing the blood pressure of salt-sensitive individuals. In California's Chino Basin, once the number-one milk-producing area in California and home to 300,000 cows in 50 square miles, groundwater contaminated with high levels of total dissolved salts and nitrates flows into the Santa Ana River, which then is used as a recharge source for the Orange County drinking water aquifer.[14] The application of dairy manure and dairy wastewater is considered the major threat to groundwater. A 1990 study found that dairy operations were responsible for 88 percent of the agricultural salt load within the dairy area.[15]

SPRAYING 348 DAYS A YEAR

Rolf Christen, family farmer who raises cattle, chickens, and various crops in Green City, Missouri

"Premium Standard Farms, my neighbor, assured us that they were building a safe hog facility next to our property and that there would be no problems. But then we discovered a waste spill into Spring Creek and found dead fish and destroyed aquatic life. A neighbor of mine grew up near where I live and used to bathe and drink out of Spring Creek. He keeps on saying that the creek has changed. Now there is a black sediment in the creek that no one can explain. After the first spill into Spring Creek, the Premium Standard Farms facilities in the state had 20 to 30 spills. Within a three-month period, I believe that more fish were killed in the state than had died in the last ten years. I feel an indescribable pain when I see fish killed in creeks and rivers that were once picturesque.

"Until recently, the company sprayed the waste onto the land through irrigation guns. The company used to send me a notice every year that I was being given four holidays on which no spraying would occur, July 4, Memorial Day, Labor Day, and Thanksgiving. I have seen pipes burst and irrigation pivots stuck in ditches. Now the company "injects" the manure, but that does not mean that the manure is sent deep into the soil and knifed in. Instead, tiny shallow holes are pressed into the soil and hoses fill the holes with liquid waste. The excess waste runs off.

"As farmers and human inhabitants of this planet, we are but caretakers of what has been given to us. The tree in front of my house will be here long after I am gone. Every tree I plant will be for my grandchildren to enjoy. Everything I destroy will be gone forever. So will it be with the land."[16]

Manure runoff contaminated with trace elements can end up in waterbodies where the metals become more concentrated as they make their way up the food chain. When heavy metals accumulate in sediments, aquatic biota, and plant and animal tissue, the reproduction and immune systems of many aquatic and avian species may be harmed and waterways may become impaired.[17] For example, feed additives such as zinc can contaminate plants, while arsenic, copper, and selenium in feed additives can poison aquatic and terrestrial life, such as bottom feeding birds.[18]

According to the U.S. Fish and Wildlife Service, concentrations of selenium in lagoons or waste storage pits may be ten times the level that is safe for aquatic life.[19] A 1998 study by that agency found that wetlands in Nebraska that received wastewater from a swine production operation had concentrations of copper and zinc that exceeded the current protective criterion of 121 ug/l; the level of copper even exceeded a proposed aquatic life criterion of 43 ug/l.[20]

Humans can also become impacted by heavy metal contamination. Human illnesses associated with high levels of trace elements include skin and internal-organ cancer and vascular complications from arsenic, liver dysfunction, and hair and nail loss from selenium, and upper deficiency anemia from zinc. While the concentration in animal manure of arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc may be comparable to the levels found in some municipal sludges. EPA regulations restricting levels of heavy metals in human sludge do not apply to animal waste.[21]

Another risk associated with heavy metals is the deterioration of soil quality. In 1995, 10 percent of the soil samples in North Carolina's largest swine-producing counties had zinc levels ten times greater than the levels crops need for their growth. The number of soil samples from these counties that exceeded this level doubled since 1985. Already this level of zinc makes it hard to grow peanuts, and other crops will begin to suffer in future decades as the metals reach higher concentrations.[22]

GROUNDWATER POLLUTION

Federal and most state regulations concerning CAFOs focus on the nutrient content of the wastewater. However, the wastewater generated by lagoon systems contains pollutants other than nutrients, such as metals and salts, that can also adversely affect surface and groundwater quality. Additionally, the pollution strength of raw manure is as much as 110 times greater than that of raw municipal sewage.[23] (See Table 4-1.)

As of 1998, close to 1,600 wells located near factory farms in North Carolina were tested for nitrate contamination. Thirty-four percent of the wells showed nitrate contamination; ten percent of the wells had a nitrate level that exceeded the drinking water standard. The state's Department of Health and Human Services stated that the cause of contamination was leaking hog lagoons and hog wastewater sprayfields.[24]

In many cases, lagoons leak because they are not lined. Only in the last few years have some states required that lagoons be lined. Lagoon linings include clay, concrete, and plastic, with clay linings the most commonly required. But many types of linings still allow seepage to occur. Seepage from lagoons occurs in two ways: vertical seepage along the bottom of the lagoons, and vertical and horizontal seepage at the berms.[25] Moreover, cracks may occur in the lagoon lining. Visual inspections are insufficient to detect when linings have been compromised, because lagoons may be structurally sound in certain places and cracked in others. Groundwater testing wells can detect problems, but groundwater monitoring is rarely required by regulatory agencies.[26]

Studies from across the nation compiled by the Minnesota Pollution Control Agency found numerous incidents of groundwater contamination near unlined, earthen manure-storage basins. Nitrate levels were above the drinking water standard of 10 mg/l in about half of the 42 basins that were monitored; the other half of the facilities

Grasses choke off a part of North Carolina's Trent River due to over-nutrification. There are more than 450 hogs-per-square mile in this watershed.

Rick Dove

TABLE 4-1

BOD_5 Concentrations for Manures and Domestic Sewage

Waste	BOD_5 (mg/l)*
Swine Manure	
Untreated	27,000 to 33,000
Anaerobic lagoon influent	13,000
Anaerobic lagoon effluent	300 to 3,600
Poultry manure	
Untreated (chicken)	24,000
Anaerobic lagoon influent (poultry)	9,800
Anaerobic lagoon effluent (poultry)	600 to 3,800
Dairy cattle manure	
Untreated	26,000
Anaerobic lagoon influent	6,000
Anaerobic lagoon effluent	200 to 1,200
Beef cattle manure	
Untreated	28,000
Anaerobic lagoon influent	6,700
Anaerobic lagoon effluent	200 to 2,500
Domestic sewage	
Untreated	100 to 300
After secondary treatment	20

*The pollution strength of the organic matter in manure or wastewater is expressed as the biochemical oxygen demand (BOD_5).
Source: U.S. Environmental Protection Agency, Office of Water, *Environmental Assessment of Proposed Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations*, EPA-821-B-01-001 (January 2001).

were found to have no or only slight levels of groundwater contamination.[27] Of particular concern were lagoons with earthen liners that were constructed on sandy soil, from which researchers found “significant” leakage of nitrogen and phosphorus, and leakage that increased greatly over time.[28] This study highlights the importance of soil type. When lagoons are located on coarse soils, seepage is more likely, but if the soil is firm, runoff from sprayfields may result.[29]

A study for the Iowa legislature by Iowa State University found that over 50 percent of the earthen waste-storage structures (slurry pits and lagoons) studied had seepage losses that exceeded current standards.[30] The study also looked at soil cores to measure the migration of waste. The soil cores were tested for a number of contaminants, and most of the sites had at least one of the contaminants present at a high concentration level. The pollution at some of the sites might have been attributed to waste spills or previous use of the areas for livestock production, but the high levels of ammonium nitrogen at five sites was attributed to seepage. The seepage was measured outside of the berm at a distance of 30 to 50 feet from inside the earthen waste-storage structure.[31] Another study in Iowa, by the state’s Department of Natural Resources, found that two of three earthen manure lagoons constructed around 1994 on clay soils seeped into the water table. Levels of chloride, organic carbon, and organic-N were increasing over time, while sulfate and nitrate concentrations were decreasing. The three-year study concluded that seepage was continuing and that none of the basins had sealed.[32]

Clay linings, which are made of compacted soil, offer greater protection, but may still seep. For example, Kansas State University researchers studied four swine lagoons and found that all of them leaked between .05 and .08 inches a day, which translates to between .99 million and 4.35 million gallons per year, or between 19.8 and 87.1 million gallons over the twenty-year life of the lagoons. The one cattle lagoon studied seeped at a rate of .094 inches a day, 6.88 million gallons per year, or 137.7 million gallons over the life of the lagoon.[33] Just for nitrogen, seepage losses from a swine waste lagoon could add up to more than 2,600 pounds/acre per year, or 250,000 pounds over the twenty-year life of the lagoon. Nitrogen losses for cattle lagoons were less than those for swine, because the effluent contains a lower concentration of nitrogen.[34]

Also, the seal that exists below and on the sides of the lagoon may weaken over time. Several studies have found that within two to four years, chlorides and ammonium begin to leak through a clay lining.[35] A study of dairy lagoons by the New Mexico Department of Health and Environment found elevated levels of nitrogen in unlined and clay-lined lagoons that were more then ten years old.[36]

Numerous studies have found seepage from and cracking of earthen and clay liners due to wet/dry cycles, the removal of manure from the lagoon, worms, roots, rodents, freeze/thaw cycles, erosion of lagoon berms, agitation during pumping, and liner collapse due to external pressure and groundwater intrusion.[37] A study for the Iowa legislature found that 27 percent of the 33 earthen waste-storage structures studied had compacted clay liners or berms that had eroded, while 6 percent had tree growth on berms.[38] Additionally, clay liners may crack if the dredging of the sludge off the bottom of the lagoon is not done properly. This dredging is typically done every five to fifteen years.[39]

Lagoon siting is critical. The study for the Iowa legislature found that 18 percent of the 34 earthen waste-storage structures (lagoons and slurry pits) studied were located over alluvial aquifers where there was a risk of contaminating private and municipal water supplies. Moreover, the study showed that 65 percent of the site areas were located on soils with seasonal water tables of less than 5 feet. Since earthen waste-storage structures are often deeper than 10 feet, the lagoon bottoms sat below the water table.[40] The study speculated that "a large percentage of earthen waste-storage structures in this study and in the state are probably below the water table or at least in contact with the water table." Moreover, "locating an earthen waste-storage structure and applying manure on permeable soils poses a substantial risk for contaminants to reach the water table."[41]

Concrete liners can offer greater protection, but concrete can crack if builders do not follow specifications related to soil suitability and structural reinforcement. Despite the fact that these specifications contribute to liner stability, there are no requirements that compel builders to follow them.[42] Plastic liners are also not fail-safe. In 1998, two of the plastic lagoon liners used at the huge Circle Four factory farm in Beaver County, Utah developed bubbles and the liners floated to the surfaces of the lagoons.[43]

SURFACE WATER POLLUTION OF LAKES, RIVERS, AND STREAMS

While many recently-built lagoons have been designed to meet the capacity of a 24-hour, 25-year storm event, several days of rain can compromise the system, because the steady rainfall weakens the berms and prevents the excess wastewater from being sprayed on already saturated fields.[44] Bursting and overflowing manure lagoons have spawned environmental disasters around the country, sending animal waste gushing into rivers, groundwater, and coastal wetlands.

▶ Between 1990 and 1994, 63 percent of Missouri's factory farms suffered spills according to Missouri's Department of Natural Resources.[45]
▶ In 1995, an eight-acre animal waste lagoon in North Carolina burst, spilling 25 million gallons of animal waste into the New River. The spill killed 10 million fish and closed 364,000 acres of coastal wetlands to shellfishing.[46]
▶ In 1997, animal feedlots were responsible for 2,391 spills of manure in Indiana.[47]
▶ In 1998, a 100,000-gallon spill into Minnesota's Beaver Creek killed close to 700,000 fish.[48]
▶ In 1996, 40 spills killed close to 700,000 fish in Iowa, Minnesota, and Missouri.[49]
▶ From 1995 to 1998, there were at least 1,000 spills or other pollution incidents at livestock feedlots in ten states, and 200 manure-related fish kills that resulted in the death of 13 million fish.[50]

The spills listed above can be attributed to a host of problems, but they point to the inherent risks of the lagoon and sprayfield system. Some problems are due to poor management. A 1999 study for the Iowa legislature found that of the 33 earthen waste-storage structures (lagoons and slurry pits) studied, over half had minor spills when manure was being unloaded, 12 percent had flow inlet pipes that were plugged or frozen, and 6 percent had inadequate freeboard.[51]

Poor siting of lagoons poses another concern. If lagoons are located near waterbodies, wetlands, floodplains, or other ecologically sensitive areas, spills are more likely to cause harm. The study for the Iowa legislature found that 18 percent of the earthen waste-storage structures studied were located in floodplains, 21 percent of the structures were within 500 of feet of ephemeral streams, and 12 percent of the structures were within 500 feet of perennial streams. A Kansas State University study speculated that in areas with high rainfall, nitrates which are highly mobile and accumulate in significant amounts in the soil beneath lagoons, could seep deeper into the soil and closer to groundwater. This happens particularly when lagoons are closed or abandoned and their bottoms dry out.[52]

A study by the U.S. Geological Survey found that in 88 percent of the 2,056 watershed outlets, manure contributed more to in-stream total nitrogen than traditional point sources; in 113 watersheds, manure was the single largest contributor.

While spills can cause catastrophic damage, the more common problem is over- or misapplication of waste onto cropland, which sends polluted runoff into waterways and leaches pollutants into groundwater. A 1992 study by the U.S. Department of Agriculture found that "nutrients from confined animals exceed the uptake potential of non-legume harvested cropland and hayland…[R]ecovereable manure nitrogen exceeds crop system needs in 266 of 3,141 counties, and that recoverable manure phosphorus exceeds crop system needs in 485 counties."[53] A study by the U.S. Geological Survey found that in 88 percent of the 2,056 watershed outlets, manure contributed more to in-stream total nitrogen than traditional point sources; in 113 watersheds, manure was the single largest contributor. This study also concluded that manure is a major contributor to in-stream, total phosphorus concentrations, even more so than commercial fertilizers.[54] The Texas Institute for Applied Environmental

Research identified the dairy industry as the primary contributor to nutrient loading in the Upper North Bosque River. The institute also measured elevated phosphorus levels at fields where animal manure had been applied.[55]

A study by the University of Northern Iowa looked at hog CAFOs with lagoons and earthen storage basins, and their field application of manure onto corn and soybean crops. The study asserted that if farm workers had applied manure at the rate at which the crops could have absorbed phosphorus, the CAFOs would need more than nine times the field area used for manure application by these CAFOs.[56] Since clearly the land area for spreading the manure was so much less than that needed for proper application, one can assume that the excess phosphorus was running off. This same study found other practices in manure management plans submitted by most of the CAFOs that would likely lead to over-application of manure, including over-estimating crop yields and underestimating the nutrient content of manure. The study also questioned the common practice of applying manure to soybeans–a crop that traditionally has not been fertilized.[57]

Inactive lagoons pose an additional threat to groundwater. North Carolina's Department of Environment and Natural Resources inventoried 1,142 inactive lagoons. The study determined that only 43 structures were low risk, while 39 lagoons were judged to be high risk because they were either overflowing or had a high likelihood of overflowing. Over 90 percent of the lagoons were determined to present a risk for groundwater contamination.[58]

ATMOSPHERIC DEPOSITION

Studies in the United States and Europe show that livestock farms in general have the potential to contribute large amounts of nitrogen to the atmosphere as ammonia.[59] Although the amount varies based on weather, sprayfield application method, type of livestock species, and manure storage method, the impact can be significant. In fact, up to 80 percent of a swine lagoon's nitrogen may change from a liquid into a gas in the process known as ammonia volatilization.[60] In contrast, dry manure systems lose 15 to 40 percent of their nitrogen to the atmosphere.[61] For beef manure, the fewer solids and more liquid that is present in the slurry, the greater the volatilization.[62] Once the ammonia is volatilized, it can be deposited onto land and water 300 miles away.[63] Sprayfields also result in ammonia losses. Several studies have found that if manure is not incorporated into the soil, more than half of the manure is lost, presumably to volatilization.[64] One study "found that soil-incorporated manure may release as little as one-tenth the ammonia emitted from surface-spread manure, other factors being equal."[65]

Up to 80 percent of a swine lagoon's nitrogen may change from a liquid into a gas in the process known as ammonia volatilization.

In North Carolina, swine operations contribute nearly half of the total atmospheric ammonia in the state coming from all other industrial and livestock sources combined; lagoons in eastern North Carolina are responsible for a third of the total swine ammonia emissions.[66] In the six-county area of North Carolina that has the most concentrated hog production, a comparison of ammonia emission levels from hog operations in two seven-year periods, 1982-1989 and 1990-1997, showed an increase of 316 percent.[67] The increase tracks the period of rapid growth in North Carolina's hog industry which occurred starting in 1989.[68] North Carolina Environmental Defense estimated that the nitrogen from atmospheric emissions from sprayfields into rivers alone ranged from eight to 38 percent in the Neuse River basin and 16 to 38 percent in the Cape Fear River basin.[69]

In addition to threatening groundwater with pollutants, the lagoon system also causes its depletion. The lagoon system relies upon a steady supply of water. It needs water to clean the barns, cool the animals, and provide drinking water for the animals. Most significant, the system requires sufficient water to make the manure wet enough to flush into the lagoon and spray onto fields.[70] Missouri activists estimate that a swine operation that finishes 80,000 animals per day consumes over 200,000 gallons of water per day, or 73 million gallons per year.[71] In many areas in which factory farms are located, the water that is utilized is groundwater–which is provided to the factory farm for free.

Alternative Approaches to the Lagoon and Sprayfield System

The lagoon and sprayfield system presents numerous risks to surface and groundwater quality, air quality, and public health. A number of alternative approaches are being used by sustainable operations. Researchers are studying many alternative technologies, at least on a pilot level. The list of approaches described below illustrates one important point–it is not the lack of alternatives that is driving factory farms to rely almost exclusively on the lagoon and sprayfield system. Factory farms continue to use this polluting system because they have been allowed to use our farmland, rural waterways, and air as disposal sites for untreated wastes. With its effluent guidelines, EPA has a historic opportunity to move feedlots beyond the lagoon and sprayfield system, but it has not yet chosen to do so. Instead, the agency may allow factory farms to continue to pass the cost of waste disposal on to the public. The wealth of approaches increasingly available across the country shows that pollution from these facilities can be eliminated or reduced, but only if we require facilities to use them.

Unfortunately, many of the systems that are being evaluated presume that it is necessary to liquify and then treat the liquid manure. There is another approach–one based upon the principle of pollution prevention and proper manure management. The sustainable agriculture approach dries the manure and often adds other dry material to keep waste from running off, or seeping into water supplies. Sustainable agriculture practices that embody these approaches benefit the environment, the producer, the animals themselves, and the communities that surround them.

It is important to note that some of the alternatives to the lagoon and sprayfield system are still in the development stage and have not necessarily been evaluated for all pollution risks. Moreover, while some of the technologies have been in use for the treatment of human waste for years, they have not been widely used for animal waste. Thus, studies on pollution reductions may only be based upon a limited sample, pilot projects, or a limited history of use. Also, many university studies evaluate certain chemical parameters, but not others, so risks could be high for pollutants not measured, such as heavy metals, which, even at low concentrations, can be toxic to plants and animals. Finally, many impacts on the environment have not been measured, for example, the likelihood of groundwater contamination. For the purposes of simplicity, "public health impacts" are identified as pathogen reduction, even though reductions in surface water, groundwater, and air contamination can all benefit public health.

Management Intensive Rotational Grazing

The use of an intensive rotational grazing system provides environmental benefits, such as enhanced soil quality, minimal soil erosion, improved stream bank quality, and enhanced wildlife habitat.

Intensive rotational grazing represents a return to the practice of using managed pasture to supply at least a portion of the nutritional needs of animals with growing grasses and legumes. Animals (dairy cows, beef cattle, egg layers, broilers, hogs and others) graze on sections of pasture that are divided into paddocks. In the pasture sections that do not contain animals, forage is allowed to grow. Using fences, animals move into different sections of the pasture where they graze, but are moved before the pasture section is over-grazed.[1] The use of an intensive rotational grazing system provides environmental benefits, such as enhanced soil quality, minimal soil erosion,[2] improved stream bank quality,[3] and enhanced wildlife habitat.[4]

Assessment of Pollution Risks:

▶ To surface water quality: If the animal ratio is appropriate for the acreage and stream banks are fenced, the system reduces agricultural runoff.[5] The potential for accumulation of soil phosphorus is also reduced if the animals' diet is not supplemented with purchased feed or mineral supplements–both of which can be significant sources of phosphorus inputs to individual operations.[6]

▶ To groundwater quality: The potential for groundwater contamination remains low as long as the site is not located in an area with karst geology or other preferential flow paths to groundwater.[7]

▶ To air quality: Ammonia volatilization is minimal.[8]

▶ To public health: Pathogen transport is minimal due to the reduced volume of surface runoff, which is further reduced if combined with filter strips.[9]

Hoop Houses

Hoop houses are structures that house hogs indoors, but allow them freedom of movement. Hoop houses are built on arched metal frames covered with a tarp. Sidewalls reach four to six feet above ground level on the sides, while end walls are typically tarps or plywood doors that can be opened for ventilation.[10] The houses are bedded deeply with straw to absorb urine and moisture in feces. The straw binds with manure and urine, keeping the waste in a more solid form than liquid-flushing systems used by industrial confinement facilities. Typically, pigs are not confined in pens in hoop houses.[11]

In a system invented by Virginia farmer Joel Salatin, egg layers are allowed to graze through the use of a mobile "eggmobile."

Joel Salatin

Assessment of Pollution Risks:

▶ To surface water quality: Hoop houses eliminate the risk of accidental discharges from manure storage ponds and lagoons during precipitation events because the manure/straw mixture is in a more solid form and the tarp provides rain protection.[12]

However, once the bedding is cleared out of the house (two or three times a year), it is either composted or, having been composted in the house, it is directly spread on fields. Proper land application of the manure is needed to prevent polluted runoff.[13]

▶ To groundwater quality: In order to prevent seepage of nitrate to groundwater, an impermeable barrier, such as a concrete floor, should be constructed between the bedding/ manure mixture and the underlying soil. The potential for the downward movement of this accumulated nitrate nitrogen to groundwater can be reduced by proper siting.[14]

▶ To air quality: If the accumulating bedding/manure mixture is not overly compacted, ammonia nitrogen mineralized from organic nitrogen compounds may oxidize to nitrate nitrogen. If the potential for nitrification is high, the potential for the formation and release of hydrogen sulfide will be low. The likelihood of the release of both ammonia nitrogen and hydrogen sulfide to the atmosphere depends on the ability to maintain conditions in the bedding/manure mixture that are conducive to aerobic microbiological activity.[15]

Weaning pigs on deep straw may prevent them from being exposed to pathogens that exist on bare, urine- or manure-covered floors.

Diane Halverson

▶ To public health: Some producers have found that the use of hoop houses eliminates the need for the routine incorporation of antibiotics in feed, because this method of production produces healthy hogs.[16] Additionally, weaning the pigs on deep straw may prevent them from being exposed to pathogens that exist on bare, urine- or manure-covered floors.[17] Pathogens generally are poor competitors in environments with diverse microbial populations and especially in aerobic environments because pathogens usually are anaerobes. Thus, significant pathogen reduction in the bedding/ manure mixture in hoop houses is a reasonable expectation if the mixture is removed infrequently and especially if there is an elevation in temperature due to microbial heat production.[18]

Composting

Composting is a biological process in which aerobic bacteria convert organic material into a soil-like material called compost that reduces erosion and enhances organic matter, soil quality, and nutrients.[19] In a simple composting system, material is laced in long rows called windrows and turned occasionally to ensure that the material is mixed well. In a complex system, odoriferous materials can be processed in drums, trenches, or tunnels for initial processing, and then cured in a covered facility.[20] Several universities are studying the use of complex systems for swine and dairy waste that involve some dewatering of the waste and adding dry materials or earthworms.[21] Most composting is aerobic, but some producers are turning to anaerobic composting systems in which methane gas is produced for electricity.[22] As with other treatment systems, proper siting of the composting away from waterways and wells is essential to prevent pollution.[23]

Assessment of Pollution Risks:

▶ To surface water quality: Composting reduces the nitrogen content of manure.[24] A roof over the compost site and a system to capture and dispose of leachate and runoff can protect adjacent surface waters.[25] Threats to water quality can be prevented by off-site disposal of composted waste when land resources for on-site utilization of manure are limited.[26]

▶ To groundwater quality: Paving and covering sites used for composting help prevent groundwater contamination.[27]

▶ To air quality: With proper management, release of objectionable odors can be minimized. However, significant odor problems can occur during the start-up of the composting process. Due to the low carbon/nitrogen ratio of animal manure, some volatilization of ammonia nitrogen is unavoidable.[28] To minimize ammonia nitrogen volatilization, readily biodegradable organic carbon, e.g., paper, leaves, or sawdust, must be added to increase the carbon/nitrogen ratio to about 30:1. Otherwise, nitrogen levels in both wet and dry atmospheric deposition will increase with subsequent adverse surface water quality impacts.[29]

▶ To public health: When thermophilic temperatures are achieved, pathogen densities are reduced substantially.[30]

TECHNOLOGY-BASED APPROACHES

Anaerobic Digestion

Anaerobic digestion uses microbes to convert the carbon fraction of livestock and poultry manures to methane and carbon dioxide, commonly referred to as biogas.[31] Digesters create an effluent that has a different chemical composition than raw manure.[32] In all digesters, liquid effluent remains after the process that must be stored until it can be applied to crops.[33] Anaerobic digestion has been used for more than 50 years to stabilize wastewater treatment sludges, and at the same time, reduce pathogen densities.[34]

Releases of noxious odors, ammonia nitrogen, and methane from anaerobic lagoons can be controlled using a flexible, gas-tight cover resulting in a covered lagoon digester.[35] Other types of digesters used successfully with animal wastes include completely mixed and plug-flow digesters. A complete mixed digester treats slurry manure in above- or below-ground tanks.[36] A plug-flow digester typically is an in-ground rectangular trench lined with an impermeable material and covered with a gas-tight flexible membrane cover.[37] These types of digesters are usually insulated and heated using a fraction of the biogas recovered as fuel. Thus, stabilization and the total yield of biogas are constant throughout the year. In contrast, the degree of stabilization and biogas yield from covered lagoon digesters varies with time of year, particularly in colder climates.

Assessment of Pollution Risks:

▶ To surface water quality: Anaerobic digestion can significantly reduce the concentration of oxygen demanding carbon compounds in animal manure. However, the concentration of these compounds will still exceed concentrations in untreated municipal wastewaters.[38] The process converts organic forms of nitrogen to ammonia nitrogen, but does not reduce phosphorus.[39] Reports of phosphorus reduction associated with anaerobic digestion are the result of phosphorus in settled solids accumulated in digesters.[40] The use of anaerobic digesters requires storage tanks or ponds. Therefore, the potential for accidental discharges due to mismanagement or during extreme precipitation events is not eliminated.

▶ To groundwater quality: The risk associated with lined covered-lagoon digesters varies and depends on soil type, geology, depth to seasonally high groundwater, and the method, quality, and management of the liner.[41]

▶ To air quality: Anaerobic digestion with biogas utilization or flaring substantially reduces methane and noxious odor emissions.[42] The system also results in lower ammonia emissions than open-air lagoons, although there still may be some volatilization when the digested manure is stored in a pond prior to land application or when it is land applied without proper injection.[43]

▶ To public health: Risk can be variable, depending upon whether the digesters are heated. Pathogenic bacteria can be significantly reduced or even essentially eliminated if the digesters are heated.[44]

Wetlands Treatment

Constructed wetlands have been used successfully for the tertiary treatment of municipal and industrial wastewaters to further reduce concentrations of nitrogen, phosphorus, biochemical oxygen demand, and suspended solids before discharge to surface waters.[45] These reductions are the result of a combination of microbial activity, plant uptake of nitrogen and phosphorus, and physical/chemical processes such as ammonia volatilization and phosphorus adsorption.[46] In this system, a wetland is constructed that filters wastewater using plants, soil, and water. After treatment, the effluent is sprayed onto crops. Seasonal weather conditions, such as cold and drought, may make the system less reliable.[47] For relatively dilute waste streams, such as swine and dairy flush waters after removal of manure solids, constructed wetlands may be a viable management option prior to storage.[48] For other animal waste, solids must be removed before the wastewater is put in the wetland and pretreatment is necessary to ensure that high ammonia concentrations do not kill off plant life.[49] These steps can be accomplished through the use of an anaerobic or aerobic lagoon, a sequencing batch reactor, a digester, or another system. Thus, constructed wetlands should be viewed as a component of a larger system to treat waste.[50]

Assessment of Pollution Risks:

▶ To surface water quality: Under normal weather conditions, any polluted runoff that results will be far less toxic than that of an anaerobic lagoon. Studies vary on pollutant reduction results, with some studies reporting reductions of half or more in nitrate, ammonia, and oxygen-depleting substances and suspended solids for dairy waste. For swine waste, some studies have found that the system removes most of the nitrogen, phosphorus, and suspended solids,[51] while other studies have found less phosphorus reduction.[52] However, excess rainwater could flood the system, so a holding pond should be constructed near the wetland to accept stormwater and act as a settling basin for removing solids.[53]

▶ To groundwater quality: The risk wetlands treatment poses to groundwater is unknown. However, like lagoon systems, siting may be a concern. If a wetland is located on porous soils, karst geography, or areas near agricultural drainage wells, groundwater contamination may be a high risk.

▶ To air quality: Wetlands may emit some ammonia, which could be reduced if the wastewater is nitrified prior to wetland treatment.[54]

▶ To public health: The risk is unknown.

Sequencing Batch Reactor

The aerated sequencing batch reactor (SBR) process is a variant of the activated sludge process, which has been used for over 75 years to treat municipal and industrial wastewater. The SBR maintains an adapted microbial population to convert the fraction of organic compounds in solution into microbial biomass that subsequently can be removed by settling or filtration. With the conventional activated sludge process, a portion of solids separated by settling after aeration is returned to the aeration basin to maintain the desired microbial population and to minimize wastewater retention time and tank size.[55]

Wastewater treatment using the conventional activated sludge process uses a continuous flow mode of operation. In contrast, SBRs are operated as batch reactors with the following sequence of operations. First, the reactor is filled with untreated wastewater, which is mixed with some fraction of the settled solids from the previous batch. Second, there is a period of aeration that also provides mixing. Third, aeration is terminated to allow suspended solids (particulate matter) to settle and separate. Finally, the clarified effluent is discharged, a fraction of the settled solids is removed, and the process sequence is repeated. The principal advantage of this batch mode method of operation, especially in municipal and industrial wastewater treatment, is that it offers more precise process control. With operating conditions conducive for nitrification, a substantial degree of nitrogen reduction through nitrification-denitrification can be achieved.[56]

Assessment of Pollution Risks:

▶ To surface water quality: The water pollution potential of clarified effluent from a SBR treating animal wastes is substantially lower than untreated waste. A university pilot program for swine waste found that the system removed chemical oxygen demand and total nitrogen by more than 90 percent, and volatile solids and phosphorus by more than 70 percent.[57] Another pilot project showed that over 60 percent of the nitrogen was removed using this system.[58] Since wastewater is in a tank, there is little likelihood of breaches.

▶ To groundwater quality: Risk is lower than using a lagoon since the manure is in a tank.

▶ To air quality: With nitrification, ammonia nitrogen emissions will be reduced. However, nitrous oxide emissions resulting from denitrification and noxious odors from stored solids may occur.[59]

▶ To public health: Significant reductions in pathogen densities in the clarified effluent are obtainable. However, there will be a concurrent concentration of these organisms in the settled solids due to sorption onto particles.[60]

Lagoon Covers

Placing a cover over a lagoon offers an approach that can reduce emissions. A number of different covers have been studied, each of which have benefits and drawbacks. The least costly option entails the use of biofilters, readily available materials that are blown onto the surface of the lagoon, such as peat, moss and straw. Other materials that may be used include plastic mats, polystyrene foam, air filled clay balls, geo-textile membranes, such as high-density polyethylene or reinforced polypropylene materials, and pumice or construction matting.[61] The problem with biofilters is that they need to be replaced often to prevent the material from sinking to the bottom of the lagoon.[62] Other cover options include rigid concrete or wood lids or roofs made of fiberglass.[63]

Assessment of Pollution Risks:

▶ To surface water quality: The risk is unknown, but it is unlikely that biocovers could prevent a major lagoon breach or spill. Impervious covers might sink during a storm event. Rigid covers and impervious covers would divert rainwater.

▶ To groundwater quality: Covers are not designed to address groundwater quality.

▶ To air quality: One study showed that straw covers reduce ammonia emissions, while peat moss absorbs ammonia and reduces nitrogen losses by 40 to 60 percent.[64] Another study found that a straw cover with a thickness of 12 inches reduced ammonia and hydrogen sulfide emissions by 80 percent, while putting straw on top of a thin geo-textile cover also resulted in significant reductions in the emissions of these gases.[65] However, in Renville County, Minnesota, ValAdCo, a large hog farming cooperative, continued to have air quality violations depsite the use of straw and cloth covers, which may be the result of the failure of the cover systems or mismanagement of them.[66] Rigid covers can reduce ammonia emissions between 80 and 95 percent.[67]

▶ To public health: The risk is unknown.

Lagoon Liners

Many earthen lagoons and storage ponds used for livestock and poultry manure have been constructed without any attempt to prevent seepage through the soil profile to groundwater except by compaction of the soil. Neither clay nor concrete liners are risk free with respect to seepage. Clay liners can crack if allowed to dry after a lagoon or storage pond is emptied. Concrete liners can also crack due to thermal expansion and contraction and settling. Also, reliable sealing of necessary expansion joints can be problematic.

Assessment of Pollution Risks:

▶ To surface water quality: Lagoon liners will not protect surface water quality directly but will prevent the base flow discharge of contaminated groundwater to adjacent surface waters.

▶ To groundwater quality: Numerous studies have found seepage through clay liners due to: 1) cracking during wet/dry and/or freeze/thaw cycles, 2) penetration by worms, roots, or rodents, 3) physical damage due to erosion of lagoon berms and agitation during pumping, and 4) liner collapse due to external pressure and groundwater intrusion.[68] Geo-textile materials are less permeable than clays but proper installation is essential. Geo-textile lagoon liners also are subject to the possibility of physical damage during agitation and pumping and due to burrowing animals.[69] Concrete liners can offer greater protection, but concrete can crack if specifications related to soil suitability and structural reinforcement are not followed; however, there are presently no such requirements.[70] Plastic liners composed of impervious materials, like those presently required by EPA for solid waste lagoons, but not for animal waste lagoons, are another option.[71] However, plastic liners also must be constructed properly to prevent problems.

▶ To air quality: Liners are not designed to address air quality.

▶ To public health: Where seepage from lined or unlined lagoons can enter groundwater without filtration through unsaturated soil, discharge of bacterial pathogens to groundwater is likely. Even where seepage is filtered through unsaturated soil, viral pathogens may be transported to groundwater.[72] (See Chapter Four.)

Many of the alternatives to the lagoon and sprayfield system for managing livestock and poultry manure described in this chapter are viable, and provide substantially greater protection to public health and the environment than the lagoon and sprayfield system. The options are available, but factory farms will not begin to use them as long as they are able to continue to externalize their pollution costs by dumping manure into the environment. However, for any method, surface water, groundwater, and public health will only be protected if manure is applied properly to the land.

CHAPTER 6

POLICY RECOMMENDATIONS

The numerous studies summarized in this report make it clear that the reliance on lagoon and sprayfield systems to store and treat animal wastes harms the health of nearby communities and pollutes the environment in numerous ways. The promulgation of EPA's new technology rules ("effluent guidelines") under the Clean Water Act presents a major opportunity to phase out open-air lagoons and sprayfields on large-scale animal operations, and to promote a more sustainable animal production system. Sustainable facilities limit the number of animals that they confine to generate only the amount of waste that can be used as fertilizer. For that reason, sustainable systems generate much less pollution and are at much less risk of catastrophic failure than lagoon and sprayfield operations.

PHASE OUT THE USE OF LAGOONS

The concentration and industrialization of animal production in this country has resulted in single facilities that produce thousands of animals and generate millions of gallons of manure. Industry trends indicate the likelihood of further concentration, resulting in more and larger lagoons if regulations are not tightened.[1]

EPA's existing technology standard allows lagoons that pollute surface water in a variety of ways indirectly to claim that they do not discharge and, therefore, that they do not need a Clean Water Act discharge permit. This has been a major factor in widespread lagoon adoption by concentrated animal feeding operations (CAFOs). (Another factor has been the fact that lagoons have been considered the least costly manure storage option.) When the existing technology standard was promulgated over twenty years ago, animal operations were smaller and lagoons were built on a much smaller scale. Today with the enormous quantities of manure that is generated and stored in lagoons, there are multiple ways for discharges to occur through the air, surface water, and groundwater. However, despite the growing body of evidence that these huge lagoons pollute the environment in numerous ways, EPA's proposed regulations would allow the riskiest lagoons to continue to operate and new lagoons to be built. Moreover, EPA envisions little or no water quality monitoring to determine if pollution problems are occurring.

Ban New Lagoons To protect the environment and public health, EPA should use all regulatory avenues possible to ensure that no new lagoons will be built. It is not enough to simply require that new lagoons to be lined and covered. While these measures may be appropriate as an interim step for existing operations to mitigate some potential problems, these approaches fail to address problems associated with lagoon breaches and overflows. For example, cracks can develop even in lagoons lined with concrete, and seepage can be a problem for lagoons lined with clay, and neither liners nor covers will prevent overflows in significant rain events. (See Chapter Four.) The storage of vast quantities of liquid manure in lagoons presents an unacceptable risk to public health and the environment. Weather events, human error, and system failures have resulted in numerous problems. EPA should not allow any CAFOs to build new lagoons.[2]

Encourage the Use of Sustainable Animal Production Systems There are sustainable animal production systems that do not impose high risk of pollution and other harms and that minimize cumulative impacts from animal production. A key component of a sustainable animal production system is that the scale of the system does not exceed the capacity of the local region to use the waste from the system beneficially. In other words, the total number of animals in a watershed should not exceed the nutrient requirements of available crop and/or timberland in that watershed. Generally, sustainable animal production systems are integrated with crop, forage, or pasture production and on-farm, best-management practices to prevent stormwater runoff from farm fields and barns. These sustainable systems are true pollution prevention systems.

While the U.S. Department of Agriculture and EPA Unified Strategy for Animal Feeding Operations[3] included an overarching principle that sustainable livestock systems be supported, this concept has not been incorporated into EPA's proposed regulations for new CAFOs. The new technology rules should encourage all new CAFOs to adopt sustainable livestock systems that protect air, surface, and water resources.

Phase Out Existing Lagoons Existing lagoons should be phased out over a five-year period. The corporations that own the animals and reap most of the profit can and should be held responsible for paying the costs of installing technologies that do not rely on lagoons and sprayfields. Alternatives to lagoons are available and now in use at farm operations that turn a profit. During this period, existing operations should be required to monitor their surface and groundwater quality to ensure that no discharges occur, and be required to line and cover their lagoons to prevent further contamination. Berms should be required to be built surrounding existing lagoons and be large enough to hold the entire contents of lagoons should they burst. Existing operations should be prohibited from expanding their lagoon systems in the 100-year flood plain or in any area in which there is a potential for seepage into groundwater that may be hydrologically connected to surface water.

The idea of a phaseout has already gained acceptance in North Carolina, a state that ranks second among hog producing states.[4] In 1999, former Governor Hunt proposed a widespread conversion of swine waste lagoons and sprayfields to new technologies.[5] Although North Carolina's Governor Easley has not publically endorsed former Governor Hunt's phaseout plan since he took office, it is worth mentioning that Governor Easley himself initiated the agreement with Smithfield, requiring the company to convert to "environmentally superior technologies," when he was the state's attorney general.[6]

BAN SPRAYFIELDS AND LIMIT LAND APPLICATION

Sprayfields constitute an integral feature of many lagoon systems, in which the waste is sprayed onto crops or pastureland. The sprayfield system poses significant risks to the environment. Since the waste is sprayed in massive quantities, polluted runoff into surface and groundwater presents a recurring problem, and the spray pollutes the air. EPA's proposed rules attempt to address the land application of manure from CAFOs. However, to do so adequately, the regulations must ensure that manure from CAFOs is applied in a manner that protects the environment and public health. The multitude of environmental risks associated with sprayfields should be comprehensively evaluated.

Rather than allowing manure to be sprayed onto fields, EPA should require that manure that is land applied be injected or incorporated into the soil. Manure should be applied at the rate at which it can be absorbed, and the rate should be based on the most limiting nutrient–whether that is nitrogen or phosphorus–found in recent soil tests. Manure should not exceed safe levels of pathogens, metals, salts, or antibiotics. Manure application should be prohibited in sensitive areas, including floodplains, wetlands, areas that drain into groundwater and drinking water sources, areas close to waterbodies, and highly erodible lands. Finally, manure should not be applied to saturated or frozen ground.

All of the requirements listed above should be explicitly mandated in Clean Water Act NPDES permits, not just in a self-drafted, largely unenforceable nutrient management plan. EPA should also require feedlots meeting the current animal unit threshold to obtain a Clean Water Act permit. All the loopholes that have allowed the majority of large feedlots to evade permitting requirements for almost three decades should be eliminated.

CONTROL ALL CAFO POLLUTION

Control All Surface Water Pollution EPA's primary focus on direct discharges into surface water ignores the harm from the lagoon and sprayfield system on air quality, even when air pollutants degrade surface water quality. Up to 80 percent of a lagoon's nitrogen escapes into the air either from the lagoon or during land application as ammonia, which is then deposited into streams or coastal waters and causes fish kills and algal blooms.[7]

The agency also directs little regulatory attention to groundwater quality, though seepage from lagoons and sprayfields is a major public health concern. In many places, groundwater connects with surface water or is used for drinking water. Numerous studies have found groundwater impacts from the use of lagoons due to events such as wet/dry cycles, worms, roots, and freeze/thaw cycles.[8] In 1996, the Centers for Disease Control linked the high nitrate levels in Indiana well water near feedlots to spontaneous abortions in humans.[9] EPA should require monitoring and controls to prevent groundwater contamination of surface water.

EPA Should Address All Clean Water Act Pollutants The regulatory action focuses almost exclusively on nutrients, ignoring resistant bacteria, antibiotic residues, and other pollutants in manure than can cause gastroenteritis and other illnesses. Though swine manure contains 100 to 10,000 times the number of pathogens in crop-applied hog waste than are allowed in treated human waste, lagoons are not designed to reduce concentrations of these pathogens.[10] Yet EPA's proposed standards for land application do not even address pathogens. EPA should set limits for pathogens and heavy metals in land-applied waste, as it does now for sewage sludge, and also require reductions in the levels of other pollutants. Discharges from land application areas should be considered violations of a Clean Water Act permit.

In addition to ensuring that the technologies that the agency recommends do not harm surface water, directly or indirectly, the agency should also provide an incentive to facilities that take proactive steps to minimize other impacts on the environment. Under this approach, multi-media permit holders that agree to monitor and control all discharges into air, water, and groundwater in advance of federal requirements would obtain benefits like a longer compliance period or a longer permit term.

Finally, EPA should join other federal agencies in a comprehensive examination of the multiple problems generated by concentrated, industrialized animal production systems. This review should include the costs and risks imposed on society and the federal subsidies expended in promoting these systems. Where EPA lacks legal authority under the Clean Water Act to address CAFO pollution, EPA should evaluate other legal avenues, including use of the Safe Drinking Water Act and the Clean Air Act.

ENDNOTES

Chapter 1—Factory Farm Pollution is a Growing Problem

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