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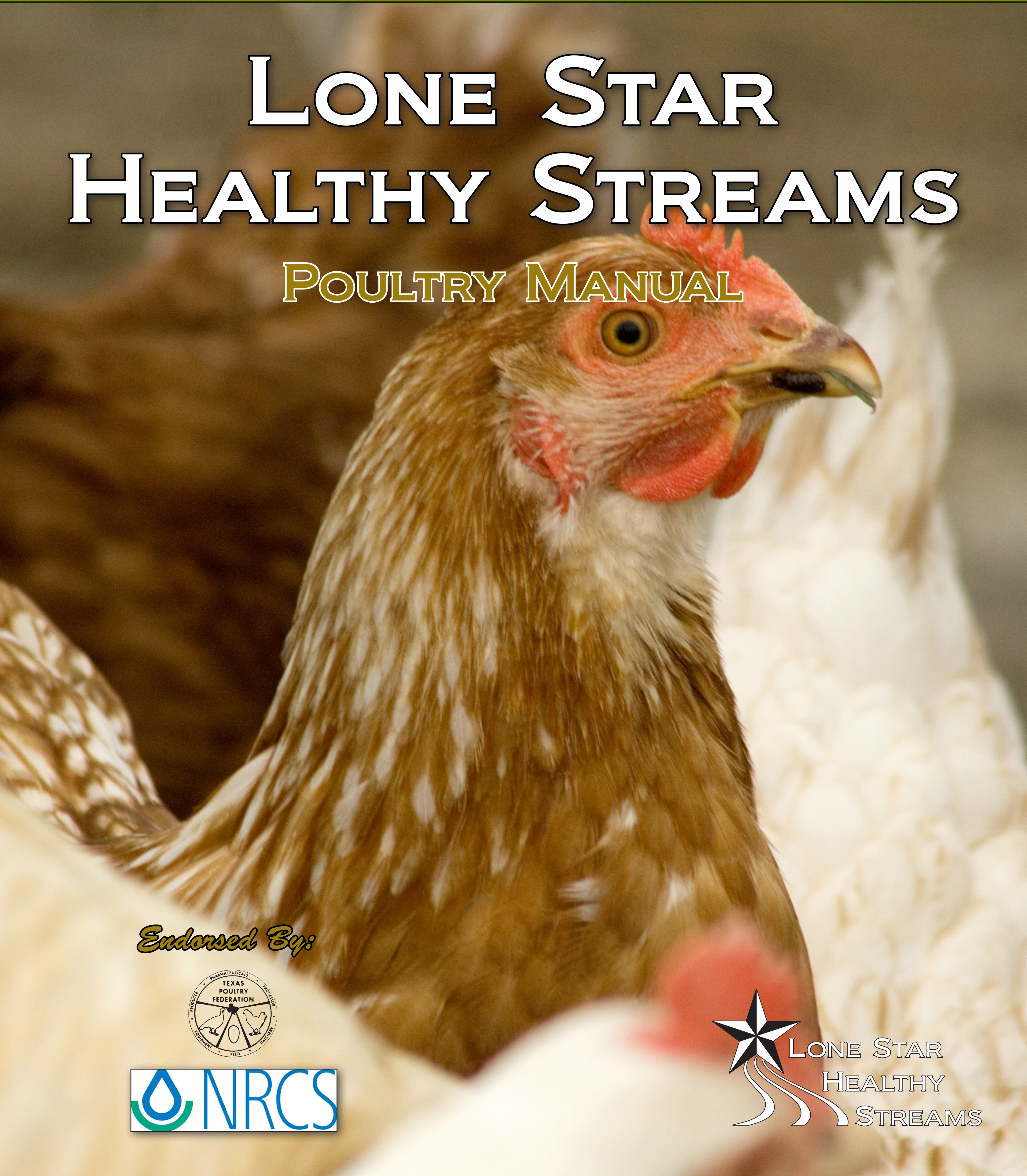
Lone Star Healthy Streams

Poultry Manual



Endorsed By:

Texas Poultry Federation

NRCS

Lone Star Healthy Streams

Keeping Texas Waters Safe and Clean…

Lone Star Healthy Streams

Poultry Manual

Authors

Jennifer Peterson
Extension Program Specialist
Department of Soil & Crop Sciences
Texas AgriLife Extension Service

Craig Coufal
Assistant Professor and Extension Specialist
Department of Poultry Science
Texas A&M University

Kevin Wagner
Associate Director
Texas Water Resources Institute

Larry Redmon
Professor and State Forage Specialist
Department of Soil & Crop Sciences
Texas AgriLife Extension Service

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- Diane Bowen and Judy Winn, Texas AgriLife Communications
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- Lone Star Healthy Streams Steering Committee

Steering Committee Members

Texas AgriLife Extension Service

- Todd Bilby
- Jim Cathey
- Galen Chandler
- Craig Coufal
- Monty Dozier
- Marvin Ensor
- Sam Feagley
- Pete Gibbs
- Ellen Jordan
- Saqib Mukhtar
- Joe Paschal
- Dennis Sigler
- Ronald Woolley

Texas State Soil and Water Conservation Board

- Mark Cochran
- Mitch Conine
- TJ Helton
- Aaron Wendt

Texas Water Resources Institute

- Kevin Wagner
- Brian VanDelist

USDA-Agricultral Research Service

- Daren Harmel

Program Development Committee Members

- Grazing Lands Conservation Initiative (GLCI)
- Independent Cattlemen's Association of Texas
- Little Wichita Soil and Water Conservation District
- Texas AgriLife Extension Service
- Texas AgriLife Research
- Texas Cattle Feeders Association
- Texas Commission on Environmental Quality
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Preface

About 300 Texas water bodies currently do not comply with state water quality standards established for *E.coli* bacteria. Elevated concentrations of *E.coli* bacteria in water are an indicator of fecal contamination and can pose an increased health risk to downstream users.

The Lone Star Healthy Streams program aims to educate Texas livestock producers and land managers on how to best protect Texas waterways from bacterial contributions associated with the production of livestock and feral hogs. To achieve this goal, groups of research scientists, resource conservation agencies, and producers have collaborated to compile this Lone Star Healthy Streams manual which includes best management practices (BMPs) known to reduce *E.coli* contributions to rivers and streams. In addition to reducing bacterial contributions, the BMPs listed in this manual will allow livestock and land owners to further protect Texas waterways from sediment, nutrient, and pesticide runoff.

We hope that landowners and livestock producers find the following information helpful in their pursuit of being the best natural resource stewards they can be. For more information about the Lone Star Healthy Streams program, please visit http://lshs.tamu.edu/.

Chapter 1
Water Quality in Texas

Water Quality in Texas

Water is a finite resource that can be significantly polluted by a variety of sources across the landscape. No one person, industry, or activity is to blame, but the agricultural sector often is singled out as a major contributor of pollutants to Texas's waterways. Although many think this claim is unjust, the agricultural community can choose to regulate itself through stewardship and conservation practices rather than have the solutions determined by those who may not understand the industry.

Poultry operators should carefully consider any measures they can take to minimize watershed pollution and reduce the potential for regulation. Pollution in water bodies has led to governmental regulations in the Bosque River watershed in Texas, the Vermillion River watershed in Illinois, the Fourth Creek watershed in North Carolina, the Chesapeake Bay watershed in Delaware, and many others across the United States.

Producers have many management options for improving water quality, some of which are fairly low cost and easy to implement. Several of these options also can improve animal performance and enhance the long-term health of the land on which the animals are raised.

Poultry producers can more easily make wise choices for reducing pollution originating on their operations if they know the benefits of clean water to agricultural operations, the current laws and policies on water quality, the ways that bacteria can enter water, and the range of solutions that are available for them to reduce water quality problems.

Value of Clean Water to Texas Agriculture

Clean water is vital to agricultural producers in Texas. Water is used for irrigating crops (Fig. 1) and raising livestock and is the reason why the Texas food and fiber system is valued at nearly $100 billion each year. Clean water can also improve animal health, gains, and reproduction, as well as increase recreational opportunities on farms and ranches.

Figure 1. Clean water is vital to crops and livestock in Texas. Photo by Blair Fannin, Texas AgriLife Extension Service.

Bacteria can severely reduce or even eliminate some of these valuable water-based activities and associated benefits. The costs of poor water quality include degraded ecosystems, limited agricultural production, reduced recreational opportunities, increased government regulation, increased water treatment costs, and threats to human health.

Water Quality Law and Policy

The foundation for surface water quality protection in the United States is the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA). Passed in 1972 and amended in 1977, the CWA was enacted to restore and maintain the chemical, physical, and biological characteristics of the nation's waters.

In brief, the Clean Water Act requires that states set standards for surface water quality; it also requires public and private facilities to acquire permits for discharging wastewater. At the federal level, the U.S. Environmental Protection Agency (EPA) is responsible for administering the water quality standards outlined in the Clean Water Act. The EPA delegates water quality management at the state level to the specific state environmental agency.

In Texas, the primary water quality agency is the Texas Commission on Environmental Quality (TCEQ, Fig. 2). The TCEQ is responsible for:

- Establishing water quality standards
- Determining how water quality will be managed
- Issuing permits for point source dischargers
- Reducing all types of nonpoint source pollution, except those from agricultural and silvicultural (forestry) sources

Point source pollution can be traced to a specific location and point of discharge, such as a pipe or ditch; nonpoint source pollution originates from multiple locations and is carried primarily by precipitation runoff.

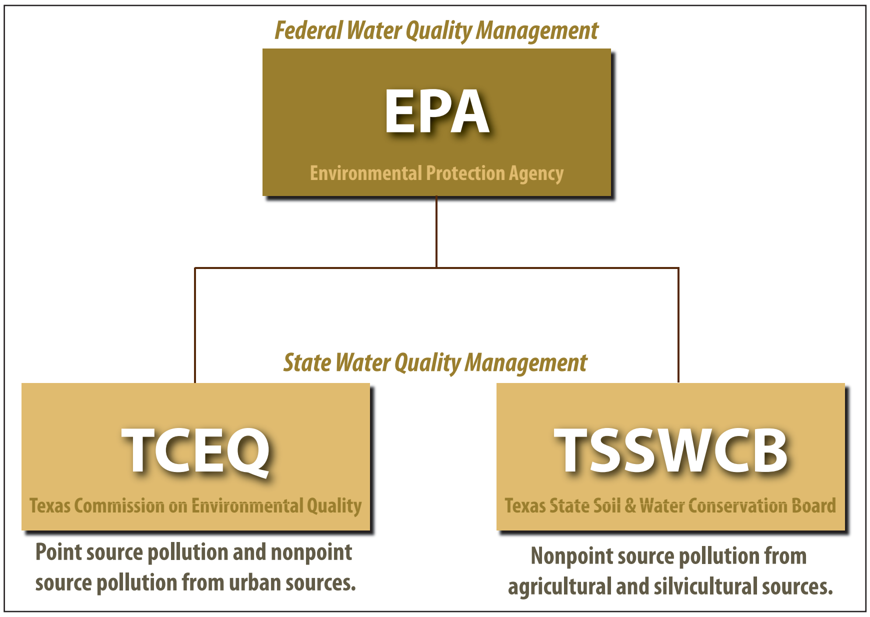


Figure 2. Hierarchy of federal and state agencies primarily involved in water quality management in Texas. Illustration courtesy of Jennifer Peterson.

In 1991, the Texas Legislature delegated some water quality authority to the Texas State Soil and Water Conservation Board (TSSWCB). The TSSWCB is responsible for administering the state's soil and water conservation law and for managing programs to prevent and reduce nonpoint source pollution from agriculture and forestry.

Specifically regarding poultry operations in Texas, Keplinger (2001) states, "Broiler operations in Texas, by virtue of their reliance on dry litter waste systems, are generally exempt from Concentrated Animal Feeding Operation (CAFO) designation at state and federal levels. The state of Texas has strong and comprehensive regulatory requirements that apply to CAFOs. Non-CAFO animal feeding operations (AFOs) are also required to conduct operations in accordance with all the technical requirements specified in Texas CAFO regulations unless they operate under a Texas State Soil and Water Conservation Board (TSSWCB) certified water quality management plan (WQMP), in which case they are exempt from Texas CAFO regulation. WQMPs have been adopted by almost all broiler operations in Texas. These site-specific plans are generally consistent with technical requirements in Texas CAFO regulation since they are both based on Natural Resources Conservation Commission (NRCS) standards. The TSSWCB has no enforcement powers, per se, however, if a broiler operation is found to be out of compliance with its WQMP, the TSSWCB may refer the operation to the TCEQ for enforcement. Broiler operations that choose not to obtain WQMPs are still required to adhere to all applicable regulations, including the technical requirements in Texas CAFO regulations."

To comply with Section 303(d) of the Clean Water Act, the TCEQ must report to the EPA on the extent to which each surface water body meets water quality standards. The report must be submitted every 2 years and is known as Texas Integrated Report for Clean Water Act, Sections 305(b) and 303(d).

The Integrated Report describes the status of all surface water bodies that were evaluated and monitored in the state over the most recent 7-year period. This report is the basis for the 303(d) List, which identifies all impaired surface bodies of water that do not meet water quality standards.

Water quality standards specify numeric levels of water quality criteria such as bacteria, temperature, dissolved oxygen, and pH that can be measured in a lake, river, or stream without impairing the designated use(s) assigned to that water body. Designated uses include aquatic life, fish consumption, public drinking water supply, and contact and noncontact recreation. Any water body whose water quality criteria measurements fall outside of the levels set by the standards for each designated use is considered impaired and is placed on the 303(d) List.

The Clean Water Act requires that a calculation be made on the pollution reductions needed to restore an impaired water body to its designated use(s). The calculation is called a total maximum daily load (TMDL). A TMDL must be developed for waters on the 303(d) List of impaired waters within 13 years of being listed. If the state does not develop a TMDL within the required time limit, the EPA will.

In Texas, both the TCEQ and the TSSWCB are responsible for developing and submitting TMDLs to the EPA. After a TMDL is complete, an implementation plan (I-Plan) must be developed. This plan includes a detailed description of the regulatory measures, voluntary management measures, and parties responsible for carrying out identified measures needed to restore water quality in accordance with the TMDL. Unlike the TMDL, the implementation plan must be

approved by only the TCEQ or TSSWCB, not the EPA.

Regulatory measures are typically applicable only to point source dischargers such as concentrated animal feeding operations (CAFOs) or wastewater discharges. However, some U.S. watersheds have also imposed regulatory measures on nonpoint sources.

According to the 2010 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d), there were a total of 621 impairments in Texas. Of these impairments, 51% were due to elevated bacteria. As of February 2012, a total of 206 TMDLs have been developed for 134 water segments in Texas.

Some watersheds may have another option that may be more viable for solving complex water issues. Instead of developing a TMDL, they may be able to develop and implement a watershed protection plan (WPP).

A WPP is a voluntary, stakeholder-driven strategy for improving water quality. These plans are developed and managed through partnerships among federal and state agencies and local groups and organizations. They rely heavily on stakeholder involvement at the local level.

To help communities create WPPs, the EPA has produced a guide, *Handbook for Developing Watershed Plans* to Restore and Protect Our Waters. The handbook outlines nine key elements that each WPP should contain:

- Causes and sources of the water quality problem
- Load reductions needed to restore water quality
- Management measures needed to achieve the load reductions
- Technical and financial assistance needed to implement the management measures
- Information and education programs needed
- Implementation schedule
- Implementation milestones
- Criteria to determine success
- Monitoring needed to determine the effectiveness of implementation

The main difference between the two approaches is that TMDLs are required by federal law, and WPPs are voluntary. In general, a WPP gives communities a way to restore water quality, remove the body of water from the 303(d) List, and avoid regulatory action in the watershed. In some cases, however, development of a TMDL is more appropriate and unavoidable, especially if the impairment causes an emergency situation.

For more information on important state laws affecting Texas poultry producers, read Appendix A.

Sources of Bacteria in Texas Waterways

Fecal bacteria are microscopic organisms found in the feces of humans and other warm-blooded animals. By themselves, they are usually not harmful, but they are important because they are indicator species and can suggest the presence of pathogenic (disease-causing) organisms.

Pathogenic organisms include bacteria, viruses, or parasites that can cause waterborne illnesses such as typhoid fever, dysentery, and cholera. In addition to the potential health risks, elevated bacteria levels can also cause unpleasant odors, cloudy water, and increased oxygen demand.

The most common types of fecal bacteria that are measured to indicate the potential presence of harmful pathogens include: total coliform, fecal coliform, fecal streptococci, enterococci, and *Escherichia coli* (*E. coli*). The EPA recommends E. coli as the most reliable indicator of contamination for freshwater and enterococci as the most reliable indicator in saltwater.

Bacterial contamination of surface waters is a major problem—it is the leading cause of water quality impairment not only in Texas, but also nationwide.

Bacteria in Texas waterways can come from many sources across the landscape (Fig. 3):

- Wastewater treatment plants, especially from plants that are not up to code or functioning properly
- Leaky septic systems
- Pet waste
- Runoff from neighborhood streets and parking lots
- Wildlife, including deer, rodents, and large flocks of birds resting on public waters
- Poultry (Table 1)
- Feral hogs (Table 1)
- Grazing livestock (Table 1)

One method to pinpoint the sources of fecal bacteria is bacterial source tracking (BST). This expensive process examines the DNA structure of bacteria to determine if it originated from human, livestock, wildlife, pet waste, or avian sources. Although still in its developmental stages, BST can be a useful tool in watershed planning. Regardless of the source, excess bacteria levels are involved in more than 50 percent

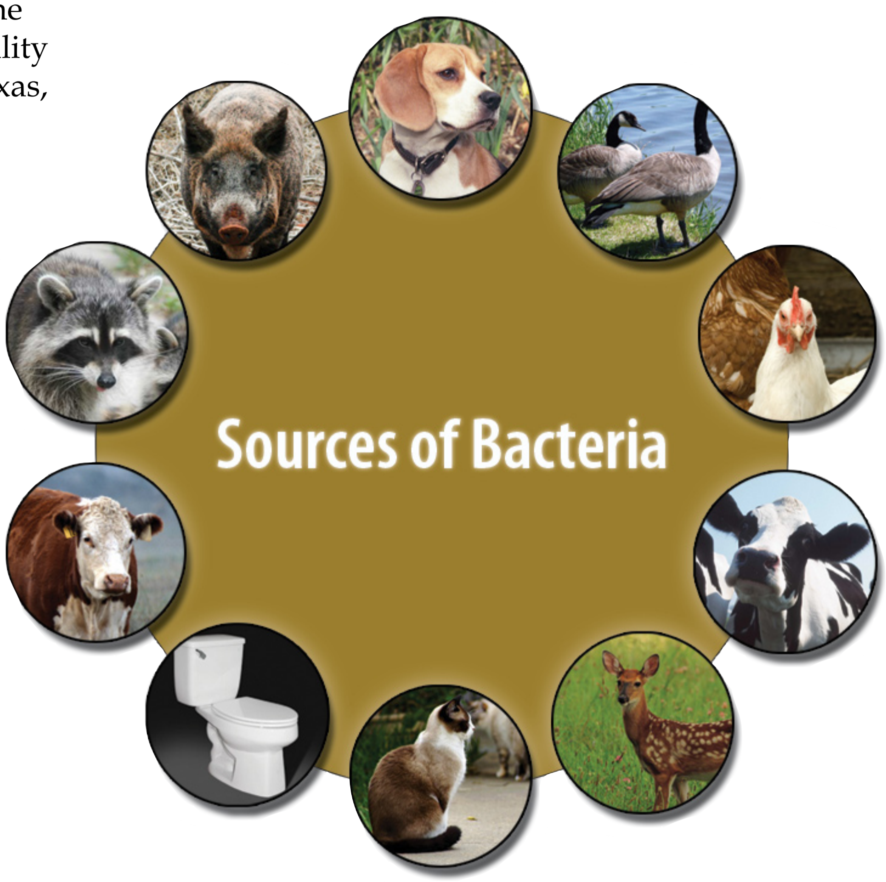


Figure 3. Bacteria in Texas waterways can originate from a variety of sources, including wastewater treatment facilities, wildlife, pets, and livestock. Illustration courtesy of Jennifer Peterson.

of the water quality impairments in Texas (Fig. 4).

Bacteria Fate and Transport

The behavior of bacteria in water is not well understood because it involves many complex factors in the environment and in the organisms themselves. As a result, it can be a challenge to reduce their levels in waterways.

Several processes affect the fate and transport of fecal bacteria (Table 2).

- **Fate processes** include growth (cell division), death by predation, and die-off.
- **Transport processes** include advection (horizontal transport), dispersion, settling, and re-suspension from the sediment bed.

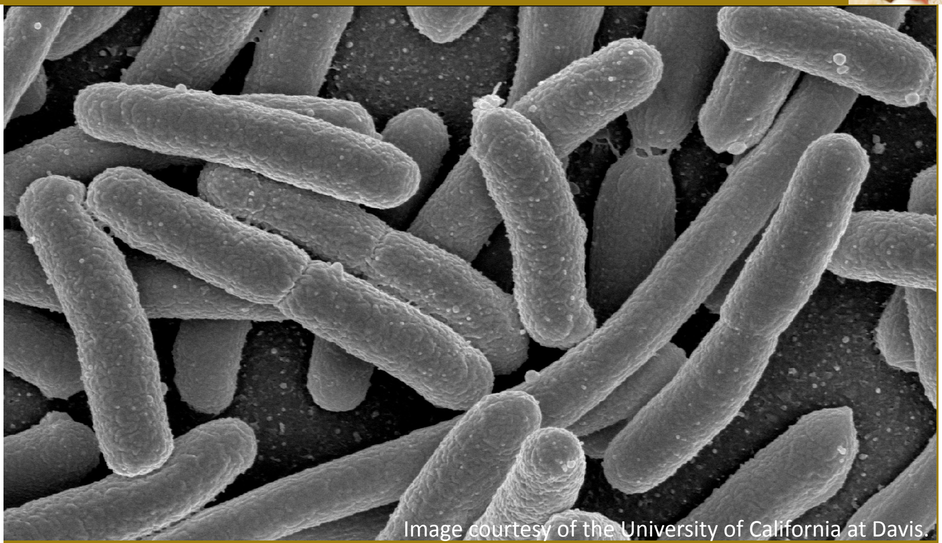


Image courtesy of the University of California at Davis.

Escherichia coli, commonly abbreviated as *E. coli*, is a rod-shaped bacterium found in the lower intestine of warm-blooded organisms. It was first discovered in 1885 by German pediatrician and bacteriologist, Theodor Escherich.

Perhaps the most recognized strain is O157:H7 which can cause serious food poisoning in humans and is often the cause of product recalls. In 2006, more than 200 people became sick and 3 people died after consuming spinach contaminated with *E. coli.*

E. coli are important in water quality because they act as indicator organisms - their presence in water can indicate the potential prescence of other harmful pathogens that are capable of causing disease in humans.

Both processes are altered by temperature, pH, nutrients, toxins, salinity, and sunlight intensity.

Computer models (Soil and Water Assessment Tool, Hydrological Simulation Program-FORTRAN) can be used to simulate the fate and transport of bacteria at the watershed-scale, however, the predictive strength of these models depends highly on the accuracy of the data entered into the model. A better comprehension of the fate and transport of bacteria is needed to understand the potential impact of the contaminant and to more effectively develop management strategies in a watershed.

Benefits of Voluntary Conservation Practices

Federal and state natural resource agencies are encouraging the voluntary use of effective conservation practices to improve water quality. Farmers and ranchers can do their part to minimize the runoff of agricultural pollutants into waterways by implementing practices that better manage water use, runoff, and chemical applications.

Although improvements in water quality from livestock owners' efforts can take years to detect, these practices can often result in tangible benefits. In one study, the benefits

Table 1. Fecal coliform production for major classes of livestock and feral hogs (Wagner and Moench 2009).

Animal	Daily fecal production (lbs/day/AU)	Daily fecal production (g/day/AU)	Fecal coliform density (cfu/g)	Fecal coliform (cfu/AU/day)
Beef Cattle	82	37,195	2.30E+05	8.55E+09
Horses	51	23,133	1.26E+04	2.91E+08
Goats	40	18,144	1.40E+06	2.54E+10
Sheep	40	18,144	1.60E+07	2.90E+11
Hogs	65	29,484	3.30E+06	9.73E+10
Layers	63	28,576	1.30E+06	3.71E+10
Pullets	63	28,576	1.30E+06	3.71E+10
Broilers	82	37,195	1.30E+06	4.84E+10
Turkey	47	21,319	2.90E+05	6.18E+09
Deer	15	6,804	2.20E+06	1.50E+10
Feral Hogs	65	29,484	4.10E+04	1.21E+09

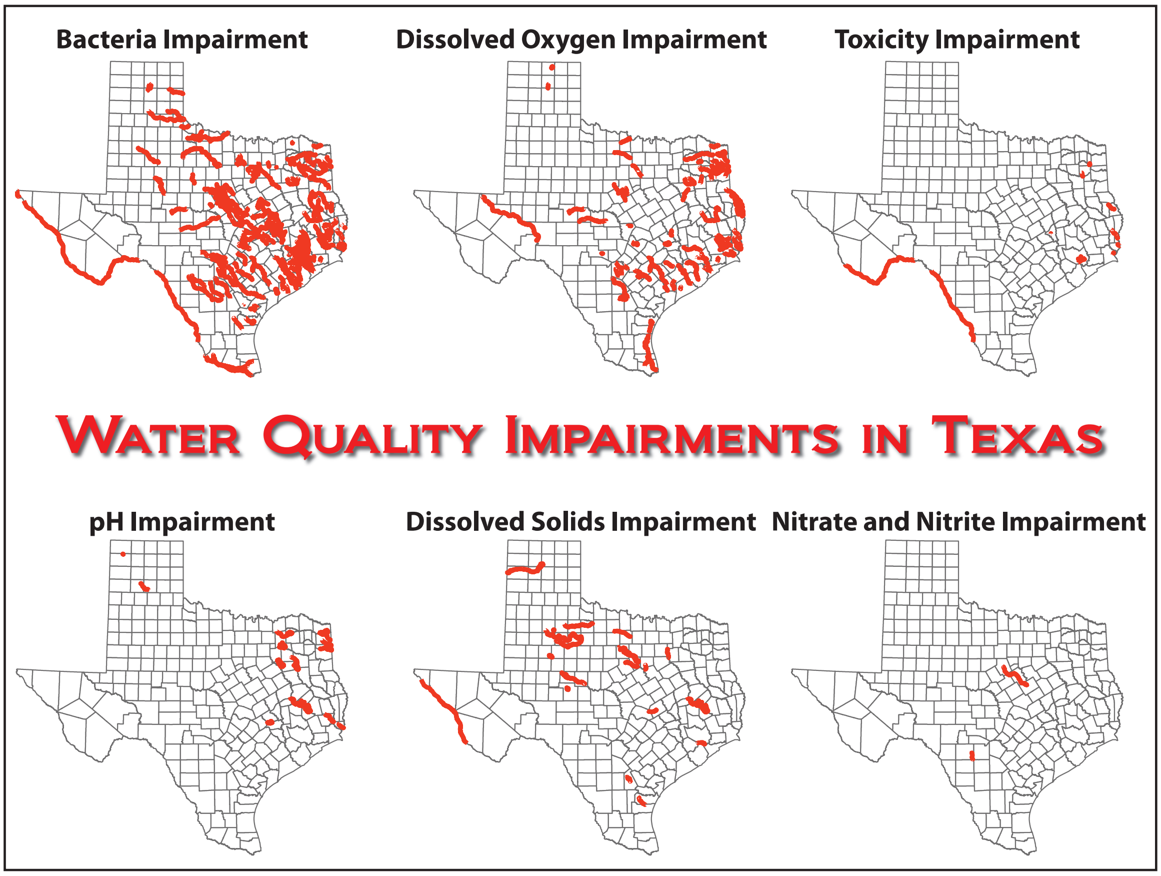


Figure 4. Types and locations of impairments in Texas water bodies. Source: TCEQ, 2008.

Table 2. Potential survival of fecal pathogens in water and soil (Olsen 2003).

		Duration of Survival			
Material	**Temperature**	**Cryptosporidium**	**Salmonella**	**Campylobacter**	***E. coli* (O157:H7)**
Water	Frozen	>1 year	>6 months	2-8 weeks	>300 days
	Cold (5°C)	>1 year	>6 months	12 days	>300 days
	Warm (30°C)	10 weeks	>6 months	4 days	84 days
Soil	Frozen	>1 year	>12 weeks	2-8 weeks	>300 days
	Cold (5°C)	8 weeks	12-28 weeks	2 weeks	100 days
	Warm (30°C)	4 weeks	4 weeks	1 week	2 days

to water quality benefits from erosion control on cropland totaled over $4 billion per year. Another study found erosion reduction measures on private lands in the United States increased the value of water-based recreation by about $373 million.

Although the implementation of conservation practices is currently voluntary and can require financial input by landowners, the benefits of having clean water resulting from these practices far outweigh the associated costs. The goal of the Lone Star Healthy Streams program is to provide information to agricultural producers and landowners on practices that can help reduce bacterial contributions. These practices will enable the agricultural sector to do its part to improve water quality.

The Texas Poultry Industry

Commercial poultry production did not begin in Texas until the 1840s and was extremely limited until the twentieth century (Moore 2011). According to data published by the Texas Department of Agriculture, the value of poultry meat and eggs produced in Texas was estimated at $2.1 billion in 2008. In total, the Texas poultry industry (meat and eggs combined) represents approximately 10.5 percent of all agricultural cash receipts. At the national level, Texas is ranked sixth in broiler production, egg production, and poultry exports. Furthermore, the poultry industry employs over 7,700 employees in the state and in 14 counties, it represents more than 50 percent of the total market value of agricultural products.

Chapter 2

Best Management Practices For Poultry

As with any other class of livestock, poultry can damage the land on which they are kept. Owners have the responsibility of managing them in a way that minimizes their impact on the surrounding environment. Although runoff from poultry operations can degrade surface water quality in many ways, most pollution stems from production, processing, and disposal of waste. Sedimentation from erosion and the excessive use of poultry litter as fertilizer on pasturelands can also contribute to the problem.

Poultry farms typically house birds in a restricted or concentrated area. If proper care is not taken, they can concentrate manure, develop digestive and behavioral disorders, and impact surrounding ecological areas and watersheds. Poultry operators should adopt best management practices (BMPs) to protect their animals and the land they manage.

Along the eastern and western coasts of the United States, the degradation of surface water quality has caused mandatory regulations to be imposed on poultry operators. To prevent or minimize such regulation in Texas, a proactive approach is necessary to prevent contamination.

No matter what kind of livestock you own and raise, voluntary BMPs can be adopted to help reduce fecal contamination of Texas streams and rivers. In addition to ensuring better water quality for you, your livestock, your neighbors, and Texas, these poultry BMPs will also help you maintain healthier watersheds, improve livestock health, and increase property values.

Poultry BMPs that can help reduce bacterial concentrations can generally be divided into three categories: runoff management, manure management, and mortality management (Table 3). These practices are not mutually exclusive. Often a combination of practices will be most beneficial to you, your land, your animals, and your watershed.

Specific NRCS conservation practice codes are mentioned throughout the text. More detailed information about these practices can be found in the NRCS Field Office Technical Guide (FOTG), which can be found in all Soil and Water Conservation District Offices, all NRCS field offices, and on the NRCS web page (EFOTG).

Runoff Management BMPs

Runoff management BMPs help control the amount of water moving across the landscape. These practices are vital to

Table 3. Poultry BMPs organized by category.

Runoff Management	Manure Management	Mortality Management
Filter strips (NRCS Code 393)	Waste storage structure (NRCS Code 313)	Proper carcass disposal
Field borders (NRCS Code 386)	Waste utilization (NRCS Code 633)	
Grassed waterways (NRCS Code 412)	In-house pasteurization of litter (NRCS Code 629)	
Roof Runoff Structure (NRCS COde 558)	Soil testing and nutrient management (NRCS Code 590)	
	Composting (NRCS Code 317)	

minimizing bacterial contamination of surface water bodies and keeping watersheds healthy. Reducing the flow of water across the landscape will cause fewer pollutants to be picked up and deposited into the water body itself.

Several BMPs help manage runoff, including filter strips (NRCS Code 393), field borders (NRCS Code 386), grassed waterways (NRCS Code 412), and roof runoff structures (NRCS Code 558).

Filter Strips

A filter strip is an area of herbaceous vegetation that is established between a body of water and cropland, grazing land, or disturbed land. It is designed to remove sediment, bacteria, organic material, nutrients, and chemicals from overland flow. A filter strip works by slowing runoff, which allows the contaminants to settle out, infiltrate, and be dispersed across the width of the filter strip (Fig. 5).

In addition to improving water quality, filter strips can also improve soil aeration, provide wildlife habitat, provide shade that improves soil m.oisture content, and recycle nutrients that promote plant growth (Green and Haney 2005).

For adequate protection, filter strips should have specific minimum widths, which vary according to the slope of the land (Table 4). Their effectiveness depends on:

- The amount of sediment that reaches the filter strip
- The amount of time that water is retained in the filter strip
- The steepness, length, and slope of the filter strip
- The infiltration rate of the soil
- The type and density of vegetation used in the filter strip
- The uniformity of the water flow through the filter strip

Table 4. Minimum widths for vegetative filter strips. Standards and Specifications No. 393, USDA-NRCS Field Office Technical Guide, 2004.

Slope	Minimum Width of Buffer Strip
1–3%	25 ft
4–7%	35 ft
8–10%	50 ft

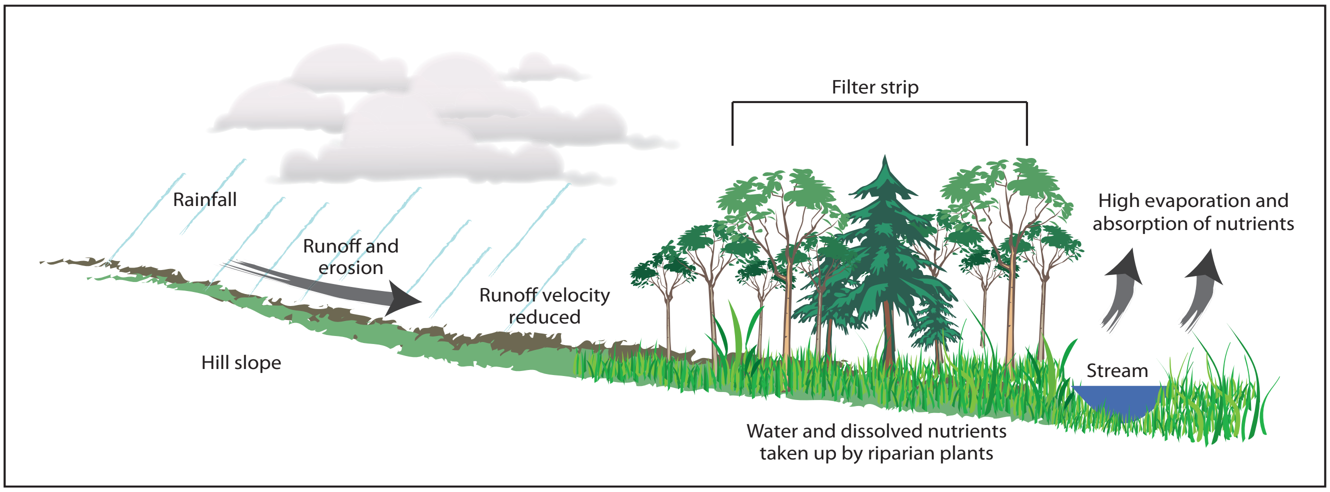


Figure 5. Conceptual model of how vegetative filter strips protect a stream from contaminants and the riparian area from erosion. Illustration by Jennifer Peterson.

- The correct installation and maintenance of the filter strip (Smith et al. 2000)

Table 5 shows the effectiveness of filter strips in reducing different types of bacteria in runoff. These data are from research conducted on land grazed by beef and/or dairy cattle. It is assumed that filter strips would be just as beneficial on land where poultry litter was applied.

Filter strips have other benefits as well:

- Reducing overland flow and erosion and increasing infiltration (Arora et al. 1993,

Table 5. Effectiveness of filter strips in removing different kinds of bacteria from runoff.

Type of Bacteria	Reduction	Source
E. coli	99.7%	Casteel et al. 2005
	94.8%-99.995%	Tate 2006
	91%	Mankin and Okoren 2003
	57.85%-98.9%	Goel et al. 2004
Total coliform	97%-99.4%	Casteel et al. 2005
	81%	Cook 1998
	69%	Young 1980
	66.89%-92.12%	Goel et al. 2004
Fecal coliform	100%	Lim et al. 1998
	99%	Sullivan 2007, Lewis et al. 2010
	87% and 64%	Fajardo et al. 2001
	83.5%	Mankin and Okoren 2003
	83% and 95%	Larsen et al. 1994
	81%	Stuntebeck and Bannerman 1998
	75% and 91%	Coyne et al. 1998
	69%	Young 1980
	67%	Roodsari et al. 2005
	55.59%-99.78%	Goel et al. 2004
	43% and 72%	Coyne et al. 1995
Fecal streptococci	83.5%	Mankin and Okoren 2003
	76%	Cook 1998
	74% and 68%	Coyne et al. 1998
	70%	Young 1980
Cryptosporidium parvum	99.9%	Atwill et al. 2002
	99.4%	Trask et al. 2004
	99%	Mawdsley et al. 1996
	97%	Miller et al. 2008
	93.5% to 99.4%	Tate et al. 2004
Giardia	26%	Winkworth et al. 2008

Arora et al. 1996, Asmussen et al. 1977, Barfield et al. 1998, Blanco-Canqui et al. 2004, Blanco-Canqui et al. 2006, Coyne et al. 1995, Coyne et al. 1998, Daniels and Gilliam 1996, Dillaha et al. 1989, Gilley et al. 2000, Hall et al. 1983, Hayes and Hairston 1983, Helmers et al. 2005, Lee et al. 2000, Magette et al. 1989, Munoz-Carpena et al. 1999, Parsons et al. 1994, Parsons et al. 1990, Patty et al. 1997, Renard et al. 1997, Rohde et al. 1980, Schmitt et al. 1999, Schultz et al. 1992, Tingle et al. 1998)

- Increasing sediment trapping from 41 to 100 percent (Fig. 6)
- Increasing total phosphorus trapping from 27 to 96 percent (Dillaha et al. 1989, Eghball 2000, Lee et al. 2000, Magette et al. 1989, Schmitt et al. 1999, Uusi-Kamppa et al. 2000, Young et al. 1980)
- Increasing nitrate-nitrogen trapping from 7 to 100 percent (Barfield et al. 1998, Blanco-Canqui et al. 2004, Blanco-Canqui et al. 2006, Dillaha et al. 1989, Eghball 2000, Lee et al. 2000, Mankin et al. 2007, Patty et al. 1997, Schmitt et al. 1999, Young et al. 1980).
- Increasing the retention of herbicide in runoff by 38 percent (Krutz et al. 2005)
- Reducing atrazine concentrations (Dillaha et al. 1985, Snyder 1998)

The cost of establishing a filter strip depends on the seed and fertilizer selected and the associated labor and equipment costs. According to the NRCS, filter strip installation can cost from $275 to $310 per acre.

Often, simply changing the stocking rate and/or grazing management will encourage filter strips to develop naturally. Riparian areas that are protected from overstocking and overgrazing will naturally develop effective vegetative filter strips.

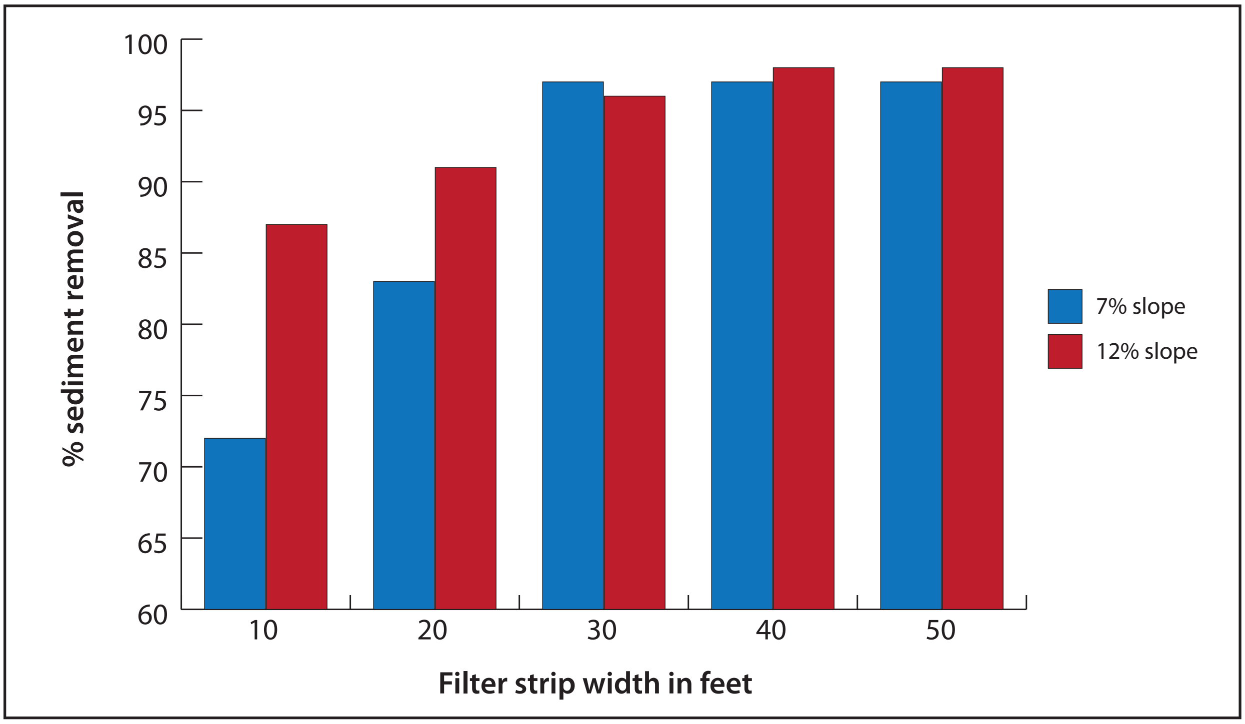


Figure 6. Percent sediment removed by a vegetative filter strip based on the width of the filter strip (Schultz et al. 1992).

The NRCS offers technical and financial assistance programs to offset 50 percent of the cost of implementation. For more information on these programs, contact the NRCS office at the local USDA Service Center (http://offices.sc.egov.usda/gov/locator/app).

Figure 7. A field border planted along a field can help save soil. Photo by Lynn Betts, USDA-NRCS.

Field Borders

Field borders are a strip of permanent vegetation established at the edge of or around the perimeter of a field (Fig. 7). They are intentionally managed as a non-crop herbaceous plant community and are often employed in addition to fence rows and drainage ditches. Field borders will vary in widths and species composition depending on the objectives for their establishment.

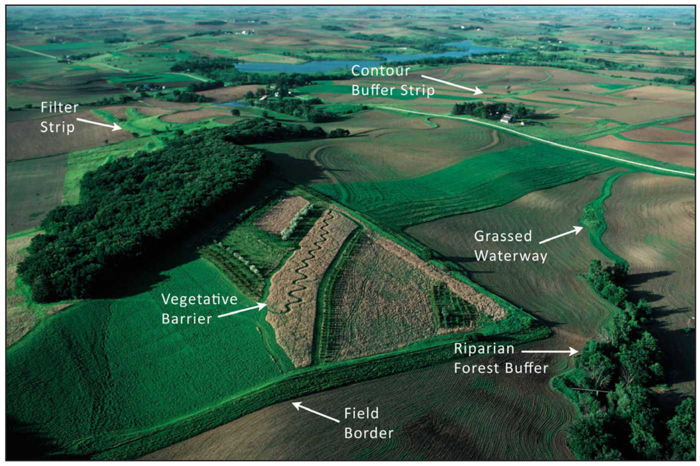


Figure 8. Schematic illustration of several in-field and edge-of-field vegetated buffers. Photo courtesy of the USDA-NRCS.

Field borders reduce soil erosion by eliminating the need to plant end rows up and down the hill. Where field edges are affected by salinity, field borders can control the spread of salinity into non-saline soils. Field borders can also act as a filter strip between a field and road or drainage ditch (NRCS 2009a).

Field borders can be applied to accomplish one or more of the following:

- Reduce erosion from wind and water
- Protect soil and water quality
- Manage pest populations
- Provide wildlife food and cover
- Increase carbon storage
- Improve air quality

Although field borders and filter strips provide similar benefits, the main difference between them is their extent (Fig. 8). Unlike filter strips, field borders can be developed around an entire field margin instead of just along a down-slope edge.

Within intensive agricultural landscapes, field borders can provide nesting, foraging, roosting, loafing, and escape cover for grassland and early successional bird species. The availability of field borders can also increase local species abundance and species richness.

For field borders to have a positive impact on water quality, the NRCS suggests they be established at a width of 30 feet and have a vegetation stem density/retardance of moderate to high (e.g. equivalent to a good stand of wheat). Furthermore, the height of the vegetation should be maintained at one foot to achieve the maximum erosion reduction possible.

Few studies have been conducted on the effectiveness of field borders in removing bacteria from runoff. One study reported a 40% drop in fecal coliform bacteria concentrations within a 4-year period with the use of field borders and other runoff management BMPs.

Because field borders and filter strips both use dense stands of established vegetation to help control runoff, bacterial removal efficiencies for filter strips will also apply to field borders in most cases. Refer to Table 5 of this manual for specific data on bacterial removal efficiencies.

In addition to removing bacteria from runoff, field borders can:

- Double the population of important grassland songbird species including the Dickcissel and the Indigo Bunting (NRCS no date).
- Increase population of foliage-dwelling predaceous arthropods in cotton fields (Outward et al. 2008).
- Increase population of bobwhite quail on small farms (Palmer et al. 2005).
- Reduce erosion from border areas by protecting soil from machinery operations.
- Trap sediment in runoff leaving crop fields at down slope end of rows.
- Manage harmful insect populations by interrupting migration paths.
- Help disperse runoff across a pasture or field.
- Reduce the amount of sediment reaching a stream by up to 75% (NRCS 2009a).
- Reduce nitrogen in surface ground water by up to 50% or more (NRCS 2009a).
- Increase crop yields by 10-30%, depending upon the crop and the buffer (NRCS 2009a).
- Protect fields from flood damage and flood debris (NRCS 2009a).
- Reduce drain and road ditch maintenance costs (NRCS 2009a).
- Reduce nutrients and pesticides in runoff water (NRCS 2009a).

The cost of establishing a field border depends on the labor and seed required for installation. According to the NRCS, field borders cost approximately $456.00 per acre (one mile length of 15 feet wide field border equates to 1.82 acres). The installed practice is designed to last 10 years. This particular cost estimate provided by the NRCS is for a field border planted around a 160-acre field that is relatively flat and designed primarily for water quality benefits. Costs include forgone income for acreage taken out of crop production as well as a perennial grass/forb pollinator seed mix.

Grassed Waterways

A grassed waterway is a shaped or graded channel that is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet (Fig. 9). A grassed waterway has several purposes:

- To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding.
- To reduce gully erosion.
- To protect/improve water quality.

By design, grassed waterways are typically broad and shallow which allows the most effective movement of surface runoff across the land without causing erosion.

Grassed waterways use existing or planted vegetation to trap bacteria, sediment, nutrients, and other pollutants so they are prevented from reaching the waterway. This vegetation also helps improve soil aeration and also provides permanent habitat for a wide variety of fauna.

Factors to consider before installing a grassed waterway include (Green and Haney 2005b):

- Types and concentrations of pollutants for which they are being designed
- Soil characteristics, such as clay content, organic material and infiltration rate
- Size of contributing area
- Previous or existing vegetation
- Steepness of slope/irregularity of topography
- Dimensions of the surrounding watershed that will be draining into the grassed waterway
- Types of vegetation adaptable to the area
- Climatic conditions at planting times
- Possible combinations of conservation practices to improve water quality
- Dominant wind direction

The bacterial removal efficiency of grassed waterways depends on soil characteristics, land slope/topography, vegetation, area of establishment, shape of the waterway, and construction and maintenance practices. In practice, a wider grassed waterway with well-established vegetation will be more effective at trapping sediment and other pollutants, due to greater surface contact area and greater contact time with runoff (Green and Haney 2005b).

Figure 9. Grassed waterways carry runoff from fields helping prevent erosion and protect water quality. Photo by Lynn Betts, URDA-NRCS.

Because grassed waterways and filter strips both use dense stands of established vegetation to help control runoff, bacterial removal efficiencies for filter strips will also apply to grassed waterways in most cases. Refer to Table 5 of this manual for specific data on bacterial removal efficiencies.

In addition to water quality benefits, grassed waterways have also been shown to:

- Reduce runoff and sediment delivery by up to 97% (Fiener and Auerswald 2003a).
- Reduce runoff volume by an average of 47% and herbicide residues in runoff by up to 56% (Briggs et al. 1999).
- Reduce ephemeral and gully erosion by 60% to 80% (NRCS 1989).
- Lower total phosphorus levels (Udawatta et al. 2004).
- Stabilize the soil by increasing soil aggregation.
- Protect soil from eroding forces of wind, water, and raindrop impact.

- Provide shade that improves soil moisture content.
- Recycle nutrients, limiting stress to crops and animals caused by dry summer winds and cold winter winds that can cause reduced production.

Costs associated with the installation of grassed waterways can vary depending on the equipment, labor, grading, seed, and fertilizer required. However, potential returns include revenue from harvesting and marketing hay from grassed waterways (Greene and Haney 2005b). Fortunately, financial and technical assistance programs exist at the federal, state, and local levels to help landowners who might be interested in installing this practice.

According to the NRCS, the cost to install and maintain grassed waterways was estimated at $800 an acre, plus costs associated with forgone income from land taken out of crop production for establishment of the waterway. The cost to plant sprigged grasses and perform mechanical and/or chemical weed control was estimated at $150 an acre while seeding with native species and using weed control was estimated at $110 per acre.

For more information on costs and financial incentive programs, contact your local County Extension Agent, Soil and Water Conservation District (http://www.tsswcb.state.tx.us/swcds) or the Natural Resources Conservation Service (http://www.usda.nrcs).

Roof Runoff Structure

Roof runoff structures are gutters, downspouts, and outlets that collect, control, and transport precipitation from roofs (Fig. 10). During heavy rains, large amounts of water drain off the roofs of farm houses, barns, and other buildings and can cause flooding, erosion, and pollution problems. These problems can be greatly minimized simply by keeping roof rainwater away from buildings and other important areas on the farm.

Figure 10. A roof runoff structure like the one pictured helps collect, control, and transport precipitation from roofs. Photo courtesy of the King Conservation Disctrict.

The first step is to install gutters and downspouts on houses, barns, and other large buildings. Downspouts should direct rainwater away from the building and to a vegetated area such as a filter strip. Minimize the water's force by protecting the ground directly below downspouts with rocks, splash blocks, or surface drains (Fig. 11).

Collecting roof runoff or diverting it to vegetated areas keeps it from flowing across impervious surfaces and waste areas where it can pick up pollutants (such as sediment, nutrients, bacteria and organic matter) and carry them into water bodies. Using roof runoff structures in conjunction with other practices such as fencing, filter strips, and the protection of heavy-use areas, has been shown to reduce the concentrations of bacteria in surface water.

Roof runoff structures also:

- Improve property aesthetics and increase property value
- Reduce soil erosion and improve soil condition
- Improve water quality
- Prevent water from flowing into barns, stables, and animal waste areas
- Protect buildings from foundation damage
- Increase the infiltration of rainwater into the soil
- Improve livestock health by reducing mud around barns and other areas where animals stand

Adding a rainwater catchment system will:

- Provide a clean source of water for livestock
- Reduce the concentration of salt in the soil (Waterfall 2006)
- Lower water bills (Sewell 2008)
- Reduce sedimentation in streams and mitigate floods (Forasté and Hirschmann 2010).

The cost of installing roof runoff structures can range from $6.70 per linear foot for gutters and downspouts to $20.60 per linear foot for collection pipes (Table 6).

Summary of Runoff Management BMPs
The use of filter strips, field borders, grassed waterways, and roof runoff structures will help control runoff and erosion across your property, and minimize the level of contaminants that enter surface water. Some, or all, of these practices might be suitable for you and your land. Assess your situation and your goals, and implement the practices that work best for you.

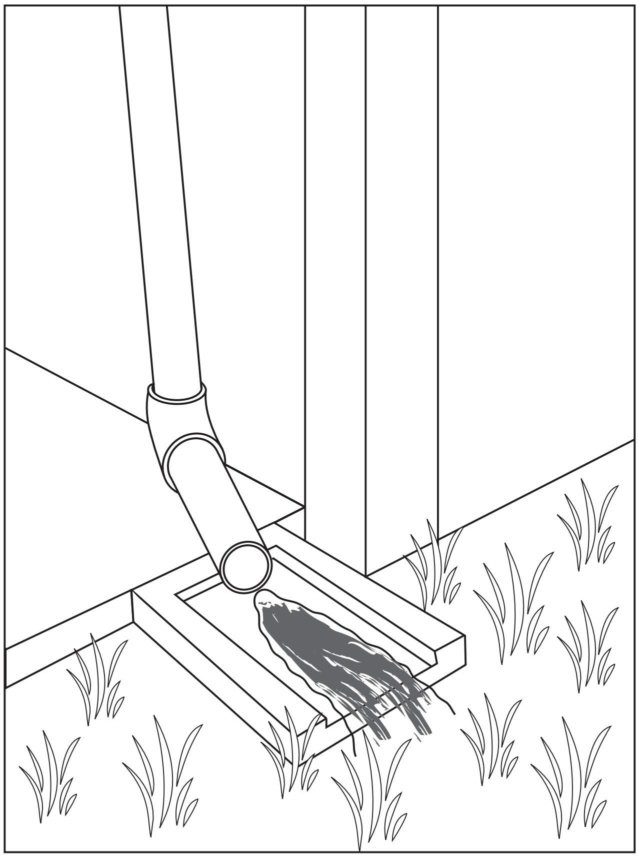


Figure 11. Protect the soil surface below the downspout from the water's force by having water fall onto splash blocks, into a surface drain, or into a stable rock outlet. Illustration by Jennifer Peterson adapted from the USDA-NRCS.

Table 6. Costs for different types of gutters and downspouts (Krishna 2005).

Material	Cost	Comments
Vinyl	$.30/foot	Easy to install and attach to PVC trunk lines
Plastic	$.30/foot	Leaking, warping and breaking are common problems
Aluminum	$3.50-6.25/foot	Must be professionally installed
Galvalume	$9-12/foot	Mixture of aluminum and galvanized steel; must be professionally installed

Manure Management BMPs

The waste (not including dead birds) from poultry operations is often referred to as litter and includes a combination of the bedding material (i.e., sawdust, wood shavings, rice hulls) and the manure (Fig. 12; Edwards and Daniel 1993). Manure is a good soil amendment and a valuable source of nutrients for plant growth.

Poultry manure contains all 13 of the essential nutrients that are used by plants (Chastain et al. 2001). In addition, poultry litter can be used as a soil amendment or potting medium for nurseries, lawns, and gardens (Donald et al. 1996). However, poultry manure contains bacteria and other pathogens; if the manure is not managed properly, it can contaminate waterways and possibly harm people and other animals. Pathogens in poultry manure include *E. coli*, *Salmonella* spp., and *Campylobacter*. Table 7 shows typical littler production rates. According to the U.S. Food and Drug Administration, 5.6 million tons of litter dry matter is produced each year in the United States (Food and Drug Administration 2001).

Table 7. Typical litter production, as removed from production houses (Collins et al. 1999)

Type of Poultry	Total Litter Production per 1,000 Birds
Broiler	
Whole litter[a]	1.25
Manure cake[b]	0.04
Roaster	
Whole litter[a]	2.6
Cornish	
Whole litter[a]	0.625
Manure cake[b]	0.06
Breeder	
Whole litter[a]	24.0[c]
Turkey poult	
Whole litter[a]	1.0
Grower hen	
Whole litter[a]	8.0
Manure cake[b]	2.5
Grower tom, light	
Whole litter[a]	10.0
Manure cake[b]	3.3
Grower tom, heavy	
Whole litter[a]	14.0
Manure cake[b]	4.4
Breeder	
Whole litter[a]	50.0[c]
Duck	
Whole litter[a]	4.25

Sources : Department of Biological and Agricultural Engineering, North Carolina State University and Department of Agricultural Engineering, University of Delaware

[a] Annual manure and litter accumulation; typical litter base is sawdust, wood shavings, or peanut hulls

[b] Surface manure cake removed after each flock

[c] Tons/1,000 birds/year

Manure management BMPs help reduce the volume of manure, destroy the harmful pathogens it contains, and ensure that it does not contaminate water sources. BMPs include using waste storage structures (NRCS Code 313), using waste properly (NRCS Code 633), soil testing and nutrient management (NRCS Code 590), composting (NRCS Code 317), and in-house pasteurization of litter (NRCS Code 629).

Waste Storage Structure

A litter storage facility functions to store and protect litter from weather until it can be spread on the landscape. As such, litter storage facilities should be located on well-drained sites at least 100 feet from flowing water and allow all-weather access for loading and unloading (Fulhage 1993). Litter storage can greatly increase the flexibility of a litter management plan and

Figure 12. Typical broiler poultry house ready for cleanout. Image courtesy of the University of Florida Extension.

assure that litter is applied under the proper conditions to protect the environment.

There are generally three types of litter storage structures that can be utilized: covered stockpiles, bunker-type storage, and roofed storage structures. A summary of the advantages and disadvantages of each is shown in Table 8. An easy, but unacceptable, method is to simply pile litter uncovered outside so that it is exposed to the elements. An exposed pile can result in runoff and cause excessive amounts of nutrients and bacteria to enter nearby water ways. In fact, stockpiling manure uncovered can result in a fivefold reduction in nitrogen in the manure, drastically reducing its value as a fertilizer (Carr et al. 1990). Litter that is going to be land applied immediately after removal from a poultry production house does not need a storage facility, but is still required to be handled in a way that doesn't cause any adverse environmental impacts. Improper design, location, and management of poultry litter manure storage structures will result in reduced fertilizer value (due to nitrogen leaching) and increased threats to water quality.

Covered stockpile: A covered stockpile is a method of temporarily storing litter such that it is covered with heavy gauge plastic sheeting (6 millimeter) that protects the pile from wind and water erosion. Litter stored longer than 3 months should be kept in a permanent storage facility. Covered stockpiles need to be located on high, well-drained sites away from any drainage ditches or other bodies of water. Compacting the litter, although not necessary, will allow more litter to be stored in the same area and reduce the amount of plastic sheeting required. If managed properly, plastic sheeting can last one or two seasons. If the sheeting tears, it should be replaced immediately to prevent water from entering the pile. To anchor the sheeting, dig a 12-inch trench around the pile, place the edges of sheeting in the trench, and backfill the trench with soil. Add used tires or another means of weight to the top of the pile to keep the sheeting and pile in place (Fig. 13).

When stockpiles must be located on high water table soils, use a temporary or permanent ground liner to prevent nitrogen leaching into groundwater and to minimize

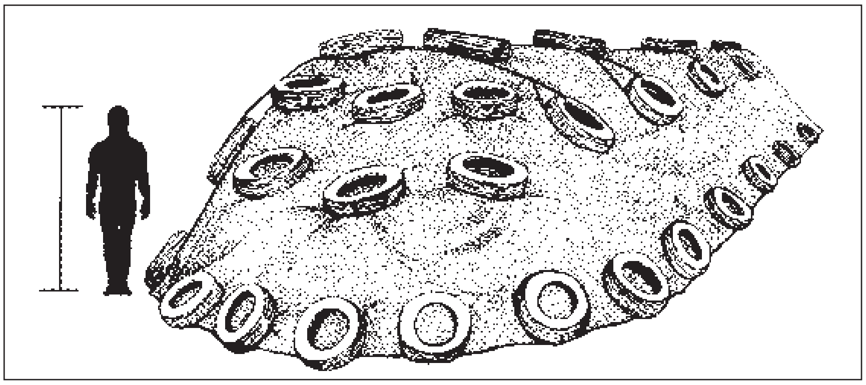


Figure 13. Covered stockpile of poultry litter (Carter and Poore 1995).

other pollutants from seeping off the pile. A 6-millimeter thick piece of plastic sheeting will usually suffice as a temporary ground liner. For a permanent liner, a 6-inch thick concrete slab poured over 6 inches of compact gravel will provide the most protection.

<u>Bunker-type storage structure</u>: This type of litter storage structure is comprised of an aboveground concrete slab with slanting walls of concrete on either side that typically range in height from 6 to 10 feet (Fig. 14). Both the front and the back of the bunker are open. To increase storage capacity, an end wall can be constructed. However, access to the structure is often easier without an end wall. Similar to covered stockpiles, always cover the litter in the bunker to prevent runoff and leachate from polluting nearby waterways. Thick plastic sheeting and tires can be utilized as an effective cover.

<u>Roofed storage structure</u>: A roofed storage structure is also known as a dry stack building for poultry litter. This type of storage structure is a pole-barn type structure used to temporarily store poultry litter in an environmentally safe manner (Fig. 15). It provides the most effective protection and eliminates the yearly labor and management involved with plastic sheeting and spare tires. Roofs should be at least 12 feet high to allow loading and unloading activities. Permanent roofs can also be constructed over concrete slabs, bunkers, or other storage structures to eliminate the need for plastic sheeting.
A dry stack building for poultry litter storage should be considered when (NRCS 2005):

- Storage is for more than 120 days
- Split applications of litter may be needed

Figure 14. Bunker-type storage structure (Ogejo and Collins 2009).

Figure 15. Poultry litter storage facility. Photo courtesy of the USDA-NRCS.

- Cleanout of the poultry houses must be done at a time when the litter cannot be land applied

Proper management of litter in the production houses will reduce the need to remove manure between flocks and will also reduce the potential risks associated with intermediate litter storage. The most

Type	Advantages	Disadvantages	Remarks
Covered Stockpile	a) new locations can be used each year or for many stockpiles b) no special construction or equipment required c) manure can be stored at or near the point of use d) water pollution potential reduced	a) cover may last only one season b) possible nutrient movement c) potential to remove topsoil from storage site during unloading d) plastic subject to damage from wind and debris	a) low investment b) 6-millimeter plastic must be used c) cover must be well anchored to stay on the pile
Stockpiles with Temporary Ground Liners	a) nutrient loss minimized b) manure can be stored at or near the point of use c) new locations can be used each or for many stockpiles d) water pollution potential reduced	a) ground plastic might cause some difficulty b) ground plastic will last only one season c) careful site preparation required to prevent ground liner puncture d) cover may last only one season e) plastic subject to damage from wind and debris	a) low investment b) 6-millimeter plastic must be used c) cover must be well anchored to stay on the pile
Stockpiles with Permanent Ground Liners	a) can be located near field b) potential water pollution significantly reduced c) fertilizer value conserved d) piling can occur during periods when soil moisture might prevent access to field storage sites	a) a permanent site is required that might not be convenient to all of the use sites b)runoff from the storage site will require control to prevent soil erosion c) cover subject to damage from wind and debris	a) moderate investment b) a compact pile or plastic cover is needed
Bunker-Type Storage Structures	a) potential water pollution significantly reduced b) fertilizer value conserved c) more manure can be stored in a smaller area d) covers can be easily secured – possible damage can be minimized allowing longer life e) can be used for grain or fertilizer storage when not storing manure	a) requires a plastic or fabric cover b) a permanent site is required that might not be convenient to all of the use sites c) requires runoff control around the site to prevent soil erosion	a) high investment
Roofed Storage Structure	a) potential water pollution significantly reduced b) fertilizer value conserved c) can be used for storage of machinery, grain, or fertilizer when not storing manure	a) requires runoff protection around the site to prevent soil erosion b) haven for birds providing possible disease transmission from farm to farm c) a permanent site is required that might not be convenient to all of the use sites d) reduced drive through capability for manure compaction which reduces structural capacity e) dry material may become airborne in winds unless sides are closed	a) high investment b) if wood construction, fire potential from spontaneous combustion c) metal construction subject to rapid corrosion

Table 8. Advantages and disadvantages of litter storage structures (Carr et al. 1990).

critical component of in-house litter management is keeping the litter dry. Wet litter increases the production of ammonia and the proliferation of bacteria and can also lead to breast blisters, skin burns, scabby areas, condemnations, and downgrades (Ritz et al. 2005). Furthermore, proper heating and ventilation of the production houses and proper operation of bird watering systems will minimize spillage and result in higher quality litter. Reduced water spillage will save water, improve bird quality, improve the production environment, reduce ammonia released from litter, reduce the volume of wet manure cake, and extend the time between litter cleanouts (Ogejo and Collins 2009).

Several studies report the effectiveness of litter storage in removing potentially harmful bacteria from poultry litter. Kelley et al. (1994) found concentrations of total coliforms, fecal coliforms, and *E. coli* declined an average of 96 percent after 16 weeks of storage. In the same study, initial elevated litter temperatures and a gradual reduction in litter moisture content aided in the reduction of pathogenic bacteria more susceptible to desiccation. Another study found stacking poultry litter for a period of at least 8 days was enough to reduce fecal coliform bacteria to below detectable levels (Hartel et al. 2000). Finally, a 7-day storage period was enough to reduce levels of *Salmonella* and *Campylobacter* to undetectable levels (Brooks et al. 2009).

Costs for litter storage facilities depend on many factors including the size of the facility, the material used, the design, and labor. Table 9 shows NRCS cost estimates for various types of litter storage facilities. Consult your local NRCS office for more information on manure storage areas and financial assistance programs (http://offices.sc.egov.usda/gov/locator/app).

Table 9. Cost estimates for constructing different types of waste storage facilities obtained from NRCS Texas eFOTG.

Type of Waste Storage Facility	Cost	Practice Life
Dry stack facility (earthen floor)	$10/square foot	20 years
Dry stack facility (concrete floor)	$13.76/ square foot	20 years
Dry stack facility (concrete/earthen floor combo)	$13.76/ square foot	20 years

Waste Utilization

This BMP concerns the proper use of agricultural wastes such as manure, wastewater, and other organic residues (Fig. 16). Manure is often applied to pastures, cropland, and landscapes because it is a soil conditioner and a good source of plant nutrients (Kelly 2011). Manure applied to pastures and cropland can improve soil structure and fertility. But it must be applied properly to protect water bodies.

Land application of poultry litter is the most common and most desirable method of poultry waste utilization because of the organic matter and its high nutrient value (Table 10). To ensure the material is applied in the most environmentally sound way, the available nitrogen and phosphorus content of the waste needs to be matched with the nutrient requirements of the crop (Table 11), and runoff and erosion from the landscape need to be prevented. Always apply litter at the appropriate rate and time. Excessive application of manure can result in high nitrate concentrations in plants. Livestock can be harmed through nitrate poisoning and nutrient imbalances can lead to grass tetany.

To determine the appropriate rate of application for poultry litter, it must be tested at a reputable laboratory for nutrient and moisture content, and a soil test must also be obtained. Based on the results of the tests, the amount of nutrient per unit volume of litter can then be calculated. If the manure does not supply adequate amounts of all of the nutrients required by the crop, supplement with a commercial fertilizer based on the soil test results. Litter and soil testing are BMPs that will be discussed in the next section.

Figure 16. Proper waste management ensures environmental protection. Photo courtesy of the NRCS.

The best time to apply poultry litter is in the spring time when the crops require nutrients for growth and have the ability to utilize the applied nutrients effectively. Applying litter on fields during a time when crops are dormant is a waste and a serious threat to water quality. In addition to bacterial contamination, organic fertilizer constituents (i.e., carbon, nitrogen, phosphorus) can lower dissolved oxygen concentrations and accelerate eutrophication which can negatively affect aquatic life. Poultry litter must be applied uniformly to prevent nutrient excesses and deficiencies, lower yields, and variable crop moisture at harvest time (Zublena et al. 1993). Proper calibration of your manure spreader can help with this as well as prevent over-application.

After litter has been applied, it should be tilled into the soil if at all possible to prevent loss of valuable nutrients. For no-till crop production or for litter application on pastureland, time the application of litter prior to an upcoming light rain to allow absorption of nutrients into the soil. Spreading litter on a recently grazed or harvested pasture with 2-4 inches of stubble will help hold the litter in place and reduce its movement to nearby waterways. In instances where the applied litter can't be incorporated into the soil through

Table 10. Average nutrient composition of broiler manures.

Manure Type	Total N	Ammonium NH_4^+-N	Phosphorus P_2O_5	Potassium K_2O
lb/ton				
Fresh (no litter)	26	10	17	11
Boiler house litter[1]	72	11	78	46
Roaster house litter[1]	73	12	75	45
Breeder house litter[1]	31	7	54	31
Stockpiled litter[1]	36	8	80	34

[1] Annual manure and litter accumulation; typical litter base is sawdust, wood shavings, peanut hulls.
Source: Biological and Agricultural Engineering Department, North Carolina State University.

tilling, maintain at least 100 feet of vegetative buffer between water bodies and areas where manure is applied. Also leave a buffer between manured areas and drinking water supplies—150 feet for private wells and 500 feet for public wells.

It is important to note that not all of the nitrogen available will be taken up by the plants. Some nitrogen may be lost through leaching and denitrification, some will be incorporated into soil organic matter, and some will remain fixed in the soil (Dick et al. 1998). As such, roughly 5% of the total nitrogen applied will carry over from one year to the next so keep this in mind when applying additional nitrogen in subsequent years.

Keeping accurate records is an important part of manure management. Poultry producers should keep records of:

- The amount of manure removed from poultry houses
- When the manure was removed and how it was used
- The amount stored, the dates of storage and how it was used
- The amount applied to each field, its nutrient content and the date of application
- The amount, date, and recipient of manure transported to another person

The NRCS estimates the cost of waste utilization to be $20.45 per acre (on-farm) to $44.74 per acre (off-farm). This includes the costs of a soil test, calculating a nutrient budget, record keeping, transport, and application.

Table 11. Nitrogen fertilization guidelines (Zublena et al. 1993).

Commodity	lb N/RYE[1]
Corn (grain)	1.0 to 1.25 lb N/bu
Corn (silage)	10 to 12 lb N/ton
Cotton	0.06 to 0.12 lb N/lb lint
Sorghum (grain)	2.0 to 2.5 lb N/cwt
Wheat (grain)	1.7 to 2.4 lb N/bu
Rye (grain)	1.7 to 2.4 lb N/bu
Barley (grain)	1.4 to 1.6 lb N/bu
Triticale (grain)	1.4 to 1.6 lb N/bu
Oats	1.0 to 1.3 lb N/bu
Bermudagrass (hay[2,3])	40 to 50 lb N/dry ton
Tall fescue (hay[2,3])	40 to 50 lb N/dry ton
Orchardgrass (hay[2,3])	40 to 50 lb N/dry ton
Small grain (hay[2,3])	50 to 60 lb N/dry ton
Sorghum-sudangrass (hay[2,3])	45 to 55 lb N/dry ton
Millet (hay[2,3])	45 to 55 lb N/dry ton
Pine trees[4]	40 to 60 lb N/acre/year
Hardwood trees[4]	70 to 100 lb N/acre/year

[1] RYE = Realistic Yield Expectation
[2] Annual maintenance guidelines
[3] Reduce N rate by 25 percent when grazing
[4] On trees less than 5 feet tall, N will stimulate undergrowth competition

Contact the NRCS office at the local USDA Service Center for more information on using waste and financial assistance programs (http://offices.sc.egov.usda/gov/locator/app).

Soil Testing & Nutrient Management

These practices involve managing the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments and require both a soil test and a manure test.

Once you know the nutrient content of your soil and the nutrient content of the manure, you can calculate a nutrient budget for nitrogen, phosphorus, and potassium that considers all potential sources of nutrients, including manure deposited by the animals, wastewater, commercial fertilizer, crop residues, legume credits, and irrigation water. Then you can determine the amount of stored manure that can be applied safely without the risk that excess nutrients will pollute surface water and groundwater.


Figure 17. A soil sample being placed into a soil sample bag. Photo courtesy of Mark McFarland, Texas AgriLife Extension Service.

Before spreading manure, have the soil analyzed by a laboratory to determine its fertilizer needs based on desired crop production and to establish a baseline for future monitoring (Fig. 17). Testing is especially important if manure has been applied to a pasture for many years. Because nutrients such as nitrogen and phosphorus are released over time, a field that has been used for manure disposal may already have high levels of nutrients and salts (San Francisco Bay Resource Conservation and Development Council 2001).

In Texas, soil sample bags, sampling instructions, and information sheets for mailing samples to the Soil, Water, and Forage Testing Laboratory at Texas A&M University (http://soiltesting.tamu.edu) can be obtained from your county Extension office. See Appendix B for information on collecting and sending soil samples.

In addition to a soil test, have a laboratory analyze the poultry litter manure to determine its nutrient content. Manure samples also can be sent to the Soil, Water, and Forage Testing Laboratory at Texas A&M University. More information on manure testing is also available from your county Extension office. A litter analysis will help ensure that manure application meets but does not exceed plant nutrient requirements. Several factors can affect the nutrient content of the poultry litter. These factors include bird type, feed composition, cleanout frequency, type of waterer, decaking management, and use of alum as a litter additive (Lory and Fulhage 1999). Because nutrient content can change from one poultry house to another, manure testing is essential.

Proper collection of poultry litter samples (and soil samples) will ensure the accuracy and worth of the poultry litter test. Poultry litter samples should be taken and analyzed in close proximity to each other and as close to the time of land application as possible. Several methods can be used to sample poultry litter. Refer to Appendix C for more information on collecting litter samples.

Using soil testing and nutrient management practices on your broiler operation will minimize bacterial contamination of waterways by ensuring that the proper amount of manure is applied at the appropriate time. This BMP also helps reduce nutrient contamination, which causes algae blooms and eutrophication (low dissolved oxygen in water). Without laboratory analyses of your soil and manure, it is impossible to know the nutrient requirements of your soil and the nutrient composition of your manure. Thus, the over-application of manure becomes a real concern.

When manure is applied according to soil test recommendations, it can offset the cost of fertilizer, improve plant growth and animal health, minimize nonpoint source pollution of surface and groundwater, protect air quality by reducing nitrogen emissions (ammonia and nitrous oxide compounds) and the formation of atmospheric particulates, and maintain or improve the physical, chemical, and biological condition of soil.

A routine soil analysis can be obtained for as little as $10 per sample from the Texas AgriLife Extension Service Soil, Water, and Forage Testing Laboratory at Texas A&M University. The laboratory also does other soil analyses (Table 12). A manure analysis costs $15 per sample. This test analyzes levels of calcium, copper, magnesium, manganese, nitrogen, phosphorus,

Table 12. Description and costs of soil tests available through the Texas AgriLife Extension Service Soil, Water, and Forage Testing Laboratory at Texas A&M University.

Test	Description	Cost per Sample
Routine Analysis (R)	pH, NO3-N, Conductivity and Mehlich III by ICP P, K, Ca, Mg, Na, and S.	$10
R + Micronutrients (Micro)	DTPA Zn, Fe, Cu, and Mn.	$15
R + Micro + Hot Water Soluble Boron (B)	Primarily for sandy or eroded soils, low in organic matter for the crops, alfalfa, cotton, peanuts, and root crops.	$20
R + Detailed Salinity (Sal)	Saturated paste extractable Ca, Mg, K, Na, conductivity and pH	$25
R + Micro + Sal	See above.	$30
R + Micro + Detailed Limestone Requirement (Lime)	The limestone recommendation is based on the amount of exchangeable acidity measured in the soil and the optimum soil pH level for the crop.	$20
R + Micro + B + Lime + Organic Matter + Sal	This analysis gives the percent organic matter in soil or compost determined by the loss on ignition. Most plants do best in soils with organic matter contents between 4 and 8 percent. Finished composts usually range from 40 to 60 percent organic matter.	$50
R + Textural Analysis	The total amounts of sand, silt, and clay sized particles are determined. Soils are categorized according to USDA soil textural classifications.	$20
R + Organic Matter	See above.	$20

potassium, sodium, zinc, and percent moisture.

Composting

Many farmers, ranchers, and landowners spread manure straight to the land after removing it from the housing, either because of inadequate storage capacity or simply for convenience. This practice can be harmful because fresh manure contains more pathogens than does stored or treated manure (Smith at al. 2000).

A good option for poultry operators is to compost litter manure (Fig. 18). Composting is a managed process that accelerates the decomposition and conversion of organic matter into stable humus, which can improve pastures, fields, and/or gardens. If done properly, composting kills pathogens and weed seeds, improves characteristics for land application, and stabilizes nutrients.

Composting poultry manure can take 30 to 60 days; adding bedding to the manure may require as long as 6 months to compost. Although composting requires extra time and expense, the benefits far outweigh the costs.

Successful composting depends on the following factors (Warren and Sweet 2003):

1. **Air**: Microorganisms need oxygen to decompose manure properly. Air space should be greater than 30%.
2. **Moisture**: Microorganisms also need moisture. The composting material should have a moisture content of 40% to 60%. The material should feel like a wet sponge.
3. **Particle size**: Because small particles decompose faster than do larger ones, shred bulky materials before adding them to the compost pile.
4. **Temperature**: Effective composting requires temperatures of 130 to 140°F.
5. **Pile size**: Smaller compost piles stay cooler and dry out faster than larger ones. A pile at least 3.5 by 3.5 by 3.5 feet (1 cubic meter) will stay hot enough for year-round composting, even in the winter.
6. **Nutrients**: Microorganisms need nutrients such as carbon and nitrogen for proper decomposition. Initially, poultry litter has a C:N ratio of 10 to 15:1. The ideal carbon-to-nitrogen ratio (C:N) for effective litter composting is about 30:1. A mixture of one part manure to two parts bedding (by volume) will usually provide this ratio, although it can be altered depending on the amount and type of bedding material used. Table 13 lists C:N ratios of common bedding materials.

Figure 18. Poultry producers check the contents of a poultry litter composter which protects the environment and supplies nutrients for grass and pastureland. Photo courtesy of the USDA-NRCS.

Table 13. Carbon to nitrogen ratios for manure and bedding materials (Warren and Sweet 2003).

Material	C:N Ratio
Raw dairy manure	10-15:1
Grass clippings	25:1
Dairy manure with bedding	20-30:1
Grass hay	30-40:1
Straw	40-100:1
Paper	150-200:1
Wood chips, sawdust	200-500:1

An on-farm composting system can be designed in several ways, and no single design is appropriate for all sizes and types of poultry facilities. Tailor your composting system to accommodate your operation, the space and equipment available, and the amount of time and effort you are willing to commit to managing the pile.

Three options include windrows, static piles, and in-vessel composting. In windrow composting, poultry litter is placed outside in long rows called windrows that are agitated and turned on a regular basis. Depending on the equipment available to turn the rows, piles can be 8 to 20 feet wide and 3 to 12 feet high. The frequency of agitation and turning depends on the composition and porosity of the material being composted. In general, rows should be aerated on weekly or two-week cycles to maintain adequate temperatures and moisture conditions. Composting can last several weeks or several months.

Static pile composting requires piles be made less than 6 feet high and 12 feet wide to encourage adequate aeration and high quality compost material. This type of composting is recommended for relatively small quantities of poultry litter and is done using a constructed bin system. Poultry litter is mixed with straw or another type of carbon-rich medium and placed in the primary composting bin. After a period of 7 to 14 days, the compost is aerated and moved to a secondary bin for an additional 10 to 14 days to complete the process.

In-vessel composting refers to composting that takes place inside a structure typically comprised of concrete or steel. This system relies on mechanical aeration and turning to enhance the composition process. Conversion of organic material to compost can take as little as a few weeks, but once removed from the vessel, still requires a few more weeks or months for the microbial activity to stabilize and the pile to cool. One benefit of in-vessel composting is that it can compost large amounts of waste without taking up as much space as the windrow method. Furthermore, this method can typically be used year-round because the environment is carefully controlled by electronic means. If the equipment is insulated or if the processing takes place indoors, in-vessel composting can be used in winter time when temperatures are very cold. On the downside, in-vessel systems are expensive and require technical knowledge and assistance to operate properly.

To protect water quality, the most important factor to consider is the physical location of the pile. Select a fairly flat site, avoid low-lying areas, and locate the pile away from groundwater and surface water sources.

Composting can effectively reduce pathogens to levels that are acceptable in organic soil amendments. When the temperature of a compost pile is at least 113°F for more than 3 days, almost 100 percent of *E. coli*, total coliform, fecal coliform, and *Salmonella* will be killed (Crohn et al. 2000, Larney et al. 2003, Millner et al. 2010, Sobsey et al. 2001). Reduce management and increase pathogen die-off by adding straw to the pile, which increases aeration, self-heating capacity, and heat retention (Millner et al. 2010).

Figure 19. Windrows are formed inside a broiler production house. Photo by Craig Coufal, Texas AgriLife Extension Service.

Besides eliminating bacteria, composting manure reduces levels of ammonia-nitrogen, water-soluble phosphorus, water-soluble organic matter, total soluble salts, weed seeds, and parasite eggs and larvae. It also reduces odor and breeding sites for flies. Composted manure has 40 to 50 percent less volume than does fresh manure. It is an excellent soil amendment that can be used on the property or given or sold to others.

The cost of constructing a compost facility depends on its size and the materials used. According to the NRCS, a 6-bin composter with 1,440 cubic feet of bin space costs about $19.74 per cubic foot to build, operate, and maintain (including materials and labor). For more information on composting and financial assistance programs, contact the NRCS office at the local USDA Service Center (http://offices.sc.egov.usda/gov/locator/app).

In-house Pasteurization of Litter

In-house pasteurization of litter is also known as in-house windrow composting or IWC. It is defined by the NRCS as the mechanical, chemical, and biological treatment of poultry litter to provide for extended reuse and timing of applying nutrients to crop needs. It can be used as both a litter management and manure management tool. As a litter management tool, IWC allows poultry producers to re-use litter for extended periods of time which can be valuable since bedding material has become a scarce and expensive commodity in recent years. Composting litter using IWC between flocks can greatly reduce microbial loads, reduce intermediate litter storage, ensure a healthy environment for chicks, reduce bird health problems, and improve the overall quality of litter used to raise successive flocks. The main differences between IWC and traditional windrow composting are that IWC is done indoors and only for a period of 5-10 days whereas traditional composting is usually done outdoors and over a period of several months.

IWC involves piling litter into rows down the length of the broiler house using a tractor and blade set on an angle or a piece of equipment specially designed for IWC (Fig. 19). With litter piled, the natural metabolism of bacteria contained in the litter initiates the composting process, generating heat within the windrows. As the temperature rises, pathogenic bacteria and other harmful microorganisms are killed, producing a higher quality litter material for the next flock.

Temperatures within the windrows should reach a minimum of 130F and starting moisture content should be 30 percent to 40 percent, although few studies have been conducted to exactly determine the optimal temperature and moisture content levels.

While a good litter management tool, IWC has also been explored as a manure management tool. When litter becomes too deep in a broiler house, a partial cleanout can be initiated and formed into windrows. After a period of 5-10 days, harmful pathogens have been destroyed and the litter can be land applied, minimizing water quality risks.

Research shows that maximum temperatures (130 – 140 F) are reached within 36 hours of windrowing and begin to decline after approximately 48 hours. This time period is long enough to kill many harmful pathogenic bacteria and viruses and reduce the overall microbial load in the litter (Macklin et al., 2006, Macklin et al., 2007, Macklin, et al., 2008). Macklin et al. (2008) found several harmful pathogens were nearly eliminated (*Salmonella* was completely eliminated) after 7 days of in-house windrow composting. Following re-spreading of the litter, 5 to 7 days is needed to reduce ammonia levels and allow the litter to cool back down. In total, a period of 10-14 days is needed between flocks to allow producers sufficient time to complete the composting process and allow time for delivery of the next flock of chicks.

The NRCS estimates the cost of IWC to be approximately $14.00 per 1,000 square feet of space. This estimate includes costs associated with equipment, fuel, and labor. For more information on composting and financial assistance programs, contact the NRCS office at the local USDA Service Center (http://offices.sc.egov.usda/gov/locator/app).

Summary of Manure Management BMPs
Proper manure management should be an important concern for every poultry operator. Manure must be stored, handled, and disposed of properly to protect water quality and keep animals, people, and the surrounding environment healthy. Storing manure, applying it to land at the proper rate and time according to soil and manure tests, and composting it are all responsible ways to control the spread of pathogens to groundwater and surface water. As always, assess your situation and goals, and implement the practices that work best for you and your land.

Mortality Management BMPs

Animal mortality must be managed to protect the health of people, animals, and the environment (Gould et al. 2002), so it is important to know your options and plan ahead. Disposing of carcasses properly reduces odors, bacterial contamination, and the spread of disease and protects public health and safety.

Large numbers of animals can die from a disease epidemic or natural disaster, but these events are rare. This section focuses on the normal, day-to-day deaths from illness or injury that every operation must deal with (the death of less than 0.3 percent of your flock per day is considered routine loss). Several methods discussed may be applicable to the management of large-scale


Figure 20. Improper disposal of dead chickens on a farm poses a water quality concern. Photo courtesy of the USDA-NRCS.

mortalities if scaled appropriately and conducted under the guidance and supervision of pertinent state and environmental agencies. See Appendix D for information from the TCEQ regarding the handling and disposal of carcasses from poultry operations.

Texas state law requires the on-farm disposal of dead animals to be done in a manner that protects public health and safety, does not create a nuisance, prevents the spread of disease, and prevents harm to water quality (TCEQ 2005). To determine the requirements for using any of the following options, contact the local regulatory agency (in Texas, the TCEQ or the Texas Animal Health Commission). If you have a certified water quality management plan (WQMP) from the Texas State Soil and Water Conservation Board (TSSWCB), follow the guidance in the plan or contact the TSSWCB.

Acceptable ways to manage poultry mortality include rendering, composting, incineration, and sanitary landfills. The method(s) chosen will depend on the scale of the poultry operation and will also determine whether you must register, apply for a permit, or notify the TCEQ. TCEQ rules prohibit on-site burial of poultry carcasses from routine loss. Poultry carcasses also cannot be left out in the open for wild animals to feed on. When routine loss of poultry occurs, carcasses must be disposed of by an approved method or stored in a refrigerated unit within 72 hours. Not following these rules puts the operator in non-compliance with state law and creates potential odor and water quality problems (Fig. 20). Furthermore, the owner can be fined up to $10,000 per violation. If disease is expected, contact the Texas Animal Health Commission immediately.

Rendering

Rendering recycles the nutrients contained in the carcasses of dead animals, most often as an ingredient in animal food, especially for pets. The meat can also be used to feed large carnivorous animals in zoos. In the process of rendering, carcasses are exposed to high temperatures (about 265°F) from pressurized steam to destroy most pathogens (Rahman et al. 2009). In Texas, the rendering plant must have authorization from the Department of State Health Services (DSHS) and trucks hauling carcasses to a rendering facility must be registered with the DSHS. For more information, visit http://www.dshs.state.tx.us/msa/render.shtm.

Depending on the distance to the facility and the expense and logistics involved with collecting small volumes of carcasses on a frequent basis can make the cost of rendering quite high. Proper biosecurity measures must be used to minimize the spread of disease from farm to farm by rendering plant vehicles and personnel. Although rendering can be a cost-effective way of dealing with poultry carcasses, it might not be an option for all poultry operators. The biggest challenges in using this disposal method are the lack of timely pickup service and long distances between rural areas and rendering plants (Rahman et al. 2009).

Composting

Composting uses the natural decomposition process in which microorganisms, bacteria, and fungi break the carcass down into basic elements (organic matter). The biosecurity agencies in the United States and other countries consider composting an effective way of managing routine and emergency mortalities (Wilkinson 2007).

Composting has advantages over other methods of carcass disposal when conducted properly. It costs less; the piles and windrows are easy to prepare with machinery available on the farm; and it is less likely to pollute air and water. Proper composting will destroy most disease-causing bacteria and viruses. Composting is popular in areas where burial and incineration are restricted or impractical.

To compost a carcass, select a site where surface water will not run off into the compost pile, where leachate from the pile will not run off the site, and where raw or finished compost nutrients will not leach into groundwater.

Other requirements (Gould et al. 2002):

- The carbon-to-nitrogen ratio must be between 15:1 and 35:1.
- The moisture content must be between 40 and 60 percent.
- Enough oxygen must be available to maintain an aerobic environment.
- The pH must range from 6 to 8.
- Temperatures must range between 90 and 140°F.

Carcasses can be composted in bins or static windrows (Keener et al. 2000). Bins are three-sided compartments; compost material is cycled through the bins as different decomposition stages are reached. Carcasses are layered in the bin with a suitable carbon source between each layer (sawdust, bedding, etc.). It is important to make sure all parts of the carcass are buried to prevent predators from destroying the piles. Turn the pile when the temperature exceeds 140F or drops below 90F (Rahman et al. 2009). Bin capacity and number will depend on the size of the facility. In general, roughly 160 cubic feet of bin capacity is required for every 1,000 pounds of bird mortality. Technical standards for the design and construction of a poultry composting facility are available from the NRCS.

Windrows are long, continuous rows of compost material (Fig. 21). For large animals, pile or windrow composting is usually easier and more effective. In this practice, the compost pile or windrow is constructed in the open on a concrete floor or a compacted soil surface such as clay. The pile is aerated by natural air movement and is turned periodically to encourage decomposition.

To protect water quality, composting operations should be located at least 150 feet from wells, 150 feet from the nearest

water body, and outside of the 100-year floodplain.

Bin and static pile composting systems can dramatically reduce bacteria levels. Research suggests that most harmful pathogens can be destroyed when pile temperatures reach at least 131F. In one study, *E. coli* concentrations were undetectable after 22 days of bin composting (Haque and Vandepopuliere 1994). In another study, *Salmonella*, *E. coli*, and *Campylobacter* were non-existent when composted litter piles were tested 4 weeks after collection.

Figure 21. Windrows, or long continuous rows of compost material. Photo courtesy of Sustainable Organic Solutions.

Incineration

Incineration destroys carcasses by burning them with fuel such as propane, diesel, or natural gas (Fig. 22). The total installation cost for an incinerator at a poultry operation can range from $7,000 to nearly $20,000 (Mukhtar et al. 2008).

Figure 22. Poultry incinerator. Photo courtesy of the USDA-NRCS.

Despite the relatively high cost, incineration/cremation is one of the most environmentally friendly ways to dispose of a carcass. Air and water quality are protected because of strict state and federal environmental regulations that apply to incinerators. Because incinerators operate at such high heat, all pathogens are killed, greatly reducing the threat to water quality. In Texas, all incinerators are required to have air quality authorization from the TCEQ (Mukhtar et al. 2008). The remaining ashes pose no environmental threat and can be returned to the owner for burial or sent to a landfill for disposal.

A list of poultry incinerators that have been registered with the TCEQ is posted on the TCEQ Web site at <www.tceq.state.tx.us/assets/public/permitting/ air/Guidance/NewSourceReview/poultryincin_lst2_08.pdf>]

Sanitary Landfills

Poultry carcasses can be placed in a sanitary landfill permitted by the TCEQ to receive municipal solid waste. For more information on existing facilities, visit http://www.

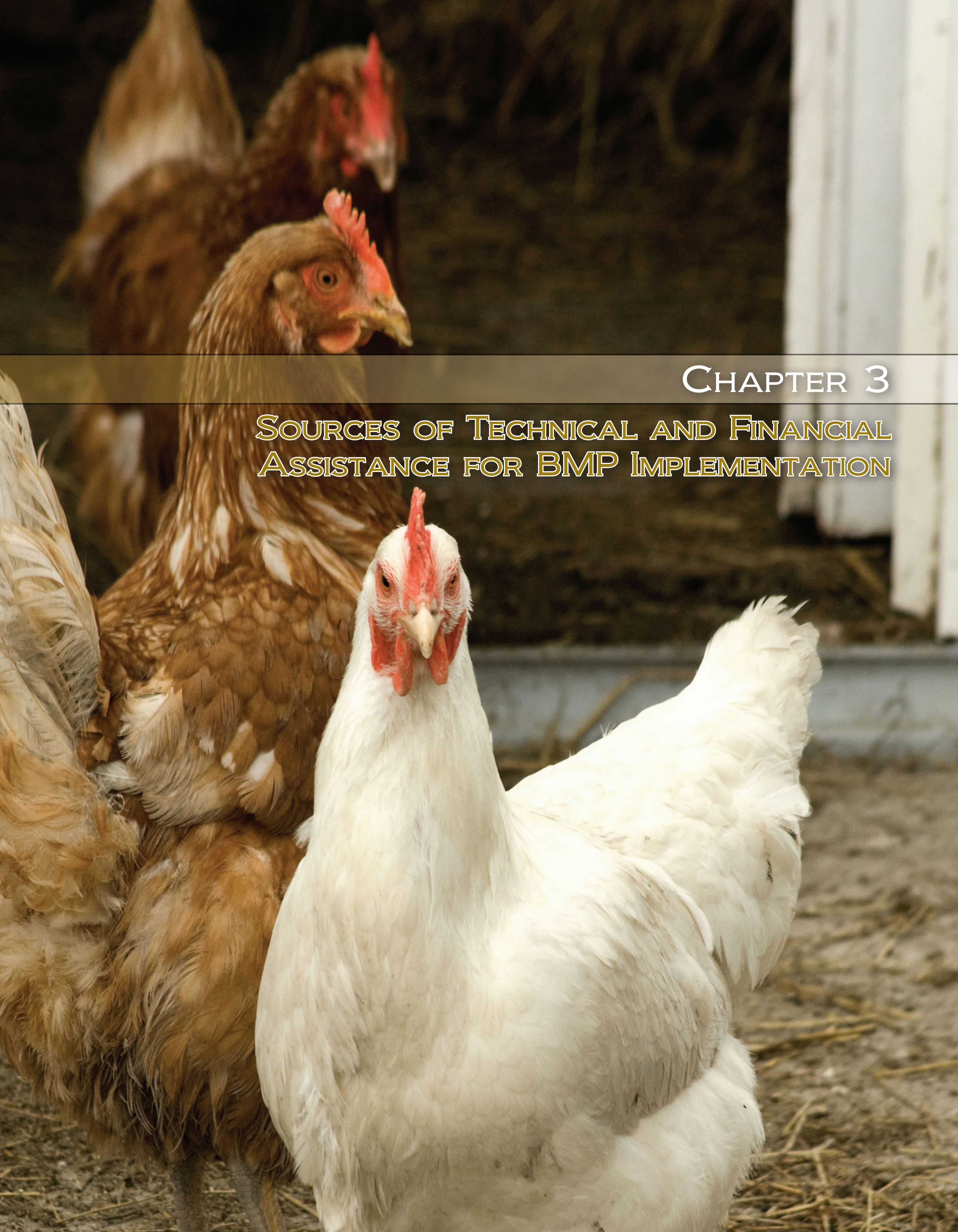
tceq.texas.gov/permitting/waste_permits/msw_permits/msw.html#query. Contact your local landfill for more information.

Summary of Mortality Management BMPs

Proper management of poultry mortality is necessary for sanitation, disease, odor prevention, and environmental protection. Several methods exist to properly manage routine loss of poultry. Of utmost importance is that you investigate the method(s) most applicable to your situation and carry them out in accordance with state and federal laws.

Chapter 3

Sources of Technical and Financial Assistance for BMP Implementation



Sources of Technical Assistance for BMP Implementation

Many agencies offer free consultations on issues you may be facing or plans you would like to implement. These agencies also routinely conduct free seminars and short courses on current information and management practices in agriculture. The agencies include the local Soil and Water Conservation District, the Texas State Soil and Water Conservation Board, the USDA–Natural Resources Conservation Service, and the Texas AgriLife Extension Service.

Soil and Water Conservation Districts

Soil and Water Conservation Districts are independent political subdivisions of state government, like a county or school district. The first SWCDs in Texas were organized in 1940 in response to the widespread agricultural and ecological devastation of the Dust Bowl of the 1930s. There are currently 216 SWCDs organized across the state. Each SWCD is governed by five directors elected by landowners within the district.

SWCDs serve as the state's primary delivery system through which technical assistance and financial incentives for natural resource conservation programs are channeled to agricultural producers and rural landowners. SWCDs work to bring about the widespread understanding of the needs of soil and water conservation. SWCDs work to combat soil and water erosion and enhance water quality and quantity across the state by giving farmers and ranchers the opportunity to solve local conservation challenges. SWCDs instill in landowners and citizens a stewardship ethic and individual responsibility for soil and water conservation.

SWCDs assist federal agencies in establishing resource conservation priorities for federal Farm Bill and CWA programs based on locally-specific knowledge of natural resource concerns. SWCDs work with the USDA NRCS, USDA Farm Service Agency, USEPA, Texas AgriLife Extension Service, TFS, and others when necessary to assist landowners and agricultural producers meet natural resource conservation needs.

Texas State Soil and Water Conservation Board

The Texas State Soil and Water Conservation Board (TSSWCB) offers technical assistance to the state's 216 SWCDs. The TSSWCB was created in 1939 by the Texas Legislature and is the lead agency in Texas for planning, implementing, and managing programs and practices to reduce agricultural and silvicultural nonpoint source pollution.

The primary means for achieving this goal is through water quality management plans (WQMPs), which are site-specific plans developed through and approved by SWCDs for agricultural or silvicultural lands. Five regional offices (Fig. 25) help local districts and landowners develop these plans.

The TSSWCB also works with other state and federal agencies on nonpoint source pollution issues as they relate to the state water quality standards, Total Maximum Daily Loads, Watershed Protection Plans, and the Coastal Management Plan.

Natural Resources Conservation Service

The USDA Natural Resources Conservation Service (NRCS), a federal agency, helps landowners and managers improve and protect their soil, water, and other natural resources. For decades, private landowners have voluntarily worked with NRCS specialists to prevent erosion, improve water quality, and promote sustainable agriculture.

The agency employs soil conservationists, rangeland management specialists, soil scientists, agronomists, biologists, engineers, geologists, engineers, and foresters. These experts help landowners develop conservation plans, create and restore wetlands, and restore and manage other natural ecosystems.

Texas AgriLife Extension Service
The mission of the Texas AgriLife Extension Service is to provide community-based education to Texans. Its network of 250 county Extension offices, 616 Extension agents, and 343 subject-matter specialists makes expertise available to every resident in every Texas county. These specialists and agents are a technical resource for agricultural producers throughout the state.

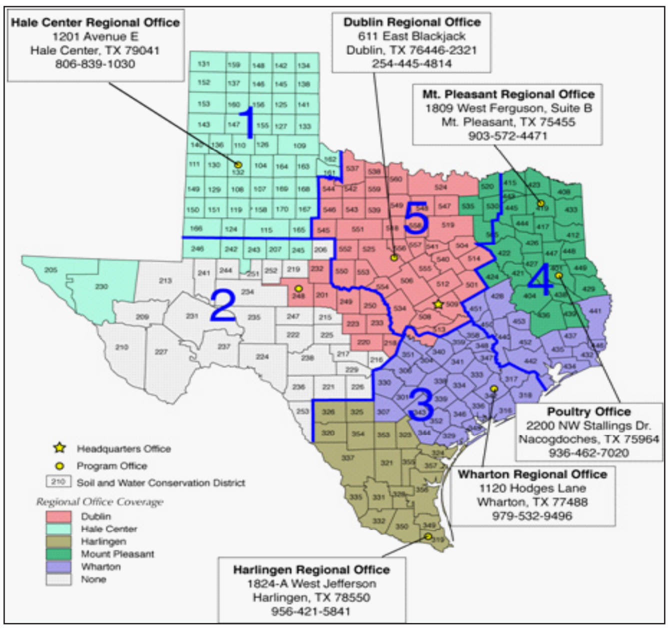


Figure 23. Map showing the five regions of the Texas State Soil and Water Conservation Board. Illustration courtesy of the Texas State Soil and Water Conservation Board.

Sources of Financial Assistance for BMP Implementation

Financial assistance for implementing BMPs is provided primarily through the Texas State Soil and Water Conservation Board, Natural Resources Conservation Service, and USDA Farm Service Agency.

Texas State Soil and Water Conservation Board
In addition to technical assistance, the TSSWCB can also offer financial assistance for the implementation of BMPs. Two programs offered by the TSSWCB provide financial assistance for the implementation of water quality management plans (WQMP) and the installation of BMPs:

- Water Quality Management Plan Program: Provides financial assistance to eligible landowners for WQMP implementation of up to 75 percent with a maximum of $15,000 per plan. Landowners and operators may request the development of a site-specific water quality management plan through local SWCDs. Plans include appropriate land treatment practices, production practices and management and technology measures to achieve a level of pollution prevention or abatement consistent with state water quality standards.
- The Clean Water Act Section 319(h) Nonpoint Source Grant Program: The U.S. Environmental Protection Agency distributes CWA 319 funds to state agencies involved in water quality management (in Texas, the TCEQ and TSSWCB). This assistance provides funding for various types of projects that work to reduce nonpoint source water pollution. Funds may be used to conduct assessments, develop and implement

- TMDLs and watershed protection plans, provide technical assistance, demonstrate new technology, and provide education and outreach.

Natural Resources Conservation Service
The Environmental Quality Incentives Program (EQIP) is the primary program offered by the NRCS for implementing BMPs.

EQIP is a voluntary conservation program that supports production agriculture and environmental quality. The program provides financial assistance to farmers and ranchers to implement BMPs. It is designed to address both locally identified resource concerns and state priorities. In FY 2011, the Texas allocation for EQIP was just under $58 million.

The amount of funding available for EQIP varies among counties. To be eligible for this program, a person must be involved in livestock or agricultural production and develop a plan of operations. This plan defines the objective to be achieved by the conservation practice proposed and a schedule of practice implementation. Applications are then ranked by the environmental benefits achieved and the cost effectiveness of the proposed plan.

The NRCS also offers other programs for BMP implementation:

- The Conservation Security Program provides financial and technical assistance to promote conservation and natural resource improvement.
- The Grassland Reserve Program is a voluntary program that helps landowners and operators restore and protect grassland.
- The Wetlands Reserve Program provides technical and financial support for landowners restoring wetlands.
- The Wildlife Habitat Incentives Program offers financial incentives to develop habitat for fish and wildlife on private lands.

For more information, see the NRCS website at http://www. nrcs. usda. gov/.

USDA Farm Service Agency
The Farm Services Agency administers several programs that can help in BMP implementation, including the Conservation Reserve Program, Conservation Reserve Enhancement Program, and Source Water Protection Program.

<u>Conservation Reserve Program</u>: This program provides annual rental payments and financial assistance to establish long-term, resource-conserving ground covers on eligible farmland. It helps agricultural producers safeguard environmentally sensitive land through practices that improve the quality of water, control soil erosion, and enhance wildlife habitat.

After enrollment, the agency will pay an annual per-acre rental rate and provide up to 50 percent cost-share assistance for practices that accomplish the above goals. The portions of property to be submitted to the program will be under contract for 10 to 15 years and cannot be grazed or farmed.

To be eligible for the program, agricultural producers must have owned or leased the land for at least 1 year before the application. Also, the land submitted must be suitable for these BMPs:

- Riparian buffers

- Wildlife habitat buffers
- Wetland buffers
- Filter strips
- Wetland restoration
- Grass waterways
- Contour grass strips

Conservation Reserve Enhancement Program: This voluntary land retirement program helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water.

Source Water Protection Program: This program helps prevent source water pollution through voluntary practices implemented by producers at the local level.

Conclusion

Texas is projected to have exponential population growth in the near future. Concurrently, our water supply is projected to decline, making water conservation and protection all the more important. As the population increases, more development and fractionation of large tracts of land is expected. This trend will contribute to runoff and decrease the ability of our land to filter it effectively. Increasing numbers of bacteria will continue to find a way into our surface waters as more livestock are applied to the land whether for recreational or commercial purposes.

This guide is primarily focused on the contribution to nonpoint source pollution from poultry operations, but there are other sources such as wastewater treatment facilities, failing septic systems, and urban runoff that contribute to water quality impairments as well. This confirms the need to educate all aspects of society on the importance of maintaining and conserving the quality of water necessary for good health.

As we have discussed, there are many important aspects to animal care that extend beyond simply owning and feeding livestock. Controlling runoff, managing manure, and maintaining facilities can take a considerable amount of time and effort, but result in far more benefits not only to the animal and operation, but to the surrounding land. The collective impact of mismanagement of poultry facilities can be environmentally harmful. The management practices that minimize these impacts will result in a farm that is healthy, saves money, and is aesthetically pleasing.

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APPENDIX A

TEXAS STATE SOIL & WATER CONSERVATION BOARD

IMPORTANT STATE LAWS AFFECTING TEXAS POULTRY PRODUCERS

Senate Bill 1693, 81st Session of the Texas Legislature
Authored by Senator Ogden (Bryan, TX)
Signed on June 19, 2009
Became effective on September 1, 2009
Amended Section 26.302 of the Texas Water Code and Section 382.068 of the Health and Safety Code;
Added Sections 26.304 and 26.305 to the Texas Water Code

Requires the Texas Commission on Environmental Quality (TCEQ) to investigate the second odor complaint against a poultry facility within 18 hours. Requires TSSWCB to adopt rules to evaluate siting and construction of a new or expanding poultry facility for its potential to cause persistent odor nuisance. Prohibits TSSWCB from certifying a *Water Quality Management Plan* if persistent odor nuisance is likely, unless TCEQ approves an odor control plan. Requires the owner/operator of a new poultry facility to complete an odor prevention training course from Texas A&M. Requires record keeping of litter use for poultry operators and end users and allows TCEQ to inspect any records required under Subchapter H of Chapter 26, Texas Water Code.

House Bill 1457, 80th Session of the Texas Legislature
Authored by Representative McReynolds (Lufkin, TX)
Signed on June 15, 2007
Became effective on September 1, 2007
Amended Section 26.303 (a) of the Texas Water Code

Removes cooking of poultry mortality for swine food as a method of poultry carcass disposal to be consistent with Section 165.026 of the Texas Agriculture Code, which prohibits feeding of restricted garbage (*ie: poultry carcasses*) to swine. It also prohibits storage of poultry carcasses on the site of a poultry facility for more than 72 hours unless the carcasses are refrigerated or frozen.

House Bill 1719, 80th Session of the Texas Legislature
Authored by Representative McReynolds (Lufkin, TX)
Signed on June 15, 2007
Became effective on June 15, 2007
Amended Section 201.026 (g) of the Texas Agriculture Code

Removes the requirement to notify the Texas Commission on Environmental Quality (TCEQ) of burial of animal carcasses if that burial is on land covered by a *Water Quality Management Plan* certified by TSSWCB that addresses site specific animal mortality burial. TCEQ rules only allow poultry carcass burial in the event of a major die-off that exceeds 0.3% per day of the total farm inventory (see 30 Texas Administrative Code §335.25).

IMPORTANT STATE LAWS AFFECTING TEXAS POULTRY PRODUCERS (continued)

Senate Bill 1339, 77th Session of the Texas Legislature
Authored by Senator Ogden (Bryan, TX)
Signed on March 8, 2001
Became effective on September 1, 2001
Amended Section 26.302 of the Texas Water Code

Requires *all persons who own or operate a poultry facility* to implement and maintain a *water quality management plan* that is certified by the State Soil and Water Conservation Board.

House Bill 3355, 77th Session of the Texas Legislature
Authored by Representative McReynolds (Lufkin, TX)
Signed on March 9, 2001
Became effective on September 1, 2001
Amended Section 201.026 of the Texas Agriculture Code

Removes the requirement for landowners to record the burial of animal carcasses in county deed records *if the landowner requests and complies with* a *water quality management plan* certified by the State Soil and Water Conservation Board.

House Bill 3673, 77th Session of the Texas Legislature
Authored by Representative Swinford (Amarillo, TX)
Signed on April 10, 2001
Became effective on September 1, 2001
Amended Section 165.026 of the Texas Agriculture Code

Prohibits the feeding of restricted garbage (*which includes cooked and uncooked poultry mortality*) to swine under any circumstances.

Senate Bill 1910, 75th Session of the Texas Legislature
Authored by Senator Ratliff (Mt. Pleasant, TX)
Signed on June 19, 1997
Act became effective on March 1, 1998
TCEQ rule implementing Act became effective September 5, 1999 (30TAC §335.25)
Added Subchapter H, *Poultry Operations*, to Chapter 26 of the Texas Water Code

Defines *poultry* as chickens or ducks. Allows burial of poultry carcasses *only* in case of major die-off. Requires poultry owner/operator to have adequate means to dispose of carcasses, litter, and other poultry waste. Requires TCEQ to adopt rules that specify approved methods for poultry carcass disposal.

IMPORTANT STATE LAWS AFFECTING TEXAS POULTRY PRODUCERS (continued)

Senate Bill 503, 73rd Session of the Texas Legislature
Authored by Senator Sims (San Angelo, TX)
Signed on April 29, 1993
Became effective on April 29, 1993
Amended Section 201.026 of the Texas Agriculture Code

Creates the *Water Quality Management Plan (WQMP) Program.* Establishes TSSWCB as the lead agency in Texas for activity relating to abating agricultural and silvicultural nonpoint source pollution.

In addition, there are TCEQ regulations relating to poultry operations under Title 30 Texas Administrative Code at:

§101.4	Air Quality Nuisance;
§106.494	Pathological Waste Incinerators;
§111.121	Single-, Dual-, and Multiple-Chamber Incinerators;
§111.125	Incineration - Testing Requirements;
§111.127	Incineration – Monitoring and Record Keeping Requirements;
§111.129	Incineration – Operating Requirements (daytime only operation);
§321.33(f)	Dry-litter Poultry CAFO Facilities
§321.47	Animal Feeding Operations
§332.3 (d)(2)	Composting – Applicability (exemption for on-farm composting);
§332.4	Composting – General Requirements;
§335.5 (d)	Deed Recordation for Burial (exemption);
§335.6 (l)	Notification for Burial (exemption);
§335.25	Industrial Solid Waste – Handling, Storing, Processing, Transporting, and Disposing of Poultry Carcasses.

TSSWCB rules relating to poultry operations are under Title 31 Texas Administrative Code at:

§523.3 (j)	Water Quality Management Plans for Poultry Facilities

If you have questions regarding these or other state laws related to poultry facilities, please contact a State Soil and Water Conservation Board (TSSWCB) office.

To ask questions or request information, write to us by email at : poultry@tsswcb.state.tx.us

TSSWCB Headquarters
4311 South 31st Street
P. O. Box 658
Temple, Texas 76503
(254) 773-2250

TSSWCB - Poultry Office
2200 NW Stallings Dr., Suite 102
Nacogdoches, Texas 75964
(936) 462-7020

TSSWCB-Dublin Regional Office
611 East Black Jack
Dublin,Texas 76446-2321
(254) 445-4814

TSSWCB-Mt. Pleasant Regional Office
1809 West Ferguson, Suite B
Mount Pleasant, Texas 75455
(903) 572-4471

TSSWCB-Wharton Regional Office
1120 Hodges Lane
Wharton, Texas 77488
(979) 532-9496

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APPENDIX B

E-534
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AgriLIFE EXTENSION
Texas A&M System

TESTING YOUR SOIL

How to Collect and Send Samples

T. L. Provin and J. L. Pitt*

Soil tests can be used to estimate the kinds and amounts of soil nutrients available to plants. They also can be used as aids in determining fertilizer needs. Properly conducted soil sampling and testing can be cost-effective indicators of the types and amounts of fertilizer and lime needed to improve crop yield.

The effects of adding a fertilizer often depend on the level of nutrients already present in the soil (Fig. 1). If a soil is very low in a particular nutrient, yield will probably be increased if that nutrient is added. By comparison, if the soil has high initial nutrient levels, fertilization will result in little, if any, increase in yield.

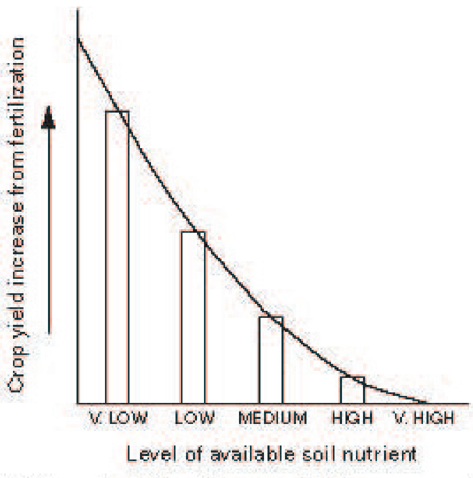

Figure 1. The probability of a crop yield increase resulting from fertilization depends on the initial amount of available nutrients in the soil.

*Assistant Professor and Soil Chemist/Laboratory Director, Program Specialist-Laboratory Manager, Soil, Water, and Forage Testing Laboratory; The Texas A&M System.

There are three steps involved in obtaining a soil test:

1) obtain sample bags and instructions,
2) collect composite samples,
3) select the proper test, and complete the information sheet and mail to the Soil, Water, and Forage Testing Laboratory at 2478 TAMU, College Station, TX 77843-2478 for U.S. mail or 2610 F&B Road, College Station, TX 77845 for commercial deliveries. Contact the lab at (979) 845-4816, FAX (979) 845-5958, or at the Web site *http://soiltesting.tamu.edu* for additional information.

Obtain sample bags and instructions

County Extension offices provide soil sample bags, sampling instructions and information sheets for mailing samples to the Soil, Water, and Forage Testing Laboratory of the Texas Agricultural Extension Service.

Sample bags provided by the Extension service hold a sufficient amount of soil for use in most soil tests. Fill the sample bag or other suitable container with approximately 1 pint of a composite soil sample. Any suitable container can be used for the sample, but it is important to complete the information sheet and follow the instructions for collecting and mailing samples.

Collect composite samples

The objective in sampling is to obtain small composited samples of soil that represent the entire area to be fertilized or limed. This composited sample is comprised of 10 to 15 cores or slices of soil from the sampling area.

To sample a field or pasture, make a map that identifies each area in the field where subsamples were taken (Fig. 2). Fields or tracts of land with differences in past crop ping, fertilization, liming, soil types or land use will require several composite samples. The field identification map should be used each time samples are collected from that field to compare results over time.

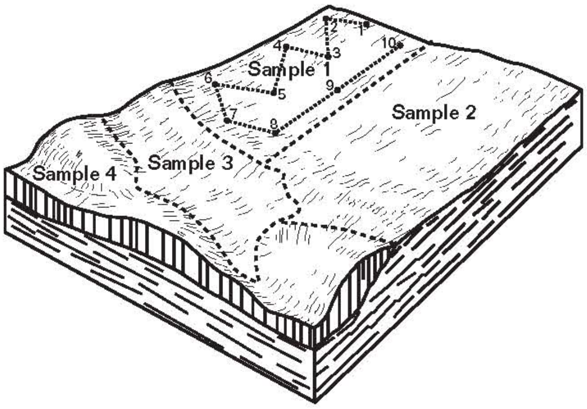

Figure 2. Fields should be subdivided into sampling units as needed and a composite sample should be collected from each unit.

Factors that will affect results include sampling tools, number of subsamples, depth of sampling, and soil compaction and moisture.

Sampling tools

Several tools can be used to collect samples (Fig. 3). The choice depends on soil conditions and sampling depth.

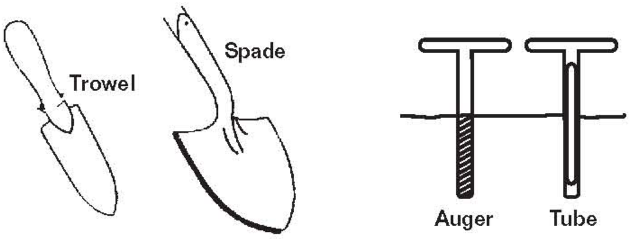

Figure 3. These tools can be used to collect soil samples.

The selected tool must be able to cut a slice or core through the desired layer of soil as illustrated in Figure 4. The objective is to obtain a cross section of the plowlayer or layer being subsampled.

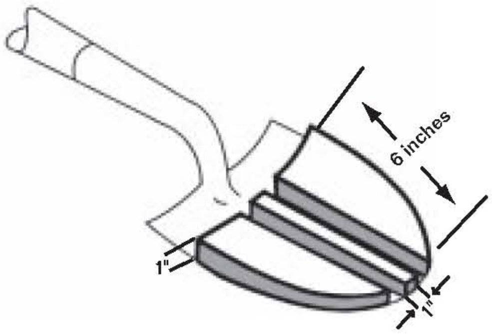

Figure 4. Collect a slice or core of soil to the desired depth.

Number of samples

In fields up to 40 acres, collect at least 10 to 15 cores or slices of soil per composite sample. Composite samples should represent the smallest acreage that can be fertilized or limed independently of the remaining field or acreage.

The development of precision agriculture has allowed some producers and fertilizer suppliers to manage soil fertility levels on 1- to 3-acre parcels. In small gardens and lawns, five to six cores may be adequate. Because soils are variable, it is important to obtain enough subsample to ensure a representative composite sample. A greater number of cores makes the sample more representative of the field.

Unusual problem areas should be omitted or sampled separately. To properly diagnose the causes of poor crop production, collect separate composite samples from the good and poor growth areas. Do not include soil from the row where a fertilizer band has been applied.

Depth of sample

Traditionally, soil samples are collected to a depth of 6 inches. This depth is measured from the soil surface after non-decomposed plant materials are pushed aside. This sampling depth can be significantly altered based on tillage or fertilization practices.

Stratification (accumulation at the surface) of phosphorus and lime from prior surface applica-tions can dramatically alter soil test data. Stratification is of particular concern in reduced tillage and nonirrigated fields that receive limited rainfall. In these instances, subsurface sampling depths may vary from 2 to 8 inches or 3 to 9 inches below the surface. Also, deviations from the traditional 6-inch sampling depth may be required if fertilizer has been placed deeper in the soil.

Deep rooted perennial crops can require deeper subsurface sampling. The slow movement of most plant nutrients prevents any dramatic manipulation of subsurface nutrient levels, however sampling data can be useful to assess pH or salinity problems. Subsurface sampling is illustrated in Figure 5.

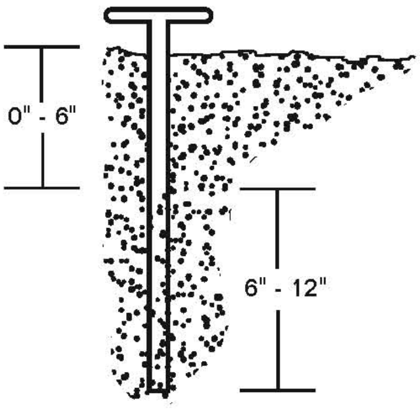

Figure 5. A sampling tube or auger is needed to collect subsurface samples.

When sampling perennial sod crops, sample to a depth of 4 inches. Discard the surface ½ inch of soil before mixing the subsamples. Use this sampling method in all established lawns, golf greens and similar turf applications.

The Texas Natural Resource Conservation Commission (TNRCC) requires extensive soil sampling for some land uses. Individuals sampling soil for TNRCC compliance should follow TNRCC protocols and directions.

Select the proper test

Several different soil tests are available at the Extension Soil, Water, and Forage Testing Laboratory. These include tests for routine nutrients, micronutrients, boron, detailed salinity, lime requirement, texture and organic matter. After taking the soil sample, select the appropriate test to obtain the desired information.

The **routine** test determines the soil pH, salinity, nitrates (NO_3-N), and levels of the primary nutrients (P - phosphorus, K - potassium, Ca - calcium, Mg - magnesium, Na - sodium, and S - sulfur) available to plants. The routine test will provide the basic N-P-K fertilizer recommendation for selected crops. This test meets most application needs.

The **micronutrient** test estimates the levels of zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu) in the soil that are available to plants. Conduct this test for specialty crops, in soils with high pH on which corn or sorghum is being grown, or to provide general guidelines for troubleshooting deficiencies.

The **boron** test determines the level of water extractable boron (B) in the soil. Conduct the test where clover, alfalfa or other legumes are grown on sandy soils or when soils are being irrigated and water quality is of concern.

The **detailed salinity** test uses a saturated paste extract to measure the pH, electrical conductivity and water soluble levels of the major cations in the soil. From these levels, the Sodium Adsorption Ratio (SAR) is calculated. Conduct this test when water quality is of concern; in soils in the western part of the state where the rate of evaporation or transpiration exceeds the rainfall; when previous soil tests have shown an increase in sodium or salinity; or in areas where brine and salt water spills have occurred. Some TNRCC permits also may require a detailed salinity test.

The **lime** requirement determines the amount of lime needed to raise the soil pH to a desired level. This determination is needed on very acidic (pH <5.2) or acidic soils (pH <6) where alfalfa or other legumes are grown.

Texture and organic matter are specialty tests for specific applications. The texture determines the amount of sand, silt and clay in the soil. This test may be requested when installing a septic system. The organic matter may be requested for general information. Both tests often are requested for environmental or research purposes.

The information form, obtained from the county Extension office, requests information about soil conditions, acreage sampled, past cropping, fertilization and an estimate of the expected yield. All information is important in relating soil test results to suggested fertilization and liming. The expected yield is an indication of intended management, past production levels and local environmental factors that control yields. Uncontrolled production factors such as nematodes and disease should be considered in estimating a yield goal or expected yield. In areas where samples are collected from problem fields, the condition of plants should be described along with observations that would aid in relating soil test results to the problem.

Soil samples should not be stored for long periods of time prior to shipping to the laboratory. The levels of nitrate-nitrogen in the soil may change if the samples are stored wet. In addition, the nitrate-nitrogen data from properly dried samples may be of little value if environmental conditions and plant growth have altered levels in the soil. Air drying samples in the shade on clean brown paper is strongly recommended. Do not oven dry the samples because high drying temperatures can alter test results.

Instructions for mailing are provided with the sampling instructions. The fee for each sample should be noted and payment should accompany the samples. The information sheet and payment should be attached to the sample package. Between 5 and 7 days are required to obtain results for routine analyses from the laboratory. In-depth analyses of samples require additional testing and processing time. Therefore, it is important to conduct sampling early in the season. This will ensure that test results are available in time to make necessary fertilizer and lime applications.

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Visit the Texas AgriLife Extension Service at *AgriLifeExtension.tamu.edu*

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APPENDIX C

Agricultural Extension Service
The University of Tennessee
SP563

Poultry Litter Sampling and Testing

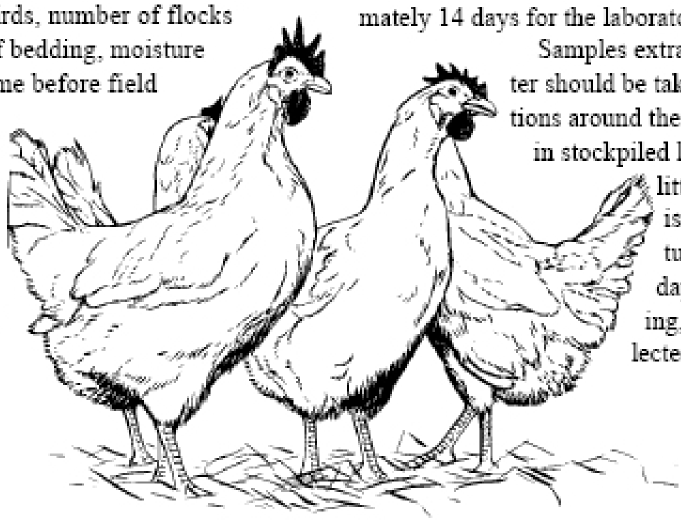
Charles Goan, Professor, Animal Science
Forbes Walker, Assistant Professor, Plant and Soil Science

Poultry litter can be a valuable resource when properly applied as a fertilizer to pasture, hay, small grains and row crops. To effectively use poultry litter as a fertilizer, nutrient content of the litter must be determined. This is easily done by laboratory analysis. However, laboratory results are no better than the sample collected for analysis.

Many Tennessee poultry farmers are required to develop a nutrient management plan for their farming operation. In completing the plan, poultry litter sampling and testing are necessary to determine the amount of nitrogen, phosphorous and potassium in the litter.

Because of environmental issues and potential variability in nutrient content involving animal wastes, **ALL** poultry farmers should have a nutrient analysis completed for their poultry litter. Also, people who operate a business that cleans out chicken houses and sells the litter should obtain a litter analysis before selling the litter.

The nutrient content of poultry litter will vary depending upon type of birds, number of flocks raised on the litter, type of bedding, moisture content and stockpiling time before field application. Poultry litter should be tested for nitrogen, phosphorous, potassium and moisture content. In addition, strong consideration should be given to testing for copper and zinc.



Collecting and Submitting Samples

Collecting representative litter samples is essential for reliable nutrient analysis, because litter nutrient value varies greatly within the poultry house. To obtain a representative sample, collect subsamples from 10-12 locations throughout the house (see diagram). Samples taken around waterers and feeders should be in proportion to the space they occupy in the house. At each location, collect approximately one pint of litter by sampling an area down to the soil, but be careful not to include the soil. Place each subsample in a clean plastic bucket and mix thoroughly. Then put at least one quart of the mixture into a plastic bag that can be sealed tightly. Be sure to leave some room in the bag in case gas is produced and the bag expands. If the litter will be going directly to application sites as a fertilizer, try to collect the litter samples as close to clean-out times as possible. It should take approximately 14 days for the laboratory results to be returned.

Samples extracted from stockpiled litter should be taken from at least 10 locations around the stockpile. Heat generated in stockpiled litter can change the litter's chemical characteristics. Since the temperature will peak in 10-20 days after initial stockpiling, samples should be collected after the temperature drops and as close to spreading time as possible. If 10 samples are collected, only two should be collected within 12 inches of the surface. The remaining samples should be taken from a depth of 18-30 inches into the pile. The subsamples should be mixed and submitted as suggested for litter from poultry houses.

Caked litter being removed after each growout needs to be sampled for nutrient content. The caked litter should be sampled after it is removed from the poultry house. Subsamples should be mixed and submitted as suggested previously.

If possible, send the sample to the laboratory the same day it is prepared. If the sample must be held overnight, refrigerate the sample. The litter samples should be sent to the laboratory early in the week (Monday or Tuesday) to avoid weekend delays. Each county Agricultural Extension Service office has a list of laboratories that will conduct a poultry litter nutrient analysis.

Interpreting the Litter Analysis Report

The litter analysis report will indicate nitrogen, phosphorous and potassium content on a percent dry weight basis, percent "as is" basis and pounds per ton "as is" basis. To calculate litter application rates for various crops, use the figures for pounds per ton "as is" basis.

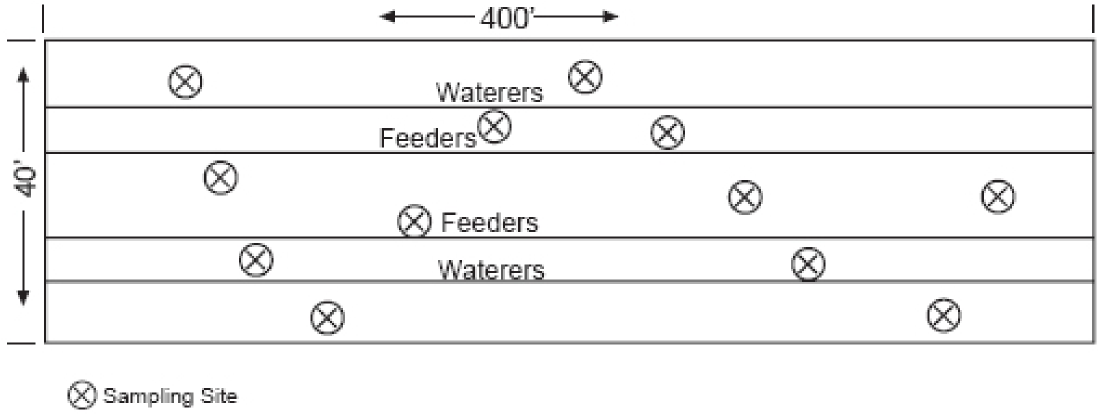
Summary

Since cleaning and litter disposal may be needed only once a year for poultry houses, the time and expense for having a sample tested is minimal. The savings in fertilizer costs will more than compensate for the litter analysis cost. In addition, the reduced risk of over-fertilization and potential water contamination should make litter sampling and testing worthwhile.

Related Agricultural Extension Service Publications:

PB 1421	Poultry Manure — Proper Handling and Application to Protect Our Water Resources
PB 1445	Dead Poultry Composting
PB 1476	Storage Facilities for Broiler Litter
PB 1510	Manure Application Management
PB 1644	Guidelines for Developing and Implementing a Poultry Nutrient Management Plan
PB 1645	Best Management Practices for Phosphorous in the Environment
SP 414	Calibrating Spreaders for the Application of Poultry Manure

Sampling Location In A Poultry House



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Agricultural Extension Service
Charles L. Norman, Dean

APPENDIX D

TCEQ REGULATORY GUIDANCE
Waste Permits Divison
RG-326 • August 2009

Handling and Disposal of Carcasses from Poultry Operations

On-farm disposal of dead animals should always be carried out in a manner that protects public health and safety, does not create a nuisance, prevents the spread of disease, and prevents adverse effects on water quality.

If you hatch, raise, or keep poultry, state law (Texas Water Code 26.303, Handling and Disposal of Poultry Carcasses) requires you to properly dispose of any birds that may die while in your care or at your facility. The purpose of this law is to prevent poultry carcasses from creating a nuisance or endangering water quality. The law requires the TCEQ to develop rules that will achieve that purpose—in part, by banning routine on-farm burial of dead poultry. The law does allow on-farm burial, but only in the event of a major die-off.

Texas Water Code 26.303 and TCEQ-related rules (Title 30, Texas Administrative Code, Section 335.25, or 30 TAC 335.25) apply to you if you own or operate a poultry facility, regardless of whether you actually own the poultry. The rules also apply to you even if you are operating a "grandfathered" facility (one exempted because it predates rule enactment) or a facility that is otherwise exempt from TCEQ rules for animal-feeding operations.

Under TCEQ rules, you must use an approved method for handling routine losses and be prepared to handle the results of a *major die-off*, i.e., any incident that causes 0.3 percent or more of your flock to die per day.

Handling Routine Losses

By planning in advance how you will dispose of carcasses due to routine losses, your facility will be better prepared to deal with environmental and health issues both routinely and in an emergency. If you have a certified water quality management plan (WQMP) from the Texas State Soil and Water Conservation Board (TSSWCB), you should follow the guidance in your plan or contact the TSSWCB. If you do not have a certified WQMP, it is recommended that you contact your local TCEQ office.

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The death of less than 0.3 percent of your flock per day is considered a *routine loss*. Routine losses must be managed by one or more of the methods listed below. Whichever method you choose, you must not allow the carcasses to cause a nuisance odor.

- Send the carcasses to a rendering plant,[1] another processing facility, or a permitted landfill.
- Process the carcasses on your farm by a method that is explicitly approved in TCEQ rules.
- Use any other method (except on-site burial), provided that you get TCEQ approval first.

TCEQ rules [30 TAC 335.25(c)] prohibit on-site burial of poultry carcasses due to routine losses.

How many carcasses should I be able to handle due to routine losses?

To ensure that you can comply with this rule, you should base your routine carcass-handling capacity on the largest number of live birds that your facility is capable of managing. Table 1 gives the number of birds equal to 0.3 percent for various flock sizes commonly managed in Texas.

Table 1. 0.3 Percent of Various Sizes of Flocks.

Flock Size	0.3% of Flock Size
16,000	48
64,000	192
128,000	384
192,000	576
256,000	768

Special requirements for animals that die of communicable diseases

Texas Animal Health Commission (TAHC) rules require disposal of animals that die from a disease recognized as communicable by the veterinary

[1] If the carcasses are to be rendered, the rendering plant must have authorization from the Texas Department of State Health Services (DSHS). Additionally, trucks hauling carcasses to a rendering facility must be registered with the DSHS. See <www.dshs.state.tx.us/msa/render.shtm>.

profession within time frames and by methods approved by the TAHC. A list of diseases that are reportable and approved methods of disposal may be obtained from the TAHC. Contact information for the TAHC appears on page 10.

But what if the TCEQ has given me permission to bury all carcasses or my permit requires burial?

Some older permits require that carcasses be buried. However, the statute establishing acceptable methods for carcass handling took effect after those permits were written, and the statute supersedes any related statements in those permits. The TCEQ will change this wording in your permit when you amend or renew it. However, if you have a permit that says you *may* or you *must* bury carcasses, the law requires you to begin to use another method starting *now*.

May I leave them for wild animals?

No. State law specifically prohibits this practice. When carcasses are left in the open, wild animals, rainfall runoff, or both can spread disease from the carcasses to humans and domestic animals, contaminate surface water and groundwater supplies, and cause nuisance odors.

What steps must be taken immediately?

Carcasses must be disposed of by an approved method, or stored in a refrigerated unit within 72 hours, for the owner or operator to remain in compliance with state law and to prevent nuisance odors. When disease is a concern, the TAHC may require immediate action and specify the method for handling and disposal of the carcasses. You must contact the TAHC (see page 10 for contact information) if disease is suspected.

Storing for 72 hours or less

Use a closed trash bin or similar varmint-proof, leakproof, spill-proof, and odor-preventing container. If you use this method, you are not required to register with, or obtain a permit from, the TCEQ.

Long-term storage

If you plan to hold the carcasses for more than 72 hours before you process them or have them removed, you must store them in a freezer or refrigerator at 40 degrees Fahrenheit or less. If you use this method, you generally will not be required to register with, or obtain a permit from, the TCEQ. However, if you intend to install an ammonia-based refrigeration unit like those used at large commercial refrigeration facilities, you must first verify that the unit will qualify for a permit by rule under TCEQ air-quality rules. If not, you must contact the TCEQ Air Permits Division to get a new permit or amend your current permit before you start building the refrigeration unit.

What kinds of processing are acceptable?

The following methods are approved for the routine disposal of carcasses:

- placement in a landfill permitted by the TCEQ to receive municipal solid waste
- cremation or incineration
- composting
- extrusion
- removal to an offsite rendering plant[2]

The method or methods you choose and the scale of your operation will determine whether you must register, apply for a permit, or notify the TCEQ. The TAHC may require a different method for disposal of diseased animals.

What are the regulatory requirements for carcass incineration?

Most incinerators used at poultry operations with an incineration capacity equal to or less than 200 lb/hr qualify for a permit by rule under the TCEQ air quality rules (Permit by Rule 106.494). If your incinerator doesn't meet the permit by rules requirements, you will need to obtain an individual air permit from the TCEQ (see page 10 for how to contact the TCEQ Air Permits Division).

Incinerators are typically authorized for use during daylight hours—that is, from one hour after sunrise until one hour before sunset. However, an incinerator with a CO or opacity monitor installed may burn after dark.

[2] If the carcasses are to be rendered, the rendering plant must have authorization from DSHS. Additionally, trucks hauling carcasses to a rendering facility must be registered with the DSHS. See <www.dshs.state.tx.us/msa/render.shtm>.

A list of poultry incinerators that have been registered with the TCEQ is posted on the TCEQ Web site at <www.tceq.state.tx.us/assets/public/permitting/air/Guidance/NewSourceReview/poultryincin_lst2_08.pdf>

You may also request a copy of the list of registered incinerators by writing or calling the Air Permits Division. Contact information appears on page 10.

How can I compost poultry carcasses?

TCEQ rules allow you to compost the carcasses of your own poultry on your own farm without registering with the TCEQ or applying for a permit, as long as your operation:

- Composts carcasses from your farm only with suitable bulking agents that have been purchased or have been obtained from your own farm only—for example, poultry litter, pine straw, wood shavings, landscape trimmings, and hay. (This requirement is important to ensure that you don't engage in activities that require additional authorizations.)
- Is kept at least 50 feet from the nearest property line if the total of composting materials and finished compost could exceed 2,000 cu yd.
- Creates no nuisance odors.
- Reduces exposure to "disease vectors"—that is, birds, flies, rodents, and other animals that could spread disease from the carcasses to humans, farm animals, pets, or wildlife.
- Does not discharge contaminants to surface water.
- Does not result in contamination of groundwater.
- Controls dust.

Composting in a covered area or in an enclosed bin can help in achieving these requirements. The USDA Natural Resource Conservation Service (NRCS) can recommend designs for bins that meet these criteria.

It is recommended (but not required) that composting operations be located at least:

- 150 ft from wells
- 150 ft from the nearest creek, stream, pond, lake, or river
- 50 ft from the nearest property line
- outside the 100-year floodplain

It is also recommended that composting operations take place in a location that is not visible to neighbors or traffic.

What are the requirements for carcass management using other methods?

If you choose another method of disposal, notify the Industrial and Hazardous Waste Permits Section in writing of your choice. Mail your notice to the address on page 10. If you are planning on using one of these methods on a large scale, contact the Air Permits Division (512-239-1240) to find out whether you need to obtain an air quality permit or, if you already have such a permit, amend it.

Handling Major Die-Offs

In the event of a major die-off (one in which 0.3 percent or more of your flock dies), you may bury the carcasses. However, if the die-off occurs among younger birds, you may find that your normal means of carcass handling will accommodate more carcasses than the number that corresponds to 0.3 percent of your overall inventory.

Carcass burial

If you choose to bury carcasses resulting from a major die-off on your farm and you have an approved water quality management plan for your site, you do not need to notify the TCEQ. The plan contains a burial map and information on how to bury the carcasses. The TSSWCB, NRCS, or local soil and water conservation district may be able to assist and confirm the appropriate location for burial in the event of a major die-off. (Information about the WQMP Program may be found at the Texas Soil and Water Conservation Web site, <www.tsswcb.state.tx.us>, or by calling 254-773-2250 or [toll-free] 800-792-3485.)

However, if you do not have a certified water quality management plan, you must notify the TCEQ Industrial and Hazardous Wastes Permits Section in a letter which contains your full name and address, the type of animals, and a short description of the locations on your farm where the carcasses will be buried. This letter will be considered as your compliance with 30 TAC 335.6 and will be acknowledged by the TCEQ. Mail your notification to the address listed on page 10.

It is also recommended that you notify the TCEQ regional office so that its staff can respond to public inquiries and to assist you with issues that may be encountered during an emergency situation.

If you do decide to bury the carcasses, then you remain responsible for controlling these and other potential impacts:

- contamination of groundwater
- contamination of surface water
- nuisance odors
- contact with disease vectors

To control these impacts, you need the right soil, the right site, and the right cover for burial of the carcasses.

Find the right soil

If you choose to bury the carcasses, you need to do so in soil that will retain the carcasses and their decomposition by-products within the excavation in order to prevent contamination of surface water or groundwater. If you have a certified WQMP, the NRCS can help you determine the suitability of your soils for burial of carcasses.

High-permeability soils such as sand may not be suitable for carcass burial without first lining the burial pit. Holders of certified water quality management plans should contact the TSSWCB or NRCS for assistance in determining the type of liner that may be appropriate for permeable soils. If you do not have a certified WQMP, you may contact the TCEQ Industrial and Hazardous Waste Permits Section (512-239-6595) for guidelines on liner construction.

Find the right site

The following are guidelines for locating an acceptable site for carcass burial based on the TCEQ rules for the disposal of household garbage, sludge, and wastewater:

- *Protect drinking-water wells.* Under TCEQ rules for wastewater holding tanks and sludge-application sites, the site must be at least 500 ft from the nearest public well, 150 ft from the nearest private well, and located outside of the 100-year floodplain.
- *Protect surface water.* TCEQ rules for septic tanks and drain fields require those facilities to be at least 50 ft from the nearest creek, stream, pond, lake, or river.
- *Protect your neighbors.* The burial site should be at least 50 ft from adjacent property lines; 200 ft or more is recommended.

Use the right cover

In order to control disease vectors and odors, the TCEQ municipal solid waste rules require that carcasses be covered with at least 2 ft of soil as soon as they are placed in a landfill. This practice is also recommended for burial of poultry carcasses on individual farms.

You are responsible for protecting our state water resources

The guidelines for carcass burial are based on other rules developed to protect state water resources. By following them, you should be able to reduce the risk of contaminating water supplies or creating a nuisance. However, you are responsible for any problem that arises from your burial of the carcasses, even if you followed these guidelines when you buried them.

Call before you dig

We also recommend that you call 800-344-8377 to make sure you will not accidentally hit a gas or utility line on your property during excavation.

Do I have options besides burial?

There is no requirement to bury carcasses resulting from a major die-off.[3] Some alternatives to burial:

- Transport carcasses to a permitted landfill or processing facility.
- Arrange to use an extra waste container temporarily (up to 72 hours) until you can get rid of the carcasses through your normal means.
- Arrange to use a refrigerated unit temporarily until you can get rid of the excess carcasses through your normal means.

Whether these or other alternatives are practical depends on the size of your operation, the size of the die-off, and other factors. Use good judgment when evaluating your choices.

What are the Penalties for Violating the Poultry Carcass Handling and Disposal Act?

You could be fined up to $10,000 per violation of the act. Each day of noncompliance may be considered a separate violation.

The act appears in the Texas Water Code, Chapter 26, Subchapter H, Poultry Operations.

[3] If the die-off is as a result of a disease outbreak, the TAHC may specify the disposal method.

Where Can I Find the Rules on Handling Poultry Carcasses?

All TCEQ rules appear in Title 30, Texas Administrative Code (30 TAC). Rules that directly apply to poultry carcass handling:

Industrial Solid Waste (30 TAC 335)

- Section 335.6, Notification Requirements
- Section 335.25, Handling, Storing, Processing, Transporting, and Disposing of Poultry Carcasses

Other TCEQ rules that are applicable to the handling of poultry carcasses include:

Control of Air Pollution by Permitting (30 TAC 116)

Permits by Rule (30 TAC 106)

- Section 106.494, Incinerators
- Section 106.373, Refrigeration Systems
- Section 106.161, Animal Feeding Operations

Concentrated Animal Feeding Operations (30 TAC 321, Subchapter B)

Composting Operations (30 TAC 332)

Municipal Solid Waste (30 TAC 330)

- Cover Requirements when Burying Dead Animals, Subsection 330.136(b)(2)

All of the rules pertaining to proper handling of poultry carcasses are found on the TCEQ Web site:

<www.tceq.state.tx.us/goto/rules>

or order copies from TCEQ Publications:

e-mail: <puborder@tceq.state.tx.us>

fax: 512-239-4488

phone: 512-239-0028

mail: Publications Ordering, MC-195
TCEQ
PO Box 13087
Austin, TX 78711-3087

Who Do I Notify?

If you don't have a certified Water Quality Management Plan, mail your notification or any other correspondence on this topic to:

Industrial and Hazardous Waste Permits Section, MC 130
PO Box 13087
TCEQ
Austin, TX 78711-3087
phone: 512-239-6595
fax: 512-239-6383

For questions about air quality rules only, contact:

Air Permits Division, MC 162
TCEQ
PO Box 13087
Austin, TX 78711-3087
phone: 512-239-1240
fax: 512-239-1300

For questions regarding burial, soils, or other information about a water quality management plan, contact the TSSWCB Poultry Program at:

Poultry Program Office
TSSWCB
PO Box 633901
Nacogdoches, TX 75963
phone: 936-462-7020

In the event of a die-off suspected to have been caused by disease, contact the Texas Animal Health Commission at:

TAHC
PO Box 12966
Austin, TX 78711-2966
phone: 800-550-8242

Facilities with a certified water quality management plan may contact the USDA NRCS for assistance in composter design and environmental issues regarding carcass burial at:

USDA NRCS
101 South Main
Temple, TX 76501
phone: 254-742-9800
fax: 254-742-9819

Other Helpful Information and Recommended References

Texas Agriculture Code <www.statutes.legis.state.tx.us/?link=AG>, Chapters 161 to 168.

Texas Occupations Code <www.statutes.legis.state.tx.us/?link=OC> 801.361, Disposal of Animal Remains.

Texas Animal Health Commission. Call 800-550-8242 before disposing of diseased animals. The TAHC also can supply a list of reportable animal diseases.

Disposal of Domestic or Exotic Livestock Carcasses (TCEQ publication no. RG-419) explains suggested guidelines from the TCEQ and the TAHC for disposal of farm or ranch animals.

Catastrophic Animal Mortality Management (Burial Method), Technical Guidance, USDA Natural Resources Conservation Service, Texas State Soil and Water Conservation Board, February 11, 2002.

NRCS TX Conservation Practice Standards, Code 316, Animal Mortality Management.

OSHA Construction rules:
www.osha.gov/pls/oshaweb/owastand.display_standard_group?p_toc_level=1&p_part_number=1926

OSHA Excavation Rules:
www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10930

Lone Star Healthy Streams

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