POULTRY WATER QUALITY HANDBOOK

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U. S. A.

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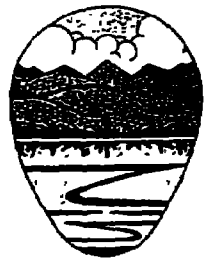
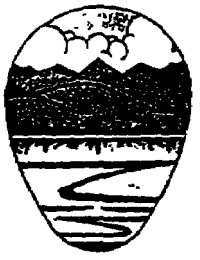
CONTENTS



PREFACE



Another New Venture for Southeastern Poultry & Egg Association

The environment and our natural resources form one of the cornerstones of our quality of life. Every industry, every company, every individual has a giant stake in the environment.

The poultry industry recognizes the significance of our natural resources and the importance of conservation and the protection of the environment. The growth and progress of the U.S. poultry industry have been phenomenal. However, rapid advancement has brought challenges that are often too complex to be solved easily or quickly. Answers are sometimes long-term and require deliberate, progressive action. Some solutions are environmentally related.

Southeastern Poultry & Egg Association understands the challenges that come with progress, particularly those that impact the environment. Industry leaders who make up Southeastern's Board of Directors, in yet another new Association venture, teamed up with key federal agencies — USDA Soil Conservation Service, Tennessee Valley Authority, and U.S. Environmental Protection Agency — to work on water quality issues related to the poultry industry The Poultry Water Quality Consortium is a cooperative effort to identify and adopt environmentally prudent uses of poultry by-products. The objective: to use by-products as a resource.

However, success requires teamwork: the combined efforts of people and organizations, industry and government. No one is excluded from responsibility, not farmers, service providers, company management, or government officials

This handbook is one part of a new and vital enterprise The goal is to consolidate information, ideas, and references to enhance water quality As this joint venture between industry and government continues, the handbook will be revised and updated to include new technology and techniques that will ensure the quality of water for everyone

ACKNOWLEDGMENTS

The *Poultry Water Quality Protection Handbook* was prepared under the direction of the Poultry Water Quality Consortium members, assisted by Ed Schwille, Liaison, with invaluable coordination provided by James M. Ransom, Tennessee Valley Authority, Muscle Shoals, Alabama; Richard D. Urban, Tennessee Valley Authority, Chattanooga, Tennessee; Harvey I. Mack, USDA Soil Conservation Service, Washington, D.C.; Ira H. Linville, U.S. Environmental Protection Agency, Atlanta, Georgia; and Richard D. Reynnells, Cooperative Extension Service, Washington, D.C. References to source material are shown on the information sheets in the handbook.

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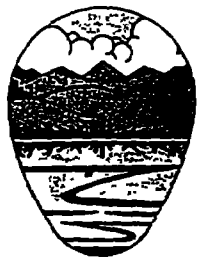

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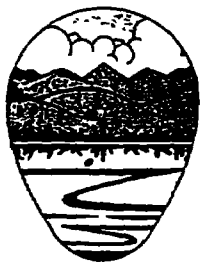


Poultry Environmental Issues and Impacts

In the United States, poultry is a major source of agricultural income. In 1992, the industry contributed over $12 billion to the economy of this nation. During the same period, U.S. exports exceeded 207 million pounds of poultry products, and U.S. per capita consumption of poultry reached 37.3 pounds per annum. Some 75,000 growers are involved in producing over 6.4 billion broilers, 269 million layers, 69 billion eggs, 285 million turkeys, and 20 million ducks, and recent estimates conclude that another half-million people are employed in hatcheries, live-bird processing plants, feed mills, and other allied operations serving the poultry industry. Both genetics and efficiency contribute to this magnitude of production.

These figures, which are projected to increase 5 percent each year into the future, are impressive, however, they also come with a yearly legacy of some 20 million tons of poultry manure and litter, over 50 million dead and unused carcasses, and over 50 billion gallons of water from hatchery, layer, and live-bird processing operations. These by-products must be safely disposed of or used. The challenge is where and how to use these poultry wastes to benefit the grower and the environment.

Traditional uses for poultry by-products are not always sufficient Expanded or new uses for poultry waste have been found, such as enhanced fertilizers, horticultural and mushroom growing medium, and feed products for livestock, dogs, cats, and aquaculture. Indeed, a continuing search for additional uses is part of the challenge.

Protecting water quality, the environment, and the natural resources of this nation is a commitment of the poultry industry and growers. The industry shares responsibility with other segments of the agricultural community and other human activities for nonpoint source pollution: the pollution that originates from diffuse sources (e.g., stormwater runoff). Some industry practices could contribute to point source pollution: the pollution that issues from a known or direct discharge (e.g., from the end of a pipe).

One must understand the complexity of poultry operations when addressing water quality and environmental issues. The industry can be separated into hatchery, breeder, broiler-roaster-Cornish (meat types), turkey, egg, duck, and other poultry and live bird processing operations. Each of these operations produces either dry or liquid waste and dead birds Environmental awareness has shifted beyond live-bird processing plants (offal, feathers, and wastewater) to the grower

As any poultry grower knows, the speed, efficiency, and methods used to produce poultry and poultry products have changed drastically over the past 20 years As a result of rapid growth, most poultry are grown in confined operations with limited use of water, except for drinking water for the birds. The expansion of the industry coupled with concentrating the growing operations has created a unique challenge — that of proper disposal of immense quantities of waste. It is important for producers and others to understand how poultry waste can pollute the environment. Each individual operation is different, yet many of the problems can be prevented or solved through proper waste disposal methods and changes in management and production methods during the production cycle.

It is important for producers to know (1) what is in the waste that must be disposed of; (2) how much waste is expected to be generated; (3) what are the impacts of the waste on water quality, the environment, and human health; (4) how these materials can get into the water; and (5) how to manage the waste in an environmentally safe manner.

The most overriding environmental issue facing growers today is the impact that poultry waste can have on water quality. Potential water pollutants from on-farm poultry operations can be classified as (1) nutrients and salts, (2) organic materials, (3) bacteria, and (4) viruses. These pollutants originate from manure and litter and dead birds improperly handled. How the waste is disposed of, treated, or managed has a direct influence on the cleanliness of surface and groundwater.

Properly managed poultry wastes from manure, litter, dead birds, and wastewater are profitable farm investments. An effective waste management plan provides for the proper collection, storage, handling, and use of poultry waste. Products derived from wastes reduce chemical fertilizer costs, improve soil quality, and protect water resources, air quality, and human and animal health. Effective waste management promotes a favorable public attitude toward the industry.

Disposing of dead birds is an increasing problem. Daily numbers and poundage of dead birds can be dictated by the birds' age and weight, the number of birds in the poultry house, and climatic conditions. Acceptable methods of disposal include (1) burial, (2) incineration, (3) composting, and (4) rendering. Burial pits may have severe environmental limitations in areas of porus or fractured soils that would allow leaching of nutrients to groundwater. Incineration has some limitations: the possibility of air pollution and fuel and labor costs.

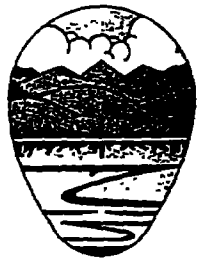
Many progressive growers are switching to composting or to rendering as preferred solutions from an environmental and economic viewpoint. A grower must choose a method compatible with his or her individual opera-

Figure 1.—Poultry cash receipts (in dollars).

tion and company preference. Dead birds must be treated as a resource that can add value to a grower's operation. Improper methods of disposal are unacceptable and cannot be condoned.

State regulations and permitting requirements vary from state to state and may be more stringent than national regulations. In general, environmental needs are site specific and regional in nature. Local sources of information, including industry associations, appropriate state agencies, soil and water conservation districts, and the USDA Soil Conservation and Cooperative Extension Service offices, should be consulted to ensure that your waste management plan complies with all state and federal regulations.

There is not a single best or optimal approach to protect or preserve water quality and the environment. Good waste management practices are essential if the poultry industry is to continue to grow and thrive under today's environmental challenges. The remainder of this handbook relates to the management of poultry wastes, mortalities, and wastewater Information sheets on these topics provide management "guidance" to help poultry producers make sound environmental decisions; additional fact sheets discuss other environmental issues and alternative technologies, and sources of assistance are provided in the section on Resource Information (RI). Producers are encouraged to seek assistance from the appropriate state and federal agencies, private consultants, and other professionals on how to implement waste management techniques that protect water quality and the environment.



PROTECTING THE ENVIRONMENT AND WATER QUALITY

Protecting natural resources is a major goal of the agricultural community in general, and poultry producers in particular, who care about the environment. The quality of our air, soil, and water resources, the welfare of our animals, and human health issues are important to us and to our children; they are our connection to the future. Water quality is the most important environmental concern of the poultry industry.

Environmental protection begins with awareness. We have to know what's at stake when we read or hear about water quality and conservation, or that high concentrations of nitrates or other contaminants have been found in surface and groundwater. We need to understand how the industry's waste management affects water quality. Above all, we must be able to assess the opportunities we have, as private producers and as an industry, to meet these environmental challenges head on

Poultry growers and the industry must be concerned about the quality of water that comes into and flows from their farms or plants The industry's first concerns are those that everyone shares: Does the water we use support our needs? Is it drinkable (potable) and palatable? What does it cost to supply water to our homes and businesses? Would additional costs for water treatment ensure its safety for our use?

Where the Water Is

Water covers 70 percent of the earth's surface, but only 3 percent of the earth's water is usable by plants, animals, and humans. Usable water exists either as surface water or groundwater. Surface water is the runoff that flows above ground through rivers, streams, and springs until it eventually drains into the sea or oceans. The land area that collects runoff in defined locations is called a watershed, and no matter how far one lives from the water, everyone lives in a watershed (see Fig. 1).

Groundwater is water that percolates through the soil or enters the earth's subsurface through sinkholes, permeable soils, and fractures in rock formations. The underground water formation is known as an aquifer within which the groundwater moves in various directions. Some aquifers are several hundred feet deep while others lie near the surface of the earth. The upper level of shallow aquifers is called the water table. It rises and falls depending on how dry or wet the season is, or how much groundwater is extracted for use

Water is a renewable resource, therefore, surface and groundwater are constantly being replenished But water can also be used up faster than it can be renewed or, in the case of groundwater, "recharged." Groundwater recharge is enhanced by limiting runoff. Human activities that speed runoff or add contaminates to surface and groundwater must be controlled. Land sediments, animal wastes, pesticides, detergents, oils, and grease are some of the human contributions to poor water quality

Understanding Water Pollution

Strictly speaking, pure water does not exist. Even rainfall contains gases, dust, and ions acquired from the air. In fact, water (a molecule containing two hydrogen atoms and one oxygen atom) is a solvent; its ability to dissolve

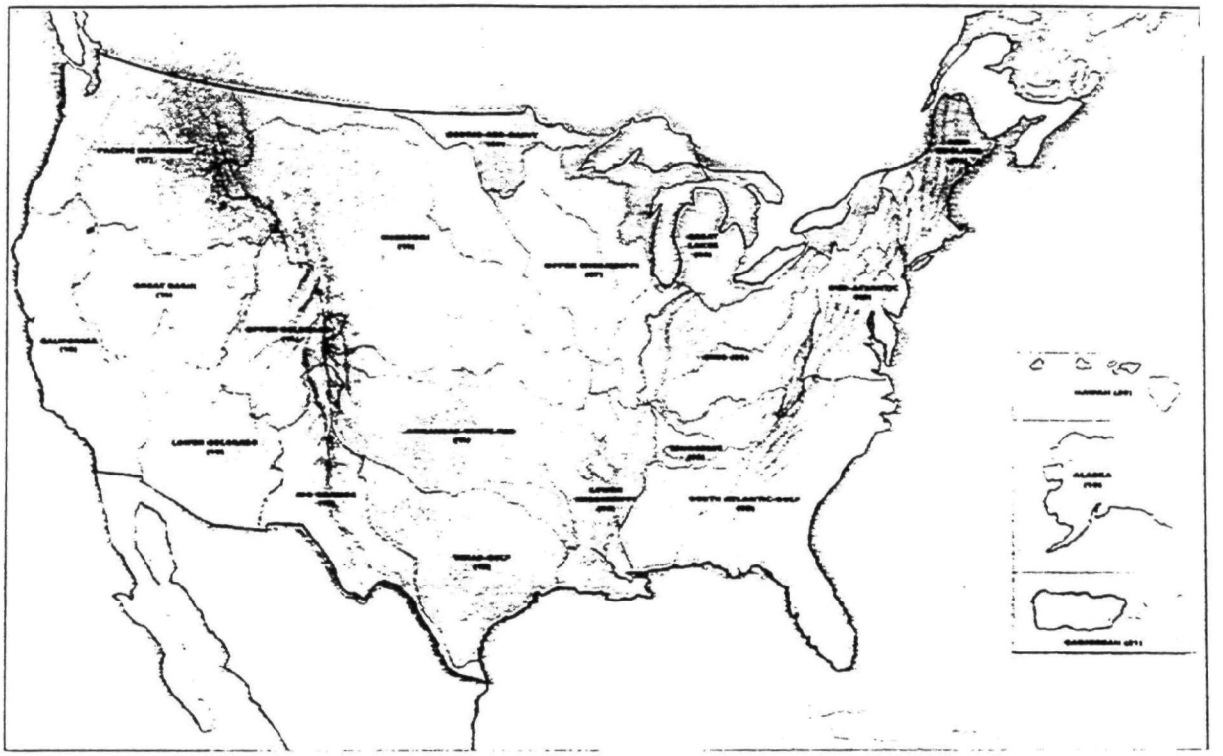


Figure 1.—U.S. Watershed Regions (Brown and Caldwell).

substances is essential to plant and animal life. Most of the substances, elements, or compounds that we think of as pollutants are also found naturally in water: nitrogen, phosphorus, potassium, calcium, magnesium, sodium, bicarbonate, chloride, sulfate, carbon dioxide, oxygen, and some heavy metals. But when one or more of these substances is found in excessive amounts, the water's use is impaired and the water may be considered polluted.

Potentially polluting substances, sometimes called dissolved substances or solids, can be organic or inorganic, and they occur in natural interaction among the elements of earth and sky. Their effects include color (or lack of clarity) and offensive taste and odor. They can be added to the water during industrial, agricultural, silvicultural, land development, or other activities that serve human needs and pleasures. In the poultry industry, for example, components of manure, dead birds, and wastewater include nutrients that may be released to water through direct discharge, excessive runoff from the land, or leaching through the soil.

We expect, then, to find some dissolved substances in water; however, water's properties are degraded — its quality impaired — if it contains chemical, biological, physical, or radiological substances in sufficient quantity to restrict its use. Water quality standards defined by the U.S. Environmental Protection Agency (EPA) identify what substances must not appear in water and at what concentrations other substances may be permissible under certain conditions. Tests or analyses performed on drinking water, surface, and groundwater illustrate the complexity of the issue.

✔ This information sheet has introduced the topic of water quality. Poultry growers and others should always check with local health agencies or state departments of environmental protection or similar agencies to ensure that they have access to current water quality criteria and standards applicable to their location. Water quality criteria are published in the Federal Register as they are developed.

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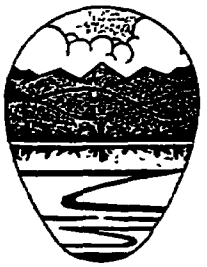

What Is Water Quality

Public domestic water supplies are regularly tested or analyzed for pollutants or contaminants. The results can be obtained from local health departments or appropriate state agencies. Private water supplies or wells should also be analyzed.

The most common tests for water quality analyze (1) pH (the level of hydrogen ions in the water), (2) total alkalinity, (3) total hardness, (4) salts, (5) chlorine, (6) dissolved oxygen, (7) metals, and (8) pathogens. Sometimes water needs to be tested for heavy metals, such as lead, mercury, or zinc, or for toxins, such as DDT or Atrazine. In some areas of the country, tests for radiological contaminants may be needed The following parameters are used to test water's chemical properties.

- The measure of pH in water determines its acidic or alkaline quality on a relative scale (For example, in a solution of hydrochloric acid, the pH is 3, for sodium hydroxide, it is 12) In water, on a scale from 0 to 14, a pH measure of 7 is neutral, for drinking water for humans and animals, the desirable measure of pH is 6 5 to 8

- The total alkalinity of water is a measure of its capacity to neutralize acidity, which is usually expressed in milligrams per liter of calcium carbonate (mg/L of $CaCO_3$) Natural waters may have less than 50 or as many as 500 mg/L of $CaCO_3$). These variations may be affected by the rocks and soils that the water passes through. The alkalinity varies with pH and hardness, but sudden fluctuations may indicate a contaminant.

- Water also contains total dissolved solids (TDS) and minerals. TDS represent the soluble mineral or salt content of water, especially calcium, magnesium, sodium, chloride, sulfate, bicarbonate, and silica. These substances, if excessive, can affect industrial processes, and their presence in water is frequently associated with discharge from industrial operations. TDS also affect the germination and growth of plants and the palatability of drinking water. Some minerals are desirable for their beneficial properties. Drinking water should not have more than 500 mg/L of TDS and irrigation waters may have up to 1,500 mg/L of soluble minerals

  Hard waters contain so much calcium and magnesium that it is difficult to make soaps lather. When heated, hard water forms scale or deposits that we see on cooking utensils and water pipes. Water softening solves the hard water problem but may increase the amount of sodium in the water — a possible danger to people on low sodium diets Sodium in drinking water should be limited to about 20 mg/L.

  Total iron (suspended and dissolved) causes problems in water if it exceeds 0 3 mg/L. High iron levels impart a reddish brown color to water or a bad taste to cooked foods and may restrict growth in turkeys.

  Chlorides in water should not exceed 250 mg/L; otherwise, the water may have a salty taste. High chlorides may also indicate pollution from sewage or other sources.

  Sulfates, which should not exceed 250 mg/L, are caused by the leaching of natural deposits of magnesium sulfate

(Epsom salts) or sodium sulfate (Glauber's salt). These salts are undesirable because of their laxative effects.

Nitrates (NO_3-) and nitrites (NO_2-) pose health problems to animals and humans, including poultry. Their presence in surface or groundwater in large amounts may indicate that someone has overfertilized a field or allowed a septic tank system failure. Nitrate levels in drinking water should not exceed 10 mg/L; and nitrites, which convert to nitrates, should not exceed 1 mg/L.

- Chlorine gas and other chlorine compounds are powerful disinfectants and oxidizing agents. Chlorine should be limited in drinking water to no more than 0.05 mg/L; however, there must be a small chlorine residual in drinking water to assure that it is disinfected.

- Dissolved oxygen (DO), which is vital for aquatic life, can be a key test for water pollution. At DO levels below 3 mg/L, fish may become stressed or die. Generally, in unimpaired waters, dissolved oxygen ranges from 7 to 14 mg/L. However, DO levels approaching 14 mg/L on sunny days may indicate high density algae growth and possible nutrient enrichment (pollution).

Usually, among these parameters, only pH, total iron, DO, and nitrates/nitrites have reference to poultry. Nevertheless, careful and complete monitoring of private water supplies and wells is a must because they provide drinking water for home and poultry operations. When the chemical properties of water exceed acceptable limits for intended uses, water quality is impaired.

Biological Properties

Private water supplies should also be tested once or twice a year for any sign of coliform bacteria. The test for fecal coliform bacteria can differentiate between the bacteria found in soils and plants and the bacteria found in warmblooded animals. Common symptoms of coliform bacteria in humans are intestinal bloating and diarrhea.

Other bacteriological tests can identify many kinds and numbers of bacteria in water, but they do not separate harmful and harmless bacteria. Tests for Fecal Streptococci, Shigella, Salmonella, Staphylococci, and other bacteria may be necessary under certain circumstances. These tests are specific, time-consuming, and expensive. They isolate bacteria that cause typhoid fever, eye and ear infections, dysentery, boils, or other skin diseases. There are also tests for viruses, protozoa, and parasites.

In surface waters, aquatic vegetation and microscopic animal and plant life may be stimulated or retarded by various water quality factors — pH, nutrients (nitrogen and phosphorus), and turbidity, among others. But growth and decay cycles may have side effects that adversely affect the water quality. Even helpful substances can become harmful in overabundance; for example, organic nitrogen in animal wastes and soils can cause "nutrient loading," which results in low DO levels and eutrophication (i.e., an overly productive waterbody.)

Physical Properties

Physical characteristics of water include turbidity, color, tastes, odors, and temperature. The presence of foam is an indicator of dissolved organic substances, perhaps raw sewage. Suspended particles may cloud the water, and dissolved substances may alter its odor or taste. Turbidity or cloudy water may indicate the presence of sediments, which reduce light penetration. Color affects quality and can be aesthetically displeasing. Taste and odors can result from dissolved metals, gases, or chemicals.

Radiological Properties

Some radioactivity in water, food, and air is natural. However, if higher levels than usual are suspected, the appropriate state agencies should be notified.

Without efficient management of poultry waste and dead birds, poultry operations could become a source of excess nutrients, disease-causing bacteria or viruses, and dissolved substances in our nation's surface and groundwater supplies. Proper waste management will enhance the quality of water for everyone.

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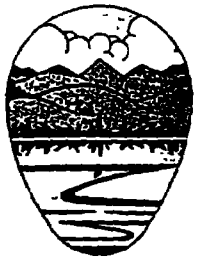

Poultry Production and Water Quality

Every year, the poultry industry produces about 20 million tons of manure/litter, 50 million tons of dead birds, and 46 billion gallons of wastewater. What happens to these by-products can be good or bad for the industry and for the environment.

On the one hand, poultry wastes can do a lot of good. They can be used as fertilizer, soil enhancers, cattle feed, or energy. Poultry producers can add value to these products — and prevent them from contaminating surface and groundwater — by using proven, acceptable methods of collection, storage, handling, disposal, and management. All such beneficial uses depend on proper management. Without such management, the value of the waste rapidly declines, resulting in its greater potential for adversely affecting the environment and water quality

To control and prevent pollution, poultry growers need to understand how these values can be enhanced and maintained and how the wastes may contribute to point and nonpoint source pollution. The value in poultry by-products and their potential to cause water pollution have the same source. That is, the wastes and dead birds contain elements of the following categories: nutrients and salts, suspended materials, products of biological reactions, and microorganisms These elements can be beneficial to the grower and other farmers, or they can be harmful to the environment.

Nutrients and Salts

Poultry manure is a valuable nutrient for grain and fiber crops, forage crops, fruits, and vegetables. However, if manure, litter, dead birds, and/or wastewater are not properly protected, water contamination can occur from the premature release of nitrogen and phosphorus into the environment.

Nitrogen is an essential plant nutrient but, in excess, it can be harmful. High concentrations of nitrate (dissolved nitrogen) in drinking water can affect human health, especially in infants and children. Ammonia in small quantities is toxic to fish and aquatic organisms.

When nitrogen and phosphorus concentrations in waterbodies rise too high, algae and rooted aquatic plants take over, prematurely aging and choking the waterbody and creating undesirable conditions — odors, offensive taste, and discoloration — all of which can make the water unfit for consumption or recreational and aesthetic use. Further, these eutrophic conditions can kill fish, clog water treatment plant filters, and lead to the growth of blue-green algae, a species that can be fatal to livestock.

Because nitrate-nitrogen is highly mobile, it can leach into groundwater and flow with stormwater runoff into surface waters. If too much poultry manure and litter are used as fertilizer, nitrogen and phosphorus concentrations in nearby waters are likely to be high Soil erosion also increases the amount of phosphorus in surface waters. Excessive phosphorus in soil, above 800 mg/L, may become soluble and move into groundwater.

Calcium and sodium salts are added to poultry feeds to help the birds maintain chemical balance and nutrition. Excess salts pass through the animals and are eliminated in manure. Sometimes, when the waste accumulates, the salts leach into groundwater and enter

surface water through unprotected runoff. There they alter the water's taste or harm freshwater plants and animals.

Suspended Materials

When suspended matter from poultry wastes reach surface water, the waterbody not only looks unattractive — the quality of the water invariably suffers. The suspended material reduces the penetration of sunlight and therefore slows the production of oxygen. The result is an oxygen demand that reduces the levels of dissolved oxygen in the water. It also clogs fish gills, makes it difficult for sight-feeding fish to find food, and settles over fish spawning areas.

Products of Biological Reactions

In a natural environment, the breakdown of organic matter, such as poultry waste, is a function of complex, interrelated, and mixed biological populations. All substances of animal or vegetable origin contain carbon and are, therefore, organic. Organic matter is converted to simple compounds by naturally occurring microorganisms. These simple compounds may be other forms of organic matter or they may be nonorganic compounds or gases, such as nitrates, orthophosphates, ammonia, and hydrogen sulfide. A biological reaction occurs when manure or other organic matter is added to water and aerobic organisms (oxygen requiring organisms) begin the decaying process. The bacteria consume free oxygen and produce carbon dioxide gas. Under anaerobic conditions (without oxygen), methane, amines, and sulfides are produced.

Microorganisms

Desirable and undesirable microorganisms live in our environment. Animal waste is a potential source of some 150 disease-causing organisms or pathogens. These organisms include bacteria, viruses, fungi, protozoa, and parasites. Examples of undesirable microorganisms include Salmonella, Listeria, coliform, New Castle (virus), ringworm, coccidiosis, and Ascaris.

When found in water or wastes, these pathogens pose significant threats to humans and other animals. They can infect humans and animals through drinking water, contact with the skin, or consumption of fish or other aquatic animals.

Most pathogens die relatively quickly. However, under the right conditions, they can live long enough to cause problems. They may persist longer in groundwater than in surface water.

✔ Producers can prevent poultry by-products or waste from contaminating water. However, environmental needs are site specific and regional in nature. In some cases, state regulations and permitting requirements may be more stringent than federal regulations. Therefore, local sources of information, including industry associations, state departments of environmental protection and public health, and USDA Soil Conservation Service and Cooperative Extension Service offices should be consulted about poultry waste or by-products that affect water quality.

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UNDERSTANDING WATER QUALITY REGULATIONS

As the poultry industry grows, so does concern for water quality, conservation, and management of our natural resources. Growers have individual and civic reasons for caring: you are responsible, with other human beings, for the earth's environment and — more personally — you realize that you, your families, and neighbors all drink the same water. Pollution is intolerable whether it is detected in your own land and water, or after it has traveled many miles downstream from the source. The arithmetic is simple: good environmental stewardship reduces the costs of production, reduces water pollution, saves natural resources, and makes good neighbors.

Changing Attitudes

It is important to note that most federal regulations are delegated to states. In some few cases, double jeopardy may exist — the effect of combined federal and state regulations Because states monitor water quality resources, poultry owners must check with state and local agencies before setting up compliance programs Often the states are more stringent than federal enforcement requires. Engineering and government consultants can help growers know, understand, and comply with the regulations in their area.

Reasons to change personal attitudes toward water use and conservation have less to do with regulation than with management. Growers want a good public image, cost reductions, efficiency, and compliance. Most operations have discovered a workable slogan and a reasonable directive in "pollution prevention pays." Making pollution prevention changes can bring a big return on investment; however, they should also be made with an eye on the best ways to protect the environment. For example, we should

- prevent the generation of wastes where possible;
- recycle wastes that cannot be prevented;
- pretreat wastes to eliminate possible contaminants; and
- dispose of unusable wastes properly as a last resort.

Water quality concerns for the poultry industry include

- protection of water quality through management of soil erosion, waste, nutrients, and pesticides;
- the continuing availability of water in sufficient quantities for washing, making brine, cooking, cooling, cleaning, processing, conveying, and sanitation; and
- the safe disposal and use of wastewater and other wastes

Management commitment and awareness, scientific research and common sense, and in some cases, new installations and equipment are needed to protect the availability and quantity of our natural resources. The scope of the problem is global, national, and industry-wide; cooperation among agencies, associations, and individuals speeds the development of technology and its transfer, and creates a participatory environment that encourages the search for solutions.

Difficulties encountered in the 1950s and 1960s often resulted from an absence of water quality standards and confusing, contradictory, or nonexistent national effluent limitations. These difficulties have been remedied by national legislation and regulations that are often administered by the states. Federal legislation for controlling water pollution that has developed over the past two decades illustrates the national commitment to develop and implement a strategy that will lead to cleaner air and water.

Point and Nonpoint Source Pollution

For best management, water pollution sources are divided into two groups depending on their point of release. Point source pollution has a known origin, such as a pipe or storage tank. Nonpoint sources of pollution are dispersed, harder to pinpoint, and cumulative. They include land uses, such as human activities, that are potentially significant because they occur in high densities. Agriculture, mining, forestry, septic and other waste disposal systems, and urban runoff are examples of nonpoint source pollution.

Poultry growers must know how to manage point and nonpoint sources because waste handling and disposal may contribute to nonpoint sources of pollution; while concentrated animal feeding operations (CAFOs), including some large poultry houses, are regulated as point sources of pollution. Federal law generally forbids point source discharges, that is, the discharge of any pollutant or contaminate to "waters of the United States." States administer the federally mandated National Pollutant Discharge Elimination System (NPDES) program. This program requires dischargers to have an operating permit before discharging potentially contaminated wastewater into streams, ponds, waterways, sinkholes, drainage ditches, or groundwater.

Practices that protect surface water include diverting off-site drainage around the feeding facility and constructing storage for manure and process-generated wastewater. Adequate runoff storage should be included in the design. Lagoons or holding ponds should be built to hold a 25-year, 24-hour duration storm

Managing Nonpoint Source Pollution

The extent and importance of nonpoint sources have been more fully realized in the last decade. But nonpoint sources are so diffuse that they are usually assessed locally on a stream-by-stream basis and controlled by best management practices (BMPs). BMPs are routine methods of animal and crop farming that also control stormwater. That is, they are farming methods that control or eliminate the potentially harmful effects of agriculture on runoff.

Compliance Issues

Water quality legislation has teeth. Section 309 of the Clean Water Act establishes criminal penalties for failure to comply with the regulations. The threat of prosecution can be a first step in forcing compliance; the charges can range from minor infringements or negligent actions (lightly punished) to more serious charges of conscious violations and knowing endangerment. Knowing and willful endangerment and outright falsification are the most serious charges

In short, point source wastewaters that leave a poultry house or plant must comply with the national effluent levels A pretreatment program may be necessary Some poultry operations have discovered that running their own pretreatment plants, though expensive, can be more efficient than other methods of compliance

The U S Environmental Protection Agency now uses audits to determine how and why publicly owned treatment works are not in compliance. Recent regulations (in 40 C R F Part 403) concern pretreatment.

- Pollutants that would interfere with the operation of the publicly owned treatment works or cause fire or explosive hazards are not permitted.
- No pH levels lower than 5.0 are allowed.
- Solid or viscous pollutants are monitored.

▼ High levels of biological oxygen demanding substances (BOD) are regulated as are oils, grease, and toxic gases.

The poultry industry should, therefore, take an active part in pretreatment programs.

Current Developments

The Clean Water Act was amended in 1987 and is scheduled for further amendment and reauthorization in 1994 or 1995. The original legislation (and NPDES program) was mainly concerned with industrial wastes; the later amendments have placed, and will continue to place, more emphasis on controlling nonpoint sources of pollution (urban and agricultural runoff).

Since 1987, nonpoint source pollution has been recognized as a major contributor to surface and groundwater contamination. In addition, permits have been required since 1972 for concentrated animal feeding operations.

Poultry growers and processors should be concerned beyond the short-term availability of water resources. But a change in our attitude about water use depends on cooperation, knowledge, and commitment to quality, efficiency, and environmental protection.

✔ Federal regulations are administered in most cases by the states, whose regulations and permitting requirements vary and may be more stringent than national regulations. Please consult local sources of information, including industry associations, state departments of environmental protection and public health, and USDA Soil Conservation Service and Cooperative Extension Service offices, to ensure that your waste management activities comply with all regulations and ordinances.

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Environmental Impacts of Poultry Waste

Agricultural activities, including the production of poultry wastes, may be increasingly responsible for contributing excess nutrients (especially nitrogen and phosphorus) to our water resources. Nutrient management planning in conjunction with land applications can reduce or eliminate this excess and contribute to more productive farming by helping farmers apply only as much nutrient to the soil as the plants can use. Most problems can be controlled if the grower knows how nutrients and soil interact and plans accordingly.

Nitrogen, phosphorus, and potassium move through cycles on a farm. As nutrients, they go from crops to animals (in feed) to the soil (waste applications) and back again to other crops If the cycle holds, everything works as it should. But if too many of these nutrients are already in the soil or too much waste is applied to the land, they can move with the soil into surface water or through the soil into groundwater until their presence in the water reaches unacceptable levels, that is, is sufficient to impair water quality

Nitrogen

Of the three major nutrients in poultry waste, nitrogen is the most complex and likely to contribute to environmental problems. Most of earth's nitrogen exists as nitrogen gas in the atmosphere (see Fig. 1). It can be transformed into inorganic forms by lightning or into organic forms by plants, such as soybeans, alfalfa, or clovers. Nitrogen can also be transformed into inorganic forms (commercial fertilizers) by energy intensive processes.

Most of the nitrogen found in animal wastes is organic nitrogen. A smaller amount of the nitrogen in litter is ammonium. Organic nitrogen can be mineralized or converted by soil bacteria into inorganic nitrogen, the form in which nitrogen is available to plants. Excessive organic and ammonium forms of nitrogen are transformed in the soil into nitrate nitrogen (that is, into water soluble nitrogen).

Losses of nitrogen from the cropping system can occur as a result of surface runoff and leaching. Surface runoff can move dissolved nitrogen (especially nitrate), ammonium nitrogen attached to eroding soil particles, and organic nitrogen contained in organic or plant residues into streams and lakes. Nitrates move with the soil or leach through well-drained soils past the root zone into the groundwater supply

High levels of nitrate can be toxic to human health, especially newborns Nitrate can reduce the blood's capacity to carry oxygen or cause internal suffocation Scientists tell us that too much nitrate can affect the weight, feed conversion, and performance of poultry Too much nitrogen in surface water can kill fish and cause the water to be less productive

Phosphorus

Poultry wastes also contain significant amounts of phosphorus (Fig. 2) Phosphorus, like nitrogen, is essential for plant and animal growth, however, if it is used improperly, phosphorus can also contribute to environmental and water quality problems It can be a major cause of water quality degradation in surface waters.

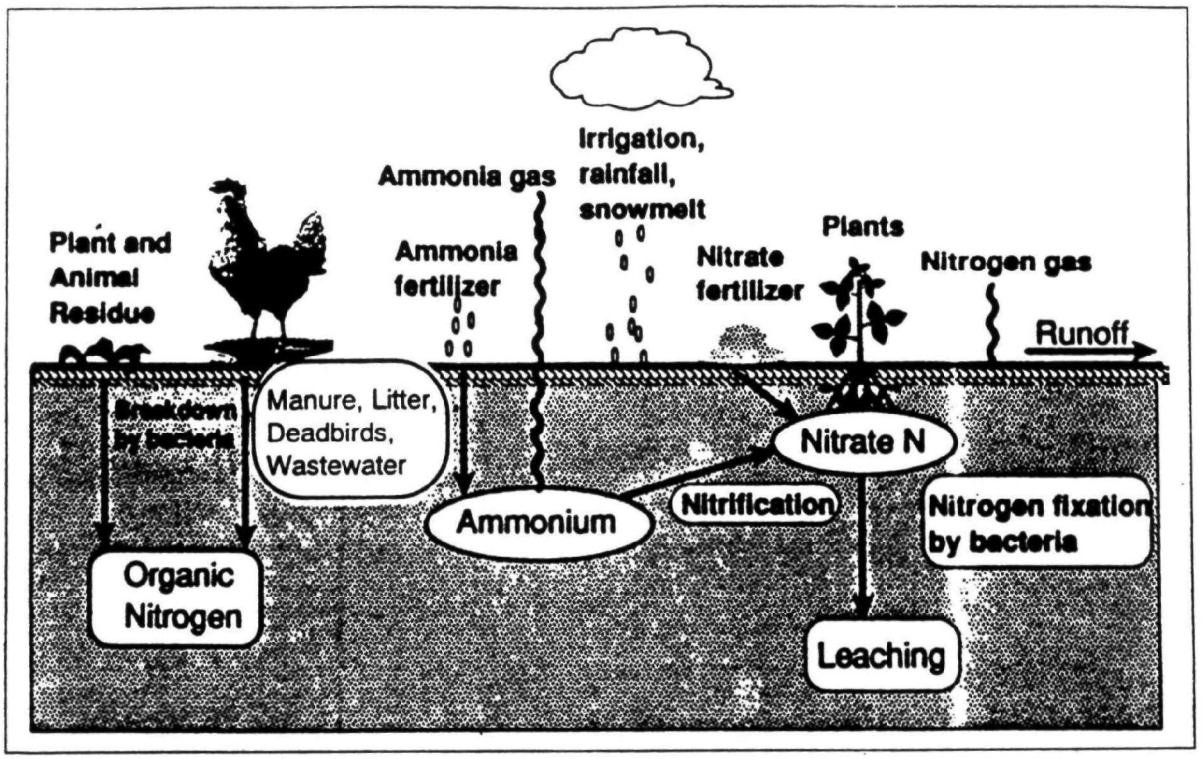

Figure 1.—The nitrogen cycle.

Phosphorus exists in either dissolved or solid form. Dissolved phosphorus usually exists as orthophosphates, inorganic polyphosphates, and organic phosphorus in the soil. Phosphorus in the solid form is referred to as particulate phosphorus and may be composed of many chemical forms. Particulate phosphorus comes in four classifications:

- adsorbed phosphorus, which attaches to soil particles;
- organic phosphorus, which is found in dead and living materials;
- precipitate phosphorus, which is mainly fertilizer that has reacted with calcium, aluminum, and iron in the soil; and
- mineral phosphorus, the phosphorus in various soil minerals.

Approximately two-thirds of the total phosphorus in soil is inorganic phosphorus; the remaining one-third is organic. Both forms are involved in transformations that release water-soluble phosphorus (which can be used by plants) from solid forms, and vice versa.

Phosphorus-laden soil moves via runoff into rivers, lakes, and streams, where it can cause excessive plant and algae growth, which in turn depletes the dissolved oxygen content in the water. Phosphorus-enriched waters contribute to fish kills and the premature aging of the waterbody. In the end, the beauty and use of the waters are seriously curtailed. Even relatively small soil losses may result in significant runoff leading to high nutrient depositions in the water.

Controlling soil erosion and proper land application of phosphorus-containing wastes will greatly reduce the amount of phosphorus in water. Care must also be taken to prevent soluble phosphorus from leaching into groundwater.

Applying poultry waste to the land at rates based on supplying the nitrogen needs of grain or cereal crops can lead to a phosphorus buildup in the soil. Planting forage crops in rotation with grain crops will help remove excess phosphorus. Maintaining soil pH at the recommended level is also an effective and economi-

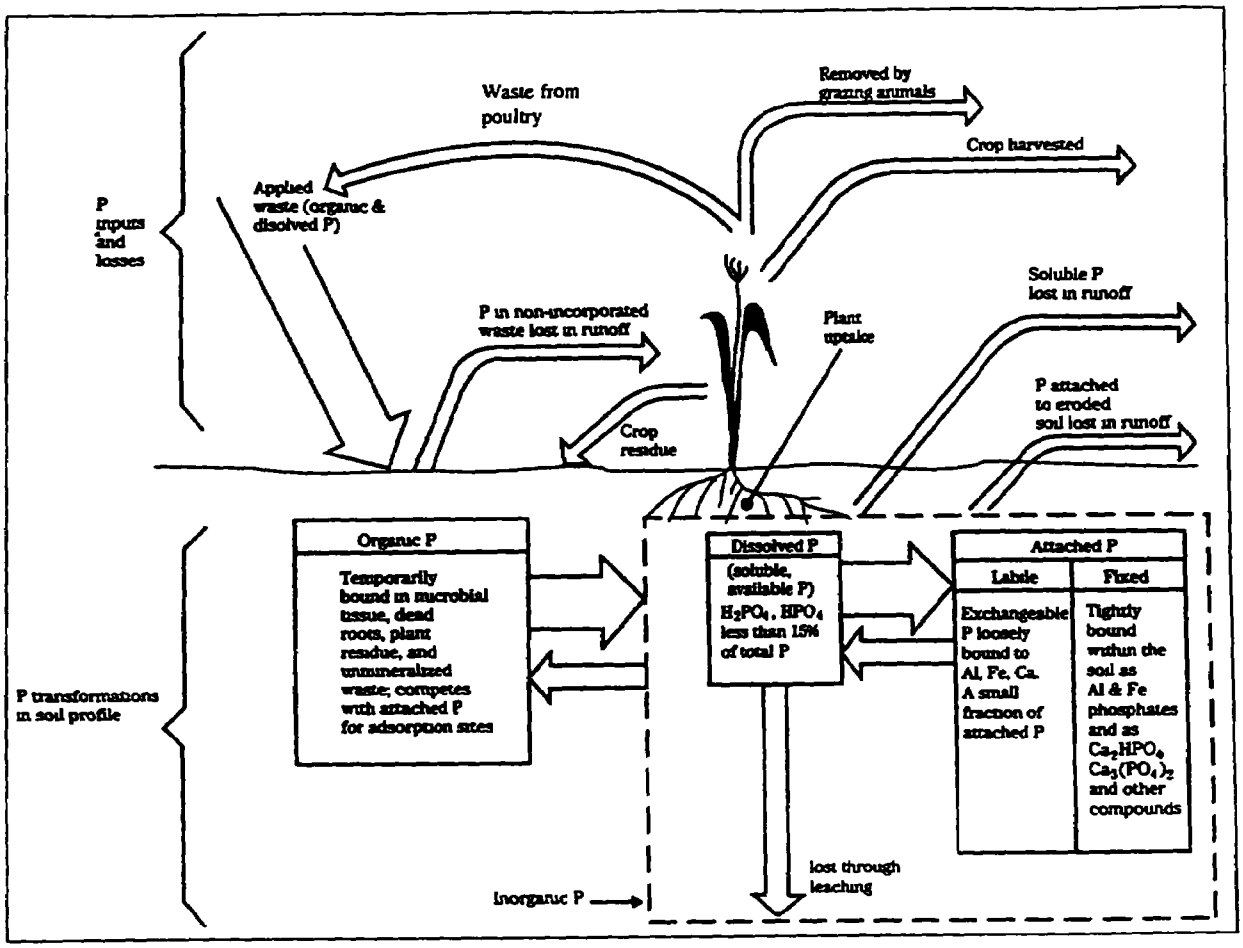

Figure 2.—Abbreviated phosphorus cycle.

cal practice for maximizing phosphorus efficiency Crops use phosphorus most efficiently when the soil pH is between 6.0 and 7 0

Soil phosphate levels are an important consideration in calculating poultry litter application rates Land applications should be made only to soils that do not already contain excessive phosphate levels. An analysis or test should be conducted on each waste source prior to land application to determine proper phosphorus application rates.

Potassium

Potassium in poultry waste is a soluble nutrient equivalent to fertilizer potassium. (Excreted as uric acid, it is combined with the feces, and referred to as excreta.) It is immediately available to plants when it is applied. Potassium is fairly mobile but does remain in the soil to help supply plant needs, for example, strong stems, resistance to disease, and the formation and transfer of starches, sugars, and oils. Excessive amounts of potassium can inhibit or restrict the growth of some plants at certain stages of development. Small amounts of potassium may be leached to groundwater, especially in sandy soils, however, potassium or potash is usually not a threat to water quality or considered a pollutant

Heavy Metals and Trace Elements

Heavy metals and trace elements, such as copper, selenium, nickel, lead, and zinc, are strongly adsorbed to clay soils or complexed (chelated) with soil organic matter, which reduces their potential for contaminating groundwater. However, excessive applications of organic waste containing high amounts of heavy metals or trace elements can exceed the adsorptive capacity of the soil and increase the potential for groundwater contamination.

Surface water contamination is a potential hazard if poultry wastes are applied to areas subject to a high rate of runoff or erosion.

Salts

Dissolved salts, mainly sodium, in high concentrations interfere with plant growth and seed germination, and may limit the choice of plant species that can be successfully grown. Poultry waste with low salt content and a high carbon to nitrogen ratio can improve soil water intake, permeability, and structure.

Using Litter Nutrients Wisely

High nitrate levels in groundwater and high phosphorus levels in surface water may be an indication that too much litter or fertilizer is being applied on too little land. Yet the fact that poultry litter is high in nutrients is precisely its value. The nutrients in this resource make it an excellent soil conditioner and fertilizer. Growers can maximize the benefits of having this resource and help protect their local water resources from high nutrient levels by planning and operating an effective nutrient management system.

Application practices will vary with the area's cropping practices, topography, and other environmental and economic conditions. Waste and soil testing are the simplest and most important aspects of nutrient management. They help farmers monitor the nutrient supply to guarantee that it is sufficient and adequately controlled to produce the best crop yields and maintain water quality.

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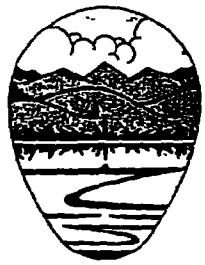

PLANNING POULTRY WASTE MANAGEMENT

Developments within the poultry industry, changes in land use patterns, and increasing restrictions or regulations on the disposal of poultry waste have significantly altered the industry's attitudes about this immense resource. Over 50 million tons of poultry waste are produced each year. Because production is concentrated in very small geographic areas, waste management planning is extremely important.

Historically, poultry growers applied poultry waste to their farms as much to dispose of the material as to use it for fertilizer. Difficulties with this practice increase with the supply for several reasons:

- Less cropland is farmed today than 20 years ago, and more poultry operations exist today
- Other resources (wastewater, composted residential waste, and sludge) are also being used for land applications, which increases competition for the remaining croplands and pastures.
- We know now that valuable nutrients — nitrogen, phosphorus, and potassium — are squandered and water resources are threatened if land applications of waste are overdone or misapplied
- Regulations regarding waste management are now enforced by many states.

Concern for water quality has been a major catalyst for the upsurge of interest in new approaches to land application. Today's growers are finding that poultry waste planning increases farm production, protects the environment, and lowers costs.

An Integrated Approach

Traditionally, poultry growers have efficiently disposed of these wastes as soon as possible by spreading the manure or litter on croplands or pasture. Now growers plan for its ultimate use, and waste management begins inside the poultry house. Along with the grower's objectives, for example, flock health,. production, and odor control; today's waste management planning must also protect water quality and contribute to a profitable farm operation. Integrating these broad objectives requires many growers to develop other options in addition to land application

Thus, to be profitable and to protect our natural resources — air, soil, water, plants, and animals — poultry growers must plan their waste management practices carefully They must base application rates and timing on soil test results and crop removal needs along with an analysis or estimate of the nutrients contained in the manure or litter

Poultry waste management planning begins before actual production and may have as many as six steps or functions (Fig 1)

The first step is to understand the waste management process. What are these wastes? How much does a particular operation produce on an annual basis? Where or how can these wastes be used? The second step, once the quantity and quality of the wastes have been determined, is to put efficient collection methods in place.

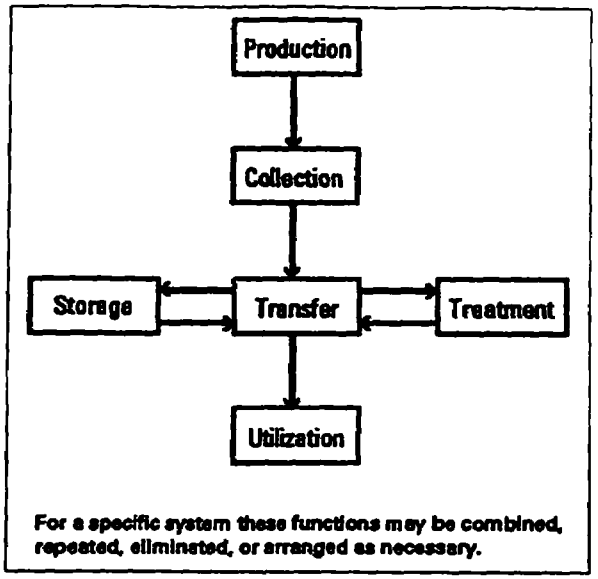

Figure 1.—Steps in an animal waste management planning system.

The third and fourth steps are to have adequate storage facilities and the ability to transfer or move the waste from the point of collection to the appropriate point of use. In some cases, a fifth step is included to determine whether biological, physical, or chemical treatment of the wastes is needed to reduce the potential for pollution or to prepare the wastes for final use.

The sixth and final step in the waste management plan is to use the wastes — normally, for land application as a fertilizer and soil improvement or as a feed ingredient — in accordance with the nutrient management plan Growers will usually have identified sufficient land on which to apply the waste before production begins If enough land does not exist, other uses must be assigned or additional lands located for disposal.

The Benefits of Nutrient Management

Nutrient management planning begins when the poultry waste management plan has proceeded from conservation and protection to the actual use of these products for land applications or energy and feed production. Nutrient management planning matches the nutritional requirements of the soils, crops, or other living things with the nutrients available in the manure or litter, thereby preventing nutrient imbalances, health risks, and surface and groundwater contamination.

Nutrient management recognizes the nitrogen, phosphorus, and potassium content of poultry waste, which is its value; and increases this value by matching the nutrients available in the resource with the nutrients needed in the application. This planning also reduces disposal and handling costs. Nutrient management planning makes it possible to use poultry manure to replace commercial fertilizers or at least to reduce their use — thereby reducing the costs of nutrients associated with crop production. Nutrient management also minimizes the potential harmful effects that overapplication can have on the environment.

An essential goal of nutrient management is to make sure that any poultry waste, especially manure or litter, is used safely and effectively. Nutrient management is, in fact, the key to using this waste as a beneficial by-product. To obtain maximum benefit and prevent possible contamination of surface and groundwater, the following management principles and practices can be applied.

- Develop and apply a Resource Management System, an Animal Waste Management System, a Nutrient Management Plan, or similar program. Assistance is available from the local offices of the U.S Department of Agriculture's Soil Conservation Service, the Cooperative Extension Service, or state departments of agriculture
- Find out if your state uses nitrogen as a basis for land application requirements. If not, is phosphorus a concern in your area?
- Analyze poultry waste regularly to monitor major nutrients and pH levels. Proper soil pH will help maximize crop yields, increase nutrient use, and promote decomposition of organic matter.
- Apply only as much fertilizer (nutrients) as the crop can use.
- Calibrate equipment and apply waste uniformly
- Incorporate poultry waste into the soil if possible to reduce runoff, volatilization, and odor problems.

- Do not spread poultry waste on soils that are frozen or subject to flooding, erosion, or rapid runoff prior to crop use.
- Spread poultry waste during specific growing seasons or as scheduled for maximum plant uptake and to minimize runoff and leaching.
- Use proper storage methods prior to land application.
- Maintain a vegetative buffer zone between the field of application and adjacent streams, ponds, lakes, sinkholes, and wells.
- Follow approved conservation practices in all fields.
- Be considerate of neighbors and minimize conflicts when transporting or land-applying poultry waste.

Training, technical assistance, and in some cases, financial aid are available to help growers and crop farmers identify problems and develop solutions for using poultry waste in their specific regions The Soil Conservation Service and Cooperative Extension Service, for example, have developed work sheets for animal waste management systems that will help growers make production estimates, obtain soil and manure analyses, and make economical and practical use of the organic resources generated on the farm These agencies and others can help growers design facilities and develop overall resource management plans.

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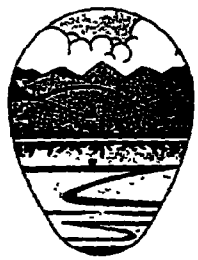

Dry Waste Management

A well-planned waste management system will account for all wastes associated with a poultry agricultural enterprise throughout the year, from the production of such wastes to their use. It is likely that the more integrated the waste management system is with the grower's other management needs, such as production, marketing, pest control, and conservation, the more profitable the farm will be.

Kinds of Poultry Waste — Manure and Litter

Poultry wastes are handled differently depending on their consistency, which may be liquid, slurry, semisolid, or solid.

The total solids concentration of manure depends on the climate, weather, amount of water consumed by the birds, type of birds produced, and their feed; it can be increased by adding litter or decreased by adding water Thus, poultry waste systems can be either liquid or dry Liquid waste management is explained in an additional fact sheet contained in this handbook (PWM-4)

Within the poultry industry, broiler, roaster, Cornish hen, pullets, turkey, and some layer operations are dry; live bird processing, some layer, and most duck and goose operations are liquid. In most dry operations, the birds are grown on floors covered with bedding materials. The manure collected from ducks, geese, and large high-rise layer operations is usually pure or raw manure, unmixed with litter. But it may be mixed with water during cleanout. Dry and liquid wastes require different collection, storage, handling, and management systems

The amount of manure produced by a given flock of poultry can be roughly estimated from the amount of feed the birds eat. Table 1 can be used to estimate how much fresh manure and manure dry matter will be produced by various species and numbers of birds. Roughly, it is estimated that 20 percent of the feed consumed by poultry is converted to manure.

Litter

Manure mixed with a bedding material is called litter. The composition of litter varies, depending on how the chickens were fed, age and size of birds, the presence of moisture, the age and type of the litter itself, frequency of cleanout, and conditions of storage. Its composition can be estimated from analyses that have already been made on similar types of waste, but all litter should be analyzed at least once a year for nutrient content. Litter moisture in a well-managed house generally ranges from 25 to 35 percent Higher moisture levels in litter result in greater weight and reduced levels of nitrogen.

Diminished productivity and income are the almost certain outcomes of an improper or failed animal waste management system Good management has two goals to reduce the production of litter and to make the best use of the litter that is produced

How much litter is produced varies widely, depending on the producer's management style, feedstocks, number of cleanouts, climatic conditions, and bird genetics. However, broilers may produce up to one ton of litter per year per 1,000 birds, or about 81 cubic feet of litter for each 1,000 birds. The bedding materials, manure, and used feed in the litter have nutrient value for land applications, but may also be useful in other ways — for example, as a fuel source, as an ingredient in compost, or as beef cattle feed.

Table 1.—Approximate manure production by poultry.

1 Type of animal	2 Market or adult live wt/animal (lb)	3 Animals/ 1000 lb animal unit	4 Flocks/yr	5 Feed eaten /animal (lb/growing period)	6 Feed eaten /animal (lb/yr)	7- Manure dry matter produced (lb/yr /animal)[a]	8 Animals to supply 1 ton dry matter manure/yr[b]	9 Nutrient content of dry manure (lb/ton)[c] N	P_2O_5	K_2O
Layer[d]	4	250	1	77/52 wk	77	15 4	130	100	40-70	40
Layer, heavy	7	143	1	90/52 wk	90	18	111	—	—	—
Pullet[d]	3	333	2	15/20 wk	30	6	333	—	—	—
Broiler	4	250	6	9/7 wk	54	10.8	185	80	40-70	60
Roaster	7	143	4	18/10 wk	72	14 4	139	—	—	—
Turkey	20[e]	50	2	60/20 wk	120	24	83	100	40	20
Duck	7	143	6	19/7 wk	114	22.8	88	—	—	—
Guinea	3-4	285	1	18/18 wk	18	3.6	555	—	—	—
Pheasant	3	333	1	16/18 wk	16	3.2	625	120	40	50
Chukar	1.5	666	2	8/18 wk	16	3.2	625	—	—	—
Quail	0.5	2000	2	3/12 wk	6	1.2	1666	—	—	—

Note: Pounds of feed at 11 to 13 percent moisture x 0.20 = pounds of manure dry matter. Fresh manure is 75 to 80 percent moisture. Manure can be air-dried in the poultry house to as low as 15 to 25 percent moisture

[a]Figure may vary with animal, ration, and season.

[b]Column 8 is obtained by dividing 2000 pounds by the value in column 7

[c]Figure may vary plus or minus 50 percent, depending on animal, ration, and manure handling.

[d]Single Comb White Leghorn.

[e]Adult turkeys may vary from 12 to 36 pounds per bird live body weight

Litter that is saturated with water is called cake. This litter must be removed from the house between flocks; it must be prevented from mixing with stormwater and becoming overly wet, and it must be dried to prevent odor. Good management practices will reduce the production of cake — for example, by checking for water leaks in the house and keeping the house at an even temperature

Litter that has not become saturated in water can be left in the house between flocks If the cake is properly removed from the house, total cleanouts can be delayed — sometimes for as long as two years or more.

Weight and volume of litter will depend on type of bedding material used, depth of bedding to start with, amount of cake removed or present, and length of time between complete cleanouts. The quality of litter depends on the method of removal, whether the material was raked or stirred between flocks, and manner and length of storage.

Outdoor or Open Range

Fields, pastures, yards, or other outdoor areas are used as ranges for chickens, turkeys, ducks, or game birds Such areas must be located and fenced so that manure-laden runoff does not enter surface water, sinkholes, or wells These operations may be required to have a discharge permit from the appropriate state regulatory agency

Manure

The best method for managing manure depends on the type of housing used, dry or liquid collection, and the way the housing is operated. Misuse of poultry manure can reduce productivity, cause flies, odor, and aesthetic problems; and pollute surface and groundwater. Poultry manure can produce dust and release harmful gases such as carbon dioxide, hydrogen sulfide, methane, and ammonia. Fresh manure is troublesome if it gets too wet.

Fresh manure can be handled in either dry or liquid form. Aerating or drying of manure requires ventilation. Ventilation can be achieved naturally (through proper housing design) or mechanically (through equipment) Aeration produces a low odor product of 15 to 25 percent moisture. Because it has less odor and weight, it is less expensive to haul, contains more nutrients, and can be stored more easily.

Liquid manure contains about 95 percent moisture and consequently weighs more than twice as much as dry manure. The trend within the industry is to avoid liquid waste handling operations and use the more convenient dry systems. Manure that is between 30 and 60 percent moisture is sticky, difficult to scrape, and more likely to break cleaning equipment.

Storage Facilities

Dry litter from broiler operations and dry manure from a layer operation are best stored under a roof or in covered stacks. These storage facilities have five essential features:

- sufficient capacity to hold the waste until it can be applied to land or transported off the farm,
- adequate conditions of temperature and humidity to permit storage of the waste until it is needed,
- a concrete or impermeable clay base to prevent leaching to groundwater,
- proper location to avoid runoff to surface waters or percolation to groundwater, and
- ventilation and containment for effective air quality and nuisance control.

Thus, the ideal storage design is a roofed structure with an impermeable earthen or concrete floor. This design keeps the litter dry, uniform in quality, and easy to handle; it also minimizes fly and odor problems. Management plans that allow for proper storage

- save water,
- improve bird quality,
- improve the production environment,
- reduce the amount of ammonia released from litter,
- reduce the volume of cake,
- extend the time between cleanouts,
- increase the product's value and flexibility, and
- prevent pollution of adjoining waters.

Kinds of Storage Facilities

Generally, storage facilities can be open, covered, or lined (permanently lined, in some cases); or they can be bunkers or open-sided buildings with roofs. Perhaps the most common facilities for collecting and storing poultry litter include floors, pits, dry-stack buildings, or covered outdoor storage facilities with impermeable earthen, or concrete flooring.

Floor Storage

Most broiler, roaster, Cornish hen, pullet, turkey, and small layer operations raise birds on earthen or concrete floors covered with bedding material (Fig. 1). A layer of wood shavings, sawdust, straw, peanut or rice hulls, or other suitable bedding material is used as a base before birds are housed Wet litter — that is, cake — is removed after each flock A complete clean-out can be done after each flock or once every 12 months or longer, depending on the producer's requirements. Slat or wire floor housing, used mainly for breeder flocks, can be handled the same way. Floor storage is the most economical method to store litter Care must be taken not to leave foreign material such as wire, string, light bulbs, plastic, or screws in the litter

Dry Stack Storage

Temporary storage of litter in a roofed structure with a compacted earthen or concrete floor is an ideal management method (Fig 2) Large quantities of waste can be stored and kept dry for long periods of time. To prevent excessive heating or spontaneous combustion of wastes, stacks should not exceed 5 to 8 feet

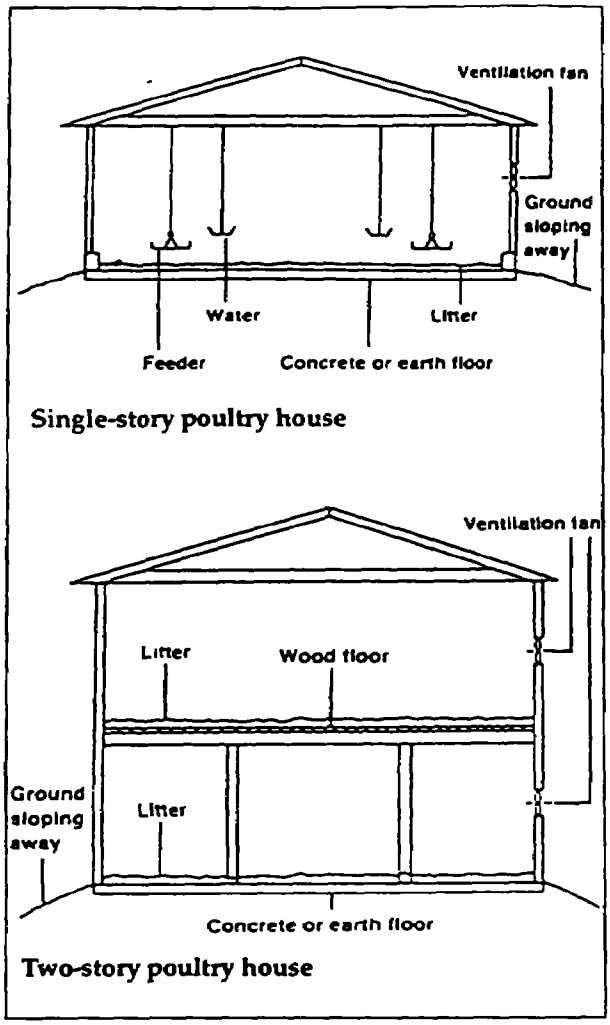

Figure 1.—Two types of litter-floor poultry houses.

Dry stacks promote ease of handling and uniformity of material, in addition, disposal is relatively easy Dry stacks protect the resource from bad weather and make it available for distribution at appropriate times

A variation on this option is a stack or windrow located in the open on well-drained areas and protected from stormwater runoff The stack must be covered with a well-secured tarpaulin or other synthetic sheeting

Grower storage in covered or uncovered facilities is not the only storage alternative Field storage on the farm, applicator storage (that is, storage by the crop farmer who will use the litter for fertilizer), cooperative storage (several growers sharing a larger facility offsite), and private storage (by entrepreneurs who will sell or process the litter to create new

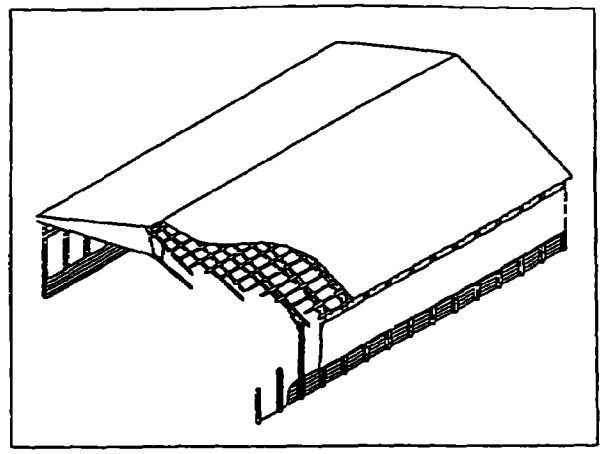

Figure 2.—Roofed structure with earthen or concrete floor.

products) are additional methods of waste storage. Each method must be evaluated in terms of cost, environmental safety, and industry and regulatory practice.

In some states, permits may be required for your storage facility or for other parts of your resource management system. Possible zoning restrictions may also influence your choice of storage systems.

Proper storage is essential to maintain the waste's fertilizer value for crops, provide ease of handling, and avoid groundwater contamination. Consider also the feasibility of processing alternatives Waste can be

- composted and pelletized to produce fertilizer,
- converted to feed for beef cattle or to briquettes for fuel, or
- deposited in lagoons for anaerobic digestion and methane production.

Above all, use soil and manure testing to improve the success (crop yields) and timing of land applications. Practice biosecurity (that is, safeguard the application from disease causing organisms and fly larvae) at all times.

Using poultry litter as a feed supplement for cattle has become popular. Methods of waste handling and storage can greatly affect the quality of the material as a feed ingredient Litter with the highest nutritional value for refeeding is found in the upper layers of the litter

pack. Large amounts of soil increase the ash content and reduce the nutritive value of litter. Feed litter should be kept covered with polyethylene at least three weeks to ensure that sufficient heat is generated to kill pathogens.

Remember. storage is an interim step in waste management planning. It should be followed by nutrient management planning and appropriate use of the litter for land application

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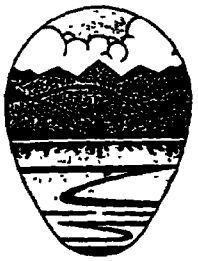

LIQUID WASTE MANAGEMENT

For ducks, geese, and some layer operations, manure is usually handled through liquid waste management systems. Water increases the amount of waste to be processed. Therefore, drying the manure naturally or through forced air systems as part of the collection and storage procedures can help control the amount of material to be managed.

A liquid waste system involves collection, storage, handling, and use. Collection and storage are generally combined into one operation that can include pits, settling tanks, or earthen storage ponds.

Advantages of a liquid waste management system are that it is easier to automate and less labor intensive. However, there are also disadvantages associated with liquid waste systems:

- constraints on management — must be emptied when full,
- costs — concrete can be costly or a grower may have insufficient land to construct a holding facility,
- toxic gases or unpleasant odors — these problems occur especially during waste removal,
- flies — insects will breed in improperly managed waste,
- volume — water vastly increases the amount of waste to be handled, and
- land applications of liquid wastes must be carefully planned and timed.

Volume comparisons between liquid and dry manure show that 10,000 caged layers produce nearly 2,500 pounds of manure per day, with an estimated volume of 50 cubic feet. In dry form, this manure weighs about 695 pounds, with 10 percent moisture, and reaches a volume of 27 cubic feet.

Most liquid waste systems require permitting by the appropriate state agency. Without the water, solid waste systems have less volume to control and lower equipment and energy costs. These considerations and operator preference help determine a particular grower's choice of poultry waste management systems.

Liquid Collection Methods

Most layer or pullet operations have cages arranged in up to four decks. The manure falls directly into a pit or is scraped into the pit from intervening dropping boards. Pits must be cleaned regularly, and the manure stored in concrete or steel storage tanks or applied directly to the land. A lagoon may be necessary to catch overflow Ventilation fans are essential to keep the manure dry, and reduce toxic gases, fly problems, and offensive odors Equipment is available for in-pit manure composting There are three basic pit designs

- Shallow-pit systems, built of concrete at ground level, are 4 to 8 inches deep and located 3 to 6 feet below the cages. Manure is scraped from the pit or flushed out with water and collected in a storage area or loaded directly into a spreader (Fig. 1).
- Deep-pit systems are usually 4 to 8 feet wide and may extend 2 to 6 feet below ground level with the cages at least 8 feet above the concrete or masonry floor. The pit floor and sidewalls must be sealed and thoroughly protected from outside surface

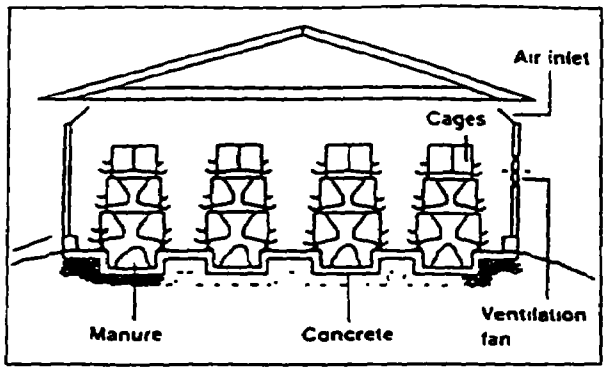

Figure 1.—Shallow-pit poultry house with cages.

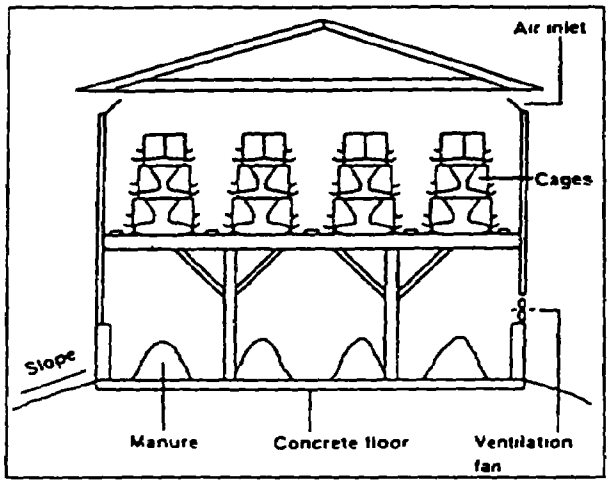

Figure 2.—High-rise poultry house with cages.

or groundwater. Foundation drains and external grading are needed to remove subsurface water and allow surface water to drain away from the building

- High-rise systems are similar to deep-pit systems but are built entirely above ground, with the cages 15 to 30 feet above the ground (Fig. 2). The pit floor should be concrete and graded, with foundation drains. The water supply must be controlled if the wastes are stored for extended periods. If outside water penetrates the system, the manure can cause a serious fly problem or leach nutrients into surface or groundwater.

Settling Tanks

Concrete, concrete block, or steel storage tanks can be used to collect solids and to skim floating material from a layer operation. A floating baffle or other separator can be installed to remove egg shells, feathers, and other debris The tank should be placed between the layer house and a waste storage pond or lagoon Normally, a settling tank is 4 feet at the deep end, sloping to ground level. Walls are slotted to allow drainage of the settled waste.

It is recommended that two settling tanks be installed; one can be drained and cleaned while the other remains in operation. The tanks must be properly constructed and sealed to prevent groundwater or surface water pollution. In tanks and storage ponds, unpleasant odors and dangerous gases may be present and may require protective measures.

Storage Pond

A storage pond or lagoon is an anaerobic storage facility. It is designed to hold liquid waste from layer or other liquid waste operations. When the potential for groundwater contamination exists because of site conditions, the pond should be lined with clay, concrete, or a synthetic material. In warmer climates, structures are designed for a 30- to 90-day holding period but in colder areas, 180-day storage is needed. It is not practical to design a structure for less than 30-day storage. When the structure becomes full, it must be emptied, regardless of weather conditions Specific criteria for construction of storage ponds can be obtained from the USDA Soil Conservation Service office

Land Applications

Solid forms of manure are probably easier than liquid for land applications, but a manure slurry or irrigation system may be used. If the application falls directly on the crop, care must be taken to prevent ammonium toxicity and burning. Because raw manure contains high amounts of uric acid, it should be thoroughly mixed before application Layer lagoon sludge is more dense than a pullet lagoon sludge because of its high grit or limestone content and should be diluted before application.

Timing is a major factor in successful land applications The manure must also be uniformly applied — whether you are using a manure spreader or an irrigation system. The applicator should be particularly careful

(especially during a drought) not to coat the plants with lagoon liquid. Instead, make several small applications of lagoon liquid, rather than one large one.

Liquid waste is primarily disposed of through land applications. Proper spreading on the land is an environmentally acceptable method of managing waste. However, with increasing environmental concerns, and the need to match closely the fertilizer needs of crops, farmers can no longer afford to simply "spread manure."

The USDA Soil Conservation Service, Cooperative Extension Service, and other agencies offer poultry waste and nutrient management planning assistance. These offices have worksheets to help growers plan liquid waste management, which includes the following tasks:

- determining the amount and volume of waste generated,
- calculating land application requirements,
- sampling and analyzing the nutrient composition in poultry litter, and
- matching the nutrients available in these products with crop nutrient requirements for land applications

Detailed information on how to prepare nutrient assessments, conduct soil testing, and calculate application rates, timing, and methods of application are also available from these agencies.

The use of nutrient management planning will help growers make economical and practical use of the organic resources generated on their farms.

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Composting Waste Products

Poultry litter or layer manure is most often land applied to pastures and crops for its value as an organic fertilizer. We know from long experience how beneficial this practice can be when soil and manure nutrient testing are integrated with crop nutrient needs to determine the amount and timing of the application. This integration makes it possible to approach land application as a wise use of resources rather than as a disposal method.

Proper storage and treatment of poultry by-products (litter, manure, hatchery waste, and dissolved air flotation [DAF] skimmings) before use are important to minimize compositional changes and decrease odor and handling problems. Depending on the by-product, dry storage, ensiling, or composting may be appropriate treatments. Resource management systems may include incineration and burial as methods of disposal; however, these techniques are not called treatments because they do not usually provide any reusable products

Composting is an environmentally sound and productive way to treat poultry by-products and mortalities (see also PMM/4). The product of composting is easier to handle, has a smaller volume, and is a more stable product than the raw materials. The nutrient content of the compost will be nearly the same as the starting materials if the composting is performed properly.

While compost can be land applied to decrease the need for nutrients from commercial fertilizers, composted by-products may also be marketed for higher value uses such as turf, nursery, and home and garden uses. It can be added as an amendment to soils for transplanting flowers, trees, and shrubs, or to establish new lawns. Compared to commercial fertilizers; poultry by-product compost will have a lower nutrient analysis (e.g., 2-2-2) for nitrogen, phosphorus, and potassium. However, there are other benefits to the soil and plant growth associated with the organic matter and micronutrients in compost.

Understanding the Process and Benefits of Composting

Composting is a natural, aerobic, microbiological process in which carbon dioxide, water, and heat are released from organic wastes to produce a stable material. Leaves and other organic debris are subject to this process all the time—that is, the activity of microorganisms transform these materials into a soil-like, humus-rich product called compost.

This natural process can also be used as a resource management technique to transform large quantities of litter, manure, and other poultry by-products into compost. The conditions under which natural composting occurs can be stimulated and controlled so that the materials compost faster and the nutrient value of the compost is maximized

The composting process is relatively simple:

1 By-products, for example, litter manure, eggshells, hatchery waste, and DAF skimmings, are placed in bins, piles, or elongated piles called windrows. A bulking agent or carbon amendment (e.g., sawdust, wood chips, yard waste, or paper that is rich in carbon but low in other nutrients) is usually necessary to provide the proper ratio of carbon to nitrogen in the mix and improve aeration.

2. Air is added to support and enhance microbial activity. Because composting

microorganisms are aerobic, that is, oxygen using, sufficient aeration is very important to the efficiency of the process. Sufficient aeration also minimizes the formation of objectionable odors that form under anaerobic (oxygen depleted) conditions. Adequate aeration can be provided by forced air systems, such as blowers or fans; or by turning the compost with a front-end loader or a commercially available compost turner as required.

3. Mechanical agitation or turning of the materials supplies aeration, helps mix the materials, and distributes any added water.

4. Temperatures in the compost must be maintained at levels above approximately 130 °F to kill any pathogens (disease-causing organisms) and promote efficient composting. Temperatures above 150 to 160 °F should be avoided because they reduce microorganisms beneficial to the composting process

5. Adequate moisture, between 50 and 60 percent, is necessary for optimal microbial activity.

Using Compost

Compost produced from poultry by-products has many potential uses it can be used directly as a soil amendment for agricultural or horticultural uses, it can be pelletized or granulated for ease of transportation and application, and it can be enhanced with conventional fertilizers to improve its nutrient value. Off-farm uses are limited more by the absence of markets for the products and competition from less costly products than by technical problems. Practically speaking, composting is a preferred method for managing a variety of poultry by-products. Composting is often recommended for use on the farm and at the hatchery.

Possible Drawbacks

Composting, like any management technique, cannot be undertaken lightly, whatever its benefits. It requires a commitment of time and money for equipment, land, storage facilities, labor, and management. Composting is an inexact process that depends heavily on the quality and characteristics of the materials being composted and the attention given to the composting process.

Although the finished product should have no odor or pest problems, such problems may occur during the composting process. Weather may also affect the process adversely. Compost releases nutrients slowly — as little as 15 percent of the nitrogen in compost may be available during the first year of application. In addition, costs associated with production-scale composting can be significant, and federal and state regulations for stormwater runoff from the composting site must be followed.

Despite these potential drawbacks, composting on the farm is a practical resource management technique. Good management will consider every opportunity to eliminate or reduce the concerns associated with composting while maximizing its benefits. Once it is realized that composting can be more than a "dump it out back and forget it" procedure, the technique can be used and adjusted to meet by-product management needs.

Composting Methods

There are four general methods of composting: passive composting, windrows, aerated piles, and in-vessel composting

▼ **Passive composting** is the simplest, lowest cost method. it requires little or no management because the materials to be composted are simply stacked into piles and left to decompose naturally over a long time.

Passive composting is not suitable for the large quantities of litter or manure produced on poultry farms. It occurs at comparatively low temperatures and decomposition occurs at a slow rate. Anaerobic conditions resulting from insufficient aeration can result in objectionable odors.

▼ **Windrow composting** occurs in long narrow piles that can vary in height and width depending on the materials and equipment available for turning. For most

efficient composting, windrows are turned as required depending on temperature and oxygen measurements.

Windrow composting (Fig. 1) is usually well suited to poultry farms. In this method, the windrows are formed from the material to be composted, water, and any bulking agent or carbon amendment. The piles can range from 3 feet high for dense materials to as high as 12 feet for lighter, more porous materials like leaves. If the piles are too large, anaerobic conditions can occur in the middle; if they are too small, insufficient heat will be maintained for pathogen reduction and optimum microbial activity.

The windrows are turned periodically to add oxygen, mix the materials, rebuild porosity (as the mixture settles), release excess heat, and expose all materials equally to the high interior heat that kills pathogens. Turning can be labor and equipment intensive depending on the method used. In the beginning, it may be necessary to turn daily or even several times a day to maintain sufficient oxygen levels; however, turning frequency declines with the windrow's age.

In addition to needing space for the windrows, the producer will also need turning equipment, a source of water, a dial thermometer, and perhaps an oxygen meter. The turning equipment (Fig. 2) can be front-end loaders, manure spreaders with flails and augers to provide good mixing, or specialty machines. Often older, unused farm equipment, for example, an old potato plow and a farm tractor, can be used for turning compost.

Temperatures within the windrow are most commonly used to determine when turning is necessary. Low temperatures and odors are signs that more oxygen is needed, while cool or hot spots at intervals along the windrow indicate that the material needs to be mixed. During fly season, all windrows should be turned at least weekly. In the winter, windrows can be combined to conserve heat as they diminish in height. Composting time can vary from weeks to months depending on the material being composted, the attention given to composting conditions, and the quantity of material composted.

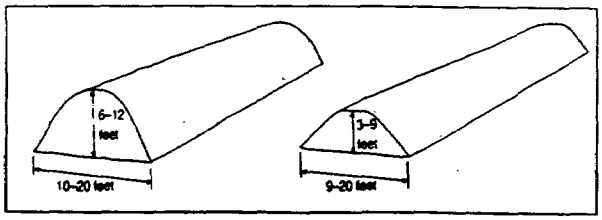

Figure 1.—Typical windrow shapes and dimensions.

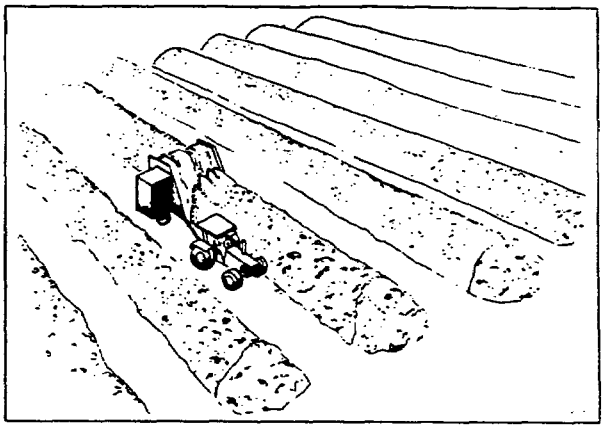

Figure 2.—Windrow composting with an elevating face windrow turner.

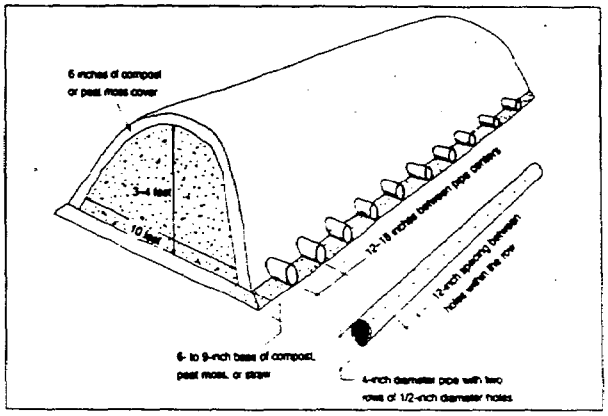

Figure 3.—Passively aerated windrow method for composting manure.

▼ **Aerated static** composting eliminates the labor of turning the compost by using perforated pipes to introduce air into piles or windrows. Air can be supplied passively, or with blowers to force air into or through the composting material.

Passively aerated windrows (Fig. 3) are a modification of windrow composting that

eliminates turning. In a commonly used system, the windrow is placed on a base of wood chips, straw, or peat, and perforated aeration pipes are added on top of this base. The material to be composted must be very well mixed, since it is not turned, and the windrow should not be higher than 3 to 4 feet. This method has the advantage of minimizing odors and helping to conserve nitrogen.

Aerated static piles or windrows add blowers to the aeration pipes. This method allows larger piles or windrows and permits more efficient composting than passively aerated static piles. Air can either be drawn into or forced through the composting material. The blowers may be controlled to turn on at set intervals or in response to temperatures in the pile or windrow.

▼ **In-vessel composting** is similar to aerated methods but the materials to be composted are contained in bins or reactors that allow for control of aeration, temperature, and mixing, in some systems.

In-vessel composting is actually a combination of methods that involve both aeration and turning. The advantages of in-vessel composting include the elimination of weather problems and the containment of odors. In addition, mixing can be optimized, aeration enhanced, and temperature control improved.

The simplest form of in-vessel composting is bin composting, which is readily adaptable to poultry farms. Bins may be plain structures with wood slatted floors and a roof, conventional grain bins, or bulk storage buildings. Other types of in-vessel composters use silos in which the air goes in at the bottom and the exhaust is captured for odor control at the top; agitated bed systems; and rotating drums. Costs for equipment, operation, and maintenance for a large quantity of materials are high for in-vessel composting.

Factors to consider in choosing a composting method are speed, labor, and costs. Windrows are common on farms; they can use existing equipment, no electricity is required (so they can be remotely located), and they produce a more uniform product. They are, however, also labor intensive and at the mercy of the weather. Adding a paved or compacted clay surface and a simple open-sided building can minimize weather problems and the impact of composting on water quality.

For more information, technical assistance, and possible cost-share programs that may be available to help you begin a composting operation, contact your local conservation district office, the Soil Conservation Service, or the Cooperative Extension Service.

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Putting Nutrient Management to Work

Land application, especially field spreading, is in most cases the best use of poultry wastes. It is cost-effective, disposes of the largest amount of waste closest to the point of production, and is environmentally safe if handled properly. To ensure that waste is not overapplied to the land, the amount and type of nutrients in it must be known and the timing of applications must be adjusted to ensure that growing plants can use the nutrients. The application should also be made evenly, so that all plants have the same access to the nutrients.

What Is a Nutrient Management Plan?

A nutrient management plan is necessary to minimize edge-of-field delivery of nutrients and limit leaching of nutrients from the root zone Nutrient management plans include developing a nutrient budget for the crop, applying nutrients at the proper time, applying only the types and amounts of nutrients necessary to produce a crop, and considering the environmental hazards of the site.

More specifically, nutrient management plans should apply nutrients at rates necessary to achieve realistic crop yields, improve the timing of nutrient application, and use agronomic crop production technology to increase nutrient use efficiency. At a minimum, nutrient management involves determining the nutrient value of manure by testing, crediting the nitrogen contribution of any legume crop, and testing the soil routinely.

An effective nutrient management plan consists of the following core components:

- farm and field maps,
- realistic yield expectations for the crops to be grown,
- a summary of the nutrient resources available (the results of soil tests and nutrient analyses of manure, sludge, or compost),
- an evaluation of field limitations based on environmental hazards or concerns (e.g , sinkholes, land near surface water, highly erodible soils),
- application plans based on the limiting nutrient,
- plans that include proper timing and application methods (avoid application to frozen soil and during periods of leaching or runoff), and
- calibration of nutrient application equipment

The USDA Soil Conservation Service and Cooperative Extension Service offices have prepared tables of the mean average amounts of key nutrients found in different kinds of manure (Table. 1). These tables may be used to estimate the nutrient content of your waste source or stockpile. However, as this resource is produced and used under many different circumstances, it is always best to have samples of your supply tested by a state or private lab

Preparing Samples

Always prepare your samples from six to 12 representative areas in the poultry house or from at least six different locations in the stockpile. (Samples collected from the stockpile

Table 1.—Nutrient content of different sources of animal manure.

MANURE TYPE AND HANDLING	INFO. SOURCE	TOTAL N	AMMONIUM-N	PHOSPHORUS P_2O_5	POTASSIUM K_2O
BROILER		lb/ton			
all types	a	51	13	64	48
fresh (no litter)	b	26	10	17	11
broiler litter	b	72	11	82	46
roaster litter	b	73	12	75	45
breeder litter	b	31	7	54	31
stockpiled litter	b	36	8	80	34
all types	d	59	15	63	40
TURKEY		lb/ton			
all types	a	61	18	57	41
fresh (no litter)	b	27	8	25	12
brooder litter	b	45	9	52	32
grower litter	b	57	16	72	40
stockpiled litter	b	36	8	72	33
LAYER		lb/ton			
all types	a	35	14	42	28
fresh (no litter)	b	26	6	22	11
under cage scraped	b	28	14	31	20
highrise stored	b	38	18	56	30
all types	d	39	15	57	30
		lb/1000 gallon			
liquid slurry	b	62	42	59	37
anaerobic lagoon sludge	b	26	8	92	13
		lb/acre-inch			
anaerobic lagoon liquid	b	179	154	46	266
SWINE		lb/ton			
fresh	c	12	7	9	9
scraped	c	13	7	12	9
		lb/1000 gallon			
liquid slurry	c	31	19	22	17
anaerobic liquid sludge	c	22	6	49	7
all types	d	40	19	37	23
		lb/acre-inch			
anaerobic lagoon liquid	c	136	111	53	133
DAIRY		lb/1000 gallon			
all types	d	28	11	19	25
HORSE		lb/10 ton			
all types	d	90	6	58	109

a - Data compiled by J. J. Camberato, Extension Agronomist, 1990-91.
b - Soil Facts-Poultry Manure as a Fertilizer Source. North Carolina Agricultural Extension Service Fact Sheet AG-439-5. J. P. Zublena, J. C. Barker, and T. A. Carter.
c - Soil Facts-Swine Manure as a Fertilizer Source. North Carolina Agricultural Extension Service Fact Sheet AG-439-4. J. P. Zublena, J. C. Barker, and J. W. Parker.
d - Using Manure to Cut Fertilizer Costs. University of Maryland Cooperative Extension Service Fact Sheet 512. V. Allan Bandel.

should be taken from a depth of about 18 inches; careful handling will ensure that no soil is intermixed in the sample.) Samples should be taken as close as possible to the time of application; however, allow sufficient time to receive test results.

To collect the sample, obtain a quart of waste from six to 12 locations in the house or stock pile and place them in a large, clean bucket. Mix the contents thoroughly; then place about a quart of the mixed sample into a clean plastic bag or bottle. Seal it tightly, but

allow room for the sample to expand. Keep the sample cool; if it is not mailed to the laboratory on the same day as it was withdrawn from the source, then the entire sample should be refrigerated. The accuracy of the lab test depends on the quality of the samples collected. Contact the lab that will be analyzing your sample for information on collection, handling, and shipping.

For Best Results

Both dry and wet samples should be routinely tested on an "as is" basis for total nitrogen, ammonia-nitrogen, phosphorus, and potassium. The key to successful land applications is to apply the right amount of waste at the right time, using the right method so that the waste's nutrient content is closely correlated with the nutrient needs of the plants and soil. Be aware that some nutrients will accumulate in the soil and reach high levels; apply the product immediately before planting, during a high growth season, and not in bad weather (when the nutrients may be washed away). Incorporate waste in the soil, if possible. For best results, use biennial soil tests in connection with your manure sample and basic calculations.

Land Application Rates and Methods

Whether the poultry waste is taken to nearby farms or spread on your own land, the amount applied, the timing of the applications, and the methods used will affect the outcome. Understanding how the soil and waste interact and calibrating the spreader will help growers apply the right amount at the right time in just the right way.

Manure spread on the surface and not worked into the soil will lose most of its volatile nitrogen compounds, which will be released as ammonium gas to the atmosphere. This release may not represent a pollution potential, but such lost nutrients are not available for plant growth

Poultry waste spread on frozen or snow-covered soil has a high potential for runoff to surface water. It should not be surface applied to soils near wells, springs, or sinkholes or on slopes adjacent to streams, rivers, or lakes. In fact, some states prohibit this activity. Conservation practices can reduce runoff, nutrient loss, and pollution.

Water pollution potential can be decreased, and the amount of waste nutrients available to plants can be increased, by working poultry waste into the soil either by tillage or by subsurface injection. Subsurface injection of waste only minimally disturbs the soil surface and would be appropriate for reduced till and no-till cropping systems.

Manure or litter must have time to break down before the nutrients in it become available to the crop. Fall applications allow this breakdown to occur, but some of the nitrogen in the manure may be lost through leaching and runoff. Spring applications prevent this nitrogen loss but do not allow enough time for the breakdown of the manure. Incorporation of poultry waste beneath the soil surface in the fall is a way to conserve the nutrients and protect water quality.

Spring and summer applications are recommended based on plant uptake, though it is always important to check for good weather before applications are planned. If litter is applied in bad weather, nutrients may be lost in stormwater runoff. Nutrient-enriched runoff from agriculture could be a leading cause of nonpoint source pollution.

How the poultry waste is applied also affects how quickly the nutrients are incorporated. Generally, incorporation within 12 hours is ideal The waste can be broadcast over the whole field, followed by incorporation tillage This method has the advantage of good distribution, because it is visible, the grower can determine the uniformity of the broadcasting. There will, of course, be some odor on the day of the application. Farmers may also want to investigate incorporation, topdress, sidedress, and band application methods.

Spreader Calibrations

Calibration of the spreader machine is also necessary to monitor and control the amount and uniformity of the application. Calibration specifies the combination of settings and travel speed needed to apply nutrients at a desired rate. By knowing a spreader's application rate, a producer can correctly apply the nutrients to

meet the needs of the plants. Generally, there are two types of nutrient spreaders — solid or semisolid and liquid. Broiler growers handle solid or semisolid nutrients; many egg producers have liquid waste systems.

Solid or semisolid waste is usually handled in box-type or open-tank spreaders, and the application rate is expressed in tons per acre. Nutrient concentrations in pounds per ton can be estimated, or calculated from the lab analysis. The nutrient application rate in pounds per acre must be determined, based on the tons per acre of waste application.

Liquid or slurry waste is usually handled by tank wagons or irrigation systems, and the application rate is expressed in gallons per acre. Nutrient concentrations in pounds per gallon (or pounds per 1,000 gallons) can be estimated or obtained from lab analysis and used with the application rate in gallons per acre to obtain pounds per acre nutrient applied.

The volumetric capacity of spreaders is generally provided by the manufacturer. Caution should be exercised in using manufacturer's data for spreader volume. A more accurate and preferred approach is to calibrate your own equipment.

Assistance is available from the USDA Soil Conservation Service or Cooperative Extension Service offices to calibrate your spreader Worksheets are available to determine spreader capacity and application rate. Unless the waste has been analyzed for nutrient content and unless the crop soil nutrient needs are known, spreader calibration may have little effect on the application's success

Once the desired application rate is obtained, record the pertinent information so that you do not have to recalibrate the spreader each time it is used. Spread poultry wastes in a uniform manner. If lush, green growth and not-so-lush growth of plants are observed, adjustments will need to be made during the next application. Calibration of the nutrient spreader is an important practice that is economically and environmentally useful.

A nutrient management plan should be periodically updated to ensure its effectiveness. Often nutrient management can save a producer money by reducing the amount of fertilizer purchased. This reduction in cost is a result of crediting for nutrients already in the soil and manure. For more information, or for nutrient management planning assistance, contact your local USDA Soil Conservation Service or Cooperative Extension Service office or a nutrient management consultant in your area.

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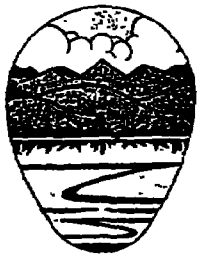

Economics of Transporting Poultry Wastes

When land suitable for spreading poultry waste as a fertilizer or soil amendment is not available or not under the control of the poultry grower, new markets for land applications and new ways to use the waste must be found. Poultry waste can be marketed as a fertilizer, soil amendment, growing medium, or beef cattle feed. These options could involve moving the material from the point of production to the point of use

A Concentrated Industry

Most poultry growers are concentrated within a 25 to 50 mile radius of the hatchery, feed mill, and live bird processing plant. The cost of broiler production increases one cent per pound when the production radius increases over 25 miles Transportation and labor costs are the reason for the increase, which can cost a broiler production unit an additional $2 million annually

However, costs must also be applied to the protection and preservation of water quality A producer must ask whether it is better to increase the area of the poultry operation to accommodate all waste products or to transport the excess materials to other areas. For example, suppose that a broiler complex that includes pullets and breeders handles about 1 million birds a week. These birds will produce about 65,000 tons of litter annually. At the rate of 4 tons per acre, a total of 16,250 acres will be needed to use this quantity of waste for land applications.

If more than the one company is operating in the area, then even more waste will be produced and more land will be needed. One method of dealing with these large quantities is to generate markets or disposal areas at a point some distance from the point of production. Growers need to find buyers for their poultry waste. In some instances, custom cleanout operators will broker the waste for the grower.

Because of the bulkiness of the solid or semisolid product, transportation will be the litter buyer's highest cost An average farm truck can carry 9 to 12 tons. A 30-foot, open trailer used for transporting grains can carry 18 to 24 tons. As load size increases, the cost per ton should decrease. Figure the cost on a round-trip basis, but if you can schedule backhauls in the empty truck, you can push the costs even lower. Current cost estimates are about $1 per mile on a round-trip basis for a 20-ton load

If the grower is paid a per ton price ranging from $5 to $10 and the litter has a value of $22 to $28 as a fertilizer or $40 to $80 as a feed ingredient, the buyer can afford to transport the litter 100 miles for land applications or up to 300 miles for use as a feed

Other Considerations

A method for loading waste into trucks that have 11-foot sides is needed. Front-end loaders or an elevator that can be loaded with a smaller tractor or skid loader will work. The storage facility must have a smooth hard pad to accommodate the loading process, and the litter must be free of foreign materials such as soil, rocks, broken glass, or other debris. Protect material from stormwater runoff.

Roads and turn-around areas at both ends of the trip must be large enough to accommo-

date the process, and storage facilities must exist at the delivery depot if land applications or other use will be delayed.

The quality and biosecurity of the waste must be protected. Poultry waste should be transported only from well-managed and disease-free farms. All trucks should be properly cleaned and disinfected, and any leakage from the trucks should be properly drained and diverted from runoff and groundwater. Before transportation to off-farm use, the product should be deep stacked so that the heat in the stack can kill off any harmful microorganisms that might be present.

Transportation of liquid waste is more or less restricted to on-farm or short local hauls because of the type and size of equipment used and transporting time.

Before waste can be readily accepted as a substitute for commercial fertilizer, growers must be confident that this waste product is truly a marketable resource. When properly collected, stored, handled, and used, poultry waste is an effective substitute for fertilizer. It also builds organic matter in the soil and improves soil quality. Thus, it is not a waste, but an economic asset.

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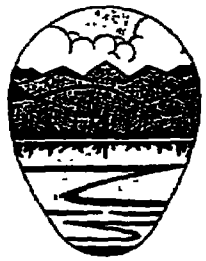

An Overview of Poultry Mortality Management

Poultry mortalities — dead birds — are a daily or near daily occurrence. Responsibility for safe and nonwasteful management of the carcasses begins with choosing the best method for their proper disposal. Because dead birds constitute a large portion of the total wastes generated in poultry production, their disposal is a practical problem for growers. In fact, even environmentally safe and economical methods of disposal can be a chore to producers.

Normal mortality for broiler production is 3 to 5 percent over the production cycle or about .01 percent per day. However, the size of flock, the number of birds on hand, and the size and age of the birds will dictate the number and weight of the carcasses that must be disposed of daily. Massive die-offs or catastrophic losses must be handled differently.

Most normal mortalities occur during the first and last two weeks of the growing cycle for broilers and from 10 to 13 weeks of age for layers Mortality rates in other kinds of poultry operations will be similar to, if not somewhat lower than, the rate for broilers. A single grower, assuming that a typical broiler house holds 20,000 birds weighing 2 to 4 pounds, may have as many as 85 pounds of dead birds to dispose of each day near the end of the growing cycle. A roaster operation may have to dispose of as many as 115 pounds per day, and a turkey operation may dispose of 150 to 200 pounds per day.

Burial in specially designed pits, incineration, and transporting the carcasses off-farm to rendering plants are the three most common means of disposing of dead birds; and recent environmental, economic, and practical concerns have sparked interest in an alternative method: composting. Each of these four methods has best management practice guidelines associated with its use in poultry mortality management.

Burial in pits is not always practical and may not always be permitted. In some places, pits may have adverse effects on water quality, a serious drawback given the intensity and concentration of today's industry. Where permitted, such pits must be properly sized, located, and constructed. The decomposition process in the pit works less well in cold weather, and the pit must be tightly covered for safety and to prevent odors.

Incineration is an acceptable alternative to the use of burial pits. It is environmentally safe, though care must be taken to insure that emissions do not create air quality problems or nuisance odors. Incineration is a more costly method of mortalities disposal; however, incinerator equipment is improving to meet air quality standards

The Composting Alternative

Composting dead birds has become an acceptable method of disposing of poultry mortalities Composting is an ancient, natural technique that was practiced with little change throughout the 18th and 19th centuries. In that era, composting methods and speed differed little from the decomposition of organic matter that occurs naturally. The use of composting as a managed method of mortalities disposal is a relatively new process to the poultry grower

Composting will result in an inoffensive end product; in fact, composting may add value to the wasfe. Composted dead birds

make good fertilizer or soil amendment — each carcass is 2 to 9 percent nitrogen, 1 to 4 percent total phosphorus, and 1 to 7 percent total potassium.

Rendering

Rendering may be the most environmentally safe method for disposal of carcasses. It, like composting, adds value to a waste product — in this case by producing feed products, such as feather meal, with or without blood, and other by-products for poultry and other animals.

A major problem with this method of mortality management is to determine how best to transport the carcasses to the plant before decomposition sets in. The grower's concern is to eliminate the possibility that disease or disease-causing organisms might be picked up in the vehicle or at the rendering plant and unintentionally transported back to the farm.

Besides the delivery of fresh carcasses to the renderer, acid preservation and lactic acid fermentation practices can be used on the carcasses. These practices help neutralize pathogens and toxic chemicals and provide for longer holding times on the farm before the carcasses are transported. Refrigeration or freezing is another method to preserve dead birds prior to delivery to the plant.

Before You Decide

Unsanctioned methods, such as feeding the carcasses to hogs or other domestic animals or abandoning them in sinkholes or creeks or in the wild, should not be attempted. Disposing of dead birds in a municipal landfill is also no longer acceptable.

In all cases, dead bird disposal should be recognized as a potential health hazard and in most states, as a regulated activity. Growers must choose the permitted disposal method that best suits them. Standards must be strictly maintained to ensure sanitary conditions and the least possible environmental consequences. Growers should check with their state regulatory agency to be certain that their planned methods of disposal comply with all dead animal disposal regulations. The USDA Soil Conservation Service and Cooperative Extension Service offices can be of assistance.

More detailed discussions of burial pits, incineration, rendering, and composting as methods for managing dead birds can be found in the Poultry Mortality Management (PMM) section of this handbook.

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Burial—A Disposal Method For Dead Birds

The burial of dead birds in trenches, open pits, and landfills is not an acceptable method of dead bird disposal. In some states, no burial pits whatsoever are permitted — or it is predicted that they will not be permitted in the future. However, in states that do permit this practice, properly constructed disposal pits may provide a safe and economical component of a mortalities management plan. In all cases, the pits must be fabricated.

Fabricated Disposal Pits

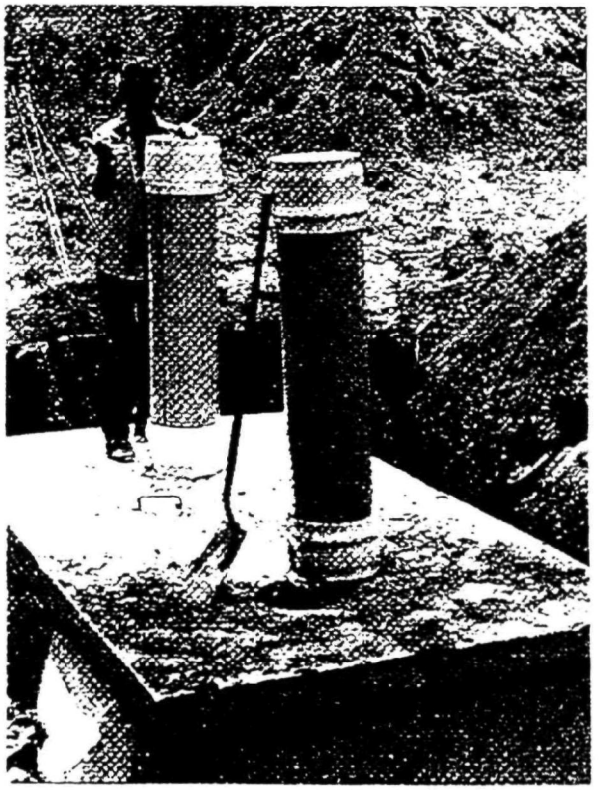
A fabricated pit is an open-bottomed, reinforced hole in the ground that has one or more openings at the top through which carcasses are dropped. An airtight cover above the openings prevents odors from escaping. The pit provides an environment for aerobic and anaerobic microorganisms to decompose organic materials. Although disposal pits require minimal labor and supervision, they must be maintained in a sanitary, legal, and socially acceptable manner.

Some prefabricated pits can be purchased from septic tank dealers and delivered to the farm ready for installation. Under no circumstances, however, should the pit be simply a hole in the ground dug with a backhoe and lined with tin. Instead, the fabricated pit should be made of concrete block, poured concrete, or treated timbers. The decomposition process produces very little water inside the pit, but the pit must be covered (with soil and planted to vegetation) to carry water away from the pit and to prevent access to heavy equipment.

The openings — also called drop chutes — are made of plastic (PVC) pipes, which protrude out of the mound at intervals of five feet. The chutes should have tightly fitted but removable covers. The bottom of the pit is earthen with holes at intervals up the sides.

Location

Generally, a disposal pit should be located at least 200 feet from dwellings and the nearest water well, 300 feet from any flowing stream or public body of water, and 25 feet from the poultry house. Before constructing a disposal pit, make certain that the soil composition is



Properly constructed disposal pits are made of concrete block, poured concrete, or treated timbers.

acceptable. Bedrock (especially limestone) should be avoided. Locate pits in soil where good surface runoff will occur.

To prevent groundwater contamination, the pit's lowest point should be at least five feet above the highest known water table and at least five feet above bedrock to keep contamination from traveling along a rock fissure. To prevent water from seeping into the pit, construction on a slope, floodplain, or low-lying area should be avoided. Sandy soils are not suitable for installing a disposal pit.

Pit Size

The pit itself should be at least six feet deep with reinforced walls. The size of the pit depends on several factors, including the expected mortality rate of the flock, bird size, and environmental conditions. Use the following table to estimate pit size:

TYPE OF PRODUCT	SIZE OF PIT IN CUBIC FEET PER THOUSAND BIRDS
Broilers	50
Turkeys (to 18 weeks)	100
Commercial layers	55

For broiler mortalities, for example, if you have a 5 percent mortality rate in a flock of 20,000 and you raise five flocks per year, your burial pit should contain at least 250 cubic feet of disposal space. That is, it should be about six feet deep, six feet wide, and about seven feet long. Sometimes it can be more convenient to use several smaller pits to prevent overloading. In cooler climates, the pit size should be larger to accommodate a slower rate of decomposition.

Durability and Cost

The life of the pit will depend on its location and whether it is properly sized, constructed, and managed. Because bacterial action is important, the pit must be operated in a way that will protect the bacterial population. High acidity can slow the decomposition of dead birds. Disposal pits are most efficient during warmer months when bacterial action is greatest. Decomposition is slowed by winter temperatures or by accumulation of water in the pit. Grinding the carcasses or splitting open the dead birds will increase the pit's efficiency and extend its life.

The cost of constructing disposal pits will vary widely depending on the materials used, site conditions, and the size of the pit. The geology — rocky soil, for example — can make digging expensive. As pit size increases, heavier construction is required for walls and tops; thus, higher costs are incurred. For a well-built pit, a useful life of five years is not uncommon, and some producers have reported that pits can be useful for eight to 10 years. Replacement is required when the pit is full.

Operation

After a pit is constructed, producers should check their facilities twice daily for mortalities, which should be transferred immediately to the pit. Covers on the drop chutes should be kept tight at all times to prevent odor and restrict unauthorized access by children, animals, and rodents. Certain insects in a disposal pit are beneficial to the decomposition of the carcasses, but insects should not be allowed to develop into a nuisance. With proper handling the disposal pit costs nothing to maintain except for the labor required to collect the carcasses

Drawbacks

Burial pits may attract flies and scavengers, and they may create offensive odors Further, today's farm may have insufficient land space for burying birds, or the capacity of the pits may be limited in wintertime. In many instances, the dead birds do not completely decompose because of the lack of oxygen Slacked lime may be added to the burial pit to break down the tissue of the dead birds, which will also, in effect, sterilize the remains. If poor soils or a high water table are not considered before pits are dug, groundwater can become contaminated.

Before constructing or installing a prefabricated disposal pit, poultry producers should

consult with their state's veterinary specialist, other agricultural offices, and environmental or natural resource agencies. These agencies may regulate the use of burial pits, or the state may have disallowed burial pits entirely, so seeking expert guidance will often save time and money. Local USDA Soil Conservation Services or Cooperative Extension Service offices can provide technical assistance to growers who want to use disposal pits as part of their mortality management plans.

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Incineration — A Disposal Method For Dead Birds

Incineration, or cremation, is a safe method of carcass disposal and may be an alternative to burial pits. The major advantage of incineration is its security — it is biologically secure, and it will not create water pollution problems. Ash is easy to dispose of and does not attract rodents or pests.

On the other hand, incineration is slow and costly — and likely to become more expensive as fuel costs rise. Incinerators must be properly sited, too, because unpleasant odors may accompany the process. Indeed, an air quality issue for poultry growers who choose this method of mortalities management is the emission of odor and dust (particulates) that may be generated during the process.

Nevertheless, incineration is considered very sanitary when properly applied. Homemade incinerators, that is, 55-gallon barrels or drums containing carcasses that have been drenched in a flammable liquid, are not acceptable and do not meet air quality standards.

Good Incinerator Design

Incinerator design and use are often regulated by states. Producers considering this method of poultry mortality management should consult with their state's environmental and natural resources agencies before incorporating incineration into their mortality management plan. A variety of commercial incinerators are available that will ensure a proper burn and air quality safeguards.

Incinerators should be sturdily built and able to accommodate normal daily mortalities. Those that have automatic controls are most convenient. The unit you purchase should be able to handle large loads and high temperatures, and the size of the incinerator should also be carefully estimated to avoid overloading the equipment. Other disposal methods should be included in your resource management plan to cover situations in which heavy, unexpected losses occur.

Incinerator Location

Additional considerations include the location and proper operation of the incinerator equipment. Nuisance complaints about incinerators are many; where and how you install and operate your equipment will influence the frequency of these complaints. First, locate the unit downwind of the poultry house, residences, and your neighbors' properties. Second, be sure that the discharge stack is far enough away from trees or wooden structures to avoid fires. Incinerators burn at intensely high temperatures. Locating the incinerator in

A variety of commercial incinerators are available.

an area convenient to the poultry house will also contribute to better management.

Sheltering the incinerator from inclement weather will extend the life of the unit. For best results, place it on a concrete slab inside a roofed structure.

Incinerator Costs

You will want to consider at least two items to determine the cost of incineration as a disposal method for poultry mortalities:

- equipment purchase and maintenance, and
- the rate of burn and fuel costs.

Purchase costs will vary depending on the size and type of the incinerator. Discharge stacks and afterburner devices that recycle the fumes can help control odors and dust, but air pollution is difficult to avoid with incinerators. Expendable parts and grates will need to be replaced periodically — perhaps every two or three years — and the whole system may need replacement (or overhaul) every five to seven years.

The rate of burn will likewise vary depending on the weight, moisture, and fat content of the carcasses and on the loading capacity of the unit (e.g., incinerators may have to be loaded several times to handle a day's mortalities). Some broiler producers have experienced an average burn rate of about 65 pounds an hour; they estimate that it costs about $3.50 (1990 estimates) to incinerate 100 pounds of mortalities. If fuel prices increase, so will the cost of each burn.

Incineration is an acceptable and safe method of poultry mortalities management. It does not risk the spread of disease or water pollution; however, it is costly. Not only are direct costs involved in the process, the choice of incineration also means the loss of any nutrient value that the mortalities might have had if composted for land applications or other uses. Growers considering incineration as a method of poultry mortalities management are encouraged to plan this action in connection with their entire resource management system.

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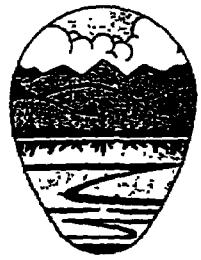

Composting — A Disposal Method For Dead Birds

Composting poultry mortalities or dead birds is a practical and sanitary alternative to burial pits and incinerators. It is a fairly odorless and biologically sound practice. Management commitment is the key to the success of composting dead birds.

Composting yields a valuable product: compost, an odorless, spongy humus-like material that has several uses ranging from soil conditioner to horticultural growing medium. However, most states require that composted birds be applied to the grower's own land. Composting also has other advantages.

- It is not a costly method of mortality disposal.
- The materials needed for composting — litter, mortalities, straw, and water — are readily available.
- It increases biosecurity; that is, composting destroys disease-causing organisms and fly larvae.
- Composting is environmentally sound; properly done, it will not cause odors or water pollution
- Once a composting system has been set up, it will not require much labor.
- Composting systems have been developed and tested to fit both large and small growers' needs.

A Natural Process

Composting is a controlled, natural aerobic process in which heat, bacteria, and fungi change organic wastes into compost. Successful composting requires a specific range of particle sizes, moisture content, carbon-to-nitrogen ratio, and temperature.

- **Particle Size.** Particles that are too small will compact to such an extent that air movement into the pile is prevented. Material that is too large allows too much exchange of air, and so prevents the heat from building up properly. A proper mixture of size allows both air exchange and temperature buildup.
- **Moisture Content.** The ideal moisture content in the composting pile is 60 percent. Too much moisture can cause the pile to become saturated, which excludes oxygen The process then becomes anaerobic, a condition that results in offensive odors and attracts flies Runoff from a composter that is too wet can pollute the soil or water Too little moisture reduces microbial activity and decreases the rate of composting.
- **Carbon-to-Nitrogen Ratio.** Carbon and nitrogen are vital nutrients for the growth and reproduction of bacteria and fungi; therefore, the ratio of carbon to nitrogen (C N) influences the rate at which the composting process proceeds. Conditions are most ideal for composting when the C:N ratio is between 20:1 and 35:1.

If the carbon ratio is too high, the process slows down because it has insufficient nitrogen. This imbalance can be corrected by

adding more manure or litter to the compost pile. If the carbon ratio is too low, the bacteria and fungi cannot use all of the available nitrogen, and the excess nitrogen is converted to ammonia, resulting in unpleasant odors. This problem is fixed by adding more straw or sawdust.

▼ **Temperature.** The best indicator of proper biological activity in the composter is temperature. Use a probe-type 36-inch stainless steel thermometer, 0 to 250 °F, with a pointed tip to monitor temperatures within the compost pile. Optimum temperature range is 130 to 150 °F. When the temperature decreases, the general problem is that not enough oxygen is available for the bacteria and fungi. Oxygen can be replenished by turning or aerating the pile. Temperatures will rise as the composting process repeats itself.

The cycle of composting, turning, composting can be repeated as long as there is organic material available to compost and the proper moisture content and C:N ratio are present. When temperatures reach the optimum range for three days, harmful microorganisms (pathogens) and fly larvae will be destroyed. Daily recording of the temperatures in the piles is important because it will indicate whether the bacteria and fungi are working properly.

Composter Design and Operation

Composting poultry mortalities can be done in or outside the poultry house, but it should always be done in an environmentally safe and healthy manner, under a roof, and protected from rain. Dead bird composters are generally classified as single-stage or two-stage structures. The small, single-stage composter was developed to dispose of small birds, to operate in normal or lower than normal mortality events, and to serve small farms without front-end loaders. The operation is simple, yet effective, and requires only a shovel or pitchfork and a thermometer.

To make an in-house composter, use four screen-and-lumber panels (about 40 by 36 inches) to make a single square bin (Fig. 1). Each bin has a capacity of up to 30 pounds of dead birds per day or a total capacity of 600

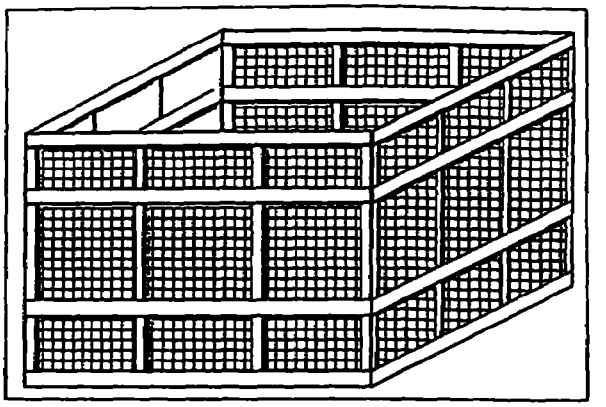

Figure 1.—Typical in-house composter.

pounds. Four to six such bins will handle the dead birds from a 20,000-bird broiler house at a cost of about $500. Position assembled bins at a location convenient for gathering the dead birds and for easy access for unloading between flocks.

The process for composting in a single-stage composter begins with the procedures previously described. The recipe or start-up materials are 200 pounds of litter, one-third bale of straw, and 15 gallons of water. Add these ingredients to a bin in the following order 6 inches of loose straw, 65 pounds dry litter, and 5 gallons of water. Repeat the layering process three times until all start-up ingredients have been used. Insert thermometer; when the material reaches 140 to 150 °F, the composter is ready to begin processing dead birds

Form a V-shaped 18-inch deep trough in the center of the bin. Add straw, litter, dead birds, water, and litter, and cover or cap with start-up ingredients. Avoid placing dead birds closer than 6 inches to the walls Mixing and aeration take place when the bin is prepared for the next load of dead birds (Fig 2). Record the temperature at a depth of 8 to 20 inches in the center of the pile daily Repeat this procedure until the bin is filled Compost may be used in place of new materials to restart.

An outside single-stage composter can be any size. However, an area 4 feet square and a 36-by-48-inch bin is a workable size Place the bins on a concrete pad with a roof to protect the compost from excessive moisture, anaerobic conditions, and pests. The management of, and recipe for, outside composters are the

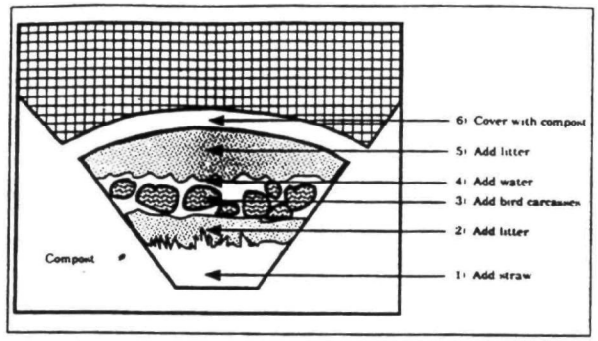

Figure 2.—Loading an in-house composter.

same as for in-house composters, but adjustments can be made to meet individual situations. The time and hand labor required to manage an outside composter must be carefully considered before installation. The cost of an outside single-stage composter varies according to its size, from $500 to $1,500.

Two-stage Composters

A two-stage composter is larger and more expensive than the single-stage composter, but it will accommodate more dead birds. A two-stage composter is also less labor intensive because it relies on mechanized equipment. However, it must be compatible with the management capabilities of the producer. The composting process is done in primary and secondary bins. The following requirements describe the design and lay-out of a two-stage composter.

- The size of the composter is 1 cubic foot of primary bin and 1 cubic foot of secondary bin per pound of daily mortality.
- The height of bins should not exceed 5 feet. Heights greater than 5 feet increase compaction and the potential for overheating.
- The width of the bins is usually selected to accommodate the loading and unloading of equipment. A width of 8 feet is normal, but the bins could be wider.
- Most bins are typically 5 or 6 feet deep, although deeper bins can be used. Longer bins are more difficult to enter and exit and take more time to work.
- Several smaller primary bins work more efficiently than a few large bins. Secondary bins can be larger, but they must have the same capacity as the primary bins (see Fig. 3).

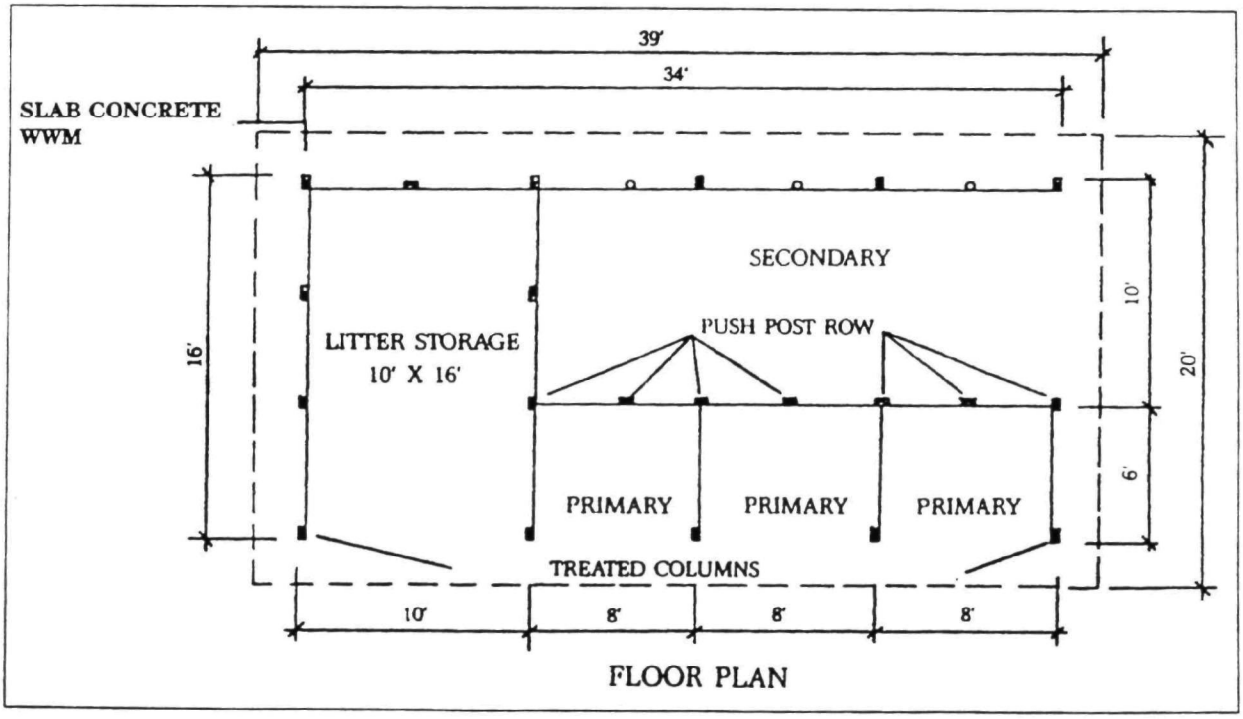

Figure 3.—Typical two-stage composter floor plan (not to scale).

- It is desirable to have extra primary bins in which to store litter and straw. If high mortalities occur, these bins could be used for composting.

- Ceiling height of the composter should be high enough to accommodate a front-end loader extended upward.

- Concrete flooring should be extended beyond the bins sufficiently to allow a tractor or other equipment to work entirely on a concrete surface. Dirt or gravel will rut, dig out, and reduce traction.

- Roof overhang must extend sufficiently to prevent blowing rain from reaching the compost. Side curtains are another option to protect the compost from blowing rain. Maintain dry conditions within the composting structures.

- A composter that has a litter storage facility can greatly enhance the management of dead birds, building cleanout, and litter spreading operations

- The composting facility should be supplied with fire protection equipment in case the compost self-ignites

- The composting facility should be equipped with water and electrical services Water is required for the compost recipe, equipment cleanup, and for the washdown of personnel. Electrical outlets are required for lights and power tools or appliances

Costs of composters depend on many factors — size, configuration (e.g., work areas, ingredients, and finished compost storage), and utilities Some composting structures have been built for as little as $500; others, for as much as $50,000. No specific plan or layout for composters works best in all cases. Many different designs will perform adequately, but management capabilities determine the success of the composting process. Standard plans and management information for poultry mortality composters are available through local USDA Soil Conservation Service or Cooperative Extension Service offices.

Financial aid or cost-share funding may be available to help pay for the design and construction of composting facilities. Check with your local conservation district, USDA Soil Conservation Service, or Cooperative Extension Service offices to learn more about these programs.

Composting Recipe

For composting poultry mortalities in a two-stage composter, a prescribed mixture of ingredients is used called a "recipe." The recipe calls for one part dead birds, one part manure and litter, two-to-three parts straw or other carbon source, and zero-to-a-half part water (Table 1). Recipes for a single-stage composter differ slightly.

Table 1.—Typical recipe for composting dead birds with litter, straw and water as ingredients.

INGREDIENTS	PARTS BY WEIGHT
Dead Birds	1.0
Litter or cake	1.5
Straw	0 1
Water*	0.2

***Water as an ingredient may not be necessary. Too much water may result in anaerobic condition.**

Proper layering of the recipe will ensure appropriate heat for composting the mortalities in about 14 days To begin, place 6 to 12 inches of litter or manure, followed by a 6-inch layer of loose straw to provide aeration, followed by a layer of dead birds Depending on the moisture content of the manure or cake, water may or may not be added Repeat this layering process until the pile or bin is full (see Fig 4)

Leave 6 to 8 inches of space between the edges of the dead bird layer and the wooden wall of the composter This space allows air movement around the pile and keeps carcasses nearer to the center of the pile, where the heat is highest. Do not stack dead birds on top of each other. They may be adjacent to one another, even touching, but they must be arranged in a single layer. Spread litter or manure and straw as evenly as possible.

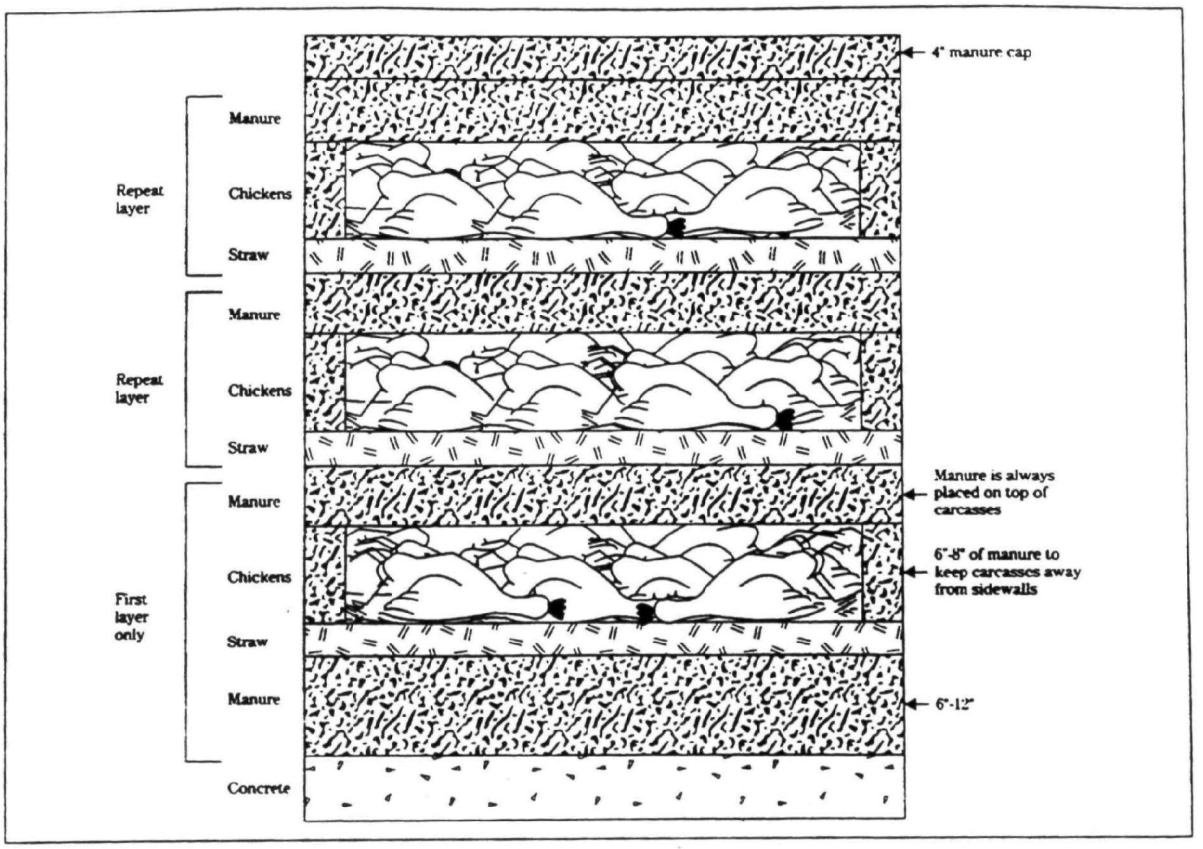

Figure 4.—Recommended layering for dead bird composting.

Use the same layering sequence (dead birds, litter, and straw) after loading mortalities that only partially complete a layer. If dead birds are carelessly loaded — stacked one on another or placed against the sidewalls of the structure — they will putrefy. Once the compost pile is complete, or full, "cap it off" with a 6-inch layer of dry litter, manure, straw, or similar material to reduce the potential for attracting flies and to provide a more pleasing appearance. This same recipe can be used for composting caged layers, broilers, turkeys, breeders, or other types of poultry.

Mixing, aerating, and moving the composting mass with a front-end loader or shovel will uniformly distribute the ingredients, add oxygen to the pile, and reinvigorate the composting process. Temperatures will rise after each mixing until all the organic material is decomposed. After the pile is capped, wait 11 to 14 days before turning the mixture. However, if the temperature falls below 120 °F or rises above 180 °F, the compost pile should be aerated or mixed immediately.

Elements of a Composting System

The decision to use a composting system for poultry mortality management means that the grower is committed to managing the composter properly and seeking help as needed. The composter should be adequately sized to process the normal mortalities that occur in an operation. To determine the proper size of the composting unit, contact the USDA Soil Conservation Service or a Cooperative Extension office for assistance. A few general principles apply.

▼ **Location and Access.** The composter should not be located near any residence. Offensive odors are not usually generated in the composting process; still, the handling of dead birds, manure, and litter on a daily basis may not be aesthetically pleasing. The site should be well drained and accessible; farm equipment is usually needed to carry dead birds and compost ingredients to the composter and to remove the finished compost.

▼ **Foundations** An impervious, weight-bearing foundation or floor, preferably of concrete, should be provided under primary and secondary composting vessels or bins. Experience has shown that after frequent loading and unloading activities, dirt or gravel tends to become rutted and pot-holed. A good foundation ensures all-weather operation, helps secure against rodent and animal activity, and minimizes the potential for pollution of surrounding areas.

▼ **Building Materials and Design.** Pressure-treated lumber or other rot-resistant materials are necessary. A roofed composter ensures year-round, all-weather operation, helps control stormwater runoff, and preserves composting ingredients at the desired moisture content. Adequate roof height is also needed for clearance when using a front-end loader. The amount of rain that is blown into the composter can be minimized by the addition of partial sidewalls or curtains and guttering along the roof.

Thus, the key requirements for a mortality composter are good management; a properly sized, properly located facility; easy access, and a well-constructed, roofed structure. Following these regulations will result in a mortalities management system that is nonpolluting and capable of producing a valuable by-product.

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Rendering — A Disposal Method For Dead Birds

Rendering — the process of separating animal fats, usually by cooking, to produce usable ingredients such as lard, protein, feed products, or nutrients — is an ancient waste management process. It is also an excellent way to recycle dead birds. We are now able to reclaim or recycle almost 100 percent of inedible raw poultry material through rendering techniques.

Until recently, the animal protein in meat and bone meal residues was considered a waste of the rendering process; it was usually discarded, though it could sometimes be used as a fertilizer Now rendering plants pick up or receive about 91 million pounds of waste annually to supply 85 percent of all fats and oils used in the United States. They also export 35 percent of the fats and oils used worldwide. Rendering operations provide a vital link between the feed industry and the poultry grower and help us control odor and prevent air and water pollution.

Rendering has not always been widely practiced as a poultry mortality management technique because

- dead birds may carry disease-causing organisms;
- suitable facilities for rendering have not always been available; and
- it can be difficult to keep the carcasses suitable for rendering.

Thus, dangers associated with the routine pick up and delivery of the carcasses to the rendering plant have been perceived as a threat to avian health and the environment.

Rendering's great advantage as a management technique is that it removes mortalities from the farm and relieves the grower of environmental concerns related to other methods of disposal. It may also provide some economic return. Therefore, as concerns for nutrient losses and water quality increase, producers and buyers of poultry products are experimenting with new techniques for delivering poultry mortalities to rendering plants as part of their mortalities management planning.

A major disadvantage of rendering as it is usually perceived is that disease may be carried back to the poultry farm by the vehicles or containers used to convey the dead birds to the rendering plant. Appropriate management and handling techniques can alleviate this difficulty.

Holding Methods

Raw or fresh poultry mortalities that are destined for a rendering plant must be held in a leak-proof, fly-proof container, and they must be delivered to, or be picked up by, a rendering company within 24 hours of death All mortalities must be held in a form that retards decomposition until they are collected

Freezing or Refrigeration, A New Holding Technique

Some producers are experimenting with a technique that combines on-the-farm freezing or refrigeration and the rendering process to determine whether freezing can be an effective way for growers to hold dead birds until they can be rendered. Large custom-built or ordinary commercial freezer boxes are being used to preserve dead birds until they can be picked

up and delivered to the rendering plant. Custom-built boxes or units are usually free standing with self-contained refrigeration units designed to operate at temperatures between 10 and 20 °F.

Ideally, these freezer units will have no environmental or health impacts. The smaller ones are designed to allow the immediate removal of the carcasses from the growers; the larger ones, to hold the birds frozen until the box is full or otherwise scheduled for delivery to the plant.

Large domestic freezers will hold about 250 to 300 pounds of dead birds. Specifically designed boxes can handle 1,600 to 2,000 pounds of dead birds and are easily loaded through various door arrangements. They must also be sealed against weather and air leakage. The grower can load the freezer each day — once is a minimum. Putting the birds in the freezer in a single layer helps ensure that all the carcasses are properly refrigerated or frozen.

Fresh unfrozen carcasses are added to the box as the top layer. The temperatures are set to allow the product to be completely frozen within 24 hours. Check the temperature gauge at each loading. Overloading may prevent the total freezing of the carcasses.

The boxes can be emptied at the end of each growing cycle or as needed. The rendering plant can send a truck to the farm, or the grower may deliver the unit to the plant Boxes or containers are picked up (using a forklift or front-end loader) and emptied. The freezer boxes open from the top, bottom, or sides for easy access and are then resealed The refrigeration unit never leaves the farm, only the container holding the dead birds is removed or emptied. Freezer units are expected to last roughly 10 years. They operate on energy efficient circuit boxes with an operating cost of about $1 50 per day.

So far, the cost of freezing as a collection method is related to the cost of energy; its potential for generating income is not yet known. The product is processed at a rendering plant. Although some companies have already made an investment in these units, other growers should be able to recoup the costs of freezer boxes and product transportation. Transfer of pathogens or harmful microorganisms between farms has not been found to be a problem with this method of collection. Additional research is needed to fully explore this management option and any pathogenic problems that may be perceived in it; however, its proponents stress its usefulness as a way to reduce or eliminate potential pollution and improve conditions on the farm.

Fermentation

Fermentation procedures have been explored to determine whether they can contribute to a biologically secure and environmentally safe method of holding poultry carcasses until their nutrient components can be recovered in a form suitable for reprocessing and refeeding.

Fermentation is, in fact, a way to safely dispose of poultry mortalities, but it also keeps them on-site until the end of the growing cycle or until sufficient volume is attained for delivery to a rendering plant. Fermentation mixes the mortalities and a fermentable carbohydrate, such as sugar, whey, ground corn, or molasses.

The fermentation process produces organic acids that lower the pH of the mixture. The acidity of fresh tissue is near neutral (pH equals 6.3 to 6.5), while the acidity of the silage is 4 0 to 4.5. Thus, the activity of anaerobic bacteria (Lactobacillus, which are found naturally in poultry) converts the sugars into lactic acid and lowers the pH to less than 5 0, thus inactivating the pathogenic microorganisms in the carcasses and preserving the organic materials

In the experiments presently underway, it has not been necessary to use any bacterial inoculant in the mixture The fermented product is incubated anaerobically in airtight containers where it can be safely stored for several months — that is, until the amount of the product suffices to warrant the cost of transportation to the rendering plant

Acid Preservation

Preserving foodstuff by acidification has been a widespread practice in agriculture. This method of preserving dead birds is the same as the fermentation process except that propionic,

phosphoric, or sulfuric acid is added to the poultry carcasses, which are kept in an airtight, plastic container. Sulfuric acid may be preferred because it (1) retards spoilage, (2) excellently preserves the carcass, and (3) is relatively low in cost.

Carcasses can be punctured with a blunt metal rod rather than placed through a grinder. Punctured carcasses can be separated from the acid solution without the accumulation of sludge in the holding container.

The product resulting from lactic acid fermentation and acid preservation reduces the transportation costs associated with rendering by 90 percent. What is more important, however, is that these processes eliminate the potential for transmitting pathogenic organisms into the rendered products or environment. Accurate costs of fermentation and preservation are limited because most of the work has been through research. It is estimated, however, that costs will range from three to four cents per pound of dead birds.

In an expanding poultry industry, the production of manure and mortalities will only increase. Producers should contact the renderers in their area to determine which holding and transportation methods are acceptable, and they must increase their search for safe, cost-effective disposal and reuse methods. Every possible safe method should be explored until each grower determines the method most compatible with his or her situation and management abilities. Rendering, like composting, adds value to the end product.

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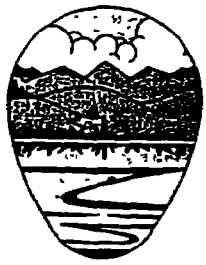

Site Selection For The Poultry Farmstead

Site selection and general farmstead planning are important elements in subsequent profitability and ease of animal waste management handling. Each site is, of course, unique, but some general environmental and safety considerations apply to all sites. Besides the visual impact, the first considerations are air quality (dust and odor control), the movement and quality of the water (drainage and supply), and availability of sufficient land for handling waste production. Site selection is also an appropriate beginning for establishing a good neighbor policy

A good location will help you minimize potential problems with odor, rats, flies, beetles, and mice. Locating the poultry house conveniently near the farm residence is useful; but the location should also be attractive, or the house should be shielded (not visible) from the road, especially if it is near a property line. Building a vegetative windbreak or fence will not only help the operation's appearance, it will also reduce dust and odors that might create a nuisance, or the perception of a nuisance, among your neighbors If the house is sited within an adequate windshed, many potential air quality problems can be avoided with little on no adverse effect on the community (see Fig. 1).

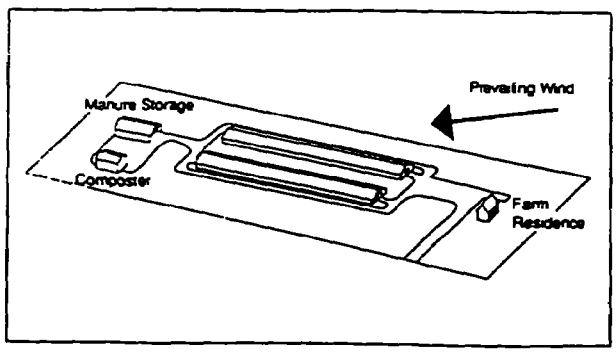

Figure 1.—Siting of a typical broiler operation.

Soil drainage (both surface and subsurface) is likewise an important consideration. A site on relatively high ground with adequate drainage can help prevent flooding, road wash outs, wet litter, and disease. Good drainage coupled with an appropriate use of gutters and grading around the outside of the building will direct runoff away from the production facility and family home. Soil drainage helps ensure access to the facility at all times on all-weather roads It also helps secure a safe drinking water supply

Subsurface drainage is also important to prevent excessive nutrients or other possible contaminants from entering the groundwater In the manure storage area, a barrier between the manure and the ground is needed, such as a plastic tarp under the gravel or concrete base of the structure Within the house itself, the removal of cake and wet litter should be planned, waterers should be inspected for leaks, and stirring, air drying, and ventilation should be part of standard operating procedures Foundation drains or footing drains can also be added to remove any subsurface water that might otherwise enter the house.

Manure Storage Sites

Manure storage sheds, stacks, or windrows should be convenient to the poultry house, but distant enough to reduce disease transmissions between flocks or houses. A distance of 100 feet is reasonable Storage structures are usually 40 feet wide with a 14-to-16-foot clearance.

The length varies depending on the amount of manure to be stored. Many of these structures are three-sided — a rectangle with one end open. The interior wall should be strong enough to withstand the weight of piled manure and the force of front-end loaders.

The site for a stack or windrow should be properly prepared before manure is laid down. If the storage time exceeds one month, a pad must be available, and the stack or windrow should be covered to reduce flies and odor problems. Manure stored on the bare earth must be completely removed to avoid creating an area in which high salinity and nitrate-nitrogen are a potential for groundwater contamination.

Dead Poultry Disposal

In the past, poultry mortalities were simply buried on site, but this disposal method is no longer feasible and is, in some places, illegal. Composting is one of several alternative methods that use this resource economically; it also helps protect water quality. For composting to work effectively, however, an appropriate structure is necessary. This structure can be conveniently attached to the manure storage facility. Refer to the appropriate fact sheets on manure storage and poultry mortality management for additional material on these topics.

The Farm*A*Syst Assessment Program

A new program that is helping to prevent water pollution in rural America is called Farm*A*Syst, the Farmstead Assessment System. It is a voluntary, farmstead or rural resident pollution risk assessment, designed to help rural residents become knowledgeable about water pollution risks and to help them develop an action plan to reduce the risks identified by the system. It may also be a useful tool for site selection and general farmstead planning.

The Farm*A*Syst program addresses nutrient contamination, water well design and location, waste and fertilizer storage, septic systems, dead bird disposal, pesticide and petroleum storage, household and farmstead hazardous waste and waste disposal, and microorganism contamination of well water. Growers can learn more about this program and how they can participate in it by contacting the National Farm*A*Syst Staff, B142 Steenbock, 550 Babcock Drive, University of Wisconsin, Madison, WI 53706 (phone 608/262-0024); or the USDA Soil Conservation Service or Cooperative Extension Service offices. Farm*A*Syst is jointly funded by the USDA Soil Conservation and Cooperative Extension Services, and the U.S. Environmental Protection Agency.

Conclusion

Proper siting and design of a poultry facility is important to the economy and success of the whole operation. It prevents problems before they arise, thus saving the grower money, time and worry, and best of all, it protects the environment and community from serious problems or distressing nuisances.

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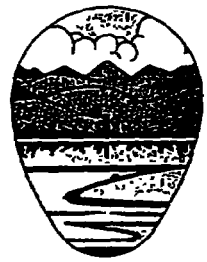

Air Quality and Its Management

The Clean Air Act of 1970 provided for uniform air quality standards and control of emissions from existing facilities. It also prohibited the construction of new facilities that violate or interfere with federal or state regulations for air quality standards. Although many of the private citizen complaints and civil suits brought against livestock and poultry operators are because of odor problems, many of the states' air quality requirements have been established as a direct result of federal legislation. The odor (and sometimes dust) problems derived from poultry operations are associated with improper or mismanaged burial pits, emissions from incinerators, and land applications of poultry waste.

The Clean Air Act Amendment of 1990 (Pub. Law 101-549) also contains provisions of importance to producers of agricultural products. Because its goals are to reduce emissions that cause acid rain and to protect stratospheric ozone, ammonia volatilization from animal and other agricultural operations will most likely come under increased scrutiny and possible control Some states are starting to request atmospheric ammonia test results on air samples taken at the property lines of animal operations

Methane emissions from "rice and livestock production" and from "all forms of waste management . . . including storage, treatment, and disposal" are mentioned in the 1990 law as being of concern with regard to ozone depletion. These sources and others, both nationally and internationally, are to be evaluated by EPA jointly with the secretaries of Agriculture and Energy, and control options will be developed that can be used to stop or reduce growth of methane concentrations in the atmosphere.

Poultry Production Facilities and Air Quality

Poultry production facilities can be the source of gases, aerosols, vapors, and dust that can, individually or in combination, create air quality problems. These problems include

- nuisance odors,
- health problems for poultry in confined housing,
- deadly gases that can affect poultry and humans, and
- corrosion.

A variety of gases are generated during the decomposition of poultry wastes Under aerobic conditions, carbon dioxide is the principal gas produced; under anaerobic conditions, the primary gases are methane and carbon dioxide About 60 to 70 percent of the gas generated in an anaerobic lagoon or pit is methane and about 30 percent is carbon dioxide Trace amounts of more than 40 other compounds have been identified in the air exposed to degrading animal waste, including mercaptans (the odor generated by skunks and the smell introduced in natural gas are in the mercaptan family), aromatics, sulfides, and various esters, carbonyls, and amines

Methane, Carbon Dioxide, Ammonia, and Hydrogen Sulfide

The gases of most interest and concern in poultry nutrient management are methane (CH_4), carbon dioxide (CO_2), ammonia (NH_3), and hydrogen sulfide (H_2S). The following paragraphs summarize the most significant characteristics of these gases.

▼ **Methane.** Methane, a flammable gas, is a possible source of energy on the farm. Because methane is also explosive, extreme care is required when attempting to generate and capture this gas for on-farm use.

▼ **Carbon Dioxide.** Carbon dioxide can be an asphyxiant when it displaces normal air in a confined facility. Because CO_2 is heavier than air, it remains in a tank or other well-sealed structure, gradually displacing the lighter gases. With high-density housing, gas and particulate levels may increase, and control becomes more difficult. Carbon dioxide increases substantially with the larger number of poultry producing CO_2, as compared with earlier low-density housing. Continued monitoring of temperature, air removal rate, and manure moisture content is required to maintain proper carbon dioxide concentrations.

▼ **Ammonia.** Ammonia is primarily an irritant and has been known to create health problems in animal confinement buildings. Irritation of the eyes and respiratory tract are common problems from prolonged exposure to this gas. It is also associated with soil acidification processes.

Ammonia concentration in broiler houses has increased in the past few years. The primary reason is that ventilation rates are reduced to conserve heat in the winter months Research also shows that dust particles serve as an ammonia transport mechanism, so overventilation to the outside may lead to odors near the house and overly dry litter inside the house.

Ammonia concentration increases with increasing pH, temperature, and litter moisture content. It is desirable to maintain litter moisture in a production house below 30 percent for ammonia control. Studies indicate that ammonia increases bird susceptibility to Newcastle disease and decreases feed intake and egg production.

▼ **Hydrogen Sulfide.** Hydrogen sulfide is deadly. Humans and farm animals have been killed by this gas after falling into or entering a manure tank or a building in which a manure tank was being agitated. Although only small amounts of hydrogen sulfide are produced as compared to other major gases, this gas is heavier than air and becomes more concentrated over time.

Hydrogen sulfide has the distinct odor of rotten eggs. Hydrogen sulfide deadens the olfactory nerves (the sense of smell); therefore, if the smell of rotten eggs appears to have disappeared, this does not indicate that the area is not still contaminated with this highly poisonous gas. Forced-air ventilation or an exhaust system helps prevent gas poisoning. Otherwise, evacuate the area until the gas can be removed.

Where to Go for Help

Information on achieving air quality standards and managing the air quality problems of poultry production facilities is available from the U.S. Department of Agriculture, U.S. Environmental Protection Agency, and the Department of Energy. Poultry associations and state water quality agencies can also help.

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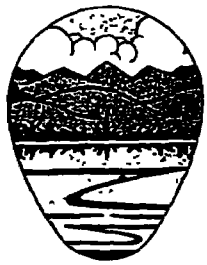

Preventing Fires in Manure/Litter Storage Structures

Hundreds of poultry manure/litter storage structures have been built as a component of a total waste management program on the poultry farmstead. Storage facilities help prevent the possibility of water pollution and provide flexibility in the timing of land applications. They also protect this resource from the weather and wildlife so that it can be used as a cattle feed.

Manure piles will generate heat, however, and care should be taken to prevent fires in the storage facility. Spontaneous combustion in a litter stack is possible, probably as a result of the buildup of combustible methane or the storage of wet and dry litter. Fires may also occur if the manure is stacked too close to wooden walls that may ignite when the temperature in the litter reaches the wood's flash point The exact causes of litter storage fires are difficult to know, but good management principles will help protect the litter.

Methane Production

Anaerobic bacteria generate about 50 to 65 percent methane, about 30 percent carbon dioxide, and a smaller percentage of other gases. Therefore, if the moisture content of stored litter is more than 40 percent in a stack with little or no oxygen, then conditions are right for anaerobic bacteria to grow and methane to result. Unvented landfills have the same problem. Methane's specific gravity is less than air, however. If the stack has adequate pore spaces (or the landfill has ventilation pipes), the methane will escape into the atmosphere.

High moisture levels in stored litter help create the potential for fires, as does layering the manure (putting new litter on top of old litter). Compacting the litter will trap heat in the pile, and failure to provide an adequate ratio of surface area to volume can also create problems.

Tips for Fire Prevention

The following guidelines will help prevent fires in storage facilities:

- Keep the litter dry and do not stack it too near the open end of the building (methane is flammable in air)
- Do not compact moist cake or mix it with dry litter, and do not stack cake or dry litter higher than 5 feet or store it against the wood
- Do not compact the dry litter, since compacting creates anaerobic conditions and prevents the natural venting of methane
- Do not cover moist litter but allow the open litter to vent naturally.
- Monitor the resources in your storage facility regularly, and remove any materials that have temperatures greater than 180 °F. If the temperatures exceed 190 °F, notify the fire department and prepare to move the material. Emptying the storage area will bring the litter out into the air, so precautions must be taken against a fire occurring at this time.

It is a good idea not to store expensive equipment in the litter storage facility.

If you are storing dry litter for later use as a cattle feed, cover it with polyethylene. This technique will suppress the temperature buildup and reduce the production of bound nitrogen, a form of protein that cattle are unable to digest.

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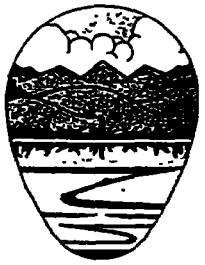

TREATMENT LAGOONS AND PONDS

Manure in shallow pits (from caged layers) can be flushed out once a day or scraped out dry every one to three days. Flushed manure can then be transferred to storage by gravity or with a pump. Semisolid or liquid manure can be stored in below or above ground ground storage tanks, steel storage tanks, or earthen basins. Thus, lagoons are a type of earthen basin used for waste storage; however, they can also be used as manure treatment systems for converting the organic matter in animal wastes into more stable products Lagoons have even been used as digesters to convert large masses of waste into gases, liquids, or sludge. Aerobic and anaerobic lagoons work with bacteria to decompose the dissolved solids in animal waste.

Lagoons became a somewhat popular component of waste management systems during the 1970s when the interest shifted from simply using waste for fertilizer in land applications to treating the waste to produce a more convenient waste management system overall

Anaerobic bacteria in animal waste (i.e., bacteria that live in animal intestines) cannot work in the presence of oxygen. Aerobic bacteria, on the other hand, must have oxygen; therefore, anaerobic lagoons are deep and airless, aerobic lagoons are spread over a large surface area, take in oxygen from the air, and support algae.

The advantages of lagoons are that they are easy to manage, convenient, and cost-efficient. Storage and land application can be handled more opportunely if the grower has a lagoon, and labor costs and operating costs are slight after the initial investment. In general, anaerobic lagoons do not require much space, and they provide storage and disposal flexibility.

Other factors, however, must also be considered. Lagoons are a source of odors and nitrogen losses and may require frequent sludge removal if they are undersized. Groundwater protection may be difficult to secure, and if mechanical aeration is used, energy costs must be included in the accounting. Proper management is essential for lagoon maintenance and operation.

Aerobic Lagoons

The design, shape, size, capacity, location, and construction of the lagoon depends on its type. Aerobic lagoons require so much surface area (to maintain sufficient dissolved oxygen) that they are an impractical solution to most waste management problems They may require 25 times more surface area and 10 times more volume than an anaerobic lagoon Nevertheless, some growers may consider using an aerated lagoon — despite its expense — if they are operating in an area highly sensitive to odor

Some of the sizing difficulty can be solved by using mechanical aeration — by pumping air into the lagoon — but the energy costs for continuous aeration can be high Aerobic lagoons will have better odor control, and the bacterial digestion they provide will be more complete than the digestion in anaerobic lagoons

Lagoon design and loading specifications should be carefully followed and monitored to increase the effectiveness of the treatment. No more than 44 pounds of biological oxygen demand (BOD) effluent should be added to the

lagoon per day per acre. The lagoon should have sufficient depth so that light will penetrate the 3 or 4 feet of water. Effluents from the lagoon should be land applied to avoid long-term ponding and to make economical use of the nutrients that remain in them.

Anaerobic Lagoons

Anaerobic treatment lagoons are earthen basins or ponds containing diluted manure that will be broken down or decomposed without free oxygen. In the process, the organic components or BOD in the manure will be liquified or degraded naturally. Anaerobic lagoons must be properly designed, sized, and managed to be an acceptable animal waste treatment facility.

Liquid volume rather than area determines the size of anaerobic lagoons. The lagoon should accommodate the design treatment liquid capacity and the amount of wastewater to be treated; it should also have additional storage room for sludge buildup, temporary storage room for rain and wastewater inputs, extra surface storage for a 25-year, 24-hour storm event, and at least an additional foot of freeboard to prevent overflows.

The design criteria for anaerobic lagoons are based on the amount of volatile solids to be loaded each day. The range is from 2.8 to 4.8 pounds of volatile solids per day per 1,000 cubic feet of lagoon liquid. The amount of rain that would collect in a 24-hour storm so intense that its probability of happening is once in 25 years requires at least 5 to 9 inches of surface storage

To protect the groundwater supply, lagoons should not be situated on permeable soils that will not seal, on shallow soils, or over fractured rock. Nor should mortalities be disposed of in lagoons; in fact, screening the wastes before they enter the lagoon helps ensure complete digestion and the quality of the wastewaters for land applications. If the site's topography indicates a potential for groundwater contamination, then any earthen basin should be lined with clay, concrete, or a synthetic liner.

New lagoons should be filled one-half full with wastewater before waste loading begins. Planning start up in warm weather and seeding the bottom with sludge from another lagoon helps to establish the bacterial population. Because bacterial activities increase in high temperatures, lagoons, in general, work best in warm climates. Manure should be added to anaerobic lagoons daily, and irrigation (drawdown) should begin when the liquid reaches normal wastewater maximum capacity. The liquid should not be pumped below the design level treatment, however, because the proper volume must be available for optimum bacterial digestion.

Drawdown (that is, the lagoon liquid) can be used for land applications guided by regular nutrient management planning and sampling of the lagoon liquids and soils to ensure safe and effective applications. When sludge accumulation diminishes the lagoon's treatment capacity, it, too, can be land applied under strictly monitored conditions.

Secondary lagoons are often needed for storage from the primary lagoon. Using a secondary lagoon for irrigation also bypasses some of the solids picked up in the primary lagoon. The size of secondary lagoons is not critical.

Information and technical assistance and some cost-share programs are available for producers who determine that a lagoon system should be part of their resource management system. The USDA Soil Conservation and Cooperative Extension Service offices can provide additional assistance.

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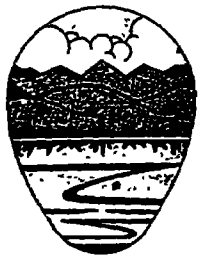

CONTROLLING STRUVITE BUILDUPS

Magnesium ammonium phosphate, sometimes called struvite, is a grayish-white crystalline salt that builds up on the internal pump and piping surfaces used for lagoon liquid recycling. It usually appears on metallic surfaces but also on plastics. Steel, cast iron, bronze, and brass are equally susceptible.

Struvite usually builds up on the internal pump components first, then moves outward to the discharge pipes. It often occurs at pipe joints, elbows, valves, or imperfections because grit and solids tend to lodge at these points, providing a base for the salt to grow. Predicting struvite is difficult because its cause is not well known. Design, maintenance, and management techniques have been researched that can reduce the buildup to acceptable levels

Pumping and Piping System

Use only high-quality, low-pressure, self-priming centrifugal or submersible pumps. They should not be oversized in relation to the piping network, and should perhaps be on a timer The suction pipe should also be large enough to prevent pump cavitation. Normally the suction pipe diameter should be one size larger than the discharge pipe. Locate the pump close to the high-water level to minimize suction lift. Replace fine mesh suction intake strainers with wire screens or baskets of 1-inch mesh or larger The diameter should be at least five times the diameter of the suction pipe. Struvite will also build up on the screens.

Use nonmetallic pipes and fittings. Pipes should be large enough to maintain flow velocities between 3 to 5 feet per second; the minimum pipe diameter at any point except at the immediate discharge point should be 1.5 inches. Sharp pipe bends (elbows and tees) should be avoided. Instead, use flexible plastic pipe and long sweep elbows for the direction changes. The system (pumps and piping) should have sufficient capacity to work only one-half to two-thirds of the time, and piping systems not in continuous use should be drained between pumping events.

Electrostatic Charges

Stray voltage is also believed to contribute to struvite. Direct grounding of the pump housing can discharge any static charges. A metal rod should be placed 10 to 12 feet into the moist soil near the lagoon's edge, and cable connections at the ground rod and pump should be checked periodically for corrosion.

Lagoon Management

Lagoons should be properly sized New ones should be charged at least half full of water before startup, and the liquid level should be brought up to design levels as soon as possible. Rainfall during normal years dilutes lagoon liquid while extended periods of hot, dry weather increase nutrient and salt levels and the rate of salt buildup in recycling systems Flushing with fresh water or irrigating a portion of the lagoon contents may help

Acid Cleaning

Salts can be dissolved with dilute acid treatments. Several doses followed by flushing the spent acid solutions will be needed to treat heavy buildups. A more thorough and more costly method is to install an acid recirculation loop. Use a 150-gallon acid-resistant tank as

the reservoir. You will need enough solution to fill the pipe length and some in reserve to keep the recirculation pump primed. Use the accompanying table to determine how much acid you will need.

Table 1.—Amount of solution needed for acid cleaning using an acid recirculation loop.

DIAMETER OF PIPE, IN INCHES	SOLUTION NEEDED PER FOOT OF LENGTH, IN GALLONS
1.0	0.06
1.5	0.13
2.0	0.20
2.5	0.29
3.0	0.43
4.0	0.70
6.0	1.53

To reduce the size of the tank, isolate sections of the line with valves and circulate the acid through only one section. The flush pump suction is switched from the lagoon and connected to the bottom of the acid tank with a quick-connect coupling. A 1-inch line returns acid from the end of each treated pipe section to the tank.

Hydrochloric acid can be purchased at most chemical supply houses or paint stores. Dilute the acid with water on a 1 to 9 ratio — 1 gallon acid to 9 gallons of water. Use caution. Mixing acids with water is a hazardous operation. Partially fill the tank with water, then add the acid slowly to the water. Eye protection is essential, and heat will be generated. To treat heavy struvite buildups, recirculate the mixture overnight and count on using the mixture only once. Spent acid may be dumped into the lagoon. Acids currently cost about $14 for a 15-gallon drum or about $33 for a 50-gallon drum. Deposits on the drums are $25 and $50, respectively.

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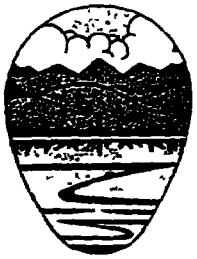

Protection Against Pests, Predators, and Darkling Beetles

Pests, often called vectors because they may be a point of entry for disease or other nuisances in the poultry house, are an aspect of waste management that should not be overlooked. Vectors can be either living or nonliving carriers of disease. Especially troublesome on the poultry farm are house flies, rats, and darkling beetles. Wildlife, especially feral dogs and coyotes, must also be controlled. Having proper waste management facilities and maintenance procedures on the farm will contribute to productivity, nutrient management, and environmental safety. A cost-effective and safe pest control system is essential.

Uncontrolled pests cause irritation to birds and workers, carry poultry disease pathogens, increase mortality, lower carcass grades and production, damage building materials, and interfere with feed conversion. In addition, and if they did nothing else, poultry pests must be carefully controlled because they can migrate from litter to nearby residences, where they may become a serious nuisance among the neighbors

Flies

Moist manure is not only a threat to surface and groundwaters; it is also an ideal breeding ground for flies. Caged layer operations are most susceptible to this problem, followed by breeder farms and, occasionally, broiler farms. Wherever poultry houses are susceptible to flooding, or litter is stored outdoors, the potential exists for fly-control problems.

Flies, which generally become active in the early spring (mid-March in many areas), have four stages of development: egg, larva, pupa, and adult. Most generations require about two weeks to develop. Females will produce 120 to 150 eggs in three or four days, and hatching occurs between eight and 24 hours later. House flies can complete their entire life cycle in as few as seven days; therefore, many of these 150 flies will also breed within a few days. Twenty to 30 generations in a fly season is not unusual. As many as 1,000 flies can develop in a single pound of suitable breeding material.

The actual rate of development depends on the temperatures and moisture levels in the breeding area. Since fresh manure is about 75 percent moisture, and flies breed in areas containing 75 to 80 percent moisture, poultry litter should be kept as dry as possible. Leakproof waterers should be installed and maintained in good condition. Broken eggs and mortalities among the flock should be cleaned up immediately

Manure should be removed from the house every four to seven days during hot weather After removal, it must be stored and used properly to achieve fly control If manure can be dried quickly or immediately liquified, it will not become a breeding ground for flies During land applications, poultry manure should be spread thinly to promote drying. If fly larvae are in the manure, then incorporating it into the soil as quickly as possible will help break the fly development cycle.

Under certain conditions, insecticides may be used to control adult flies in barns and poultry houses. But these products should be reserved for critical times when the management system breaks down, because flies quickly develop resistance. Insecticide applications may

be regulated in some states and should be handled carefully to minimize any harmful effects associated with toxic ingredients.

Rats and Mice

Voles, field mice, and cotton rats are not usually the source of problems for poultry growers. Norway rats and roof rats, however, are two non-native species of rats that can be troublesome — and they proliferate rapidly. A pair of rats will produce six to 12 young in 21 days — and each of these becomes sexually mature in three months. A single pair of rats, if they find food, water, and shelter, can produce a colony of 640 rats in a year.

Poultry houses provide everything the rats need: food, water, and shelter. Norway or wharf rats usually nest under buildings and concrete slabs and in garbage dumps. They are great burrowers and may have an extensive system of burrows under the poultry house, with several escape routes. They eat anything but prefer nuts, grains, meats, and some fruits They can easily find meats and grains in the poultry house.

Roof or black rats are more aerial than Norway rats. They enter buildings from the roof or utility lines. They usually live in trees, so access to the poultry house is easy: up the walls, across vines, along pipes. Exterior walls should be hard, flat surfaces, and all entrance holes should be plugged up. Rats can make themselves "paper thin" to come in under doors and through holes as small as one-half inch in diameter

The best rat control program is proper resource management, maintenance, and sanitation, but the food supply in the poultry house makes rat occupation probable. Some chemical controls or rodenticides may, and probably should be, added to your control program To administer rat poison effectively, first know how many rats you are dealing with; then, establish bait stations near the walls in areas of rodent activity.

To determine how many rats are in the poultry house, observe the area at night as well as in the daylight. Rats are nocturnal; if you see no rats in the day or at night, there probably are not many around. If you see old droppings or gnawed areas, no rats during the day, and only a few at night, rats are probably present in medium numbers only. Finally, if you see fresh droppings and tracks, some rats during the day, and three or more at night, large numbers are probably present.

To control the infestation, use single or multiple doses of a rodenticide in the bait stations. Avoid making the rats sick; if they get sick and do not die, they will become bait-shy and not eat the poison. Place the bait stations appropriately and protect them from moisture, dust, and weather to encourage the rats to eat from these stations. Rats, like many animals, prefer fresh food.

Because rats are colorblind and have poor eyesight, rodenticides can be marked for safety. If other conditions make poisons inadvisable, rats can be trapped with common snap traps, glue boards, or in live traps.

Darkling Beetles

Known as litter beetles, lesser mealworms, or "black bugs," the darkling beetle (*Alphitobius diaperinus*) is found in large numbers in poultry houses, in the woods, and around feed bins These black or reddish-brown beetles are troublesome in turkey and broiler production because deep litter and open-floor housing provide an ideal habitat in which the beetles can survive and reproduce.

The total effect of darkling beetles on poultry production is not known They may be more problematic as a nuisance than as a vector (carrier of disease) However, beetles are thought to harbor a number of disease organisms — for example, fowl pox, *E coli*, *Salmonella* spp , Newcastle disease, and avian leukosis — and to be involved in the transmission of the causative organism for Marek's disease, although immunization against Marek's disease is now available. Darkling beetles are also an intermediate host for poultry tapeworms and cecal worms. If they are in litter that is land applied, their possible effects on wildfowl must be considered.

An undisputed second concern related to the darkling beetle is that they can damage the insulation in poultry houses. Larvae bore into the insulation to find safe places to pupate. But adult beetles who eat the pupae soon enlarge the larval tunnels in their search for an easy

meal. Birds and mice then claw at the insulation to get at the adult beetles, larvae, and pupae. In a severe darkling beetle infestation, as much as 25 percent of the insulation can be lost in a single year.

Another potential problem arises if infested litter is spread on crops. Adult beetles may migrate from the field into nearby residences; the result can be a nuisance complaint to the health department — and sometimes lawsuits.

Temperature and moisture affect the amount of time an insect needs to complete its life cycle. Temperatures between 60 and 100 °F and moisture levels above 12 percent are optimum for its survival. Food sources, decaying litter, an occasional bird carcass, and the absence of major predator and parasite complexes in the poultry house help the beetle population to increase.

The life cycle of the beetle takes 35 to 60 days to complete. The adult female lays eggs individually or in clusters at intervals of one to five days throughout her life cycle. The eggs hatch into tiny larvae after four to seven days and grow through five to nine stages, called instars. This period lasts for seven weeks; then the beetles pupate in cracks and crevices, in the soil and lower strata of the litter, and in building insulation. The pupal state lasts for seven to 11 days, after which a new adult emerges.

To manage darkling beetles effectively requires monitoring, cultural practices, and some insecticide applications. Treatment should be maintained regularly, even if beetle numbers are low Individual beetles or larvae (100 or fewer) pose no problem, however, their presence indicates a need for continued monitoring, ideally on a weekly basis, from the time the birds are brought into the house until they are removed. Visual inspection is the best way to monitor the open-floored, deep litter house The grower should look at litter, carcasses, cracks and crevices, equipment, and insulation at intervals of 30 to 40 feet throughout the house.

- Litter should be examined along walls, around support posts, and under brooder hoods and feeders. Dig down 1 to 2 inches in caked litter to look for small, early instars
- Carcasses should be examined during daily collections. A large number of beetles on a large number of carcasses may point to a heavy infestation.
- Equipment and cracks and crevices are favorite beetle habitats. Be sure to check the framing joints and other cracks as well as the brooder guard, house dividers, drinkers, and feeders.
- Insulation in new houses should be checked for clusters of small holes along seams, in corners, at the eaves, and along the gable. Insulation board may also be discolored. If mice damage appears, look also for beetle tunnels. In older houses, it will be hard to distinguish between old and new beetle damage.

Trapping beetles is a second control method. Traps can be made using a 2-inch schedule 40 PVC pipe, a 10-to-12-inch section for each trap. Put a roll of corrugated cardboard (brooder guard) inside the pipe, and place six or so traps between the wall, feeder, and brooder locations from one end of the house to the other. To prevent the birds from moving the traps, stake the traps in place. Remove the cardboard and count the beetles on a weekly schedule. Their presence or a rapid rise in their number indicates a need for treatment.

Cultural methods for controlling beetles are nonchemical ways to reduce the pest population. Cold weather is the most effective measure, and proper litter handling is also an essential for good control If the weather cooperates, open the house to the cold between flocks. If the temperature drops below 30 °F, all stages of the darkling beetle will die. As soon as the birds are moved, the grower can remove litter and litter cake from the poultry house. Darkling beetles will move to protected areas in the empty house within a few days; therefore, moving the litter before that time will more effectively control the beetle population.

Fresh litter that is applied to cropland should be incorporated to prevent any return of the darkling beetle. Stockpiled or composted litter should be turned every two weeks to promote enough heat to kill beetle eggs and larvae.

Although all insecticides registered as controlling darkling beetles will work, none controls the house for more than one flock. Therefore, a treatment program should be maintained year-round. Most products remain active about a week and are designed to be applied when the birds have been removed from the house. The best time for application is on the first day after the birds have been removed followed by cleanup immediately on the second day. Treating the house again — and its outside perimeter — just before the placement of a new flock, is also useful. Surface sprays, dusts, and baits are available for making these applications.

Beetles love temperatures between 70 and 90 °F; they are nocturnal and can be found everywhere. Seeing them during the day is a sure sign of infestation — of their presence in great numbers. Young chicks will eat them. Darkling beetles can fly up to one mile a night. If a million or so are taken from a house, 15,000 of those taken will return in the direction of the house from which they came. Approved insecticides are Rabon, Sevin, and boric acid compounds. Best control methods are careful cleanout and spraying.

Beetles cause reductions in feed conversions and weight gains, and possible disease. Under dry conditions, they will eat the flesh of dead or down birds, and at night crawl up the feathers of resting birds and bite the skin around the feather follicals. Bitten birds may have weeping skin lesions or pink and swollen areas around the feather follicals that resemble skin leukosis The birds are forced to rest and wander all night instead of eating and sleeping as they would in properly managed houses

Darkling beetles are a general nuisance because they are attracted by light; therefore, they will crawl out of the litter and move toward the light at night. Large numbers of beetles on or in houses create a negative public image and give rise to complaints against the broiler producer. To prevent migration, spray the pit walls and posts, or use well-sealed, angled, metal flashing attached to pit walls at posts and masonry frame wall joints.

Coyotes and Feral Dogs

Coyotes and feral dogs are opportunistic feeders. If they live in the area, their presence around a poultry house is not remarkable. They will kill the poultry for food, but they can easily be prevented from gaining access to the house. Complete confinement of the poultry is the best way to stop predation. Heavy wire should be used to cover all openings. Sanitation and the proper disposal of mortalities will cut down on the attraction of coyotes to the area.

Predator calling and shooting may be used in most states to harvest these animals. Predator calling is a mechanical device that attracts the animals within shooting range. Trapping is also an effective control method. Traps and trap sizes as well as hunting and trapping seasons may be regulated in some places. Leghold traps that do not harm the animal or traps with padded jaws may offer the best control in some situations.

Controlling animals and pests in poultry houses involves a combination of resource management, sanitation, and exclusion, and some special measures such as chemicals, hunting, or trapping

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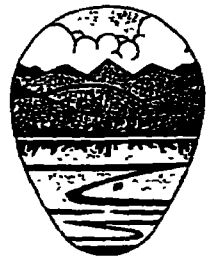

CONSTRUCTED WETLANDS

Agricultural runoff contributes about 60 percent of the nonpoint source pollution that threatens water quality in the rivers and lakes of the United States. Water that flows off the land after precipitation events picks up fertilizers and animal wastes that have been applied to the soil and deposits them in lakes and rivers.

If the runoff is uncontrolled, it causes soil erosion and the flow of high amounts of suspended solids, nutrients, pesticides, herbicides, and metals into the receiving waters. Flooding and the degradation of rivers, streams, and lakes are the consequence. Nonpoint source pollution can also threaten groundwater quality as the same pollutants leach through the soil.

Runoff can be controlled. Best management practices (BMPs) can be adopted as part of the poultry grower's operating procedure For example, stormwater can be diverted from poultry houses and manure storage areas, and land applications can be made when no storms are predicted. In addition, the arsenal of BMPs now includes the use of natural or constructed wetlands for treating runoff and wastewater

Functions of Wetlands

Wetlands are defined as transitional areas between the land and water. They support water-tolerant or aquatic plants, and their soils are saturated (waterlogged) or covered with shallow water for some part of the year. Bogs, swamps, marshes, and sloughs are types of wetlands.

Wetlands help improve water quality, store floodwaters, reduce erosion, and recharge groundwater. They are also habitat for wildlife and home to about one-third of our endangered species, though our focus is on wetlands for waste treatment. The treatment process involves complex physical, biological, and chemical interactions, but it can be simply described.

If surface runoff flows through wetlands before reaching open water, its progress will be slower here than in channelized flows over drier lands. Suspended solids will settle or filter out, and microorganisms will pick up the organics and nutrients in the water for food. Metals will settle into the soil and be absorbed by plants. Thus, pollutants in stormwater runoff can be reduced, cleansed, or transformed into harmless substances during the runoff's passage or treatment in natural or constructed wetlands. Most pollutants are transformed into basic elements, compost, or biomass.

The constructed wetland is the heart of the treatment system. It cleans wastewater by filtering and settling solids, decomposing organics, and adsorbing/absorbing other pollutants such as phosphorus and trace metals The dissolved organic pollutants are removed by a complex group of microbes (bacteria, fungi, algae, and protozoa) that live in the wastewater and on plant and sediment surfaces Since waste materials are food for most of these microbes, pollutants are gradually converted through complex food cycles into environmentally harmless by-products (gases that escape to the air and inert solids that stay in the system).

The primary purpose of wetland plants is to provide a place for these microbes to attach and grow. Generally, treatment effectiveness increases with plant density, which allows a larger quantity of attached microbes to exist within the system. The density of plants also affects flow hydraulics. Uniform flow is enhanced by uniform plant densities, but variable densities create short-circuiting which

reduces the retention time and treatment effectiveness of the wetland. In addition, plants make the system attractive and provide food and shelter for wildlife.

The system remains effective during winter because the microbes are still present on the dead stalks and stems of the vegetation. Because the biological processes slow down during winter, wetland systems are typically sized to meet treatment objectives during cold weather.

Notwithstanding their usefulness, over 50 percent of the natural wetlands in this country have been destroyed, according to estimates from the U.S. Fish and Wildlife Service. Wetlands have been drained and converted into farmland or drained and filled for urban development. They have even been used as dumps for hazardous wastes. Until recently, many people believed that wetlands were nothing more than a nuisance — a source of mosquitoes, flies, mildew, and unpleasant odors. These attitudes and our care of wetlands is changing rapidly as we become more knowledgeable about total resource and animal waste management procedures.

Section 404 of the Clean Water Act protects our nation's wetlands by regulating the discharge of dredge or fill materials into most wetlands, and the U.S. Fish and Wildlife Service purchases some wetlands each year with federal funds Numerous private incentives also support wetlands conservation. For example, the 1986 tax reform bill prohibits deductions by farmers to drain or fill wetlands, and the 1985 Swampbuster Program removes both flood and crop insurance and price supports from farmers who drain wetlands.

Designing Constructed Wetlands

Constructed wetlands can effectively treat poultry industry wastewaters, including stormwater runoff. These wetlands are designed by engineers and built to restore, enhance, or replace the physical, chemical, and biological processes in natural wetlands. They are typically used as polishing cells following conventional primary treatment facilities such as lagoons, settling basins, or septic tanks. The integrated treatment system provides a higher quality wastewater that may be recycled or discharged to a receiving stream if appropriate permits are obtained

In addition, the volume of treatable wastewater may be substantially reduced during the growing season because of evaporation. For example, a poultry producer currently having difficulty with overflowing lagoons during wet weather now has the option of adding constructed wetlands, which can be used to hold the lagoon wastewater during the growing season. Typically the wastewater in the wetlands will evaporate or percolate into the soil, but any effluent can also be recycled as process waste or as irrigation water.

Constructed wetlands consist of one or more "cells" of wetland plants in series or parallel. Construction can be easily accomplished. Excavate the area to shape the bottom of the wetlands and build small dikes around it. Use PVC pipe to distribute and collect wastewater and to control water levels in the wetland. Water levels are normally shallow — about 3 to 12 inches. Uncontaminated runoff can be diverted from the system by berms or other buffers or grading.

A lagoon, detention basin, or other type of solids trap is used in front of the constructed wetlands to remove heavy or coarse solids Some runoff contains high sediment loads and decomposing organic matter that may settle in bottom deposits. Because these deposits can adversely affect the hydrology and life forms in the wetland, the solids trap is particularly important.

Most wetland systems for treating agricultural related wastewaters will not be larger than 1 or 2 acres. In general, they should not be located in areas with steep topography, shallow topsoil, or limited space. They must be properly constructed to ensure groundwater protection. The potential for constructed wetlands to adequately treat agricultural wastewaters is so great that the USDA Agricultural Stabilization and Conservation Service has approved the development of cost-sharing for this practice. Consult your local soil and water conservation district for more information.

Management

Wetland plants include mixtures of cattails, reeds, bulrushes, sedges, and grasses that are

normally native to the area. The plants provide the right conditions for the microorganisms that live in the wetlands and break down the pollutants.

Pond and wetland systems are particularly effective because ponds can be designed to catch the stormwater and slowly release it to the wetlands following the storm. This technique keeps the wetlands wet for longer time periods, which can be especially important during dry seasons.

The systems need little routine maintenance but should be inspected periodically to detect any loss of plants, leakage through the dikes, clogging of the pipes, mosquitoes, or short-circuiting of the flow. These problems and others are usually easily corrected.

Properly managed constructed wetlands are cost effective, energy efficient, and simple to operate. They accept varying pollutant loads, attract a variety of wildlife, and add beauty to the farm landscape. Above all, constructed wetlands can help achieve clean water

Information on the design and construction of wetlands for managing wastewater is available from USDA Soil Conservation Service local offices.

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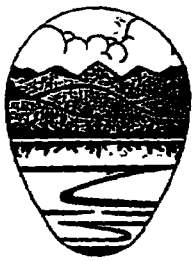

Feeding Litter To Ruminants

Broiler litter has long been considered a problem by-product. It is usually applied to the land as a fertilizer, but the concentration of the industry in relatively small geographic areas contributes to an oversupply of litter for this purpose. Broiler litter that is not managed in an environmentally sound manner may contribute to surface and groundwater contamination. An alternative, and indeed a more economical, use of broiler litter is as a source of dietary nutrients for beef cattle and other ruminants, whose unique digestive system is well able to process wastes and other by-products. Turkey litter and poultry manure can also be used for this purpose.

Litter is a source of protein, energy, and minerals. Using it as a feed ingredient helps to conserve nutrients and to offset costs. The plant nutrients in the litter — nitrogen, phosphorus, and potassium — and other minerals will be redeposited on pasture land as cattle manure. For this reason, even when the cost of transporting the litter is factored in, feeding litter to ruminants can be an economical waste management technique

There may be a problem with the public's perception of litter as a cattle feed. We readily accept and even prefer vegetables that are organically grown — in fact, mushrooms go directly from the manure bed to the grocery store — but we have a hard time accepting litter as a food ingredient. Yet a cow's food is broken down and processed much more completely than a plant assimilates food into its tissues.

Regulations on Feeding Litter

In 1967, the Food and Drug Administration (FDA) discouraged the use of litter as a cattle feed. But in 1980, FDA issued a statement leaving it to the states to regulate this use. At least 22 states have current regulations. No state regulates the private use or exchange of litter for this purpose; many states, however, regulate this commodity on the commercial market.

Processed broiler litter offered for sale may be required to carry warning labels about the presence of any drugs that may be present in the litter. To minimize the potential for any drug residues in the cattle, all litter feeding should be discontinued at least 15 days before the animals are marketed for slaughter. This responsibility for selling only wholesome animals falls on the producers, regardless of regulations.

Generally, attention to safety precautions — such as the 15 day withdrawal period before slaughter, not feeding litter to lactating cows, and not feeding litter with high copper concentrations to copper-sensitive sheep — are sufficient to eliminate health risks Litter has in fact been used as a feed ingredient for 35 years without any reported adverse effects on human or animal health.

Nutritional Value of Litter

The kind and amount of bedding material used in a broiler house and the number of batches housed on the litter affect the nutritional value of the litter, which should always be tested before being used as a food product for ruminants. The average nutrient contents are as follows

- **Moisture.** The moisture content of the manure has little nutritional value; but litter that is too dry may be unpalatable, and litter that is too wet may be difficult to handle as a food ingredient. An acceptable range seems to be from 12 percent to 25 percent moisture.

- **Total Digestible Nutrients.** The sum of the crude protein and crude fiber values is used to calculate the total digestible nutrients (TDN) in the litter. If the litter has a calculated value of 50 percent TDN, it is comparable to hay as an energy source.

- **Crude Protein.** The average amount of crude protein in broiler litter is about 24.9 percent. But about 40 percent of that amount is probably nonprotein nitrogen or uric acid. Young cattle cannot use this nonprotein nitrogen as easily as mature cattle can, so broiler litter should be fed only to cattle weighing over 450 pounds.

- **Bound Nitrogen.** Insoluble or bound nitrogen occurs in litter that has been overheated. Bound nitrogen is less easily digested than other nitrogen. Average litter samples have 15 percent bound nitrogen; overheated litter may have as much as 50 percent bound nitrogen.

- **Crude Fiber.** The fiber source in litter comes mainly from the bedding materials. Ruminants, however, need long roughage, such as hay. At least 5 percent of the litter ration should be in the form of hay or other long roughage.

- **Minerals.** Excessive minerals in litter are not usually a problem, though excessive calcium can cause milk fever in beef cows at calving Withdrawing the litter from the cows' food for 30 days overcomes this difficulty Microminerals, such as copper, iron, and magnesium, are also present in large amounts. Copper should not be fed at more than 150 parts per million. It builds up in the liver but is usually not harmful

- **Ash.** Ash content is an indication of litter quality and should not exceed 28 percent. About 12 percent of the ash is made up of calcium, phosphorus, potassium, and trace minerals, the rest is soil. Management techniques that reduce the soil content in the litter should be practiced.

Survey of Broiler Litter Composition

In some, all litter to be used as a beef ration should be analyzed — tested for nutrient content. Litter used for feed should have at least 18 percent crude protein and less than 28 percent ash. Not more than 25 percent of the crude protein should be bound or insoluble.

Litter that has too much ash is not suitable as a food ingredient. If broilers are reared on dirt floors, the litter may be contaminated with soil during cleanout.

The number of broods reared on the litter prior to cleanout of the broiler house also affects the quality of the litter; the more broods reared (five or more), the higher the litter is in nutrients.

Charred litter, that is, litter that has been exposed to too much heat during storage and has a burnt wood appearance, is only half as digestible as litter stored in stacks that were protected from excessive heat.

Processing and Storing Broiler Litter

All litter, regardless of its source, should be processed to eliminate pathogenic organisms, such as salmonella; pesticide residues; medicated poultry rations, such as antibiotics, coccidiostats, copper, and arsenic Dead birds may not be composted with poultry litter if the litter is to be used as a feed ingredient

Litter can be processed by fermentation (ensiled with other feed ingredients such as corn or sorghum), directly acidified, or heat treated. The easiest, most economical method of treatment is deep stacking Deep stacking should be done for 20 days or more at a temperature of 130 °F. Most of the antibiotics approved for chickens are also approved for cows, and deep stacking inhibits molds (mycotoxins). Excessive heating to temperatures of 140 °F or more is cause for alarm. Therefore, the deep stack should be covered with a polyethylene tarp to exclude oxygen. Covered litter stacks will reach a temperature high enough to destroy pathogens but not so high that nitrogen digestibility is threatened.

Table 1.— Suggested Rations.

RATION NUMBER	1 DRY BROOD COW	2 LACTATING COW	3 STOCKERS
Ingredients	Pounds		
Broiler Litter	800	650	500
Cracked Corn	200	350	500
Total Pounds	1,000	1,000	1,000

Suggested Rations

Table 1 indicates rations that can be fed to dry brood cows, lactating cows, and stockers. These rations are recommended guidelines, not absolutes, since the nutrient levels in litter are variable. Vitamin A should be added to all rations. To reduce bloating, feed the animals Botavec or Rumensin. Supplementing winter and summer grazing for stocker cattle increases the animals' weight gain and the total beef produced.

Summary

Because of the unique ability of ruminant animals to digest forages, other fibrous materials, and inorganic nitrogen such as urea, there is a growing awareness worldwide that by-products of agriculture can serve as low-cost alternative feed sources for these animals The use of broiler litter may become more widespread as the need for economy and responsible waste management becomes more urgent. Alabama, for example, produces about 1.8 metric tons of litter per year; in fact, litter is the state's most collectible animal waste. Since management practices on the farm affect the litter's quality, attempts to market the litter as a feed ingredient begin with a focus on management techniques.

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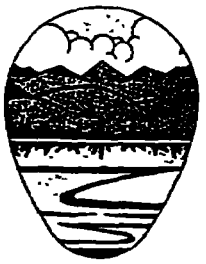

Horticultural Uses Of Litter

Because it has no unpleasant odors, composted broiler litter can be used indoors in a soilless potting medium. In fact, its nutrient content makes litter an ideal fertilizer for both indoor and outdoor gardens. It is also a good organic material for improving soil structure and drainage.

Soil Amendment

Gardeners can add composted litter to soils that otherwise contain too much sand or clay to support a garden. Work the top soil loose to a depth of 1 foot; then, spread 3 or 4 inches of compost on the soil. About 2 inches of compost may suffice at a minimum, but in really poor soils, 6 inches can be applied. Turn the soil over after the application to incorporate the compost

Flower and Vegetable Transplants

Annual and perennial flowers and vegetable transplants also do well in compost-amended settings Use a trowel to dig a hole in the new location Remove the plant from its container and tear a hole in the bottom of the root-ball — otherwise, the roots will continue to grow in a tight circle — before setting it into the ground. Fill the hole with amended soil and water thoroughly Mulching will help the plants retain water, thereby conserving this resource as well

Transplanting Trees and Shrubs

If you are transplanting trees or shrubs, use the techniques listed above, but make sure that the hole you dig for the plant is at least twice the size of its present container. Work about 3 to 6 inches of composted litter into the soil in the hole and place the tree or shrub therein. Keep as much soil as possible around the root-ball when you take it out of the container. Do, by all means, remove the container, especially if it is plastic, so that the new growth will have plenty of room. The soil line on your plant should be level with your garden. Fill in the hole with the amended soil, and water the plant thoroughly to remove any air pockets that may have been in the backfill.

Potting Mix for Indoor Plants

To make your own potting medium, use equal parts of composted litter and composted pine bark — all living things need nitrogen and carbon. The bark may be screened to remove large pieces (one-half inch or larger) before mixing Fill the new pot with 1 or 2 inches of the planting medium, spread out the roots of your plant, and set it in the pot Remove any buds or flowers before replanting to ensure that the plant has time to get properly established Transplant from one pot size to the next one only; skip one size if you have to, but don't go from a 1-inch pot to a 4-inch pot and expect to succeed. Water the plants in the fall and winter, fertilize them in the growing seasons — spring and summer.

Lawns

Composted broiler litter is a superior product to use to establish new lawn areas Spread about 2 inches of composted litter on the area to be seeded. Then turn the soil over to a depth of 6 inches to incorporate the material. Place turf on the prepared soil and water it as usual. The addition of compost to the soil helps hold moisture and improves drainage.

Fertilizer

The nutritional analysis of composted litter will vary, depending on conditions of waste production and handling, among other variables. However, most composted litter will have an analysis similar to 2-2-2 commercial fertilizer. That is, it should have no less than 2 percent nitrogen (N), 2 percent phosphoric acid (P_2O_5), and no less than 2 percent potassium (K_2O). Two quarts of broiler litter compost can be applied monthly to your vegetable and flowering plants. It should be worked into the soil lightly — at the drip line or where the water falls naturally from the leaves.

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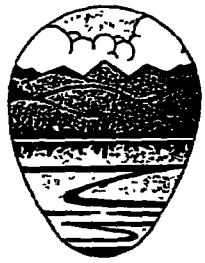

Poultry Water Quality Consortium

The poultry industry and three government agencies have formed the Poultry Water Quality Consortium to promote better environmental management by the rapidly growing poultry industry.

The Consortium encourages the use of poultry by-products as a resource rather than letting them become a pollution source. As the industry grows, protecting natural resources is becoming a major priority, demanding new technologies in poultry by-product development, storage, utilization, and land application.

The Consortium is responding to this challenge by promoting cooperation and information exchanges between government and industry on water quality and by-product utilization issues. By focusing on pollution prevention, the Consortium encourages the development and transfer of new technologies designed to protect water quality and promote a clean environment.

Members of the Consortium:

- Southeastern Poultry & Egg Association
- U.S. Department of Agriculture – Soil Conservation Service
- Tennessee Valley Authority
- U.S. Environmental Protection Agency

Contact

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Other pages in this handbook contain more detailed information on these subjects. Permission is hereby granted to producers, growers, and associations serving the poultry industry to reproduce this material for further distribution. The Poultry Water Quality Consortium is a cooperative effort of industry and government to identify and adopt prudent uses of poultry by-products that will preserve the quality of water for everyone.

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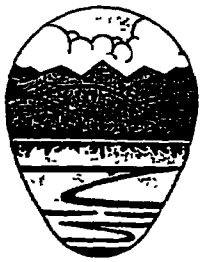

Southeastern Poultry and Egg Association

The Southeastern Poultry and Egg Association (Southeastern) is dedicated to the growth and development of the poultry industry and represents the entire industry — from the producers of eggs, broilers, and turkeys, to the processors of poultry and egg products, along with the allied companies that serve the industry. The association emphasizes technology transfer, in order to ensure that knowledge and information are exchanged and shared. The association's extensive and diverse programs have been developed to help members keep abreast of rapid changes in the poultry and egg industry.

Services Available to Poultry Growers

Southeastern is best known for its annual International Poultry Exposition, held in January in Atlanta, Georgia. The Expo features the world's largest display of technology, equipment, and supplies used to produce and process poultry and egg products.

Continuing education is a high priority The association's seminar program has expanded into a comprehensive schedule of workshops and clinics to keep the poultry industry informed. Twelve seminars are held each year.

Through its government relations program, Southeastern keeps Congress and federal agencies apprised of industry needs, and informs members of government actions.

The association's research program returns millions of dollars to the industry. Research grants are used to find better ways of producing poultry and egg products. Members are kept aware of industry developments through the distribution of newsletters, reports, and memos.

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U.S. Department of Agriculture
Soil Conservation Service

Agency's Commitment to the Poultry Industry

The Soil Conservation Service (SCS), an agency within the U.S. Department of Agriculture (USDA), administers national soil and water conservation programs with the cooperation of landowners and operators in local soil conservation districts and other government agencies. It provides USDA leadership to assist landowners and local groups to practice resource conservation. In this role, it protects and enhances the nation's surface and groundwater resources and provides technical assistance to the U.S agricultural community to help plan, design, and implement waste management systems and other conservation projects. The 1990 Farm Bill focused the SCS on major agricultural concerns including pesticides, nutrients, animal waste, and agricultural pollutants in surface and groundwater.

Services Available to Poultry Growers

Through its conservation practices, the SCS provides planning, design, and construction assistance on waste treatment lagoons, manure and litter dry-stacking facilities, poultry mortality facilities, management, and nutrient management plans based on soils, crops, and equipment availability. It also serves as technical representative for USDA cost-share programs to implement nutrient and poultry mortality management systems; and, in some cases, provides financial as well as technical assistance in special project areas. The SCS works closely with state regulatory agencies in waste management.

Contact

For more information about SCS programs and assistance, call or visit the SCS office listed in your local telephone directory under U.S Department of Agriculture.

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TENNESSEE VALLEY AUTHORITY

Agency's Commitment to the Poultry Industry

An overall objective of the Tennessee Valley Authority (TVA) is to develop and implement programs and activities that will further develop agriculture and agribusiness to protect the environment. The poultry industry is an integral part of the agricultural economy. Protecting water quality is a major concern as illustrated by TVA's ongoing projects related to proper management and use of animal wastes.

Much of TVA's work is accomplished in cooperation with federal and state agencies, and universities and private organizations concerned with animal waste management. TVA is in an excellent position to identify, demonstrate, and transfer poultry by-product resources technology to potential users.

Services Available to Poultry Growers

TVA's programs and projects primarily deal with helping prevent or reduce impacts of the industry on the environment. This service is accomplished through educational workshops and demonstrations in cooperation with other federal and state agencies to focus on preventing or reducing the environmental impacts of by-products generated by the poultry industry.

Current project areas are composting poultry mortality; animal waste lagoon management; production and marketing of poultry litter products for use as a soil amendment, fertilizer, and cattle feed; creating agribusiness that will produce and market poultry by-products; and conducting research and demonstrations that show correct use of by-products.

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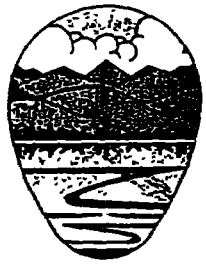

U.S. Environmental Protection Agency

Agency's Commitment to the Poultry Industry

The U.S. Environmental Protection Agency (EPA) is dedicated to improving and preserving the quality of the environment, both national and global, and to preventing and reducing water pollution associated with poultry by-products. Historically, EPA has distinguished between point and nonpoint sources of water pollution in its management programs. Under the Clean Water Act, certain poultry processing or rendering plants are regulated and required to remove pollutants from process wastewater.

Certain large concentrated animal feeding operations (CAFOs) may be regulated and may be required to obtain a discharge permit. The new Coastal Zone Act Reauthorization Amendments of 1990 address nonpoint source pollution affecting coastal waters. This Coastal Zone Act requires EPA to issue guidance on nonpoint source management measures that represent the best available means of reducing nonpoint source pollution in coastal waters

Services Available to Poultry Growers

EPA administers a variety of nonpoint source control programs to address animal waste problems associated with smaller operations. Under section 319 of the Clean Water Act, states have developed nonpoint source assessment reports on the nature and extent of their nonpoint pollution problems, including problems associated with poultry waste. In addition, section 319 requires states to develop comprehensive management programs to mitigate the problems.

Currently, funds are provided under 319(h) to states to implement their nonpoint source management programs including, for example, demonstrations of poultry composting facilities or development of educational manuals or regulations to address poultry by-products. EPA provides assistance to states to implement nonpoint source controls under other programs such as the Chesapeake Bay Program and the Clean Lakes Program

Contacts

The U.S. Environmental Protection Agency, headquartered in Washington, DC, operates 10 regional offices.

U.S. EPA, Region 1
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U.S. EPA, Region 2
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U.S. EPA, Region 3
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RESOURCE INFORMATION

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Dallas, TX 75202-2733
(214) 655-6668

U.S. EPA, Region 7
(IA, KS, MO, NE)
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7034

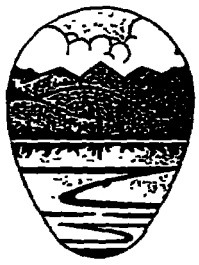
U.S. EPA, Region 8
(CO, MT, ND, SD, UT, WY)
999 18th Street, Suite 500
Denver, CO 80202-2413
(303) 293-1703

U.S. EPA, Region 9
(AS, AZ, CA, GU, HI, MP, NV, TT)
75 Hawthorne Street
San Francisco, CA 94105
(415) 705-2177

U.S. EPA, Region 10
(AK, ID, OR, WA)
1200 Sixth Avenue
Seattle, WA 98101
(206) 553-6911

U.S. EPA, Headquarters
Office of Water
401 M Street, SW
Washington, DC 20460
(202) 260-5700

POULTRY WATER QUALITY CONSORTIUM
HB-2C, 1101 Market Street • Chattanooga, TN 37402-2801
Tel: (615) 751-7297 • Fax: (615) 751-7479



DIRECTORY OF POULTRY ASSOCIATIONS

STATE, REGIONAL, AND NATIONAL

The following state, regional, and national organizations are listed in alphabetical order. The organizations in most states are therefore listed together; however, if you are looking for a particular association, please consult the entire list. The Wilkes Area Poultry Association, for example, is listed under W, not under North Carolina. We hope that we have not inadvertently omitted or incorrectly identified any organization or its address. This material will be updated from time to time.

ALABAMA POULTRY & EGG ASSOCIATION
One Court Square, Suite 315
Montgomery, AL 36104
TEL (205) 265-2732
FAX (205) 265-0008

ALASKA DIVISION OF AGRICULTURE
PO Box 949
Palmer, AK 99645
TEL (907) 745-7200
FAX (907) 745-7112

AMERICAN EGG BOARD
1460 Renaissance Drive
Park Ridge, IL 60068
TEL (708) 296-7043
FAX (708) 296-7007

AMERICAN POULTRY ASSOCIATION
26363 South Tucker Road
Estacada, OR 97023
TEL (503) 630-6759

ARIZONA POULTRY IMPROVEMENT BOARD
Agricultural Science Building, Room 328
University of Arizona
Tucson, AZ 85721
TEL (602) 621-1095

ARIZONA POULTRY FEDERATION
c/o Hickman's Egg Ranch
7403 North 91st Avenue
Glendale, AZ 85305
TEL. (602) 872-1120
FAX (602) 872-9220

ARKANSAS POULTRY FEDERATION
PO Box 1446
Little Rock, AR 72203-1446
TEL (501) 375-8131
FAX (501) 375-5519

CALIFORNIA EGG COMMISSION
1150 North Mountain Avenue, Suite 114
Upland, CA 91786
TEL. (714) 981-4923
FAX (714) 946-5563

CALIFORNIA POULTRY INDUSTRY FEDERATION
3117 A McHenry Avenue
Modesto, CA 95350
TEL (209) 576-6355
FAX (209) 576-6119

COLORADO POULTRY IMPROVEMENT BOARD
4816 E Co Road, #30
Ft Collins, CO 80525
TEL (303) 226-3680

CONNECTICUT POULTRY ASSOCIATION
Department of Agriculture
16 South Capitol Avenue
Hartford, CT 06106
TEL (203) 566-5268
FAX (203) 566-6576

DELAWARE POULTRY IMPROVEMENT ASSOCIATION
RD 2, Box 48
Georgetown, DE 19947
TEL (302) 856-7303

DELMARVA POULTRY INDUSTRY, INC.
RD 6, Box 47
Georgetown, DE 19947
TEL: (302) 856-9037
FAX. (302) 856-1845

EGG ASSOCIATION OF AMERICA
808 17th Street, N.W.
Washington, DC 20006
TEL: (202) 296-8248
FAX: (202) 223-9569

FLORIDA POULTRY FEDERATION
4508 Oak Fair Boulevard, Suite 290
Tampa, FL 33610
TEL. (813) 628-4551
FAX· (813) 620-4008

GEORGIA EGG ASSOCIATION AND COMMISSION
16 Forest Parkway
Forest Park, GA 30050
TEL. (404) 363-7661
FAX: (404) 363-7664

GEORGIA POULTRY FEDERATION
P.O Box 763
Gainesville, GA 30503-0763
TEL (404) 532-0473
FAX. (404) 532-7543

GEORGIA POULTRY IMPROVEMENT ASSOCIATION
P.O. Box 20
Oakwood, GA 30566
TEL: (404) 535-5996
FAX (404) 539-1948

GEORGIA TURKEY ASSOCIATION
PO Box 127
Watkinsville, GA 30677-0127
TEL (706) 769-5668

HAWAII FRYER COUNCIL
1818 Kanakanui Street
Honolulu, HI 96819
TEL (808) 841-2828

HAWAII EGG PRODUCERS ASSOCIATION
841 Bishop Street, Suite 850
Honolulu, HI 96813
TEL (808) 522-5133
FAX (808) 522-5144

IDAHO POULTRY INDUSTRY FEDERATION
c/o Merrill Poultry Farms Inc
Rt 2, Box 2184
Paul, ID 83347
TEL (208) 438-4605
FAX (208) 438-8694

ILLINOIS POULTRY INDUSTRY COUNCIL
324 Mumford Hall
1301 West Gregory Drive
Urbana, IL 61801
TEL (217) 244-0195
FAX: (217) 244-2871

ILLINOIS STATE TURKEY GROWERS ASSOCIATION
9193 Tampico Road
Rock Falls, IL 61071
TEL: (815) 438-2580

INDIANA STATE POULTRY ASSOCIATION
Purdue University
1026 Poultry Science Building
W Lafayette, IN 47907-1026
TEL: (317) 494-8517
FAX: (317) 494-6349

IOWA POULTRY ASSOCIATION
535 East Lincoln Way
P.O. Box 704
Ames, IA 50010-0704
TEL: (515) 232-2103
FAX: (515) 232-2825

IOWA TURKEY FEDERATION
PO Box 825
Ames, IA 50010-0825
TEL. (515) 232-7492
FAX. (515) 232-2825

KANSAS POULTRY ASSOCIATION AND KANSAS TURKEY FEDERATION
1816 Alabama
Manhattan, KS 66502
TEL (913) 539-5441
FAX (913) 532-5681

KENTUCKY POULTRY FEDERATION/EGG COUNCIL
PO Box 21829
Lexington, KY 40522-1829
TEL (606) 257-2694

KENTUCKY POULTRY IMPROVEMENT ASSOCIATION
604 Garrigus Building
Lexington, KY 40546
TEL (606) 257-7259
FAX (606) 258-1027

LOUISIANA POULTRY FEDERATION
241 Knapp Hall
Louisiana State University
Baton Rouge, LA 70803
TEL (504) 388-8667
FAX· (504) 388-2478

POULTRY INDUSTRIES OF LOUISIANA, INC.
Louisiana State University
Extension Service
221 Knapp Hall
Baton Rouge, LA 70803
TEL. (504) 388-8667
FAX: (504) 388-2478

MAINE POULTRY FEDERATION
P.O. Box 228
Augusta, ME 04330-0228
TEL. (207) 622-4443
FAX: (207) 623-3748

MARYLAND EGG COUNCIL, INC.
3109 Animal Science Center
University of Maryland
College Park, MD 20742
TEL: (301) 405-5775
FAX: (301) 314-9557

MASSACHUSETTS POULTRY ASSOCIATION
22 Kimball Place
Fitchburg, MA 01420
TEL. (508) 345-4103
FAX: (508) 345-7187

MICHIGAN ALLIED POULTRY INDUSTRY, INC.
PO Box 153
Stevensville, MI 49127-0153
TEL (616) 465-5531
FAX (616) 465-4730

MIDWEST POULTRY FEDERATION AND MINNESOTA TURKEY GROWERS ASSOCIATION
2380 Wycliff Street
St Paul, MN 55114
TEL (612) 646-4553
FAX (612) 646-4554

MIDWEST UNITED EGG PRODUCERS
PO Box 170
124 North Second Street
Eldridge, IA 52748
TEL (319) 285-9100
FAX (319) 285-9109

MISSISSIPPI POULTRY ASSOCIATION, INC.
PO Box 13309
Jackson, MS 39236-3309
TEL (601) 355-0248
FAX (601) 353-3840

MISSOURI POULTRY FEDERATION
2100 East Broadway, Room 319
Columbia, MO 65201
TEL. (314) 874-1920
FAX (314) 874-1921

NATIONAL BROILER COUNCIL
The Madison Building, Suite 614
1155 15th Street, N.W.
Washington, DC 20005
TEL: (202) 296-2622
FAX: (202) 293-4005

NATIONAL GOOSE COUNCIL, INC.
7 Oak Street West
P.O. Box 267
Sisseton, SD 57262-0267
TEL: (605) 698-7651

NATIONAL INDEPENDENT POULTRY AND FOOD DISTRIBUTORS ASSOCIATION
604 Green Street, Suite 3
Gainesville, GA 30501
TEL: (404) 535-9901
FAX: (404) 535-7385

NATIONAL RENDERERS ASSOCIATION, INC.
1101 Connecticut Avenue, N.W., Suite 100
Washington, DC 20036
TEL: (202) 857-1136
FAX. (202)775-2625

NATIONAL TURKEY FEDERATION
11319 Sunset Hills Road
Reston, VA 22090
TEL (703) 435-7206
FAX (703) 481-0837

NEBRASKA POULTRY IMPROVEMENT ASSOCIATION
A 103 Animal Sciences
P.O Box 830908
University of Nebraska
Lincoln, NE 68583-0908
TEL. (402) 472-2051
FAX (402) 472-6362

NEW ENGLAND POULTRY ASSOCIATION
PO Box 725
Augusta, ME 04330
TEL (207) 623-3940
FAX (207) 623-3748

NEW HAMPSHIRE POULTRY GROWERS ASSOCIATION
20 Goodhue Road
Boscawen, NH 03303
TEL (603) 796-2890

NEW YORK STATE POULTRY COORDINATED EFFORT, INC.
26 York Ave
Saratoga Springs, NY 12866
TEL (518) 584-5912

NORTH CAROLINA EGG ASSOCIATION
1213 Ridge Road
Raleigh, NC 27607
TEL. (919) 828-8188
FAX (919) 828-8189

NORTH CAROLINA POULTRY FEDERATION AND TURKEY FEDERATION
4020 Barrett Drive, Suite 102
Raleigh, NC 27609
TEL. (919) 783-8218
FAX: (919) 783-8220

NORTH DAKOTA TURKEY FEDERATION
North Dakota State University
Animal Science Department
Fargo, ND 58105
TEL. (701) 237-7691

NORTHEAST UNITED EGG PRODUCERS
808 17th Street, N.W., Suite 200
Washington, DC 20006
TEL: (202) 296-8248
FAX: (202) 223-9569

NORTHWEST EGG PRODUCERS COOPERATIVE ASSOCIATION
P.O. Box 1038
1700 Cooper Point Road, S W
Suite B-3
Olympia, WA 98507-1038
TEL. (206) 754-4401
FAX: (206) 754-4414

OHIO POULTRY ASSOCIATION
674 West Lane Avenue
Columbus, OH 43210
TEL (614) 292-2089
FAX (614) 292-7227

OKLAHOMA EGG COUNCIL
201 Animal Science Building
Stillwater, OK 74078
TEL (405) 744-6058
FAX (405) 744-5339

OKLAHOMA STATE POULTRY FEDERATION
PO Box 357
Hartshorne, OK 74547
TEL. (918) 297-7219

OREGON BROILER GROWERS ASSOCIATION
762 Driftwood Drive
Eugene, OR 97402
TEL (503) 829-9682

OREGON POULTRY COUNCIL
32914 South Highway 213
Molalla, OR 97038
TEL. (503)829-9682

OREGON POULTRY INDUSTRIES ASSOCIATION
P.O Box 3003
Portland, OR 97208-3003
TEL. (503) 777-1320
FAX. (503) 777-2373

OREGON TURKEY IMPROVEMENT ASSOCIATION
5705 Cooper Hollow Road
Monmouth, OR 97361
TEL: (503) 623-3722

OREGON TURKEY GROWERS
P.O. Box 5324
Salem, OR 97302
TEL: (503) 364-3323
FAX: (503) 364-6142

PACIFIC EGG AND POULTRY ASSOCIATION
1620 North Carpenter Road
Building A-4
Modesto, CA 95351
TEL: (209) 524-9666
FAX: (209) 524-3047

PENNSYLVANIA POULTRY FEDERATION
500 North Progress Avenue
Harrisburg, PA 17109
TEL. (717) 652-7530
FAX. (717) 652-0230

POULTRY PRODUCERS OF RHODE ISLAND
49 Hillsdale Road
West Kingston, RI 02892
TEL: (401) 792-2072
FAX: (401) 792-4017

SOUTH CAROLINA POULTRY FEDERATION
1201 Main Street, Suite 1220
AT&T Building
Columbia, SC 29201
TEL (803) 748-1283
FAX (803) 748-1294

SOUTH CAROLINA TURKEY FEDERATION
930 Hawthorne Lane Ext
Rock Hill, SC 29730
TEL (803) 327-6037

SOUTH DAKOTA POULTRY INDUSTRY
PO Box 2170
South Dakota State University
Brookings, SD 57007
TEL. (605) 688-5165
FAX. (605) 688-6170

SOUTHEASTERN POULTRY AND EGG ASSOCIATION
1530 Cooledge Road
Tucker, GA 30084
TEL: (404) 493-9401
FAX. (404) 493-9257

SOUTHERN UNITED EGG PRODUCERS
P.O. Box 957253
Duluth, GA 30136
TEL. (404) 476-2771
FAX· (404) 476-9762

TENNESSEE EGG & POULTRY ASSOCIATION
PO Box 11082
Knoxville, TN 37939-1082
TEL. (615) 974-7351
FAX: (615) 974-7448

TENNESSEE POULTRY IMPROVEMENT BOARD, INC.
P.O. Box 40627, Melrose Station
Nashville, TN 37204
TEL: (615) 360-0120
FAX. (615) 781-5309

TEXAS POULTRY FEDERATION
8130 Burnet Road
PO Box 9589
Austin, TX 78766-9589
TEL (512) 451-6816
FAX (512) 454-4221

UNITED EGG ASSOCIATION
One Massachusetts Avenue, N W., Suite 800
Washington, DC 20001
TEL (202) 842-2345
FAX (202) 408-7763

UNITED EGG PRODUCERS
1303 Hightower Trail, Suite 200
Atlanta, GA 30350
TEL (404) 587-8571
FAX (404) 587-0041

USA POULTRY & EGG EXPORT COUNCIL
2300 West Park Place Boulevard, Suite 100
Stone Mountain, GA 30087
TEL (404) 413-0006
FAX (404) 413-0007

UTAH TURKEY MARKETING BOARD
PO Box 408
Moroni, UT 84646-0408
TEL (801) 436-8365
FAX. (801) 436-8280

VERMONT POULTRY IMPROVEMENT BOARD
Vermont Department of Agriculture, Food and Markets
120 State Street
Montpelier, VT 05620
TEL. (802) 828-2500
FAX (802) 828-2361

VIRGINIA EGG COUNCIL, INC.
911 Saddleback Court
McLean, VA 22102
TEL (703) 790-1984

VIRGINIA POULTRY FEDERATION
PO Box 552
Harrisonburg, VA 22801
TEL: (703) 433-2451
FAX· (703) 433-3256

WASHINGTON POULTRY INDUSTRY ASSOCIATION
1605 Fifth Street, S.W.
Puyallup, WA 98371
TEL (206) 840-2040

WASHINGTON POULTRY IMPROVEMENT ASSOCIATION
c/o Washington State University
Puyallup Center
Puyallup, WA 98371
TEL (206) 840-4537

WEST COAST UNITED EGG PRODUCERS
P.O Box 1526
Rancho Cucamonga, CA 91729-1526
TEL (909) 980-5114
FAX (909) 945-3575

WEST VIRGINIA POULTRY ASSOCIATION
PO Box 612
Moorefield, WV 26836-0612
TEL (304) 538-2725

WILKES AREA POULTRY ASSOCIATION
PO Box 1393
North Wilkesboro, NC 28659
TEL (704) 872-6227
FAX (704) 872-1452

WISCONSIN POULTRY IMPROVEMENT ASSOCIATION
260 Animal Science Building
1675 Observatory Drive
Madison, WI 53706
TEL (608) 262-9764
FAX (608) 262-6005

Other pages in this handbook contain more detailed information on these subjects Permission is hereby granted to producers, growers, and associations serving the poultry industry to reproduce this material for further distribution. The Poultry Water Quality Consortium is a cooperative effort of industry and government to identify and adopt prudent uses of poultry by-products that will preserve the quality of water for everyone

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POULTRY WATER QUALITY CONSORTIUM
HB-2C, 1101 Market Street • Chattanooga, TN 37402-2801
Tel: (615) 751-7297 • Fax: (615) 751-7479

Other Supporting USDA Agencies

Agricultural Stabilization and Conservation Service

The USDA's Agricultural Stabilization and Conservation Service (ASCS) helps to assure a continuous supply of food and fiber for all Americans, and to promote sound resource management systems. As part of this mandate, ASCS works with poultry producers to share the costs of solving erosion and water quality problems that result from nonpoint source pollution. The cost-sharing program is called the Agricultural Conservation Program, or ACP.

Services Available to Growers

Under the ACP, ASCS has the authority to share with producers up to 60 percent of the cost of building facilities that handle and/or store poultry waste. Facilities include lagoons, dry-stacks, and composting units. Producers who have been in business for less than five years or who have substantially enlarged their operations may not be eligible for this assistance.

Contact

For more information about ACP and other ASCS programs, call or visit the ASCS office listed in your telephone directory.

Cooperative Extension Service

The Extension Service, U.S. Department of Agriculture (ES-USDA) and the state Cooperative Extension System (CES) link research-based information and technology to help people improve their lives through an educational process that uses scientific knowledge focused on issues and needs. Cooperative Extension, created by the Smith-Lever Act in 1914, was designed as a partnership of the USDA and the land-grant universities that were established under the Morrill Acts of 1862 and 1890.

USDA and state and local agencies form a network of Extension professionals throughout the United States and its territories. Offices are located in more than 3,150 counties across the nation, with technical and administrative suppport for county agents located at state and land-grant universities

Services Available to Growers

Educational programs to protect natural resources and the environment, to manage waste efficiently, and to deal with water quality are included in the national priority initiatives of the Cooperative Extension System

Contact

For more information about ES-USDA and the Cooperative Extension System, call or visit the CES office listed in your telephone directory under local government.

Other pages in this handbook contain more detailed information on these subjects Permission is hereby granted to producers, growers, and associations serving the poultry industry to reproduce this material for further distribution. The Poultry Water Quality Consortium is a cooperative effort of industry and government to identify and adopt prudent uses of poultry by-products that will preserve the quality of water for everyone

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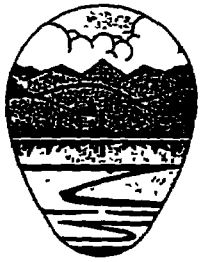
POULTRY WATER QUALITY CONSORTIUM
HB-2C, 1101 Market Street • Chattanooga, TN 37402-2801
Tel: (615) 751-7297 • Fax: (615) 751-7479



DIRECTORY OF STATE WATER QUALITY AGENCIES

ALABAMA SOIL AND WATER CONSERVATION COMMITTEE
2800 Zelda Road
Suite 200-9 and 200-10
Montgomery, AL 36106-2686
TEL: (205) 242-2620

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
1751 Cong. W. L. Dickinson Drive
Montgomery, AL 36109
TEL. (205) 271-7700

ALASKA DEPARTMENT OF NATURAL RESOURCES
P.O Box 949
Palmer, AK 99645-0949
TEL. (907) 745-7200

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
P.O Box 0
410 Willoughby Avenue, Suite 105
Juneau, AK 99801-1795
TEL (907) 465-5000

ARIZONA SOIL AND WATER CONSERVATION AGENCY
Natural Resource Conservation Division
1616 West Adams, Room 419
Phoenix, AZ 85007
TEL (602) 542-4625

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
3033 N Central Avenue
Phoenix, AZ 85012
TEL (602) 207-4512

ARKANSAS SOIL AND WATER CONSERVATION COMMISSION
101 E Capitol
Suite 350
Little Rock, AR 72201
TEL (501) 682-1611

CALIFORNIA SOIL AND WATER CONSERVATION AGENCY
Resources Control Board
Division of Water Quality
901 P Street
Sacramento, CA 95801
TEL: (916) 657-1727

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD
P.O Box 100
Sacramento, CA 95812
TEL. (916) 657-2390

COLORADO STATE SOIL CONSERVATION BOARD
1313 Sherman Street
Room 219
Denver, CO 80203
TEL· (303) 866-3351

COLORADO WATER QUALITY AGENCY
Water Quality Control Division
4300 Cherry Creek South
Denver, CO 80222-1530
TEL (303) 692-3500

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION
79 Elm Street
P.O Box 5066
Hartford, CT 06102-5066
TEL (203) 566-7049

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL
89 Kings Highway, Box 1401
Dover, DE 19903
TEL (302) 739-4860

FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION
2600 Blair Stone Road
Tallahassee, FL 32399-2400
TEL (904) 488-4805

GEORGIA STATE SOIL AND WATER CONSERVATION COMMISSION
P.O. Box 8024
Athens, GA 30603
TEL: (706) 542-3065

GEORGIA WATER QUALITY MANAGEMENT PROGRAM
7 Martin Luther King Drive
Suite 643
Atlanta, GA 30334
TEL. (404) 656-4988

HAWAII DIVISION OF WATER RESOURCE MANAGEMENT
PO Box 621
Honolulu, HI 96809
TEL: (808) 587-0214

HAWAII DIVISION OF ENVIRONMENTAL PLANNING
5 Waterfront Plaza
Suite 25D
500 Ala Moana Boulevard
Honolulu, HI 96801-9984
TEL: (808) 543-8337

IDAHO SOIL CONSERVATION COMMISSION
1215 W State Street
Boise, ID 83720-7000
TEL (208) 334-0210

IDAHO DIVISION OF ENVIRONMENTAL QUALITY
1410 N Hilton
Boise, ID 83706
TEL (208) 334-5860

ILLINOIS DEPARTMENT OF AGRICULTURE
PO Box 19281
State Fairgrounds
Springfield, IL 62794
TEL (217) 782-6297

ILLINOIS DIVISION OF WATER POLLUTION CONTROL
Box 19276
2200 Churchill Road
Springfield, IL 62794
TEL (217) 782-3362

INDIANA DEPARTMENT OF NATURAL RESOURCES
Division of Soil Conservation
402 W Washington Street, Room 265W
Indianapolis, IN 46204
TEL (317) 233-3870

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
105 S. Meridian Street
P.O Box 6015
Indianapolis, IN 46206-6015
TEL: (317) 232-8603

IOWA DIVISION OF SOIL CONSERVATION
Wallace State Office Building
Des Moines, IA 50319
TEL. (515) 281-6143

IOWA DEPARTMENT OF NATURAL RESOURCES
Water Quality Planning Division
East 9th and Grand Avenue
Des Moines, IA 50319-0034
TEL. (515) 281-5145

KANSAS STATE CONSERVATION COMMISSION
109 S.W. Ninth Street
Suite 500
Topeka, KS 66612-1299
TEL. (913) 296-3600

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
Landon State Office Building
Room 901
Topeka, KS 66612-1290
TEL (913) 296-1522

KENTUCKY SOIL AND WATER CONSERVATION COMMISSION
691 Teton Trail
Frankfort, KY 40601
TEL. (502) 564-3080

KENTUCKY DIVISION OF WATER - NONPOINT SOURCES
14 Reilly Road
Frankfort, KY 40601
TEL (502) 564-3410

LOUISIANA DEPARTMENT OF AGRICULTURE AND FORESTRY
Office of Soil and Water Conservation
PO Box 3554
Baton Rouge, LA 70821-3554
TEL (504) 922-1270

LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY
PO Box 82263
Baton Rouge, LA 70884-2263
TEL (504) 765-0741

MAINE SOIL AND WATER CONSERVATION COMMISSION
Maine Department of Agriculture, Food, and Rural Resources
State House Station 28
Augusta, ME 04333
TEL: (207) 289-2666

MAINE BUREAU OF WATER QUALITY CONTROL
Department of Environmental Protection Agency
State House, Number 17
Augusta, ME 04333
TEL: (207) 289-3901

MARYLAND STATE SOIL AND WATER CONSERVATION COMMITTEE
Maryland Department of Agriculture
Annapolis, MD 21401
TEL: (410) 841-5863

MARYLAND DEPARTMENT OF THE ENVIRONMENT
Watershed Management Administration
2500 Broening Highway
Baltimore, MD 21224
TEL: (301) 631-3552

MASSACHUSETTS STATE COMMISSION FOR THE CONSERVATION OF SOIL
100 Cambridge Street
20th Floor
Boston, MA 02202
TEL (617) 727-1552

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
1 Winter Street
Boston, MA 02108
TEL (617) 727-0437

MICHIGAN DEPARTMENT OF AGRICULTURE
PO Box 30017
Lansing, MI 48909
TEL (517) 373-9797

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
Surface Water Quality Division
PO Box 30273
Lansing, MI 48909
TEL. (517) 373-2867

MINNESOTA BOARD OF WATER AND SOIL RESOURCES
155 South Wabasha Street, Suite 104
St Paul, MN 55107
TEL (612) 296-3767

MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road
St Paul, MN 55155
TEL (612) 296-6300

MISSISSIPPI SOIL AND WATER CONSERVATION COMMISSION
P.O. Box 23005
Jackson, MS 39225-3005
TEL. (601) 359-1281

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
P.O. Box 10385
Jackson, MS 39289-0385
TEL: (601) 961-5171

MISSOURI DEPARTMENT OF NATURAL RESOURCES
P.O. Box 176
Jefferson City, MO 65102
TEL: (314) 751-4810

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
P.O. Box 202301
Helena, MT 59620-2301
TEL: (406) 444-6667

MONTANA DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES
Cogswell Building
Room A-206
Helena, MT 59620-0909
TEL: (406) 444-2406

NEBRASKA NATURAL RESOURCE COMMISSION
301 Centennial Mall South
P.O Box 94876
Lincoln, NE 68509-4876
TEL (402) 471-2081

NEBRASKA DEPARTMENT OF ENVIRONMENTAL CONTROL
P.O Box 98922
Lincoln, NE 68509
TEL (402) 471-4220

NEVADA STATE DIVISION OF CONSERVATION DISTRICTS
333 W Nye Lane, Room 126
Carson City, NV 89710
TEL (702) 687-6977

NEVADA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
Capitol Complex
333 W Nye Lane
Carson City, NV 89710
TEL (702) 687-4670

NEW HAMPSHIRE DEPARTMENT OF AGRICULTURE
P.O. Box 2042
Concord, NH 03302-2042
TEL: (603) 271-3551

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES
P.O. Box 95
6 Hazen Drive
Concord, NH 03302-0095
TEL: (603) 271-3503

NEW JERSEY STATE SOIL CONSERVATION COMMITTEE
New Jersey Department of Agriculture
CN 330, Room 204
Trenton, NJ 08625
TEL: (609) 292-5540

NEW JERSEY BUREAU OF WATER QUALITY PLANNING
401 East State Street, CN 423
Trenton, NJ 08625-0423
TEL: (609) 633-7021

NEW MEXICO SOIL AND WATER CONSERVATION BUREAU
Energy and Forestry Resource Conservation
P.O. Box 1948
Santa Fe, NM 87504-1948
TEL (505) 827-5830

NEW MEXICO ENVIRONMENTAL DEPARTMENT
NMED/Purchase Water Quality Bureau
PO Box 26110
Santa Fe, NM 87502
TEL (505) 827-0187

NEW YORK STATE DEPARTMENT OF SOIL AND WATER CONSERVATION
1 Winners Circle
Albany, NY 12235
TEL (518) 457-3738

NEW YORK DEPARTMENT OF ENVIRONMENTAL CONSERVATION
50 Wolf Road
Room 306
Albany, NY 12233-3500
TEL (518) 457-6674

NORTH CAROLINA DIVISION OF SOIL AND WATER CONSERVATION
Department of EHNR
Box 27687
Raleigh, NC 27611-7687
TEL (919) 733-2302

NORTH CAROLINA DEPARTMENT OF HEALTH AND NATURAL RESOURCES
Division of Environmental Management
P.0 Box 27687
Raleigh, NC 27611
TEL: (919) 733-4064

NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE
State Capitol
600 East Boulevard Avenue
Bismarck, ND 58505-0790
TEL: (701) 224-2650

NORTH DAKOTA DEPARTMENT OF HEALTH AND CONSOLIDATED LABS
1200 Missouri Avenue
Box 5520
Bismarck, ND 58502-5520
TEL: (701) 221-5210

OHIO DEPARTMENT OF NATURAL RESOURCES
Soil and Water Conservation District
1939 Fountain Square Court
Building E-2
Columbus, OH 43224
TEL. (614) 265-6637

OHIO ENVIRONMENTAL PROTECTION AGENCY
1800 Watermark Drive
Columbus, OH 43215
TEL: (614) 644-3020

OKLAHOMA CONSERVATION COMMISSION
2800 N Lincoln Boulevard
Suite 160
Oklahoma City, OK 73105
TEL (405) 521-2384

OKLAHOMA DEPARTMENT OF POLLUTION CONTROL
P O Box 53504
Oklahoma City, OK 73152
TEL (405) 521-2384

OREGON DEPARTMENT OF AGRICULTURE
Natural Resources Division
635 Capitol Street, NE
Salem, OR 97310
TEL (503) 378-3810

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY
811 SW 6th Avenue
Portland, OR 97204
TEL (503) 229-5630

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
Water Quality Management
P.O. Box 2063
Harrisburg, PA 17105-2063
TEL. (717) 783-8303

PUERTO RICO SOIL CONSERVATION COMMITTEE
Department of Agriculture
P.O. Box 10163
Santurce, PR 00908-1163
TEL: (809) 721-2120

PUERTO RICO ENVIRONMENTAL QUALITY BOARD
1413 Fernandez Juncos Avenue
Santurce, PR 00909
TEL: (809) 729-6920

RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
291 Promenade Street
Providence, RI 02908
TEL (401) 277-3961

SOUTH CAROLINA LAND RESOURCES CONSERVATION COMMISSION
2221 Devine Street
Suite 222
Columbia, SC 29205
TEL. (803) 734-9100

SOUTH CAROLINA BUREAU OF WATER POLLUTION CONTROL
2600 Bull Street
Columbia, SC 29201
TEL. (803) 734-5228

SOUTH DAKOTA DEPARTMENT OF AGRICULTURE
Division of Conservation
445 East Capitol
Pierre, SD 57501-3185
TEL (605) 773-3258

SOUTH DAKOTA DIVISION OF WATER RESOURCE MANAGEMENT
523 E Capitol
Pierre, SD 57501
TEL (605) 773-4216

TENNESSEE STATE DEPARTMENT OF AGRICULTURE
Agriculture Resource Division
Ellington Center
PO Box 40627
Nashville, TN 37204
TEL (615) 360-0108

TENNESSEE DEPARTMENT OF CONSERVATION AND ENVIRONMENT
401 Church Street
6th Floor L & C Annex
Nashville, TN 37243-1534
TEL: (615) 532-0625

TEXAS STATE SOIL AND WATER CONSERVATION BOARD
P.O. Box 658
Temple, TX 76503
TEL: (817) 773-2250

UTAH STATE SOIL CONSERVATION COMMISSION
Department of Agriculture
350 North Redwood Road
Salt Lake City, UT 84116
TEL: (801) 538-7171

UTAH DIVISION OF WATER QUALITY
288 N. 1460 West
Salt Lake City, UT 84114-4870
TEL: (801) 538-6146

VERMONT NATURAL RESOURCES CONSERVATION COMMISSION
103 South Main Street
Waterbury, VT 05671-0301
TEL. (802) 241-3601

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
Agency of Natural Resources
Building 10 North
103 South Main Street, 2nd Floor
Waterbury, VT 05671-0408
TEL (802) 241-3770

VIRGIN ISLANDS ECONOMIC DEVELOPMENT AND AGRICULTURE
Estate Lower Love
Kingshill, VI 00850
TEL (809) 778-0997

VIRGIN ISLANDS DIVISION OF ENVIRONMENTAL PROTECTION
45A Estate Nisky Center, Suite 231
St Thomas, VI 00802
TEL. (809) 774-3320

VIRGIN ISLANDS DEPARTMENT OF PLANNING AND NATURAL RESOURCES
Nisky Center, Suite 231
St Thomas, VI 00802
TEL. (809) 774-3320

VIRGINIA DIVISION OF SOIL AND WATER CONSERVATION
203 Governor Street, Suite 206
Richmond, VA 23219
TEL. (804) 786-2064

STATE OF WASHINGTON CONSERVATION COMMISSION
Mail Stop PV-11
Olympia, WA 98504-8711
TEL. (206) 438-7883

WASHINGTON STATE DEPARTMENT OF ECOLOGY
PO Box 47600
Olympia, WA 7600
TEL. (206) 459-6000

WEST VIRGINIA STATE SOIL CONSERVATION COMMISSION
1900 Kanawha Boulevard East
Charleston, WV 25305-0193
TEL. (304) 558-2204

WEST VIRGINIA DEPARTMENT OF NATURAL RESOURCES
1201 Greenbrier Street
Charleston, WV 25311
TEL. (304) 558-2107

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Box 7921
Madison, WI 53707
TEL. (608) 267-7610

WYOMING DEPARTMENT OF AGRICULTURE
2219 Carey Avenue
Cheyenne, WY 82002
TEL. (307) 777-6579

WYOMING WATER DEVELOPMENT COMMISSION
Herschler Building
4th Floor
West Cheyenne, WY 82002
TEL (307)-777-7626

POULTRY WATER QUALITY CONSORTIUM
HB-2C, 1101 Market Street • Chattanooga, TN 37402-2801
Tel: (615) 751-7297 • Fax: (615) 751-7479