BENEFICIAL MANAGEMENT PRACTICES

Environmental Manual for Hog Producers in Alberta

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ALBERTA PORK

Alberta
AGRICULTURE, FOOD AND RURAL DEVELOPMENT

FOREWORD

Beneficial Management Practices: Environmental Manual for Hog Producers in Alberta

These farm practices guidelines were developed for Alberta pork producers through the cooperation of industry, government and interested stakeholders to create greater awareness and understanding of beneficial management practices for the environment for pork 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 hog producers 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 pork 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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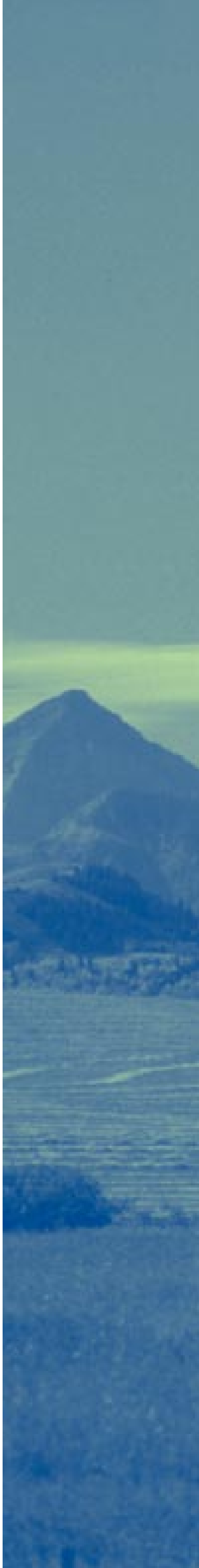

Disclaimer

The primary purpose of the *Beneficial Management Practices: Environmental Manual for Hog 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 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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BENEFICIAL MANAGEMENT PRACTICES: ENVIRONMENTAL MANUAL FOR HOG PRODUCERS IN ALBERTA

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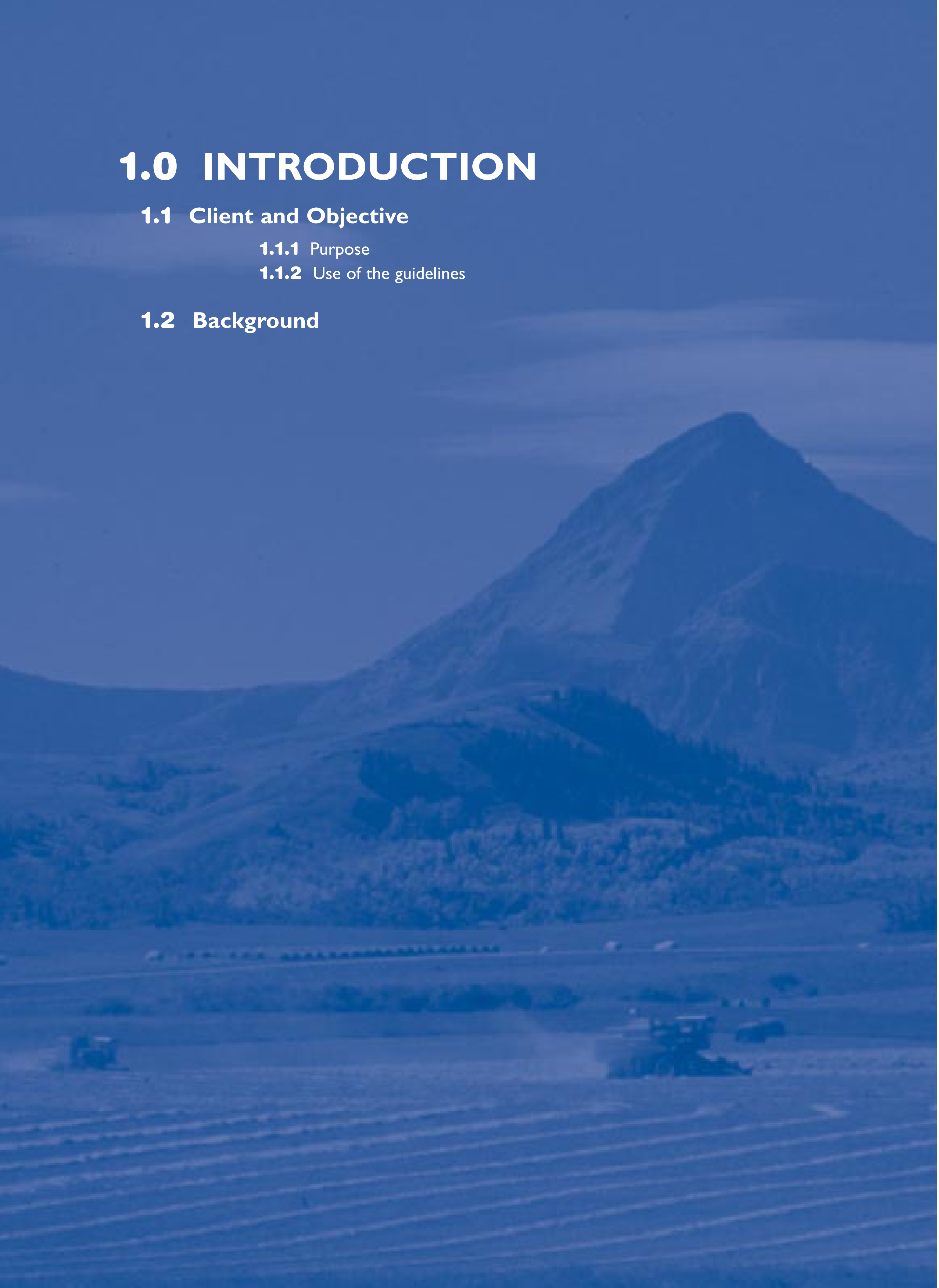

1.0 INTRODUCTION

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1.2 Background

1.0 INTRODUCTION

1.1 Client and Objective

This document was prepared for Alberta hog producers.

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

- The potential risks of livestock production on air, water and soil.
- 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 *Beneficial Management Practices: Environmental Manual for Hog Producers in Alberta* is to document, for producers and society, management options that are environmentally sound, comply with existing regulations and are economically obtainable.

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

With the hog industry's commitment to advancing management practices, as demonstrated in the evolution of hog 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 pork 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 who do not possess a strong knowledge of pork production should not assess an operation based solely on this publication.

1.2 Background

In the past twenty years, Alberta's hog industry has undergone significant changes, both in size and production methods. Hog production is a specialized industry that is highly integrated with crop production. In many cases, hog operations have become much larger and more capital intensive.

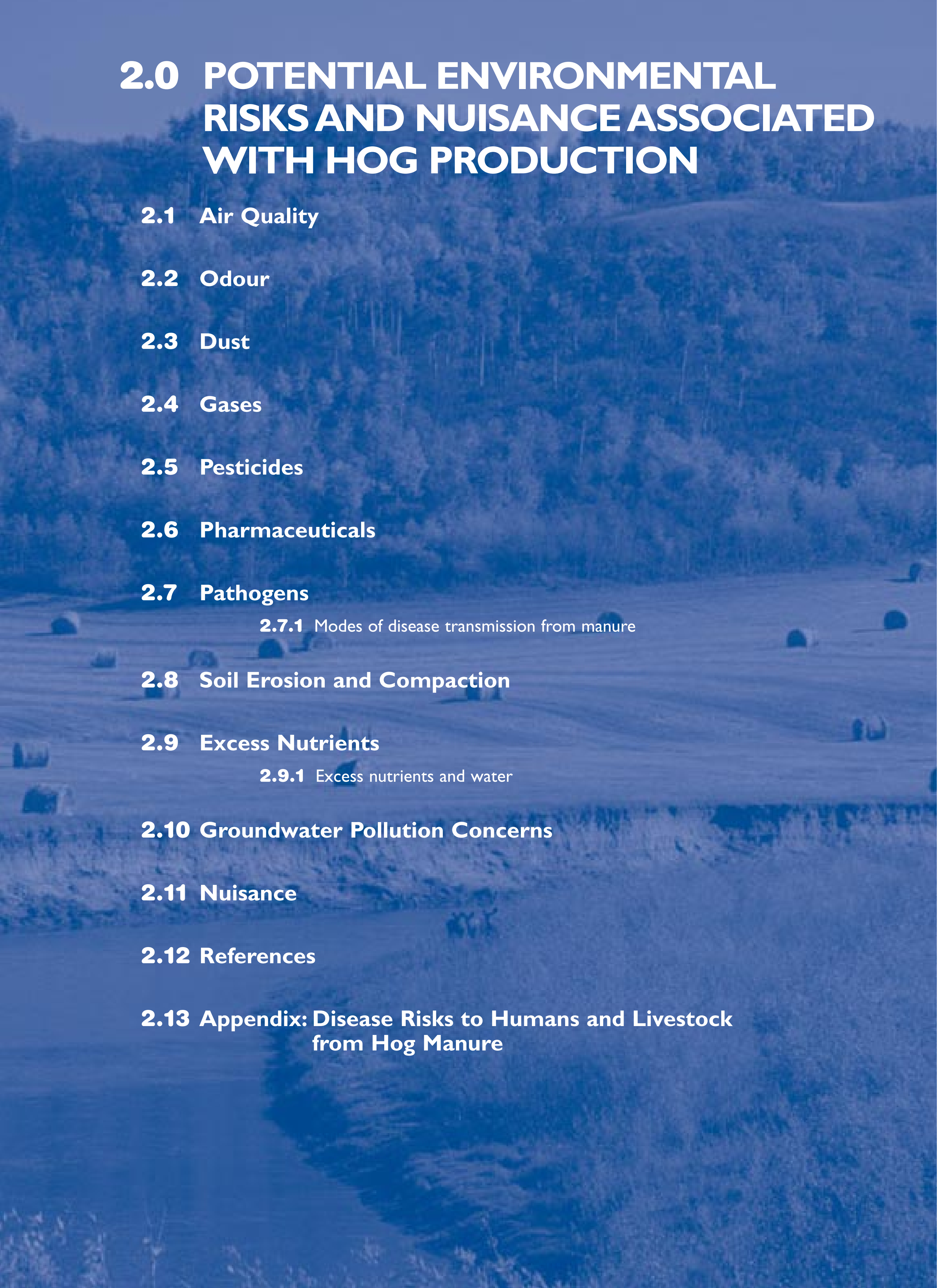
At the same time, the character of Alberta's rural residential population has also seen significant changes. New rural housing represents a major personal investment and owners are sensitive to any activity that may affect enjoyment and/or property value.

The combined result of the changes in the hog industry and in rural residential development has occasionally created conflicts. 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. Hog producers must be aware of this attitude shift and give it due consideration in the management of their operations.

Alberta Pork, along with its many partners, is leading efforts to maintain and develop an environmentally responsible, sustainable and prosperous pork industry. It is continually developing practices, standards and guidelines to assist the pork industry to be environmentally sustainable, globally competitive and publicly acceptable.

Furthermore, hog producers have a greater understanding that, to remain competitive in world markets, those involved in the production of pork 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.


1.0



2.0 POTENTIAL ENVIRONMENTAL RISKS AND NUISANCE ASSOCIATED WITH HOG PRODUCTION

2.0 POTENTIAL ENVIRONMENTAL RISKS AND NUISANCE ASSOCIATED WITH HOG PRODUCTION

2.1 Air Quality

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

Gases and particulate matter are of the greatest concern to the people working directly with livestock, because these people are exposed to the highest concentrations of contaminated air. In general, neighbours are at a 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 human 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 directly 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 hogs 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 may have different indicators.
- 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 strive to reduce the nuisance to neighbours, by minimizing the frequency, intensity, duration and offensiveness (FIDO) of odours.

2.3 Dust

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

- Organic dust is biologically active and may react in the respiratory tract of humans and hogs. Organic dust includes hog dandruff, dried manure and urine, feed, mold, fungi, bacteria, and endotoxins produced by bacteria and viruses. Seventy to 90 percent of the dust in animal housing is organic.
- Inorganic dust is composed of numerous 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 Administration (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 in the size category of less than 10 microns. Exposure to fine particles of dust, less than 10 microns, can cause eye and throat irritation and can potentially contribute to respiratory conditions, such as asthma or chronic bronchitis. Organic airborne particles in hog barns generally have a 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 does not represent a direct health risk to neighbours, because the survival rates of airborne micro-organisms between the source and the neighbours is considered very low and the dilution factor of the air high. However, airborne particulate matter can contribute to odour and dust, and may be a carrier of odour.

2.4 Gases

Gases emitted from livestock operations may have an impact on global warming, acid rain, nuisance odour and water quality. Gases can be generated in the barn, and during manure storage and land application. These gases 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." Water vapour, carbon dioxide (CO_2), methane (CH_4), halocarbons (used in refrigerants), and nitrous oxide (N_2O) 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 global warming.

The bulk of agricultural emissions are N_2O and CH_4 and the majority of emissions from hog production come from manure.

Although the intensity and offensiveness of an odour may be high, it is not necessarily an indication of the presence of greenhouse gases. Research is required to establish if there is a relationship between greenhouse gases and odours.

Figure 2.1 **Properties and Effects of Gases Emitted From Pork Production**

Gas	Source	Properties
Ammonia (NH_3)	• manure decomposition, composting, commercial fertilizer handling, storage and manure application	• sharp, pungent odour (glass cleaner) • lighter than air
Hydrogen sulphide (H_2S)	• bacterial decomposition of 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
Methane (CH_4)	• decomposition of manure without oxygen (anaerobic)	• no smell • lighter than air
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
Nitrogen oxides** (NO_x)	• NO_x naturally generated by bacterial processes, decomposition, and fires • humans contribute primarily through burning fossil fuels • hog manure emits more N_2O than other livestock in Alberta	• 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
Trace gases associated with odour	• anaerobic decomposition of manure	• often have distinct smells

2.5 Pesticides

Pesticides include insecticides, herbicides, fungicides and rodenticides. Pesticides can be a risk to non-target organisms, applicators and workers, if these products are not handled and applied properly. During pesticide application, spray droplets, mists or vapours may form. These airborne particles can drift and contaminate adjoining properties and water. 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 eliminate beneficial insects, inhibit crop growth and

Health Effect		Environmental Effect
Concentration	**Symptom**	
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 formation of airborne particulates •may react with other compounds potentially leading to acid rain and ozone depletion
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
50,000 ppm 500,000 ppm	•explosive when mixed with air •can cause headaches and eventually asphyxiation when oxygen is displaced	•a greenhouse gas that may contribute to global warming
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 min.	•removed from the air by photosynthesis and ocean absorption •a greenhouse gas that may contribute to global warming
	•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 •may deplete ozone
•in low quantities, these compounds are not considered a serious threat to human health		•contributes to odour •may form airborne particulate matter

** Threshold Limit Values (TLV) 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).*

reduce viable crop varieties. Domestic animals and wildlife may be harmed by eating contaminated crops or soil. Pesticides that accumulate in plant and animal tissue can make food unfit for human consumption. Pesticides have great potential to pollute both surface and groundwater. Water pollution from pesticides can be the result of drift, runoff, leaching, erosion of contaminated soil, spills and direct introduction. The severity of pesticide contamination depends on the pesticide toxicity and management.

2.6 Pharmaceuticals

A range of pharmaceutical products, including antibiotics, dewormers and reproductive hormones (for the breeding herd) are used in the swine industry. Most of these products are completely broken down in the animal's body and do not present a risk to the environment. However, concern has surfaced that some of these products could find their way from livestock manure into the environment and have a negative impact on the ecosystem. Two specific areas of concern are:

- Reproductive hormones that could act as endocrine disruptors. Endocrine disrupters are chemicals that affect the function of the body's endocrine system. They may cause health problems, reproductive failure and developmental abnormalities in both humans and wildlife. There are many other sources of endocrine disruptors in the environment, including phytoestrogens (from plants), mycotoxins (from molds), and man-made chemicals that imitate certain hormones, for example, birth control pills.
- Antimicrobial medications that may be excreted into the environment in an active form. This could potentially alter the population of bacteria in the environment or select for the development of drug-resistant bacteria.

There is little evidence to confirm that either of these concerns is a significant issue at this time. The risk to the environment from pharmaceuticals is low. Drug residues are excreted at very low levels and are then diluted with water and manure from other untreated animals. Drug residues are further diluted when the manure is spread on the land. Because the amount of drugs present is extremely small, the concentrations in hog manure may not be high enough to have any effect on animals that come in contact with the residue. Thus far, there has been no evidence that residues from pharmaceuticals used in hog production have created problems with the health of humans, wildlife or the environment. Research is ongoing to evaluate the potential environmental risk associated with certain antimicrobials and reproductive hormones.

2.7 Pathogens

In recent years, outbreaks of waterborne diseases have occurred in humans in North America and, in many 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 agriculture, two things are certain. Poorly handled manure can result in waterborne disease in humans. Other sources of contamination, such as human sewage, are also responsible. It is critical that manure is handled appropriately to minimize the risk of disease to both livestock and humans.

There are a wide range of micro-organisms present in hog manure, including bacteria, viruses, protozoa and other parasites. Under certain conditions, some of these can cause disease in humans or other livestock. Many of these organisms are also present in human sewage and in the feces of other livestock, pets and wildlife.

Currently in Alberta, hog manure is not considered a major source of disease for humans or other livestock. There are three main reasons for this. First, many infectious diseases of hogs that occur in the rest of the world are not found in Canada (See Section 2.13 Appendix). Second, modern production practices and drinking water supply systems reduce the risk of disease transmission. Third, the hog density in Alberta is very low compared to the major hog-producing provinces and countries.

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, and cause disease in both, are referred to as zoonoses or zoonotic diseases.

Air. There are no diseases in Alberta that can be transmitted from hog manure through the air to humans or other livestock that are outside the hog barn. The odour of hog manure alone cannot cause infectious disease.

Swine Influenza Virus (SIV) is the only zoonotic disease found in Alberta that can potentially be transmitted through the air to humans. Direct contact with infected hogs or working inside barns infected with SIV is necessary to contract the disease. People outside barns are not considered at risk, because the virus is highly diluted in the air. Airborne transmission of certain diseases that only affect hogs, such as Transmissible Gastroenteritis (TGE), does occur in Alberta.

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 can occur through consumption of drinking water contaminated by livestock or wildlife manure, grazing on pasture recently spread with manure or by ingesting manure.

Humans can ingest manure pathogens through consumption of contaminated drinking water, swimming in contaminated surface water and by failing to wash their hands after handling infected livestock or manure. People most at risk of zoonotic disease are those working in barns or handling manure.

The main public health concern related to manure handling is contamination of surface water. In order for manure pathogens to cause disease through water contamination, several steps need to occur. If any one of these steps is blocked, then transmission will not occur.

- First, the pathogen has to be excreted by the hog. Not all pathogens are found in every herd and some can be reduced by management or medication.
- Second, the pathogen has to reach a water supply either by the animal defecating in the water, or by manure entering surface or groundwater through runoff.
- Third, the pathogen must remain alive and capable of causing infection by the time it is ingested. Heat, cold and dryness can destroy many pathogens in a short period of time.
- Fourth, the pathogen must be ingested in high enough numbers to cause an infection. Some organisms, such as *Salmonella*, must be ingested in very high numbers to cause disease, whereas only a few *Cryptosporidium* organisms may cause disease.

Often it is 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 many sources and using new diagnostic techniques to determine the strain of the organism are usually necessary to pinpoint the source of disease, although they still are not definitive. Refer to Section 2.13 Appendix for a full description of pathogens that may be present in hog manure in Alberta.

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 when winds are strong enough to move soil particles. Wind and water erosion can cause environmental problems if soil nutrients or fine-grained material, such as silt and clay, enter water bodies.

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. However, excessive tillage leading to compaction 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, and potassium. Excess nitrogen and phosphorus can cause soil and water quality problems. Excess potassium on forages can result in reduced feed quality. An overabundance of these nutrients can result in toxicity to plants and reduce crop yields. As well, nutrients that are not used by plants can leach out of the root zone and contaminate groundwater or 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. Eutrophication is the nutrient enrichment of surface waters. The most visible effects of eutrophication are massive blooms of algae and other aquatic plants. When algae and aquatic plants die, oxygen can be depleted, reducing fish survivability. Bluegreen algae can be toxic to domestic animals and humans when injested. These also can deplete oxygen levels in surface waters.

Nitrates in drinking water. Nitrate is formed through the nitrification process from the mineralization of organic nitrogen to ammonium and from ammonium to nitrite. Nitrate is a form of inorganic nitrogen that is soluble in water and is readily used by plants. Nitrate is very soluble in water and tends to move quickly down through the soil profile. Consequently, nitrate can concentrate in shallow groundwater.

Sources of nitrate in water include natural sources (e.g. peat bogs), commercial fertilizers (e.g. anhydrous ammonia), domestic sewage systems and manure. Studies in Alberta have shown that high levels of nitrate from livestock and land application of fertilizer or manure can be transported to 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 for infants less than one year old, although this has rarely been reported.

2.10 Groundwater and Pollution Concerns

Groundwater. Groundwater is the water that occurs in the pore spaces of soil and rocks. Aquifers are water-bearing layers that hold groundwater in usable amounts. Typical aquifers are overlain by deposits such as clay or shale. Unconfined aquifers or water table aquifers are close to the ground surface and exposed directly 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 risk of contamination for confined aquifers is through direct movement of contaminants into the well from the wellhead or improperly maintained well casing. Manure or chemical spills or seepage into the well 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.

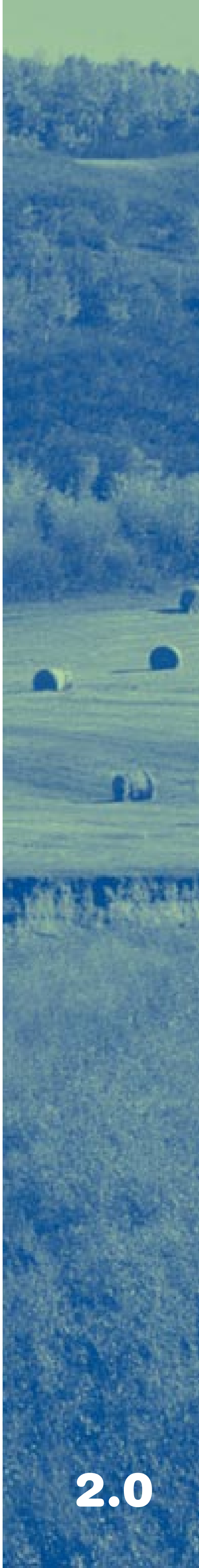
Salt. Salt levels, as shown by electrical conductivity measurements and sodium adsorption ratios, can increase in soils after successive manure applications. Manure can contain salts from the water used for livestock watering or from salts and minerals in feed. In many cases, nutrients, such as nitrogen, phosphorus and trace elements are less likely to limit manure applications on a field than salt levels. Sodium, in particular, can cause problems with the soil, since it can cause structural changes in the soil and is 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. Metals may contaminate groundwater, move into surface water and accumulate in fish tissue, making them unsuitable for human consumption.

Petroleum products. Gasoline, antifreeze, paints, solvents, hydraulic fluids and other oil-based substances can have 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. Also, petroleum products can 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 chapters may minimize irritation to neighbours.



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2.13 Appendix: Disease Risks to Humans and Livestock from Hog Manure

Overview

Hog manure contains a wide range of micro-organisms, including bacteria, viruses, protozoa, and parasites. Under certain conditions, some of these can cause disease in humans or other livestock. Many of these organisms are also present in the feces of other livestock, pets, and wildlife and in human sewage.

Currently in Alberta, hog manure is not considered a major source of infectious disease for humans or other livestock. There are three main reasons for this. First, many infectious diseases of hogs that occur in the rest of the world are not found in Canada. Second, modern production practices and drinking water supply systems prevent many diseases from being transmitted. Third, the density of hogs in Alberta is very low compared to the major hog-producing provinces and countries.

In recent years, many large outbreaks of waterborne disease have occurred in humans in North America. The increase in intensive livestock production has often been blamed. While it is not yet known how much of the problem can be attributed to agriculture, two things are certain: poorly handled manure can result in waterborne disease in humans; other sources of contamination (such as human sewage) are also responsible. It is critical that manure be handled appropriately to minimize the risk of disease to both livestock and humans.

How disease is transmitted from manure

Disease-causing mico-organisms are referred to as pathogens. Diseases that can be transmitted from animals to humans are referred to as zoonoses or zoonotic diseases. Manure pathogens are most often transmitted by the fecal-oral route (i.e. ingestion of manure or manure-contaminated feed or water). In livestock, this can occur through consumption of drinking water contaminated by manure, grazing on pasture recently spread with manure, or when they have direct access to manure. Humans can ingest manure pathogens through consumption of contaminated drinking water, swimming in contaminated surface water, and not washing hands after handling infected livestock or manure. People most at risk of zoonotic disease are those working in barns or handling manure.

There are no diseases in Alberta that can be transmitted from hog manure through the air to humans or other livestock that are outside the hog barn. The odour of hog manure alone cannot cause infectious disease. Swine Influenza Virus (SIV) is the only zoonotic disease in Alberta that can be transmitted through the air to humans. Direct contact with infected hogs or working inside barns affected with SIV is necessary to contract the disease. Those working outside barns are not considered at risk as the virus is diluted in the air. Airborne transmission of certain diseases that affect only hogs does occur in Alberta.

Contamination of surface water is the main public health concern when handling manure. In order for manure pathogens to cause disease through water contamination, several steps need to occur. If any one of these steps is blocked, then transmission will not occur.

- The pathogen has to be excreted by the hog - not all pathogens are found in every unit, and some can be reduced by management or medication.
- The pathogens has to reach a water supply either by the animal defecating in the water, or from surface runoff, or from contaminated groundwater flow.
- The pathogen must remain alive and capable of causing infection until the time it is ingested. Heat, cold and dryness can destroy many pathogens in a short period of time.
- The pathogen must be ingested in high enough numbers to cause infection. Some organisms, such as *Salmonella*, must be ingested in very high numbers to cause disease, whereas only a few *Cyrptosporidium* organisms may cause disease.

It is frequently difficult to determine the source of a waterborne outbreak of disease. Many of the same disease-causing micro-organisms are found in wildlife, pets or human sewage. Therefore, if testing finds the suspect organism in one location, it cannot be automatically assumed this was the source. Testing many sources and using new diagnostic techniques to determine the strain of the organism are usually necessary to pinpoint the source of disease.

Pathogens in hog manure in Alberta

Several classes of pathogens may be present in hog manure in Alberta:

- Viruses.
- Bacteria.
- Protozoan parasites.
- Helminth parasites (worms).

Viruses

Most hog viruses found in Alberta infect only hogs and are not considered a risk to humans or other livestock. Most viruses are also easily destroyed once outside the body and do not survive long in manure. Therefore, viruses in hog manure are not considered a significant disease risk at this time.

In Canada, the only virus that can be transmitted between hogs and humans is the Swine Influenza Virus (SIV). This virus occurs in Alberta and is a risk for those working in infected hog barns, or in direct contact with infected hogs. SIV causes flu-like symptoms and respiratory disease that lasts several days in humans. This virus does not survive well outside the hog or the hog barn, especially in Alberta's dry, cold climate. SIV is, therefore, a minimal risk for those not entering hog barns.

Bacteria

Bacteria that may be present in hog manure in Canada that can cause disease in humans include:

- *Escherichia coli* (*E. coli*).
- *Salmonella species.*
- *Campylobacter coli.*
- *Yersinia enterocolitica.*
- *Leptospira sp.*

These bacteria can be transmitted to humans through contaminated drinking water, contaminated food, or from direct contact with manure or infected animals. The first four pathogens can cause diarrhea, fever, cramps, vomiting and occasionally death in humans. Infection from these organisms (except *Leptospira sp.*) is more often traced to consumption of contaminated food products than waterborne disease. Contamination of food can occur during processing or handling by the consumer, and is not confined only to meat or dairy products. Contaminated fruits and vegetables have also been sources of infection.

Many of these organisms are found in other livestock and wildlife manures, as well as human sewage. Normal healthy livestock may carry these bacteria without any signs of illness. The number of bacteria in manure declines over time while in storage. Bacteria can survive for varying lengths of time in the soil after application, but are generally destroyed by exposure to heat, cold, sunlight and drying. More research is needed to fully understand the survival of bacteria in soils and surrounding watersheds after manure spreading. Adequate manure storage and proper handling is necessary to prevent surface and groundwater contamination with these organisms. Municipal water treatment systems are capable of removing these bacteria from the water supply.

Producers should practice good hygiene when handling manure and livestock (hand washing, etc.). Manure should be stored, handled and spread to prevent contamination of waterways. The elderly and those individuals with compromised immune systems should avoid contact with livestock and manure.

Escherichia coli (E. coli). Many strains of *E. coli* are beneficial to human health and live in the gut of all healthy animals. However, some strains, such as *E. coli* O157:H7, can cause severe disease and even death. Infection with O157:H7 causes bloody diarrhea and can progress to a life-threatening complication known as hemolytic uremic syndrome (HUS). This infection is particularly dangerous for children and the elderly. Outbreaks have occurred from contaminated drinking water. *E. coli* O157:H7. has been found in hog manure, but only rarely. Cattle feces are acknowledged as the main source of this organism.

Salmonella species. There are a large number of species of *Salmonella*. Some strains infect only one animal species, while others are able to infect humans and a wide variety of domestic and wild animals, birds and reptiles. Infected hogs can carry the bacteria without any signs of illness. Outbreaks of diarrhea and death can occur and are usually triggered by stresses such as overcrowding. Recently, new *Salmonella* strains have evolved that are resistant to many antibiotics (multi-drug-resistant *S. typhimurium DT 104*). These are of great concern, as they are difficult to treat. There is speculation that these strains are evolving in response to antibiotic use in livestock.

Research has shown that about one-third to one half of hog farms in North America may have *Salmonella*. This varies by region. On most farms that test positive for *Salmonella*, only a few animals will shed the bacterium. On a few farms, many positive samples from hogs and the environment can be obtained. The barn environment, including dust, rodents or birds, can also harbour *Salmonella.*

The main concern with *Salmonella* in swine is food-borne disease rather than waterborne disease. Research is underway to find methods to control or eliminate *Salmonella* on hog farms, especially those farms that are heavily infected. Denmark has a stringent testing and control program in place to keep *Salmonella* levels low. Current recommendations on reducing *Salmonella* in hog barns include maintaining high standards of hygiene, reducing rodent and bird access and reducing mixing of hogs. The Canadian Quality Assurance (CQA™) program for pork producers contains specific recommendations on reducing *Salmonella*.

***Campylobacter coli* and *Campylobacter jejuni*.** *Campylobacter sp.* occur in all livestock, but the major animal sources of Campylobacter infection in humans are poultry and cattle. Most infections are from food. The number of human infections involving antimicrobial-resistant *C. jejuni* in North America is increasing. There is concern that the resistance is developing in livestock because of antibiotic use.

The importance of *Campylobacter sp.* in hogs is not clear. *C. jejuni* is rarely found in swine while *C. coli* appears to live in the normal hog intestinal tract. Water runoff from hog operations is not considered a major source of Campylobacter infections in humans.

Yersinia enterocolitica. Swine and humans are the major source of *Yersinia*. Most strains of *Yersinia* carried by hogs do not infect humans, but certain types can. Although uncommon in humans, yersiniosis can be a serious infection in children. It is most commonly associated with eating contaminated food, rather than with hog production.

Leptospirosa sp. *Leptospira* differs from the previous four organisms in that it affects the kidneys rather than the digestive system. There are many species of *Leptospira* that affect livestock, wildlife and humans. Leptospirosis occurs worldwide, but is not common in swine in Alberta, likely due to the cold, dry climate.

Infected swine may have a fever, or loss of appetite, or show no signs at all. Infections in sows cause abortions, stillbirths, weak piglets and infertility. Kidney damage may be seen at slaughter in otherwise normal hogs.

Leptospira bacteria live in the kidneys and are excreted in the urine of infected animals. Contamination of drinking water by urine of infected animals is one method of infection. Wildlife, especially skunks and rodents, are known to carry the disease and can infect swine and other livestock. Introduction of carrier hogs into the herd is also a common method of infection.

Leptospira can survive in standing water or in liquid manure for several months. *Leptospira* does not survive in composted manure, dry soil or over winter. Damp climates, marshy regions and close contact with wildlife are typically associated with outbreaks of disease in livestock. Humans often contract the disease by swimming in contaminated water.

Prevention of leptospirosis depends on stopping transmission from infected wildlife, rodents or livestock. An effective rodent control program, including removal of vegetative cover near the barn is essential. Wildlife should not have access to water sources, such as dugouts, or to manure from infected livestock. Outdoor swine and other livestock should not have access to standing water in areas where the disease is known to exist. Breeding stock should be purchased from a clean herd and be quarantined.

Vaccination in swine reduces the symptoms of the disease, but does not completely prevent infection. Routine vaccination of breeding stock is recommended in most areas of Canada. Medication may reduce losses in an infected herd, but will not prevent infection. Good sanitation is essential to reduce spread in an infected herd.

Protozoan parasites

Protozoan parasites are microscopic single-celled parasites that are found in a wide range of animals. Today they are considered to be some of the most important causes of water-borne disease in humans. Water contaminated with these parasites is usually associated with animals defecating directly into the water, or with human sewage. It has been shown that indoor-housed hogs managed with appropriate manure handling practices are not a source of contamination for watersheds.

Giardia. Giardiasis, or "beaver fever" is caused by a protozoan parasite called *Giardia duodenalis* (also called *Giardia lamblia*). It is found throughout the world and is the most common disease-causing intestinal parasite of humans. The parasite causes moderate to severe diarrhea; children and immunosuppressed individuals are the most vulnerable. Between two and seven percent of humans in

Europe and North America are estimated to be infected. As many as 40 percent of people in developing countries may be infected. *Giardia* is transmitted through the fecal-oral route (usually between humans, e.g., day-care centres) but waterborne transmission is also common.

Giardia occurs in livestock, pets and wildlife. It does not often cause disease in animals. It has been found in pristine wilderness waterways and is particularly common in the Canadian Arctic. Outbreaks of giardiasis in humans have been linked to drinking water contaminated with human sewage, agricultural runoff, and wildlife feces. Giardiasis is the most frequently diagnosed waterborne disease in Alberta.

Giardia has been found in hogs in Canada, the United States and in Europe. A large Alberta study showed that while it is found on many farms (70 percent), *Giardia* was seen only in a few animals on each farm (8.5 percent).

Some strains of *Giardia* are specific to certain animals and are not easily transmitted to other animals or humans. Other strains are easily transmitted between animals and humans. It is only these strains that are a risk to human health. The few hog strains studied, so far, are not likely to cause human infections.

Giardia produce cysts that can survive for months in water, resisting cold or freezing temperatures. These cysts are resistant to chlorination, which is commonly used to destroy pathogens in drinking water. For this reason, this parasite can be difficult to remove from drinking water. *Giardia* cysts can be removed from water through filtration or can be inactivated by boiling water or using powerful chemical agents (e.g. ozone).

Giardia cysts in liquid hog manure storage facilities deteriorate over time. It is considered unlikely that they could survive to be a serious risk for contamination of surface water when manure is spread on the land.

Cryptosporidium parvum. *Cryptosporidium parvum*, also known as "crypto," is a small protozoan parasite that causes diarrhea. Humans, a wide variety of domestic animals (e.g., cattle, hogs, horses, sheep, dogs, cats), and wildlife can be affected. Infections in animals and humans may not result in any disease at all, or in mild diarrheal illness that resolves itself in two weeks. There is no effective treatment.

Cryptosporidium was not considered an important cause of disease in humans or animals until recently. Over the last two decades, an increasing number of people have developed weakened immune systems due to cancer therapy, organ transplantation, or infections (e.g. HIV human immunodeficiency virus). In these people, cryptosporidiosis is severe, difficult to treat, and can cause death.

This parasite is also transmitted by the oral-fecal route, often through contaminated water. Poor hygiene leads to transmission between humans and from animals to humans. Fecal contamination of water by animals and humans may lead to waterborne outbreaks of cryptosporidiosis. Such an outbreak occurred in Milwaukee, Wisconsin, and led to the infection of over 5,000 humans. The source was traced to human sewage.

Cryptosporidium has been found in hogs around the world, but is not considered a significant cause of swine disease. In a large Alberta study, *Cryptosporidium* was found in 32 percent of farms, but in only 2.8 percent of manure samples. Infection was mainly in weaners (10.4 percent). The parasite was found in only one percent of hog liquid manure samples in the same study, but not in soil samples. This low prevalence indicates that hogs are not likely an environmental source of this parasite in Alberta.

Cryptosporidium produces environmentally resistant oocysts or eggs that are shed in manure. They are resistant to chlorination, and are so small that many water filtration systems cannot remove them. Therefore, contamination of drinking water with this parasite is of great concern.

Most human infections are acquired by person-to-person transmission (day-care centres, hospitals) and through consumption of drinking water contaminated by human sewage. There are several reports of veterinary students, farm workers and researchers developing infections after exposure to calves shedding large numbers of oocysts. There are no reports of humans being infected with *Cryptosporidium* from hogs. The strain of *Cryptosporidium parvum* carried by hogs is not likely infective to humans.

Helminth parasites

Roundworms or Ascarids. Roundworm or ascarid infection in humans is usually caused by the human ascarid, *Ascaris lumbricoides.* The human ascarid is rare in Canada due to our high standards of hygiene, and is usually seen only in individuals that have travelled to or lived in developing countries.

Ascaris suum, the pig roundworm, can occasionally infect humans. Infections are uncommon, even in producers that are in regular contact with hog manure. Cases are most often reported in developing countries, and are related to poor hygiene and contact with heavily infected manure. In North America over the past decade, there have been several cases of *Ascaris suum* reported in humans, usually associated with ingestion of contaminated manure. Cases have often involved researchers studying the parasite, children of hog farmers or small children playing in gardens fertilized with infected hog manure. Infection may produce no symptoms, and is only noticed when a worm is passed in the feces.

Pig ascarids are found worldwide. Approximately 10-15 percent of Alberta market hogs have milk spots in the liver, evidence of previous *A. suum* infection. Infection is self limiting in larger swine, with most harboring only one or two adult worms. A Saskatchewan survey showed that 17 percent of slaughter swine had adult worms in their intestinal tract, with an average of 2.5 worms per animal. Ascarids in hogs can be controlled with medication; indoor hog units with worm control programs have very low infection rates. Indoor production units that practice all-in-all-out hog flow will also have minimal infection rates. Indoor units populated with worm-free stock can remain worm-free without medication. Since ascarids have a negative effect on growth and cost of production, it's to the producer's advantage to control the parasite.

Ascarid eggs are hardy, sometimes surviving four to seven years or more, under the right environmental conditions. Eggs do not survive dryness and humidity levels of 30-60 percent will destroy eggs within a week. While some eggs can survive for a year or more after manure is spread on the land, most do not survive for extended periods of time. Temperatures over 32C will also kill eggs. Storage of manure in manure piles, through the natural heat from bacterial composting activity, will effectively destroy ascarid eggs.

Producers should have a good worm control program in place and use regular slaughter checks to monitor the effectiveness of the program. Uncomposted hog manure should not be used to fertilize gardens or root vegetable crops. Good hygiene practices, such as hand washing, should be used, and children especially should avoid contact with hog manure.

Other diseases of swine that may be of concern to the public

Several other zoonotic diseases carried by swine have sometimes raised public concern. These are included for general information. But none can be transmitted in manure and are rare in Canada.

Trichinella spiralis. *Trichinella spiralis* is a small worm that can occur in the muscle of the hog. It causes disease (trichinosis) in humans who eat infected pork that is not adequately cooked. Hogs become infected when they eat infected rodents or eat carcasses of other hogs. Humans cannot contract the disease from hog manure or contact with hogs. This parasite does not exist in the Alberta hog industry.

Toxoplasma gondii. This tiny coccidian parasite is also found in the muscle of the hog. It causes illness (toxoplasmosis) in humans who eat infected pork that is not adequately cooked. Hogs become infected by eating infected feces from cats or other wildlife. Toxoplasma cannot be transmitted to humans through hog manure. To reduce the incidence, producers should keep cats and kittens out of the barn, keep cat feces out of hog feed, and neuter the farm's cats.

Taenia solium. This human tapeworm is almost unknown in Canada, except in those who have travelled to developing countries. Hogs pick up the parasite by ingesting feces from infected humans. Humans become infected by eating inadequately cooked pork. Infection is prevented by good sanitation and not allowing hogs to come in contact with human feces.

Alberta advantage

Hog manure in Alberta is not currently considered a major source of infectious disease for humans or other livestock. Modern production practices, low hog density, and a cool, dry climate prevent many disease problems. However, several micro-organisms present in hog manure can cause disease if manure is allowed to contaminate waterways. Producers should take strict precautions to prevent any contamination of surface or groundwater with manure during the storage, handling or spreading procedures.

Producers should also follow good production practices inside their barns to keep the levels of certain organisms at a minimum. Practicing good hygiene, good sanitation, keeping diseases under control, using an effective worm control program, and controlling the access of cats, rodents and birds to the barn are essential to minimize zoonotic disease risks.

Consult a veterinarian to develop a biosecurity program, and contact Alberta Quality Pork to participate in the On-Farm Food Safety Program.


2.0

3.0 ENVIRONMENTAL OBLIGATIONS AND REGULATORY APPROVALS FOR LIVESTOCK PRODUCERS

3.1 Environmental Law Relating to Hog 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 Hog 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

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), the *Alberta Environmental Protection and Enhancement Act,* the *Public Health Act,* 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 these rules are affected by the AOPA.

The approval and siting process for the development and expansion of hog operations can be time consuming and complicated. An increased awareness of this process can assist producers in planning for the development or expansion of their operations. Prior to January 1, 2002, the approval process for hog 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 Safe and Economic Handling of Animal Manures (Code of Practice),* the *Water Act,* and potentially the *Public Highways Development Act.* Since January 1, 2002, primary responsibility for hog operation approvals has been transferred from municipalities to the provincial Natural Resources Conservation Board (NRCB) under the AOPA. (Additional information on the site selection and planning approval process described in Section 5.0.)

3.1 Environmental Law Relating to Hog Production – Environmental Protection Standards

A. ALBERTA LEGISLATION

3.1.1 Agricultural Operation Practices Act

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

3.1.1.1 Environmental Protection Standards

The *Act and the Standards 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 regulation.

3.1.1.2 Design and operating standards

The Regulations describe 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 and 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 annual tonnes is being applied.

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. It also allows for restricted manure application on frozen 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 regulation contains requirements for the design and location of earthen storage and catch basins for the storage of liquid manure for new and expanding operations. The regulation states that 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 with such compaction to achieve a hydraulic conductivity of not more than 1×10^{-6}cm/sec. In addition, the regulation requires the construction of side slopes appropriate for the stability of the soil and contains details regarding specific slope standards.

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

- Avoid areas with shallow water tables.
- 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.

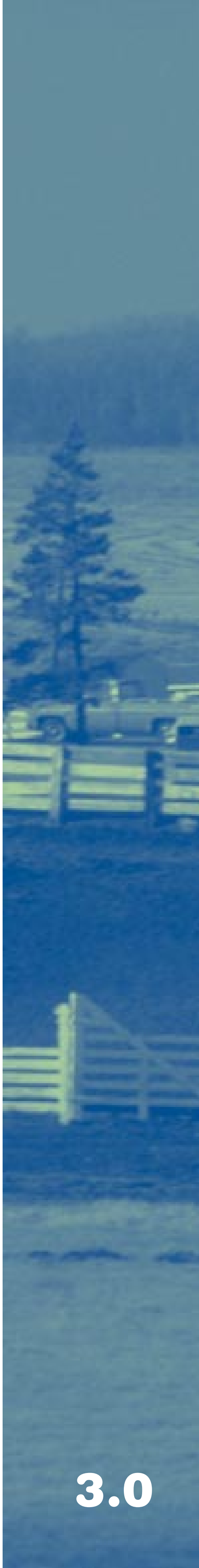
Minimum Distance Separation. A minimum distance separation is required between new or expanding operations and their neighbours. The setback distances depend on the size of the new or expanding operation and the type of neighbour. The setback distances are measured from the portion of the operation closest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

The minimum distance separation 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, in writing, the minimum distance separation.

Records. The regulation requires producers to record 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 of manure 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 *Environmental Protection and Enhancement Act* (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 which will overload the nutrient value of the land, or if a producer releases manure on land where the manure will run into a watercourse, the 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, to order that individual to, among other things, prevent, minimize or remedy the offensive odour or destroy the cause of the odour. However, these powers do not apply to offensive odours which result from an agricultural operation that is carried on in accordance with generally accepted practices for that operation. There is no definition of generally accepted practices for similar agricultural operations. Whether a producer is following generally accepted practices will be decided by the Environmental Appeal Board or a judge.

3.1.2.2 Duty to report

EPEA requires producers to report to Alberta Environment any releases that may cause an adverse effect on the environment. Failure to report a release can result in significant fines.

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 re-occurring.

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 whether or not the corporation itself is prosecuted for the violation and regardless of whether the officer, director or agent works for a large corporation or simply a small incorporated family farm. This means that an officer, director or agent of a corporate producer 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 did cause 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 at issue. That is, if the producer can show that all reasonable steps were taken to prevent the contravention of the EPEA, the producer will not be found guilty under the EPEA. Due diligence will be discussed in further detail in Section 3.1.6.1.

3.1.2.5 Fines

An individual is liable for a fine of not more than $50,000 for each offence under EPEA and a corporation is liable for a fine of not more than $500,000 for each offence under EPEA. Each day that a release or impairment occurs is treated as a separate offence. For example, a release from a lagoon occurring over two days would be treated as two offences and would expose the corporation to a maximum fine of $1,000,000.

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. The PHA has priority over all provincial statutes, except the *Alberta Bill of Rights*.

The PHA allows a regional health authority, if it has reasonable and probable grounds to believe that a nuisance exists, to enter onto property to inspect the property, take samples of any substance or equipment being used and perform tests at the property. 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 the private place 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 to the regional health authority and the regional health authority applies to the courts to obtain an order, the PHA provides the judge with the authority to grant such an order without requiring the owner to have prior notice of the court application. Once the inspection, testing or taking of samples have occurred, if the regional health authority has reasonable and probable grounds to believe that a nuisance exists, the regional health authority can order the property to be vacated, declared unfit for habitation, closed or destroyed. In addition, the regional health authority has the authority to prohibit or regulate the selling of any livestock from the property.

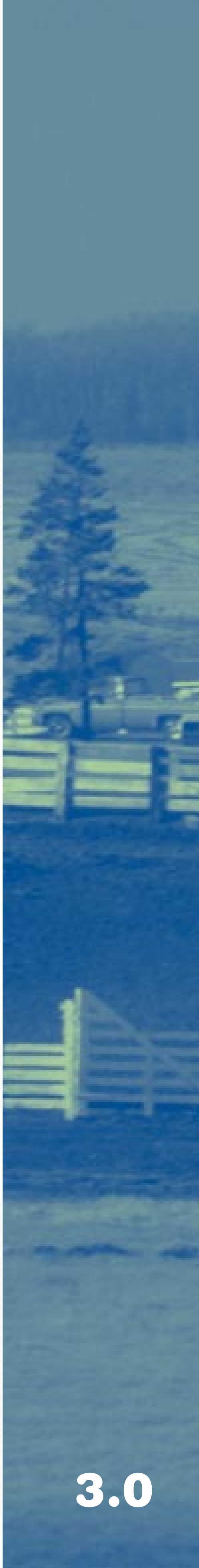
As a result, should a regional health authority become aware of a public health hazard at a hog operation, the regional health authority can take steps to protect the public health and have the health hazard eliminated. In addition, if an operator contravenes the regional health authority's orders, that operator is liable to a fine of not more than $100 for each day the contravention continues.

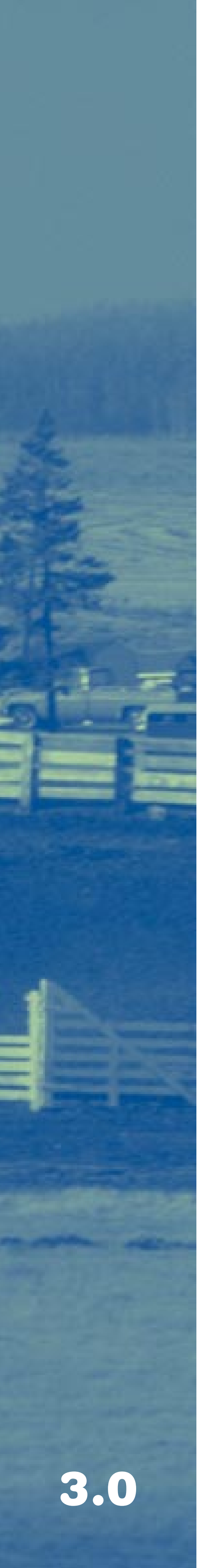
3.1.4 Livestock Diseases Act

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:

- Burying it with a covering of at least four feet of earth, according to conditions in the *Act*.
- Burning it.
- Transporting it to a rendering plant.
- Scavenging, under very restricted circumstances.

If a producer fails to properly dispose of the dead animal, the producer is in violation of the *Livestock Diseases Act* and liable to a fine of not more than $10,000 or to imprisonment for a term of not more than one year or to both a fine and imprisonment. 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. To protect fish habitat, the federal government has enacted the *Fisheries Act*. The *Fisheries Act* prohibits anyone from depositing or permitting the deposit of anything into any type of 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, a producer commits an offence under the *Fisheries Act* when he spreads manure on land located near a stream frequented by fish, which then migrates into the stream. The 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, a producer commits an offence under the *Fisheries Act* if he spreads manure on land which 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 to enter 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 the producer has not committed an offence under the Act.

3.1.5.2 Liability of directors and officers

If a corporation violates the *Fisheries Act,* any officer, director or agent of the corporation who was involved with the incident, even in a minor way, is liable on conviction to punishment 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. This means that, as with the Alberta *Environmental Protection and Enhancement Act,* an officer, director, agent or a corporate producer can be 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 *Alberta Environmental Protection and Enhancement Act,* 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 as to whether the deposit of deleterious or harmful substances was intentional. The courts are only concerned 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. In addition, the courts are only concerned with 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 performed either of these activities, the courts will convict the producer, unless the producer can show that:

(1) at all material times, the water is not, has not been and is not likely to be frequented by fish;
(2) the producer acted with due diligence to prevent the commission of the activity at issue; or
(3) the producer reasonably and honestly believed in the existence of the facts that, if true, the producer's conduct would be rendered innocent.

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 to imprisonment for a term of not exceeding three years or to 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 *Alberta Environmental Protection and Enhancement Act* and the federal *Fisheries Act,* a producer must have acted with due diligence in running the operation and in carrying out the activity at issue.

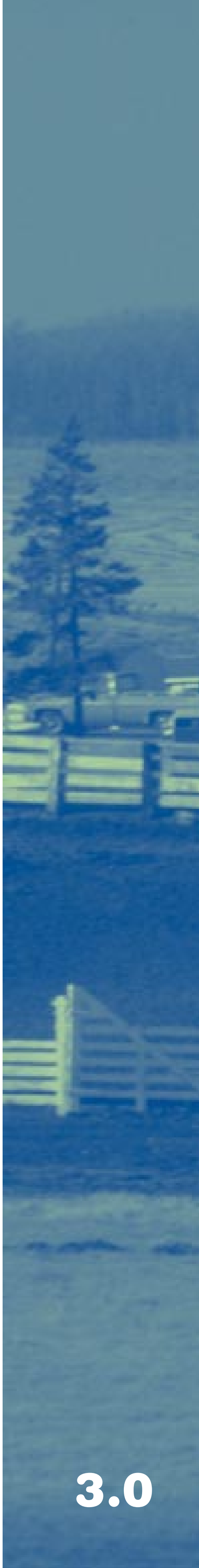
Whether a producer acted with due diligence in any particular circumstance will be determined by the courts on a case-by-case basis. Generally, the courts have indicated, that to act with due diligence, one "must take all reasonable steps to avoid harm. However, that does not mean [one] must take all conceivable steps."[1] In addition, the courts have established that, "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 accused 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 environmental due diligence has been exercised:

- Did the livestock operation establish and monitor a pollution prevention "system?" For example, is there a reasonable nutrient management plan for the operation?
- Did the livestock operation ensure that it instructed employees to:
  - **i** Set up a pollution prevention system so that the operation complied with the industry practices and environmental laws; i.e. the AOPA and the permit 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?
- 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?)
- 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?)
- Was the livestock operation aware of the industry standards regarding environmental pollutants and risks?
- Did the livestock operation address problems immediately?[4]

In addition, a court may examine whether a corporation has an environmental management system, what the environmental management system contains, how detailed it is, and whether it is followed by the company, to determine whether the company acted with due diligence in carrying out the activity in question.

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.
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.



3.1.6.2 Environmental management systems

Environmental management systems are used by corporations 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 the following:

- How these operations impact the environment.
- Which policies and procedures can be implemented to lessen or eliminate the operation's 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 the policies and procedures to reduce the livestock operation's environmental impacts and to properly train the corporation's employees to meet and maintain the applicable environmental standards and laws. Finally, an environmental management system will provide for a periodic re-evaluation of these environmental policies and procedures.

Producers adopting an environmental farm plan 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 deals with 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, 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, which potentially could force the producer to shut down.

However, the Alberta government recognized that farms will typically produce some odours, noise and dust, so it enacted AOPA to offer protection to producers from nuisance claims. The 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 the operation by a court injunction or order, if the producer has not contravened the local land-use bylaw 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.

The determination of "generally accepted practices for similar agricultural operations" is determined by a peer review board appointed by the Minister of Agriculture, Food and Rural Development.

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 which has a reasonable chance of causing harm or injury to another individual. Of course, it is impossible for any individual to avoid all activities which might harm another individual. Therefore, the law sets standards of conduct that must be met. The standard is one of being reasonable – the individual must behave in the 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 hog operator has a duty to operate in such a manner 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 hog 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 the manure spreading during spring runoff.
- The operator knew or ought to have known that neighbours receive their domestic water supply from the creek.
- Neighbours' health is affected by 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 Hog Operations

3.2.1 Provincial approvals

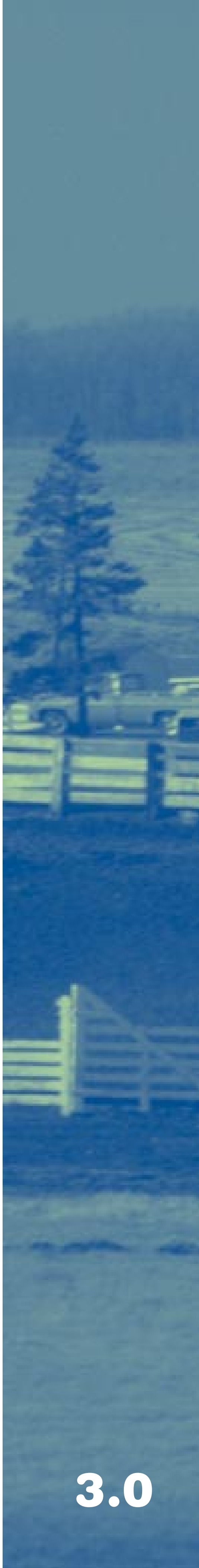
Prior to January 2002, producers obtained approvals to build or expand a livestock operation from municipal governments through the issuance of a development permit.

The approval of livestock operations has been transferred to the Natural Resources Conservation Board (NRCB); under the AOPA, development permits are no longer required.

Under the AOPA, an "Approval" is required to build or expand the following sizes of hog operations:

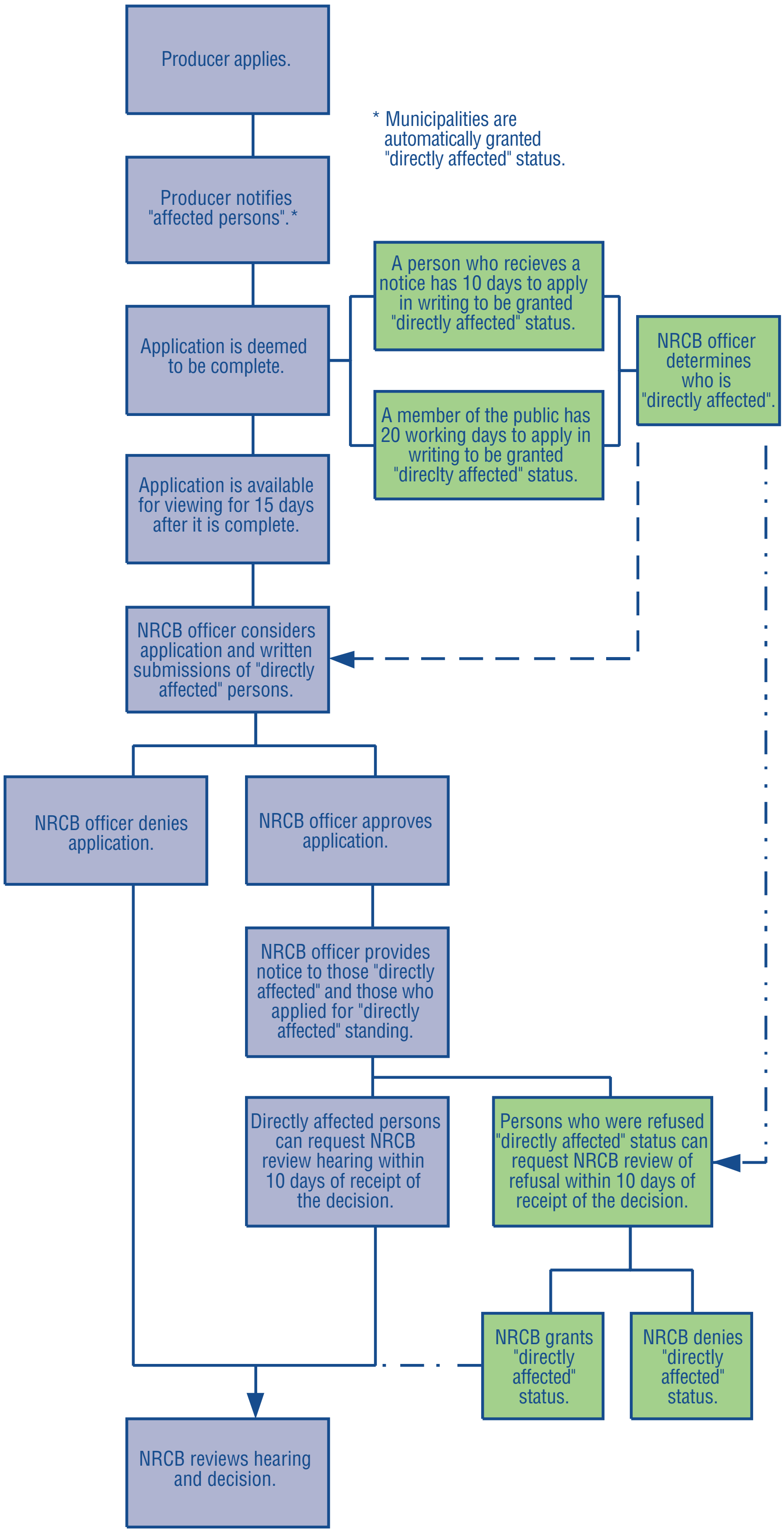
Sows – farrow to finish	250 or more
Sows – farrow to wean	1,000 or more
Feeders	3,300 or more
Weaners	9,000 or more

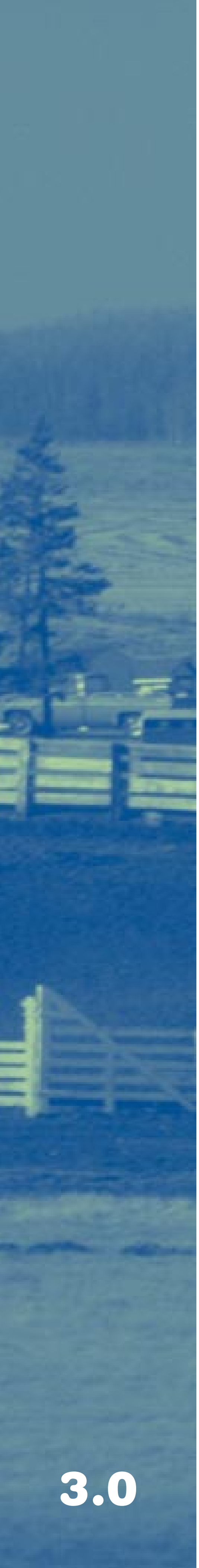
Producers building or expanding to a size below these numbers are required to obtain a "Registration." A Registration can be obtained from the NRCB through a streamlined review and approval process. In addition, producers seeking to build or modify a lagoon on an existing operation are required to obtain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



3.2.1.1 NRCB approval process

Figure 3.1 **The NRCB Approval Process**





The NRCB requires producers seeking an approval to provide the NRCB with the following (see Figure 3.1):

(1) Name, address and telephone number of the applicant.
(2) A list of the persons who live close to the proposed site and who may be affected by the operation.
(3) An evaluation of whether the application is consistent with the applicable municipal development plan.
(4) Engineering plans for manure storage facilities, manure collection area and contamination management.
(5) Hydro-geological assessments.
(6) Numbers and species of livestock and stage of animal development of the livestock that will be at the confined feeding operation.
(7) Legal description of the land on which the confined feeding operation is located.
(8) 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.
(9) An explanation of how the operation or expansion and its operation will meet the requirements of the regulations under the Act.
(10) The legal description of the land where manure is to be spread for the first three years of the operation.
(11) A nutrient management plan.

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 to the concerns, 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 have been met, the Board can issue an Approval for the project.

Those persons who filed a statement of concern and who were found to be directly affected by the project, are given notice of the Approval and provided an opportunity to request that the Board review the Approval.

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

3.2.2 Water act approvals

3.2.2.1 Process

A producer building a new livestock operation may require either a water approval or a water licence under the *Water Act*. The *Water Act* became law in January, 1999.

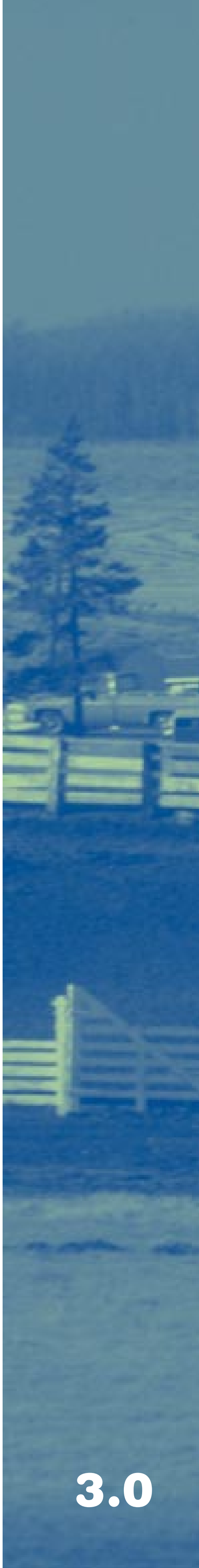
A water approval is required for the undertaking of an activity. Under the *Water Act,* an "activity" includes the construction, operation or maintenance of a structure which may:

- 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 it is necessary for the producer 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. In the application for either an approval or a licence, a producer should include the plans for the project, including scaled drawings, the legal land location, details regarding the affected water bodies, the location of any structures to be built or affected, the rate of diversion and the anticipated quantity of diversion. In addition, the producer 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 approval or licence application to Alberta Environment, the department will require the producer to publish a notice of the application in one or more issues of the local newspaper in the area of the proposed approval or licence. The notice of the application will include, among other things, the location of the activity, the name of the applicant, a description of the activity or diversion and an indication that if any individual is directly affected by the application, a statement of concern can be submitted 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 will require 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. This notice must indicate that an individual who submitted a statement of concern to Alberta Environment regarding the application, can file a notice of objection to the Environmental Appeal Board, within a specific period 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 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 from a primary highway, 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 Permit, 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.

Addendum

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

Additional information of these issues can be obtained from Alberta Agriculture, Food and Rural Development's extension staff, the Natural Resources Conservation Board, consultants and lawyers.

Copies of the Acts and Regulations can be obtained online or via mail from the Queen's Printer.

- AAFRD 1-866-882-7677
  www.agric.gov.ab.ca
- NRCB 1-866-383-6722
  www.nrcb.gov.ab.ca
- Queen's Printer 1-780-427-4952
  www.qp.gov.ab.ca

4.0 PREVENTING, MANAGING AND RESOLVING CONFLICT

4.0 PREVENTING, MANAGING AND RESOLVING CONFLICT

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 their mutual issues, the result can be disagreement or conflict.

In today's world, conflict is inevitable and is present everywhere. Most people perceive conflict as negative or bad and try to avoid it. However, conflict that is properly managed, can be productive and constructive.

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. Debated issues encompass a variety of environmental, political, economic and social issues. Public concern for human health and the environment has risen, 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) flagged issues management as one of the industry's top five priorities. In early 1999, focus groups were held across Canada to learn about farmer experiences related to farm and community conflicts. The focus groups also gathered 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 also consulted during the study. From this CFBMC study and the current Alberta situation, the following sources of farm conflict have been identified.

4.1.2 Sources of conflict

Farm neighbours may have the following 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 an issue 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 to help producers prevent, manage and resolve conflict are based on the CFBMC focus groups involving producers and government representatives.

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 what upsets neighbours.

Focus group participants also suggest that compliance with the laws governing farm management practices should be regarded as the bare minimum. Employing progressive farm management practices and doing the very 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).

4.2.1 Be 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 up 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 the neighbours and let them get to know the operation.
- Be friendly.
- Keep neat, well-maintained farmyards, which are less likely to draw complaints.
- Be helpful to 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 consequences.
- 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 a new project development 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 are held in a neutral location.

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

- Showcases the 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 that participants will learn more about generally accepted farming practices and hog production.

Annual summer BBQ for neighbours:

- The payback from investing in annual community events is the good will that is generated and the opportunity for neighbours to ask questions in a relaxed atmosphere.

Tips for conducting 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 are 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, "normal" farming practices may be of concern to non-farmers.
- Ensure there are no hazards to public safety on the tour and that the farm is clean and tidy and livestock is healthy. Avoid waste disposal areas, sick animals and storage areas for medications and agri-chemicals. Avoid any 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.
- Practice answering questions with family members or colleagues. Video the practice session. 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. Then offer to find an answer. Do not be baited or goaded into saying something that will 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. Whether guests are school children, politicians, business people or other farmers, avoid using farming jargon.
- Talk about relevant topics; do not be side-tracked.
- 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 washrooms and hand disinfection facilities.
- Smile. Have fun. Guests should leave with good feelings about the tour.

More information to help prepare for questions during the open house or tour is available from the following Web site: www.Canpork.ca/facts.html.

4.2.3 Noise and traffic

Noise generated from operating equipment and traffic to and from the farm site is inevitable. To minimize noise impacts, machinery should be properly maintained and noisy activities should be restricted to regular daytime hours, whenever practical. 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 that it would be foolish to insist 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.
- When 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 the plans for addressing any issues.
- Try to anticipate other people's reactions. Have answers to their concerns.
- Do not let minor disputes blow out of control.
- Fight battles privately, 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 had the following tips to help prevent a conflict from escalating:

- 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. Don't debate their issues.
- Search out and identify the real issues. What people say may be quite different from what they're really concerned about. Often people's concerns are rooted in fear of change or the unknown or a lack of understanding, or fear of losing control or the ability to influence decisions that will affect them.
- 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 their concerns.
- Stay on top of on-going 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 problem solve may include:

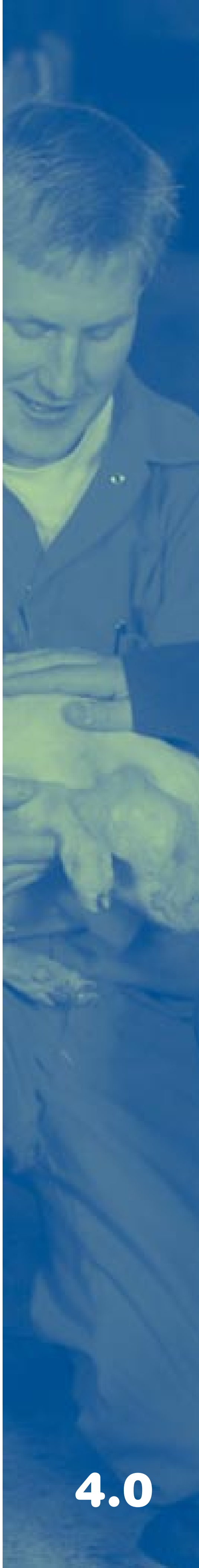
- Bad publicity.
- Lost credibility.
- Fines and penalties.
- Litigation – lawsuits and appeals.
- Referendums, petitions.
- Endless meetings, more studies.
- Project delays, escalated costs.
- Loss of goodwill.
- More regulations for the whole industry.
- Increased probability of future conflicts.
-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



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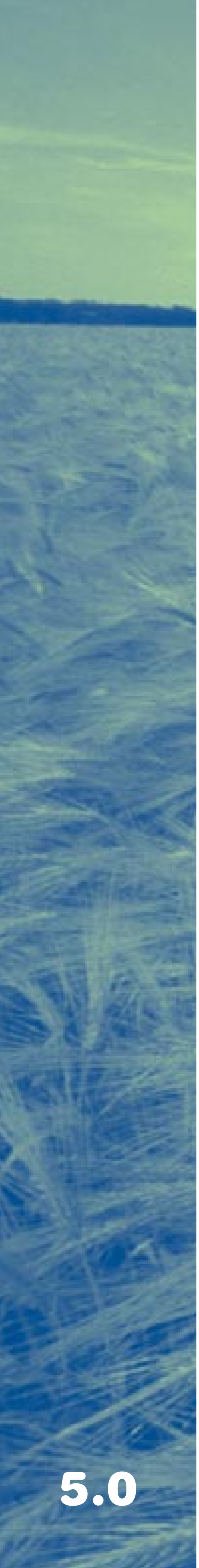
5.0 SITE SELECTION AND PLANNING



5.0 SITE SELECTION AND PLANNING

5.1 Site Selection

The selection of a site for a hog 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.

Selection of the appropriate site for a hog barn will also provide the opportunity to meet longer-term goals, such as future expansion. Expansion opportunities are largely determined by the site selected.

Regardless of the size of operation, the site selection principles remain the same. However, finding an appropriate site for a large operation may require additional investigation to 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, only 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 environmentally sustainability issues.

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

5.1.1 Site selection checklist

Establishing the process for development involves the preparation of a list of logical steps. This should ensure that time and energy is spent efficiently and that development is successful.

When evaluating potential sites, it is important to include the interests of the other stakeholders. This includes such parties as neighbours (residence and landowner) and the local municipality.

Recommended steps taken between finalizing the business plan and actual construction:

- Assess local/community perception of livestock developments.
- Gather development application requirements from the NRCB.
- Evaluate ability of the site to meet development requirements (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 preceding checklist, apply to the NRCB for the approval. To speed up the decision-making process, work with a NRCB Approval Officer to ensure all the necessary information is included. The permit process is dependent on having complete information. Delays in providing this information will slow the process and a decision on the application.

> For an application form, contact the Natural Resources Conservation Board Web site: at http://www.nrcb.gov.ab.ca/ILOpage.html

5.1.2 Assess perceptions of hog developments

Assess community and neighbours' perceptions of the hog industry and the 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 will allow analysis of any potential risks of future opposition and save time and money. It is important to address all concerns, both real and perceived.

5.1.3 Gather development application requirements

At this stage, producers must contact the NRCB Approval Officer to determine application requirements. Depending on the number of animals, a producer may require an approval or a registration. The Approval Officer will describe the applicable approvals required under the *Agricultural Operation Practices Act (AOPA), Water Act* and *Public Lands Act.*

The application must contain all the necessary approvals for the hog 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*. Any water diversion also requires a permit from Alberta Environment. Regional Health Authorities, 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 any necessary action if a livestock operation has or exhibits the potential to have an impact on public health, the environment, or transportation infrastructure.

The application is reviewed to ensure that it has all of the relevant information required to make 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.

Parties that might be affected by the operation, such as neighbours or municipalities, may submit statements of concern. These statements of concern will be reviewed. Attempts will be made to resolve issues raised by affected parties. Once all the input from the municipalities, Alberta Environment (*Water Act*), etc., has been received, the Approval Officer makes a decision regarding the application. The Approval Officer has three options: approve the application, reject it or approve with conditions.

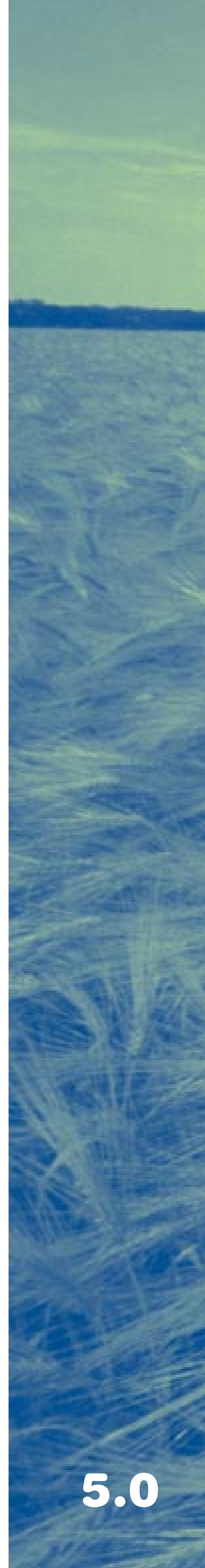
An approval for the development must be issued before construction begins.

5.1.4 Conduct a site assessment

Assess the site's capacity 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 hog production. However, there may be local factors that influence the siting of the development, such as wind, air drainage, other livestock operations and environmental concerns.

Wind. Prevailing wind is an important factor to consider; however, 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. For example, under calm conditions odours will not disperse as readily.



Air drainage. Under calm, summer conditions, the air near the ground cools and can drift down a slope. This is known as air drainage.

Other livestock. Consider other livestock operations when selecting a site for a new operation. Providing an 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 the transfer of infectious organisms.

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

• Minimum distance separation (MDS)

The minimum distance separation refers to the setback or buffer established between a confined feeding operation (source) and adjacent land users (receptors) in order 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 Regulations* include criteria for safe storage of liquid and solid manure, as well as average volumes necessary for sizing the storage.

• Nutrient management

The *Act, Standards and Regulations* also include requirements to manage nutrients from manure 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 outlined.

5.1.5 Evaluate resource base

Determine whether the site offers the required resource support necessary 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 must also be considered, as do availability of rural services and water resources.

Land base. The land base required should be based on the agronomic use of manure. It should accommodate projected crop production and be close enough for economical manure application. It may be necessary to engage in spreading agreements with neighbours or explore alternate uses for the manure (see Section 8 and AOPA).

Rural service. Any off-site inputs require reasonable accessibility to related agribusiness and staff. Good road access to the site is critical. Availability of utilities such as power and gas are also significant factors affecting site selection.

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

Water supplies and systems must be designed to meet peak demands. Water requirements can vary, based on animal size, washing requirements, temperature, spray cooling systems, water quality, as well as the animals' physiological state, activity level and diet. Calculation of average daily and annual water requirements can be completed based on the number and size of animals, using Figure 5.1. Water requirements will be influenced by the ration fed and the minerals in the drinking water (Figure 5.2).

Figure 5.1 Recommended Flow Rates and Water Intake

Type of hog	millilitres/min Min	millilitres/min Max	Water intake (litres/day)
Suckling	0.3		-
Weaner	750	1000	3
30 kg grower	1000		4 - 5
70 kg finisher	1500		5 – 7
Adult	1500	2000	5 - 8
Lactating sow			15 - 20
Nipple bite drinker	1500	2000	15 - 20
Nose drinker	2500		
Gestating sow			5 - 8
Flush trough system	500	1000	

Figure 5.2 Canadian Water Quality Guidelines for Livestock

Item	Maximum Recommended Limit, ppm
Major ions	
Calcium	1,000
Nitrate + nitrite	100
Nitrite alone	10
Sulphate	1,000
TDS	3,000
Heavy metals and trace ions	
Aluminum	5.0
Arsenic	0.51
Beryllium	0.12
Boron	5.0
Cadmium	0.02
Chromium	1.0
Cobalt	1.0
Copper (swine)	5.0
Fluoride	2.03
Iron	no guideline
Lead	0.1
Manganese	no guideline
Mercury	0.003
Molybdenum	0.5
Nickel	1.0
Selenium	0.05
Uranium	0.2
Vanadium	0.1
Zinc	0.0

Recommended maximum limits for water quality for hogs that should not be exceeded:

Total dissolved solids	3000 mg/L
Sulphate	1000 mg/L
Nitrate+nitrite (as N)	100 mg/L
Nitrite alone	10 mg/L

Sources of water quality information for hogs include:

- The Canadian Pork Council, 1998. *Canadian Quality Assurance Producer Manual.*
- Patience, J.F., P.A. Thacker and C.F.M. de Lange, 1995. *Swine Nutrition Guide, 2nd edition.* Prairie Swine Centre. Pg 241 - 249 Inc. ISBN 0-9698426-1-9.
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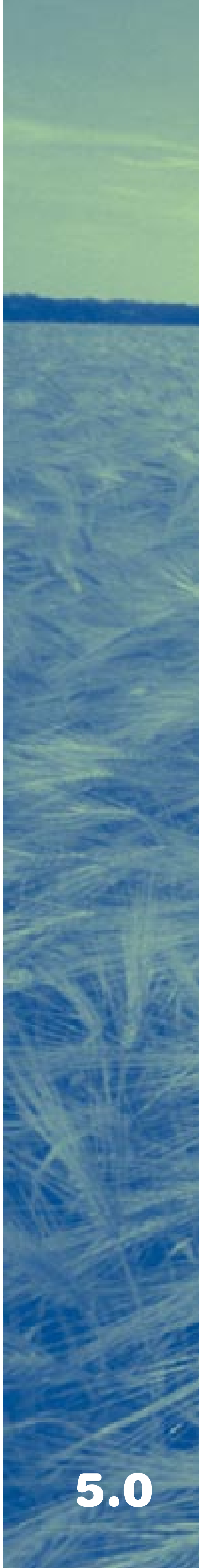


Groundwater availability. Information on groundwater availability in an area can be obtained from the Groundwater Information Service of Alberta Environment (Phone 780 427-2770). A hydrology specialist (AAFRD, Alberta Environment, PFRA or a private consultant) or local water well drilling contractors 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. Construction of a large reservoir or dugout for a farm operation requires investigation of the subsoil conditions at the site and consideration of the drainage area. Test drilling or test pits can provide valuable information regarding dugout design and selection of the appropriate construction equipment. Dugouts can be constructed in almost any texture of soil, but may require lining to prevent excessive seepage. Lining adds significant 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 the irrigation area of the province, 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 off to the side of the watercourse, then the water can be diverted into the dugout, or past the dugout, depending on the quality. All waterways that supply the dugout should be grassed to prevent erosion and provide sediment and nutrient trapping.

Steps to prevent contamination of surface and groundwater. Agricultural activities around a well or dugout may have negative impacts on water quality. To prevent well and dugout contamination, ensure the following:

Wells

- Ensure wells are properly constructed and sealed.
- Locate wells up-slope, 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.
- Ensure that manure storage structures, such as earthen manure storages, are built to prevent seepage into groundwater.
- Direct surface drainage from contaminated sources away from wells.
- Ensure well casing, cap and venting are always 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 excess nutrient levels in the runoff water. This causes increased algae and weed growth in dugout water.
- Avoid spreading manure on snow or frozen ground. Research in Manitoba showed 10 to 60 times as much phosphorus in spring runoff from winter-spread fields, compared to control fields.
- 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.

5.1.6 Complete management plans specific to site

It is extremely important for hog producers and stakeholders, that clear, functional and appropriate management plans are developed. This includes the overall operational plan as it relates to the AOPA comprehensive nutrient management plan. A comprehensive nutrient management plan outlines in-barn management, transport to the storage, storage period and land application as directed by the nutrient management plan. This must also include a management plan for disposing of waste such as dead animals 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 regulatory requirements of 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 or supporters are unlikely to change their position. The remaining 80 percent, called the silent majority, are either undecided, indifferent or sceptical about the project. Failure to bring the silent majority on side can lead to opposition and can seriously jeopardize the project. Various communication strategies can be used to win the support of this group. Open public participation is one communication strategy that has proven to be successful.

It is wise to begin development by consulting with the community. This helps to 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 the 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. How might they be affected? Which information do these individuals want and need? Could the project be changed to better meet their needs? What is the history of the community? Which areas had problems initiating new projects in the past? Who are the people with power and influence? What is the perspective of community stakeholders? Gathering this type of information helps to develop a community social profile. This profile is vital to creating effective communication strategies.

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

To reach young families, communicate through the school newsletter or parent advisory meetings. The senior's activity centre is a good contact point. 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 the information to be shared, who to communicate with and when. Do not always rely on print material or meetings to get the message across. Try to use a creative variety of public participation approaches to provide information and receive feedback.

Gather meaningful feedback from the public. Inviting the public to express their views and concerns about the project can help to enhance community support and ultimately the success 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. It may be that not enough information has been provided. Perhaps the timing is off, or the location is wrong. Take advice from the community and let its members know where their input has made a difference. If the intention is not to use feedback, do not ask for it. There is no integrity in the public participation process if the decisions have already been made. By allowing the community to provide input, it will attach some ownership in the project.

Plan communication strategies. These strategies have proven to be effective in communicating with the public and building support for a community project.

- Informal consultation.
- Use of media.
- Open house. (see Section 4).
- Fact sheet with tear-off response.
- Reference centre.
- Public forum.

5.2 Site Planning

Once a site has been located, a site plan is required. The location and orientation of structures can influence the potential for environmental impacts. Good site planning can also prevent neighbourhood disputes. When designing a site plan, the following aspects should be considered:

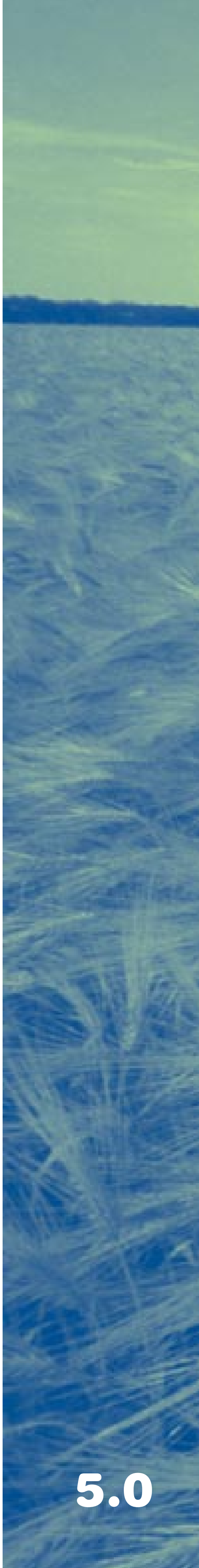
- Adhere to required permit criteria, such as setback distances from roads and property lines or water diversion pathways.
- Locate buildings and storage facilities for fuel, fertilizer, manure, compost or pesticides at least 100 metres (328 feet) from wells and 30 metres (98.4 feet) from common bodies 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, being careful to avoid low areas subject to flooding. Refer to the AOPA, *Standards and Administration Regulation* for requirements on site planning.
- Grade the area to divert contaminated runoff and prevent it from entering surface or groundwater.
- Grade or berm yards to allow collection of 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, odour and dust impact on adjacent property owners.
- Allow roof runoff and any clean water to be diverted away from the site.
- Adhere to the recommendations of 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.
- Before building new feed storage facilities, design a complete storage and handling system, which incorporates both present and future requirements.
- Locate the feed processing and handling centre in an area that will allow large vehicle access and provide sufficient setback from neighbours. This will ensure they are protected from noise, dust, traffic and the threat of fire.

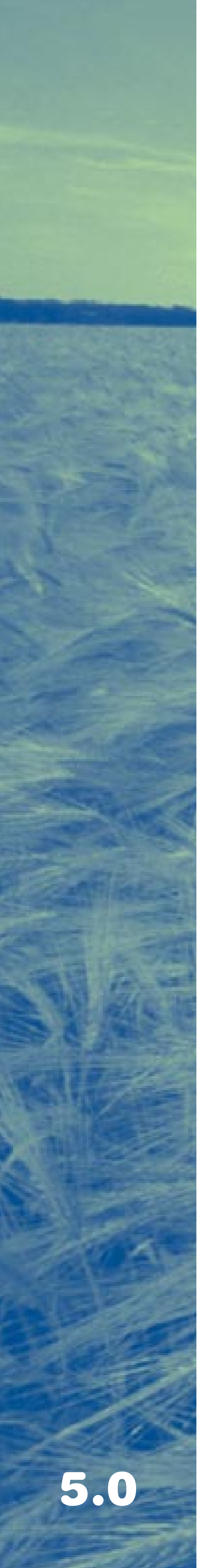
5.3 Shutting Down Livestock Operations

The development approval may define the period of time a facility can be empty before another approval is required for the operation.

General points:

- No matter how short the shutdown period, take steps to minimize the risk to humans and animals entering manure storage areas and buildings. Ensure signs are posted to advise of any potential dangers.
- Remove manure from buildings.
- During short-term shutdowns of one month or more, turn off water, unnecessary gas and electricity, control weeds and insects and transport 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 a certain period of time. Depending on permit requirements within the municipality, a new development permit may be necessary before restocking the barn.
- For a permanent shutdown, check with the municipality for decommissioning (i.e termination of permitting conditions) requirements. Some jurisdictions may also require a demolition permit for site cleanup.





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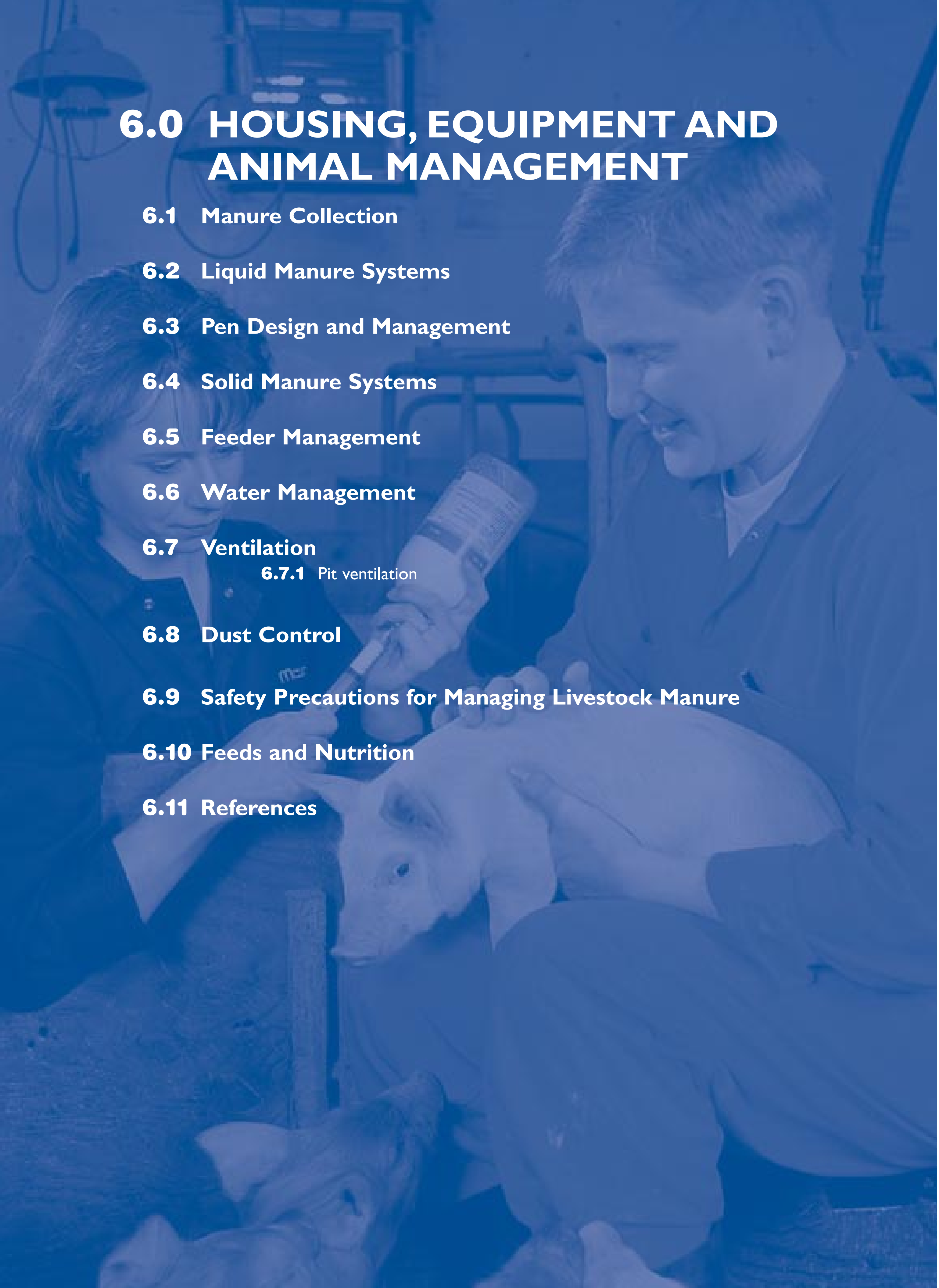
- The Canadian Pork Council, 1998. *Canadian Quality Assurance Producer Manual.*
- Institute for Research in Construction, National Research Council, Canada. *Canadian Farm Building Code*, Publication Sales, M-20, Ottawa, Canada, K1A 0R6.
- Patience, P.A. J.F., Thacker, and C.F.M. de Lange, 1995. *Swine Nutrition Guide, 2nd edition.* Prairie Swine Centre. Pgs. 241 - 249 Incl.

Additional references available from AAFRD

- *Water Analysis Interpretation* Agdex 400/716-2.
- *Water Wells that Last for Generations*.
- *Dugouts for Farm Water Supplies* Agdex 716 (B30).
- *Dugout Maintenance* Agdex 716 (B31).
- *Seepage Control in Dugouts* Agdex 716 (B32).
- *Float Suspended Intake for Dugouts* Agdex 716 (B34).
- *Dugout Aeration with Compressed Air* Agdex 716 (B36).
- *Hydrated Lime for Algae Control in Dugouts* Agdex 716 (B37).



6.0 HOUSING, EQUIPMENT AND ANIMAL MANAGEMENT

6.0 HOUSING, EQUIPMENT AND ANIMAL MANAGEMENT

6.1 Manure Collection

The factors that influence the choice of manure handling systems include:

- Size of operation.
- Personal preference.
- Labour requirements.
- Economics.
- Available equipment.
- Issues related to animal well-being.
- Location.
- Environmental concerns.

Manure handling systems are generally designed to handle solid or liquid manure. Regardless of the type of manure being handled, it is important to use properly designed equipment and to operate and maintain the equipment according to manufacturer instructions. The equipment must be reliable in a corrosive environment. Equipment also requires proper maintenance for a long service life. Preventative maintenance and the use of reliable equipment are critical to avoiding problems.

Hog manure, a mixture of urine and feces, typically contains about 85 to 90 percent water and 10 to 15 percent solids when it is excreted. In liquid manure handling systems, wash and spilled water dilute the manure. By the time the manure reaches the storage lagoon, it contains about 95 percent water and 5 percent solids. The following classifications are generally used to describe manure from a handling perspective:

Liquid manure.................0 to 5 % solids
Slurry manure.................6 to 13 % solids
Semi-solid manure.........15 to 23 % solids
Solid manure..................more than 25 % solids

(American Society of Agricultural Engineers 1999)

6.2 Liquid Manure Systems

The most common liquid manure collection system is slatted floors that cover shallow collection pits where feces, urine, wash water and water spillage collect. Collection pits are usually the full width of the slatted areas in the pens. Pit dividers and plugs lead to discharge pipes that take the manure to the long-term storage outside the barn. Typically, the pits are allowed to fill before being emptied by a combination of gravity flow and water flushing. Storage capacity in the pits varies depending on the size of animals being housed and the design of the facility.

Less frequently, liquid manure is collected and stored in deep pits (2.4 metres or 8 feet) under the slats. Some manure handling systems also incorporate scrapers or gravity flushing to gather the manure into a central collection area in the barn, before it is pumped to the long-term storage or applied to the land. These systems may require agitation to bring solids back into suspension before the manure can be pumped (see Section 7). Agitating stored manure can release dangerous toxic gases.

Removing manure from animal rooms to separate long-term storage locations reduces the risk of toxic and odorous gas emission. These odorous and toxic gases result from the decomposition of manure by the microorganisms in the feces. Ammonia is the major product of this breakdown but a host of other gases, such as hydrogen sulphide, are also produced (see Section 2.4).

6.3 Pen Design and Management

Proper pen design and selection of slats that clean easily with animal traffic will greatly reduce the hogs' contact with manure and reduce manure accumulation on the slats. The following pen management practices can be used to maximize hog and pen cleanliness, minimize odour production, control flies and facilitate easy cleaning:

- Minimize in-barn manure storage time.
- Use slats with adequate void-to-surface ratio. Slat spacing that is too narrow does not allow the manure to fall into the pit, leading to dirty pens, which encourages fly breeding and odour. Narrow slats that are laden with manure can also obstruct airflow through the pit ventilation, particularly in winter. If the opening between the slats is too wide, it causes feet and leg problems for the animals. For flooring advice, contact an agricultural engineer and pen equipment suppliers.
- Scrape manure that collects on the pen floor into the gutters at least daily.
- Design partially slatted floors with approximately one-third slats and two-thirds solid floor. A step in the floor, between the slats and the solid flooring, will help define the dunging area (slatted floor) and reduce manure tracking into the resting area (solid floor).
- Maintain correct pen stocking density. The minimum standard for stocking densities should be based on the *Recommended Code of Practice for the Care and Handling of Farm Animals: Pigs* (1993).* See Figures 6.1 and 6.2.

Figure 6.1 **Recommended Pen Floor Space Allowances for Growing Hogs* (based on body weight)**

Body Weight		Fully Slatted $(0.035*BW^{.667})$‡		Partial Slats $(0.039*BW^{.667})$		Solid Bedded $(0.045*BW^{.667})$	
kgs	lbs.	m^2	ft^2	m^2	ft^2	m^2	ft^2
10	22	0.16	1.7	0.18	1.9	0.21	2.2
20	44	0.26	2.8	0.29	3.1	0.33	3.5
50	110	0.48	5.2	0.53	5.7	0.61	6.6
75	165	0.62	6.7	0.70	7.5	0.80	8.6
90	198	0.70	7.5	0.78	8.4	0.91	9.7
100	220	0.76	8.2	0.85	9.1	0.97	10.4
110	242	0.81	8.7	0.90	9.7	1.03	11.1

‡ For calculations; body weight BW is in kg, area in m^2.

Figure 6.2 **Recommended Pen Floor Space Allowances for Replacement Gilts and Sows***

Body Weight		Partial Slats $(0.054*BW^{.667})$‡		Solid Bedded $(0.059*BW^{.667})$	
kgs	lbs.	m^2	ft^2	m^2	ft^2
100-150	220-330	1.5	16	1.7	18
150-200	330-440	1.8	19	2.0	22
200-250	440-550	2.1	23	2.3	25
>250	>550	2.3	25	2.6	28

‡ For calculations; body weight BW is in kg, area in m^2.

* *Recommended Code of Practice for the Care and Handling of Farm Animals : Pigs* (1993).

- Manage ventilation and room temperature to influence animal dunging habits. In winter, direct cold air away from the sleeping area, but in summer, direct incoming air onto the sleeping area to help cool the animals.
- Maintain a comfortable barn temperature. To cool off, animals will play with the water dispensers or wallow in manure.
- When stocking partially slatted floor pens, keep the hogs off feed for several hours before moving them. Spread some feed on the solid floor area to introduce the hogs to their new sleeping area.
- With partially slatted floors, use open pen partitions in the dunging area to encourage socializing and animal movement. Use solid partitions in the resting area to prevent drafts and provide privacy.
- Install cooling sprinklers over the dunging area.
- Locate the water source over the slatted area and the feeders at the junction of the slatted and solid floor areas.

6.4 Solid Manure Systems

Economics and public concern over environmental and welfare issues have stimulated interest in straw-based and other solid floor manure handling systems. These systems use bedding materials to absorb urine and feces. The bedding is renewed as required. Stored hog manure is considered a solid when it has a solid content greater than 25 percent. To produce solid manure, the liquid must be drained and the manure dried or have bedding added.

Although these systems often require a low capital input, bedding and labour costs may be greater than in liquid systems. These systems are most commonly used to house finishing hogs; however, gestating females are also housed in bedded pens.

Manure from these systems must be managed to prevent pollution:
- Use sufficient straw to absorb most of the liquid. This will control runoff and provide a comfortable environment for the hogs.
- Contain runoff on the property in a way that avoids leakage and does not pollute surface water or groundwater (see Section 7).
- Evaluate bedding on a daily basis to control pen cleanliness, odour and gas production.

Housing systems that use bedding are normally cleaned after every batch of finished hogs, or on a regular schedule when they are used for sow housing.

6.5 Feeder Management

To reduce flies, odour and gas build-up, it is important to:
- Reduce the amount of feed spilled by adjusting feeders properly and cleaning up feed spills.
- Adjust feeders to allow the hogs to eat to appetite, with minimum waste.
- Locate feeders so that spills fall into the gutter.
- Locate feeders so that traffic patterns and dunging areas can be maintained without disrupting resting areas.
- Repair leaking waterers as soon as possible to reduce water wastage, and minimize fly breeding areas and odour.

6.6 Water Management

Water is often a limiting resource for livestock production and therefore requires careful management. Water waste also increases manure volume and subsequent transportation costs. Typical water requirements for hogs are shown in Section 5.1.5. Water requirements are influenced by feed rations and minerals in the drinking water.

Water can be conserved through the following practices:

- Evaluate the design of the waterers. Wet/dry feeders are reported to reduce water usage by 10 to 40 percent in the grower-finisher area.
- Frequently assess the height and angle of the waterers. To prevent pen fouling, waterers should be installed at the smallest animal's shoulder height, with a slightly downward angle.
- Repair leaking waterers quickly. In addition to wasting water, leaky waterers create damp areas that contribute to dirty pens, fly loads, odour and poor air quality.
- Ensure that the ratio of hogs to water source is appropriate. Research data suggests that one watering location per 25 grow-finish hogs is adequate. However, most commercial units provide two drinkers for groups of 12 or more hogs. Multiple drinkers should be spaced 1 to 1.5 metres apart.
- Choose room designs and equipment that are easy to wash and use minimal amounts of water.
- Use a washing protocol that minimizes the amount of water required:
  - Remove all feed from feeders before washing.
  - Use high pressure washing systems (1500 to 2000 PSI).
  - Presoak pens, walls and feeders prior to washing.
  - Keep dirty areas soaked and do not allow them to dry out.
  - Use a systematic approach to keep pushing the water forward.
  - Start at the highest point on the walls and work down.
  - Repair leaky pull plugs in the storage pit to reduce the amount of water needed to properly flush and drain pits.

6.7 Ventilation

The sources of atmospheric contamination in a hog barn include the following:

- Heat, moisture and carbon dioxide are produced by hogs.
- Decomposition of manure by micro-organisms produces gases.
- Feed dust.
- Sloughed skin cells and hair from the animals.
- Concrete dust.
- Dust entering the barn through the ventilation system.

The role of ventilation is to:

- Provide adequate fresh air in the building.
- Control the temperature and humidity.
- Remove dust, gas, odour and other contaminants.

Improper design and operation of ventilation systems can influence the dunging pattern of hogs, which will compromise air quality in the barn and eventually hog performance. Barns that are dirty, damp or dusty are more prone to odour complaints and have a significant influence on the health and well-being of both staff and animals.

As part of the operation's ventilation maintenance protocol, determine the following on a daily basis:

- Are the hogs behaving normally?
- Is the temperature consistent throughout the barn?
- Are there drafts?
- Is there condensation in the barn?
- Is the room dusty or smelly?
- Is cool air dumping onto the sleeping areas?

To ensure the ventilation system is working properly:

- Clean fan blades and shutters weekly.
- Ensure the fans are operating properly and that shutters are opening and closing.
- Inspect heating system weekly.
- Inspect alarm system weekly.
- Lubricate moving parts regularly.
- Clean dust from circulation ducts.
- Make necessary repairs promptly.

6.7.1 Pit ventilation

Ventilating the pit space between the manure and flooring releases odorous air outside the barn. However, even if odours are diluted compared to a non-ventilated head-space, the odours may still be quite strong and unpleasant and may pose a problem to neighbors. Research is currently underway in Alberta to develop a biofiltration technique to reduce the intensity and offensiveness of odours exhausted from hog barns.

6.8 Dust Control

There are many ways to approach dust control:

Ventilation. The first line of defence for dust control is a properly designed and operated ventilation system. The ventilation system removes stale air that contains dust and exhaust air flow rates have a significant impact on relative humidity. Although higher humidity reduces dust concentrations, excess humidity contributes to respiratory problems and microbe activity. Operating the barn at the ideal relative humidity, about 50 percent, will optimize dust and microbe control.

Feeding management.

- Feed delivery to wet/dry and dry feeders. Cover any areas where dust can escape, for instance at feed drop pipes leading into feeders and feed carts. This can be as simple as a used feed bag or as complex as a molded cover.
- Prevent feed spillage as much as possible and clean up spilled feed.
- Add oil to the feed to bind the particles and reduce the potential for dust as feed is moved and dropped into feeders. In extreme cases, at the drop, a fine mist of water aimed at the feed will reduce dust.
- Consider using pelleted feed or liquid feeding systems.

Housecleaning. Regular cleaning is important to reduce dust.

- Sweep or blow dust off all horizontal surfaces including feed lines, penning, conduit and water lines.
- Regularly clean recirculation systems to prevent excess dust build-up in the barn.
- Ensure dung patterns are maintained to prevent manure from drying out and becoming a source of dust. Messy floors are a source of dust when the manure dries.

Vegetable oil. When sprayed on surfaces, it decreases dust by up to 80 percent. It also reduces gas levels, probably by absorption. New oil must be applied every day. The Prairie Swine Centre is currently completing research on an application system that allows easy oil application. Currently, oil sprinkling is by far the most effective way to reduce dust levels.

Misting systems. Used to control dust, these systems also create a cooling effect and raise humidity in the barn.

Other dust control technologies under investigation include:

- Ionization systems. The ionization system works well at the beginning of a cycle, but as soon as dust accumulates on surfaces, it creates electrical resistance and dust reduction quickly deteriorates. After five to six weeks, dust reduction will be reduced to a range of only 10 to 20 percent.
- Electrostatic precipitation. This is a common method of removing particles from air in residential houses and commercial facilities. Due to the relatively large dust load in barns, these systems are currently uneconomical and require high maintenance.
- Cyclone filters. These use a high air flow to separate out particles; however, they are costly and require a high level of maintenance.

Research has shown that dust can pose a health risk to barn workers. To reduce the impact of dust on personal health, always wear a mask. A mask should be properly fitted to the face (facial hair makes this very difficult) and be designed for the dust levels present. Check with a supplier for the proper equipment.

6.9 Safety Precautions for Managing Livestock Manure

As manure decomposes, dangerous gases are released. The gases released from stored manure can be fatal. The publication, *Manure Gas* (M-8710), from Canada Plan Service, discusses the sources and types of gases of concern. This leaflet is available from Alberta Agriculture, Food and Rural Development.

The most important of these dangerous gases is hydrogen sulphide. When liquid manure is stored in an enclosed space, hydrogen sulphide can accumulate in the headspace of the storage pit. Although hydrogen sulphide is readily detectable at low concentrations, at higher levels the gas paralyzes the sense of smell. Therefore, it is possible to unknowingly encounter a dangerous situation. As the concentration increases, the hydrogen sulphide paralyses the nerves that control the diaphragm, causing breathing to stop. When concentrations are high, a single breath of the gas can be fatal. When stored manure is agitated, toxic gases can be released.

Removing manure from animal rooms to a separate storage location reduces the risk of toxic and odorous gases collecting. However, if it is necessary to agitate in-barn manure storage, it is important to:

- Provide maximum ventilation.
- Instruct all personnel to work in pairs.
- Vacate people and animals from the room prior to emptying the pit or adequately ventilate the head space above the manure.
- Create several feet of headspace for the gases by initiating pumping without agitation.
- Agitate below the surface and agitate as little as possible.

Good building design and safe work procedures can prevent accidents related to manure gases. Workers should be properly trained to deal with manure gases, especially hydrogen sulphide. Long-term storage should not be in the same air space as animals or workers. Connections between the barn and long-term storage must be separated by a gas trap to prevent the gases from returning to the barn. The facility should be designed so that all service work can be performed without entering the storage.

A detailed standard operation procedure should be developed on how to enter manure storage areas and only trained personnel should be assigned to carry out these duties. A manure storage area should never be entered without proper respiratory equipment. A specifically built breathing apparatus comprised of a full facemask and remote air tank and hose, is required. Always work in pairs. If an accident does occur, apply appropriate first aid.

Provide signage around confined manure storage areas as a warning not to enter the storage and of the hazards related to confined manure storage.

6.10 Feeds and Nutrition

Hog manure, a mixture of urine and feces, is primarily composed of undigested and indigestible components of the feed plus some products created from digestion and metabolism. Use the following approaches to reduce manure volume and the amount of nutrients excreted by hogs. To reduce nutrient intake and/or improve the nutrient availability (digestibility) of feed:

Determine the animal's usual feed intake and growth rate and formulate herd-specific diets to match the hogs' requirements. This approach reduces diet costs and significantly reduces the amount of nitrogen, phosphorus and other nutrients excreted. The best guide to the protein, amino acid and mineral requirements of swine is the *National Research Council, Nutrient Requirements of Swine* (1998). An accompanying computer program can be used to determine the nutrient requirements of a specific group of hogs. Nutritionists can also help develop farm-specific diets that will maintain optimum growth and production while addressing environmental challenges.

Phase feeding. As animals get heavier, their nutrient requirements, expressed as a percentage of the total diet, decreases. Daily feed intake increases with age, while growth rate as a percentage of total weight, decreases. Therefore frequent changes in diet formulation to more closely match the changing requirements of the hog (phase feeding) will decrease the quantity of nutrients excreted. Similarly, formulating separate diets for pregnant and

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lactating sows may reduce nitrogen and phosphorus and other mineral excretion by as much as 20 percent.

Split-sex feeding. Gilts fed to appetite consume less feed than barrows, but gilts have similar or greater lean tissue growth rates. Therefore diets for gilts should be more nutrient dense than barrow diets. When gilts and barrows are penned in mixed sex groups, diets tend to be over-formulated for barrows, which results in greater nutrient excretion. By using split-sex feeding, the unique lean growth and feed intake of each gender can be met, while reducing input costs and nutrients excreted.

Improving feed conversion efficiency. Feed conversion efficiency (FCE) is an important determinant of profitability in animal production. It is defined as the amount of feed required to produce one unit of animal growth. Any improvement in FCE has the potential to reduce excreted nutrients, as it reduces the amount of feed required to achieve similar weight gain or product output. It is estimated that a 0.1 percent improvement in feed conversion reduces phosphorus excretion by 0.14 kg per hog. Improvements in overall feed efficiency can be achieved by:

- Genetic advances that produce faster growing and leaner animals.
- Production technologies that reduce disease, such as all-in, all-out animal flow, segregated weaning, better biosecurity, better use of vaccines and disease control strategies.
- Improved environmental conditions.
- Proper diet formulation.
- Use of high quality feed ingredients with readily available nutrients.
- Improved feed processing (e.g. pelleting and grinding).
- Adjustments to feeders to reduce waste.

Nutrient availability and digestibility can be improved by pelleting and grinding feeds. Findings indicate that for each 100 micron reduction in particle size, there is a 1.0 to 1.5 percent improvement in FCE for hogs fed corn-based diets. Proper feed processing ensures good performance and results in reduced daily excretion of nutrients.

Improvements in feeder design and operation can reduce feed waste and subsequently improve feed efficiencies. Studies have shown that feed waste accounts for three to eight percent of the feed and that an estimated reduction in feed waste of two percent would reduce phosphorus excretion by 32 grams per hog.

Mineral withdrawal in late finishing. Several studies have shown that supplemental minerals may be withdrawn from the diets of hogs weighing 90 to 120 kilograms (market weight) without any detectable negative effects on growth rate, carcass quality or bone strength. Because feed usage and manure output are highest during this period, removal of the mineral supplement from the diet can reduce mineral excretion by 30 to 50 percent.

Nutrient availability of ingredients. The digestibility of nutrients varies considerably between ingredients. For example, digestible phosphorus in wheat is 50 percent available while corn provides only 14 percent of its total phosphorus to the hog, with the rest excreted. If formulations are based on available phosphorus, the comparative value of wheat is higher (when phosphorus is the nutrient constraint), allowing a decreased amount of phosphorus to be excreted in the manure. Nitrogen excretion can be significantly reduced by formulating diets on the basis of digestible phosphorus, ideal digestible amino acid levels and the correct ratio of dietary essential amino acids to lysine.

Feed additives. Feed additives such as antibiotics and beta-agonists may contribute to reduced nitrogen and mineral excretion by improving growth rate and feed conversion efficiency. Studies estimate that antibiotics in the diets of weaned hogs and growing hogs reduced nitrogen and phosphorus excretion by seven and three percent respectively compared to unsupplemented diets. Research has concluded that the use of specific feed additives results in a reduction in manure and phosphorus excretion of about six percent.

Nitrogen excretion can be reduced by reducing the crude protein in the diet. Incorporating synthetic amino acids in diets for growing-finishing hogs can reduce crude protein content in the diet by two percent without any reduction in hog performance. Lowering the dietary crude protein level for growing-finishing hogs by two percent could reduce nitrogen excretion by approximately 20 percent.

Lysine is 100 percent digestible in some ingredients, but as low as 50 percent digestible in other ingredients. Poor digestibility leads to an increase in undigested nutrients in manure. By formulating diets that include more digestible nutrients, for example, using synthetic lysine, protein in the diet can be decreased, as well as the nitrogen in the manure.

6.10.1 Use of Enzymes to Improve Availability of Phosphorus and Other Nutrients

The majority of ingredients in animal diets are of plant origin. It is estimated that more than two-thirds of the phosphorus in cereals and oilseeds is in the bound form of phytate phosphorus. Only 30 percent of the phosphorus in phytate phosphorus is available to swine. The following strategies can be used to meet the hogs' need for phosphorus, while reducing excreted phosphorus:

Source of P. To meet the animals' requirements for phosphorus, inorganic sources of phosphorus, such as dicalcium phosphate and monocalcium phosphate, must be added to the diet. If inorganic sources are chosen on the basis of bioavailability of phosphorus rather than total phosphorus, the excretion of phosphorus can be reduced. The digestibility of phosphorus in dicalcium phosphate, which is commonly used in swine diets, ranges from 65 to 70 percent compared to 75 to 80 percent phosphorus digestibility in monocalcium phosphate.

Ca:P ratio. Ensure a proper calcium to phosphorus ratio. A suggested ratio of total calcium-to-phosphorus for grain-soybean meal diets is between 1:1 and 1.25:1. Wider Ca:P ratios will lower phosphorus absorption and increase phosphorus excretion.

Phytase. The amount of phosphorus excreted by hogs can be significantly reduced by improving the availability of phytate in grains and vegetable protein supplements. There is now considerable evidence that the addition of microbial phytase in hog diets will increase phosphorus digestibility. Studies suggest that, in general, addition of phytase in swine diets will allow phosphorus content of the diet to be reduced by 0.1 percent. It has been observed that phytase supplementation of swine diets can improve feed utilization by one to two percent.

Research has also shown that, in addition to improving the digestibility of phosphorus by 27 to 30 percent, phytase also improved the digestibility of some amino acids and trace minerals. The benefits of phytase can be realized without an effect on hog performance, carcass quality, or bone strength.

Vitamin D. It has been reported that increasing the level of vitamin D in the diet increases phosphorus utilization. An estimate of the reduction in phosphorus excretion resulting from various feeding strategies is shown in Figure 6.3.

Figure 6.3 **Feeding Strategies to Reduce Phosphorus Excretion from Livestock**

Factor	Estimated reduction in N and P excretion in manure (%) P	N
Feed Additives		
Phytase	25 - 30	5
Growth promoting substances	5	5
Feeding Strategies		
Reduce protein with supplemental amino acids		15 - 20
Formulating closer to requirements	10 - 15	10 - 15
Phase feeding	10 – 20	10 – 20
Use of highly digestible feed ingredients	5	5

Sources: Baidoo, 1999; Schwartz, 1998; Viaene and Verbeke, 1998

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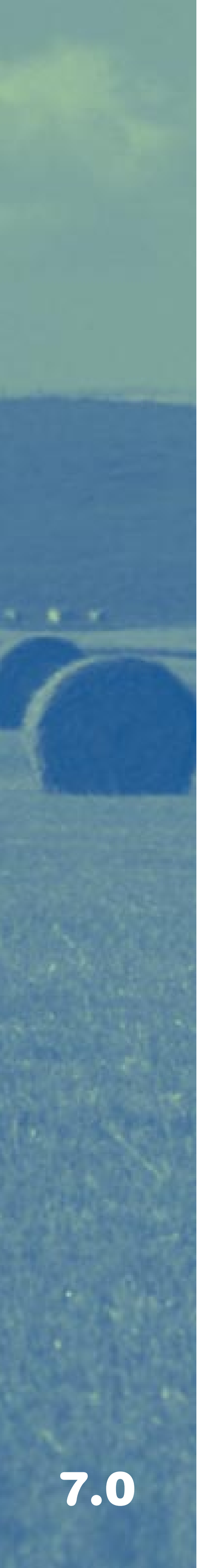
7.0 MANURE COLLECTION, STORAGE, TRANSPORTATION AND TREATMENT



7.0 MANURE COLLECTION, STORAGE, TRANSPORTATION AND TREATMENT

Hog manure is a valuable by-product from swine farms. However, to avoid pollution, a well-planned manure storage system is required. This section deals with storage site selection, sizing and maintenance. Manure transportation and treatment are also included.

As manure storage facilities have potential to contaminate water, they need to be designed and monitored to ensure they are both structurally and environmentally sound. The facility must meet the requirements in the *Agricultural Operation Practices Act* (AOPA), *Standards and Administration Regulation.*

The design of the storage will depend on the number of animals involved, the storage time required, the type of manure to be stored, and the site evaluation. A storage facility is a permanent structure or location designed and operated to contain manure, other wastes and contaminated runoff in an environmentally sound manner. The facility should be sized to hold manure until it can be used as a fertilizer. Generally the facility should be able to hold nine months of manure production, as a minimum. Timing and amount of manure to apply on cropland is explained in Section 8: *Land Application of Manure.*

Alternatively, if manure is being picked up and removed from the farm, a manure storage structure sized for one cleanout may be suitable to temporarily store the manure. Check with the NRCB to determine temporary storage requirements.

7.1 Design Considerations

7.1.1 Manure characteristics

Depending on the housing situation, hog manure may be handled and stored as a liquid, solid or semi-solid. From a handling perspective, the following classifications are generally used to describe manure.

Liquid manure.................0 to 5 % solids
Slurry manure..................6 to 13 % solids
Semi-solid manure.........15 to 23 % solids
Solid manure...................more than 25 % solids

7.1.2 Anaerobic vs. aerobic storage

Manure storages are either anaerobic or aerobic depending on oxygen availability. Anaerobic activity occurs in the absence of oxygen; aerobic action occurs in the presence of oxygen. Aerobic conditions are created by mechanical mixing or aeration. Anaerobic storages are generally less costly than aerobic storage, but more odorous. Although aerobic storage is less odorous, more ammonia is released from the storage, which reduces the fertilizer value of the manure and can contribute to acid rain. Most storages in Alberta are anaerobic.

7.1.3 Site selection and construction of manure storage structures

According to AOPA, the manure storage must:

- Meet local property setback requirements.
- 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, ditches, etc.
- Be constructed according to the design criteria outlined in the AOPA to prevent water, soil and air contamination.
- Be located at least one metre above the 1:25 year flood level.
- Have at least 0.5 metres vertical distance between the full level of the structure and the upper edge (freeboard).
- Be structurally sound with professionally engineered designs.
- Be accessible by an all-weather road.
- Have berm and liner protection at locations in the storage affected by scouring (inlets, transfer pipes, and agitation sites).
- Be adequately fenced to prevent accidental entry of humans, animals and machinery.

A minimum of nine months storage is required for manure storage facilities. The manure storage should:

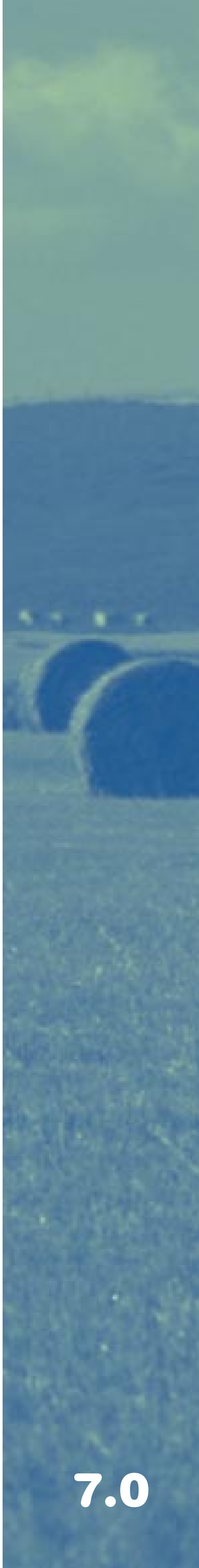
- Be sized to provide enough storage to enable the operator to spread manure when crop uptake of the nutrients will occur and when manure runoff from fields to surface water is unlikely.
- If open, the structure must be sized to hold the expected local precipitation.
- Be close enough to the barns to allow for convenient filling.
- Accommodate future expansion.
- Be constructed to prevent surface runoff from collecting in the storage. Berms or ditches are commonly used to divert surface water.
- Be seeded to grass on the berm and down to the maximum fill level to prevent shifting and blowing and to prevent cracks and holes that result from exposed liners, freeze thaw cycles and tree roots.
- Have a grassed buffer strip to intercept manure that could enter a watercourse in the event of a leak or overflow.
- Minimize odour and nuisance to neighbours.
- Be located away from roads and traffic.
- Be kept tidy to reduce flies and rodents and promote a positive image.

7.1.4 Site evaluation

A thorough evaluation of the site is necessary to develop an economically feasible, structurally sound and environmentally safe storage design. A suitable design is based on assessment of the soils, geology and hydrogeology of the area. It is also necessary to consider social and economic factors. The initial site assessment must obtain sufficient information to evaluate the following basic site factors:

- Topographic characteristics including land slope and distance from water bodies.
- Surface and subsurface soil characteristics, such as soil permeability and the suitability of the excavated materials and other related information to build a clay liner.
- Site hydrogeology, including depth to water table, depth and quality of bedrock, existence of perched water tables, depth to the local aquifer and its quality and sensitivity.

Following a proper site assessment, strict design and construction requirements for the storage should be followed to achieve a dependable liner. If no concern arises from the initial site assessment, an earthen manure storage can be considered. If there is lack of information or a concern arises in the preliminary assessment, a more rigorous site investigation may be required. This will include a geotechnical field investigation of soil depth, texture and uniformity at the proposed site. Geotechnical parameters such as plasticity characteristics and actual permeability measurements may be required.



7.2 Types of Storage

Liquid storage. The most common type of liquid storage in Alberta is the earthen manure storage, which is lined with compacted clay or plastic material. In unusually sensitive geologic settings, concrete or steel storage tanks may be required. When concrete or alternative storage facilities are used the manufacturer should be consulted about ongoing maintenance. The design and construction of all storages should be verified by a Professional Engineer.

The cost of installing steel tanks limits their use in Western Canada. Steel tanks are always circular and may be built above or below grade.

A concrete storage may be an alternative if local soil conditions, economics or regulations prevent use of an earthen structure. Leakage can be minimized with proper structural design and installation. A layer of clay or some other liner below the storage foundation system will also reduce potential for leakage.

Concrete storages are generally smaller in surface area and will collect less precipitation (if uncovered) than earthen storages. Concrete storages can be built above ground, below ground or be incorporated into the barn design. Long term manure storage below the livestock building is known as "deep pit" storage. Deep pit storage generally holds six to 12 months of manure in a deep pit under the livestock flooring. Most deep pit facilities use a fully slatted livestock floor above the pit area. Finisher swine facilities have been the main swine facility using the deep pit storage. There are several advantages/disadvantages of a deep pit facility versus outdoor storage.

Figure 7.1 **Advantages and Disadvantages of Various Concrete Manure Storages**

Style	Advantages	Disadvantages
Below Ground	• Gravity flow may be possible. • Reduced pump sizes (if required). • Soil may be used to help support the walls of the storage.	• Fencing is important to prevent accidental entry of humans, animals or machinery. • Leakage or cracking may be more difficult to detect. • Additional soil excavation may be required.
Above Ground	• Leakage or cracking may be easier to detect. • There may be less ground excavation required.	• Gravity flow is usually not possible. • Increased pump sizes are necessary to pump manure higher up. • Piping may be above ground with increased chances of freezing and maintenance. • Soil cannot be used for structural support on the side wall.
Deep Pit	• Building and manure storage are contained in the same space. • There may be reduced minimum separation distances from neighbours or property lines. • Reduced odours (real or perceived). • Precipitation cannot enter pit since it is covered. • Cost is less than having an outdoor storage.	• Manure being held under the slats has the potential to release hydrogen sulphide that may be harmful to humans and livestock. • Agitation and pumping of manure is done directly under the livestock unless the building is emptied during this time. • Any structural or construction problems with the pit will have a direct impact on the remainder of the building (or vice versa).

Semi-solid storage. Hog manure will be semi-solid when scraped from facilities that use minimal amounts of bedding, such as solid floor farrowing and feeding pens. In the wetter areas of the province, semi-solid manure should be stored in closed, shed-type, manure holding structures. These structures should:

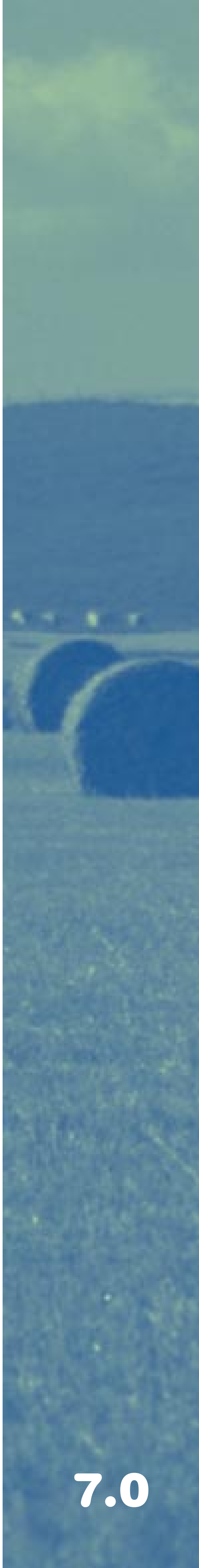
- Meet the criteria listed in Section 7.1.3 for manure storage structures.
- Have reinforced concrete walls, or equivalent, to adequately contain the manure.
- Have a concrete floor which is sealed to the walls to provide a manure-tight storage and eliminate the entrance of ground or surface water.
- In areas with a high water table, be constructed entirely above ground to minimize seepage of groundwater into the structure (this will also facilitate the cleaning out operation).
- Be adequately roofed to keep out rain and snow in areas with high annual or seasonal precipitation.
- If roofed, be well ventilated to prevent the accumulation of hazardous gases in the head space area and to aid the drying of the stored manure.
- Have access doors constructed of tight tongue-and-groove pressure treated timber, or equivalent. Seepage, if any, should be contained to prevent a pollution hazard.
- If fitted with a ramp, have guard rails and safety stops on the ramp to prevent a tractor from being buried in the manure.
- Have a suitable concrete slab area for tractor and manure spreader activity. This slab should be sloped away from the building so that water on the slab does not enter the storage area.

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

- Have reinforced concrete sidewall or equivalent on three sides of the structure.
- Have a concrete, floor, sloping downward from the open side, which is sealed to the walls to provide a manure-tight storage, and have provision to control and contain seepage.

Solid storage. Solid storage can be classified as: short-term, long-term and in-pen. Short-term storage contains manure for no more than six months over a three-year period. Long-term storage is storage greater than six months.

- Ensure surface water runoff from the storage does not enter an open body of water or leave the owner's property.
- Do not construct manure storages on the banks of rivers, drainage channels, or depressions that may carry surface runoff to water sources.
- Use berms, catch basins and/or vegetative buffers to prevent runoff.
- The storage bottom must be at least 1 metre above the water table.
- Storages for solid and semi-solid manure must be constructed at least 1 metre above the 1:25 year flood level. If the 1:25 year floodplain is unknown, the storage must be located at least 1 m above the highest known flood level.
- In-pen storage is used for alternative housing facilities and must be constructed as a long-term storage. Drainage and adequate bedding must be provided with in-pen storage to prevent contaminated water from collecting in the pen. A slope of two to four percent in the pens will provide the necessary drainage.
- Compost can be either short or long-term storage, but must comply with the *Alberta Environment Code of Practice for Compost Facilities.* These regulations come into effect based on a volume of compost.



7.3 Runoff Control from Manure Storage

7.3.1 Options to control surface runoff

Runoff considerations. The considerations for determining a runoff utilization area are the quantity of runoff, topography, infiltration rate, soil water-holding capacity, crop nutrient utilization and soil SAR (sodium adsorption ratio) or EC (electrical conductivity).

Options to control surface runoff include constructed wetlands, vegetative filter strips and diversion to cropped areas.

Vegetative filter strips. Vegetative filter strips are widths or lengths of vegetation that act as a "filter" to trap and utilize sediments and nutrients from runoff.

Vegetative filter strips may be sufficient to minimize runoff contamination from some livestock operations, manure stockpile sites and from manure spread on cultivated fields.

Factors influencing the effectiveness of vegetative filters are:

- Drainage area up-slope from the operation.
- The amount and form of precipitation (snow, rain, or both).
- Slope of the operation site and whether the natural topography lends itself to sheet or channel runoff.
- Vegetation type (summerfallow, stubble, grass or trees, etc.).
- Soil type (sandy, loam, or clay, etc.).

For example, frozen ground in the spring, combined with a packed non-vegetative thatch, will not "filter" contaminants as effectively as the ground in the summer.

To date, there is minimal definitive research that verifies how to design a vegetative filter strip based on all the above variables. However, the limited research that has been done seems to indicate that the 30 metre-wide separation from a watercourse, as specified in the AOPA, *Standards and Administration Regulations* (60 metre for four to six percent slope; 90 metre for six to 12 percent slope) will be adequate under most conditions. Further research is required to determine more specific design details.

Wetlands. Wetlands are either naturally-occurring sloughs or lowlands, or "constructed" wetlands that are designed and landscaped. In some instances, they might be used to collect and treat contaminated runoff from livestock operations. The nutrients and contaminants from the runoff are absorbed and utilized by the bullrushes, sedges and other marsh-type vegetation growing in the wetland area.

Wetlands must be properly evaluated and designed to ensure adequate retention and filtering. As a minimum, these lowlands or wetlands must be entirely contained on the producer's property, and soil conditions must be tested to ensure they will not leach into groundwater.

7.4 Manure Storage Capacity

Manure storage facilities should provide enough storage space to allow the operator to spread manure when optimum crop uptake of the nutrients will occur and when manure runoff from fields to surface water is unlikely. To allow manure spreading when manure application is the most beneficial, a minimum storage period of nine months is recommended in the the AOPA, *Standards and Administration Regulations*. However, manure storage facilities are commonly built with a storage capacity of 12 to 14 months to minimize spreading costs.

Estimate storage capacity:

To estimate the volume of manure produced, use Figures 7.2 and 7.3 as guidelines.

- Evaluate an existing operation that is similar to the planned facility.
- Contact experienced professionals.

Account for management practices and facilities:

The volume of manure produced can vary due to spilled water and the amount of water used for washing. For example, where washing is regularly performed, such as in farrowing and nursery operations, the volume of waste from the facility will be higher than other types of facilities.

If bedding is used in solid systems, the weight of manure may increase by 20 percent and the volume may double.

Account for the historical rainfall in the area.

Where precipitation can enter the storage, the storage must have sufficient capacity when it is ready for clean-out, to handle a major rainstorm without overflowing. Storages should be designed to account for the highest rainfall that has occurred in the past 30-year period.

Allow reserve capacity in the storage to hold accumulated solids.

Provide enough storage to allow flexibility to spread manure when field conditions, labour availability, weather and local regulations permit.

Short-term storage may mean increased management and labour, as time for setting up and putting away equipment is increased. More importantly, poor weather, labour shortages and equipment breakdowns can seriously disrupt the timing of this seasonal operation.

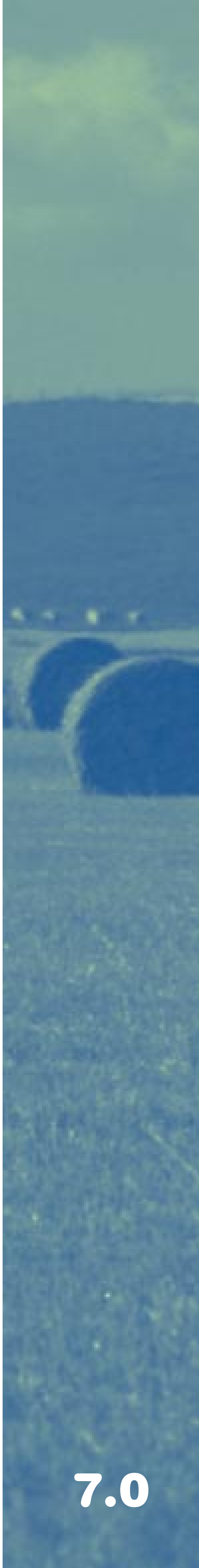
Figure 7.2* **Solid Manure Production Volume**

	DAILY			MONTHLY			YEARLY		
	lbs.	kgs	cu.ft.	lbs.	kgs	cu.ft	tons	tonnes	cu.ft.
Farrow to Finish	86.4	39.3	1.74	2590	1180	52.3	15.76	14.29	637
Farrow to Wean	26.6	12.1	0.54	800	360	16.1	4.85	4.40	196
Farrowing	21.3	9.7	0.43	640	290	12.9	3.88	3.52	157
Weaner	2.8	1.3	0.06	80	40	1.7	0.50	0.46	20
Feeder	8.2	3.7	0.17	250	110	5.0	1.50	1.36	61

Figure 7.3* **Liquid Manure Production Volume**

	DAILY			MONTHLY			YEARLY		
	gallons	litres	cu.ft.	gallons	litres	cu.ft.	gallons	cu. m	cu.ft.
Farrow to Finish	14.4	65.7	2.31	430	1950	69	5272	24.0	844
Farrow to Wean	4.4	20.2	0.71	130	590	21	1622	7.4	260
Farrowing	3.5	15.9	0.56	110	500	17	1278	5.8	204
Weaner	0.5	2.3	0.08	20	90	2	183	0.8	29
Feeder	1.6	7.1	0.25	50	230	7	568	2.6	91

**Taken from AOPA*



7.5 Maintenance and Monitoring

Signage and fencing. Hazardous areas such as storage structures, dugouts and water basins should be fenced and warnings posted to prevent curious humans and animals from accidents. *The American Society of Agricultural Engineers Standards ASAE S441* (SAE J115 Jan. 87) has information on creating signage.

Mowing. Keeping weeds and grass mowed promotes a positive image, reduces the potential for liner damage and reduces fly and rodent habitats.

Odour. Decomposition of manure in storage stuctures can create odours that may be quite strong and offensive. When manure is undisturbed, gases are trapped beneath the surface within clusters of solid material. With time, the entrapped gases increase in volume and rise to the surface in a bubble. At the surface, the bubble bursts and the odorous gases are released into the atmosphere. This is a natural process that occurs slowly over time. It is important to note that strong and highly offensive odours are generated intermittently from manure storages. Weather conditions and loading and emptying practices can impact the odour released.

Weather conditions. Temperature influences the generation of odorous gases. During warm summer conditions, the temperature rises in stored manure, increasing microbial activity, resulting in the faster decomposition of waste matter and an increase in the volume of odorous gases released from the manure. Under cold, winter conditions, bacterial activity ceases in storages. Odour levels increase when bacterial activity stops or starts.

Wind and rain may influence the odours released from manure storages because they agitate the contents of the storage. A crust on the surface of outdoor manure storages helps contain odorous gases. However, if strong winds or heavy rains agitate the storage or disturb the crust that forms on the surface, the release of odorous gases may increase.

Loading and emptying. Manure solids will quickly separate from liquids during storage; therefore agitation is required to bring the solids back into suspension to obtain the consistent slurry of liquids and solids that will flow during loading or pump out.

Chopper pumps are appropriate since they do not plug easily. These agitation pumps have capacities of about 200 L/sec. (2,600 gal./min). Due to the high settling rate of hog manure solids, pipeline velocities must be maintained in excess of 0.5 m/sec. (2 ft./sec.) to prevent pipeline plugging.

Pumps used in liquid systems require some method of screening out or breaking up solid material. Problems can occur when clumps of solids enter the pump. Care should be taken to prevent solid materials such as stones, pharmaceutical waste and construction materials from entering the manure system. Care should also be taken to protect the berm and liner of the storage at locations affected by scouring (inlets, transfer pipes and agitation sites).

Agitation can release gases that are dangerous. This is particularly important to remember when dealing with deep pit storage. To control odour and gas release, agitation should be conducted so that the pump system does not "break" the liquid surface.

To reduce odour when adding new manure to a pre-existing volume in a manure storage, it is advisable to discharge the new material beneath the surface of the manure. The discharge point should be at least 0.9 metres (3 feet) from the surface of the manure and 0.3 to 0.6 metres (1 to 2 feet) from the bed of solids at the bottom. This limits the disturbance of gases trapped in the manure. In addition, a low discharge flow rate will prevent vigorous agitation of the manure.

Be aware that several of the gases released by disturbed manure can be fatal. Several deaths have occurred in Alberta because of a lack of training and personal protection equipment while working with stored manure. For more information on the risk associated with manure gases, see Section 2.4.

7.5.1 Odour control strategies

Windbreaks. 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 required to create adequate air movement between the windbreak and the storage is being investigated.

Covers. Covers can be used to reduce odour and gas emissions from manure storages. Several different types of covers have been studied.

- **Straw covers.** These have been reported to have excellent odour control when the cover is first installed and as long as the straw remains dry and floats. Straw covers are the least expensive option for covering storages. The downside is that the straw can cause problems during pump-out and the efficiency of the cover declines as the straw sinks. Reapplication of straw is necessary throughout the year. The Prairie Farm Machinery Institute (PAMI) found that barley straw is the best material for straw covers. PAMI has also calculated the cost of applying and maintaining straw covers.
- **Alternative cover materials.** These include foam glass or clay particles, floating plastic sheets, plastic covers with a frame, and geotextile covers held in place by negative air pressure. These covers have provided excellent odour control results. However, cost, anchoring and pump-out issues must still be resolved.

Additives. Studies have been conducted to evaluate the effect of different types of feed and storage additives on the release of odour from barns and manure storages. The results of these studies are mixed.

Multi-cell storages. This is the most basic method of solid/liquid separation. Solid/liquid separation can reduce odour emission rates because large mats of solids do not rise to the surface of the second cell. The solid basin releases little odour since the solids layer on the surface is dry. On an annual basis, the liquid can be pumped out without agitation and the solids can be removed with a backhoe. This storage system requires far less agitation prior to land application than single-cell storages.

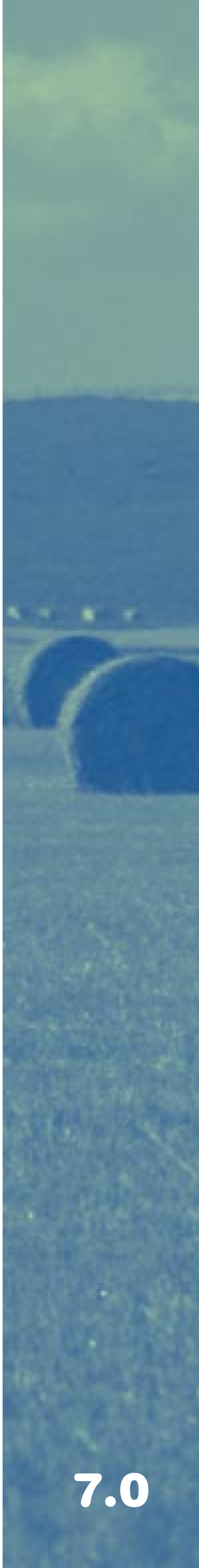
7.5.2 Monitoring

Visual. There are several visual indicators of storage problems:

- Content levels that don't change.
- Wave damage to the liner.
- Erosion where manure enters or is pumped from the storage.
- Cracking or slumping of the liner.
- Seepage, soft spots or slumping on the outside of the berm or several feet out from the berm indicate leakage. Any leakage or slumping is a serious problem that requires immediate attention.
- Evidence of rodents. Rodent burrows damage the liner and walls of the manure storage.
- Trees, if planted, should be away from the storage, outside the boundary of their mature root zone. To prevent roots from penetrating the liner and creating leaks, remove trees and plants that start to grow in the manure storage.

Although research into leakage from earthen manure storage structures has shown minimal problems, there may be some site-specific cases where more than visual monitoring is warranted. These situations might include lagoons constructed in coarse soils, or where groundwater or water tables are within three metres of the bottom of the lagoon (AAFRD, Agdex 729-1). Sampling wells can be used as additional monitoring methods.

Sampling wells. Sampling wells can be installed to regularly monitor water quality and detect changes in water quality near manure storages. Regular monitoring can be used to verify that the manure storage practices are protecting the environment or can act as an early warning that a change or repair is needed. A qualified engineer or hydrogeologist should design the monitoring well system and analyze the water quality data. After the wells are installed they must be sampled to determine background conditions. This sampling should be done three to four times per year for the first one to two years. After that, sampling once or twice per year should be sufficient.



7.6 Manure Transportation

Moving manure from storage to the field is an important component of the manure management system. Manure hauling from storage to field requires an economically sound system that is safe and responsible. The 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. Traffic on gravel roads during dry, windy periods can result in significant dust generation. If these conditions exist in "sensitive areas", such as near neighbours, dust suppression or detouring may be necessary. Dust suppression can include watering roads or applying calcium chloride. Contact a water hauling contractor for road watering services.

Manure is considered a biodegradable product. However, direct spillage from manure trucks must be kept to a minimum. Manure haulers need to be aware of the risks associated when hauling on roads. Whether it is a wet or dry product, spillage may result from seepage, overloading, or blowing.

Whatever the case, appropriate management and equipment is required to keep the roads and ditches free from manure spillage. This may mean 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 required.

The intensity of traffic during manure hauling may have a significant impact on lower grade roads. Many livestock operators have entered into road use agreements with their local municipalities, which clearly define responsibilities. These same road-use agreements may also include responsibilities regarding dust generation and spillage.

Manure spills on the road can be in violation of the *Transportation Act* (litter) and the *Alberta Environmental and Enhancement Act* (pollution). Also, producers should check with the local municipality regarding road bans prior to hauling manure.

Transporting manure is an important component of a good nutrient management plan. Safe and efficient manure hauling is possible when these factors are considered.

7.7 Manure Treatment

Manure is a major source of nutrients for crop production and its application on cropland is generally recommended. However, there are cases where the availability of cropland is insufficient for recycling all of the manure produced from a livestock operation and special situations where direct land application is not acceptable.

An alternative to direct land application of hog manure is to treat the manure prior to application or off-farm use. If manure can be land-applied, treatment is unnecessary. The most common methods of manure treatment in Alberta include solid/liquid separation and composting.

7.7.1 Solid/liquid separation

Advantages of separating the liquid and solids:

- Reduced solid settling problems in large volume storages.
- Improved pumping and pipeline handling of liquid manure. Pumping liquids from one location to another does not require robust equipment.
- A more consistent liquid portion for managing nutrients on land.
- A solids product that is suitable for composting, thus creating value-added possibilities.
- Separates and concentrates the major phosphorus source in the solids. This increases options for improved phosphorus management.
- Volume reduction, making storage and handling more cost effective.

Disadvantages of separating the liquid and solids:

- Creates two manure types (solids/semisolids and liquid) and requires separate storage and handling systems for both.
- Added cost, maintenance and labour.

Current Technologies include:

Multi-cell earthen storages. This is the most basic and least effective method of solid/liquid separation.

Centrifugal separators. Several types have appeared on the market. They are generally high in price, low in capacity and low in ability to produce a low-moisture solids fraction.

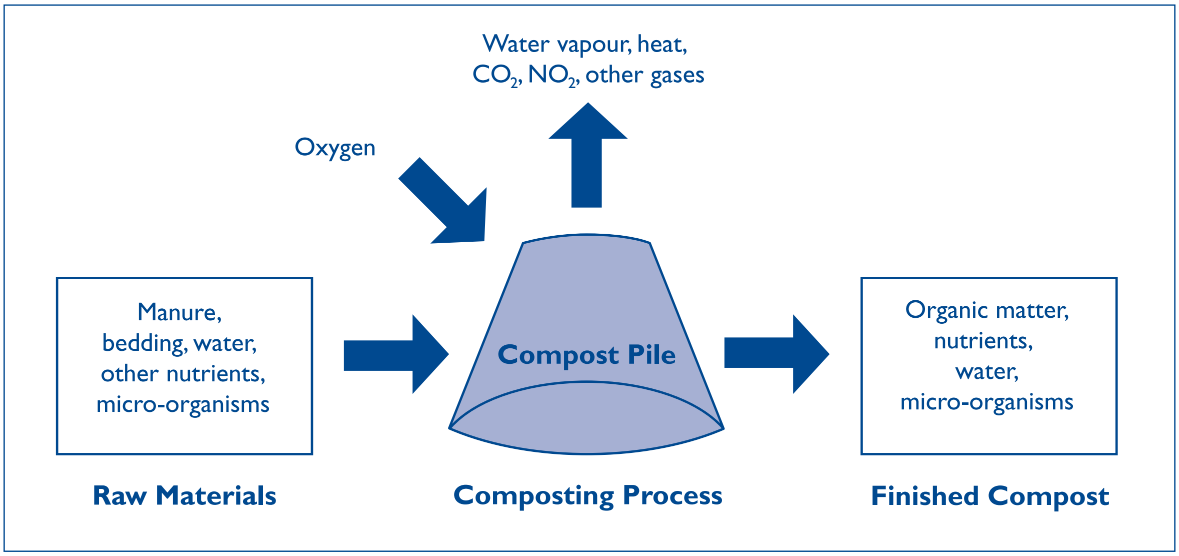
Screens. Many variations exist for screen separators, from the simple stationary sloped bar screen and vibrating screen, to screens with mechanical assistance. Most separators on the market are variations of the screen separator, usually with mechanical assistance in the form of scrapers, screws and/or hydraulic heads to provide additional separating force. Costs of these separators vary greatly from cost-prohibitive to practical on large operations.

The liquid fraction of manure can be irrigated onto fields. The liquids are diluted with irrigation water and applied using a centre pivot system with standard irrigation nozzles. Research indicates diluting the liquids with irrigation water reduces odour intensity and offensiveness.

For more information about liquid-solid separation, contact a livestock engineer at Alberta Agriculture, Food and Rural Development.

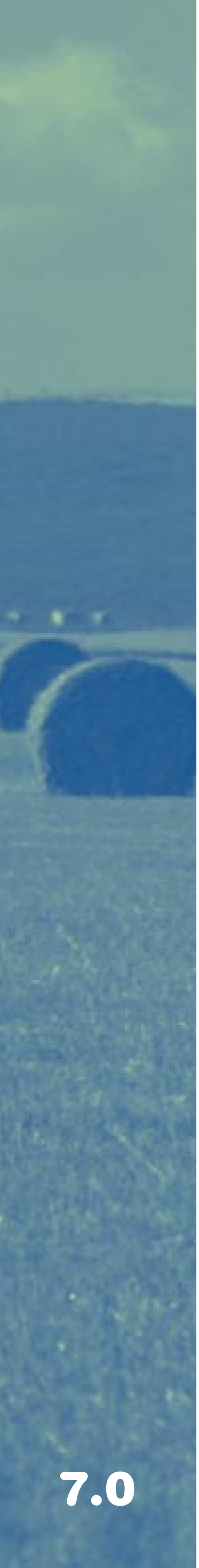
7.7.2 The composting process

Figure 7.4 **The Basic Composting Process**



The composting process has several basic requirements:

- Moisture content in the range of 40 to 65 percent. Below 40 percent moisture, the process is slow; above 65 percent moisture, the process can become anaerobic and produce unpleasant odours. Since liquid manure is about 96 percent water, the solids must be separated from the liquid in order to be composted. This requires a liquid/solids separation process to obtain a suitable material to compost. Housing systems using straw or shavings for bedding produce solids suitable for composting.
- A carbon to nitrogen ratio between 20:1 and 30:1. The C:N ratio of hog manure tends to be lower than optimum, so additional carbon may be needed, such as shavings or straw. If the C:N ratio is too low, ammonia will volatilize, and if it is too high, the composting time increases because nitrogen is in short supply.
- An oxygen supply. Oxygen enters either by regular mechanical turning of the compost or by forcing air through the material.
- A pH of 6.5 to 8.0.
- A temperature of 40 to 65 C in the compost pile. Maintaining temperatures of 55 C or greater for 15 days will eliminate most pathogens and weed seeds.



7.7.2.1 Methods of composting

A wide range of technology is available for composting. Most composting methods for livestock manure require low investment and low labour inputs.

WINDROWS.

The manure piles or windrows are aerated by frequent mechanical turning, which maintains the compost process. A front-end loader or a specifically designed windrow turner can be used for turning.

Advantages:

- Rapid product drying under warm temperatures.
- Produces a drier product.
- Handles large volumes of material.
- Produces a stable product.
- Relatively low capital cost.

Disadvantages:

- Requires large land areas.
- High operational costs.
- Releases odours.
- May require large volumes of bulking agent.
- Weather dependent.

STATIC PILE/PASSIVE AERATION.

This is the low-end compost process available to most producers without capital investment. The manure windrow or pile undergoes a natural degradation process without the assistance of mechanical agitation.

Advantages:

- Low cost.
- Good pathogen destruction if 55 C is maintained for at least 15 days.
- Good odour control.
- Good product stabilization.

Disadvantages:

- Not space efficient.
- Disease-causing micro-organisms can survive this process if adequate temperatures are not maintained for at least 15 days.
- Compost produced by this method may be very inconsistent and may contain viable weed seeds
- Affected by climate.
- Anaerobic conditions and/or overheating can cause unpleasant odours.

IN-VESSEL AERATION.

This is the high-end process in terms of cost, requiring a specifically designed compost vessel usually of concrete, wood or steel. Aeration is enhanced by mechanically forcing air through the composting material. The optimum conditions of this system allows better control of the process and produces a consistent product with high weed and micro-organism kill.

Advantages :

- Can be covered for weather protection and odour control.
- Space efficient.
- Can be designed as a continuous process.

Disadvantages:

- Highly mechanized and capital intensive.
- Requires careful management.
- Less flexible than other methods of composting.
- Difficult to work around piping and ducting that is used to move air.
- Costly to operate and maintain the equipment.

IN-BARN COMPOSTING.

Some housing systems using bedding can be adapted to enable composting inside the barn.

7.7.2.2 Composting regulations

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

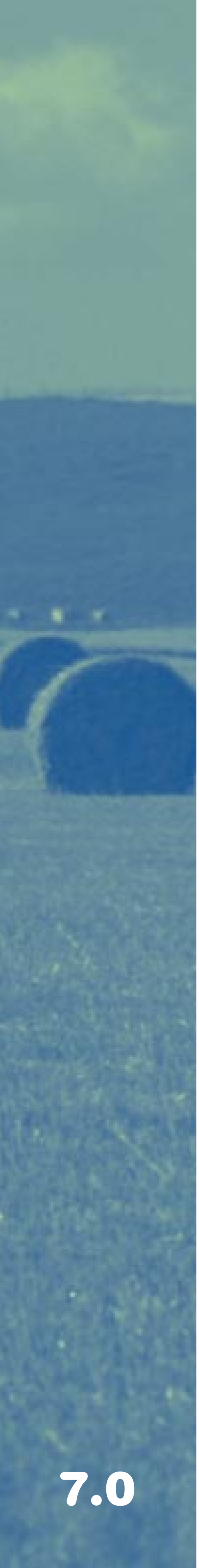
Alberta Environmental Protection
Northeast Boreal and Parkland Regions
Regional Director
5th Floor, 9820 - 106 Street
Edmonton, AB T5K 2J6
Phone: (780) 427-9562
Fax: (780) 422-5120

Alberta Environmental Protection
Northwest Boreal and Northern
East Slopes Regions
Regional Director
Provincial Building
203, 111 - 54 Street
Edson, AB T7E 1T2
Phone: (780) 723-8395
Fax: (780) 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 metres of clay-type material having a permeability of less than 5×10^{-8} m/sec. (or alternate material that provides equivalent protection).
- It must be constructed with a minimum slope of 2 percent so that the pad does not collect water or leachate.
- The provision of a run-on control system must be included to prevent the flow of surface water onto the storage, processing or curing areas.
- A runoff control and management system that provides protection of surface water quality is also required.
- In addition, a groundwater monitoring system may be required.

The eggs of the hog roundworm, *Ascaris suum,* may be present in hog manure (see Section 2.13 Appendix). These eggs can infect humans if they are ingested from the surface of root vegetables and can infect children playing in gardens fertilized with hog manure. *Ascaris suum* eggs will not survive the composting process, if high temperatures are sustained for long periods of time (i.e. several weeks). Composted hog manure should be used to fertilize gardens only if the manure is well composted and has been composted at high temperatures for several weeks.



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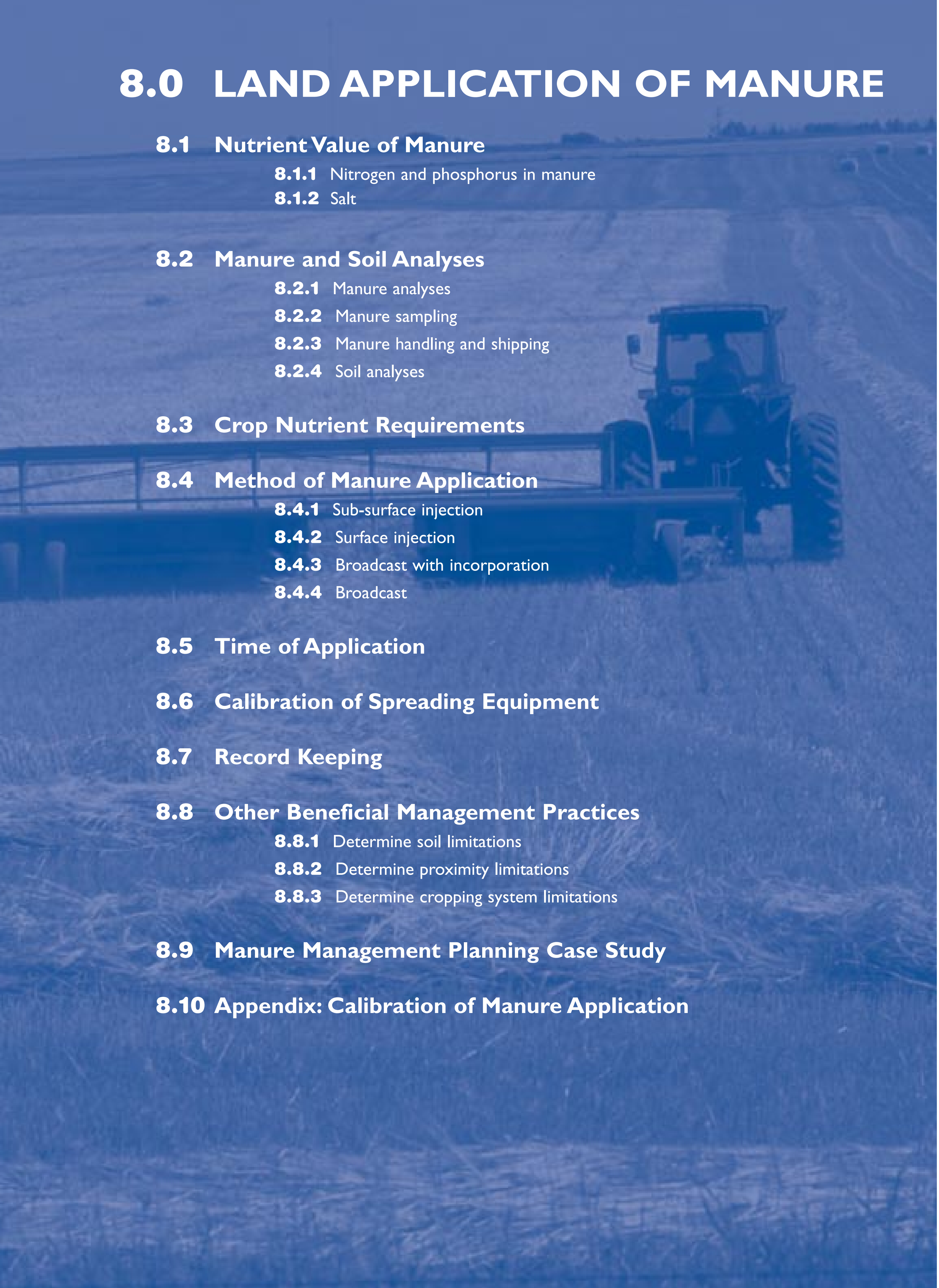
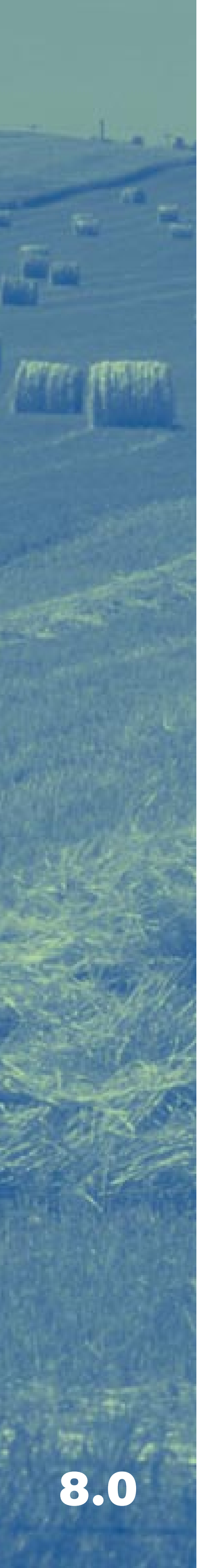


8.0 LAND APPLICATION OF MANURE



8.0 LAND APPLICATION OF MANURE

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 a source of plant nutrients. Manure can also 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 fertilizer 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 that may be associated with land application of manure and compost include:

- Excess phosphorus (P) and nitrogen (N) application on land from manure and mineral fertilizers may result in phosphorus runoff to surface water bodies and nitrate leaching to groundwater.
- Excess phosphorus in water bodies may cause excessive growth of aquatic plants. The decomposition of these plants can reduce oxygen to critical levels, which may adversely affect fish survival.
- Organic matter in a water source may cause physical and biological damage, including oxygen depletion.
- Excess nitrates may reduce ground or surface water quality and become toxic to aquatic life, humans and livestock.
- Disease-causing organisms may contaminate water, making it unsuitable for human and livestock consumption.
- Ammonia toxicity can poison fish and other aquatic organisms.
- Nitrogen gases, including ammonia and nitrous oxide (a greenhouse gas), may reduce air quality.
- High salinity in manure may decrease soil quality.

In this chapter, Nutrient Management Planning (NMP) will be addressed by outlining some 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 reduce 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 can be effectively recycled when manure is used as a fertilizer, which can reduce the need for commercial fertilizers.

To use manure as a resource, it is important to understand its composition. Manure is a mixture of water, organic matter, minerals, nutrients and other chemicals. The proportion of each component and the nutrient profile of the manure depends on animal age, manure storage and handling, bedding material and diet fed. The nutrients available in manure are 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 manure is that the forms and ratio of the nutrients are not easy to change. Nitrogen is present in manure as ammonium or as organic compounds. Generally, the environmental risks associated with nitrogen are losses to groundwater through leaching or losses to air through denitrification and volatilization. Phosphorus is present in manure as organic and inorganic forms and generally the risk to the environment is the movement of phosphorus 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 (mineralized) and nitrate (nitrification) forms to be 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 the current plant available nitrogen and phosphorus. 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 phosphorus runoff losses.

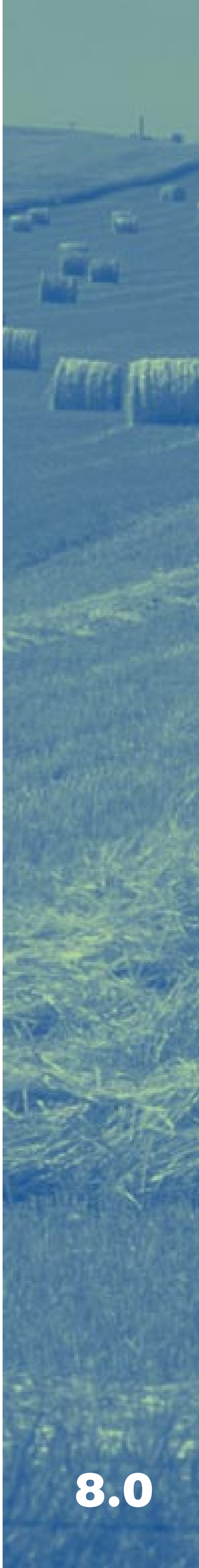
Figure 8.1 **Nitrogen and Phosphorus in Manure***

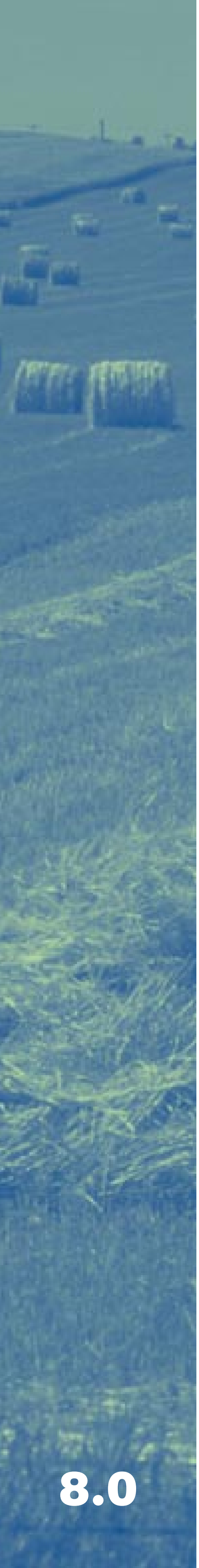
	Form in Manure	Available 1st year	Available 2nd year	Available 3rd year	Environmental Risks
Nitrogen (N)	• Ammonium (NH_4^+) • Nitrate (NO_3^-) • Organic N	NH_4^+ + NO_3^- + 25% of organic N content	12% of initial organic N content	6% of initial organic N content	• Nitrate in groundwater • Volatilization** 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

*The percentages listed in the figure are only estimates. The availability of nutrients from organic sources, such as manure, depends on biological processes in the soil, and these processes are affected by many factors, such as 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.

Practices that may reduce nitrate leaching:

- Apply manure based on the nitrogen rate from soil test recommendations.
- When a high amount of nitrogen is 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 the highest demand for nitrogen uptake by the crop (e.g. apply in spring while plants are actively growing).
- Do not apply if heavy rain is predicted.
- Do not apply near streams or other water bodies. Manure must 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 (*Agricultural Operation Practices Act* [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 crop advisor 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 analyzed for nutrient content, book values can be used (AOPA). This will reduce excess nutrients in the soil and minimize buildup.
- Apply manure when it can be incorporated. Avoid spreading manure on snow or frozen soil.
- If manure is applied on forage, direct-seeded crops, frozen or snow-covered ground, or if manure must be applied to alleviate storage capacity, application must be in accordance with the nutrient limits, and other manure application requirements (e.g. proximity to water). 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 only acceptable if the minimum setback distances are met (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).
- Currently there are no soil phosphorus limits in Alberta, but research is underway to identify environmental limits.

To reduce nutrient losses by wind and water erosion:

- Leave some of last year's crop residue on the surface and reduce tillage. This is effective for increasing water infiltration and reducing 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.

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

8.1.2 Salt

Manure can contain significant amounts of salt that may affect soil quality.

- Management of soil salinity is crucial for sustainable crop production. Saline soils can reduce crop production and limit cropping options (contact a crop advisor for information on crop salinity tolerance).
- Salt can destroy soil quality. High levels of sodium 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.
- In soils with a high EC and high SAR, do not apply manure.

8.2 Manure and Soil Analyses

Manure analysis provides information on nutrient content in manure. Based on nutrient analysis, the amount of nutrients available for crop growth can be estimated. To estimate crop-available nutrients in manure, 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) should be considered. When calculating manure application rates, include residual crop-available nutrients from manure applied in recent years.

Accurate manure analysis and application are important because problems can result from either inadequate or excessive nutrients in the soil. Manure analysis recommendations are based on the nutrient content in manure, crop to be grown, soil type, soil tests, climate, soil moisture, and other management practices, such as dryland versus irrigation.

8.2.1 Manure analysis

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

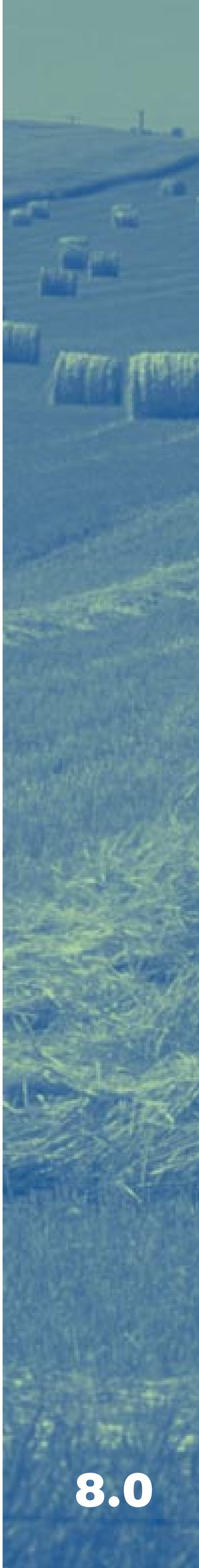
Although the best source of information is from sampling the operation's manure, book values of nutrient content are available and are better than not considering the nutrients in the manure at all (e.g. AOPA).

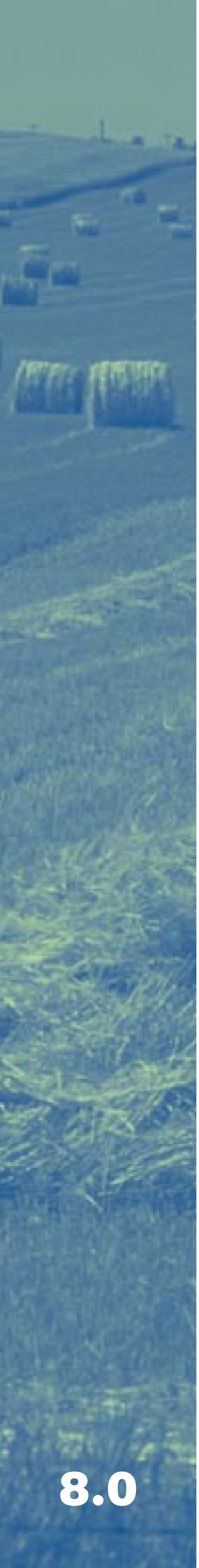
8.2.2 Manure sampling

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 represent the entire volume of manure, not just the surface application. Appropriate manure application rate is closely related to how manure samples are collected.

For manure sampling:

- Collect composite samples that reflect the overall variability of the manure.
- When sampling liquid manure, agitate completely prior to sampling. If agitation is not done, sub-samples from different locations and depths of the storage facility should be taken.
- When sampling solid manure containing bedding and other materials, all compounds in the sample should be in the same proportion as they are in the pile.
- Collect about 20 samples from each manure source. Mix the samples together, remove a sub-sample (about 1 kilogram), and place





in a sealed container. Keep cool and send to the laboratory as soon as possible.
- Sampling before, but as close to land application as possible, helps build an accurate database. A good time to collect liquid manure samples is after lagoon agitation. Solid manure is best sampled directly from the manure truckloads (three to four samples per load).
- Use the manure analysis information to determine manure application rates.

8.2.3 Manure handling and shipping

A good understanding of how manure is handled helps to characterize the variability of manure composition in different manure piles, and assists in the collection of a representative sample.

For manure sample handling:
- Any handling that can alter the physical and chemical composition of manure samples should be avoided (i.e. 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 putting the bag inside another freezer bag (double bagging).
- For liquid manure, use plastic or glass containers.
- The samples should be sent immediately to the lab. Otherwise, the samples must be frozen until delivery.
- In all situations, the container should be only half full and labelled with the 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 sample size, shipping instructions and costs.

Manure laboratory results:
- Manure tests should at least include percentage dry matter, total nitrogen, ammonium nitrogen, and total phosphorus. If there is a possibility of other soil deficiencies, other nutrients can be measured, such as potassium, sulphur and micro-nutrients. Analyzing electrical conductivity and the sodium adsorption ratio in manure are only necessary to determine if changes in feed rations affect manure quality.
- Manure test results should be in the same units as used for calibrating the manure application equipment (pounds or kilograms). Take special care when converting units.
- Manure nutrient results should be on a wet (or "as is") basis since manure is spread wet.

8.2.4 Soil analysis

Soil analysis is used as an index for nutrient availability in soil. Decisions about nutrient management cannot be made without knowing the nutrients available in the soil and their levels. The higher the nutrients in the soil test, the lower the application rate of fertilizer/manure. An accurate soil test (proper soil sampling and interpretation of soil test) 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 should also be used to indicate nutrient or salt excesses. If an excess is found, manure application rates should be based on the excess nutrient; then inorganic fertilizer can be used to supplement other nutrient levels.

For soil sampling:
- 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 kilogram (1 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. Augers can also be used, but it can be difficult to accurately separate depth intervals. Tools may be borrowed or purchased from soil testing laboratories or fertilizer dealers.
- Ideally, samples should be taken prior to seeding, but if time is a constraint, then fall sampling is the best alternative. Because changes in soil nutrients are slower below soil temperatures of 7 C, collect soil samples at or below this temperature, but prior to freeze-up.
- Analyze soil for at least plant-available nitrogen and phosphorus. Analyze for other nutrients (sulphur, potassium, micro-nutrients), if there is a possibility the soil may be deficient. It is also important to monitor soil salinity (EC) and possibly SAR on a regular basis.

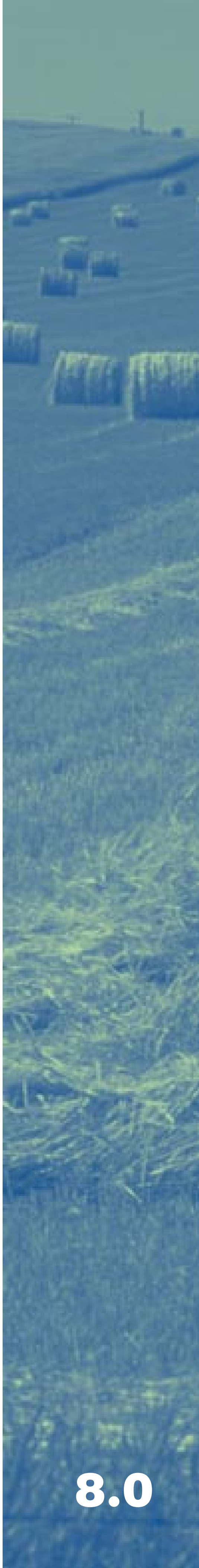
Soil test interpretations:
- If nutrient recommendations are included in the laboratory report, there is no need for soil test interpretations.
- If recommendations are not included with soil test results, consult with a crop advisor or private consultant to provide soil test interpretations and recommendations.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

8.3 Crop Nutrient Requirements

Nutrient requirements vary from one crop to another. Therefore, for the same conditions, application rates will be different, 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 rate. To estimate targeted yield, average the yields of the previous four harvests for a given field and add five to ten 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. An illustrated example is presented as a case study at the end of this section to show how all the 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 will reduce the cost of hauling as a lower amount of manure is needed when nutrient concentration is higher.



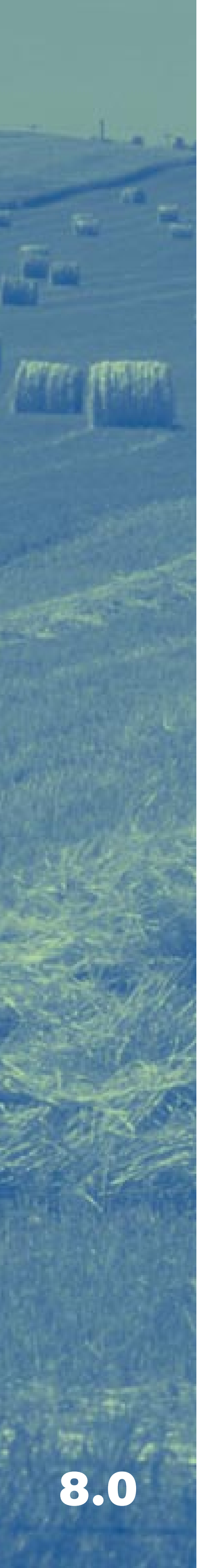


Figure 8.3 **Nutrient Uptake and Removal by Various Crops**

Crop		Yield	N	P_2O_5	K_2O
		tonne* or kg/ha	kg/ha		
Spring Wheat	Removal	2690	67	27	20
	Uptake	2690	95	36	82
Winter Wheat	Removal	3360	55	29	19
	Uptake	3360	76	35	80
Barley	Removal	4300	87	38	29
	Uptake	4300	124	50	120
Oats	Removal	3810	69	29	21
	Uptake	3810	120	46	164
Rye	Removal	3450	66	28	22
	Uptake	3450	103	52	147
Corn	Removal	6280	109	49	31
	Uptake	6280	171	71	145
Canola	Removal	1960	76	41	20
	Uptake	1960	126	58	91
Flax	Removal	1510	57	18	17
	Uptake	1510	80	22	49
Sunflower	Removal	1680	61	18	13
	Uptake	1680	84	29	41
Potatoes	Removal	45*	143	41	242
	Uptake	45*	255	75	334
Peas	Removal	3360	131	39	40
	Uptake	3360	171	47	154
Lentils	Removal	1290	68	21	37
	Uptake	1290	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

Conversion of yields to metric units assumed the following bushel weights (in pounds per bushel): wheat = 60; barley = 48; oat = 34; rye = 56; corn = 56; canola = 50; flax = 56; sunflower = 30; pea = 60; and lentil = 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: Fertilizer Institute of Canada (Modified)

8.4 Method of Manure Application

Different methods of manure application have been developed to:

- Optimize nutrient availability.
- Minimize nutrient losses.
- Minimize odour.
- Spread manure uniformly.

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.

8.4.1 Sub-surface injection

The point of delivery is below the soil surface. Manure is placed in the soil using a shank-mounted opener. Examples include cultivator shank-mounted openers, such as spoons and sweeps with hoses located behind the shanks.

Sub-surface injection is an acceptable method of manure application, provided the manure is applied at proper rates and meets the following guidelines:

- Pooling of manure on the soil surface does not occur.
- Soil should cover all the manure and trenches should not be left in the field.

Proper sub-surface injection provides excellent odour control, low runoff potential, and low nutrient loss through volatilization and leaching. The drawback of sub-surface injection is high soil disturbance, especially at higher ground speeds. This may pose a problem in minimal till and forage situations.

8.4.2 Surface injection

The point of delivery is at or below the soil surface. A small furrow is created in the soil using a disk and manure is placed in the groove using a hose. Some machinery closes the groove using a packing wheel. Examples include disk systems, such as coulters.

Surface injection is an acceptable method of manure application provided the manure is applied at proper rates and meets the following guidelines:

- All manure is placed in the furrows and remains there. Pooling of manure outside the furrows should not occur.
- Manure placed in the trenches should not be visible for very long after application.
- Care must be taken when applying manure to sloping land, since the manure can travel down-slope, along the furrows. Consider applying the manure along the contours of the land.

Proper surface injection provides good odour control, low runoff potential, and low-to-moderate nutrient loss from volatilization or leaching. The drawback of surface injection is that some machinery creates levels of soil disturbance that are unacceptable for minimal till and forage situations.

8.4.3 Broadcast with incorporation

The point of delivery is above the soil surface. Manure is placed on top of the soil, crop, or litter and is later tilled into the soil. Examples of broadcasting equipment includes the dribble bar, splash plate, and beater (solid manure). Examples of incorporation equipment include the harrow, plough and cultivator.

Broadcast with incorporation is an acceptable method of manure application provided the manure is applied at proper rates and meets the following guidelines:

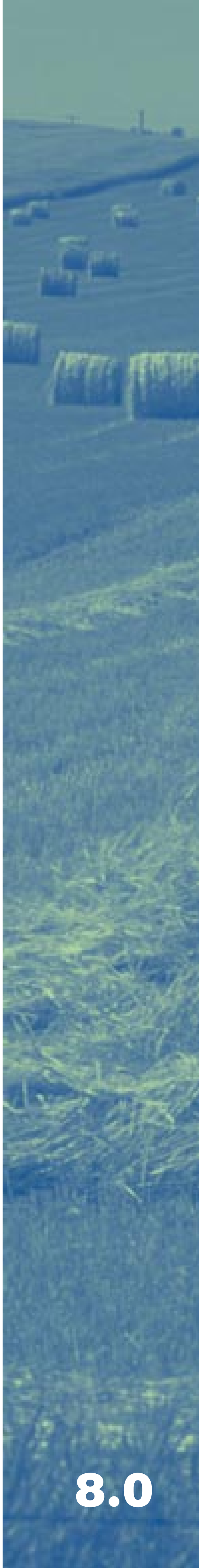
- After incorporation, pooling of manure on the soil surface does not occur.
- The sooner the incorporation, the lower the nitrogen loss to the air (incorporation within 48 hours).

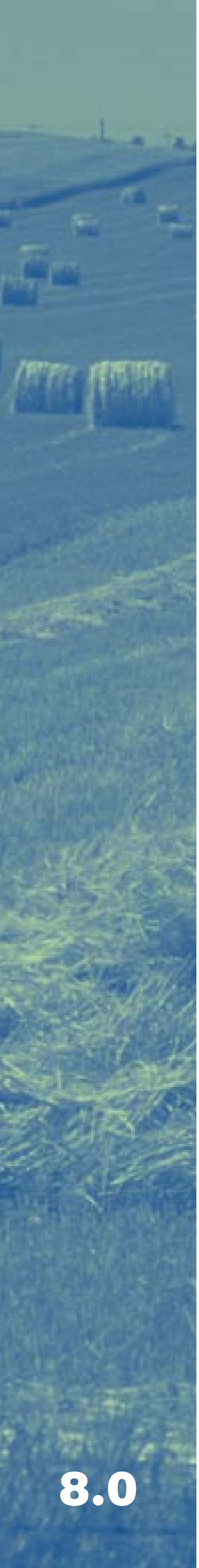
Proper broadcasting with incorporation provides moderate to high nutrient loss and moderate runoff potential. The drawback of broadcast with incorporation is soil disturbance. This method is, therefore, incompatible with minimum till and forage situations.

8.4.4 Broadcast

The point of delivery is above the soil surface. Manure is placed on top of the soil, crop and trash. Examples of broadcasting equipment include dribble bar, splash plate, and beater (solid manure).

Broadcast is only acceptable without incorporation on forage crops, direct-seeded crops and/or frozen or snow-covered ground. Broadcast method of manure should be applied at proper rates to minimize nutrient loss and runoff.





8.5 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 matches crop uptake. However, in the spring there are usually fewer opportunities for application due to inclement weather conditions, risk of soil compaction and time required for other activities. The longer the time between manure application and the stage at which the crop can use the nutrients, the higher the risk of nutrient losses. Within a given season, nitrogen loss by ammonia to the air from surface applications, is higher on dry, warm, windy days than on days that are humid and/or cold.

Figure 8.4

Timing of Manure Application

Season	Watch For	BMP
Winter	•Runoff that can pollute surface water. •Sensitive areas. •Sloping topography •Manure that soaks in too slowly on wet ground. •Wet soils that are prone to compaction.	•Manure should be going 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 liquid manure can flow into drainage systems. •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. •Work manure into soil within 48 hours of application. •Inject liquid manure. •Apply to well-drained soils. •Till very dry soil with large cracks before applying manure. •Allow for more time to dry following application of liquid manure.
Summer	•Loss of nitrogen if there is no rainfall within 72 hours. Rain will help manure soak in. •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; inject liquid manure. •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. •Consider injection of liquid manure.
Fall	•Denitrification in cold, wet soils. •Manure that soaks in slowly on wet fields; excess water will run off. •Wet soils that are prone to compaction. •Large dry cracks where liquid manure can flow into the drainage system.	•Apply liquid manure to grassland that has no history of runoff or floods. •Apply to annual crop lands 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.

8.6 Calibration of Spreading Equipment

Spreading is an important operation in manure management. The possibilities for over or under-application are significant. Therefore, it is crucial to correctly calibrate manure spreading equipment. It is ineffective to do proper soil and manure analyses and determine application rates based on targeted crop yield, if spreading is not accurate.

Equipment calibration should address the rate and uniformity of application. In fact, one of the main concerns in manure application is how uniformly nutrients are distributed. Uneven distribution of nutrients in the field creates areas where crop yield may be depressed by either excess or insufficient nutrients. The other concern is how to deliver the intended manure application rate.

The two main reasons for calibrating manure spreaders are:

- To provide information on the actual rate applied—therefore, the exact amount of nutrient applied.
- To allow for an accurate rate of application. In this case, speed and delivery rate are the parameters to be determined.

Calibrate the spreader using manufacturer guidelines to ensure proper rate of application before each use. Check all parts of the spreader to ensure proper working order. Refer to Section 8.10 for more information on equipment calibration.

8.7 Record Keeping

Recording and keeping all documents related to nutrient management is important. Documents can provide information on how nutrient management is implemented on the farm and where and when changes are needed. As well, keeping records will help to generate accurate on-farm data that can be used to generate site specific information.

Records that must be kept for 5 years according to the AOPA are:

– Volume or weight of manure production.
- If transferring or receiving manure from another operation, record name and address of operation, date of the transfer and the weight transferred.
- If applying manure at 300 tonnes or more per year, keep the following records:

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

Other records that would be helpful to keep include:

- Farm manure production by type of animal and stage of production.
- Manure analyses by type or by storage unit.
- When and how manure is incorporated.
- Crop planted and yields by field and by year.
- Weather conditions.

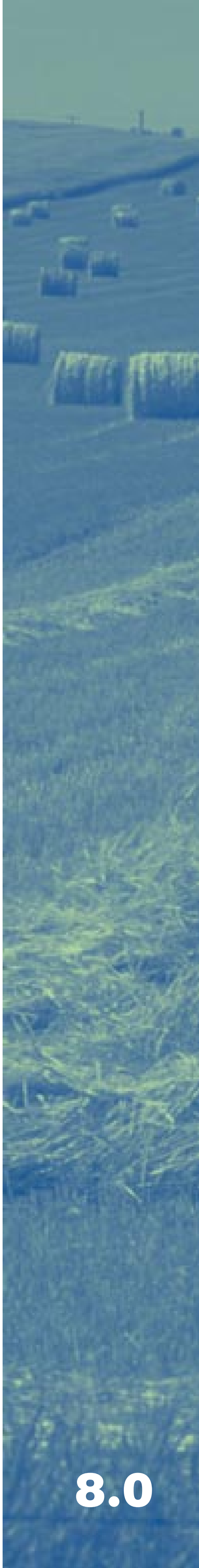
Records should be kept for five years.

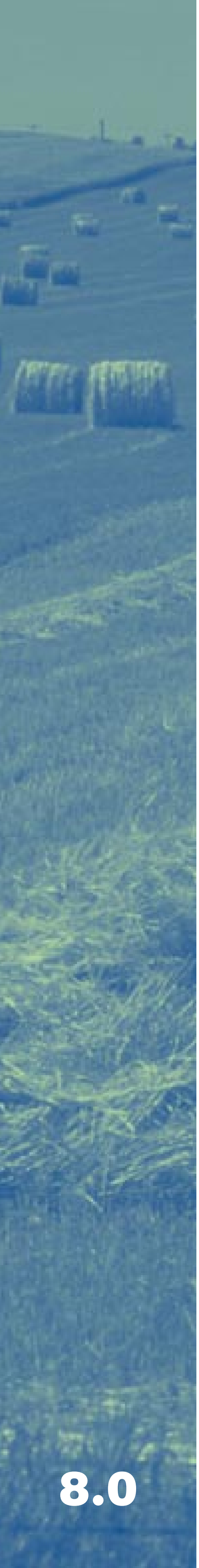
8.8 Other Beneficial Management Practices

8.8.1 Determine soil limitations

Not all soils are the same. In fact, the same manure application rate has different effects on different soils. When making decisions on manure application, consider these factors as related to soil type:

- Leaching potential.
- Runoff potential.
- Erodibility.





8.8.2 Determine proximity limitations

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

8.8.3 Determine cropping system limitations

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

8.9 Manure Management Planning Case Study

This example plan will illustrate, step by step, all the information reported in this chapter regarding nutrient management planning. As an example, a hog farm will be used, with four fields for manure application (Fields 1 to 4). Two different lagoons of manure will be used.

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

STEP 1: Determine on-farm manure production.

The implementation of manure nutrient management planning starts with an estimate of on-farm nutrient resources. Determination of manure production can be estimated by storage capacity, or by the herd size and the average daily, monthly or yearly production rate per animal (See *Agricultural Operation Practices Act* (AOPA), *Standards and Administration Regulation*, Part 2, Schedule 3, Figure 6 for solid manure; Figure 7 for liquid manure).

Equation 1

Estimated manure production = [Number of animals] x [Amount produced per animal per year]

Example:

Animals numbers are:

- Sows farrow to finish = 250
- Weaners = 350
- Feeders = 300

The AOPA, *Standards and Administration Regulation*, Part 2, Schedule 3, Figure 7 Liquid Manure Production Volume, gives the following amount of manure produced yearly.

- 5272 gal./animal for sows - farrow to finish.
- 183 gal./animal for weaners.
- 568 gal./animal for feeders.

Therefore:

Estimated Manure Production = (250 x 5272 gal./year) + (350 x 183 gal./year) + (300 x 568 gal./year) = 1,552,450 gal./year.

STEP 2: Analyze manure.

Example:

Assume two different lagoons of liquid hog manure. The lab results are as follows:

Lagoon 1

Total-N = 44 lb./1,000 gal.

Ammonium-N = 20 lb./1,000 gal.

Total P = 8.2 lb./1,000 gal. = 8.2 x 2.29* = 18.8 lb./1,000 gal. P_2O_5

Total K = 20.6 lb./1,000 gal. = 20.6 x 1.20* = 24.7 lb./1,000 gal. K_2O

*See Units and Conversion Figure for explanation

Lagoon 2

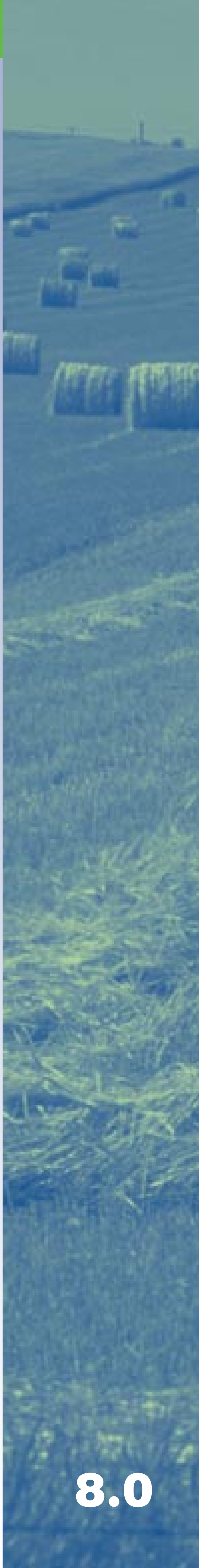
Total-N = 26 lb./1,000 gal.

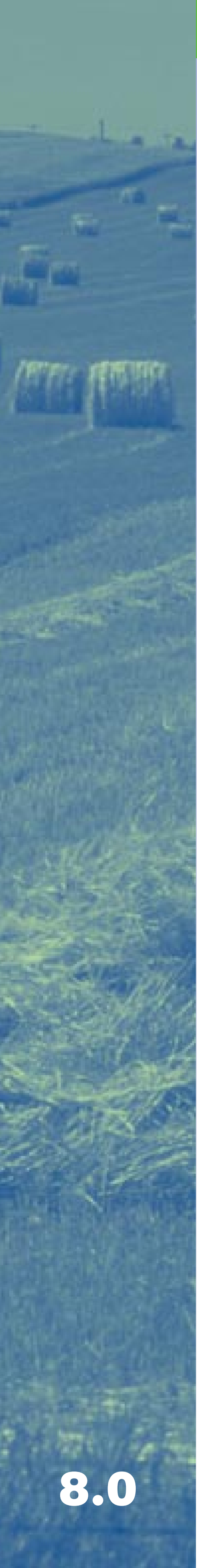
Ammonium-N = 12 lb./1000 gal.

Total P = 13.8 lb./1,000 gal. = 13.8 x 2.29* = 31.6 lb./1,000 gal. P_2O_5.

Total K = 12.4 lb./1,000 gal. = 12.4 x 1.20* = 14.9 lb./1,000 gal. K_2O.

*See Units and Conversion Figure for explanation .





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
Available N = [organic-N x 0.25] +[Ammonium-N – [Ammonium-N x Loss Coefficient]]

Equation 3
Available P_2O_5 = Phosphate x 0.5

Equation 4
Available K_2O = Potash x 0.9

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.

AAFRD and Landwise Inc. 2001

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

Lagoon 1
Organic N = total N – ammonium N = 44 - 20 = 24 lb./1,000 gal.
Available N = (24 x 0.25) + [20 – (20 x 0.3)] = 20 lb./1,000 gal.
Available P_2O_5 = (18.8 x 0.5) = 9.4 lb./1,000 gal.
Available K_2O = (24.7 x 0.9) = 22.2 lb./1,000 gal.

Lagoon 2
Organic N = total N – ammonium N = 26-12 = 14 lb./1,000 gal.
Available N = (14 x 0.25) + [12 – (12 x 0.3)] = 11.9 lb./1,000 gal.
Available P_2O_5 = (31.6 x 0.5) = 15.8 lb./1,000 gal.
Available K_2O = (14.9 x 0.9) = 13.4 lb./1,000 gal.

STEP 4: Determine nutrient recommendations.

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

When requested, nutrient recommendations are provided in the laboratory reports. If not, contact an AAFRD specialist or private consultant to help determine nutrient recommendations.

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

Example:

Figure 8.6 Nutrient Recommendations for Each Field

Field	Soil Tests			Nutrient Recommendations		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	lb./ac.					
1	20	30	450	160	30	0
2	50	30	450	100	30	0
3	40	15	450	170	60	0
4	80	30	150	50	40	60

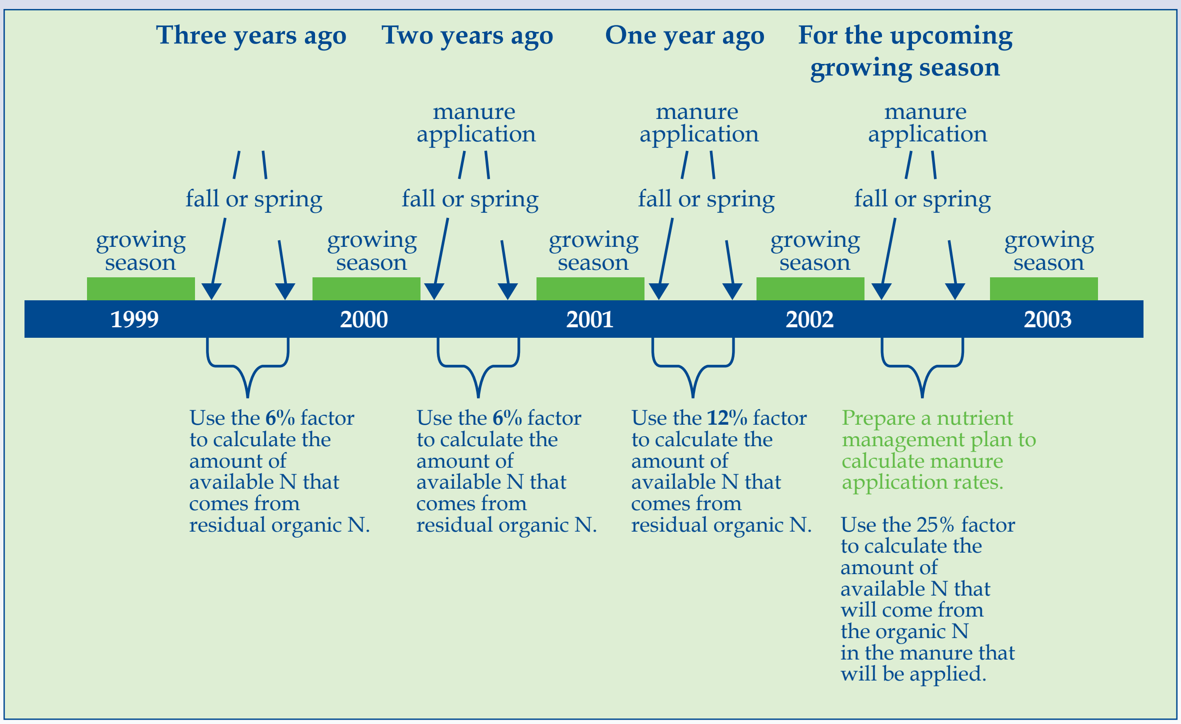
STEP 5: Calculate residual available N.

Calculate the residual available N from previous manure applications using the following equation:

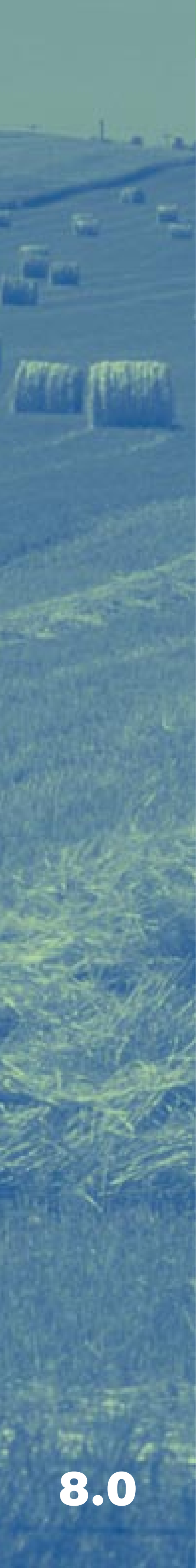
Equation 5
Residual N = [0.12 x Manure applied one year ago x Organic- N content of the manure]+[0.06 x Manure applied two years ago x Organic- N content of the manure]

Determine the manure application of previous years by using Figure 8.7.

Figure 8.7 Residual Organic N in Manure



From Barry Olson, AAFRD Personal Communications, 2002.



Example:

Figure 8.8 Residual Nitrogen from Previous Manure Application

Field	Manure Applied 1 year ago	Manure Applied 2 years ago	Organic-N Content of Manure 1 year ago	Organic-N Content of Manure 2 years ago	Residual-N
	gal./ac.	gal./ac.	lb./1000 gal.	lb./1000 gal.	lb./ac.
1	15,000	10,000	18	19	43.8
2	20,000	0	17	-	40.8
3	0	10,000	-	20	12
4	0	0	-	-	0.0
Col 1	*Col 2*	*Col 3*	*Col 4*	*Col 5*	

Residual-N from previous applications is calculated (Col = Column number):

Field 1
Residual N = (0.12 x Col 2 x Col 4) +(0.06 x Col 3 x Col 5) = 43.8 lb./ac.

Field 2
Residual N = (0.12 x Col 2 x Col 4) = 40.8 lb./ac.

Field 3
Residual N = (0.06 x Col 3 x Col 5) = 12 lb./ac.

STEP 6: Determine field and AOPA limitations.

It is important to determine the following field and AOPA limitations before applying manure:
- Slope.
- Proximity to water body and connecting streams.
- Nitrate-nitrogen limits in AOPA.
- Distance from manure storage (hauling distance).

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

Example: **Figure 8.9**

Field Characterization

Field	Hauling Distance miles	Field Limitations	AOPA Limitations
1	3	Slope 6%	With incorporation within 48 hours, 30 metres away from a common body of water or well.
2	4	Slope 4% and connected to a surface water body	With incorporation within 48 hours, 30 metres away from a common body of water or well.
3	5	Forage	If less than 4% slope, must be 30 metres away from a common body of water or well.
4	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, the nitrate-nitrogen content would be over the allowable limit and no manure would be allowed to be applied to this field. * Nitrate-nitrogen limits in AOPA.

STEP 7: Field prioritization.

This is where information is integrated to determine accurate rates, which 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, the manure lagoon or storage having the highest phosphorus nutrient content will be used.
- Field 3 is in pasture. Incorporation is not an option; therefore, application will be based on phosphorus.

Calculation of application rate for each field:

Field 1:

Due to the steep slope, this field manure rate will be based on phosphorus.

Figure 8.6 shows the phosphate recommendation is 30 lb./ac.

- **If manure from Lagoon 1 is to be used:**

If manure is to be applied on P basis:

Equation 6

Manure rate of application based on phosphorus = [Recommended amount (Figure 8.6)] / [Available phosphate in manure (Equation 3)]

Manure application rate based on phosphorus = 30 lb./ac. / 9.4 lb./1,000 gal. = 3,191.5 gal./ac.

Equation 7

Crop available N = [Available N (Equation 2) x Rate of application] + Residual N (Equation 5)

Crop available N = (20 lb./1,000 gal. x 3,191.5 gal./ac.) + 43.8 lb./ac. = 107.6 lb. N/ac.

Equation 8

Fertilizer N to be added = Recommended amount (Figure 8.6) – [amount provided by manure, which is Crop available (Equation 7)

Fertilizer N to be added = 160 lb./ac. – 107.6 lb./ac. = 52.4 lb. N/ac.

If manure is to be applied on N basis:

Equation 9

Manure application rate based on nitrogen = [Recommended amount (Figure 8.6) – Residual N (Equation 5)] / Available N (Equation 2)

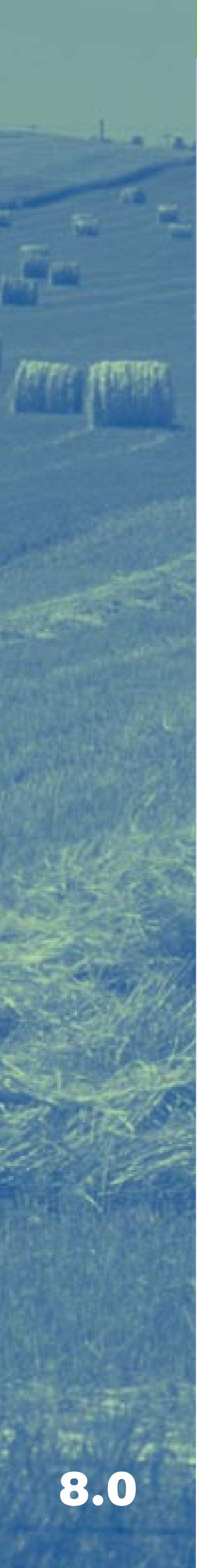
Manure application rate = (160 lb./ac.– 43.8 lb./ac.) / 20 lb./1,000 gal. = 5,810 gal./ac.

Therefore,

Phosphate applied = Manure application rate for N (Equation 9) x Available P_2O_5 (Equation 3)

Phosphate applied would be = 5,810 gal./ac. x 9.4 lb./1,000 gal. = 54.6 lb. P_2O_5/ac.

This rate will result in an excess application of 24.6 lb./ac. (54.6 lb./ac. Calculated to 30 lb./ac. recommended) of phosphate. The steep slope in this field means there would be a high risk for phosphorus runoff. Therefore, it is not recommended to base the manure application on N.



- **If manure from Lagoon 2 is to be used:**

  Manure application rate based on phosphorus (Equation 6) = 30 lb./ac./15.8 lb./1,000 gal. = 1,898.7 gal./ac.
  Crop available N (Equation 7) = (11.9 lb./1,000 gal. x 1,898.7 gal./ac.) + 43.8 lb./ac. = 66.4 lb. N/ac.
  Fertilizer N to be added (Equation 8) = 160 lb./ac. – 66.4 lb./ac. = 93.6 lb. N/ac.

For Field 1, using manure from Lagoon 1 or 2 makes a difference on the rate of manure application, 3,191.5 gal./ac. and 1,898.7 gal./ac. It is recommended to apply manure from Lagoon 2 as this will decrease hauling costs. Save manure from Lagoon 1 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.

Figure 8.6 shows the phosphate recommendation is 30 lb./ac.

- **If manure from Lagoon 1 is to be used:**

  Manure application rate based on phosphorus (Equation 6) = 30 lb./ac. / 9.4 lb./1,000 gal. = 3,191.5 gal./ac.
  Crop available N (Equation 7) = (20 lb./1,000 gal. x 3,191.5 gal./ac.) + 40.8 lb./ac. = 104.6 lb. N/ac.
  Fertilizer N to be added (Equation 8) = 100 lb./ac. –104.6 lb./ac. = -4.6 lb. N/ac.
  Therefore, the addition of mineral fertilizer is not needed.

- **If manure from Lagoon 2 is to be used:**

  Manure Application Rate based on Phosphorus (Equation 6) = 30 lb./ac. / 15.8 lb./1,000 gal. = 1898.7 gal./ac.
  Crop Available N (Equation 7) = (11.9 lb./1,000 gal. x 1898.7 gal./ac.) + 40.8 lb./ac. = 63.4 lb. N/ac.
  Fertilizer N to be added (Equation 8) = 100 lb./ac. – 63.4 lb./ac. = 36.6 lb. N/ac.

For Field 2, it is again recommended to apply manure from Lagoon 2, which allows lower application rate, therefore low hauling costs.

Field 3:
This field is on pasture; the manure rate will be based on phosphorus.

Figure 8.6 shows a phosphate recommendation of 60 lb./ac.

- **If manure from Lagoon 1 is to be used:**

  Manure application rate based on phosphorus (Equation 6) = 60 lb./ac. / 9.4 lb./1,000 gal. = 6,383 gal./ac.
  Crop available N (Equation 7) = (20 lb./1,000 gal. x 6,383 gal./ac.) + 12 lb./ac. = 139.7 lb. N/ac.
  Fertilizer N to be added (Equation 8) = 170 lb./ac. – 139.7 lb./ac. = 30.3 lb. N/ac.

- **If manure from Lagoon 2 is to be used:**

  Manure application rate based on phosphorus (Equation 6) = 60 lb./ac. / 15.8 lb./1,000 gal. = 3,797.5 gal./ac.
  Crop available N (Equation 7) = (11.9 lb./1,000 gal. x 3,797.5 gal./ac.) + 12 lb./ac. = 57.2 lb. N/ac.
  Fertilizer N to be added (Equation 8) = 170 lb./ac. – 57.2 lb./ac. = 112.8 lb. N/ac.

For Field 3, using manure from Lagoon 1 or 2 makes a difference on the rate of manure application and amount of commercial nitrogen fertilizer. Although applying manure from Lagoon 2 would keep hauling costs down, after some economic assessment it may be better to apply manure from Lagoon 1. The hauling costs will be higher but some of that will be offset by lower commercial fertilizer cost.

Field 4:
This field has no landscape proximity limitations; however based on soil tests, if this soil was present in the Brown Soil Zone the nitrate-nitrogen content would be greater than the allowable limit and no manure would be allowed to be applied to this field. See AOPA, under *Standards and Administration Regulation, Part 1, Nutrient Management.*

Figure 8.6 shows a nitrogen recommendation of 50 lb./ac.

- **If manure from Lagoon 1 is to be used:**

  Manure application rate based on nitrogen (Equation 9) = [50 lb./ac. – 0 lb./ac.] / 20 lb./1,000 gal. = 2,500 gal./ac.
  Crop available phosphorus (*Equation 7*) = (9.4 lb./1,000 gal. x 2,500 gal./ac.) + 0 lb./ac. = 23.5 lb. N/ac.
  Fertilizer phosphate to be added (*Equation 8*) = 40 lb./ac. –23.5 lb./ac. = 16.5 lb. P_2O_5/ac.

  Therefore, the addition of mineral fertilizer is not needed.

- **If manure from Lagoon 2 is to be used:**

  Manure application rate based on nitrogen (Equation 9) = [50 lb./ac. – 0 lb./ac.] / 11.9 lb./1,000 gal. = 4,201.7 gal./ac.
  Crop available phosphorus (Equation 7) = (15.8 lb./1,000 gal. x 4,201.7 gal./ac.) + 0 lb./ac. = 66.4 lb. N/ac.
  Fertilizer phosphate to be added (*Equation 8*) = 40 lb./ac. – 66.4 lb./ac. = 26.4 lb. P_2O_5/ac.

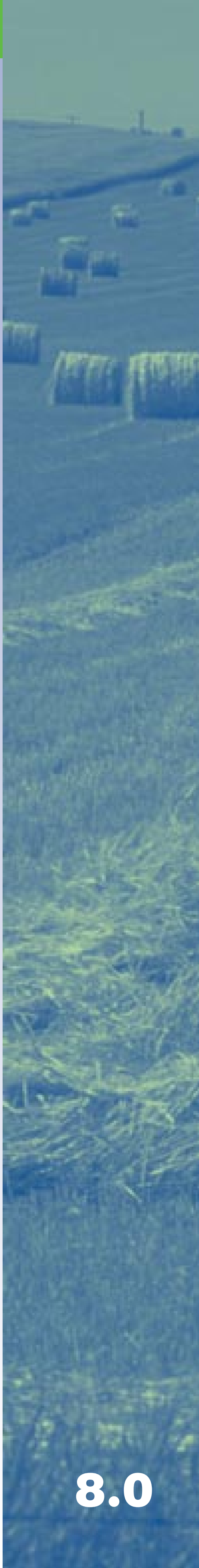
For Field 4, using manure from Lagoon 1 or 2 makes a difference on the rate of manure application. However, it is recommended to apply manure from Lagoon 2 as it has a relatively low hauling distance.

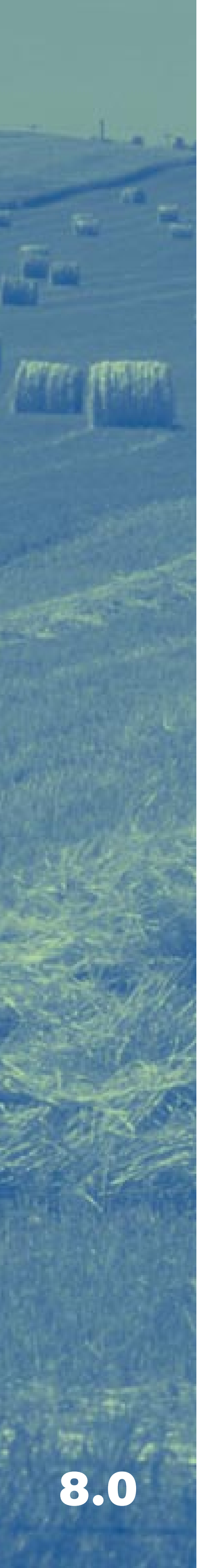
STEP 8: Manure and fertilizer needs per field.

Figure 8.10 **Nutrients Summary: Needs and Balance**

		Application Rate			Total Application		
Field	Acres	Manure gal. /ac.	Fertilizer lb. /ac.		Manure gal.	Fertilizer lb. /ac.	
			N	P_2O_5		N	P_2O_5
Field 1	100	1,898.7	93.6	0	189,870	9,360	0
Field 2	150	1,898.7	36.6	0	284,705	5,490	0
Field 3	100	6,383	30	0	638,300	3,000	0
Field 4	50	4,201.7	0	26.4	210,085	0	1,320
			Total Required		1,322,960	17,850	1,320
			Balance*		**+229,490**	**-17,850**	**1,320**

*Manure Balance:
Total manure in storage was 1,552,450 gallons. After application of 1,322,960 gallons, the manure remaining will be approximately 229,490 gallons.
Fertilizer needs are:
- 17,850 lb. of nitrogen.
- 1,320 lb. of phosphate.





8.10 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), rate adjustments can be made by adjusting the equipment and/or varying the ground speed.

There are a number of methods for calibrating manure spreaders, including:

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, the rate of application is:

$$\text{Rate of application} = (\text{Volume or weight})/\text{area} \qquad \text{Eq(1)}$$

To calculate the spreading speed:

- C = capacity of the spreader (in tons, gallons) [use dimensions or user manual to calculate C].
- W = width of spread (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).
- 43,560 is the number of feet per acre.
- 5,280 is the number of feet per mile.
- 3,600 is the number of seconds per hour.

Application rate is calculated as follows:

$$R = (43{,}560 \times C) \div (W \times D) \qquad \text{Eq(2)}$$

Therefore,

$$D = (43{,}560 \times C) \div (W \times R) \qquad \text{Eq(3)}$$

Speed is calculated as follows:

$$\text{Speed} = (D+5{,}280) \div (t+3{,}600) \qquad \text{Eq(4)}$$

If equations (3) and (4) are merged, then

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

$$\text{Speed} = 29{,}700 \times [C \div (t \times W \times R)] \quad \text{(miles/hr)} \qquad \text{Eq(6)}$$

Where:

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

Example:

Considering these 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,

$$\text{Speed} = 29{,}700 \times [C \div (t \times W \times R)] \quad \text{(miles/hr.)}$$
$$= 29{,}700 \times [5{,}400 \div (400 \times 12 \times 10{,}000) = 3.34 \text{ miles/hr.}$$

To calculate the rate of application from spreading speed consider these parameters:

- C = capacity of the spreader (gal.)
- W = width of spread (ft.)
- t = time it takes to empty one load (sec.)
- Speed (mile/hr.)

Eq(6) can be rearranged to calculate the actual application rate as follows:

$$R = 29{,}700 \times [C \div (t \times W \times \text{Speed})] \quad \text{(ton or gal./acre)} \qquad \text{Eq(7)}$$

Where:

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

Example:

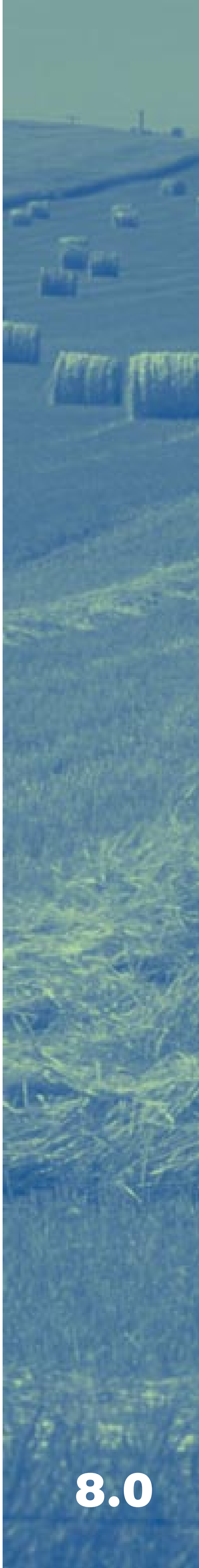
- C = capacity of the spreader = 5,400 gal.
- W = width of spread = 12 ft.
- t = time it takes to empty one load (5,400 gal) = 400 sec.
- Speed = 4 miles/hr.

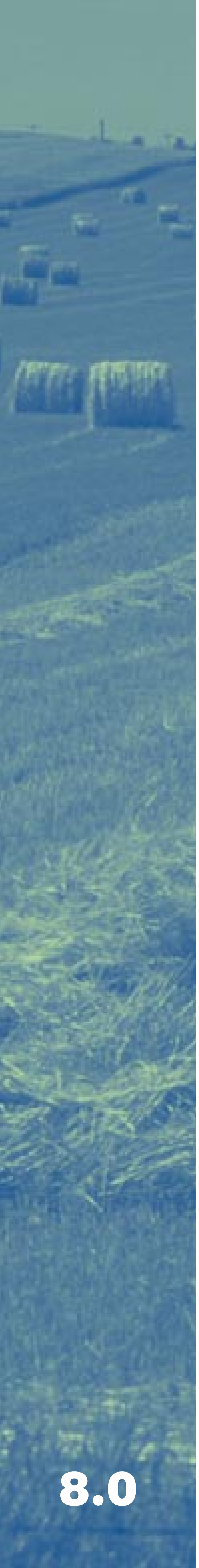
Then,

$$R = 29{,}700 \times [C \div (t \times W \times \text{Speed})]$$
$$= 29{,}700 \times [5{,}400 \div (400 \times 12 \times 4)] = 8{,}353 \text{ gal./ac.}$$

Tarp method.

Another method is to lay out several tarps (3 m x 3 m in size) and drive over them with the spreader. Weigh each tarp with manure and subtract the weight of the tarps. Once the area of the tarps is known, the application rate can be calculated. Many tarp samples may be required to obtain an accurate value. To check on uniformity of application, lay five small tarps side by side in a row, then drive over the tarps perpendicular to the row. Weigh the manure on each tarp. In addition to checking uniformity and application, the rate can also be calculated.

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9.0 DISPOSAL OF FARM WASTE

9.1 Disposal of Dead Animals

9.2 Disposal of Veterinary Waste

9.2.1 Sharps

9.2.2 Expired medicines

9.3 Disposal of Chemical Farm Waste

9.3.1 Pesticides

9.3.1.1 Pesticide disposal

9.3.1.2 Pesticide storage

9.3.1.3 Pesticide container disposal

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

9.3.2.1 Health and environmental risks

9.3.2.2 Financial/liability risks

9.4 Leaks and Spills

9.4.1 Fuel leaks/spills

9.4.2 Lubricant leaks/spills

9.5 Options for Disposing of Contaminated Soils

9.0 DISPOSAL OF FARM WASTE

9.1 Disposal of Dead Animals

Refer to the *Destruction and Disposal of Dead Animals Regulations* under the *Livestock Diseases Act,* for details on regulations pertaining to the disposal of dead animals and to Section 3 of this publication. A copy of these regulations may be obtained from an Alberta Agriculture, Food and Rural Development (AAFRD) office, or by visiting the AAFRD Web site at www.agric.gov.ab.ca/navigation/department/acts/index.html. Two other useful references are *Livestock Mortality Burial Techniques, Agdex 400/29-2*, and *Livestock Mortality Management (Disposal), Agdex 400/29-1*. These are also available from AAFRD.

Some death loss will occur on hog operations, no matter how well they are managed. Disposing of dead animals quickly and effectively is important to reduce the risk of disease. It is also important in maintaining good neighbour relations. Carcasses can be a source of disease if scavenged by wildlife or pets. Some of these diseases can then be passed back to livestock or even humans. Carcasses are also an eyesore, a source of odour and can contribute to fly problems.

The current *Destruction and Disposal of Dead Animals Regulations* requires that all dead animals be disposed of within 48 hours by incinerating, burying, rendering, or natural disposal (scavenging). Incineration and natural disposal composting may be used under very restricted circumstances described in the regulation.

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

- 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.
- Outside during winter months when the ambient temperature is low enough to keep the dead animal completely frozen.

or

- In a freezer unit.

There are restrictions on the use of composting, burial and natural disposal 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 specific distances from waterways, well sources, major roads, residences and parks. For more information on these restrictions refer to Section 3 or the *Destruction and Disposal of Dead Animals Regulations.* These sites must be on the producer's own property or property leased by the producer. Animals euthanized by drugs or those known to have died from infectious diseases (e.g. *Salmonella*) or reportable diseases must not be disposed of by natural disposal.

Storage. Some operations use special storage bins, or refrigerate or freeze carcasses until they can be taken to a rendering facility. This reduces odour, keeps them out of sight and prevents scavenging. Dead animal storage areas should be located in areas that will minimize the spread of disease, for example, at the entrance to a farm site to prevent collection vehicles from having to enter the property.

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

Burial. If dead animals are buried, it should be done promptly to control odour, insects and scavenging. In the winter, during periods of intense cold, this may be difficult due to frozen ground. Producers should be prepared to store the carcasses in a frozen state or have them picked up for rendering during these times. The burial pit area should be screened from view by trees, shrubs or fences, and be located at some distance away from livestock. Burial pits should not be located where runoff could contaminate surface water and should not be located near wells or other water sources.

Other animal tissue waste, such as afterbirths and tissues from surgery (e.g. castration) can be disposed of as carcasses or sent to a landfill in a sealed plastic container or bag. Blood or blood products from animals can be safely flushed down the drain.

Composting. For more information on composting dead animals, refer to the following resources:

National Pork Producers Council, 1997. *Swine Mortality Composting Module.* National Pork Producers Council, Clive, Iowa www.nppc.org.

Code of Practice for Compost Facilities under Waste Contol Regulation A. R. 192/96. Developed and administered by Alberta Environmental Protection.

Swine Mortality Composting Agdex 440/29-1. Available from AAFRD.

9.2 Disposal of Veterinary Waste

9.2.1 Sharps

Sharps are veterinary and laboratory materials capable of causing cuts or punctures. Sharps include needles, syringes, scalpel blades, slides, coverslips, 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. Bacteria or viruses from blood on used needles are a potential disease risk in needle stick injuries.There are currently no regulations covering the disposal of sharps in agriculture.

To safely dispose of sharps:

Separate sharps from other waste. Injuries can occur while handling sharps on the farm or at the landfill, if staff are unaware of their presence, or if they are not in rigid containers. Plastic bags are unacceptable.

Use a labelled rigid sharps container for 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 containers should be narrow-mouthed or have well-sealed lids with a small hole. Ensure children or 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 will pick up medical waste. Contact the 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 24APR01. All drugs past the expiry date should be discarded, as product safety and efficacy can no longer be guaranteed.

Medicines not past 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 and whether it is still safe or effective (e.g. vaccine left at room temperature overnight), 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 - consult a veterinarian.

There are two classes of expired medicines - unused (unopened) and used (opened). Unused expired drugs can be returned to the point-of-purchase, such as the vet clinic. Many manufacturers will accept them for disposal. Used or expired drugs can be discarded the same way as sharps. Modified live virus vaccines should be rendered non-infectious before disposal to prevent the virus from potentially infecting workers or animals. This can be done by freezing, autoclaving, burning or adding bleach to the bottle. When disposing of either 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 with the 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 and 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 district offices or from the Publishing Branch, 7000-113 Street, Edmonton, Alberta T6H 5T6.

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. Offer unused pesticide supplies to neighbours. Pesticides that have no further use must be disposed of as hazardous waste. Names of companies that are 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 the farm over the winter. Read the label for specific storage instructions during temporary storage. Pesticides should be stored in a cool, dry place in the original containers. Keep pesticides from freezing and protect from excessive heat. A pesticide storage area should have an impervious floor with curbs, no floor drains, and be stocked with an overpack container and a supply of absorbent material, such as sand or kitty litter.

Pesticides should not be stored near feeds, food or fertilizers and should never be stored in well houses or feed mixing and milling rooms. As well, these products should never be stored or mixed within 30 metres of an open body of water.

Pesticides should not be stored around the home and should be out-of-reach of animals and children. Products that are highly toxic to mammals, such as certain rodenticides and parasiticides, should be stored 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,* 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,* or 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.*

Paper bags and cardboard containers should be thoroughly emptied and disposed of in a sanitary landfill. Paper bags or cardboard containers should not be burned. 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.

Containers from topical parasiticides, (e.g. pour-on compounds or powders for lice and mange) should be disposed of in a safe manner. These compounds can be toxic to fish, wildlife, other livestock and humans. These products should be kept out of waterways and streams and not be allowed to contaminate foods or feeds. 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. Containers should not be reused and empty containers should be made unsuitable for re-use. 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 storage and handling on the farm 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 possible causes of cancer. Spilled fuels will kill plant life and fish. Livestock will sometimes drink fuel. Fuels can cause 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. They also may contain heavy metals such as lead, arsenic, cadmium or chromium, which can be toxic or leave residues in meat. All lubricants should be washed 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. It is sweet tasting, so certain animals, particularly cattle and pets, will drink large quantities if given the opportunity. Shortly after ingestion, animals appear drunk. They may vomit, become weak, convulse and die. If treated early, they may survive, 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 lubricants and glycol, both new and used. They may require environmental assessments before approving loans or insurance policies. Spills of fuels or lubricants may come under the jurisdiction of the *Environmental Protection and Enhancement Act (EPEA)* and if deemed serious enough, appropriate cleanup measures will have to be taken.

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, leakage, spillage and evaporation. It can be obtained from AAFRD, Publications Branch, 7000-113 Street, Edmonton, T6H 5T6.

9.4 Leaks and Spills

The best and lowest-cost method of dealing with a potential environmental problem is prevention.

To prevent environmental contamination:

- Always 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, keep the following points in mind:

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

Above ground. In the event of 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, 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 shoveling the 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.
- Ensure that all ignitable vapours are dispersed before resuming normal activities.
- It is a regulatory requirement that all spills and leaks of 200 litres or more of gasoline or diesel fuel must be reported to Alberta Environmental Protection. Spills or leaks of lesser amounts must also be reported if they have, or may have, an adverse effect on the environment. An adverse effect is defined in the *Environmental Protection and Enhancement Act* as impairment of or damage to the environment, human health or safety, or property. Any leak or spill of any amount into a watercourse, water body 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 beneath the containers. 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 Section 9.5.)

Disposing of waste lubricants. Most bulk fuel agents will 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. The farmer may even get 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.

Disposing of Glycols. Glycols (antifreeze) should not be drained onto the ground. Waste antifreeze should be collected in plastic containers and taken to the depots mentioned above.

None of the above products should be accessible to livestock, children or wildlife. Containers should be well labelled and have secure child-proof lids. Most cases of poisoning occur when these products are accidentally handled by children or animals.

Motor oils or fuels should not be used directly on 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. In addition, these products should not be used to control dust in yard sites or on roads.

9.5 Options for Disposal of Contaminated Soils

Land spreading. Using naturally occurring soil micro-organisms in conjunction with cultivation, organic matter (manure) and added nitrogen fertilizer appears to be a reasonable method of breaking down hydrocarbons. Specific details as to amounts of contaminated soils, per given area of cultivation for a given length of treatment time, are presently being studied. However, an adequate mix would appear to be 2.5 centimetres (1 inch) of contaminated soil spread on a field surface with approximately 45 kilograms (100 pounds) of manure and about 0.1 kilograms (1/4 pound) of nitrogen per 95 m^2 (100 ft^2) and roto-tilled to a depth of 12 centimetres (5 inches). Work the area (aerated) every four weeks for at least one year to ensure adequate breakdown of fuels and possibly for two or more years for the breakdown of waste oils.

Landfill. Contaminated soil can be hauled to an approved landfill site. Contact the landfill authority to ensure that this is acceptable.

Burning. Approved mobile thermal extractors can be used; they have the proper after-burners to completely combust all of the hydrocarbons and heavy metals. Names of companies providing this service can be obtained from Alberta Environment. Open burning of 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 = 1000 milligrams (mg)
- 1 km = 1000 metre (m) = 3,281 feet = 39,370 inches = 0.6214 mile
- 1 m^3 = 1000 liters (L) = 220 gallons (Imperial) = 264.2 gallons (US)
- 1 hectare (ha) = 10,000 m^2 = 107,639 ft^2 = 2.471 acres
- 1 kg/ha = 1.12 lb./ac.
- 1 tonne = 1000 kg = 2205 lb. = 1.1025 ton (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 (or kg) lb. of K_2O
- 1 ppm N, P or K *(in 6 inches or 15 cm soil depth)* is approximately equal to1.8 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 the 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.

BENEFICIAL MANAGEMENT PRACTICES

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ALBERTA PORK

Alberta AGRICULTURE, FOOD AND RURAL DEVELOPMENT