FOREWORD

Guidelines to Beneficial Management Practices: Environmental Manual for Poultry Producers in Alberta

These farm practices guidelines were developed for Alberta poultry producers through the co-operation of industry, government and interested stakeholders to create greater awareness and understanding of beneficial management practices for the environment for poultry producers in Alberta. Information presented in this publication is based on the best available research data and years of experience. The guidelines presented are intended to provide a range of management options for poultry operations of various sizes. This document is a living document and will be updated regularly to incorporate new proven technologies and information on environmental practices. Individuals not experienced in poultry production practices should not extract portions of this publication, nor draw inference, without considering all aspects of production. These guidelines should not be adopted literally into legislation, in whole or in part, by any level of government.

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Disclaimer

The primary purpose of the *Guidelines to Beneficial Management Practices: Environmental Manual for Poultry Producers in Alberta* is to assist producers in implementing beneficial management practices.

It is important to be aware that while the authors have taken every effort to ensure the accuracy and completeness of the manual, the manual should not be considered the final word on the areas of the law and practice that it covers. Producers should seek the advice of appropriate professionals and experts as the facts of individual situations may differ from those set out in the manual.

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1.0 INTRODUCTION

1.1 Client and Objective

Guidelines to Beneficial Management Practices: Environmental Manual for Poultry Producers in Alberta was prepared for Alberta poultry producers.

The objective is to use beneficial practices and nutrient management planning to reduce the impact of livestock production on soil, air and water. The practices outlined in this manual will help to reduce the nuisance effects of livestock production. This publication provides information in the following subject areas:

- The potential risks of livestock production on air, water and soil quality.
- Legal requirements of livestock operations.
- Social obligations of livestock operations.
- Site planning and management.
- Nutrient management.
- Alternative methods of manure treatment.
- Safe and responsible storage and disposal of agri-chemicals, petroleum products, medical waste and dead animals.

1.1.1 Purpose

The purpose of the *Guidelines to Beneficial Management Practices: Environmental Manual for Poultry Producers in Alberta* is to document, for producers and society, management options that are environmentally sound, comply with existing regulations and are economically feasible.

Due to the variability of local and regional conditions, not all of the practices herein pertain to any one specific poultry operation. Rather, one or a combination of these, coupled with other alternatives, may provide optimal results.

With the poultry industry's commitment to advancing management practices, as demonstrated in the evolution of poultry production over the past few decades, this manual will be updated as new standards are adopted.

These guidelines describe beneficial management practices designed to protect the environment and minimize nuisances such as odour, flies and dust.

1.1.2 Use of the guidelines

Experienced poultry producers may use these guidelines to evaluate and improve their current environmental management practices. When seeking a solution to a particular issue, all aspects of environmentally acceptable farm management should be taken into account.

It is not recommended that individuals extract portions of this publication without considering the entire environmental context of the operation. Individuals should not assess an operation based solely on this publication.

1.2 Background

In the past twenty years, Alberta's poultry industry has undergone significant changes, both in size and production methods. In many cases, poultry operations have become much larger and more capital intensive. Legislative requirements for producers have also changed.

At the same time, the character of Alberta's rural residential population has changed significantly. New rural housing represents a major personal investment and owners are sensitive to any activity that may affect enjoyment and/or property value.

The combined result of the changes in the poultry industry and in rural residential development has occasionally created conflict. In today's changing society, people in general are less tolerant of perceived infringements on their rights. This attitude extends to both rural residents and other agricultural producers. Poultry producers must be aware of this attitude shift and give it due consideration in the management of their operations. They must also keep up with changing legislative requirements.

Alberta poultry commodity groups, along with their many partners, are leading efforts to maintain and develop an environmentally responsible, sustainable and prosperous poultry industry. The industry as a whole is continually developing practices, standards and guidelines to assist producers in being environmentally sustainable, globally competitive and publicly acceptable.

Furthermore, poultry producers have a greater understanding that, to remain competitive in world markets, those involved in the production of poultry need to use common sense approaches, reasonable management skills appropriate for their operation, and accepted scientific knowledge to avoid detrimental environmental impacts and undue environmental risk.

2.0 POTENTIAL ENVIRONMENTAL RISKS AND NUISANCE ASSOCIATED WITH POULTRY PRODUCTION

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Take-home messages in this section:

- There are several air quality concerns associated with poultry production including odour, dust and gases.
- Pesticides and pharmaceuticals used on poultry operations also represent a potential environmental hazard.
- Environmental concerns associated with soil and water quality include soil erosion and compaction, groundwater pollution, and over-application of nutrients to the available land base.

This section provides background information on the potential environmental risks associated with poultry production and encourages poultry producers to consider the environmental consequences of all aspects of their management. It discusses the impacts on air, soil and water quality and the nuisances associated with poultry production. This section does not provide beneficial management practices to mitigate the impact of poultry operations on the environment. Those are found in subsequent sections.

2.1 Air Quality

The three primary sources of odour and air contaminants from poultry production are barns, manure storages and land application of manure. Dust and fumes from traffic associated with livestock production sites can also reduce air quality. The presence of contaminants does not equate to an environmental or health risk unless minimum threshold values are exceeded. Air contaminants released from these sources include micro-organisms, particulate matter (dust), endotoxins and gases. Gases include ammonia, hydrogen sulphide, methane, sulphur and nitrogen compounds.

Gases and dust should be of great interest to those working directly with livestock, because these people are exposed to the highest concentrations of contaminated air. In general, neighbours are at minimal risk from air contaminants because these contaminants are well diluted and dispersed in the air after travelling very short distances from their source.

2.2 Odour

The primary complaint about livestock operations is odour. The impact of odour on health and well-being causes concern, especially when odours are disagreeable and persistent. However, odour is generally considered a nuisance rather than a health risk to neighbours because of the degree of dilution and dispersion that occurs within short distances from the odour source.

There is a difference between the psychological and physiological health effects related to odour exposure. Psychological effects, such as irritation, can result from exposure to odour and often occur at levels well below those that can harm human health. Physiological effects can occur through exposure to specific compounds that make up odour, for example, asphyxiation from exposure to elevated levels of hydrogen sulphide (H_2S) in a confined space. The human health effects of poultry and swine facilities have been studied and more research is underway in this area.

It is difficult to evaluate odour and its health effects for the following reasons:

- Psychological and physical health effects are not necessarily independent.
- Odour from poultry manure is made up of about 160 compounds. Humans have many and varied responses to these compounds.
- The proportion and characteristics of odour contributed by each of the primary sources (barns, storages and land application) is not well understood. Research is underway to characterize odours released from each of these sources.
- Odour intensity and odour offensiveness varies between individuals.
- Combining different odorants can have positive and negative effects on intensity and offensiveness. These effects are not easily predicted.

Eliminating all odour from livestock operations is not feasible. However, there are management practices that can control odour impact within reasonable limits. Odour mitigation practices should focus on reducing the nuisance to neighbours, by minimizing the frequency, intensity, duration and offensiveness of odours.

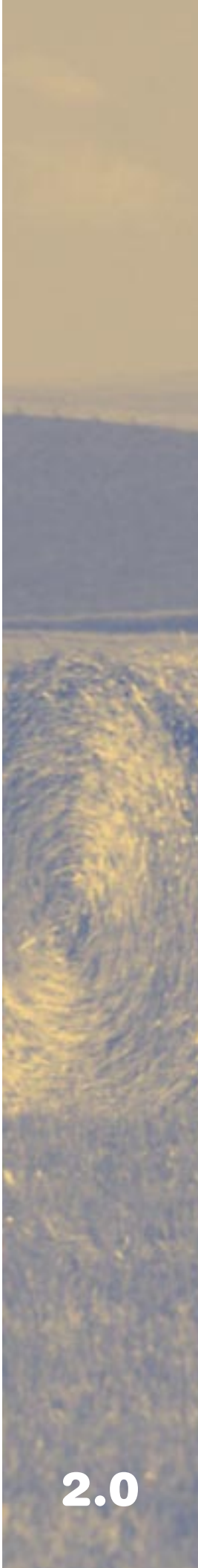
2.3 Dust

Dust is composed of fine aerosol particles in suspension. These particles are of various shapes and sizes and are both inorganic and organic.

- Organic dust may react in the respiratory tract of humans and poultry. Organic dust includes dandruff, dried manure and urine, feed, mold, fungi, bacteria, and endotoxins produced by bacteria and viruses. Between 70 and 90 percent of the dust in animal housing is organic.
- Inorganic dust is composed of aerosols from building materials and the environment (concrete, insulation, soil).

Air quality in livestock facilities can affect the health of humans and animals if they are exposed to high concentrations of contaminated air. Occupational Health and Safety Association (OHSA) recommends that total dust should not exceed 10 mg/m^3 and respirable dust should not exceed 5 mg/m^3.

Total dust includes all airborne particles, while respirable dust is less than 10 microns in size. Exposure to fine particles in respirable dust can cause eye and throat irritation and can potentially contribute to respiratory conditions such as asthma or chronic bronchitis. Airborne organic particles in poultry barns generally have high protein content and have been associated with allergic reactions. Dust masks are essential to protect the health of barn workers.



Dust and particulate matter exhausted from livestock facilities do not represent a direct health risk to neighbours because the survival rates of airborne micro-organisms between the source and neighbours is very low and the dilution factor of the air is high. However, airborne particulate matter can contribute to odour and dust, and may be a carrier of odour.

Dust concentrations in poultry houses usually vary between 0.02 and 81 mg/m^3 for inhalable dust and between 0.01 and 6.5 mg/m^3 for respirable dust.

Factors that affect dust concentrations in poultry houses include:

- Class of animal.
- Animal activity levels.
- Choice of bedding materials.
- Cleanliness of the buildings.
- Temperature.
- Relative humidity.
- Ventilation rate.
- Stocking density.
- Feeding method.

Management practices that can greatly reduce the amount of dust in poultry buildings include:

- Proper sanitation.
- Reducing the dust originating from feed.
- Managing relative humidity. For instance, if the air in a broiler or turkey house is too dry (i.e., low relative humidity) the amount of dust in the exhaust ventilation air will be excessive.

2.4 Gases

Gases emitted from livestock operations can impact climate change, acid rain, nuisance, odour and water quality. These gases can be generated in the barn and during manure storage and land application. They include ammonia, hydrogen sulphide, methane, sulphur, nitrogen compounds and several trace gases associated with odour. The properties and effects of these gases are shown in Figure 2.1.

Global warming refers to the increase in the earth's atmospheric temperature, which many scientists believe is a result of an increase in the concentration of "greenhouse gases," including water vapour, carbon dioxide (CO_2), methane (CH_4), halocarbons (used in refrigerants) and nitrous oxide (N_2O), which are the main greenhouse gases in the atmosphere. Increases in the concentration of all of these gases, except water vapour, are believed to contribute to climate change.

Greenhouse gases contribute to global warming by absorbing radiation emitted by the earth, which results in warmer atmospheric temperatures (Janzen et. al., 1998). Nitrous oxide and methane represent the bulk of greenhouse gas emissions from agricultural activity. The majority of emissions from poultry production come from manure. Although the intensity and offensiveness of an odour may be high, it does not necessarily indicate the presence of a greenhouse gas. Further research is needed to determine if there is a relationship between greenhouse gases and odour.

Figure 2.1 **Properties and Effects of Gases Emitted from Livestock Operations**

Gas	Source	Properties	Health Effect		Environmental Effect
			Concentration	Symptom	
Ammonia (NH_3)	• manure decomposition • composting • commercial fertilizer handling, storage and manure application	• sharp, pungent odour (like glass cleaner) • lighter than air	**25 ppm** 2 – 6 ppm 20 – 30 ppm 40 – 200 ppm 3,000 ppm 5,000 ppm	**Acceptable TLV*** Detectable but not considered a risk to public health. Burning eyes. Headaches, nausea, respiratory irritation. Asphyxiating. Could be fatal.	• soil and water acidification • contributes to odour • contributes to the formation of airborne particulates • may react with other compounds, potentially leading to acid rain and ozone depletion
Hydrogen sulphide (H_2S)	• bacterial decomposition in manure without oxygen (anaerobic)	• heavier than air • accumulates near the floor in enclosed buildings • initially a rotten egg smell, but lethal concentrations paralyze sense of smell	**10 ppm** 2 ppm 20 ppm 50 ppm >500 ppm	**Acceptable TLV** Detectable. Paralyzes sense of smell. Dizziness, nausea, headache, respiratory irritation. Death from respiratory paralysis in seconds.	• may react with other compounds, potentially leading to acid rain
Methane (CH_4)	• decomposition of manure without oxygen (anaerobic) conditions	• no smell • lighter than air	50,000 ppm 500,000 ppm	Explosive when mixed with air. Can cause headaches and eventually asphyxiation when oxygen is displaced.	• may contribute to climate change
Carbon dioxide (CO_2)	• anaerobic and aerobic decomposition of organic materials • plant and animal respiration • combustion of fossil fuels • manure is not considered a major source of CO_2	• no smell • heavier than air	**5,000 ppm** 30,000 ppm 40,000 ppm 100,000 ppm 300,000 ppm	**Acceptable TLV** Increased rate of breathing. Drowsiness, headache. Dizziness, unconsciousness. Could be fatal in 30 minutes.	• removed from the air by photosynthesis and ocean absorption • a greenhouse gas that may contribute to climate change
Nitrogen oxides** (NO_x)	• NO_x naturally generated by bacterial processes, decomposition and fires • humans contribute primarily through burning fossil fuels	• NO and N_2O are colourless, NO_2 is reddish brown • NO_2 is the most common of NO_x • NO_2 is one of the main components of smog	NO_x are not very soluble so symptoms may be delayed. Effects include respiratory irritation, coughing, fever and, in extreme situations, respiratory failure.		• potentially toxic to plants, leading to reduced growth • NO_x are the most potent greenhouse gases emitted by agriculture and may contribute to climate change • may deplete ozone
Trace gases associated with odour	• anaerobic decomposition of manure	• often have distinct smells	In low quantities, these compounds are not considered a serious threat to human health.		• contributes to odour • may form airborne particulates

* Threshold Limit Values (TLV). TLVs are exposure limits that serve as guidelines to control health hazards in work environments. These values are established by Occupational Health and Safety Association.

** Nitrogen oxides (NO_x) include nitric oxide (NO), nitrogen dioxide (NO_2) and nitrous oxide (N_2O) (laughing gas).

2.5 Pesticides

Pesticides include insecticides, herbicides, fungicides and rodenticides. Pesticides represent a potential risk to non-target organisms, applicators and workers, if handled or applied improperly. During pesticide application, airborne spray droplets, mists or vapours may form and drift. These can contaminate adjoining properties and water sources. Soil pollution can occur when pesticides are applied using improper application methods or rates, when disposal protocols are not followed and during spills. Storing large amounts of pesticides increases the potential for a significant pesticide spill to occur.

Pesticide mismanagement can harm beneficial insects, inhibit crop growth and reduce viability of certain crop varieties. Consumption of contaminated crops or soil may harm domestic animals and wildlife, and accumulation of pesticide residues in plant and animal tissues can render food unfit for human consumption. Pesticides have great potential to pollute both surface and groundwater. Contamination can be a result of drift, runoff, leaching, erosion of contaminated soil, spills and direct introduction. The severity of contamination depends on the pesticide's toxicity and management.

2.6 Pharmaceuticals

Antibiotics, anticoccidials and dewormers have been used safely and effectively in poultry production for more than 50 years. Most, if not all, of these products are broken down into harmless components in the animal's body or by micro-organisms in the manure or soil. Hormone residues are not an issue because hormones are not used in poultry production in Alberta. However, there is concern that anti-microbial products may enter the environment and cause negative effects on the ecosystem. The specific concern is that antibiotics may be excreted in an active form and may then alter the population of bacteria in the environment, which could lead to the rise of drug resistant bacteria. Drug residues, even if excreted in active form, are excreted at very low levels and are then diluted by litter material and other manure. Further dilution occurs when the manure is applied to the land, where natural degradation occurs. Thus far, there is no evidence that drug residues in poultry manure affect human or animal health; however, research in this area is ongoing.

2.7 Pathogens

In recent years, outbreaks of waterborne disease have occurred in humans in North America and, in several cases, the increase in intensive livestock production has been blamed. While it is not yet known how much of the problem can be attributed to animal agriculture, two things are certain. Poorly handled manure can result in waterborne disease in humans, and other sources of contamination, such as human sewage, are also responsible. It is critical that manure is handled properly to minimize the risk of disease to livestock and humans.

There are a wide range of micro-organisms present in poultry manure, including bacteria, viruses, protozoa and other parasites. The vast majority of these are specific to birds only, but under certain conditions, some of them may cause disease in humans or livestock.

Currently in Alberta, poultry manure is not considered a significant source of disease for humans or other livestock. There are three main reasons for this. First, many infectious poultry diseases that occur in other parts of the world are not found in Canada. Second, modern production practices and regular treatment of drinking water reduce the risk of disease transmission. Third, poultry farms in Alberta are generally not in close proximity to each other.

2.7.1 Modes of disease transmission from manure

Disease-causing micro-organisms are referred to as pathogens. Diseases that can be transmitted from animals to humans are referred to as zoonotic diseases.

Air. There is little risk in Alberta that a disease could be transmitted from poultry manure through the air to humans or other livestock outside the poultry barn. Dust particles or droplets of water may contain bacteria or viruses, and some of these agents (e.g. infectious bronchitis and avian influenza) may spread between barns on the same operation or between barns on separate operations. But, because viruses and bacteria are susceptible to temperature variations, desiccation and ultra-violet solar rays, close proximity is a necessity for disease transmission to occur. Consequently, airborne disease transmission between operations is highly unlikely. The odour of poultry manure alone cannot cause an infectious disease.

Fecal-oral transmission. Manure pathogens are mainly transmitted through the fecal-oral route (i.e. ingestion of manure or manure-contaminated feed or water). In livestock this occurs through consumption of drinking water contaminated with poultry manure, through grazing pasture that has recently received manure or through direct consumption of manure. The main public health concern relates to the contamination of surface and groundwater supplies.

Humans can ingest manure pathogens by consuming contaminated drinking water, swimming in contaminated surface water and by failing to wash their hands after handling infected livestock or manure.

Composting poultry manure and litter creates enough heat to destroy most pathogens. Evidence also suggests that increasing levels of ammonia in poultry manure during decomposition will destroy *Salmonella* species and other pathogens that can potentially harm humans.

It is often difficult to determine the source of a waterborne outbreak of disease. Many of the same disease-causing micro-organisms in livestock are found in wildlife, pets and sewage. Therefore, identifying the source of contamination is difficult. Testing several possible sources and using new diagnostic techniques to determine the strain of the organism are usually necessary to pinpoint the source of disease, although results are still not definitive.

With regard to human health, the bacterial contaminants of greatest concern are *Salmonella, Campylobacter* and *Listeria* species. *Campylobacter* species are very susceptible to desiccation, ultra-violet light and temperature fluctuations outside a narrow range. *Salmonella* species are slightly more tolerant, but cannot survive prolonged exposure to dry conditions. Human health concerns relating to poultry pertain more to food and food preparation than to environmental issues.

2.8 Soil Erosion and Compaction

Soil erosion refers to the loss of soil due to wind or water. Erosion potential depends on management practices and the specific topography, climate and soil type of a region. Water erosion can be the result of surface runoff from rainfall or irrigation. Wind erosion occurs when soil is not adequately covered and winds are strong enough to pick up and carry soil particles. Wind and water erosion can cause environmental problems if soil nutrients or fine-grained material, such as silt and clay, enter bodies of water.

To avoid soil erosion when applying and incorporating manure, a balance must be achieved among incorporation techniques, timing and tillage. Incorporating manure prevents nutrient losses and mixes organic matter in manure with soil. Mixing organic matter with soil increases the binding of soil particles and can reduce the potential for erosion. Excessive tillage and compaction, however, will decrease soil porosity and destroy soil structure and aggregate characteristics. This reduces the movement of water, air, nutrients and soil microbes through the soil. Timing manure application to avoid applying manure on wet soil is critical to reduce soil compaction. Farm traffic, especially on headlands, can cause soil compaction, particularly when the soil is wet.

2.9 Excess Nutrients

Spills, improper storage and over-application of fertilizers or manure may lead to excess nutrient concentrations in soil. Primary nutrients of concern are nitrogen, phosphorus, salt and potassium. Excess nitrogen and phosphorus can cause soil and water quality problems. Excess potassium on forages can reduce feed quality. An overabundance of these nutrients can result in toxicity to plants and reduced crop yields. The accumulation of excess nutrients in plant tissue may be harmful to humans. As well, nutrients not used by the plants can leach out of the root zone and contaminate groundwater, or can run off and contaminate surface water.

2.9.1 Excess nutrients and water

Surface Water. Elevated nutrients in watercourses can be caused by manure or fertilizer entering a watercourse directly, by runoff from fertilized fields or nutrient-rich soil eroding from croplands. Nutrients, primarily phosphorus and nitrogen, accelerate eutrophication of water bodies, which is the nutrient enrichment of surface waters. The most visible effects of eutrophication are massive blooms of algae and other aquatic plants. When these algae and aquatic plants die, dissolved oxygen can be depleted, reducing fish survival. Blue-green algae can also be toxic to domestic animals and humans when ingested.

Nitrates in drinking water. Nitrate is formed through the mineralization of organic nitrogen to ammonium and then to nitrite, a process also known as nitrification. Nitrate is a form of inorganic nitrogen that is readily used by plants and is highly water-soluble, and therefore has the tendency to move quickly down through the soil profile. As a result, it can accumulate in shallow groundwater.

Sources of nitrate in water include natural sources (e.g. peat bogs), commercial fertilizers (e.g. anhydrous ammonia), domestic sewage and manure. Studies in Alberta have shown that high levels of nitrate from livestock and fertilizer or manure application can be present in surface runoff.

The established drinking water quality, Maximum Acceptable Concentration (MAC), for nitrate is 45 mg/L measured as nitrate (10 mg/L measured as nitrate-nitrogen). Nitrate levels below 45 mg/L do not appear to cause health problems. Above this level, however, there may be health concerns, particularly for pregnant women and infants less than one year old.

2.10 Groundwater Pollution Concerns

Groundwater. Groundwater is water that occurs in the pore spaces of soil and rocks. Aquifers are water-bearing layers that hold groundwater in usable amounts. Deposits such as clay or shale typically overlie aquifers. Unconfined aquifers or water table aquifers are close to the surface and are directly exposed to the atmosphere through openings in the soil. As a result, the risk of contamination to unconfined aquifers is great. Over-application of nutrients can result in nutrient leaching directly into the groundwater.

A confined aquifer is trapped below an upper confining layer of rock, clay or shale. The main risk of contamination for confined aquifers is through direct movement of contaminants into a well through the wellhead or an improperly maintained well casing. Manure, chemical spills or seepage into wells should be prevented.

Seepage from improperly constructed or maintained manure storage structures and the associated risk of groundwater contamination is a serious concern in some areas, particularly where the subsoil underlying the storage consists of sand, gravel or fractured bedrock that allows movement of contaminants through the soil profile to shallow groundwater.

Over-application of manure on cropland or forage land can also present a risk of elevated nitrate levels in shallow groundwater. Studies in Alberta have shown that continuous over-application of manure can increase nitrate levels in shallow groundwater.

Salt. Salt levels, as shown by electrical conductivity measurements and sodium adsorption ratios, can increase in soils after successive manure applications. Manure can contain salts from the water used for livestock watering or from salts and minerals in feed. In many cases, nutrients, such as nitrogen, phosphorus and trace elements are less likely to limit manure applications on a field than salt levels. Sodium, in particular, can cause problems because it causes structural changes in the soil. It is also toxic to plants at high levels.

Metals. Metals include nickel, manganese, lead, chromium, zinc, copper, iron and mercury. Trace quantities of some metals are necessary for the growth of living things. However, even low metal concentrations can have cumulative effects that are toxic to most life forms. Metals are found in manure, waste oil and hydraulic fluids, and may contaminate groundwater, or move into surface water and accumulate in fish tissues, making the fish unfit for human consumption.

Petroleum products. Gasoline, antifreeze, paints, solvents, hydraulic fluids and other oil-based substances can have both direct and indirect harmful effects on groundwater and surface water. Direct adverse effects include immediate toxic contamination of aquatic organisms that ingest petroleum products and respiratory interference in fish. Indirect negative effects include the destruction of fish food such as algae and other plankton, devastation of spawning areas, a reduction in the rate of photosynthesis by aquatic plants and poor stream aeration. Petroleum products can also taint the flavour of fish, affecting its quality for human consumption.

2.11 Nuisance

Odour, noise, traffic and flies related to agricultural enterprises are a potential nuisance to the surrounding community if not managed properly. Noise and traffic are inevitable, but the beneficial management practices discussed throughout the following sections may minimize irritation to neighbours.

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3.0 ENVIRONMENTAL OBLIGATIONS AND REGULATORY APPROVALS FOR LIVESTOCK PRODUCERS

3.1 Environmental Law Relating to Poultry Production – Environmental Protection Standards

A. ALBERTA LEGISLATION

3.1.1 Agricultural Operation Practices Act

- **3.1.1.1** Environmental Protection Standards
- **3.1.1.2** Design and operating standards

3.1.2 Environmental Protection and Enhancement Act

- **3.1.2.1** Prohibited releases
- **3.1.2.2** Duty to report
- **3.1.2.3** Liability of directors and officers
- **3.1.2.4** Strict liability offences
- **3.1.2.5** Fines

3.1.3 Public Health Act

3.1.4 Livestock Diseases Act

B. FEDERAL LEGISLATION

3.1.5 Fisheries Act

- **3.1.5.1** Deleterious substance
- **3.1.5.2** Liability of directors and officers
- **3.1.5.3** Strict liability offences
- **3.1.5.4** Fines

3.1.6 Due diligence and environmental management systems

- **3.1.6.1** Due diligence
- **3.1.6.2** Environmental management systems

3.1.7 Common law of nuisance and the Agricultural Operation Practices Act

3.1.8 Common law of negligence

3.2 Regulatory Approvals for Poultry Operations

3.2.1 Provincial approvals

- **3.2.1.1** NRCB approval process

3.2.2 Water Act approvals

- **3.2.2.1** Process
- **3.2.2.2** Environmental Appeal Board Appeals

3.2.3 Transportation approvals

3.0 ENVIRONMENTAL OBLIGATIONS AND REGULATORY APPROVALS FOR LIVESTOCK PRODUCERS

Take-home messages in this section:

- Several federal and provincial laws are in place to protect soil, air and water from all sources of pollution, including agricultural pollution.
- Statutes that producers should be aware of, include the *Agricultural Operation Practices Act, Alberta Environmental Protection and Enhancement Act,* the *Public Health Act,* the *Livestock Diseases Act,* the *Water Act* and the federal *Fisheries Act.*
- This section deals with these acts from an environmental standards viewpoint, as well as a regulatory approval perspective.
- The *Agricultural Operation Practices Act* establishes specific environmental protection standards for new and existing poultry operations, as well as design and operating standards for new and existing poultry operations.
- The *Environmental Protection and Enhancement Act* prohibits producers from releasing into the environment a substance in an amount, concentration or level, or at a rate of release that causes or may cause a significant adverse effect on the environment.
- The *Public Health Act* gives health authorities significant powers to protect the public health.
- The *Livestock Diseases Act* contains strict requirements regarding the disposal of dead animals, including poultry.
- The federal *Fisheries Act* deals with the deposition of deleterious substances into any water frequented by fish.
- Copies of Acts and Regulations are available through the Alberta Queen's Printer (www.gov.ab.ca/qp) or contact at qp@gov.ab.ca or 780-427-4952 (toll-free in Alberta by first dialing 310-0000).

The environmental obligations of existing poultry producers and the regulatory approval requirements for new and expanding operations are discussed in detail in the sections below.

Meeting environmental obligations requires an awareness of environmental law. The environmental obligations of a livestock producer are set out in statutes enacted by the provincial and federal legislatures, and through the common law, which is the body of law and rules established by the courts. The statutes that producers should be aware of include the *Agricultural Operation Practices Act* (AOPA), *Alberta Environmental Protection and Enhancement Act* (EPEA), the *Public Health Act* (PHA), the *Livestock Diseases Act,* the *Water Act,* and the federal *Fisheries Act.* Livestock producers should also be informed of the common law rules of nuisance and how AOPA affects these rules.

There is an approval and siting process for the development and expansion of poultry operations. Increased awareness of this process can help producers plan the development or expansion of their operations. Prior to January 1, 2002, the approval process for poultry operations was governed by the *Municipal Government Act,* municipal development plans, land-use bylaws and Alberta Agriculture, Food and Rural Development's *Code of Practice for Responsible Manure Management and Livestock Development* (Code of Practice), the *Water Act,* and potentially, the *Public Highways Development Act.* Since January 1, 2002, primary responsibility for poultry operation approvals has been transferred from municipalities to the provincial Natural Resources Conservation Board (NRCB), under AOPA. (Additional information on the site selection and planning approval process is described in Section 5.)

3.1 Environmental Law Relating to Poultry Production – Environmental Protection Standards

A. ALBERTA LEGISLATION

3.1.1 *Agricultural Operation Practices Act*

AOPA establishes specific environmental protection standards for new and existing poultry operations.

3.1.1.1 Environmental Protection Standards

The *Act, Standards and Administration Regulation* describe the specific standards that producers should understand.

The *Act* authorizes the NRCB to issue an enforcement order against a producer if the NRCB is of the opinion the producer is:

- Creating a risk to the environment.
- Causing an inappropriate disturbance.
- Contravening the *Act* or regulations.

3.1.1.2 Design and operating standards

The *Regulation* describes the design and operating standards for livestock operations. Some of the standards apply to new and expanding operations, while others apply to all operations, including existing operations.

Manure management. The regulatory requirements for manure management apply to both existing and new operations. Producers are required to have sufficient land base to safely utilize the manure. The *Regulation* contains tables for determination of land base. It is an offence to exceed the nitrate-nitrogen limits of the regulations and the soil must be tested prior to application of manure if more than 300 tonnes are being applied annually.

Manure must be incorporated into the soil within 48 hours of being applied to the land. The *Regulation* allows exemptions where the manure is being used on a forage or direct-seeded crop. They also allow for restricted manure application on frozen or snow-covered ground where the land is flat and additional setbacks are maintained.

General setbacks for manure spreading are as follows:

- No manure is to be applied within 30 metres of a water well.
- A minimum of 10 metres separation must be maintained from a body of water where manure is being applied by subsurface injection and 30 metres where manure is applied by incorporation.

Manure storage. The *Act, Standards and Administration Regulation* contain requirements for the design and location of earthen storage and catch basins for the storage of liquid manure for new and expanding operations. If a producer uses earthen storage for liquid manure, the earthen storage must be able to hold nine months of storage and must be constructed of such compaction to achieve a hydraulic conductivity of not more than 1×10^{-6}cm/sec. In addition, the construction of side slopes must be appropriate for the stability of the soil. Specific slope standards are outlined in the *Regulation*.

With respect to the suggested location of earthen storage and catch basins, the regulations require a producer to:

- Avoid areas with a shallow water table.
- Maintain a minimum of 100 metres setback from a spring or water well and 30 metres from a body of water.
- Prevent surface water from entering the lagoon or catchment pond.
- Install a leakage detection system to monitor for potential contaminants.
- Implement fly control measures.
- Design for the bottom filling of the lagoon.
- Control access to the area and place warning signs.

Minimum distance separation. A minimum distance separation (MDS) is required between new or expanding operations and their neighbours. The setback distances depend on the size of the new or expanding operation and the type of neighbour. The setback distances are measured from the portion of the operation closest to the neighbouring residence. For the purpose of measurement, the facility's manure storage is considered to be part of the operation.

The MDS does not apply to residences owned or controlled by the producer. It also does not apply where the neighbours themselves operate livestock operations and waive the MDS.

Records. The *Regulation* requires producers to keep records of any documents that were used to obtain approvals. In addition, producers are required to keep the following records if they apply more than 300 tonnes per year:

- Volume or weight of manure produced.
- Legal description of the land to which the manure was applied.
- Date and volume of manure applied to land.
- Application rates and incorporation methods used.
- Information on any person the producer gave manure to if more than 300 tonnes was given.

Producers are required to keep copies of these records for five years.

3.1.2 *Environmental Protection and Enhancement Act*

3.1.2.1 Prohibited releases

The EPEA prohibits producers from releasing into the environment a substance in an amount, concentration or level or at a rate of release, that causes or may cause a significant adverse effect on the environment. While "significant" is not defined in EPEA, "adverse effect" is broadly defined to mean the "impairment of, or damage to, the environment, human health or safety, or property." This means that a producer cannot release or spread manure if the release or spreading of manure may cause a significant adverse effect to the environment. That is, if a producer spreads manure on land at a rate that will overload the nutrient value of the land, or releases manure on land where the manure will run into a watercourse, that producer will be in violation of EPEA.

EPEA also gives the government the power to issue an environmental protection order to an individual responsible for the release of an offensive odour. An environmental protection order, among other things, requires the individual to prevent, minimize or remedy the offensive odour or destroy the cause of the odour. These powers, however, do not apply to offensive odours emitted from an agricultural operation operating in accordance with "generally accepted practices" for that operation. The Environmental Appeal Board or a judge will determine compliance with "generally accepted practices" based on the testimony of witnesses that the Board determines have credible expertise in the discipline.

3.1.2.2 Duty to report

EPEA requires producers to report any releases that may cause an adverse effect on the environment to Alberta Environment. Failure to report a release can result in a fine as described in Section 3.1.2.5.

Typically, when a producer reports a release, Alberta Environment will require the producer to identify the steps that the producer is taking to prevent harm to the environment and to prevent the release from reoccurring.

3.1.2.3 Liability of directors and officers

If a corporation violates EPEA, any officer, director or agent of the corporation who was involved with the incident, even in a minor way, could face prosecution under EPEA. This applies regardless of whether the corporation itself is prosecuted for the violation or whether the officer, director or agent works for a large corporation or simply a small incorporated family farm. In other words, an officer, director or agent of a corporation is held personally responsible for violations of EPEA, if the officer, director or agent directed or participated in the violation in any way.

3.1.2.4 Strict liability offences

Offences under EPEA are "strict liability" offences. Unlike criminal offences, with strict liability offences, the courts are only concerned with whether the producer committed the offence, and not whether the producer intended to commit the offence. If a producer caused impairment to the environment by releasing manure into a watercourse, the courts will not examine whether the producer meant to cause the impairment; the courts will only determine whether the producer caused the impairment.

If the producer caused the impairment, the courts will convict the producer unless the producer can show that the action was in accordance with "due diligence" in running the operation and in carrying out the activity in question. In other words, if the producer can demonstrate that all reasonable steps were taken to prevent the contravention of the EPEA, the producer will not be found guilty under EPEA. Due diligence will be discussed in further detail in Section 3.1.6.1.

3.1.2.5 Fines

Under EPEA, an individual can be fined $50,000 to $100,000, while a corporation can be fined $500,000 to $1,000,000 for each offence, depending on the offence. Each day that a release or impairment occurs is treated as a separate offence. For instance, a release from a lagoon occurring over two days would be treated as two offences and expose the corporation to a maximum fine of $1 million.

3.1.3 *Public Health Act*

It is important for producers to be aware of the responsibilities regional health authorities have under the *Public Health Act* (PHA). The PHA gives health authorities significant powers to protect the public health and takes priority over all provincial statutes, except the *Alberta Bill of Rights.*

If there are reasonable and probable grounds to believe a nuisance exists, the PHA allows a regional health authority to enter onto and inspect a property, take samples of any substance or equipment being used and perform on-site tests. The PHA defines "nuisance" as:

> "…a condition that is or that might become injurious or dangerous to the public health, or that might hinder in any manner the prevention or suppression of disease."

In order for the regional health authority to enter onto private property to perform these inspections and tests, the regional health authority requires either the consent of the owner, or a court order allowing these activities to occur. If the owner does not give consent and the regional health authority applies to the courts to obtain an order, the PHA provides the judge with the authority to grant a court order without requiring the owner to have prior notice of the court application. Once the inspection, sampling or testing has occurred, the regional health authority can order the property to be vacated, declared unfit for habitation, closed or destroyed, if there are reasonable and probable grounds to believe a nuisance exists. In addition, the regional health authority has the power to prohibit or regulate the sale of any livestock from the property.

In short, a regional health authority that is made aware of a public health hazard at a poultry operation can take steps to protect the public health by eliminating the health hazard. In addition, any operator that contravenes the regional health authority's orders is liable for a fine of not more than $100 for each day the contravention continues.

3.1.4 *Livestock Diseases Act*

The *Livestock Diseases Act,* through its regulations, requires that the owner of a dead animal dispose of the dead animal within 48 hours of death, by:

- Burial.
- Incineration.
- Transportation to a rendering plant for disposal.
- Scavenging (under very restricted circumstances).

Strict requirements for each of these disposal methods can be found in the *Poultry Mortality Disposal Guidelines for Alberta,* and in the following Agdex publications:

- *Livestock Mortality Management (Disposal)* Agdex 400/29-1.
- *Livestock Mortality Burial Techniques* Agdex 400/29-2.
- *Poultry Mortality Composting* Agdex 450/29-1.

If a producer fails to properly dispose of a dead animal, the producer is in violation of the *Livestock Diseases Act* and is liable to a fine of not more than $10,000, imprisonment for a term of not more than one year or both. Producers should review *Destruction and Disposal of Dead Animals Regulations* for specific disposal standards.

B. FEDERAL LEGISLATION

3.1.5 *Fisheries Act*

3.1.5.1 Deleterious substance

Under the Canadian Constitution, the federal government has jurisdiction over the protection of fish habitat. The *Fisheries Act* prohibits anyone from depositing or permitting the deposit of anything into any water frequented by fish, which can have a "deleterious" or harmful effect on the fish. Further, the *Fisheries Act* prohibits anyone from depositing a deleterious or harmful substance in any place under any condition where the deleterious or harmful substance may enter any water frequented by fish. The *Fisheries Act* defines the phrase, "water frequented by fish" very broadly to include all internal waters of Canada. Therefore, this definition includes any creek, river, stream, lake or slough which is frequented by fish, including any creek which contains minnows in the spring, but dries later in the summer.

As a result, it is an offence under the *Fisheries Act* if a producer spreads manure on land, located near a stream frequented by fish and the manure migrates into the stream. An offence results even if the deposit of the manure does not actually cause harm to the fish. The mere fact that the manure migrated into water frequented by fish causes a violation of the *Fisheries Act* and may result in charges under this *Act,* unless the producer can prove that at all material times, the water is not, has not been, and is not likely to be frequented by fish.

In addition, it is an offence under the *Fisheries Act* if a producer spreads manure on land that has a stream frequented by fish, even if the deposit of the manure does not in fact enter the water, but had a reasonable chance of entering the water. The mere fact that the manure had a reasonable chance of entering water frequented by fish violates the *Fisheries Act* and may result in charges under this *Act.* However, again, if the producer can prove that at all material times, the water is not, has not been and is not likely to be frequented by fish, then no offence has been committed under the *Act.*

3.1.5.2 Liability of directors and officers

Any officer, director or agent of a corporation in violation of the *Fisheries Act* who was involved with the incident, even in a minor way, may be charged, convicted and punished under the *Fisheries Act,* whether or not the corporation itself has been charged. This is true regardless of whether the officer, director or agent works for a large corporation, or a small incorporated family farm. In other words, as with the EPEA, an officer, director, agent or a corporate producer can by held personally responsible for violations of the *Fisheries Act,* if the officer or director directed or participated in the violation in any way.

3.1.5.3 Strict liability offences

As with the EPEA, offences under the *Fisheries Act* regarding the deposit of deleterious substances or harmful substances into water frequented by fish are "strict liability" offences. That is, the courts are not concerned with intent, only with whether a producer deposited a substance into any type of water frequented by fish where the substance could have a deleterious or harmful effect on the fish, or whether a producer deposited a deleterious substance in any place under any condition where the deleterious substance may enter any water frequented by fish. If a producer has engaged in either of these activities, the court will convict the producer, unless the producer can demonstrate that:

- At all material times, the water is not, has not been and is not likely to be frequented by fish.
- The producer acted with due diligence to prevent the commission of the activity.
- The producer reasonably and honestly believed in the existence of the facts that, if true, the producer's conduct was not in violation of the law.

3.1.5.4 Fines

An individual or corporate producer is liable to a fine not exceeding $1,000,000 for the producer's first deleterious substance offence and to a fine not exceeding $1,000,000 or imprisonment for a term of not exceeding three years or both for any subsequent deleterious substance offence.

3.1.6 Due diligence and environmental management systems

3.1.6.1 Due diligence

In order to avoid a conviction under the EPEA and the federal *Fisheries Act,* a producer must have acted with due diligence in running the operation and in carrying out the activity in question.

Whether a producer acted with due diligence in any particular circumstance will be determined by the courts on a case-by-case basis. The courts have indicated that, in general, to act with due diligence, one "must take all reasonable steps to avoid harm. That does not however mean [one] must take all conceivable steps."[1] In addition, "reasonable care and due diligence do not mean superhuman efforts. They mean a high standard of awareness and decisive, prompt and continuing action."[2]

In considering whether an individual acted with due diligence, the courts, "examine what was done, what controls were in place, what was the state of technology that existed through the evidence of lay and expert witnesses to determine if the accused acted reasonably in the circumstances."[3]

A court may examine the following points to determine whether due diligence has been exercised:

(a) Did the livestock operation establish and maintain a pollution prevention system? For example, is there a reasonable nutrient management plan for the operation?
(b) Did the livestock operation instruct employees to:
    (i) Establish a pollution prevention system that ensures the operation complies with industry practices and environmental laws, i.e. the Code of Practices and the permit or Registration/Approval conditions?
    (ii) Report to the manager if the livestock operation was not complying with the system? For example, if soil-testing analysis indicated high nitrate levels, making it dangerous to apply more manure, was management told?

1. R. v. British Columbia Hydro and Power Authority [1997] B.C.J. No. 1744, paragraph 55.
2. R. v. Courtaulds Fibres Canada (1992) 9, C.E.L.R. (N.S.) 304 at 313 (Ont. Prov. Ct.).
3. R. v. Northwood Pulp and Paper (1992) 9, C.E.L.R. (N.S.) 289 at p. 293.

(c) Did the livestock operation review the environmental compliance reports provided by the operation's officers? Is there an annual review of the report and system?
(d) Did the livestock operation ensure that its officers and employees promptly addressed environmental concerns brought to its attention by government agencies or other concerned parties? Was the problem fixed?
(e) Was the livestock operation aware of industry standards regarding environmental pollutants and risks?
(f) Did the livestock operation consider these problems as a priority and were they addressed in a timely fashion?[4]

A court may also examine whether a corporation has an environmental management system, what activities are covered by the environmental management protocol, its depth of detail, and whether it is followed by the company, to determine whether the company acted with due diligence in carrying out the activity in question.

3.1.6.2 Environmental management systems

Corporations use environmental management systems to establish and implement policies and procedures for operating an environmentally sustainable business. An environmental management system will examine the corporation's operations to determine:

- How these operations impact the environment.
- Which policies and procedures can be implemented to minimize or eliminate environmental impacts.
- Which environmental standards and laws the corporation must follow.
- Whether the corporation is following these standards and laws.

The environmental management system will then put into place policies and procedures to reduce the livestock operation's environmental impacts, and to properly train the corporation's employees to meet and maintain applicable environmental standards and laws. Finally, an environmental management system will mandate periodic re-evaluation of these environmental policies and procedures.

Producers who adopt Alberta Environmental Farm Plans are taking the preliminary steps toward development of an environmental management system.

3.1.7 Common law of nuisance and the *Agricultural Operation Practices Act*

The common law of nuisance is an individual's unreasonable interference with a neighbour's use and enjoyment of the neighbour's land. If a producer unreasonably interferes with the use and enjoyment of a neighbour's land by creating offensive odours, excessive noise or dust, or the presence of flies, the courts may force the producer to pay damages to the neighbour to compensate the neighbour for the nuisance, and potentially could force the producer to shut down.

However, the Alberta government enacted AOPA to offer protection to producers from nuisance claims, as the government recognized that farms typically produce some odours, noise and dust. AOPA states that a producer will not be liable in court for any nuisance resulting from the producer's operation, nor will the producer be prevented from carrying on its operation by a court injunction or order, if the producer has not contravened the local land-use bylaws and has followed "generally accepted practices for similar agricultural operations." The *Act* defines a "nuisance" to include an activity which:

- Arises from unreasonable, unwarranted or unlawful use by a person of the person's own property, which causes obstruction or injury to the right of another person or to the public and produces such material annoyance, inconvenience and discomfort that damage will result.
- Creates smoke, odour, noise or vibration, which interferes with the reasonable and comfortable use of a person's property.
- Is found to be a nuisance at common law.

Generally accepted practices for similar agricultural operations are determined by a peer review board appointed by the Minister of Agriculture, Food and Rural Development.

4. R. v. Bata Industries Ltd. [1992] O.J. No. 236 at page 24-25 (Ont. Prov. Div) online: QL (O.J.), rev'd in part on other grounds 14 O.R. (3d) 354, rev'd in part on other grounds 127 D.L.R. (4th) 438.

3.1.8 Common law of negligence

In law, an individual is negligent if he fails to live up to a "duty of care" he owes to another individual. A "duty of care" is a duty held by one individual to avoid carrying out an activity that has a reasonable chance of causing harm or injury to another individual. It is impossible for any individual to avoid all activities that might harm another individual. Therefore, the law sets standards of conduct that must be met. The standard is one of reasonableness – the individual must behave in a way that a reasonable individual of ordinary intelligence and experience would behave in the same circumstance. How an ordinary individual would behave depends on factors such as the degree of harm that might occur and standard industry practices.

A poultry operator has a duty to operate in such a manner so as to not cause harm to those individuals who could reasonably suffer harm if the operator does not act reasonably in running the operation. For example, a poultry operator may be negligent if:

- The operator spreads manure on frozen land that has a heavy slope towards a creek.
- The creek becomes contaminated from manure spreading during the spring runoff.
- The operator knew or ought to have known that neighbours receive their domestic water supply from the creek.
- The operator's neighbours become sick from the contamination.

In this situation, the "reasonable" operator would know or ought to have known that spreading manure on these lands with these conditions could result in the neighbours suffering harm. As a result, the livestock operator could be held liable for the harm or injury suffered by the neighbours.

3.2 Regulatory Approvals for Poultry Operations

3.2.1 Provincial approvals

Prior to January 2002, producers obtained approvals to build or expand a livestock operation from municipal governments through the issuance of a development permit.

The approval of livestock operations has been transferred to the NRCB. Under AOPA, development permits are no longer required.

Under AOPA, an "Approval" is required to build or expand the following sizes of poultry operations, based on one time counts:

- Poultry (broilers).....60,000 or more
- Poultry (breeder hens).....16,000 or more
- Poultry (layers).....30,000 or more
- Poultry (pullets).....60,000 or more
- Turkeys (toms).....30,000 or more

Producers building or expanding to a size below these numbers are required to obtain a "Registration." A Registration can be obtained from the NRCB through a review and approval process. In addition, producers seeking to build or modify a lagoon or manure storage on an existing operation are required to obtain an "Authorization" from the NRCB.

3.2.1.1 NRCB approval process

The NRCB approval process is illustrated in Figure 3.1.

The NRCB requires producers seeking an Approval to provide the NRCB with the following:

(a) Name, address and telephone number of the applicant.
(b) A list of the persons who live close to the proposed site and who may be affected by the operation.
(c) An evaluation of whether the application is consistent with the applicable municipal development plan.
(d) Engineering plans for manure storage facilities, manure collection area and contamination management.
(e) Hydro-geological assessments.
(f) Numbers and species of livestock and stage of animal development of the livestock that will be at the confined feeding operation.
(g) Legal description of the land on which the confined feeding operation is to be situated.
(h) A site plan, to scale, showing the location of all:
    (i) Water bodies.
    (ii) Water wells.
    (iii) Property lines.
    (iv) Residence locations of affected persons.
    (v) Barns, corrals and pens.
    (vi) Manure storage facilities and manure collection area.
    (vii) Run-on and runoff controls.
(i) An explanation of how the operation or expansion and its operation will meet the requirements of the regulations under the *Act*.
(j) Legal description of the land where manure is to be spread for the first three years of operation.

Once an application is deemed complete, notice of the application is advertised in the local paper or notices are sent to those in the area of the proposed site.

Anyone wishing to comment on the application has 20 days to file a written statement of concern. The NRCB reviews the concerns and, if there is merit, forwards the statement to the producer. The producer then has an opportunity to respond to the statement of concern.

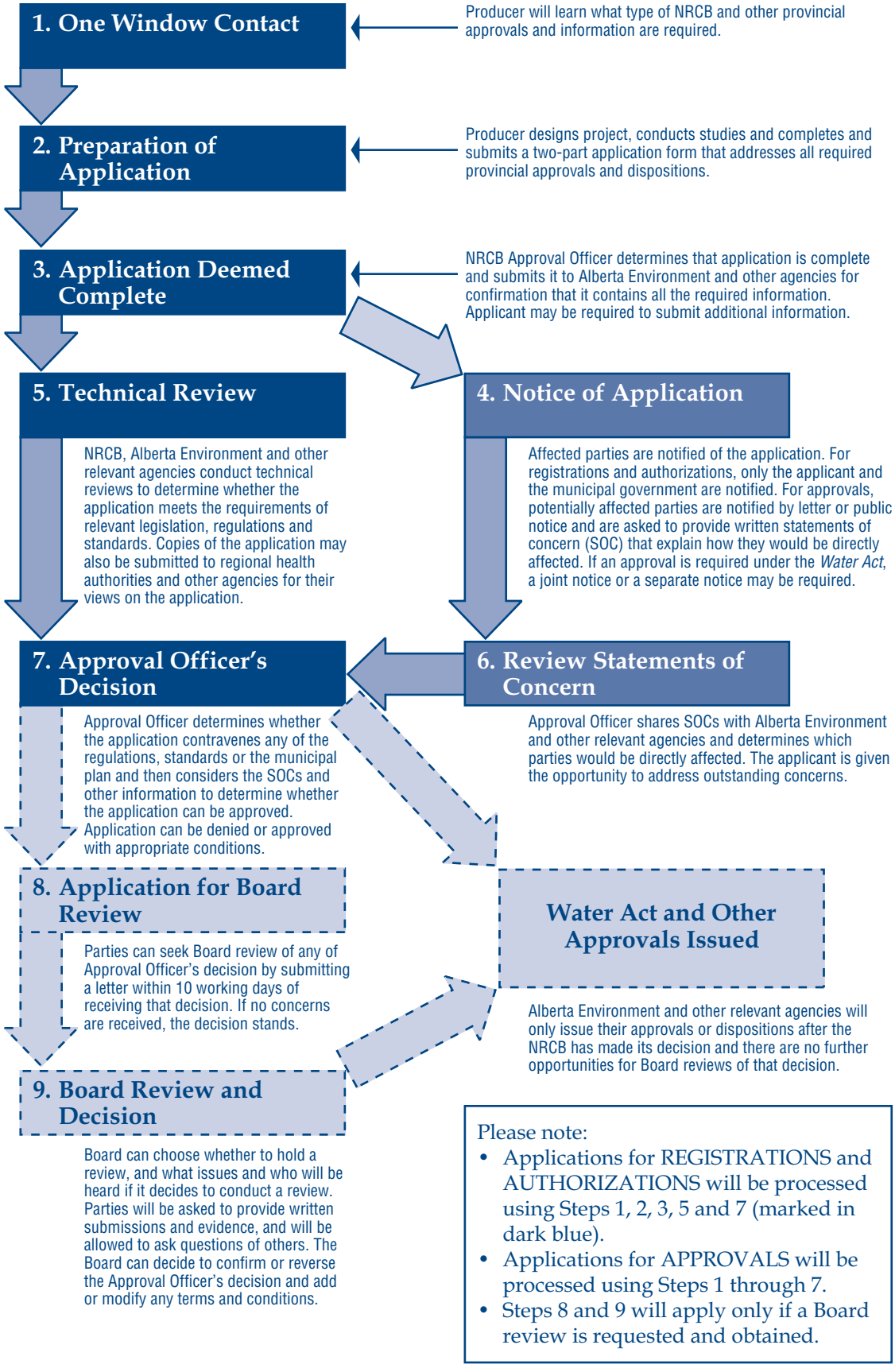
Once the NRCB is satisfied that the statement of concern has been addressed and the requirements of the *Act* and regulations met, the Board can issue an Approval for the project.

Persons who filed a statement of concern and are directly affected by the project are given notice of the Approval and provided an opportunity to request the Board review the Approval.

The NRCB will convene a review hearing at which the Approval will either be upheld or refused.

Figure 3.1

NRCB Approval Process



3.2.2 *Water Act* approvals

3.2.2.1 Process

New livestock operations may require either a water approval or a water licence under the *Water Act*. The *Water Act* became law in January 1999.

A water approval is required for the undertaking of an activity. Under the *Water Act*, an "activity" includes the construction, operation or maintenance of a structure that may:

- Alter the flow or level of water.
- Change the location or direction of flow of water.
- Cause the siltation of water.
- Cause the erosion of any bed or shore of a body of water.
- Cause an effect on the aquatic environment.

If the producer wants to divert and use more than 6,250 cubic metres of surface water or groundwater per year (273,000 gallons/year), a water licence is required.

Applications for an approval or licence are submitted to Alberta Environment, and should be accompanied by the plans for the project (including scaled drawings), legal land location, details regarding the affected water bodies, location of any structures to be built or affected, rate of diversion and the anticipated quantity of diversion. In addition, applicants should include reports related to the project, including a description of the project and hydrologic information regarding the project.

Once a producer has submitted the application for approval or licence to Alberta Environment, he or she is required to publish a notice of the application in one or more issues of the local newspaper in the area of the proposed operation. This notice will include, among other things, the location of the activity, the name of the applicant, a description of the activity or diversion and a statement to the effect that any individual directly affected by the application may submit a statement of concern to Alberta Environment within a specific period of time.

3.2.2.2 Environmental Appeal Board Appeals

If the producer's application for a water approval or licence is granted, Alberta Environment requires the producer to publish a notice of the approval or licence in one or more issues of the local newspaper in the area of the proposed approval or licence. The notice of the approval will indicate that the individual who submitted the statement of concern to Alberta Environment regarding the application can file a notice of objection to the Environmental Appeal Board, within a reasonable amount of time. In addition, if the producer's application for a water approval or licence is denied, the producer can file a notice of objection to the Environmental Appeal Board regarding the denial within a certain period of time.

If a notice of objection is filed with the Environmental Appeal Board, the Board will conduct a hearing. In ruling on an appeal, the Board may confirm, reverse or vary the decision of Alberta Environment. A decision of the Environmental Appeal Board can be appealed to the courts in very limited circumstances.

3.2.3 Transportation approvals

The *Highway Development Control Regulation* under the *Public Highways Development Act* prohibits the erection or placement of a development within 300 metres of a primary highway and 800 metres from the centre point of an intersection of a primary highway and another highway or public roadway. As a result, if a producer plans to construct an operation within these distances, the producer will be required to apply for and obtain a Roadside Development Approval from Alberta Infrastructure to construct a development near a primary highway. The Roadside Development Approval will set out the road access and setback conditions for the development.

If a producer is required to apply for a Roadside Development Approval, the producer should include the engineering drawings, the property description, the existing and proposed land-use and the closest distance of the proposed development to the highway property line.

Note: The information provided regarding the environmental obligations and the approval process for poultry production in Alberta is for information only and should not be relied upon as legal advice. The producer should consult a lawyer since the facts of the producer's situation may change the producer's legal rights or the law may change.

Additional information on these issues can be obtained from the NRCB, consultants and lawyers.

Copies of Acts and Regulations are available through the Alberta Queen's Printer (www.gov.ab.ca/qp) or contact at qp@gov.ab.ca or 780-427-4952 (toll-free in Alberta by first dialing 310-0000).

4.0 PREVENTING, MANAGING AND RESOLVING CONFLICT

4.0 PREVENTING, MANAGING AND RESOLVING CONFLICT

Take-home messages in this section:

- Conflict is a struggle between two or more parties because of a real or perceived difference in needs or values.
- Conflict in farming communities arises mostly from nuisance issues and concern over possibility of water contamination.
- Open, honest and thorough communication with neighbours can reduce the risk of conflict.
- Follow the operation's biosecurity plan during tours and incorporate the plan into the tour so that participants will learn more about generally accepted farming practices and poultry production.
- Conflict may be unavoidable, no matter how much effort is taken to avoid it. When conflict does erupt, manage it to minimize the damage.

4.1 What is Conflict?

Conflict is a struggle between two or more parties because of a real or perceived difference in needs or values. When people or groups of people are unable to reach a satisfactory understanding of the mutual issues, the result can be disagreement or conflict.

In today's world, conflict is inevitable and is present everywhere. Many perceive conflict as negative or bad and try to avoid it. However, when properly managed, conflict can provide a forum for productive and constructive debate.

Conflict:

- Encourages people to examine issues more carefully.
- Deepens the understanding of problems.
- Opens the door to new ideas and alternative solutions.
- Helps people foresee the consequences of proposed actions.
- Enables people to take risks and solve problems.

4.1.1 Conflict in agriculture

In recent years, the number and intensity of conflicts facing farmers has risen sharply. Debates encompass a variety of environmental, political, economic and social issues. Public concern for human health and the environment has increased, as has inquiry into the agri-food industry and its practices.

A 1998 survey of Canadian farm organizations and producers identified conflict over farm practices as one of the leading threats to the agriculture industry's future competitiveness. A study commissioned by the Canadian Farm Business Management Council (CFBMC) identified management of contentious issues as one of the industry's top five priorities. In early 1999, focus groups were held across Canada to learn about farmer experiences relating to farm and community conflicts and to gather ideas on dealing with conflict situations. The purpose of the study was to develop strategies and tools to manage conflict. Representatives from municipal, regional and provincial governments were consulted. The following sources of conflict were identified from this CFBMC study and the current situation in Alberta.

4.1.2 Sources of conflict

Farm neighbours have several concerns about livestock production. The biggest concern is that livestock production will disrupt their quality of life and affect their health, mainly due to nuisance odour. Producers can lessen anxiety by exercising caution, consideration and common sense. While manure odour may not be a concern to those living on the farm, others may find it offensive. A commitment to sound manure management is a necessity. Once that commitment is made, it must be kept. Another concern is the possibility of groundwater and surface water contamination. Nuisance related to storage and handling of dead animals also creates conflict.

4.2 Preventing Conflict

The following tips and strategies are based on the CFBMC focus groups and are designed to help producers prevent, manage and resolve conflict.

The single most important thing producers can do to reduce the risk of conflict is to ensure communication with neighbours is open, honest and thorough. This kind of communication is essential to lessen the impact of livestock operations on neighbours and to understand their concerns.

Focus group participants also suggested that compliance with laws governing farm management practices should be regarded as the bare minimum. Employing progressive farm management practices and doing the best job possible will help prevent conflicts.

A copy of the publication *Farming with Neighbours, A Guide for Canadian Farmers on Preventing and Resolving Community Conflicts over Farming Practices,* is available from the Canadian Farm Business Management Council phone: 1-888-232-3262, fax: 1-800-270-8301. E-mail: council@cfbmc.com.

Farm Animal Care Alert Line

Set up in 1995, the Animal Care Alert Line service combines a confidential response line and an on-site response team of producers to help producers ensure livestock are properly cared for. Over 100 experienced livestock producers and handlers assist with the Alert Line.

Producers in need of crisis support regarding livestock care are urged to call. Knowledgeable counsel on feeding or marketing livestock is available on a confidential basis. Anyone concerned about livestock care situations in their local area can call the 1-800 Animal Care Alert Line at 1-800-506-CARE (2273).

4.2.1 Being a good neighbour

Farmers need to communicate with all of their neighbours to build "social capital" that could be drawn upon like a bank account when problems arise. Being a good neighbour, having a public relations strategy for the farm and contributing to the community are good ways to build social equity within the community.

Knowing and understanding neighbours is the first step in addressing concerns about a livestock operation. Producers should:

- Get to know neighbours and let them get to know the operation.
- Be friendly.
- Keep neat, well-maintained farmyards, which are less likely to draw complaints.
- Help neighbours in need.
- Get involved in the community. Join a local service group.
- Support local businesses. Hire local youths.
- Develop a public relations program for the farm. Support and make donations to local charities and community groups such as sports teams and youth groups. Get the farm recognized for its contributions.
- Host farm tours, within the constraints of the operation's biosecurity protocol, but do a dry run to prevent unintended negative outcomes.
- Help neighbours learn more about the farm. Explain why farmers do what they do. Have an open house, picnic, barbecue or potluck.

4.2.2 Open house/farm tours

Several types of open house/farm tours can be organized:

A public open house prior to building:

- Is a common approach for spreading information in a community.
- Can be used early in the development phase of a new project to gather ideas and test initial reaction of neighbours and the local community.
- Allows the public to learn more about the project.
- Provides neighbours with an opportunity to express their concerns.
- Ideally is held in a neutral location.

A tour held on-site prior to start-up:

- Showcases features of the operation to the livestock industry and the community.

A tour of existing operations:

- Follow the operation's biosecurity plan during tours and incorporate the plan into the tour so participants will learn more about generally accepted farming practices and poultry production. Restricted areas should be discussed but not entered. This will provide an opening to discuss the operation's biosecurity plan and explain its importance in the production of safe, high-quality products.

Annual summer barbecue for neighbours:

- The reward for investing in annual community events is the goodwill generated and the opportunity for neighbours to ask questions in a relaxed atmosphere.

To conduct a successful tour or open house:

- Find out who plans to come, why and what they want to see.
- Decide in advance and tell guests whether photos will be allowed.
- Do a dry run. Walk around the farm, ideally with a non-farm friend to get input on the way guests will see it. Remember that "normal" farming practices may be of concern to non-farmers.
- Eliminate all hazards to public safety on the tour and ensure that the farm is clean and tidy, and livestock are healthy. Avoid waste disposal areas, sick animals and storage areas for medications and agri-chemicals. Avoid direct contact with the animals.
- Anticipate the questions guests are likely to ask, including challenging issues, such as food safety, genetically modified foods, chemicals and residues, air and water, as well as soil pollution and animal welfare. Have clear, factual, well-reasoned answers ready for these questions. For information on these and other topics, see the Alberta Agriculture Web site at www1.agric.gov.ab.ca or contact the Ag-Info Centre by calling 1-866-882-7677.
- Practise answering questions with family members or colleagues. Videotape the practice session, if possible. It is important to appear confident; otherwise people may think questions are being avoided or the truth is being concealed.
- If the answer to a question isn't known, say so. Offer to find an answer and follow up with the individual involved. Avoid making statements that may be regretted later.
- Plan the tour and develop a presentation for each different visiting group.
- Emphasize the positive. Draw attention to the modern practices farmers are using to address society's concerns, as well as the agri-food industry's contribution to the economy and community fabric.
- Tailor each presentation to the audience. Farming jargon should be avoided, regardless of whether the guests are school children, politicians, business people or other farmers.
- Talk about relevant topics and avoid getting sidetracked.
- If possible, borrow professional displays on topics of interest.
- Have technical experts available to answer questions and enhance confidence in the operation's technology.
- If appropriate, and in keeping with the biosecurity protocol, provide an activity that involves guest participation.
- Provide washroom and hand disinfection facilities.
- Smile and have fun! Guests should leave with a positive feeling about the tour.

4.2.3 Noise and traffic

Noise generated by operating equipment and traffic to and from the farm is inevitable. To minimize noise impacts, machinery should be properly maintained and noisy activities should be restricted to regular daytime hours, where possible. Adhere to road bans and speed limits to reduce the impact of traffic. Tarp or cover trucks to reduce spillage of manure or spreading of weed seeds from grain.

4.2.4 Further advice

- Have a good attitude. Be considerate and respectful to other people and their concerns or opinions.
- Know the rights of producers and others. Recognize the impact of insisting on acting on some rights.
- Be considerate. Let neighbours know in advance when manure spreading is planned. If neighbours have special events planned, try to work around them.
- Whenever possible, avoid farm practices that are noisy, dusty or cause odour on or immediately before weekends, especially long weekends.
- Before planning to expand, diversify or make changes to the operation, consider the impact on neighbours and the environment. Prepare an assessment of the local situation, detailing assumptions and understandings about who the neighbours are, what they care about, potential problems and plans for addressing any issues.
- Try to anticipate other people's reactions and try to provide answers to their concerns.
- Do not let minor disputes escalate.
- Handle disputes tactfully, away from public and media view.
- Learn how to deal with and develop a relationship with the media, municipal and provincial governments.
- Search out individuals and groups that can be allies. Identify, inform and involve people who support the operation and enlist their help in dealing with opponents.
- Concentrate on keeping supporters happy. Do not spend the majority of available resources dealing with opponents.

4.3 Managing Conflict

4.3.1 Damage control

Sometimes conflict is unavoidable, no matter how much effort has been made to resolve an issue. When conflict does erupt, manage it to minimize the damage. Canadian farmers offered the following tips to prevent a conflict from escalating (study by CFBMC):

- Take the matter seriously.
- Do not deny there's a problem and hope it will go away.
- Stay calm. Avoid getting angry or defensive. Refrain from blaming, accusing, chiding or belittling other people; it could escalate the conflict.
- Think before acting or speaking. "Sleep on it." Be diplomatic.
- Prevent small, specific conflicts from mushrooming into big, broad conflicts.
- Ask lots of questions. Find out what the other person is upset about. Do not debate the issues.
- Search for and identify the real issues. What people say may be quite different from what they are really concerned about. Often people's concerns are rooted in fear of change or the unknown, in a lack of understanding, or in a fear of losing control or the ability to influence decisions.
- Deal with emotions first. Then deal with the subject of the conflict.
- Listen to and validate concerns. Acknowledge understanding of the concerns and offer to look into the matter.
- Be prompt when getting back with the information needed to ease concerns.

- Stay on top of ongoing problems. Keep people informed of changes on the farm and progress being made.
- Do whatever is practical to fix problems and mitigate damage.
- Always tell the truth.
- Admit to mistakes. Take responsibility for employees' actions.
- Apologize. Make amends if possible.
- When others make mistakes, help them save face.
- Shift the emphasis to mutually acceptable solutions.

Consequences of failing to solve problems may include:

- Bad publicity.
- Loss of credibility.
- Fines and penalties.
- Litigation – lawsuits and appeals.
- Referendums, petitions.
- Endless meetings, more studies.
- Project delays, escalated costs.
- Loss of goodwill.
- More regulations for the whole industry.
- Increased probability of future conflicts.
- Increased difficulty to resolve future conflicts.

4.4 Resolving Conflict

The most common reason for discussion breakdown and disagreement is poor communication. Communication is a fundamental element of resolving issues and therefore must be understood and practised well.

Producers should listen and understand first, then explain their intentions. Listening also means understanding the meaning of the other person's message looking at it from their perspective.

In today's society, conflict prevention management and resolution skills are essential. Learning the skills necessary to prevent, manage and resolve conflict will boost farmers' personal and collective competitiveness and prosperity.

4.5 References

- Alberta Agriculture, Food and Rural Development, September 1999. *Building Community Support for Your Project.*
- Alberta Agriculture, Food and Rural Development, October 1998. *Livestock Producers as Good Neighbours.*
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- Streibel, Dr., David, 1992. *Resolving Municipal Disputes: When talking makes things worse, someone won't negotiate, there's no trust.* Association of Bay Area Governments, (Palo Alto, CA).

5.0 SITE SELECTION AND PLANNING

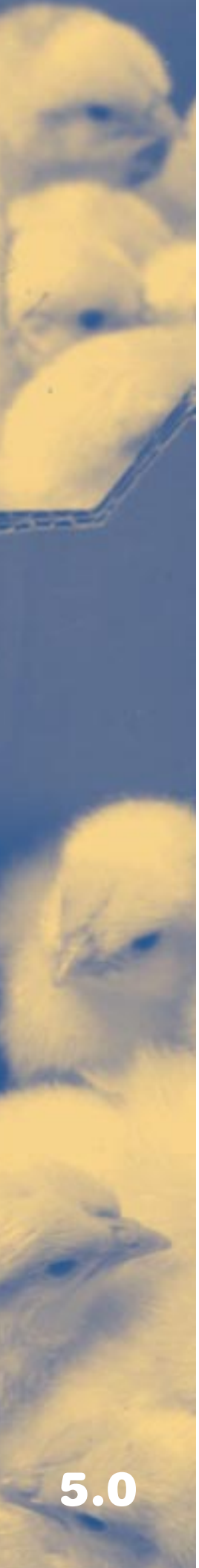
5.1 Site Selection

- **5.1.1** Site selection checklist
- **5.1.2** Assess local/community perception of poultry developments
- **5.1.3** Gather development application requirements
- **5.1.4** Conduct a site assessment
  - **5.1.4.1** Wind
  - **5.1.4.2** Air drainage
  - **5.1.4.3** Other livestock
  - **5.1.4.4** Environmental concerns
- **5.1.5** Evaluate resource base
  - **5.1.5.1** Water resource management
  - **5.1.5.2** Land base
  - **5.1.5.3** Rural service
- **5.1.6** Complete management plans as related to the specific site
- **5.1.7** Share intent with stakeholders
  - **5.1.7.1** Knowing your community is critical to building support
  - **5.1.7.2** Keep the community informed
  - **5.1.7.3** Gather meaningful feedback from the public
  - **5.1.7.4** Plan communication strategies

5.2 Site Planning

5.3 Shutting Down Livestock Operations

5.4 References



5.0 SITE SELECTION AND PLANNING

Take-home messages in this section:

- Selecting an appropriate site for a poultry barn will provide the opportunity to meet longer-term goals such as future expansion.
- When considering a new or expanded operation, contact a Natural Resources Conservation Board (NRCB) Approval Officer for information and/or advice.
- Ensure that the application is complete and includes all required information. This facilitates the review and approval of the application by the NRCB.

5.1 Site Selection

The selection of a site for a poultry barn is an important decision that has a strong influence on the economic and environmental sustainability of an operation. A good site will provide many of the elements required for an operation to be successful in both the short and long-term. Operators must balance the economic forces affecting their operation with consideration of issues such as environmental protection, animal welfare, food safety and other stakeholder concerns.

Selecting an appropriate site for a poultry barn will impact how the operation will meet long-term goals, including expansion. Expansion opportunities are largely determined by the site selected.

Site selection principles remain the same regardless of the size of operation. Finding an appropriate site for a large operation may, however, require additional investigation to ensure it can accommodate present and future needs. All operations require similar resources to operate effectively, while ensuring environmental sustainability and acceptable levels of impact on neighbours and neighbouring land uses. The size of the operation does not change these requirements, but it does influence the level of demand and the magnitude of potential impacts.

Expansion of an existing operation requires equal consideration of the operator's business plan resource requirements and environmental sustainability issues.

This section outlines the basic process for site selection for poultry operations. When considering a new or expanded operation, contact a Natural Resources Conservation Board (NRCB) Approval Officer for information and/or advice.

Refer to the NRCB Web site at www.nrcb.gov.ab.ca, or contact an NRCB office for more information.

5.1.1 Site selection checklist

The process of development involves a list of logical steps. This ensures that time and energy are spent efficiently and that development is successful.

When evaluating potential sites, it is important to include the interests of other stakeholders, such as neighbours (residents and landowners) and the local municipality.

Recommended steps between finalizing the business plan and actual construction:

- Assess local/community perception of poultry developments.
- Gather development application requirements from the NRCB.
- Evaluate ability of the site to meet development requirements, such as minimum distance separation (MDS), land base, soil and groundwater investigation.
- Evaluate resource base (water supply, land and rural services).
- Complete management plans as related to the specific site.
- Share intent with stakeholders.
- Complete and submit required applications.
- Build upon approval, or return to development process.

When a suitable site has been located, based on the above checklist, apply to the NRCB for the approval. To speed up the decision-making process, work with the NRCB Approval Officer to ensure all the necessary information is included. All of the required information must be included in the application before a decision can be made. Delays in providing this information will slow the process and a decision on the application.

5.1.2 Assess local/community perception of poultry developments

Assess the community and the surrounding neighbours' perceptions of the poultry industry and potential development. Determine how previous concerns about livestock developments in the area were handled. Identify community and local leaders who will have an impact on or be impacted by the development. This allows analysis of any potential risks of future opposition and will save a great deal of time and money. It is very important to address all concerns, both real and perceived.

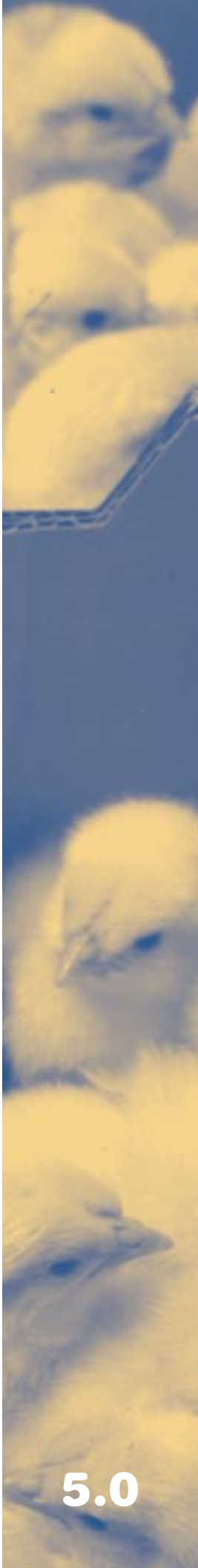
5.1.3 Gather development application requirements

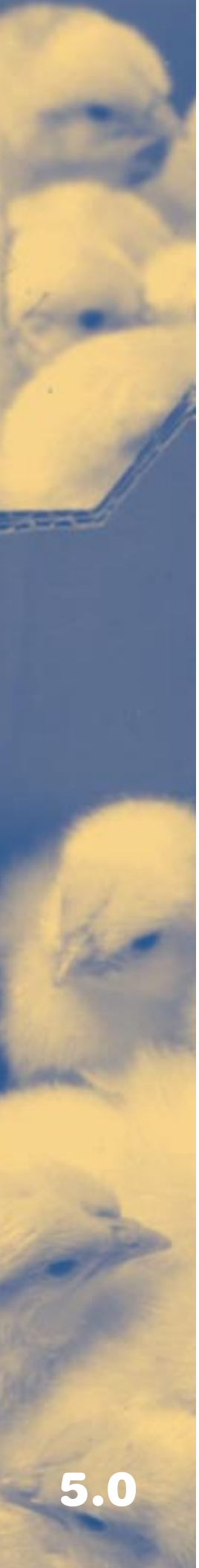
At this stage, it is important to contact an NRCB Approval Officer to determine application requirements. The Approval Officer will describe the approvals required under the *Agricultural Operation Practices Act* (AOPA), the *Water Act* and the *Public Lands Act.*

The application form should include all the necessary documentation for the poultry operation (e.g. an application for a *Water Act* licence from Alberta Environment). Once the application is prepared and submitted to the NRCB, the Approval Officer screens the application to ensure the necessary information is included. The Approval Officer forwards the completed application to other agencies for their approvals. For example, Alberta Environment is responsible for the allocation of water resources under the *Water Act.* As such, any water diversion also requires a permit from Alberta Environment.

The application is reviewed to ensure that it has all of the required information necessary for a decision on the application. Once this information is provided, the application is deemed complete. Depending on the size of the operation (Approval vs. Registration), the NRCB may be required to notify affected parties of the proposed operation. Municipalities are always notified of an application.

Neighbours, municipalities or any other parties that might be affected by the operation may submit statements of concern for review.





Attempts will be made to resolve issues raised by affected parties. Following this process, once all required input has been received (e.g. from the municipalities and Alberta Environment), a decision will be made by the Approval Officer. The Approval Officer has three options: approve the application, reject it or approve with conditions.

An Approval for the development must be issued before construction begins.

Regional Health Authorities, Alberta Environment, Sustainable Resource Development (Public Lands) and Alberta Transportation may receive referrals on development applications. These provincial government agencies have the responsibility to investigate and take necessary action if a livestock operation is or exhibits the potential to have an impact on public health, the environment or transportation infrastructure.

5.1.4 Conduct a site assessment

Assess the site's ability to meet the geographical, physical and regulatory requirements of a livestock development. A general assessment of the geographical requirements of the development should have been done in the business plan phase. Assess the site based on its ability to provide convenient access to the infrastructure and resource base required to manage the proposed operation.

Ensuring suitable climatic conditions is generally not a pressing issue, as most locations in Alberta have a climate suitable for successful poultry production. However, there may be local factors that influence site selection for the development such as wind, air drainage, other livestock operations and environmental concerns.

5.1.4.1 Wind

Prevailing wind is an important factor to consider, but the direction can vary between seasons. During summer, when odours are more intense and neighbours are outdoors more often, it is important to consider the direction of the prevailing winds. Also consider the effects of calm summer evenings, as odours will not disperse as readily under these conditions.

5.1.4.2 Air drainage

Under calm, summer conditions, the air near the ground can cool and drift down a slope. This is known as air drainage. This occurs frequently during summer evenings, often the time when most people like to be outdoors.

5.1.4.3 Other livestock

Consider the location of other livestock operations when selecting a site for a new operation. Allowing adequate separation distance from other livestock operations is an important step in preventing the spread of livestock disease and cumulative nuisance effects. Consult a veterinarian to determine adequate separation distances from other livestock to prevent transfer of disease.

5.1.4.4 Environmental concerns

AOPA is designed to help livestock producers minimize the environmental impact of livestock operations. The primary elements covered in the *Act, Standards and Administration Regulation* are designed to address the potential for contamination of surface and groundwater, soil and air. These elements are minimum distance separation (MDS), manure storage and nutrient management.

Minimum distance separation (MDS). The MDS is the setback or buffer established between an intensive livestock facility (source) and adjacent land users (receptors) to minimize odour nuisance. Minimum distance separations for various sizes of livestock operations are identified in the AOPA, *Standards and Administration Regulation.*

Manure storage. Appropriate containment and storage of manure specific to the proposed site must be addressed. The *Act, Standards and Administration Regulation* includes criteria for safe storage of liquid and solid manure, as well as average volumes necessary for sizing the storage.

Nutrient management. The *Standards and Administration Regulation* also includes requirements to manage manure nutrients to prevent negative environmental impacts. Nutrient management requirements, manure application limits, soil protection and records that must be kept by producers and users of manure are also outlined.

5.1.5 Evaluate resource base

Determine whether the site provides the required resource support for the proposed operation. This includes availability of water, feed or land base necessary to produce feed and proximity to purchased input requirements and labour. Land base requirements for manure spreading should also be considered.

5.1.5.1 Water resource management

Providing a safe, reliable supply of quality water for livestock is critical. Poor water supply can limit the size of an operation or affect animal production and performance. A water or hydrology specialist (Alberta Agriculture, Food and Rural Development [AAFRD], Alberta Environment, the Prairie Farm Rehabilitation Administration [PFRA] or a private consultant) can assist in determining the suitability of a water source for poultry production.

Water supplies and systems must be designed to meet peak demands. Water requirements can vary, depending on bird size, washing requirements, temperature, spray cooling systems, water quality, physiological state, activity level and the type of diet. Calculation of average daily and annual water requirements can be completed based on the number and size of birds using Figure 5.1.

Figure 5.1 Average Daily Water Requirements for Poultry

Poultry Type	lpd (litres per day)	gpd (gallons per day)
Broilers	0.159	0.035
Roasters/Pullets	0.182	0.040
Layers	0.250	0.055
Breeders	0.318	0.070
Turkeys – Growers	0.591	0.130
Turkeys – Heavies	0.727	0.160

* Water requirements will be influenced by the kind and size of bird, physiological state, activity level, the ration fed to birds, minerals in their drinking water, and environmental conditions, including temperature.

Source: *Farm Water Supply Requirements,* AAFRD Agdex 716 (C01), January 2000.

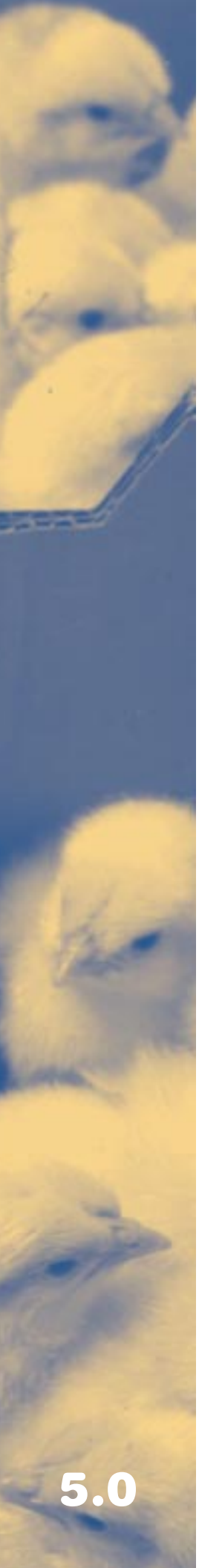


Figure 5.2 Drinking Water Quality Guidelines for Poultry

Element, Contaminant or Characteristic	Maximum Acceptable Level
Bacteria	
Total bacteria	500/100 mL
Coliform bacteria	10/100 mL
Fecal coliform bacteria	0/100 mL
Nitrate (NO_3)	25 mg/L
Nitrite (NO_2)	4 mg/L
pH	6.0 – 8.0
Alkalinity (measured as $CaCO_3$)	500 mg/L
Hardness	180 mg/L
Naturally Occurring Elements/Compounds	
Calcium (Ca)	600 mg/L
Chloride (Cl)	250 mg/L
Copper (Cu)	0.6 mg/L
Iron (Fe)	0.3 mg/L
Fluoride (F)	40 mg/L
Lead (Pb)	0.02 mg/L
Magnesium (Mg)	125 mg/L
Sodium (Na)	50 mg/L
Sulphate (SO_4)	250 mg/L
Zinc (Zn)	1.5 mg/L

Sources:

Carter, T.A. and R.E. Sneed. 1998. *Drinking Water for Poultry.* Poultry Science & Technology Guide #42. North Carolina Cooperative Extension Service. North Carolina State University. Raleigh, NC.

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Groundwater availability. Information on groundwater availability in an area can be obtained from the Groundwater Information Service of Alberta Environment (Phone (780) 427-2770). A water or hydrology specialist (AAFRD, Alberta Environment, PFRA or a private consultant) or local water well drilling contractor can also provide more information on groundwater availability. In some cases, test drilling may be required to determine availability of water and its quality. Shallow water wells may be more susceptible to contamination and fluctuation in quantity than deeper wells. The *Water Act* may require a licence prior to drilling a well. Contact the NRCB or Alberta Environment for additional information on water licence requirements.

Dugouts and surface water. Constructing a large reservoir or dugout for a farm operation requires investigation of the sub-soil conditions at the site and consideration of the drainage area. Test drilling or test pits provide valuable information that can be used to design the dugout and choose the appropriate construction equipment. Dugouts can be constructed in almost any texture of soil, but may require lining to prevent excessive seepage. Lining adds significantly to the cost, so a good clay-based site is preferable.

Dugouts that are filled only by spring runoff should be designed to hold at least a two-year water supply, unless an alternative source can be used to fill the dugout in a drought year. Dugouts in irrigated areas, or dugouts adjacent to rivers or lakes, must be at least large enough to supply water from the time the water is not available in the fall until water flows again in the spring. A one-year storage capacity is the recommended capacity for these dugouts. Planning and design information is available through PFRA or AAFRD.

Dugouts should not be located directly in a watercourse. If the dugout is located to the side of a watercourse, then the water can be diverted into the dugout, or past the dugout, depending on the water quality. Waterways that supply the dugout from a watercourse should be grassed to prevent erosion and provide sediment and nutrient trapping.

Steps to prevent contamination. Agricultural activities around a well or dugout may have negative impacts on water quality. To prevent well and dugout contamination:

Wells

- Ensure wells are properly constructed and sealed.
- Locate wells upslope, away from sources of contamination.
- Properly plug any old unused wells, as they can contaminate newer wells.
- Do not over-apply manure; nitrate seepage can contaminate groundwater.
- Construct manure storage structures so they will not seep into groundwater.
- Direct surface drainage from contaminated sources away from wells.
- Ensure well casings, cap and venting are in good repair.

Dugouts

- Construct dugouts in proper drainage areas away from potential sources of contamination.
- Apply manure and fertilizers to meet crop nutrient needs. Excess soil nutrient levels can lead to high nutrient levels in the runoff water, which causes increased algae and weed growth.
- Avoid spreading manure on snow-covered or frozen ground. Research in Manitoba has shown 10 to 60 times as much phosphorus exists in spring runoff from winter-spread fields, compared to control fields. Follow regulations in Section 8 if spreading manure on snow-covered or frozen ground.
- Maintain manure storages and sewage lagoons to prevent runoff or seepage.

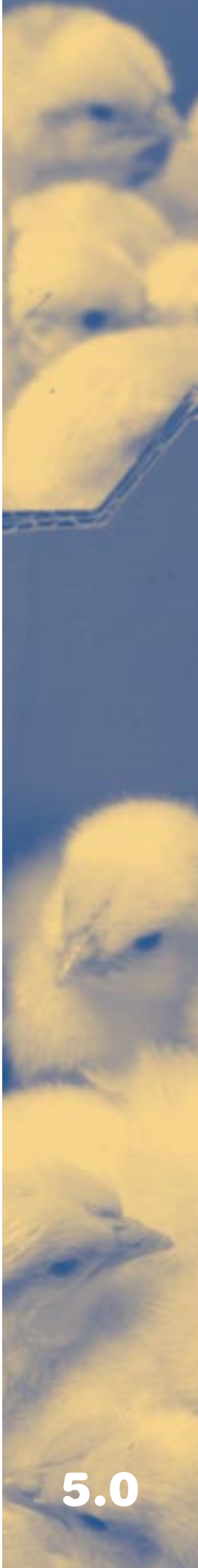
Contact an experienced hydrologist (AAFRD, Alberta Environment, PFRA or a private consultant) to develop a plan to protect the operation's water resource.

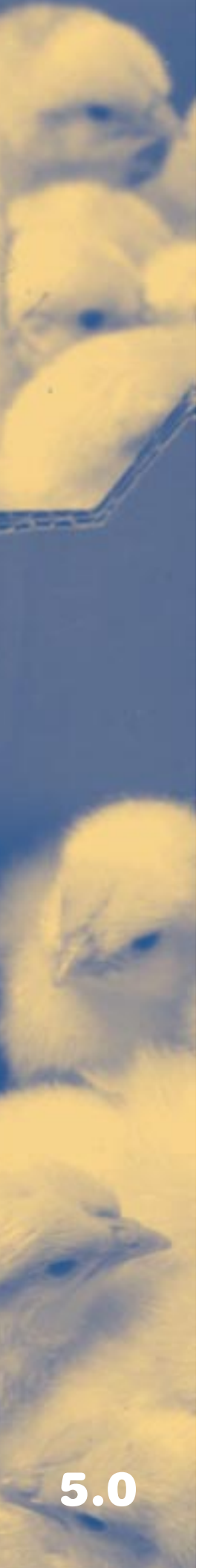
5.1.5.2 Land base

The land base required should be based on the agronomic use of manure. The land base should accommodate projected crop production and be economically viable for feed production and manure application. It may be necessary to have spreading agreements with neighbours or to explore alternate uses for the manure (see Section 8 and AOPA).

5.1.5.3 Rural service

Off-site inputs require reasonable accessibility to related agribusiness and staff. Good road access to the site is critical. The accessibility to utilities such as power and gas are also significant factors affecting site selection.





5.1.6 Complete management plans as related to the specific site

It is extremely important for poultry producers and stakeholders to develop clear, functional and appropriate management plans. This includes the overall operational plan as it relates to AOPA. A comprehensive nutrient management plan outlines in-barn management, transport to the storage site, storage period and land application. It should also include a management plan for disposing of waste, such as dead birds and pesticides (see Section 9).

It is important to be prepared, with a clear, informed message regarding management intentions as they relate to minimizing nuisance, specifically odour, and meeting the AOPA requirements for a livestock operation.

5.1.7 Share intent with stakeholders

A new project generally represents some form of change to a community. Typically, five to 10 percent of community members will support the project initially and five to 10 percent will oppose it. Opponents and supporters are unlikely to change their position. The remaining 80 percent, the silent majority, are either undecided, indifferent or skeptical about the project. Failure to bring the silent majority on side can lead to opposition and seriously jeopardize the project. Various communication strategies can be used to win the support of this group. Open public participation is one such strategy that has proven to be successful.

It is wise to begin by consulting with the community. This helps build trust, understanding and support for the project. If the project proceeds too far before the public is informed, there may be problems with rumours and misinformation. Under AOPA, directly affected parties will be notified by the NRCB and will have an opportunity to review the application and raise concerns. Members of the public also have an opportunity to review an application for an Approval, and may also submit statements of concern together with reasons why they should be considered to be directly affected parties.

Public participation is not the only way to gain community support, but it is a powerful approach for paving the way. The following points outline key considerations and communication strategies for public participation in a successful project.

Knowing the community is critical to building support. One of the first steps is to identify the individuals and organizations in the community who will be affected by the project. Seek answers to the following questions:

- How might they be affected?
- What information do these individuals want and need?
- Could the project be changed to better meet their needs?
- What is the history of the community?
- What areas had problems initiating new projects in the past?
- Who are the people with power and influence?
- What is the perspective of community stakeholders?

This information helps to develop a community social profile, which is vital to creating an effective communication strategy.

Keep the community informed. To build community support for the project, ensure the community is well informed and, if possible, part of the initial planning. Communication about the project must be open, honest and timely. There are a variety of approaches suitable for reaching different groups.

Communicating through school newsletters or parent advisory meetings are good ways to keep young families informed. Reach seniors in the community through the local senior's activity centre. Quick lunch hour gatherings in a central location might appeal to the working crowd. Some approaches may be more effective at different developmental stages of the project. Consider what information to share, who to share with and when. Do not always rely on print material or meetings to get the message across. Try to make creative use of a variety of public participation approaches to provide information and receive feedback.

Gather meaningful feedback from the public. Inviting the public to express its views and concerns about the project can help enhance community support, and may ultimately guarantee the project's success. As initiators of the project, be prepared to listen, respond and incorporate feedback given by community members.

If the community does not support the project, stand back and try to be objective. Perhaps not enough information has been provided, the timing is off or the location is wrong. Consult the community and provide feedback on how its input has contributed to the project. Do not solicit feedback if there is no intention of incorporating it into the project. There is no integrity in the public consultation process if decisions are already made. A community that provides input will likely attach some ownership to the project.

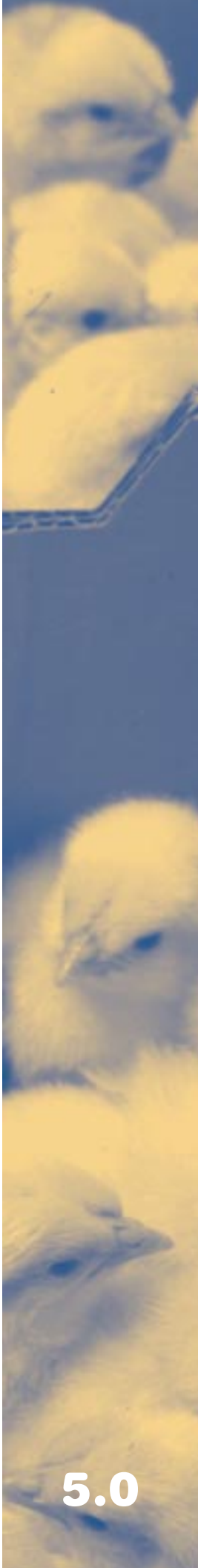
Plan communication strategies. The following strategies have proven to be effective in communicating with the public and building support for a community project. (See Section 4 for more information.)

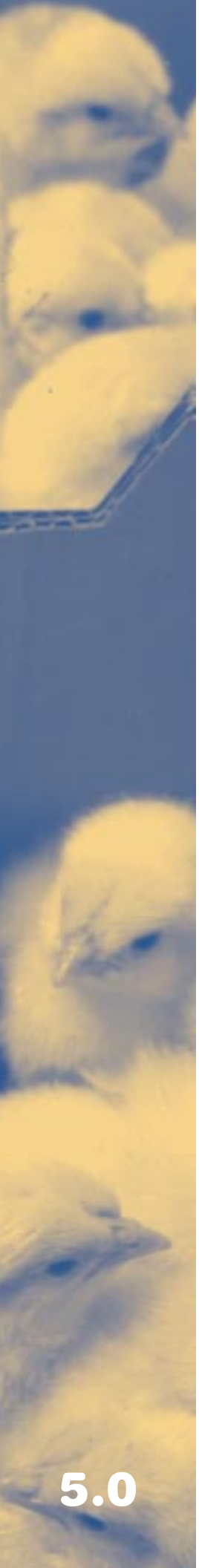
- Informal consultation.
- Use of media.
- Open houses.
- Fact sheet with tear-off response.
- Reference centres.
- Public forums.

5.2 Site Planning

Once a site has been chosen, a site plan is required. The location and orientation of structures can influence the potential for environmental impacts. Good site planning can also prevent conflict with neighbours. When designing a site plan, consider the following:

- Adhere to required permit criteria such as setback distances from roads and property lines or water diversion pathways.
- Locate buildings and storage facilities for fuel, fertilizer, manure, compost or pesticides at least 100 metres (328 feet) from wells and 30 metres (98.4 feet) from common bodies of water. If possible, choose a site of lower elevation than wells, to prevent runoff or seepage of harmful substances into the water supply.
- Locate buildings and facilities on an adequately drained site, avoiding low areas subject to flooding. Refer to AOPA, *Standards and Administration Regulation* for on-site planning requirements.
- Grade the area to divert contaminated runoff and prevent it from entering surface or groundwater.
- Grade or berm outside yards to collect contaminated runoff before it reaches surrounding waterways, and to reduce nuisance impacts on neighbours.
- Ensure that emergency vehicles can access facilities in case of fire or other emergency.
- Position high activity buildings and work areas away from neighbours to minimize sight and sound impacts.
- Use screens, such as shelterbelts, to provide wind protection and reduce the operation's visual and odour impact on adjacent property owners.
- Divert roof runoff and clean water away from the site.
- Design and build structures in accordance with the *Canadian Farm Building Code.*
- Invest in good storage and processing facilities for feed and feed ingredients. Adequate facilities and proper management can help avoid pollution and reduce losses due to spoilage, insect and rodent damage, and fire from spontaneous combustion.
- Design a complete storage and handling system before building new feed storage facilities. The design should accommodate present and future requirements.
- Locate the feed processing and handling centre in an area that allows large vehicle access and provides sufficient setback from neighbours. This ensures that they are protected from noise, dust, traffic and the threat of a fire.





5.3 Shutting Down Livestock Operations

If the development permit was obtained from the municipality before January 1, 2002, it may define the period of time a facility can be empty before another Approval is required for the operation. Keep a copy of the permit. Take steps to minimize any health or safety risk to humans and animals and to reduce any environmental impact.

General points:

- No matter how short the shutdown period, take steps to minimize the risk to people and animals entering manure storage areas and buildings. Post signs to advise of any potential dangers.
- Remove manure from buildings.
- During short-term shutdowns of one month or more, turn off water and unnecessary gas and electricity, control weeds and insects, and move manure from the barn to proper storage facilities.
- For longer-term shutdowns of six months or more, conditions of the permit and regulations may require a cleanup procedure within 12 months. Depending on Approval or Registration requirements, a new development Approval or Registration may be necessary before restocking the barn. Check with the local municipality and the NRCB.
- For a permanent shutdown, check with the NRCB, as well as the municipal office for decommissioning requirements. Some jurisdictions may also require a demolition permit for site cleanup.

5.4 References

Additional references are available from AAFRD.

- *Agricultural Operation Practices Act.* www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/acts5986?opendocument
- Alberta Agriculture, Food and Rural Development, 1999. *Livestock Expansion and Developers Guide.* Livestock Expansion and Development Team, Red Deer, Alberta.
- The American Society of Agricultural Engineers Standards ASAE S441 (SAE J115 Jan 87).
- Canadian Farm Building Code, Publication Sales, M-20, Institute for Research in Construction.
- *Dugout Aeration with Compressed Air* Agdex 716.B36.
- *Dugout Maintenance* Agdex 716.B31.
- *Dugouts for Farm Water Supplies* Agdex 716.B30.
- *Float Suspended Intake* Agdex 716.B34.
- *Hydrated Lime for Algae Control in Dugouts* Agdex 716.B37.
- *Seepage Control in Dugouts* Agdex 716.B32.
- *Water Analysis Interpretation* Agdex 400/716-2.
- *Water Wells that Last for Generations* Agdex 716 (A10).

6.0 HOUSING, EQUIPMENT AND MANURE SYSTEMS

6.0 HOUSING, EQUIPMENT AND MANURE SYSTEMS

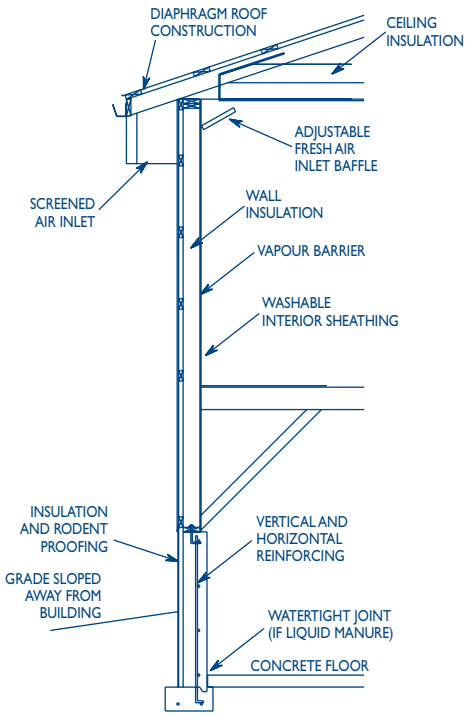
Take-home messages in this section:

- Design and construct buildings in accordance with the *Canadian Farm Building Code.*
- Ensure the ventilation system is operating correctly, and install shutters and fan hoods on exhaust ports.
- Provide safe access for feed delivery trucks.
- Keep manure as dry as possible. Check bird-watering devices to correct spillage or leakage problems. If operation requires dry manure, use pit drying fans.
- Store manure on impermeable surfaces, such as concrete or compacted clay, that are sealed to prevent seepage and the escape of contaminants into the environment.
- Construct a firm, impermeable surface at the end of the building as a manoeuvring area for tractors and manure spreaders during cleanout.
- Contain runoff from outdoor range areas in a suitable catchment or liquid manure holding tank, or filter it through an appropriate vegetative filter strip, if warranted by the stocking density.
- Adhere to setback distances from wells, watercourses and property lines when siting barns or outdoor ranges.

6.1 Building Construction

Although not currently a requirement in Alberta, buildings should be designed and constructed in accordance with the *Canadian Farm Building Code.* Information is available from Alberta Agriculture, Food and Rural Development (AAFRD) on building design and construction. Figure 6.1 shows a typical barn wall with environmentally sound construction. Check with the local municipality to determine if provincial or municipal codes apply or if other permits are required.

Figure 6.1 **Typical Barn Wall**



To aid in sanitation and waste handling, poultry buildings should:

- Have concrete foundation walls extending at least 0.3 metres (1 foot) above the grade line.
- Be kept in a proper state of repair.
- Where feasible, have eavestroughs to divert roof drainage away from the building.
- Have gravel splash pads at the base of the wall, for erosion control, where roof runoff falls.
- Have adequate perimeter drainage to direct roof and surface water away from the building.

6.2 Ventilation

Bird comfort affects productivity and feed conversion, which makes barn ventilation an important part of overall management. A good ventilation system will:

- Remove dust, harmful gases and odours from the buildings.
- Maintain an adequate supply of fresh air within the building.
- Control the temperature and humidity of the air inside the building, which improves bird comfort and keeps manure dry.

A variety of ventilation systems are available. Figure 6.1 illustrates one baffle location option. Many plans incorporate the commonly used cross-flow system, consisting of automatically adjusted air intake slots on one or both sides of the building and banks of exhaust fans on one side or in the end wall. In deep pit houses, exhaust fans may be located in the manure pit area. An ideal system provides maximum flexibility between the minimum and maximum ventilation rate. For proper ventilation, buildings must be adequately insulated according to local climatic conditions.

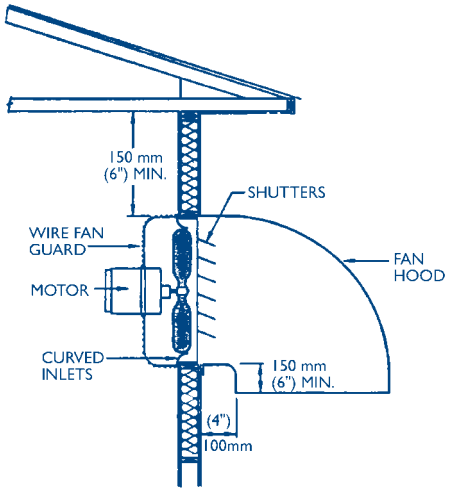
For bird comfort, provide continuous low-level winter ventilation. Thermostats can control the higher ventilation rates required in the summer.

A standby generator maintains ventilation during electrical power failures. In the absence of a generator, construction plans should include insulated panels that can be opened for emergency natural ventilation.

Keep fans, louvers and air inlet screens clean. This improves energy efficiency and keeps manure dry.

To avoid nuisance conditions, exhaust fans should direct discharge downwind from nearby residences and public places, where possible. In buildings where dust and odour levels can be high, installing hoods on exhaust ports that direct discharge down toward the ground will help reduce odours. In all cases, hoods or protective flaps on ventilation ports will help prevent entry of rain and snow and ensure predictable exhaust rates. During warmer months installing shutters over exhaust fans will prevent backdrafts. In the winter, insulated covers that form a good seal offer complete backdraft prevention on unused summer fans (Figure 6.2). For detailed ventilation information, refer to the *Canadian Farm Building Handbook, Canada Plan Service Poultry Series leaflets* or contact AAFRD engineers.

Figure 6.2 **Exhaust Fan**



6.3 Watering Facilities

The following information relates to environmental concerns surrounding watering facilities. For more information about water developments, see other AAFRD and PFRA publications listed in the reference section of Section 5.

The use of surface and groundwater in Alberta requires a water licence and an Approval is required for any work in or around a stream, both of which are available from Alberta Environment.

The odours from dry poultry manure are less offensive than those from moist manure. Furthermore, dry manure is less attractive to flies. For these reasons, make an effort to strictly control water spillage from drinking equipment by taking the following steps:

- Select waterers with individual cup designs or nipples, and equip them with suitable control valves to provide proper dispensing.
- Choose a nipple drinker that reduces water wastage (e.g. no side access).
- If water troughs are used, maintain water levels at a depth not more than 12 mm (0.5 inches) or a depth at which spillage will not occur.
- Avoid continuous flow water troughs as these are not recommended in new poultry buildings. Where these units are in use in existing facilities, equip them with adequate drainage to remove water from the building in its uncontaminated state. Consider replacing these waterers at the earliest possible convenience.
- Keep all watering devices properly maintained to minimize leakage.
- For range operations, locate waterers so that accumulated manure and spillage cannot contaminate water bodies (see Section 6.14 Runoff Control and Collection).

6.4 Feed Facilities

Good storage and processing facilities for feed and feed ingredients are a sound investment. Adequate facilities and proper management help prevent contamination and reduce losses from spoilage, insect and rodent damage, and fire caused by spontaneous combustion.

Before building new feed storage facilities, design a complete storage and handling system that incorporates present and future requirements. Choose a building site with good drainage, preferably elevated and easily accessible. Divert roof water and clean water away from the site.

Contain all feed ingredients for processing, as well as processed and stored feed. Uncontained feed can contaminate surface or groundwater. Collect and store all contaminated runoff.

To reduce odours, rodent activity and contaminated runoff, clean up feed spills as soon as possible. Locate the feed processing and handling centre in an area that allows large vehicle access. Sufficient setback from neighbours is also important because of noise levels, dust, traffic and the threat of fire.

6.5 Manure Handling Systems

In Alberta, most poultry producers use some form of confined housing and feeding facility, although in drier climates, turkeys may be raised for part of the year on an outdoor range. Housing facilities for various enterprises, such as turkey, egg or broiler production, differ greatly in size, appearance and arrangement. A properly located facility that is well-insulated, equipped with proper ventilation and efficient heating and lighting systems, along with an environmentally sound waste handling and storage system is important for all poultry operations, regardless of the layout.

Several waste handling systems currently in use will be discussed in the following sections. While a number of manure handling methods exist, producers are urged to adopt a system in which manure is kept as dry as possible. Handling dry manure not only minimizes fly and odour problems, but also helps in general sanitation and reduces the volume and weight of manure that must be handled. For this reason, using cage houses with manure belt drying systems or using litter or heated floors in solid floor houses is recommended for new poultry operations.

Housing systems commonly involved in each of the various poultry production operations, along with their respective recommended animal densities are given in Figure 6.3.

Figure 6.3 Poultry Housing System Requirements and Recommendations

Poultry Type	Housing System	Recommended Density m^2/bird ($ft.^2$/bird)	Recommended Density kg/m^2 (lb./$ft.^2$)	Time in Housing System (weeks)	Live Weight Range at End of Housing Period (kg)	Cycles per Year
Pullets	Cage Floor	0.03 (0.36) 0.14 (1.51)	44 (8.1) 9.4 (1.9)	18 – 19	1.28 – 1.35	2.5
Layers	Cage Floor Range	0.04 (0.47) 0.2 (1.83) 10 (111)	20 (4.0) 10 (2.0) 0.17 (0.03)	51 – 54	1.7 – 2.0	1.0
Broiler Breeder Pullets	Floor	0.15 (1.6)	15.4 (3.1)	16 – 18	1.8 – 2.5	2.5
Broiler Breeder Layers	Cage Litter Slat/wire	0.06 (0.67) 0.19 (2.0) 0.17 (1.8)	60 (13.4) 21 (4.5) 23.5 (5.0)	40 – 52	3.1 – 5.0	1.2
Broiler Chickens	Floor	0.06 (0.71)	31 (6.2)	5 – 6	1.7 – 2.2	6.5
Roaster Chickens	Floor	0.12 (1.3)	25 (5.2)	7 – 8	2.3 – 3.8	5.2
Turkey Broilers	Floor Range	0.19 (2.0) 10	32.6 (6.9)	10 – 11	4.5 – 6.2	4.0
Turkeys – Large Hens	Floor Range	0.19 – 0.28 (2.0 – 3.0) 15	32.6 – 35.0 (6.9 – 7.2)	13 – 15	6.2 – 9.8	2.5
Turkeys – Large Toms	Floor Range	0.37 (4.0) 20	35.8 (7.3)	16 – 18	9.8 – 13.5	2.5

6.6 Cage Housing, Deep Pit System

Deep pit systems offer several operational advantages over other systems. For example, they don't require a separate manure storage facility. In a properly functioning deep pit system, manure drops into a 1.5 to 3.0-metre (5 to 10-foot) deep pit under the cages where the droppings undergo a natural composting drying process. That process results in a biological degradation of the wastes and a reduction of the manure weight and volume. If properly operated, a deep pit may not need to be cleaned out for one to three years, depending on the depth of the pit. This is an easy system to manage and requires only a front-end loader and a conventional manure spreader for cleaning.

The success or failure of a deep pit system depends upon the extent to which excess water is excluded from the pit. If the manure is wet, the composting process will not occur, resulting in odour, fly problems and the need for frequent cleanouts. Odour and flies are not a problem in the deep pit system, as long as the manure in the pit is kept dry. Dry systems should result in manure with less than 25 percent water. The deep pit system is effective in controlling flies, partly because the manure storage area is completely closed and dark, manure is kept dry, and partly because of the natural predators that thrive in the manure compost. If natural predators are not present, they can be added to the manure. After cleanout, some manure may be left to ensure repopulation of fly predators.

The following guidelines are extremely important when designing and managing a deep pit system:

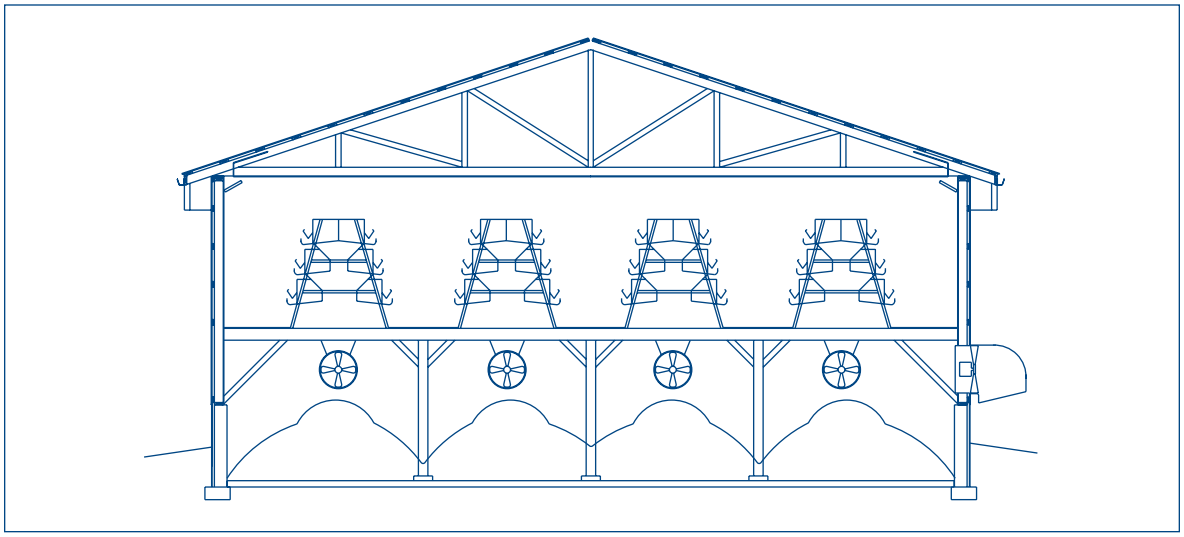
- Construct the deep pit of concrete and seal it to prevent seepage of groundwater into the pit and the escape of contaminants into the environment. In cases where the water table is very high, construct the deep pit cage house completely above-ground. This simplifies cleanout.
- Use nipple drinkers designed to reduce water wastage. These drinkers, as well as the water distribution system, should be inspected daily for leaks and malfunctions. Reducing water spillage keeps manure dry and reduces odour.
- Water quality is extremely important. Water must be low in salts to prevent loose droppings. Water must be low in sulphates and other solids (sand, clay, organics) to minimize scale and plugging of water lines and drinkers.
- Locate the exhaust fans in deep pit cage houses so that air is drawn across the droppings in the pit. This provides continuous drying of the manure and reduces odour.
- In high-density cage houses, manure in the pit may need to be further dried. Place auxiliary circulation fans over the manure in several locations along the pit.
- Cover the deep pit area with sawdust or shavings after cleanout prior to housing a new flock. If the old manure is very dry at cleanout, this dry material may be spread over the floor in place of sawdust. Sawdust absorbs moisture from the manure, which makes the manure easier to handle.
- Construct a concrete slab at the end of the building as a manoeuvring area for tractors and manure spreaders during cleanout.

A deep pit system can be a reasonable housing and manure storage system if it meets these criteria. If it doesn't meet these requirements, however, it can be a poor system, especially from a pollution, odour and fly standpoint.

An example of a deep pit cage house is shown in Figure 6.4.

See Section 7 for information on manure storage methods when manure must be stored after removal from the deep pit barn.

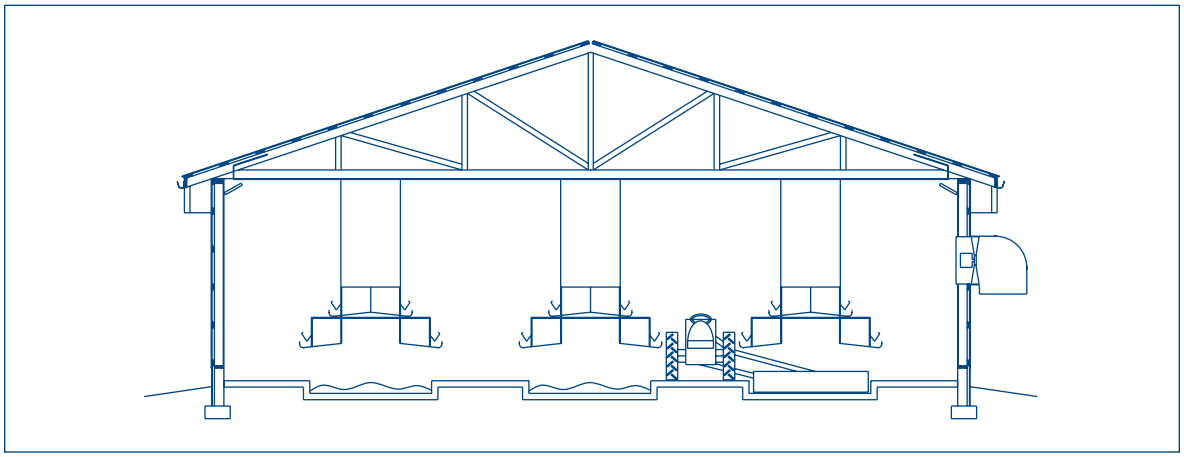
Figure 6.4 **Deep Pit Layer Barn**



6.7 Cage Housing, Shallow Pit System

In the shallow pit system, a concrete pit 15 to 20 cm (6 to 8 inches) deep is used to collect the droppings from overhead cages (Figure 6.5). The manure accumulates for a short time (preferably not more than one week) and is then scraped into a holding facility by using a dragline scraper or a small tractor-mounted scraper.

Figure 6.5 **Shallow Pit Layer Barn**



In cases where it is not practical to clean on a weekly basis, the droppings may be allowed to "cone up" under the cages. In this case, additional air circulation at floor level is necessary to dry the manure and reduce odour.

To help control odour and flies when manure is stored for more than one week, periodically top-dress droppings with sawdust or shavings. Also, spread a shallow layer of sawdust or shavings over the bottom of the pit between cleanings to facilitate manure removal.

Stockpile manure scraped from the shallow pit cage house in a suitable manure storage structure for disposal at a later time. See Section 7 for more poultry manure storage details.

As with deep pit systems, the pit should be constructed of concrete and suitably sealed to prevent seepage of groundwater into the pit and to prevent the escape of contaminants into the environment. Construct a concrete slab at the end of the building as a manoeuvring area for tractors and spreaders during cleanout.

6.8 Cage Housing, Liquid System

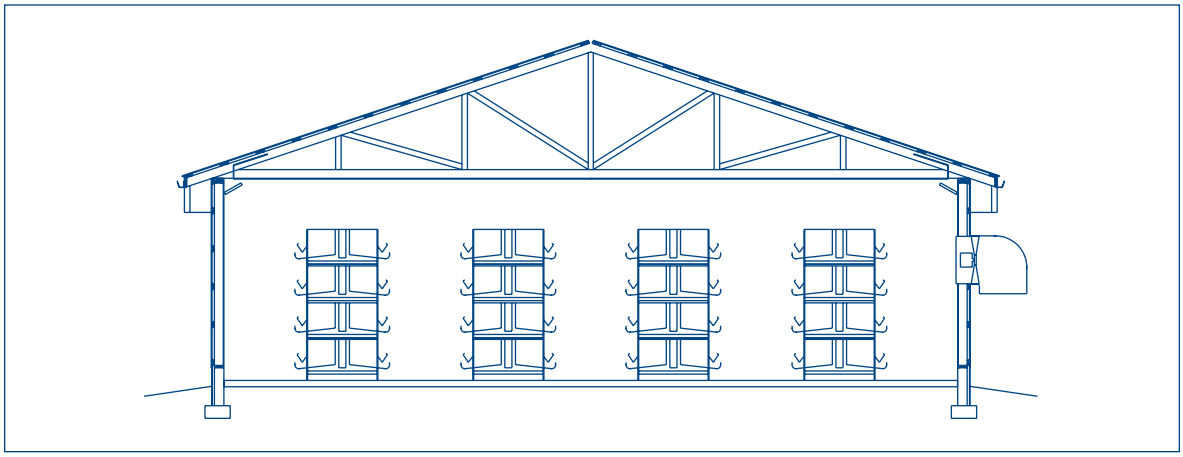
Shallow pit systems as described in Section 6.7 can be adapted for liquid manure handling. In this system, manure is frequently flushed into a suitable liquid manure holding tank outside the poultry building. The holding tank should have the capacity to store at least nine months of manure production and the flushing liquids required for cleaning.

Handling liquid poultry manure is generally not recommended for several reasons: probable odour and fly problems, greater potential for pollution from storage facilities, larger volumes of waste for ultimate disposal, increased nutrient losses to the atmosphere and increased labour costs.

6.9 Cage Housing, Manure Belt System

Many newer cage systems consist of three to eight tiers of stacked cages with plastic manure belts under each tier (Figure 6.6). Manure is collected on the belts for 12 to 48 hours, then is dumped off the belts onto a cross conveyor that transfers it to an outside covered storage facility (see Section 7.1, Figure 7.1). Proper management of the ventilation and heating system can significantly reduce the moisture content of the manure before it is removed from the barn. Some cage systems have specially designed circulating duct or paddle-fan systems to improve the drying of the manure on the belts.

Figure 6.6 **Manure Belt Layer Barn**



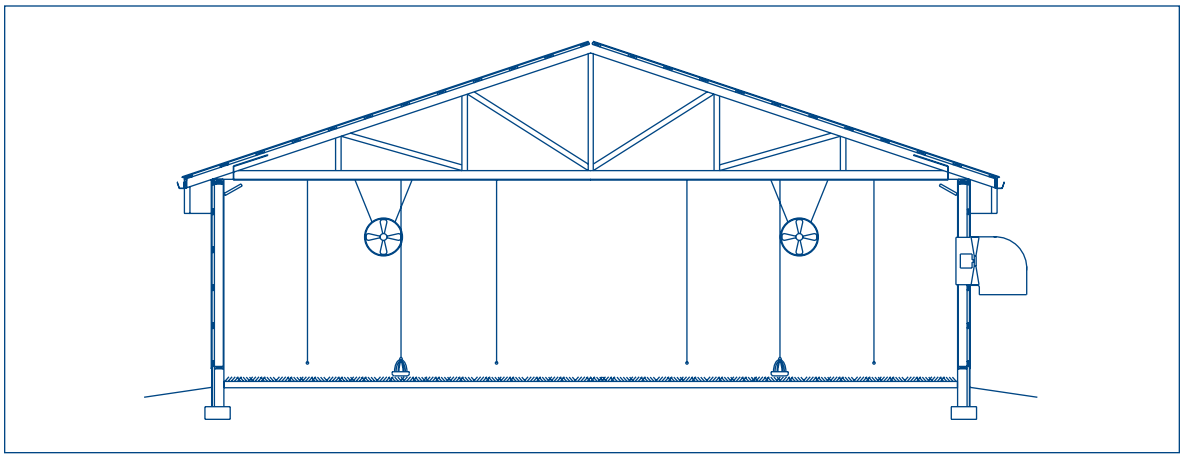
6.10 Floor Housing, Litter System

Broilers, turkeys, breeder pullets and some layer pullets can be raised on litter (Figure 6.7).

In litter type houses, consider the following guidelines:

- Use any clean, absorbent material such as wood shavings, shredded paper products, sawdust and straw for litter. Litter material should be dry and should not produce excessive amounts of dust.
- Cover the floor with fresh litter material before restocking the barn with a new flock of birds.
- Use a depth of litter on concrete floors of four to eight centimetres (1.5 to 3 inches).
- Store litter removed from the building in a suitable containment area or structure. For more detail, see Section 7 on Manure Storage.
- Use concrete to construct the floor and a minimum of 30 centimetres (12 inches) of sidewall. Seal it to prevent seepage of groundwater onto the floor and to prevent the escape of contaminants into the environment.
- In existing earthen floor turkey barns, use a greater amount of litter to ensure all liquids are absorbed. Recommended depth of litter is 6 to 7.5 centimetres (2.4 to 3 inches). If the bottom of the litter is moist, it is possible that leachate is escaping. If this is the case, install an impermeable floor (concrete or compacted clay).
- Construct a firm, impermeable surface at the end of the building as a manoeuvring area for tractors and manure spreaders during cleanout.

Figure 6.7 **Litter Manure System**



6.11 Floor Housing, Heated Floor System

Because of the difficulty and expense involved in acquiring good quality litter in some areas of the province, hot water floor heating can be used as an alternative in poultry growing houses. In this system, hot water (approximately 37 to 50°C) is circulated through plastic pipes embedded in the concrete floor. By controlling the rate of circulation, incoming water temperature and pipe spacing, floor temperature can be maintained between 18 and 35°C, depending on the age of the birds.

Applying heat to the floor dries the manure, thereby reducing odour and simplifying manure handling. This also reduces manure volume and makes it suitable for use as a fertilizer and soil amendment. Some wet spots may develop occasionally as the birds mature and less heat is applied. When this happens, continue to heat the floor for several days after removing the birds to dry the manure.

The heated floor system has some disadvantages, such as greater likelihood of chicks becoming dehydrated during brooding and increased dust due to the drier litter.

Remove manure prior to restocking the barn. Generally, about four centimetres (1.5 inches) of material will accumulate for each cycle of birds. Because this manure is slightly drier than manure produced in other housing systems, there are fewer odour problems during storage. See Section 7 on manure storage, to determine the amount of storage space required.

Similarly to litter type houses, use concrete to construct the floor and a minimum of 30 centimetres (12 inches) of sidewall and completely seal it to prevent seepage of groundwater onto the floor and to prevent the escape of contaminants into the environment. Construct a concrete pad of sufficient size at the end of the building to accommodate manoeuvring tractors and manure spreaders used for cleanout.

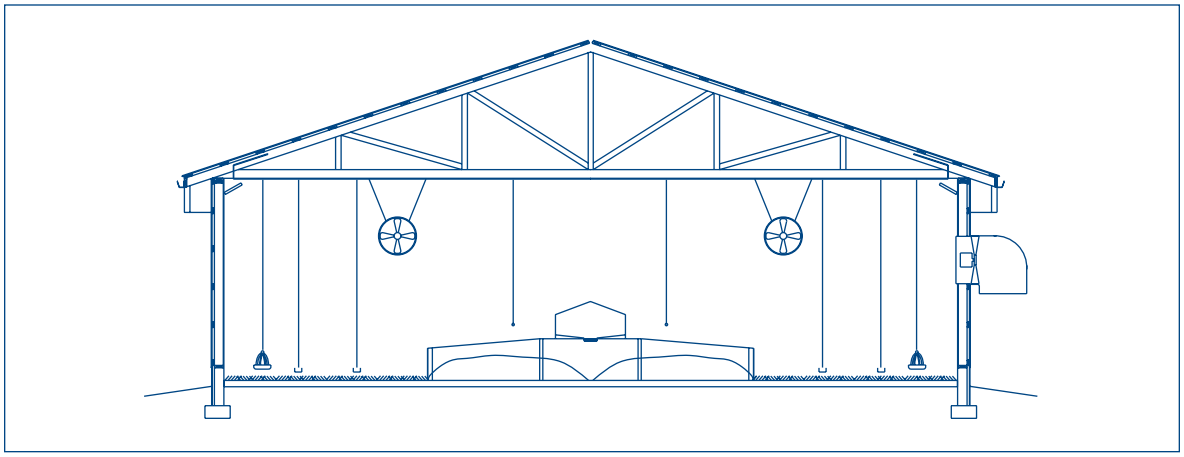
6.12 Floor Housing, Partially Slatted Floor System

Breeders and barn-egg layers are typically housed on partially slatted/partially littered floors (Figure 6.8). Partially slatted floors offer some advantages over conventional solid floor litter systems. By using waterers and roosts, and in some cases, feeding over the slatted portion of the floor, most of the manure is collected in a pit beneath the slats. The litter on the solid portion of the floor remains clean and does not need to be replaced as often as in the solid floor litter system. The slatted floor storage can provide sufficient capacity for up to 12 months of manure production.

This system could be used for barn-egg layers (as an alternative to cage layers), but would likely result in a higher percentage of "contaminated" floor eggs. This system may also result in increased odour and fly problems depending on the moisture content of the litter under the slats.

However, partially slatted floor systems are commonly used for breeders and pullets and are currently considered acceptable alternatives for these types of operations. In cases where the water table is very high, the partially slatted floor system should be constructed completely above-ground. This design also simplifies cleanout. As with other systems, construct the pit of concrete and completely seal it to prevent seepage of groundwater into the pit and to prevent the escape of contaminants into the environment.

Figure 6.8 **Partially Slatted Floor System**



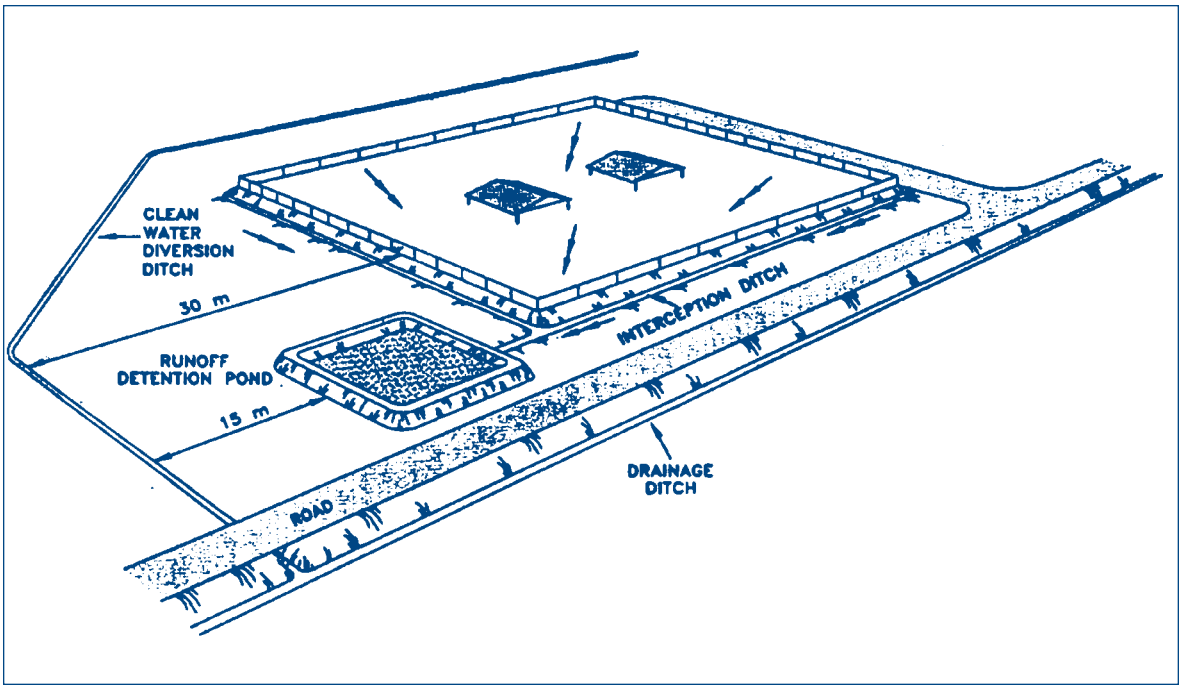
6.13 Poultry Ranges

Open ranges, with their greater potential for runoff, require more intensive manure management than conventional poultry operations. Depending on bird numbers, poultry range facilities may be considered a confined feeding operation under the *Agricultural Operation Practices Act* (AOPA). Check with the Natural Resources Conservation Board (NRCB) to determine whether an Approval or Registration is required.

When ranges are used:

- Allow at least one hectare of rangeland for every 500 turkeys or 1,000 to 1,200 replacement pullets and young birds more than eight weeks old, (200 turkeys/acre or 400 to 500 replacement pullets and young birds/acre).
- Move feeders, waterers and shelters often to maintain flock health and to prevent wet spots, which can result in odour problems.
- Remove wet manure from the range area when necessary to prevent the development of objectionable odours. Spread this manure on cropland as outlined in Section 8, Land Application of Manure or store as outlined in Section 7, Manure Storage.
- Cover concentrated areas with sawdust where dust is a problem.
- Divert clean water from roofs and the surrounding area away from the open yard to prevent it reaching contaminated water on the range.
- Locate the range so that all runoff is collected and stored in an environmentally acceptable facility (for more detail, see Section 7, Manure Storage). Contain runoff from the yard area in a suitable catchment or liquid manure holding tank, or filter it through an adequate vegetative filter strip (see Section 6.14, Runoff Control and Collection).
- Locate the poultry range and manure storage structures at least 30 metres (100 feet) from an open body of water and 100 metres (328 feet) from springs or wells.

Figure 6.9 **Runoff Control Facility**



6.14 Runoff Control and Collection

Animal densities and manure storage duration dictate that poultry ranges and manure storage areas require runoff control and collection. Figure 6.9 shows a typical poultry range with a runoff control facility.

Perimeter ditches. Reducing the volume of off-site runoff entering the site reduces manure storage size and costs. Whenever possible, direct all off-site runoff away from the confined poultry range or manure storage area. Perimeter diversion ditches are commonly used to direct runoff.

Runoff collection. Direct runoff from each yard to a collection basin or the manure pit. This prevents contamination of surface or groundwater. If bodies of water are more than 100 metres away, vegetative buffers may be adequate for controlling runoff.

Collection basin sizing. The size of collection basins to store runoff from manure storage areas and poultry range areas depends on the size of the runoff area and the amount of precipitation that occurs during storage.

Collecting runoff from manure storage areas or poultry ranges will prevent nutrients from gaining access to areas where they might adversely impact the environment. An estimate for the expected amount of runoff can be calculated for design purposes.

Assuming that catch basins will be emptied as required, they can be sized based on a 1:30 year precipitation event. It is estimated that about 50 percent of rainfall runs off and about 30 percent of the snowfall runs off. Therefore, the estimated catch basin volume would be:

- $V=P_r$ (or P_s) x R_c x A
- Where V = volume of catch basin (m^3)
- P_r = 1 in 30 year rainfall event (mm)
- P_s = 1 in 3 year accumulated snowfall (mm)
- R_c = runoff coefficient (0.5 for rainfall, 0.3 for snow melt)
- A = runoff area (range or manure stockpile)

One in thirty (1:30) year rainfall and accumulated snowfall events for numerous locations in Alberta are given in Figure 6.10.

EXAMPLE 6.1: Determining Runoff Volume from Poultry Range Areas (Summer Only)

Question: What volume of runoff could result from a 1,000 m^2 (10,765 $ft.^2$) dirt yard poultry range on a farm in Wetaskiwin?

1. The 1:30 one day rainfall for Wetaskiwin is 90 to 95 mm (Figure 6.10)
2. To convert precipitation in mm to m, divide by 1,000, i.e. $\frac{93 \text{ mm}}{1{,}000 \text{ mm/m}} = 0.093 \text{ m}$
3. Rainfall runoff volume: $V = P_r \times R_c \times A = 0.093 \times 0.5 \times 1{,}000 \text{ m}^2 = 46.5 \text{ m}^3$ (for example, 0.3 m x 12m x 12.5 m)
4. Converting to imperial units $46.5 \text{ m}^3 \times 35.3 \text{ ft.}^3/\text{m}^3 = 1{,}642 \text{ ft.}$ (for example, 1 foot x 40 feet x 41 feet)

Answer: This poultry farm will require a runoff storage facility large enough to accommodate 46 m^3 (1,642 $ft.^3$) of contaminated runoff expected from the outside range area.

Figure 6.10 **One in Thirty Year (1:30) Precipitation Events**

City or Town	P_r One Day	P_s Accumulated	City or Town	P_r One Day	P_s Accumulated
Airdrie	95	122	Lethbridge	90	122
Athabasca	80	185	Medicine Hat	85	112
Barrhead	80	173	Peace River	60	214
Bonnyville	75	184	Pincher Creek	100	153
Brooks	80	122	Provost	80	184
Drayton Valley	85	194	Red Deer	90	194
Edmonton	90	173	Rocky Mtn. House	75	184
Edson	75	204	Sedgewick	95	184
Fairview	80	255	Smoky Lake	75	84
Foremost	70	163	Strathmore	80	133
Fort Vermilion	60	204	Three Hills	80	173
Grande Prairie	80	214	Vegreville	80	184
Hanna	90	184	Vermilion	80	173
High Prairie	75	224	Wetaskiwin	80	194
High River	95	133			

Source: AOPA, *Standards and Administration Regulation,* Schedule 2, Table 2.

EXAMPLE 6.2: Determining Runoff Volume from Manure Stockpiles (Winter)

Question: What volume of runoff could result from a 50,000-bird broiler operation in the Edmonton area?

1. Assume three cycles where manure has to be stockpiled. In Section 7, Figure 7.2 "Average Weekly Manure Production Rates Per Bird" shows broilers produce 0.58 litres per week or 3.48 litres per production cycle; therefore, 50,000 broilers will produce approximately 174,000 litres of manure per cycle (or 174 cubic metres) or up to 522 m^3 per winter. If the stockpile(s) are three metres wide and 1.5 metres high there would be approximately 2.75 cubic metres of manure for every one metre length of the stockpile(s). The stockpile(s) might be approximately 190 metres long. The runoff area then is 3 m wide x 190 m long = 570 m^2.
2. The 1:30 accumulated snowfall for Edmonton is about 170 mm (Figure 6.10).
3. To convert precipitation in mm to m, divide by 1,000, i.e. $\frac{170 \text{ mm}}{1{,}000 \text{ mm/m}} = 0.17 \text{ m}$
4. Snowfall runoff volume: $V = P_s \times R_c \times A = 0.17 \times 0.3 \times 570 = 29.1 \text{ m}^3$
   (for example: need a catch basin 0.5 m x 7 m x 8.3 m)
5. Converting to imperial units: $29.1 \text{ m}^3 \times 35.3 \text{ ft.}^3/\text{m}^3 = 1{,}027 \text{ ft.}^3$
   (for example: 1.5 ft. x 23 ft. x 30 ft.)

Answer: Assuming that the pile is 190 metres long, the total expected volume of runoff from this operation would be 29.1 m^3 or 1,027 $ft.^3$.

6.15 Nutrition

Poultry diets are usually formulated for high performance. It is a common practice to include safety margins when formulating diets by exceeding the animal's requirements. However, in order to reduce the cost and environmental impact of feeding birds, it is important to supply nutrients at levels not greatly in excess of the birds' requirements.

6.15.1 Nitrogen

One strategy for reducing the environmental impact of poultry production is to reduce the amount of nitrogen excreted. Nutrients have historically been fed in excess of bird requirements with little or no emphasis on environmental concerns, perhaps because no cost was assigned to the disposal of the resulting manure. In the future, emphasis will likely shift towards tailoring dietary nutrient concentrations more closely to bird requirements, with more attention being paid to environmental concerns and the cost associated with the disposal of excreted nutrients. Researchers have successfully fed reduced levels of dietary protein to laying hens with no reduction in egg production or quality. But, it did result in a marked decrease in fecal nitrogen content, as well as absolute nitrogen excretion per bird, which was attributed to the reduced dietary protein level.

6.15.2 Phosphorus

Much of the total phosphorus in the bird's diet is in the form of phytate phosphorus, which is digested and absorbed to a very limited extent. After protein and energy, phosphorus supplements, such as dicalcium phosphate, are the most costly feed ingredients added to poultry diets. Because of its vital role in bone formation and energy metabolism, liberal quantities of phosphorus are typically added to the bird's diet in order to prevent deficiencies. Much of the phosphorus excreted by the bird is undigested dietary phosphorus.

6.15.2.1 Reducing dietary P

In recent years, the poultry industry has reduced phosphorus excretion by lowering the level of available phosphorus (non-phytate phosphorus) in many diets from 0.45 to 0.50 percent to approximately 0.40 percent. Research has demonstrated that phosphorus levels could be further reduced to 0.30 percent in layer diets without adversely affecting performance.

6.15.2.2 Phytase

The commercially available microbial phytase enzyme, which digests phytate, therefore releasing previously unavailable phosphorus, has been used in poultry feeds to increase the utilization of phytate from feedstuffs fed to broilers. In one study, phytase supplementation permitted the reduction of dicalcium phosphate levels in the diet to 0.56 percent, which was half the level present in the control diet. Daily phosphorus excretion from broilers supplemented with phytase was reduced by a third compared to those on the control diet. This demonstrates that broiler performance can be maintained while reducing dietary phosphorus below levels currently used in the industry.

6.15.2.3 Chemical amendments

Chemical amendments added to manure during storage such as aluminium (Al), calcium (Ca) and iron (Fe), can reduce levels of soluble P runoff from poultry manure. Chemical amendments can potentially limit P solubility, thereby reducing the risk of eutrophication of sensitive surface waters adjacent to lands where poultry manure is applied.

6.16 Pest Control

Pests such as rodents, insects, wild birds and scavengers are attracted to poultry operations and, if not controlled, can adversely impact community relations. Mice, wild birds, flies and beetles can transmit many human and animal pathogens, parasites and diseases such as *Salmonella, Campylobacter,* Newcastle disease, avian influenza, coccidiosis, botulism, Marek's disease, ascarids (roundworms) and tapeworms. These pests can travel considerable distances, easily transferring disease from one place to another. For instance, flies have an average dispersal range of 0.5 to 2 miles and have been reported to travel as far as 20 miles; darkling beetles can fly up to one mile; and mice may easily travel up to two miles.

A quality pest control program will prevent pest access to feed, shelter and water. Some tips to consider when planning an effective pest control strategy are:

- Ensure facilities are pest-proof (snug fitting doors, concrete floors, secure screens, and soffit and fascia under eaves, intact siding).
  - Mice can enter through a hole the size of a dime.
  - Repair holes with galvanized sheet metal.
- Eliminate nesting sites inside and outside the barn, for instance, clean up tall grass/ weeds, shrubs, garbage, broken equipment and lumber.
- Dispose of dead birds in a timely and secure manner.
- Clean up feed spills as soon as they occur.
- Manage manure so that it is unattractive to insects (keep it dry and remove wet spots).
- Maintain the grade around facilities to prevent pooling of water.
  - Stagnant water serves as a breeding ground for insects and bacteria.
- Inspect for pests on a regular basis.
  - Use sticky fly ribbons and rodent snap traps to monitor pest activity.
  - Check litter, cracks and small crevices for signs of darkling beetles.
  - Walk the outside perimeter of facilities and remove any bird nests in and around buildings.
- Use rodent/fly baiting and trapping inside and outside of the building (e.g. service room, perimeter of building, etc.).
  - Baits work best in a dust-free container. Place small amounts of bait in plastic bait stations or on a piece of drainage pipe. Locate baits to prevent contamination of bird feed and water. As well, ensure the bait is inaccessible to children, pets and livestock.

6.17 References

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- *Canadian Farm Building Handbook.*
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7.0 MANURE STORAGE

7.0 MANURE STORAGE

Take-home messages in this section:

- Manure storage facilities need enough storage capacity to allow for the spreading of manure when crop uptake of the nutrients will occur and when manure runoff from fields to surface water is unlikely. Nine months storage is required for long-term storage under the *Agricultural Operation Practices Act* (AOPA).
- In areas with high precipitation, manure storage facilities should be roofed to prevent the manure from becoming too wet.
- In areas with high winds, manure storage facilities should be adequately protected to prevent the manure from blowing onto neighbouring property.
- Storage facilities should be structurally sound, which may require professional engineering.
- Manure should be collected and stored in such a way to prevent pollution.
- When selecting sites for manure storage structures, adhere to setback distances from wells, watercourses and property lines.

7.1 Introduction

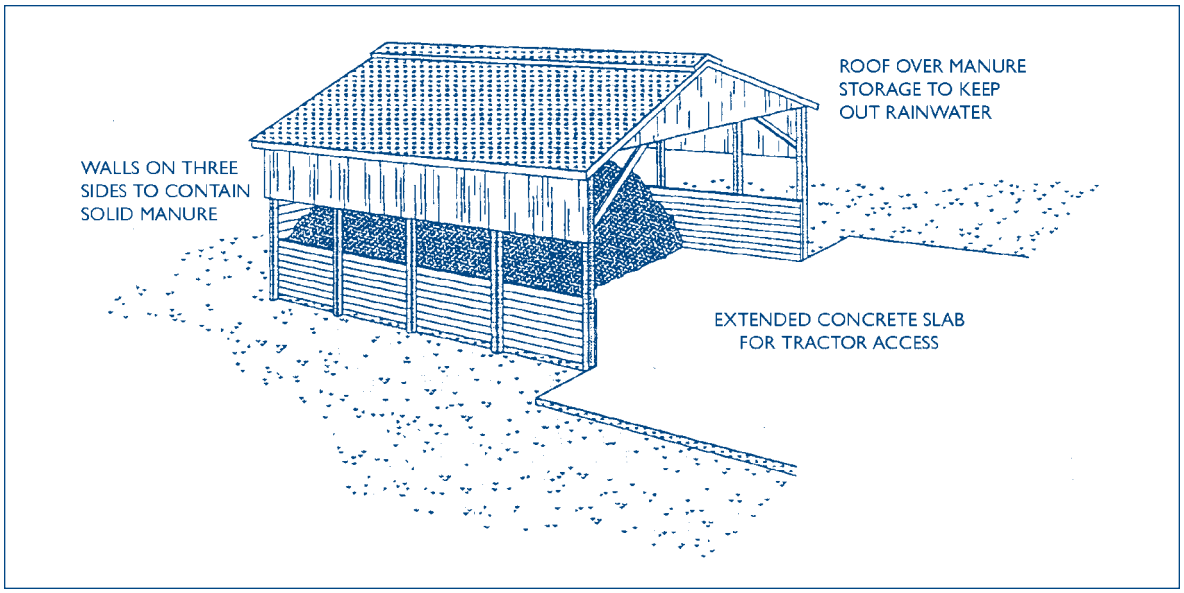
Poultry manure is a valuable by-product of poultry operations. To avoid pollution problems, a well-planned manure storage system is required. This section deals with planning the size of manure storage facilities and structures, and stockpiling manure.

Manure storage facilities have enormous potential to contaminate groundwater, and as such must be evaluated to ensure they are both structurally and environmentally sound. The facility must meet the requirements in AOPA, *Standards and Administration Regulation.*

A storage facility (see Figure 7.1) is a permanent structure or location designed and operated to contain manure, other wastes and contaminated runoff in an environmentally sound manner. Design the facility with sufficient capacity to hold manure until it can be used as a fertilizer. In general, manure storage facilities must hold a minimum of nine months of manure production. Timing of manure application and application rate are discussed in more detail in Section 8, Land Application of Manure.

Alternatively, if manure is regularly removed from the farm, a manure storage structure sized for one cleanout may be suitable for temporary storage. Check with the Natural Resources Conservation Board (NRCB) to determine temporary storage requirements.

Figure 7.1 **Manure Storage Facility**



7.2 Manure Storage Capacity

Manure storage is required for those times of the year when manure cannot be applied to cropland because of the risk of contamination. Design a manure storage facility with enough capacity to contain a minimum of nine months of manure production.

For open manure storages, the design needs to take into account the highest one-day rainfall that has occurred in a 30-year period (see Figure 6.10). To obtain an estimate of the storage capacity required for a poultry operation, follow these steps:

- Multiply the suggested weekly manure storage per bird, found in Figure 7.2, by the average number of birds on the farm to determine weekly manure storage volumes required for each class of poultry.
- Determine total weekly storage volume by adding weekly storage volume requirements for each class of poultry.
- Multiply total weekly storage volume by the required storage duration (AOPA requires a minimum of 36 weeks). Add any other wastes that need to be stored (such as contaminated runoff) to obtain the total required storage capacity.

Example 7.1 **Calculating Required Size for a Covered Poultry Manure Storage Facility**

Question: How big does a roofed manure storage facility have to be to store nine months of manure produced by a 30,000 cage layer operation with a solid manure system (typical manure belt system)?

1. Weekly manure volume	= Figure 7.2 value x number of birds = 0.81 litres/bird/week x 30,000 birds = 24,300 litres/week
2. Storage capacity desired	= weeks storage x weekly manure production = 36 weeks x 24,300 litres/week = 874,800 litres or 874.8 m^3
Example size	= 12 m x 29 m x 2.5 m deep (with a roof)
3. Converting to Imperial units	= 874.8 m^3 x $\frac{35.3\ ft.^3}{m^3}$ = 30,880 $ft.^3$
Example size	= 40 ft. x 96 ft. x 8 ft. deep (with a roof)
4. To convert units	= 1,000 litres = 1 m^3 = m^3 = 35.3 $ft.^3$

Answer: This farm requires access to a storage volume of 875 m^3 (30,880 $ft.^3$). Piling manure 2.5 m (8 ft.) in a roofed facility to 12 m x 29 m pile size (40 ft. x 96 ft.) would be adequate.

Figure 7.2 **Average Weekly Manure Production Rates for Different Classes of Poultry (from AOPA)**

Poultry Type	Housing System	Manure Leaving the Barn (at the end of each cycle)	
		Weight kg/week	Volume litre/week
Pullets	cage[a]	0.48	0.60
	cage[b]	0.12	0.30
	floor[c]	0.14	0.45
Layers	cage[a]	1.40	1.75
	cage[b]	0.31	0.81
	floor[d]	0.37	0.92
Broiler Breeder Pullets	cage[b]	0.15	0.39
	floor[c]	0.19	0.60
Broiler Breeder Layers	cage[b]	0.40	1.04
	floor[d]	0.48	1.19
Broiler Chickens	floor[c]	0.19	0.58
Roaster Chickens	floor[c]	0.20	0.60
Turkey Broilers	floor[c]	0.32	1.01
Turkeys – Heavy Hens	floor[c]	0.53	1.67
Turkeys – Heavy Toms	floor[c]	0.81	2.52

To convert to Imperial units: 1 kg/week = 2.2 lb./week
1 litre/week = 0.035 ft.^{3}/week

a Manure removed from barn at 80 percent moisture content with a density of 800 kg/m^3 (50 lb./ft.^{3}).
b Manure removed from barn at 35 percent moisture content with a density of 384 kg/m^3 (24 lb./ft.^{3}).
c 5 cm (2 inches) shavings placed on floor. Manure and litter removed from barn at 25 percent moisture content, with a density of 320 kg/m^3 (20 lb./ft.^{3}).
d One-third litter floor, two-thirds slatted floor. Manure and litter removed from barn at 40 percent moisture content, with a density of 400 kg/m^3 (25 lb./ft.^{3}).

7.3 Temporary Manure Storage

7.3.1 Covered holding area

A manure holding area located close to the end of a barn is an excellent, versatile form of temporary storage. This allows manure to be quickly cleared to the holding area in one operation, avoiding extra costs from double handling. This system, combined with the use of a conveyor positioned beside the holding area, can be very efficient and cost-effective for loading large trucks. In addition, covered holding areas are more flexible for scheduling manure handling and end-use operations.

Restricting the addition of moisture to the manure maintains its quality, which improves its end-use options. Since the structure is only designed to hold a relatively small volume (one cycle) of manure, construction costs are minimal. With the exception of size, covered holding areas should meet the suggestions in Section 7.4, Manure Storage Structures.

7.3.2 Short-term solid manure stockpiles

Under AOPA, short-term solid manure storage refers to an accumulated total of not more than six months of storage over a period of three years.

Short-term solid manure storages must be located a minimum of:

- One metre above the water table.
- 150 metres from the nearest neighbour.

7.4 Manure Storage Structures

Under AOPA, manure storage structures and runoff collection systems require specific site and size considerations. These structures should:

- Meet setback requirements from roads and property lines.
- Be located at least 100 metres (328 feet) from a spring or water well and at least 30 metres (100 feet) from a common body of water, such as streams, creeks and ditches.
- Be sized to provide enough storage to enable the operator to spread manure when crop uptake of the nutrients will occur and when manure runoff from fields to surface water is unlikely. The minimum requirement is nine months storage capacity.
- Contain the expected local winter precipitation, if the structure is not covered.
- Be structurally sound, with professionally engineered designs.
- Be watertight with a liner to prevent groundwater contamination.
- Be located so that clean surface runoff from adjacent areas is excluded; land grading can also accomplish this.
- For contaminated runoff storage, be appropriately located and of sufficient capacity to contain the estimated runoff from snow and/or rain (see Section 6.14, Runoff Control and Collection).
- Be located at least one metre above flood level.
- Be adequately fenced to prevent the accidental entry of humans, animals or machinery.

Dry poultry manure that becomes wet will heat up as micro-organisms break down the manure, which could cause fires in manure storage structures. As prevention, separate manure storage facilities from other buildings by 10 metres (33 feet). Store manure in stacks no more than 1.5 to 2.5 metres (five to eight feet) in height, and prevent large variations in moisture that could start fires in the manure storage.

7.4.1 Solid manure storage structures

Open-type manure storage structures are suitable in most regions of Alberta. In areas of high precipitation, an enclosed structure may be required. Open-type manure storages should:

- Meet the criteria listed in Section 7.4 for manure storage structures.
- Have a base of concrete or other impervious material and have a curbed sidewall on at least three sides.
- Have a leachate and runoff collection system that consists of either an adequately grassed separation from a watercourse or a designed catch-basin system.
- Be located out of sight and downwind from public places and neighbouring residential areas, where possible.

In areas of high precipitation, manure storage facilities should be roofed to prevent manure from becoming too wet (see Figure 7.1). In areas with high winds, protect manure storage facilities to prevent the manure from blowing onto neighbouring properties.

7.4.2 Semi-solid manure storage structures

Most poultry manure will be semi-solid when scraped from shallow pit cage houses or partially slatted floor litter houses, where only a minimal amount of litter is used and little attempt is made to dry the manure.

In high precipitation areas, store semi-solid manure in closed shed-type, manure-holding structures. These structures should:

- Meet the criteria listed in Section 7.4 for manure storage structures.
- Have reinforced concrete walls (or equivalent) to adequately contain the manure.
- Have a concrete floor that is sealed to the walls to provide tight storage and eliminate entry of ground or surface water into the structure.
- Be constructed entirely above-ground in areas where the water table is high, to minimize seepage of groundwater into the structure. This will also facilitate cleanout operations.

- Be adequately roofed to keep out rain and snow in areas with high annual or seasonal precipitation.
- Be well ventilated if equipped with a roof, to prevent accumulation of hazardous gases in the headspace area and to aid in drying the stored manure.
- Have access doors constructed from tight, tongue-and-groove pressure-treated timber (or equivalent). Doors must have some provision for controlling or containing seepage.
- Have guardrails and side curbs. If equipped with a ramp, a rough or grooved surface will provide tractor traction.
- Have a suitable concrete slab area for tractor and manure spreader activity. Slope this slab away from the building so that water on the slab does not enter the storage area.

In colder, drier regions of the province, an uncovered, three-sided storage structure may be suitable. This structure should:

- Have reinforced concrete sidewalls (or equivalent) on three sides.
- Have a concrete floor, sloping downward from the open side, that is well-sealed to the walls to provide a manure tight storage. It must have some provision for controlling or containing seepage.

7.4.3 Liquid manure storage structures

Although liquid manure systems are not generally recommended for poultry operations, storage structures must meet AOPA standards.

Where liquid waste management is used, earthen, concrete or steel storages must meet the criteria listed in Section 7.4, Manure Storage Structures. Also consider the following points:

Liquid manure storages must be designed according to AOPA, *Standards and Administration Regulation.*

- If the facility is constructed in clay soils and is not lined, it must:
  - Be constructed of at least 10 metres of naturally occurring material with a hydraulic conductivity of not more than 1×10^{-6} cm/sec., and,
  - Have a floor elevation at least one metre above the top of an aquifer.
- If the liner of the manure storage is constructed from compacted, naturally occurring material:
  - The liner must be at least one metre thick.
  - The floor elevation of the storage must be at least one metre above the top of an aquifer.
  - The compacted material must have a hydraulic conductivity of not more than 1×10^{-6} m/sec.

7.5 Maintenance and Monitoring

Signage and fencing. Fence hazardous areas such as manure storage structures, dugouts and open water sources and post warnings to prevent curious humans and animals from entering. The American Society of Agricultural Engineers Standards ASAE S441 (SAE J115 Jan 87) has information on creating signage.

Mowing. Keep weeds and grass mowed around manure storages to promote a positive image, reduce the potential for liner damage and reduce fly and vermin habitats.

Odour. Decomposition of manure can create strong and offensive odours that may be intermittently released from storage structures. Weather conditions and practices related to loading and emptying can impact odour release.

Weather conditions. Temperature influences the creation of odorous gases. During warm summer conditions, temperature increases in stored manure increase microbial activity, resulting in accelerated decomposition of waste matter and an increase in the volume of odorous compounds released. In cold, winter conditions, microbial activity in storages will end. In general, odour emissions increase when microbial activity begins or ends.

7.5.1 Odour control strategies

Windbreaks, such as trees and fences, can be used to control odour. On a calm day, odorous air leaves the source in a stable plume. Windbreaks create turbulence that breaks up and dilutes odour-laden air. The distance that creates adequate air movement between the windbreak and the storage is currently being investigated.

Presently, several research groups are actively investigating different management strategies and technologies that can be used to reduce the production and emission of odours from intensive livestock operations.

7.5.2 Monitoring

Visually inspect manure storage facilities regularly. Visual indicators of storage problems include:

- Evidence of rodents. Burrows may damage the liner and walls of the manure storage.
- Vegetation. Remove trees and plants that start to grow in the manure storage area.

When planting trees to shelter the storage area, plant them outside the boundary of their mature root zone, in order to prevent roots from penetrating the liner and creating leaks.

7.6 Manure Transportation

Moving manure from storage to the field or to other users is an important component of a manure management system. Hauling manure must be economically sound, safe and responsible. Nuisance risks associated with manure transportation include dust, spillage and physical impact on roads.

Manure hauling traffic can be very intense for short periods of time and traffic on gravel roads during dry, windy periods can result in significant dust generation. In "sensitive areas" near neighbours, dust suppression or a detour may be necessary. Dust suppression methods can include watering roads or applying calcium chloride. Check the Yellow Pages under Water Hauling Contractors for road-watering services.

Although manure is considered a biodegradable product, it is important to minimize direct spillage from manure trucks. Be aware of the risks when hauling manure on roads. Spillage may result from seepage, overloading or blowing. Use appropriate management methods and equipment to keep roads and ditches manure-free. This may require smaller loads, covered loads or sealed end-gates on the manure truck. In the event of excessive spillage, cleanup measures such as sweeping will be necessary.

Intense traffic during manure hauling can significantly impact lower grade roads. Many livestock operators have road use agreements with their local municipalities that clearly define the responsibilities of each party. Road use agreements may also include responsibilities related to dust and spillage.

Manure spills on roads may constitute a violation of the *Transportation Act* (litter) and the Alberta *Environmental Protection and Enhancement Act* (pollution). Check with local municipalities regarding road bans before hauling manure.

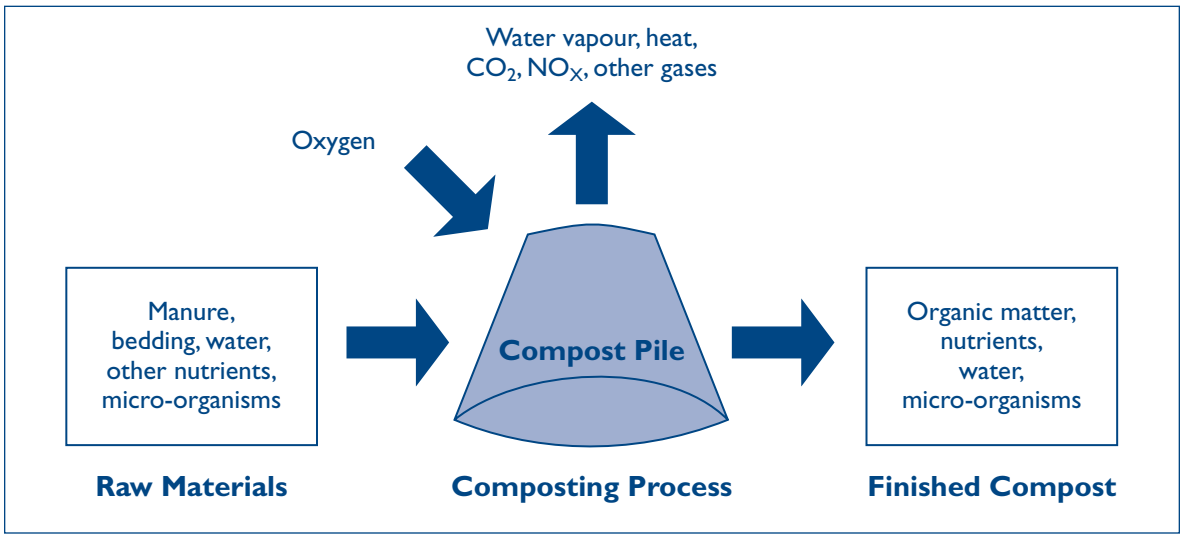
7.7 Manure Treatment

Manure can supply a major portion of the nutrients required for crop production. Manure application to cropland is an acceptable practice. There are, however, situations where available cropland acreage is insufficient for applying all manure produced on a livestock operation, as well as other situations where direct land application is not considered acceptable.

An alternative to direct land application of poultry manure is to treat it prior to application, or use it off-farm. Once manure has been treated, its nutrient content changes and the application rates in Section 8 no longer apply. If manure is land-applied, treatment is unnecessary. The most common method of manure treatment in Alberta is composting.

7.7.1 The composting process

Figure 7.3 Overview of the Composting Process



The composting process has several basic requirements:

- A moisture content between 40 and 65 percent. In manure with moisture content below 40 percent, the process is slow, and above 65 percent moisture, the process may become anaerobic (i.e. fermentation), producing unpleasant odours.
- A carbon:nitrogen (C:N) ratio between 20:1 and 30:1. If the C:N ratio is too low, ammonia will volatilize, and if it is too high, composting takes longer because nitrogen is in short supply.
- An oxygen supply. Oxygen is introduced to the system either by regular mechanical turning of the compost or by forcing air through the material.
- A pH of 6.5 to 8.0.
- Temperature of 40 to 65°C in the compost pile. Temperatures maintained at 55°C or greater for 15 days eliminate most pathogens and weed seeds.

7.7.1.1 Methods of composting

A wide range of technology is available for composting. Relatively little investment or labour is required for most composting systems, including windrows and static pile/passive aeration.

Windrows. Manure piles or windrows are aerated by frequent mechanical turning, which maintains the composting process. Use a front-end loader or a specifically designed windrow turner.

Advantages:

- Rapid drying of the product during warm weather.
- A drier end product.
- The capacity to handle large volumes of material.
- A stable end product.
- Relatively low capital cost.

Disadvantages:

- A large area requirement.
- Relatively high operational cost.
- Odour release.
- May require a large supply of bulking agent.
- Weather dependent.

Static pile/passive aeration. This low-end composting process requires little capital investment. Manure windrows or piles undergo a natural degradation process without the assistance of mechanical agitation. However, compost produced by this method may be inconsistent and may contain viable weed seeds. Micro-organisms that can cause diseases are also likely to survive this process.

Advantages:

- Low cost.
- Good odour control.
- Good end product stability.

Disadvantages:

- Inefficient use of space.
- Affected by climate.

In-vessel aeration. This is a high-end process in terms of cost, which requires a specifically designed compost vessel, usually constructed of concrete, wood or steel. Aeration is enhanced by mechanically forcing air through the composting material. This system offers better control of the composting process. Under optimal conditions, it results in a more consistent product, free of weed seeds and pathogens.

Advantages:

- Protection of compost from weather and odour control, when covered.
- Efficient use of space.
- Can be designed as a continuous process.

Disadvantages:

- Highly mechanized and capital intensive.
- Careful management is required.
- Reduced flexibility compared to other methods of composting.
- Inconvenience associated with working around the piping and ducting used to aerate piles.
- Expense associated with operation and blower maintenance.

7.7.1.2 Composting regulations

Site selection and operation of composting facilities is regulated under the *Environmental Protection and Enhancement Act.* For more information, contact Alberta Environmental Protection.

Alberta Environmental Protection
Northeast Boreal and Parkland Regions
Regional Director
5th Floor, 9820 – 106 Street
Edmonton, AB T5K 2J6
Phone: (780) 427-9562
Fax: (780) 422-5120

Alberta Environmental Protection
Northwest Boreal and Northern East Slopes Regions
Regional Director
Provincial Building
203, 111 – 54 Street
Edson, AB T7E 1T2
Phone: (403) 723-8395
Fax: (403) 723-8542

The *Alberta Environment Code of Practice for Compost Facilities* outlines specific requirements for constructing compost facilities.

- A composting pad must be constructed with a minimum of 0.5 m of clay-type material (or alternate material that provides equivalent protection), with a permeability of less than 5×10^{-8} m/sec.
- It must be constructed with a minimum slope of two percent so that water or leachate does not accumulate on the pad.
- The provision of a run-on control system must be included to prevent the flow of surface water into storage, processing or curing areas.
- A runoff control and management system that protects surface water quality is required.
- A groundwater monitoring system may be required.

7.8 References

- The American Society of Agricultural Engineers Standards ASAE S441 (SAE J115 Jan 87).
- *The National Farm Building Code of Canada,* 1995. Issued by the Canadian Commission on Building and Fire Codes, National Research Council of Canada.
- *AAFRD Swine Mortality Composting* Agdex 440/29-1.
- *AAFRD Poultry Mortality Composting* Agdex 450/29-1.
- *AAFRD Livestock Mortality Burial Techniques* Agdex 400/29-2.
- *AAFRD Livestock Mortality Management (Disposal)* Agdex 400/29-1.

8.0 LAND APPLICATION OF MANURE

8.0 LAND APPLICATION OF MANURE

Take-home messages in this section:

- Manure should be managed as a resource to maximize its benefits and minimize its risks.
- As with commercial fertilizer, manure should be applied on a nutrient basis, which requires an analysis to determine the composition of the manure.
- Soil analysis is needed to know which nutrients are not required.
- Crop nutrient requirements vary from crop to crop and need to be considered when determining an accurate manure application rate.
- Choosing a method of manure application depends on the physical characteristics of manure (liquid or solid), type of operation, handling and storage, type of spreader and cost.
- Spring application is the most desirable for Alberta conditions, as high nutrient availability coincides with crop uptake of nutrients.
- Calibration of spreaders is important to ensure proper rate of application and should be done before each use.
- Recording and keeping all documents related to nutrient management is important, not only for information on when and where changes need to be made, but also because the *Agricultural Operation Practices Act* (AOPA) requires that certain manure management records be kept for five years.

Manure or compost application to land can be a sustainable agricultural practice, provided proper nutrient management practices are followed. Manure is an organic fertilizer and an important source of plant nutrients. In addition, manure can improve soil tilth, structure, aeration and water-holding capacity. This is particularly true for coarse-textured soils, soils low in organic matter or degraded soils. Manure serves as a viable substitute for commercial inorganic fertilizers because of its on-farm availability, nutrient composition and ability to enhance the organic matter content of soil. However, if manure application is not properly managed, excess nutrients may be applied to agricultural land. In addition to nutrients, micro-organisms (including pathogens), weed seeds and salts are also present in manure.

Risks associated with land application of manure and compost include:

- Phosphorus runoff to surface water and nitrate leaching to groundwater as a result of excess phosphorus (P) and nitrogen (N) application from manure and mineral fertilizer sources.
- Excessive growth of aquatic plants because of excess P in water bodies. Decomposition of these plants can reduce oxygen to critical levels, which may impact fish survival.
- Physical and biological damage, including oxygen depletion, if organic matter is allowed to enter a water source.
- A reduction in ground or surface water quality because of increased nitrate levels that may become toxic to aquatic life, humans and livestock.
- Contamination of water by disease-causing organisms, which makes the water unsuitable for human and livestock consumption.
- Poisoning of fish and other aquatic organisms because of increased ammonia levels in water.
- A reduction in air quality, caused by nitrogenous gases, including ammonia and nitrous oxide (a greenhouse gas).
- Reduced soil quality because of high salt content in manure.

In this chapter, Nutrient Management Planning (NMP) will be addressed by outlining possible Beneficial Management Practices (BMPs) related to land application of manure or compost. The overall objective of NMP is to effectively use manure, compost and/or mineral fertilizers as nutrient resources for optimum crop production in a manner that will minimize the impact of agriculture on the environment.

8.1 Nutrient Value of Manure

Manure should be managed as a resource to maximize its benefits and minimize its risks. Nutrients are effectively recycled when manure is used as a fertilizer, which can reduce the need for commercial fertilizers.

To use manure effectively as a resource, it is important to understand its composition. Manure is a complex mixture of water, organic matter, minerals, nutrients and other chemicals. The nutrient profile of the manure is affected by animal age, manure storage and handling, bedding material and the diet fed. Important nutrients in manure include nitrogen, phosphorus, potassium, calcium, magnesium, sodium, sulphur; and micro-nutrients such as boron, chlorine, copper, iron, molybdenum, zinc, selenium, chromium, iodine and cobalt.

8.1.1 Nitrogen and phosphorus in manure

Manure provides the same nutrients for crop production as commercial fertilizers, but the challenge with using manure is that the forms and ratios of the nutrients are not easy to change. Nitrogen is present in manure as ammonium or organic compounds. The predominant environmental risks associated with nitrogen are losses to groundwater through leaching or losses to air through denitrification and volatilization. Phosphorus is present in manure in both organic and inorganic forms and poses a risk to the environment through its potential to migrate in surface runoff from spring snowmelt and seasonal rainfall.

Facts about nitrogen and phosphorus:

- Only ammonium and nitrate (mineral or inorganic nitrogen) can be used by plants. Organic nitrogen must be transformed to ammonium (through mineralization) and nitrate (through nitrification) forms before being used by plants.
- Phosphorus is generally found in three forms: particulate phosphorus (P attached to sediments), dissolved phosphorus (water soluble P) and organic phosphorus.
- Soil test nitrogen and phosphorus are measurements of current plant available nitrogen and phosphorus in the soil. These measurements can be used to determine if additional nitrogen and phosphorus are required for optimum crop growth. Soil test phosphorus can also be used in the assessment of potential for phosphorus runoff losses.

Figure 8.1 Nitrogen and Phosphorus in Manure*

	Form in Manure	Available 1st year	Available 2nd year	Available 3rd year	Environmental risks
Nitrogen (N)	• Ammonium (NH_4^+) • Nitrate (NO_3^-) • Organic N	NH_4^+ + NO_3^- + 25% of initial organic N content	12% of initial organic N content	6% of initial organic N content	• Nitrate in groundwater • Volatilization** of ammonia • Denitrification*** as nitrous oxide
Phosphorus (P)	• Inorganic P ($H_2PO_4^-$ and HPO_4^{2-}) • Organic P	50% of initial total P content	20% of initial total P content	6% of initial total P content	• P in surface runoff (particulate and dissolved) • P leaching into groundwater

* Percentages listed in the figure are only estimates. Availability of nutrients from organic sources, such as manure, depends on biological processes in the soil, which are affected by many factors including temperature, moisture and soil type.
** Volatilization is the gaseous loss of a substance (e.g. ammonia) into the atmosphere.
*** Denitrification is the transformation of nitrate to gaseous forms (under high moisture or saturated soil conditions), which can be lost to the atmosphere.

To reduce nitrate leaching:

- Apply manure based on the nitrogen rate from soil test recommendations.
- When high levels of nitrogen are required, split the total amount required into two-thirds manure and one-third mineral fertilizer. Apply mineral fertilizer later in the season.
- Reduce the amount of time between application of manure and maximum nitrogen uptake by the crop (i.e. apply in spring while plants are actively growing).
- Do not apply manure if heavy rain is expected.
- Do not apply manure near streams or other water sources. Manure must not be applied within 10 metres of an open body of water if subsurface injection is used; within 30 metres of an open body of water if manure is applied to the surface and incorporated within 48 hours; or within 30 metres of a water well (AOPA).

To reduce ammonia losses into the air:

- Apply manure on humid and/or cold, non-windy days.
- Incorporate manure as soon as possible.

To reduce denitrification:

- Avoid manure application in low, wet areas.
- Apply manure prior to seeding, so nutrients can be used while plants are actively growing.

To reduce phosphorus in surface runoff:

- Inject or incorporate fertilizers and manure to avoid losses by runoff in areas and soils that are adjacent to water bodies and/or have high runoff potential.
- Test soil phosphorus at least once every three years to avoid over-applying fertilizers or manure. Over-application of manure will raise soil phosphorus levels above the recommended agronomic levels (contact a crop adviser or soil laboratory for recommended P levels for each crop).
- Test soils in different landscape locations (e.g. knolls, low spots) to determine if excess levels exist in low areas where runoff collects.
- Apply manure according to soil test recommendations, crop yield goals and manure analyses. If manure is not analysed for nutrient content, book values can be used (AOPA, *Standards and Administration Regulation,* Schedule 3, Table 5). This reduces excess nutrients in the soil and minimizes buildup.
- Apply manure when it can be incorporated. Avoid spreading manure on snow or frozen soil.
- Apply manure in accordance with nutrient limits and other manure application requirements (e.g. proximity to water) if it is being applied to forage, direct-seeded crops, frozen or snow-covered ground, or if manure must be applied to alleviate storage capacity. Application must not adversely impact groundwater, surface water or create an odour nuisance.
  - Surface application of manure on frozen or snow-covered land or on forage and direct-seeded crops without incorporation is acceptable only if minimum setback distances are met (see Figure 8.2). Surface water that comes in contact with surface-applied manure must not enter an open body of water or leave the owner's property.
- Base the nutrient management plan on phosphorus for areas that are particularly vulnerable to phosphorus runoff or leaching (e.g. flood plains, steeply sloped land, land with high water tables or aquifers).

Figure 8.2 **Minimum Setback Distances for Application of Manure on Forage or Direct-Seeded Crops or on Frozen or Snow-Covered Land (AOPA)**

Mean Slope	Required Setback Distance from Open Body of Water
Less than 4%	30 m
4% but less than 6%	60 m
6% but less than 12%	90 m
12% or greater	No application allowed

To reduce nutrient losses from wind and water erosion:

- Leave some of last year's crop residue on the surface and reduce tillage. This increases water infiltration and reduces nutrient losses in wind-blown sediments and runoff.
- Build a runoff control basin or an embankment across a depression of concentrated water in a field. The embankment will act as a terrace, slowing water movement, depositing particulate load and reducing gully erosion. By slowing water movement, the re-deposition of P in the field will increase.
- Construct a terrace by breaking longer slopes into shorter ones.
- Establish grassed waterways in erosion-prone areas to slow water movement from the field.

8.1.2 Salt

Soil quality can be adversely affected by salt concentrations in the manure. Managing soil salinity is crucial for sustainable crop production. Saline soils can reduce crop production and limit cropping options (contact a crop adviser for information on crop salinity tolerance). High levels of sodium can also disperse aggregates, degrade soil structure and reduce water infiltration through soil.

To control salt:

- Monitor salt levels in feed rations (contact a livestock nutritionist for recommended levels in feed).
- Monitor electrical conductivity (EC) level in soil. Electrical conductivity is a measurement of soil salt content, and a change of more than 1 dS/m may indicate a soil quality problem. If the EC is more than 2 dS/m, plant growth and yield may be affected. If the EC is more than 4 dS/m, do not apply manure (AOPA).
- Monitor the sodium adsorption ratio (SAR) levels in soil. Sodium adsorption ratio is a measurement of sodium in relation to calcium plus magnesium. SAR levels above 8 in soil can decrease soil permeability and increase the potential for water-logging.
- Do not apply manure to soils with a high EC and high SAR.

8.2 Manure Analysis

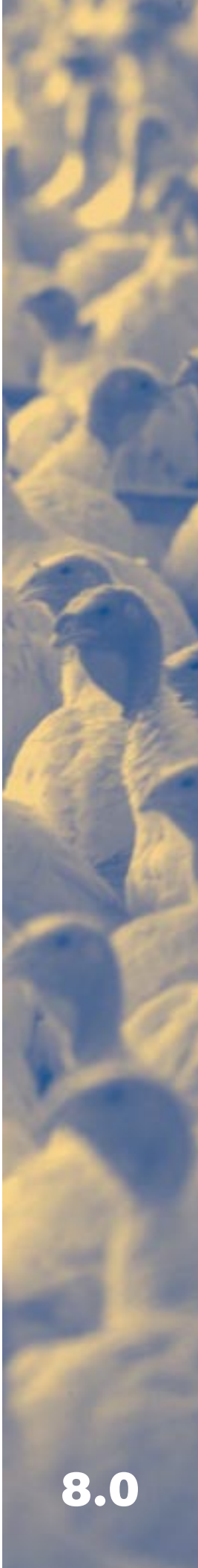
Manure analysis provides information on nutrient content of manure. Based on nutrient analysis, the amount of nutrients available for crop growth can be estimated. To estimate crop available nutrients, consider the chemical make-up of the nutrients in manure, previous manure applications, volatilization, nitrogen fixation and mineralization (breakdown of organic matter into available plant nutrients). When calculating manure application rates, include residual crop-available nutrients from manure applied in recent years.

Accuracy in manure analysis and application is important as problems can result from either inadequate or excess nutrients in the soil. Manure analysis recommendations are based on nutrient content of manure, crop to be grown, soil type, soil tests, climate, soil moisture, and other management practices such as dry-land versus irrigation.

8.2.1 Manure analysis

Analyse manure for three to five consecutive years and compare the results to book values. If there is a large discrepancy, do not use the book values; instead develop new average values for the operation.

Although the best source of information is from sampling the operation's manure, using book values of nutrient content is better than ignoring manure nutrient content altogether (e.g. AOPA).



8.2.2 Manure sampling

Manure testing helps generate a long-term database for planning and economic evaluation, as well as demonstrating due diligence. It is important that manure samples are representative of the entire volume of manure, not just the surface application. Manure application rate will ultimately be affected by how carefully manure samples were collected.

To sample manure:

- Collect composite samples that reflect the overall variability of the manure.
- Take samples from different locations and depths of the storage facility.
- Sample solid manure containing bedding and other materials in such a way that the proportion of components in the sample reflects their proportion in the manure pile.
- Collect about 20 samples from each manure source. Combine the samples, take a one kilogram sub-sample and place in a sealed container. Keep the sub-sample cool and send to the laboratory as soon as possible.
- Sample manure prior to, but as close to land application as possible in order to build an accurate database. A good time to collect liquid manure samples is after lagoon agitation. Solid manure is best sampled directly from the truck (e.g. three to four samples per truckload).
- Base manure application rates on the results of the manure analysis.

8.2.3 Manure handling and shipping

A good understanding of how manure is handled leads to an understanding of the variability of manure pile composition and assists in the collection of a representative sample.

When handling manure samples:

- Avoid handling that can alter the physical and chemical composition of manure samples (e.g. leakage, nutrient losses to the air, loss in moisture, room/warm temperature).
- Use sealable freezer bags for solid manure. Seal the bag and prevent leakage by double bagging the sample.
- Use plastic or glass containers for liquid manure samples.
- Send samples to the lab immediately, otherwise freeze samples until delivery.
- Do not fill containers more than half full and label each with name, date and sample identification. The sooner the sample is sent to the lab, the more reliable the laboratory results will be.
- Contact the laboratory prior to sampling to obtain specific information on appropriate sample size, shipping instructions and costs.

Manure laboratory results:

- Should at least include percent dry matter, total nitrogen, ammonium nitrogen and total phosphorus. If other soil deficiencies are suspected, other nutrients such as potassium, sulphur and micro-nutrients may be measured. Analysing EC and the SAR in manure would be necessary only to determine if changes in feed formulation affect manure quality.
- Should be in the same units used for calibrating the manure application equipment (pounds or kilograms). Take special care when converting units.
- Should be expressed on a wet (or "as is") basis since manure is spread wet.

8.3 Soil Analysis

Soil analysis is used to indicate nutrient availability in soil. Nutrient management decisions cannot be made without knowing the nutrients available in the soil. The greater the nutrient concentration in the soil, the lower the application rate of fertilizer or manure. An accurate soil test, achieved through proper soil sampling, that is interpreted properly can be an excellent nutrient management tool.

However, misuse of a soil test leads to increased costs, yield losses and/or environmental contamination. Soil tests

may also indicate nutrient or salt surpluses. If a nutrient surplus is identified, manure application rates should be based on the nutrient present in excess; inorganic fertilizers can be used to supplement other nutrient levels.

When sampling soil:

- Collect a representative sample based on in-field variations in topography (slope), soil type, cropping management and cropping history.
- Collect soil samples from depth intervals of 0 to 15 centimetres (0 to 6 inches), 15 to 30 centimetres (6 to 12 inches) and 30 to 60 centimetres (12 to 24 inches) at 20 to 30 sites per field or field management area. Place samples from each depth in a separate container. Sample to greater depths (below one metre) every three to five years to check for nitrate leaching in fields that receive regular manure application or fields with a history of heavy manure application.
- Mix samples taken from same depth intervals and remove about 0.5 kilograms (one pound) from each depth. If the field is variable, keep the samples from different areas (variations) separate.
- A soil sampling probe is best for taking samples. While an auger can be used, it can be difficult to accurately separate depth intervals. Tools may be borrowed or purchased from soil testing laboratories or fertilizer dealers.
- Sample prior to seeding. If time is a constraint, fall sampling is an acceptable alternative. Because changes in soil nutrients occur more slowly below soil temperatures of 7°C, collect soil samples at or below this temperature, but prior to freeze-up.
- Analyse soil for plant-available nitrogen and phosphorus as a minimum. Analyse for other nutrients (sulphur, potassium, micro-nutrients) if a deficiency is suspected. Monitor soil salinity (EC) and possibly SAR on a regular basis.

Soil test interpretations:

- If nutrient recommendations are included in the laboratory report, there is no need for soil test interpretations.
- If recommendations are not included with soil test results, consult a crop adviser or private consultant to provide soil test interpretations and recommendations.
- Not all manure will have the right composition to meet crop requirements. Nutrients are not present in organic materials in the same proportions that crops require them.
- Adjust application rates to meet the requirement for nutrients that will result in the lowest application rate. Use inorganic fertilizers to supplement other nutrients.
- Avoid yearly manure application to the same land unless manure and soil tests indicate there is no risk of excess nutrients.

8.4 Crop Nutrient Requirements

Nutrient requirements vary among crops. Therefore, for the same conditions, application rates will differ, depending on the crop. Targeted yield for a given crop is an important factor in determining the amounts of nutrients to be added. Crop yield targets are used to determine nutrient requirements and the manure application rate. To estimate targeted yield, average the yields of the four previous harvests for a given field and add five to 10 percent as an expected improvement factor.

The overall objective for considering manure and soil analyses, as well as cropping system components, is to determine an accurate manure application rate. A case study at the end of this section is presented to illustrate how all these components are integrated.

To determine crop nutrient requirements:

- Apply the manure with the highest nutrient content to crops with the highest nutrient requirements (see Figure 8.3).
- Generally legumes do not require additional N. Do not apply manure to legumes.
- Apply manure with the lowest nutrient content to fields closest to the manure storage site and the highest nutrient content to the farthest fields. This reduces the cost of hauling, as less manure will be needed when nutrient concentration is higher.

Figure 8.3 Nutrient Uptake and Removal by Various Crops

Crop		Yield Tonne* or kg/ha	N	P_2O_5	K_2O
			kg/ha		
Spring Wheat	Removal[1]	2,690	67	27	20
	Uptake[2]	2,690	95	36	82
Winter Wheat	Removal	3,360	55	29	19
	Uptake	3,360	76	35	80
Barley	Removal	4,300	87	38	29
	Uptake	4,300	124	50	120
Oats	Removal	3,810	69	29	21
	Uptake	3,810	120	46	164
Rye	Removal	3,450	66	28	22
	Uptake	3,450	103	52	147
Corn	Removal	6,280	109	49	31
	Uptake	6,280	171	71	145
Canola	Removal	1,960	76	41	20
	Uptake	1,960	126	58	91
Flax	Removal	1,510	57	18	17
	Uptake	1,510	80	22	49
Sunflower	Removal	1,680	61	18	13
	Uptake	1,680	84	29	41
Potatoes	Removal	45*	143	41	242
	Uptake	45*	255	75	334
Peas	Removal	3,360	131	39	40
	Uptake	3,360	171	47	154
Lentils	Removal	1,290	68	21	37
	Uptake	1,290	103	28	86
Alfalfa		11*	103	28	86
Clover		9*	255	75	334
Grass		7*	242	63	226
Barley Silage		10*	115	34	146
Corn Silage		11*	174	59	138

[1] Total nutrient taken up by the crop.
[2] Nutrient removed in harvested portion of the crop.

* Conversion of yields to metric units assumed the following bushel weights (in pounds per bushel): wheat = 60; barley = 48; oats = 34; rye = 56; corn = 56; canola = 50; flax = 56; sunflower = 30, peas = 60; and lentils = 38.
P_2O_5 x 0.4364 = P
K_2O x 0.8301 = K
kg/ha x 0.8924 = lbs./ac.
tonne/ha x 0.4461 = ton/ac.

Source: *Canadian Fertilizer Institute (Modified)*

8.5 Methods of Manure Application

Different methods of manure application have been developed to:

- Optimize nutrient availability.
- Minimize nutrient losses.
- Minimize odour.
- Optimize uniform manure spread.

Choosing a method of manure application depends on the physical characteristics of manure (liquid or solid), type of operation, handling and storage, type of spreader and cost.

The choice of application options can be determined by answering four key questions:

- Does this option optimize nutrient availability?
- Does this option minimize nutrient losses?
- Does this option minimize odour?
- Does this option allow for uniform manure spreading?

For solid manure, surface application with incorporation is the best management practice.

Incorporation can be achieved by knifing, plowing or discing. The sooner solid manure is incorporated, the lower the nitrogen loss to the air. Incorporation of solid manure considerably reduces odour nuisance. Incorporation also reduces the risk of nutrient losses by surface runoff. Research is currently underway to determine the method of manure incorporation that best protects surface water quality.

8.6 Time of Application

The best time to apply manure is before the early stages of crop growth. Spring application is the most desirable for Alberta conditions, as high nutrient availability coincides with crop uptake. However, in the spring, there are usually fewer opportunities to apply manure because of inclement weather conditions, risk of soil compaction and time required for other activities. The longer the period between manure application and maximum nutrient uptake by the crop, the greater the risk of nutrient losses. Within a given season, nitrogen losses in the form of ammonia from surface applications are higher on dry, warm, windy days than on humid and/or cold days.

Figure 8.4 **Timing of Manure Application**

Season	Watch For	BMP
Winter	• Runoff that can pollute surface water. • Environmentally sensitive areas. • Sloping topography. • Manure that soaks in too slowly on wet ground. • Wet soils that are prone to compaction.	• Manure should be going directly into storage. • Avoid application on frozen or snow-covered ground. • Avoid spreading on land with a history of floods or heavy runoff. • In case of emergency, apply on grass or winter cover crops or on areas of high crop residue where there is less danger of runoff or floods. • Apply only on level, non-sensitive areas and only in emergencies (see Figure 8.2).
Spring	• Wet soils that are prone to compaction. • Denitrification that happens in cold, wet soils. • Excessive application that can create a pollution hazard. • Very dry soil with large cracks where dissolved nutrients can flow into drainage systems or reach groundwater. • Heavy surface residue that slows the drying process of seedbeds. • Planting too soon after heavy manure application, which can create ammonia toxicity and reduce germination and seedling growth.	• Apply to land before seeding annual crops. • Apply to row crops as a side dressing after plants emerge. • Incorporate manure into soil within 48 hours of application. • Apply to well-drained soils. • Till very dry soil with large cracks before applying manure.
Summer	• Loss of nitrogen if there is no rainfall within 72 hours. Rain helps dissolve manure nutrients and allows them to infiltrate the soil. • Mature crops that are not growing; they don't need nutrients. • Application on forages and direct-seeded crops; see slope and setback distances in Figure 8.2.	• Apply to grasslands. • Apply lightly onto hay fields after cuttings. • Apply early enough to pasture to avoid trampling re-growth. • Compost manure to reduce odour and break up clumps.
Fall	• Denitrification in cold, wet soils. • Manure infiltrates soils slowly on wet fields; excess water will run off. • Wet soils that are prone to compaction. • Large dry cracks where dissolved nutrients can flow into the drainage system or reach groundwater.	• Apply to annual cropland before ground freezes and incorporate within 48 hours. Base application rates on soil tests and crop rotation for next year. • Apply to well-drained soils. • Till very dry soil with large cracks before applying manure.

Source: *Best Management Practices, Livestock and Poultry Waste Management: Agriculture and Agri-Food Canada and Ontario Ministry of Agriculture and Food, 1994.*

8.7 Calibration of Spreading Equipment

Spreading is an important part of manure management. The potential for over or under-application is significant, therefore it is crucial to correctly calibrate manure spreading equipment. If spreading equipment is not properly calibrated, manure application rates, even if based on manure and soil analyses, will be ineffective.

Spreading equipment calibration should address the rate and uniformity of application, both of which are concerns during the manure application process. Uneven distribution of nutrients in the field creates areas where crop yield may be depressed by either nutrient deficiency or excess. Another consideration is how to apply manure at the desired application rate.

The two main reasons for calibrating manure spreaders are:

- To provide information on the actual rate of manure application, and therefore the estimated nutrients applied.
- To enhance the precision of the application procedure. Speed and delivery rate are the parameters that need to be determined.

Before each use, calibrate the spreader according to manufacturer guidelines to ensure proper rate of application. Check all parts of the spreader to ensure they are in proper working order. Refer to Section 8.10 for more information on equipment calibration.

8.8 Record Keeping

Keeping records pertaining to all aspects of nutrient management is key to the success of a nutrient management plan. Documentation provides valuable information on the success of the nutrient management plan and may indicate areas of the operation where changes are needed. Complete records also help generate accurate, on-farm data that may be used to generate operation-specific information.

Records that must be kept for five years according to AOPA are:

- Volume or weight of manure production.
- If transferring or receiving manure from another operation, the name and address of the other operation, the date of the transfer and the weight of manure transferred.

If applying 300 tonnes or more per year, record the following:

- Legal land description of land to which manure is applied.
- Area of the land to which manure is applied.
- Weight of manure applied.
- Manure and fertilizer application rates by field and year.
- Dates of application and incorporation, and methods used for each field.
- Soil test results by field.

Additional records that would be helpful include:

- Farm manure production by animal type and production class.
- Manure analyses by type or by storage unit.
- Crops planted and yield by field and by year.
- Weather conditions.

8.9 Other Beneficial Management Practices

8.9.1 Determine soil limitations

Not all soils are the same. The same manure application rate will have different effects on different soils. When making decisions on manure application, consider the following factors related to soil type:

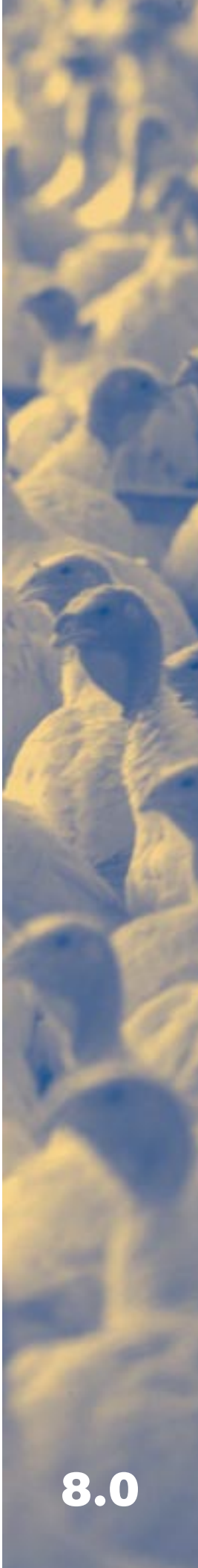
- Leaching potential.
- Runoff potential.
- Erodibility.

8.9.2 Determine proximity limitations

Manure and nutrients must be managed with more caution near open bodies of water, wells, rivers, creeks and drinking water to reduce the risk of contamination. Take into account connectivity to water sources, as well as runoff and erosion potential when applying manure.

8.9.3 Determine cropping system limitations

Extra precaution is needed when manure is used on reduced or no-till fields, pasture or crop cover. In these systems, incorporation of manure is only partially possible or is not possible at all. Therefore, the risk of runoff losses is relatively high, depending on the landscape. To minimize nutrient losses from these systems, land with low runoff potential should be considered the most suitable.



8.10 Manure Management Planning Case Study

The following example will illustrate, step-by-step, all the information reported in this chapter regarding nutrient management planning. This example is based on a hypothetical 60,000-broiler operation that applies manure from two distinct barns to four distinct fields.

In this example, phosphorus and potassium are expressed as phosphate (P_2O_5) and potash (K_2O), respectively.

STEP 1: Determine on-farm manure production.

Implementation of a nutrient management plan must start with an inventory of on-farm nutrient resources. Estimate manure production using storage capacity, or flock size and the average daily, monthly or yearly production rate per bird or 100 birds (See AOPA, *Standards and Administration Regulation,* Part 2, Schedule 3, Table 6 for solid manure; Table 7 for liquid manure).

Equation 1

Estimated manure production = (Number of birds) x [Amount produced per bird (or per 100 birds) per year]

Example:

Flock size: 60,000 broilers

The AOPA, *Standards and Administration Regulation,* Part 2, Schedule 3, Table 6 for solid manure production volume, gives the following amount of manure produced yearly:

- 0.99 tonnes/100 birds

Therefore:

Estimated Manure Production = 60,000 birds x 0.99 tonnes/100 birds = 594 tonnes/year

STEP 2: Analyse manure.

Example:

Manure will originate from two distinct piles or barns. The lab results for each are as follows:

Barn 1

Total N = 34.0 kg/tonne
Ammonium N = 18.0 kg/tonne
Total P = 9.7 kg/tonne = 9.7 x 2.29* = 22.2 kg P_2O_5/tonne
Total K = 8.5 kg/tonne = 8.5 x 1.20* = 10.2 kg K_2O/tonne

*See Unit Conversion Factors on last page of Section 9.

Barn 2

Total N = 30.0 kg/tonne
Ammonium N = 19.0 kg/tonne
Total P = 7.2 kg/tonne = 7.2 x 2.29* = 16.5 kg P_2O_5/tonne
Total K = 6.9 kg/tonne = 6.9 x 1.20* = 8.3 kg K_2O/tonne

*See Unit Conversion Factors on last page of Section 9.

STEP 3: Calculate available nutrients in manure.

Calculate available nutrients and ammonia loss in manure for the current year's application using the following equations:

Equation 2
Organic N = Total N – Ammonium N

Equation 3
Available N = (Organic N x 0.25) + [Ammonium N – (Ammonium N x Loss Coefficient)]
Assume 25 percent (0.25) of organic N becomes available for crop use.

Equation 4
Available P_2O_5 = Total P_2O_5 x 0.5
Assume 50 percent (0.5) of total P_2O_5 becomes available for crop use.

Equation 5
Available K_2O = Total K_2O x 0.9
Assume 90 percent (0.9) of total K_2O becomes available for crop use.

Figure 8.5 Predicted % Losses of Ammonium N Between Spreading and Incorporation of Manure Under Various Weather Conditions

Treatment	Average	Cool Wet	Cool Dry	Warm Wet	Warm Dry
			Spring/Summer		
Incorporated within 1 day (24 h)	25	10	15	25	50
Incorporated within 2 days (48 h)	30	13	19	31	57
Injected in season	5	5	5	5	5
Irrigation, incorporation within 3 days (72 h)	30	N/A	N/A	N/A	N/A
			Fall		
Early	66	40	50	75	100
Late	25	25	25	25	25
Cover crop if grown after manure application	35	25	25	40	N/A

Losses expressed as percentage of total ammonium N spread.

Source: AAFRD and LandWise Inc. 2002.

Example:

According to AOPA, *Standards and Administration Regulation,* Part 1, *Nutrient Management,* manure must be incorporated within 48 hours. Therefore, assume an average ammonium loss rate of 30 percent (0.30) (Figure 8.5).

Barn 1

Organic N = total N – ammonium N = 34 – 18 = 16 kg/tonne
Available N = (16 x 0.25) + [18 – (18 x 0.3)] = 16.6 kg/tonne
Available P_2O_5 = (22.2 x 0.5) = 11.1 kg/tonne
Available K_2O = (10.2 x 0.9) = 9.2 kg/tonne

Barn 2

Organic N = total N – ammonium N = 30 – 19 = 11 kg/tonne
Available N = (11 x 0.25) + [19 – (19 x 0.3)] = 16.1 kg/tonne
Available P_2O_5 = (16.5 x 0.5) = 8.3 kg/tonne
Available K_2O = (8.3 x 0.9) = 7.5 kg/tonne

STEP 4: Determine nutrient recommendations.

Determine nutrient recommendations based on soil tests, crops and expected yields.

Nutrient recommendations are provided in laboratory reports upon request. If not, contact an AAFRD specialist or private consultant to help interpret laboratory soil test results and to determine crop nutrient recommendations.

For a given field, a combination of AOPA, soil tests, crops and targeted yield data should be used to determine nutrient recommendations.

Example:

Figure 8.6 Hypothetical Nutrient Recommendations for Each Field in the Case Study

	Soil Tests			Nutrient Recommendations		
Field	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	lb./ac.					
1	22	34	475	180	35	0
2	56	34	475	110	35	0
3	45	17	475	190	65	0
4	90	34	150	55	45	65

Note: When reviewing a soil test report, be sure to note whether results for P are expressed as elemental phosphorus (P) or as phosphate (P_2O_5). To convert phosphorus to phosphate, simply divide the amount of phosphorus by 2.29.

STEP 5: Calculate residual available N.

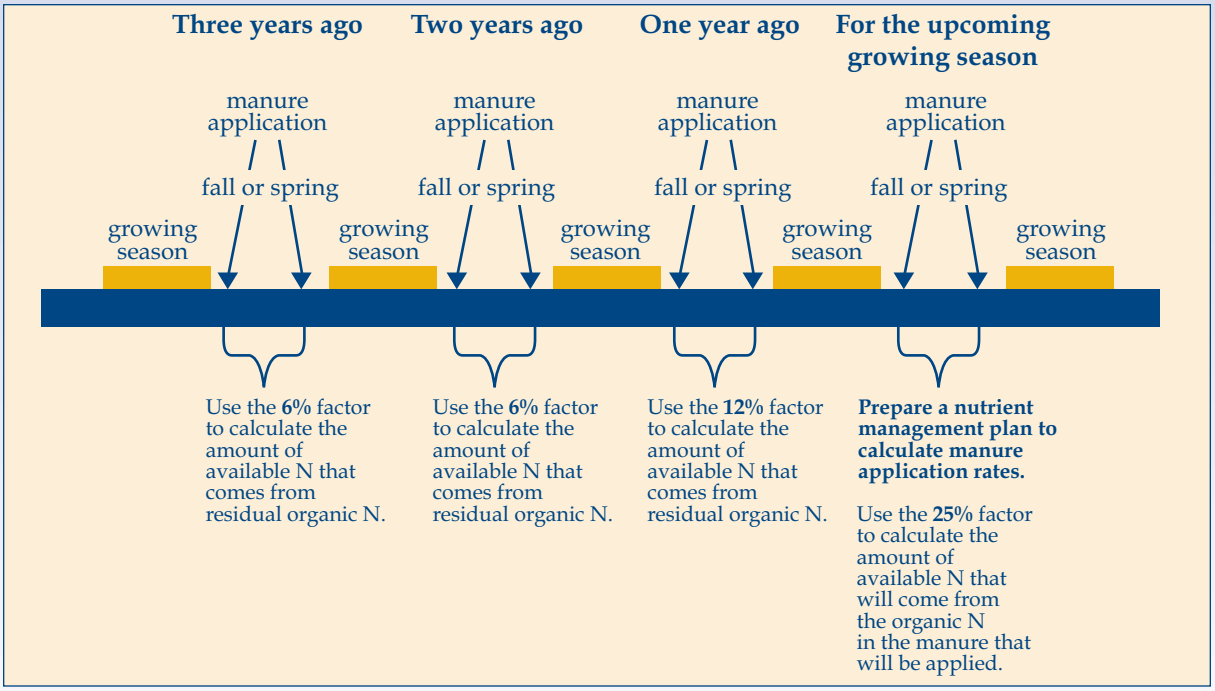
Assume that 12 percent and six percent of the organic N applied the previous year and two years ago respectively will be available for the upcoming crop. To calculate the residual available N from previous manure applications, use the following equation:

Equation 6

Residual N = (0.12 x Manure applied last year x Organic N content of the manure) + (0.06 x Manure applied two years ago x Organic N content of the manure)

Determine residual N in each field using the manure application data in Figure 8.7.

Figure 8.7 Pattern of Residual Organic N in a Soil from Several Annual Applications of Manure



Source: Barry Olson and Mohamed Amrani, AAFRD, Personal Communication, 2002.

8.0

Example:

Figure 8.8

Residual Nitrogen from Previous Manure Application

Field	Manure Applied		Organic N Content of Manure		Residual N
	1 year ago	2 years ago	1 year ago	2 years ago	
	---------- tonne/ha ----------		---------- kg/tonne ----------		kg/ha
1	38	0	4.9	0	22.3
2	0	45	0	6	16.2
3	22	0	6.3	0	16.6
4	0	0	0	0	0
Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*

Residual N from previous applications for each field is calculated as:

Field 1
Residual N = (0.12 x *Column 2* x *Column 4*) + (0.06 x *Column 3* x *Column 5*)
= (0.12 x 38 x 4.9) + (0.06 x 0 x 0) = 22.3 kg/ha

Field 2
Residual N = (0.12 x 0 x 0) + (0.06 x 45 x 6) = 16.2 kg/ha

Field 3
Residual N = (0.12 x 22 x 6.3) + (0.06 x 0 x 0) = 16.6 kg/ha

Field 4
Residual N = (0.12 x 0 x 0) + (0.06 x 0 x 0) = 0 kg/ha

STEP 6: Determine field and AOPA limitations.

It is important to determine the following field parameters and compare them to the AOPA limits before applying manure:

- Slope.
- Proximity to water body and connecting streams.
- Nitrate-nitrogen in soil.
- Soil salinity.
- Distance from manure storage (hauling distance).

Slope, proximity to water bodies and nitrate-nitrogen limits are discussed in AOPA, *Standards and Administration Regulation,* Part 1, *Nutrient Management.*

Figure 8.9 **Physical Characteristics of Fields in the Case Study**

Field	Area (ha)	Hauling Distance (km)	Field Limitations	AOPA Limitations
1	100	3	Slope 6%	With incorporation within 48 hours, 30 metres away from a common body of water or well.
2	150	4	Slope 4%	With incorporation within 48 hours, 30 metres away from a common body of water or well.
3	100	5	Forage	If less than 4% slope, must be 30 metres away from a common body of water or well.
4	50	0.3	None	With incorporation within 48 hours, 30 metres away from a common body of water or well. * Based on soil tests, if this soil was present in the Brown Soil Zone, nitrate-nitrogen content would be over the allowable limit and no manure application would be allowed on this field.

* Nitrate-nitrogen limits in AOPA.

STEP 7: Field prioritization.

This is where information is integrated to determine accurate rates that optimize economic return and minimize nutrient loss to the environment.

Example of factors to consider:

- The slopes in Fields 1 and 2 are steeper compared to other field slopes; therefore, manure application should take phosphorus into consideration.
- The cost of hauling manure to Fields 2 and 3 might be relatively high; therefore, manure from the barn or storage having the highest phosphorus nutrient content will be used.
- Field 3 is in pasture, and therefore incorporation is not an option. Consequently, application rate will be based on phosphorus (P).

Calculation of application rate for each field:

Field 1:

Due to the steep slope, this field manure rate will be based on P.
Figure 8.6 shows the phosphate recommendation is 35 kg/ha.

1. If manure from Barn 1 is to be used and the application rate is based on P:

Equation 7
Manure application rate (based on P) = [Recommended amount (Figure 8.6)] ÷ [Available phosphate in manure *(Equation 4)]*
Manure application rate (based on P) = 35 kg/ha ÷ 11.1 kg/tonne = 3.2 tonne/ha

Equation 8
Crop available N = [Available N *(Equation 3)* x Application rate] + Residual N *(Equation 6)*
Crop available N = (16.6 kg/tonne x 3.2 tonne/ha) + 22.3 kg/ha = 75.4 kg N/ha

Equation 9
Fertilizer N to be added = Recommended amount (from Figure 8.6) – [Crop available N provided by manure *(Equation 8)]*
Fertilizer N to be added = 180 kg/ha – 75.4 kg/ha = 104.6 kg N/ha

If manure is to be applied on N basis:

Equation 10
Manure application rate (based on N) = [Recommended amount (from Figure 8.6) – Residual N *(Equation 6)*] ÷ Available N *(Equation 3)*
Manure application rate (based on N) = (180 kg/ha – 22.3 kg/ha) ÷ 16.6 kg/tonne = 9.5 tonne/ha

Equation 11
Crop available P_2O_5 = [Available P_2O_5 *(Equation 4)*] x [Rate of application based on N *(Equation 10)*]

Phosphate applied would be = 11.1 kg P_2O_5/tonne x 9.5 tonne/ha = 105.5 kg P_2O_5/ha

This rate will result in an excess application of 70.5 kg/ha (105.5 kg/ha calculated versus 35 kg/ha recommended) of phosphate. The steep slope in this field means there would be a high risk of phosphorus runoff. Therefore, it is not recommended to base the manure application on N.

If supplemental phosphate were required it would be calculated as:

Equation 12
Fertilizer P to be added (if required) = Recommended amount (Figure 8.6) – [amount provided by manure, which is crop available *(Equation 11)*]

2. If manure from Barn 2 is to be used:

Manure application rate (based on P) *(Equation 7)* = 35 kg/ha ÷ 8.3 kg/tonne = 4.2 tonne/ha
Crop available N *(Equation 8)* = (16.1 kg/tonne x 4.2 tonne/ha) + 22.3 kg/ha = 89.9 kg/ha
Fertilizer N to be added *(Equation 9)* = 180 kg/ha – 89.9 kg/ha = 90.1 kg N/ha

Summary for Field 1: Manure application rate will depend on whether manure from Barn 1 (3.2 tonnes/ha) or Barn 2 (4.2 tonnes/ha) is used. It is recommended to apply manure from Barn 2 as this will reduce hauling costs. Manure from Barn 1 should be saved for fields that are closer to the manure storage.

Field 2:

Due to the steep slope and the field's close connection to surface water, this field manure rate will be based on phosphorus.

The phosphate recommendation for this field from Figure 8.6 is 35 kg/ha.

1) If manure from Barn 1 is to be used:

Manure application rate (based on P) *(Equation 7)* = 35 kg/ha ÷ 11.1 kg/ha = 3.2 tonne/ha
Crop available N *(Equation 8)* = (16.6 kg/tonne x 3.2 tonne/ha) + 16.2 kg/ha = 69.3 kg/ha
Fertilizer N to be added *(Equation 9)* = 110 kg/ha – 69.3 kg/ha = 40.7 kg N/ha

2) If manure from Barn 2 is to be used:

Manure application rate (based on P) *(Equation 7)* = 35 kg/ha ÷ 8.3 kg/ha = 4.2 tonne/ha
Crop Available N *(Equation 8)* = (16.1 kg/tonne x 4.2 tonne/ha) + 16.2 kg/ha = 83.8 kg/ha
Fertilizer N to be added *(Equation 9)* = 110 kg/ha – 83.8 kg/ha = 26.2 kg N/ha

Summary for Field 2: It is again recommended to apply manure from Barn 2 which may be applied at a higher rate, thereby reducing hauling costs.

Field 3:

Since this field is pasture, manure application rate will be based on phosphorus.

The phosphate recommendation for this field from Figure 8.6 is 65 kg/ha.

1) If manure from Barn 1 is to be used:

Manure application rate (based on P) *(Equation 7)* = 65 kg/ha ÷ 11.1 kg/tonne = 5.9 tonne/ha
Crop available N *(Equation 8)* = (16.6 kg/tonne x 5.9 tonne/ha) + 16.6 kg/ha = 114.5 kg N/ha
Fertilizer N to be added *(Equation 9)* = 190 kg/ha – 114.5 kg/ha = 75.5 kg N/ha

2) If manure from Barn 2 is to be used:

Manure application rate (based on P) *(Equation 7)* = 65 kg/ha ÷ 8.3 kg/tonne = 7.8 tonne/ha
Crop available N *(Equation 8)* = (16.1 kg/tonne x 7.8 tonne/ha) + 16.6 kg/ha = 142.2 kg N/ha
Fertilizer N to be added *(Equation 9)* = 190 kg/ha – 142.2 kg/ha = 47.8 kg N/ha

Summary for Field 3: The amount of manure and commercial N fertilizer will be affected by whether manure from Barn 1 or 2 is used on this field. Although applying manure from Barn 2 would keep hauling costs down, applying manure from Barn 1 would likely be preferred. Higher hauling costs would be offset by the reduced need for commercial fertilizer.

Field 4:

This field has no landscape proximity limitations. Based on soil tests, however, if this soil was present in the Brown Soil Zone, nitrate-nitrogen content would be greater than the allowable limit and manure application would not be permitted on this field. See AOPA, *Standards and Administration Regulation,* Part 1, *Nutrient Management.*

Nitrogen recommendations for this field from Figure 8.6 are 55 kg/ha.

1) If manure from Barn 1 is to be used:

Manure application rate (based on N) *(Equation 10)* = (55 kg/ha – 0 kg/ha) ÷ 16.6 kg/tonne = 3.3 tonne/ha
Crop available P *(Equation 11)* = 11.1 kg/tonne x 3.3 tonne/ha = 36.6 kg P_2O_5/ha
Fertilizer phosphate to be added *(Equation 12)* = 45 kg/ha – 36.6 kg/ha = 8.4 kg P_2O_5/ha

2) If manure from Barn 2 is to be used:

Manure application rate (based on N) *(Equation 10)* = (55 kg/ha – 0 kg/ha) ÷ 16.1 kg/tonne = 3.4 tonne/ha
Crop available P_2O_5 *(Equation 11)* = 8.3 kg/tonne x 3.4 tonne/ha = 28.2 kg P_2O_5/ha
Fertilizer phosphate to be added *(Equation 12)* = 45 kg/ha – 28.2 kg/ha = 16.8 kg P_2O_5/ha

Summary for Field 4: The decision whether to use manure from Barn 1 or Barn 2 will affect the recommended application rate. It is recommended that manure from Barn 1 be used in this instance, as this field is closer (i.e. relatively short hauling distance) and there would be less need for commercial phosphate fertilizer.

STEP 8: Manure and fertilizer needs per field.

Based on the calculations in the previous example, there will not be enough manure to meet the needs for all four fields as illustrated in Figure 8.10. Recommendations given on an individual field basis therefore need to be re-evaluated. One option may be to start by applying manure to closer fields or fields with fewer nutrient limitations, and continue to apply manure until it is all used. Based on this example, only one and a half to two fields will receive manure. Nutrient needs for the remaining area, which would not receive manure, would need to be entirely met with commercial fertilizers.

Figure 8.10 **Field Manure Requirements Versus Actual Manure Supply**

Field	Size (ha)	Manure Application Rate (tonne/ha)	Manure Required (tonne/field)
Field 1	65	4.2	273
Field 2	60	4.2	252
Field 3	60	5.9	352
Field 4	50	3.3	165
		Total Required (tonnes)	1,042
		Manure Available (tonnes)	594
		Manure Surplus (+)/Deficit (–)	**–448**

8.11 Appendix: Spreading Equipment Calibration

Simple method

Weigh several spreader loads of manure and determine the area in the field that is covered after spreading. Determine the weight of the spreader and try to fill each load to a similar level. Once calibration rate is determined (volume or weight/area), the spreading rate can be altered by adjusting the equipment and/or varying the ground speed.

Below are two methods for calibrating manure spreaders.

1) Calibrating for surface manure application. Determine volume or weight of manure and size of area to be spread with one full load (area in acres).
   - Weight can be determined by the difference in the spreader weight before and after spreading (be sure that the tank is completely empty).
   - Volume can be calculated using tank sizes.

   Therefore, application is calculated as:

   Application rate = (Volume or weight) ÷ unit area *Equation 11*

2) Application rate may also be calculated as:

   $$R = (43{,}560 \times C) \div (W \times D)$$ *Equation 12*

   Where:
   C = capacity of the spreader (in tons/gallons), from user manual or calculated from dimensions.
   W = width of spread (in feet).
   t = time (in seconds) it takes to empty one load (C).
   R = application rate (in tons or gallons/acre).
   D = distance (in feet) it takes to empty one load (C).
   - There are 43,560 square feet per acre.
   - There are 5,280 feet per mile.
   - There are 3,600 seconds per hour.

   Calculate distance to empty one load as:

   $$D = (43{,}560 \times C) \div (W \times R)$$ *Equation 13*

   Calculate speed as:

   $$\text{Speed} = (D + 5{,}280) \div (t + 3{,}600)$$ *Equation 14*

   If Equations (13) and (14) are merged,

   $$\text{Speed} = (t \times 43{,}560\ C) \div (3{,}600 \times 5{,}280 \times W \times R)$$ *Equation 15*

   $$\text{Speed (in mph)} = 29{,}700 \times [C \div (t \times W \times R)]$$ *Equation 16*

   Where:
   - t is in seconds
   - C is in gallons or tons
   - W is in feet
   - R is in gallons or tons per acre

Example:
Consider the following parameters:
- C = capacity of the spreader = 5,400 gal.
- W = width of spread = 12 ft.
- t = time it takes to empty one load (5,400 gal.) = 400 sec.
- R = application rate = 10,000 gallons/acre

Then,
Speed = 29,700 x [C ÷ (t x W x R)] (miles/hr.)
= 29,700 x [5,400 ÷ (400 x 12 x 10,000) = 3.34 miles/hr.

To calculate application rate from spreading speed, consider the following parameters:
- C = capacity of the spreader (in gal.)
- W = width of spread (in ft.)
- t = time it takes to empty one load (in sec.)
- Speed (in mph.)

Equation 16 can be rearranged to calculate actual application rate as follows:

$$R = 29{,}700 \times [C \div (t \times W \times Speed)] \text{ (ton or gal./acre)} \qquad \textit{Equation 17}$$

Where:
- t is in seconds
- C is in gallons or tons
- W is in feet
- Speed is in mile/hr.

Example:
- C = capacity of the spreader = 5,400 gal.
- W = width of spread = 12 ft.
- t = time it takes to empty one load (5,400 gal) = 400 sec.
- Speed = 4 miles/hr.

Then,
R = 29,700 x [C ÷ (t x W x Speed)]
= 29,700 x [5,400 ÷ (400 x 12 x 4)] = 8,353 gal./ac.

8.12 References

- AOPA.
- Canadian Fertilizer Institute. 2001. *Nutrient Uptake and Removal by Field Crops: Western Canada, 2001. Factsheet.* Available at: http://www.cfi.ca/uploaddocuments/d161+NU_W_01.pdf (Accessed: August 2003)
- Agriculture and Agri-Food Canada and Ontario Ministry of Agriculture and Food. 1994. Best Management Practices, Livestock and Poultry Waste Management.
- Alberta Agriculture, Food and Rural Development and LandWise Inc. 2002. Nutrient Management Planning for Livestock Curriculum.

9.0 DISPOSAL OF FARM WASTE

9.1 Disposal of Dead Animals

- **9.1.1** Destruction and Disposal of Dead Animals Regulations
  - **9.1.1.1** Storage
  - **9.1.1.2** Cleanup
  - **9.1.1.3** Burial
  - **9.1.1.4** Composting

9.2 Disposal of Veterinary Waste

- **9.2.1** Sharps
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9.3 Disposal of Chemical Farm Waste

- **9.3.1** Pesticides
  - **9.3.1.1** Pesticide disposal
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- **9.3.2** Handling and disposal of petroleum products (fuels and lubricants)
  - **9.3.2.1** Health and environmental risks
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9.4 Leaks and Spills

- **9.4.1** Fuel leaks/spills
- **9.4.2** Lubricant leaks/spills
  - **9.4.2.1** Disposing of waste lubricants
  - **9.4.2.2** Disposing of gylcols
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9.5 Options for Disposing of Contaminated Soils

- **9.5.1** Land spreading
- **9.5.2** Landfill
- **9.5.3** Burning

9.0 DISPOSAL OF FARM WASTE

Take-home messages in this section:

- Waste items on the farm should be managed with care to protect the environment and reduce nuisance potential.
- Under normal circumstances, mortalities may only be stored on-farm for 48 hours.
- Natural disposal is not permitted for birds that were euthanized with drugs or died of infectious disease.
- If burying carcasses, do it promptly to control odour, insects and scavenging.
- Take care when handling sharps to prevent injury.
- Regularly check all drugs to make sure they have not expired.
- Contact Alberta Environment for information on how to dispose of chemical waste.

9.1 Disposal of Dead Animals

9.1.1 *Destruction and Disposal of Dead Animals Regulations*

Refer to the *Destruction and Disposal of Dead Animals Regulations* under the *Livestock Diseases Act.* Copies are available through the Alberta Queen's Printer (www.gov.ab.ca/qp) or contact at qp@gov.ab.ca or (780) 427-4952 (toll-free in Alberta by dialing 310-0000).

Some death loss will occur on all poultry operations, regardless of how well they are managed. Disposing of dead birds quickly and effectively is important to reduce the risk of disease. Carcasses can act as a disease reservoir, and if scavenged by wildlife or pets, there may be a risk of disease being transmitted back to livestock or to humans. Handling mortalities properly is also important to maintain good relations with neighbours. Improperly handled carcasses can be an eyesore, a source of odour and can contribute to fly problems.

Destruction and Disposal of Dead Animals Regulations

The current *Destruction and Disposal of Dead Animals Regulations* require that all dead animals be disposed of within 48 hours by incineration, burying, rendering or composting. Natural disposal (scavenging) may also be used under special conditions, but this practice is not recommended for poultry because of the increased risk of disease transmission.

9.1.1.1 Storage

A dead animal may only be stored for more than 48 hours after its death if it is stored:

a) For not more than one week in an enclosed structure with impervious walls and floors that have been constructed for the storage of dead animals.
b) Outside during winter months when the ambient temperature is low enough to keep the dead animal completely frozen.
c) In a freezer unit.

There are restrictions on the use of composting, burial and natural disposal of poultry mortalities that must be followed in order to minimize the risk of disease spread and nuisance concerns. Composting, burial and natural disposal sites are all required to be located specific distances from waterways, well sources, major roads, residences and parks.

These sites must be on a producer's own property or property leased by the producer. Natural disposal is not permitted for carcasses from birds that have been euthanized with drugs and those known to have died from infectious (e.g. Salmonella) or reportable diseases.

Some operations use special storage bins, or refrigerate or freeze carcasses until they can be taken to a rendering facility. This reduces odour, keeps carcasses out of sight and prevents scavenging. Mortality storage areas should be located in areas that will minimize the spread of disease. For instance, carcasses can be stored in a secure bin at the entrance to the farm to prevent collection vehicles from entering the property.

For more information on disposal of poultry mortalities, refer to the *Destruction and Disposal of Dead Animals Regulation* or the following references:

- Poultry Mortality Disposal in Alberta.
- *Livestock Mortality Management (Disposal)* Agdex 400/29-1.
- *Livestock Mortality Burial Techniques* Agdex 400/29-2.
- *Poultry Mortality Composting* Agdex 450/29-1.

9.1.1.2 Cleanup

Ensure storage areas are thoroughly cleaned after each pickup and that wastewater does not run into streams or other surface water.

9.1.1.3 Burial

If burying carcasses, do it promptly to control odour, insects and scavenging. Burial may be difficult during winter conditions because of frozen ground. In such instances, store carcasses in a frozen state or have them picked up for rendering. Obstruct the burial pit area from view by using trees, shrubs or fences, and locate the area some distance away from livestock. Do not locate burial pits where runoff could contaminate surface water, or near wells or other water sources.

9.1.1.4 Composting

For more information on composting poultry mortalities, refer to the following resources:

- *Poultry Mortality Composting* Agdex 450/29-1.
- *Code of Practice for Compost Facilities under Waste Control Regulation* A. R. 192/96 developed and administered by Alberta Environmental Protection.

9.2 Disposal of Veterinary Waste

9.2.1 Sharps

Veterinary and laboratory materials capable of causing cuts or punctures are known as sharps. They include needles, syringes, scalpel blades, slides, cover slips, pipettes, broken glass and empty or expired pharmaceutical containers. There is a risk of needle stick injuries or cuts when these materials are not handled or disposed of properly. Certain drugs or vaccines may cause reactions or infections if they are present on broken glass or used needles that break the skin. Blood on used needles, collection tubes or other equipment may contain viruses or bacteria that can cause illness following a cut or needle stick injury. At present, there are no regulations governing the disposal of sharps in livestock production.

To safely dispose of sharps:

- **Separate sharps from other waste.** Injuries can occur when handling sharps on the farm or at the landfill if staff are unaware of their presence or if the sharps are not stored in rigid containers. Plastic bags are unacceptable.
- **Use a labelled, rigid container for sharps disposal.**
  - For needles and surgical blades, use a rigid plastic or metal puncture-proof container with a sealed lid. These special containers can be obtained at many local veterinary clinics. Label clearly as sharps containers and not for recycling. A plastic jug with a narrow mouth, or a 5-gallon (20-litre) pail with a narrow opening in the lid also work well. Injuries can occur if workers try to retrieve an object from the container, so use narrow-mouthed containers or make a small hole in a well-sealed lid. Ensure children and animals cannot remove the lid. Do not attempt to recap needles before disposal - this is a common cause of needle stick injury.
  - For pharmaceutical bottles and syringes, use a pail or other rigid container.
- **Remove waste from the farm.** Take pails of bottles and syringes and full containers of waste needles and surgical blades to the local vet clinic or hospital for disposal. Contact them first to ensure they accept sharps. There are also private companies that pick up medical waste. Contact a local vet clinic or hospital for information. Labelled, sealed containers can also be taken to Class 2 landfills (which accept medical waste, have perimeter fencing, etc.).
- **Do not burn sharps containers.**

9.2.2 Expired medicines

Regularly check all drugs for the expiry date. Expiry dates appear on the label as EXP 08 2000, for example, or as 01AUG00. All drugs past their expiry date should be discarded, since their safety and effectiveness can no longer be guaranteed.

Medicines that have not yet reached their expiry date sometimes need to be discarded as well. Products such as vaccines must be handled carefully (e.g. refrigerated) to maintain efficacy. If in doubt about how a product has been handled (e.g. vaccine left at room temperature overnight) and whether it is still safe and effective, consult a veterinarian.

On some vaccines, the label states "Use entire contents when first opened." The remaining vaccine should be discarded after vaccination is complete. For further information, consult a veterinarian.

Expired medicines may be grouped in two classes – unused (unopened) and used (opened). Unused, expired drugs can be returned to the point-of-purchase, such as the vet clinic. Many manufacturers take them back for disposal. Used, expired drugs can be discarded similarly to sharps. Render modified live virus vaccines non-infectious before disposing to prevent the virus from potentially infecting workers or animals. This can be done through freezing, autoclaving, incinerating or adding bleach to the bottle. When disposing of used or unused, expired medicines, do not attempt to empty or wash bottles. Discard them with their contents. Every May in Alberta, veterinary clinics collect outdated medications. Consult a local veterinarian to find out more about this program.

9.3 Disposal of Chemical Farm Waste

Chemical farm waste includes pesticides (herbicides, fungicides, insecticides, rodenticides), pesticide-treated seed, topical parasiticides (pour-on or powders for treating parasites), cleaners, disinfectants and petroleum products.

9.3.1 Pesticides

For complete details on safe pesticide use and disposal, consult the *Crop Protection Manual* (Agdex 606-1) available from AAFRD Publications Office, 7000-113 Street, Edmonton, Alberta T6H 5T6, 1-800-292-5697 toll-free) or by using the online order form at: www.agric.gov.ab.ca/forms/ordrfree.html.

9.3.1.1 Pesticide disposal

Unwanted or expired pesticides must be disposed of carefully. Pesticides are hazardous wastes and cannot be disposed of in sanitary landfills or by burning. If pesticide supplies cannot be used, offer them to neighbours. Pesticides with no further use must be disposed of as hazardous waste. Information on companies licensed to handle hazardous waste can be obtained from Alberta Environment's Recycle Information Line at 1-800-463-6326. Unused products can also be returned to the dealer.

9.3.1.2 Pesticide storage

Pesticides should be purchased on an as-needed basis and should not be stored on-farm over the winter. Read the label for specific storage instructions during temporary storage. Store pesticides in a cool, dry place in their original containers and protect them from freezing and excessive heat. Pesticide storage areas should consist of an impervious floor with curbs, no floor drains, an overpack container on-site and a supply of absorbent material such as sand or kitty litter.

Do not store pesticides near feed, food or fertilizers. Never store pesticides in well houses or feed mixing and milling rooms, and never store or mix these products within 30 metres of an open body of water.

Also, do not store pesticides around the home and ensure they are inaccessible to animals and children. Store products that are highly toxic to mammals, such as certain rodenticides and parasiticides, under lock and key.

9.3.1.3 Pesticide container disposal

Empty pesticide containers must be disposed of carefully. Unrinsed empty pesticide containers have the potential to contaminate ground and surface water, and can be toxic to fish and wildlife. Under the Alberta *Environmental Protection and Enhancement Act* (EPEA), non-refillable plastic or metal pesticide containers (restricted, agricultural and industrial products) must be disposed of at a pesticide container collection site. A list of pesticide container disposal sites in Alberta and their hours is available from each municipality, in the *Crop Protection Manual* and from Alberta Environment.

Containers must be clean (triple rinsed or pressure rinsed) and well drained (dry) before disposal. In most cases, triple rinsing leaves plastic, metal or glass pesticide containers more than 99 percent free (less than 1 ppm) of residues. For details on rinsing, consult the *Crop Protection Manual.*

Thoroughly empty and dispose of paper bags and cardboard containers in a sanitary landfill. Do not burn paper bags or cardboard containers. Outer packaging (e.g. cardboard box) can be burned or disposed of in a regular landfill. Some pesticide container sites have bins or separate areas for collecting outer packaging materials.

Some products are controlled under the *Pest Control Products Act* and it is an offence to use them other than as directed on the label. Do not reuse containers and ensure empty containers are made unsuitable for reuse. For specific information on the disposal of unused and unwanted product and the cleanup of spills, contact the regional office of Conservation and Protection, Environment Canada.

9.3.2 Handling and disposal of petroleum products (fuels and lubricants)

Fuels and lubricants can be toxic to humans, livestock, wildlife and fish. Proper on-farm storage and handling are necessary to limit risks to human and animal health and the environment.

9.3.2.1 Health and environmental risks

Gasoline and diesel fuel. In humans, skin contact with gasoline and diesel fuel can cause irritation or chemical burns, while breathing vapours can result in headaches, dizziness and nausea. These products are also possible carcinogens. Spilled fuel kills plant life and fish. Livestock will sometimes consume fuel, resulting in bloat and vomiting, depression, confusion, pneumonia and death, depending on the amount ingested. There is no effective treatment.

Waste lubricants. Waste lubricants include used motor oil, transmission fluid and power steering fluids. Like fuels, these products are petroleum distillates and may also contain heavy metals such as lead, arsenic, cadmium or chromium, which can be toxic or leave residues in meat. Wash all lubricants from exposed skin as soon as possible. Livestock will consume these products and therefore should not have access to them.

Ethylene glycol (antifreeze). Antifreeze is extremely toxic to the kidneys of livestock, pets, wildlife and people. Because of its sweet taste, it is palatable to certain animals, and given the opportunity, cattle and pets in particular may ingest large quantities. Shortly after ingestion, animals appear drunk, may vomit, become weak, convulse and die. Affected animals may survive if treated early, but generally ethylene glycol poisoning is fatal.

9.3.2.2 Financial/liability risks

Lending and insurance agencies are concerned about the environmental risks associated with fuel storage or spillage, as well as the storage of both new and used lubricants and glycols. Environmental assessments may be required before agencies approve loans or insurance policies. Fuel or lubricant spills may come under the jurisdiction of the EPEA and if deemed serious enough, appropriate cleanup measures may be required.

Storing and Handling Fuel on the Farm, published jointly by United Farmers of Alberta and AAFRD, provides more complete details on storage tank options, and the risks associated with fire, leaks, spills and evaporation. It can be obtained from AAFRD, Publications Branch, 7000-113 Street, Edmonton, T6H 5T6, phone: (780) 427-0391 (toll-free in Alberta 310-0000).

9.4 Leaks and Spills

Prevention is the preferred, lowest cost method of avoiding potential environmental problems.

To prevent environmental contamination:

- Maintain separation distances from buildings, ignition sources and propane tanks.
- Store combustible materials away from fuel storage tanks.
- Keep vegetation mowed.
- Monitor fuel storage tanks to catch leaks early.

9.4.1 Fuel leaks/spills

In the event that leaks and spills do occur, consider the following:

Underground tanks. In the event of a confirmed leak in an underground tank or line, contact Alberta Environmental Protection (1-800-222-6514) for the proper procedures to follow.

Above-ground. For an above-ground spill or leak:

- Maintain separation distances from buildings, ignition sources and propane tanks.
- Stop the flow of fuel. Remove all sources of ignition. Be prepared to use a fire extinguisher. Remember that gas vapours flow downhill and are extremely explosive.
- Contain the spilled fuel by damming with earth or another suitable absorbent material. Protect water sources and septic systems.
- Work from the upwind side to avoid inhaling vapours and becoming engulfed in flames if a fire starts.
- Clean up and dispose of all fuel by shovelling contaminated earth or absorbent material into metal or plastic containers. Be extremely cautious with sparks from contact with rocks, metal, etc. Dispose of contaminated cleanup materials in accordance with Alberta Environmental Protection guidelines (see: *Options for Disposing of Contaminated Soils*).
- Ensure that all ignitable vapours are dispersed before resuming normal activities.
- The law requires that all spills and leaks of 200 litres or more of gasoline or diesel fuel be reported to Alberta Environmental Protection. Smaller spills or leaks must also be reported if they have, or may have, an adverse effect on the environment. An adverse effect is defined in the EPEA as impairment of or damage to the environment, human health or safety, or property. Any leak or spill of any amount into a watercourse, body of water or groundwater must be reported.

9.4.2 Lubricant leaks/spills

Leaks or spills from lubricant drums or containers can be contained using a grated pan-pallet that the containers are stored on. Floor spills can be cleaned up with sawdust, rags or other absorbent material. Numerous commercial companies have specific products for preventing or cleaning up lubricant spills on concrete. For spills on soil, excavate the soil and dispose of it in accordance with Environmental Protection guidelines. (See 9.5 Options for Disposing of Contaminated Soils.)

9.4.2.1 Disposing of waste lubricants

Most bulk fuel agents accept waste oil, oil filters and oil containers, as well as solvents, cleaning fluids and glycols. Engine oil, transmission fluid, hydraulic fluid and power steering fluid can be combined, but must not contain water, solids, solvents or glycols. Most bottle depots also have facilities to accept smaller volumes of waste oil, filters and containers. Several large waste-oil companies will pick up waste oils on the farm, if the farm has about 1,000 litres of product per visit. Farmers may be paid one or two cents per litre, if the waste oils are not contaminated. These companies can be found in the Yellow Pages under Oil-Waste.

9.4.2.2 Disposing of glycols

Glycols (antifreeze) should not be drained onto the ground. Collect these in plastic containers and take to the depots mentioned above.

Ensure that the above products are not accessible to livestock, children or wildlife. Containers should be well labelled and have secure, childproof lids. Most cases of poisoning occur when these products are left out accidentally and are found by children or animals.

9.4.2.3 Motor oils or fuels

Motor oils and fuels should not come into contact with the skin of livestock. While these products were once recommended in the treatment of certain diseases, their ingestion in small quantities can produce illness or residue in the meat. Do not use these products to control dust in yard sites or on roads.

9.5 Options for Disposing of Contaminated Soils

9.5.1 Land spreading

Hydrocarbons are broken down satisfactorily by naturally occurring soil micro-organisms in conjunction with cultivation, organic matter (manure) and added nitrogen fertilizer. Specific information pertaining to the acceptable volume of contaminated soil that may be added to a given cultivated area, as well as the length of time required for degradation to occur, are currently under investigation. One acceptable treatment regime is to spread one inch of contaminated soil on a field surface with approximately 100 pounds of manure and 0.25 pounds of nitrogen per 100 square feet, and then to roto-till to a depth of five inches. Work the area (aerate) every four weeks for at least one year to ensure adequate breakdown of fuels and for two or more years for the breakdown of waste oils.

9.5.2 Landfill

Haul contaminated soil to an approved landfill site. Contact the landfill authority to ensure that this is acceptable.

9.5.3 Burning

Approved mobile thermal extractors can be used because they have the proper after-burners to completely combust all hydrocarbons and heavy metals. Names of companies providing this service can be obtained from Alberta Environment. Openly burning contaminated soil or cleanup materials is not an approved method of disposal.

UNIT CONVERSION FACTORS

Laboratories report test results using different units. To properly calculate manure or fertilizer application rate, it is crucial to understand the units expressed in the laboratory report.

Abbreviations:

- Phosphorus is elemental P.
- Phosphate is P_2O_5, which is a fertilizer unit.
- Potassium is elemental K.
- Potash is K_2O, which is a fertilizer unit.
- Nitrogen is N.
- Organic nitrogen is organic N = total N – inorganic N (or ammonium N).
- Total nitrogen is total N = organic N + inorganic N.
- Inorganic N (also called mineral or plant-available N) is ammonium N and nitrate N.
- Most of the inorganic N in manure is in ammonium form.

Units:

- 1 kilogram (kg) = 2.205 lb = 35.28 ounces = 1,000 milligrams (mg)
- 1 km = 1,000 metres (m) = 3,281 feet = 39,370 inches = 0.6214 miles
- 1 m^3 = 1,000 litres (L) = 220 gallons (Imperial) = 264.2 gallons (U.S.)
- 1 hectare (ha) = 10,000 m^2 = 107,639 $ft.^2$ = 2.471 acres
- 1 kg/ha = 1.12 lb./ac.
- 1 tonne = 1,000 kg = 2,205 lb. = 1.1025 tons (short)
- 1% = 10 kg/tonne = 10,000 mg/kg = 10,000 parts per million (ppm)
- 1 ppm = 1 mg/kg (solid) or 1 mg/L (liquid)
- 1 lb. (or kg) of P = 2.29 lb. (or kg) of P_2O_5
- 1 lb. (or kg) of K = 1.2 lb. (or kg) of K_2O
- 1 ppm N, P or K (in 6 inches or 15 cm soil depth) is approximately equal to 1.8 lb. of N, P or K/ac. = 2 kg of N, P or K/ha.
- 1 ppm N, P or K (in 12 inches or 30 cm soil depth) is approximately equal to 3.6 lb. of N, P or K/ac. = 4 kg of N, P or K/ha.

For example:
If a lab report shows that P content in soil is 20 ppm in the top 15 cm, this is equivalent to 40 kg P/ha. or 36 lb. P/ac.

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