
JURISDICTIONAL SCAN OF AGRICULTURAL WASTE MANAGEMENT REGULATIONS AND GUIDELINES

Prepared for:

B.C. Ministry of Environment

2975 Jutland Road

Victoria, B.C.

Prepared by:

R. McDougall, M.Sc., PAg.

Consulting Agrologist

2935 Fred Street

Armstrong B.C. V0E 1B1

March 2010

Executive Summary

This report presents the results of a review of agricultural waste management regulations from twelve jurisdictions including:

- Four Canadian jurisdictions: Alberta, Manitoba, Ontario and Quebec.
- Four U.S. jurisdictions: Pennsylvania, Washington State, Texas and California.
- Four European jurisdictions: Ireland, UK, the Netherlands (Holland) and Denmark.

The review was completed during February and March of 2010 and covers several areas of agricultural waste management in these jurisdictions. Topics include nutrient management regulations, manure storage and application requirements, regulation of on-farm disposal of mortalities, control of odour and emissions, and regulation of emerging technologies.

The information for this report was gathered through an extensive web-based search for the relevant Acts, Regulations and guidelines for each jurisdiction as well as from additional background information where it was available. The report was prepared to provide background information for the B.C. Ministry of Environment's planned review of the B.C. Agricultural Waste Control Regulation.

Most of the regulations reviewed have been brought into force within the past decade and many are not yet fully implemented. This suggests that issues relating to environmental degradation from agricultural waste are becoming critical throughout Europe, the U.S. and Canada at approximately the same time. European jurisdictions have been regulating agricultural waste and nutrient management since 1985-1990 when they acknowledged that manure surpluses in many areas were impacting water quality. The European jurisdictions surveyed have introduced more restrictive regulations recently because earlier legislation had not resulted in the desired improvements in water quality. The North American jurisdictions surveyed are now in the process of developing and implementing regulations that will improve manure storage and handling on-farm and nutrient management. In some jurisdictions (Texas, California) the new regulations are in response to water quality degradation due to agriculture. In other jurisdictions (Pennsylvania, Washington State and the Canadian jurisdictions) regulatory agencies are acting proactively to avoid water quality problems experienced elsewhere.

The strategies adopted by jurisdictions for nutrient management vary widely although the issues being addressed are very similar and the goal is the same - to maintain or improve environmental quality, with emphasis on surface and ground water quality. All of the jurisdictions surveyed regulate the application of nutrients to agricultural land although the strategies used to do this are different in each jurisdiction. Nutrient application regulations limit manure application based on nitrogen, phosphorus or both and in some instances, additional parameters, and application limits are based on maximum soil, crop or water nutrient levels, through the use of standards written into legislation or through the use of certified experts and best management practices. Manure application setbacks from water and neighbours have been written into legislation of all jurisdictions surveyed except Washington State.

All jurisdictions have introduced new regulations for manure storage, acknowledging that leaching and runoff from storage areas can cause pollution of surface and ground water. Strategies also vary widely,

with some jurisdictions writing extensive siting and construction standards into legislation (Manitoba and Ontario) and others relying on professional judgment and approved best management practices (Pennsylvania, Quebec and Washington State). Most jurisdictions now have minimum storage capacity requirements based on conditions in their area. Most also have standards for field storage of manure and confined outdoor feeding areas to reduce the potential for leachate and runoff from these sites.

On-farm disposal of mortalities is changing as well. While burial continues to be the standard disposal option in many jurisdictions including Canada, on-farm composting is becoming more common due to concerns about groundwater impacts from burial sites. Some jurisdictions (Texas, California, the UK and Ireland) have banned on-farm burial. In those jurisdictions where it is still permitted, siting restrictions, volume limits and other requirements have been implemented.

In response to the increasing incidence of complaints about odours from large agricultural operations, several jurisdictions have implemented new regulations requiring farms to address odours (Alberta, Texas and Pennsylvania). The strategies for regulating odours vary. Texas now requires new and expanding agricultural operations to demonstrate that they have measures in place to control odours. Pennsylvania requires producers to implement odour best management practices. Alberta producers are required to use odour assessments to determine the required setback of a new barn or manure storage from neighbours.

In terms of other impacts from agriculture, requirements for control of dust, volatile organic compounds and ammonia emissions were found in the regulations surveyed. Texas requires all poultry farms to have an approved plan to deal with dust produced by all aspects of the operation. California is in the process of regulating the emission of volatile organic compounds from dairy farms in the San Joachin Valley and is assessing which management factors are most effective at reducing these compounds. Holland has legislated low ammonia emission manure storage and application methods in response to EU legislation requiring a reduction in ammonia emissions from agriculture.

There is increasing interest in technologies that can generate energy from agricultural wastes. Several jurisdictions (Ontario, California and Washington State) have implemented regulations for the operation of on-farm anaerobic digesters, and Ontario and the U.K. have introduced regulations requiring the digestate to be land-applied as a nutrient source. No other regulations for emerging technologies were found in the review although in the European jurisdictions there are several alternative energy programs underway.

List of Abbreviations and Definitions

AEU or animal equivalent unit (Pennsylvania) – one animal equivalent unit is equal to 1000 pounds live weight of livestock or poultry on an annualized basis.

AFO (USEPA, Texas, California and Washington State) – an animal feeding operation where animals are confined for 45 days or more in any 12 month period and where a crop or vegetation is not maintained on the confined area.

Animal Unit (Manitoba) – ‘the number of animals of a particular category of livestock that will excrete 73 kilograms of total nitrogen in a 12 month period’.

AOPA - Alberta Operation Practices Act (2002), contains manure management standards.

CAFO (USEPA, Texas, California and Washington State) – Concentrated Animal Feeding Operation, defined as an animal feeding operation that meets the size definition of a large or medium sized AFO. See [Section 3.1.2](#) for more detail.

CAO (Pennsylvania) – concentrated animal operation, defined as an animal operation with more than 8 animal equivalent units on site and where the animal density exceeds 2 animal equivalent units per acre.

CFO (Alberta) – concentrated feeding operation, defined as ‘fenced or enclosed land or buildings where livestock are confined for the purposes of growing, sustaining, finishing or breeding’. See Section 2.1 for size categories.

cm - centimetre

Codes of Good Agricultural Practice – voluntary best management practices guidelines for EU farmers not located within nitrate vulnerable zones, developed by each EU state.

DEFRA – UK Department for Environment, Food and Rural Affairs

EU – European Union

ha - hectare

kg - kilogram

kg/ha – kilograms per hectare

km - kilometre

Livestock maximum density (Denmark) – maximum livestock density is equal to 2.3 cows or 1.7 other livestock per hectare.

Mehlich III P test – soil test for plant-available phosphorus

mg – milligram

mg/kg – milligrams per kilogram, equivalent to parts per million.

mg/L - milligrams per litre, equivalent to parts per million.

MINAS (Netherlands) – mineral accounting system, a farm-based nitrogen and phosphorus accounting system.

Nitrate (NO_3)– leachable, plant-available form of nitrogen. Convert nitrate to nitrate-N by dividing by 4.4.

Nitrate Directive – 1991 EU legislation that requires individual member states to address impacts of nitrates from agriculture on surface and ground water in the EU.

Nitrate vulnerable zone or NVZ – land areas within the EU that drain into waters that have or are vulnerable to impacts from nitrate pollution.

NRCS – National Research Conservation Service, a branch of the United States Environmental Protection Agency that provides guidance and technical standards for agricultural waste management.

Nutrient Unit (Ontario) – ‘the amount of nutrients that give the fertilizer replacement value of the lower of 43 kilograms of nitrogen or 55 kilograms of phosphate’.

Slurry – liquid manure

TABLE OF CONTENTS

1	Introduction	4
2	Discussion by Jurisdiction of the Regulation of Agricultural Waste and Nutrient Management	4
2.1	Alberta.....	4
2.2	Manitoba.....	6
2.3	Ontario	7
2.4	Quebec.....	7
2.5	USEPA Concentrated Animal Feeding Operation (CAFO) Rule	8
2.6	Pennsylvania	8
2.7	Washington State.....	9
2.8	Texas	9
2.9	California.....	10
2.10	European Union Nitrates Directive (1991).....	11
2.11	Ireland	12
2.12	UK.....	12
2.13	Netherlands (Holland).....	13
2.14	Denmark.....	15
2.15	Scan of manure and nutrient management regulations in Asian jurisdictions	16
3	Review of Nutrient Management Regulations (Table 1)	17
3.1	Regulatory triggers (Table 1a).....	17
3.1.1	Canada	17
3.1.2	United States.....	17
3.1.3	European Union	18
3.2	Regulatory mechanisms and the role of Best Management Practices in regulating manure and nutrient management (Table 1b and 1d).....	19
3.3	Regulation of nutrient application (Table 1c)	19
3.4	Soil, manure, crop and water testing requirements (Table 1e).....	20
3.4.1	Manure.....	21
3.4.2	Soil.....	21
3.4.3	Other testing – water and crop.....	22
3.5	Record keeping and reporting requirements (Table 1f)	22

3.6	Effectiveness of nutrient management regulations	23
3.6.1	Measuring the effectiveness of agricultural waste regulations – the Netherlands, Denmark and California	23
3.6.2	Compliance strategies.....	25
4	Manure Application Requirements (Table 2).....	26
4.1	Prohibited application period (Table 2)	26
4.2	Application requirements (Table 2)	27
4.3	Application buffers and setbacks (Table 2).....	27
5	Manure Handling and Storage Requirements	28
5.1	Manure storage (Table 3)	28
5.1.1	General requirements (Table 3).....	28
5.1.2	Required storage capacity (Table 3)	28
5.1.3	Siting standards (Table 3).....	28
5.1.4	Constructions standards (Table 3)	29
5.2	Field storage requirements (Table 4).....	29
5.3	Management of confined (or concentrated) outdoor feeding areas (Table 5)	30
6	Regulation of On-farm Disposal of Mortalities (Table 6).....	30
6.1	On-farm burial (Table 6).....	31
6.2	On- farm composting of mortalities (Table 6)	31
6.3	On-farm incineration of mortalities (Table 6).....	31
7	Regulation of On-farm Composting of Manure and Other Agricultural Wastes (not mortalities) (Table 7)	32
8	Odour Regulation (Table 8).....	32
9	Regulation of Emissions and Dust.....	33
9.1	Reduction of volatile organic compounds from dairy farms	33
9.2	Reduction of ammonia emissions.....	34
9.3	Dust control.....	34
10	Regulation of Emerging Technologies.....	34
11	Summary	34
12	List of References and Web Pages	37
12.1	Nutrient and manure management regulations by jurisdiction	37
12.2	On-farm composting regulations and guidelines.....	41

12.3 On-farm mortality disposal regulations	41
<i>Table 1. Regulation of Nutrient Management</i>	43
Table 1a. Regulatory Trigger	43
Table 1b. Regulatory Mechanisms	45
Table 1c. Regulated Nutrients.....	47
Table 1d. Role of Best Management Practices	49
Table 1e. Soil, Manure, Crop and Water Testing Requirements	50
Table 1f. Record Keeping and Reporting Requirements.....	51
<i>Table 2. Manure Application Requirements</i>	53
<i>Table 3. Manure Storage Facility Requirements.</i>	59
<i>Table 4. Requirements for Field Storage of Manure</i>	64
<i>Table 5. Requirements for Management of Confined (or Concentrated) Outdoor Feeding Areas</i>	66
<i>Table 6. On-Farm Mortality Disposal Options and Requirements</i>	67
<i>Table 7. Regulation of On-farm Composting</i>	74
<i>Table 8. Odour Regulations</i>	76
<i>Table 9. Regulation of Emissions and Dust</i>	77

1 Introduction

This report contains the results of a review of the agricultural waste management regulations from 12 jurisdictions including:

- Four Canadian jurisdictions: Alberta, Manitoba, Ontario and Quebec.
- Four U.S. jurisdictions: Pennsylvania, Washington State, Texas and California.
- Four European jurisdictions: Ireland, UK, the Netherlands and Denmark.

The review covers various aspects of agricultural waste management in these jurisdictions including nutrient management regulations, manure storage and application requirements, regulation of on-farm disposal of mortalities, control of odour and emissions, and regulation of emerging technologies.

The report is divided into two sections. The first section (Section 2.1 – 2.15) includes a discussion of general agricultural waste management regulations in each of the twelve jurisdictions, identifying key regulations and general regulatory strategies. Also included are the results of a brief scan for Asian regulations.

The second section of the report (Sections 3 through 10) consists of discussion of each of the agricultural waste topics covered.

At the end of the report are comprehensive tables summarizing the requirements and standards in each jurisdiction for each topic area.

The information for this report was gathered through an extensive web-based search for the relevant Acts, Regulations and guidelines for each jurisdiction as well as additional background material when available. The information contained in this report is based on each jurisdiction's most recent agricultural waste management and nutrient management regulations unless noted. The report has been prepared to provide background information for the B.C. Ministry of Environment's planned review of the B.C. Agricultural Waste Control Regulation.

2 Discussion by Jurisdiction of the Regulation of Agricultural Waste and Nutrient Management

2.1 Alberta

In Alberta, the [*Alberta Operation Practices Act*](#) (AOPA, 2002) and *Regulations* regulates manure storage and application as well as odour and dust emissions. Manure application requirements in the legislation apply to all agricultural operations in the province while manure storage requirements are required to be met only by operations that meet the definition of a concentrated feeding operation (CFO). Large CFO's are required to operate under an approval. The following size of operation is considered a large CFO:

- >350 beef cows or finishers

- >500 beef feeders
- >200 milking dairy cows
- >250 sows in a farrow to finish operation
- >30,000 layer birds
- >60,000 broilers

Medium sized CFO's are required to operate under a registration. Medium CFO's are operations with the following livestock numbers:

- 150-349 beef cows or finishers
- 50-199 milking dairy cows
- 30-249 sows in a farrow to finish operation
- 5,000-29,999 layer birds
- 2,000-59,999 broilers

Size allocation for other types of livestock and poultry are outlined in the legislation. Operations with fewer animals on site are not required to meet the manure storage requirements in the AOPA.

Under the AOPA, manure collection areas such as feedlots and barn floors are required to meet the same siting and construction standards as manure storage facilities, such as a required impermeable layer to prevent leaching from the site. New CFO's are required to have 9 months manure storage capacity unless they are able to field-store solid manure prior to application. CFO's in operation prior to 2002 are exempt from meeting the storage requirements.

Manure application and nutrient management standards apply to all agricultural operations in the province. Manure application is regulated by limiting the nitrogen level in the soil (nitrate-N) and the soil conductivity level. New CFO's must demonstrate that they have access to sufficient land to comply with the nitrogen standard before they are issued a permit. An accompanying [*Manure Characteristics and Land Base Code \(2006\)*](#) contains minimum land base requirements for different livestock species and sizes of operation that are used to determine whether the proposed operation has access to sufficient land. The land base requirements are based on standard values for crop-available nitrogen in the manure and standard crop nitrogen requirements. Alternatively, the operation can have a Nutrient Management Plan written and approved.

Manure must be incorporated within 48 hours unless the site is planted to forage or direct seeded crops. Application on frozen or snow-covered ground is allowed only under permit. The Act legislates setbacks to surface water and neighbours.

New and expanding CFO's are also required to have an odour assessment done for the facility that takes into consideration the type and volume of manure, the type of neighbourhood surrounding the facility and other factors to determine the risk of odours causing problems in the area.

Alberta has best management practice manuals for each commodity group but these are used by producers voluntarily for education purposes.

2.2 Manitoba

Manitoba is currently (2010) in the process of phasing in comprehensive nutrient management regulations with the goal of protecting water quality by regulating or prohibiting:

- the application of nitrogen and phosphorus.
- agricultural operations in areas where the surface or ground water is sensitive to impacts from nutrients.

Legislation consists of the [*Livestock Manure and Mortalities Management Regulation*](#) (2004) and the [*Nutrient Management Regulation*](#) (2008). The legislation will not be fully phased in until 2013, although dates for compliance with various parts of the legislation vary.

The new legislation will regulate the application of both nitrogen and phosphorus from manure and chemical fertilizer. Soil phosphorus content is used to determine whether land can receive manure and how much it can receive. Soils below the threshold level of 60 ppm of available phosphorus can be regulated based on meeting the nitrogen requirement of the crop to be grown. Soils with higher concentrations of phosphorus are restricted to an application rate of manure that supplies 1-2 times the crop uptake level of phosphorus, depending on the soil background concentration. Soil nitrogen level is required to be kept below the threshold level of residual nitrate (30 to 140 pounds per acre of residual nitrate), and cannot exceed twice the threshold level at any time during the crop year.

The legislation restricting application of nitrogen and phosphorus in manure applies to all crop land in Manitoba with a few exceptions. Other legislation covering manure storage and application applies to large operations only (those with greater than 300 or 400 animal units where an animal unit is the number of animals that will excrete 73 kilograms of total nitrogen in a 12 month period). The government has also identified areas of the province where the amount of phosphorus in manure exceeds the capacity of the crops grown on the land base to use it. In these areas, there will be a moratorium on expansion of all hog facilities and all other farms with greater than 300 animal units unless the farmer can demonstrate that the soil phosphorus level will stay beneath the threshold level of 60 mg/kg.

The regulatory tools in Manitoba will be both farm plans and standards passed into law with smaller farmers having a choice between the two (farms with less than 300 animal units on site). For smaller farms, if the farm plan option is chosen (either a Manure Management Plan or a Nutrient Management Plan), the plan contains manure application rates, which can be higher than the standards in legislation provided that approval is obtained from authorities for the alternative standards.

Farms with more than 300 animal units on site are required to have a Manure Management Plan prepared and approved by regulatory authorities, and must also implement a Nutrient Management Plan if ordered to by regulatory authorities. This plan is intended to cover sources of nutrients other than manure. The regulations are being phased in until 2013.

2.3 Ontario

In 2002, Ontario introduced the [Nutrient Management Act](#) and associated Regulations and Protocols which expands the nutrient management requirements for farmers and brings all aspects of agricultural waste management and nutrient management under the same Act.

The new Nutrient Management Act requires Ontario farms with large numbers of livestock and poultry to comply with the Act (defined as farms that generate 300 or more nutrient units annually where a nutrient unit is the fertilizer replacement value of the lower of 43 kg nitrogen or 55 kg of phosphate). Regulated farms are required to implement a Nutrient Management Strategy that describes how agricultural wastes are managed on the farm, and, if the manure is applied on-site, to implement a Nutrient Management Plan that outlines land application requirements.

Application of nutrients in manure to farm land is regulated on the basis of nitrogen, phosphorus and potassium, but the rate-limiting nutrient is phosphorus. Manure application is limited to sites where the plant-available phosphorus and potassium are less than 101 and 251 mg/kg respectively. Farmers must limit phosphorus application in manure to either crop uptake or crop requirements balanced over the 5 year period of each Nutrient Management Plan. The application of nutrients in chemical fertilizer is not regulated under the Nutrient Management Act.

The Nutrient Management Act contains application setbacks and buffers, limits on winter application of manure and it places restrictions on certain methods of manure application. It mandates required manure storage capacity and siting requirements for new storages as well as management of outdoor livestock feeding areas.

Application to agricultural land of other organic residuals such as municipal biosolids is also regulated under the Act.

Ontario has Best Management Practices guidance manuals available for use by farmers but does not require the use of the manuals in development of Nutrient Management Plans.

2.4 Quebec

Quebec introduced new nutrient management legislation in 2002. The [Agricultural Operations Regulation \(2002\)](#) contains a number of new requirements for farms to limit impacts of manure and other fertilizers on the environment. The regulation applies to farms that generate more than 1600 kilograms per year of phosphate in manure, or which have no livestock but farm more than 15 hectares of land on which they use manure and other fertilizers. The regulation limits the application of manure and fertilizer based on the phosphorus content of the manure and of the soil, and the phosphorus requirement of the crop. Farms are required to have access to sufficient land to spread manure based on its phosphate content. This requirement was phased in over the period 2005 to 2010, giving producers time to access additional land as required.

Regulated farms are required to have a professional agrologist or other appropriately trained person prepare an Agro-Environmental Fertilization Plan that details the crop and fertilizer application limits for each field. Following fertilizer and manure applications, there must be a sign off by the professional

indicating that the applications were done according to the plan. Farms are also required to have prepared an annual phosphate report that details the amount of phosphate from manure and other nutrient sources to be spread on the land base during the year. Farms must keep records of the fertilizer and manure applied, application rates and times, and the land base used. New or expanding farms that will produce more than 3200 kilograms of phosphate per year in manure must apply for a permit to operate.

The regulation also contains standards for manure application setbacks, timing and methods. It contains detailed requirements for field storage of manure and for manure storage.

2.5 USEPA Concentrated Animal Feeding Operation (CAFO) Rule

The U.S. government passed legislation in 2003 and expanded it in 2008 to require all large concentrated animal feeding operations in the U.S. (those meeting the definition of a CAFO based on the number of animals present on the site) (see Section 3.1.2 for detail) to obtain a permit to operate. As well, all CAFO's must operate under a Nutrient Management Plan designed to reduce impacts on surface water from waste from these operations ([USEPA CAFO Rule](#)). Application rates of manure and other farm wastewater must be based on agronomic application of nitrogen and phosphorus. Nutrient Management Plans must reference federally-approved Best Management Practices to remedy deficiencies in manure storage and application procedures. New and expanded manure storage facilities must be designed to hold rainfall and runoff from the 100-year, 24-hour storm event at the site. Each state was delegated the responsibility to enforce the rule within their own boundaries and each state has developed different strategies for meeting the requirements of the rule.

2.6 Pennsylvania

Pennsylvania enacted its [Nutrient Management Regulations](#) in 2005 (Act 38 of 2005). It requires regulated farms to submit and have approved a Nutrient Management Plan for their operation. Regulated farms are those with both high livestock or poultry numbers (more than 8000 pounds of animals on site) and high density (greater than 2000 pounds of livestock per acre of arable land). Non-production livestock operations (e.g., horses, exotic livestock) are included in the definition as well.

There are few standards contained in the legislation. The regulatory mechanism in Pennsylvania is the Nutrient Management Plan, which is required to be prepared by a qualified person (in some cases this person can be the farmer), and must be submitted to and approved by State regulatory authorities. The Plan must reference State-approved Best Management Practices to remedy manure management deficiencies.

Manure application rates must be nitrogen-limited. The application of manure must consider the nitrogen status of the site including residual nitrogen and other applied nitrogen sources and must not exceed realistic crop requirements. In addition, on sites that are considered to have the potential for impacting surface water due to runoff or subsurface drainage, the field must be rated using the Pennsylvania phosphorus index. Manure application on these sites is phosphorus-limited.

Pennsylvania also regulates odours from agricultural operations under the same legislation. New and expanding high density farms are required to reduce odours by implementing Best Management Practices. The level of odour control required is based on a site assessment using the Pennsylvania Odour Site Index.

2.7 Washington State

Washington State regulates agricultural waste and nutrients through state-approved Nutrient Management Plans for those livestock facilities that are regulated. The state regulates all dairy farms and large non-dairy concentrated animal feeding operations (CAFO's) which for example, have more than 1000 beef animals or 2500 mature swine. The dairy program began in 1998 and nutrient management planning requirements were phased in by 2002. This program is administered by the Washington State Department of Agriculture. Regulation of non-dairy CAFO's came into force in 2006 and requirements will be fully phased in by the end of 2010. Non-dairy CAFO's are permitted through the Department of Ecology and must submit a professionally-prepared Nutrient Management Plan for approval. Upon plan approval, a permit is issued. Small or medium sized non-dairy confined livestock operations can also be required to operate under a Nutrient Management Plan at the discretion of regulatory authorities.

The Nutrient Management Plan is required to demonstrate that the manure handling and storage system will not cause pollution of state waters and that the application of manure is done at an agronomic rate such that there will be minimal risk to groundwater. Federally approved Best Management Practices must form the basis of the recommendations in the Plan and once approved, it must be implemented.

State legislation contains few standards or requirements for manure storage or application. Surface water and groundwater are protected through the use of federally-approved management practices contained in federal guidance documents or through the use of state-approved equivalent practices.

2.8 Texas

Texas regulates agricultural waste and nutrient management as follows:

- All concentrated animal feeding operations (CAFO's) in the state must have a permit to operate. To obtain a permit, they must implement a [Pollution Prevention Plan](#) for their operation which directs manure handling, storage and application as well as nutrient management. The goal is to reduce the impact of the operation on surface and ground water quality. Texas uses the federal definition of CAFO which is large and medium sized AFO's (e.g., farms with more than 200 dairy cows or 750 hogs).
- All state poultry operations regardless of size require a [Water Quality Management Plan](#) which is similar to the Pollution Prevention Plan and is a comprehensive plan covering all aspects of manure handling, storage and land application. Nutrient management is part of the plan. Poultry CAFO's must comply with additional state regulations for manure management. New or expanding poultry operations must also develop an odour management plan that includes an odour potential assessment for the facility and procedures for reducing odours and dust.

- Large dairy operations (meeting the federal definition of a CAFO) in two watersheds where phosphorus loading has been identified as a water quality issue are required, in addition to their permit requirements, to implement a [Comprehensive Nutrient Management Plan](#). This plan expands on the basic nutrient management planning which is required for all CAFO's to include more in-depth nutrient management, such as exporting of manure from the watersheds, composting of manure so that it can be applied to other land and more careful scrutiny of nutrient levels in the soils in the watershed.

State legislation regarding poultry operations and other large livestock operations has been implemented in stages from 2004 to 2009. The state CAFO and AFO regulations contain standards for the siting, construction and maintenance of manure storages including confined outdoor feeding areas where manure collects. The regulations also contain requirements for annual soil and manure sampling and soil phosphorus limits. As well, all operations in which animals are confined regardless of size (referred to as AFO's) are required to have an odour management plan which outlines how odours and dust will be minimized. All AFO's are required to keep records of manure volumes produced and distributed, on-going maintenance of manure storages and inspections of storages. CAFO's are also required to submit a yearly Annual Report which contains information on the maintenance of manure storages, and on manure application volumes and sites, weather before and after manure application, results of soil and manure testing and any off site movement of manure.

2.9 California

Until 2007, California had very limited manure handling and land application standards. As the result of increasing incidences of elevated nitrates and total suspended solids in groundwater in the state, new and much more extensive regulations were passed into law in 2007 and are being phased in until 2011. At this time the new regulations apply only to dairy farms located in the Central Valley region of the State. This part of the state has the majority of large confined livestock operations and the highest density of dairy farms in the U.S. There are approximately 2,000 confined livestock operations in the area, 1,700 dairies, 200 poultry operations and 100 others (swine, horse, sheep and others). Most dairy farms have 200-1,400 milking cows. Because of the large number of dairy operations and the fact that the level of nitrates in groundwater under dairy farms has been increasing as the number and size of operations has increased, the state chose to regulate the dairy industry first. At this time, dairy farms in other areas of the state and other CAFO's are still required to comply with the much less stringent pre-2007 regulations.

The 2007 regulations ([Waste Discharge Requirements General Order for Existing Milk Cow Dairies R5-2007-0035](#)) require all 1,700 dairy farms in the Central Valley region to:

- Implement annual or more frequent monitoring of manure and waste water, plant tissue, soil, tile drainage water, well water and surface runoff from their property.
- Upgrade existing manure storages to provide sufficient storage to hold all waste produced between manure land application events, all drainage from manure-affected areas and the storm runoff from a 25-year, 24-hour storm event.

- Implement a Nutrient Management Plan prepared for their operation using the results of the required monitoring to ensure that application of manure, wastewater and other nutrients does not exceed crop requirements for nitrogen.
- Submit an Annual Report containing the required monitoring data and evidence that manure storages are adequate and properly maintained and that land application was done in accordance with the Nutrient Management Plan.

The new regulations in California were driven by the desire to slow the rate of impact on groundwater as well as to reduce impacts on surface water from runoff and leachate from manure collection and storage areas as well as from land application areas. To this end, the regulations require extensive monitoring to set baseline conditions for groundwater quality, surface water quality, and manure, soil and crop nutrient levels. Annual or more frequent sampling of water from all wells on site, of water from tile drains, of irrigation water and of surface runoff water during storm events is required with the results used to determine whether nutrient application rates are in balance with crop uptake. Testing data from manure and crop tissue is used to develop application rates. Dairies where one or more existing wells have nitrate-N levels over 10 mg/L will be required to install monitoring wells up-gradient and down-gradient from manure storages and land application areas on a case-by-case basis (studies have shown that up to 63% of dairy farms have at least one well with elevated nitrates) and monitoring results are to be used to assess to what extent these operations are reducing nutrient movement into ground and surface water.

These regulations came into force in 2007. The requirements for Nutrient Management Plans, upgrades to existing manure storage capacity and monitoring wells are being phased in between 2009 and 2011. All regulated dairies are required to be collecting monitoring data now and must be in the process of upgrading storage facilities and implementing Nutrient Management Plans.

2.10 European Union Nitrates Directive (1991)

In 1991, The European Union (EU) passed into law the '[*Nitrates Directive*](#)' as the result of increasing levels of nitrates in surface and groundwater in member states. This law was designed to limit the application of nitrogen in all fertilizing materials including livestock manures with the goal of improving water quality throughout the EU. This piece of legislation has resulted in the development of regulations and Codes of Good Agricultural Practice by each member state of the EU.

Each member state has been required to:

1. Identify 'nitrate vulnerable zones' within its borders. These were defined as land areas that drain into waters that had been affected by pollution or that were vulnerable to being impacted by nitrate pollution. The member state alternatively could designate the whole country as being a vulnerable zone and apply requirements throughout the country.
2. Establish action programs for identified nitrate vulnerable zones. The action program was required to outline measures to be implemented by farmers in vulnerable zones to reduce nitrate pollution. The following measures were required:
 - Manure application must supply less than 170 kilograms of nitrogen per hectare per year

unless approved by the EU.

- Member states must establish periods of time during the year when manure application was prohibited.
 - Manure storage capacity must be sufficient to carry each farm over the no-application period.
 - Application of fertilizer materials must be nitrogen-based and must balance the crop nitrogen requirement with soil and residual nitrogen and application of nitrogen in manure and fertilizer.
 - Manure application must also consider local soil, climate and land use.
3. Establish Codes of Good Agricultural Practice that are to be applied voluntarily by farmers not in nitrate vulnerable zones. These are to suggest practices by which farmers can limit nitrate movement to water from manure and fertilizer application.
 4. Develop a monitoring program to assess the effectiveness of these programs. Surface and groundwater monitoring stations to be established and monitored every four years.

A review of the program in 2002 found that 20% of groundwater and 30-40% of surface water in the EU had elevated nitrate. It also determined that agriculture contributed 50-80% of nitrate entering water. Another review in 2007 found that while surface water quality had stabilized or improved at 86% of monitoring stations, groundwater quality had worsened at 36% of monitoring stations.

2.11 Ireland

Ireland designated the whole country as a 'nitrate vulnerable zone' (as per the EU *Nitrate Directive*) and developed an action program for nutrient management that applies to all farms throughout the country. New regulations, '[Good Agricultural Practice for Protection of Waters Regulation 2009](#)' contain the requirements of the action program to protect water quality. The regulation contains extensive standards and limitations for the handling, storage and application of manure and other fertilizers on-farm. Farms are required to limit application of manure and other fertilizer sources to a total of 170 kilograms of nitrogen per hectare per year, but can with permission apply up to 250 kilograms per hectare per year on grazing land. Farms must maintain a fertilizer plan for their operation which tracks application of nutrients, land base, exports of manure, and manure storage capacity which is submitted annually to the Ministry of Agriculture. There are legislated prohibited application periods and other application requirements. Manure storage capacity is also legislated.

Ireland has linked farmer support payments with compliance with the regulation. Annually, up to 5% of farms are inspected for compliance with the manure regulation and other farm-related legislation and those out of compliance can have support payments withheld.

2.12 UK

In response to the EU *Nitrate Directive*, the UK has designated 70% of the land base of the country as nitrate vulnerable zones based on existing or potential nitrate pollution of the surface or ground water, and has developed an action program for those areas. The requirements for manure storage and application, and nutrient management for those farms within the vulnerable zones are found in the '[Nitrate Pollution Prevention Regulations 2008](#)', administered by the Department for Environment, Food and Rural Affairs (DEFRA). All farms located in these vulnerable zones are required to comply with the regulations. Farms in the remaining areas of the country are asked to comply with a voluntary Code of

Good Agricultural Practice which contains many of the same manure management requirements as the Regulations.

In nitrate vulnerable zones, farms are required to limit the application of nitrogen in manure to 170 kilograms per hectare per year averaged over the whole farm, and a maximum of 250 kilograms per hectare per year on an individual field. Manure volume and content of nitrogen are based on standard values found in the legislation. Farms are also required to have sufficient storage capacity to cover the winter prohibited manure application period or to demonstrate that they have sufficient land base that is considered at low risk of nitrogen runoff into surface water.

As in Ireland, farm subsidy payments are linked to compliance with the regulation. Failure to comply with the requirements of the regulations could result in deductions to subsidy payments.

2.13 Netherlands (Holland)

The Netherlands has one of the highest densities of livestock in the EU and as a result has had a manure surplus for many years which has impacted surface and ground water quality throughout the country ([Manure policy and MINAS, 2005](#)). In 1997, the country as a whole had a nitrogen surplus of 249 kilograms per hectare from manure and chemical fertilizer. The country has instituted various policies to deal with the manure surplus and has reduced but not eliminated the surplus. Nitrate levels in surface and ground water in many areas of the country remain above the EU standard of 50 mg/L.

The Netherlands has had programs in place since 1985 to reduce the excess loading of nitrogen and phosphorus from agriculture. The first program placed a moratorium on expansion of the pig and poultry industries and capped application rates of phosphorus on agricultural land. It introduced a milk quota system to cap expansion of the dairy industry. The program also encouraged technological solutions to the manure surplus such as pelletizing of manure so that it could be exported. This program resulted in only minor reductions in the nutrient surplus.

Further restrictions on application of nutrients were enforced in 1990. These included a gradual reduction of the application limit for phosphorus from all sources (as phosphate) from 350 kilograms per hectare in 1990 to 80 kilograms per hectare in 2002. There was also a ban on winter application of manure, a legislated lowering of protein and phosphorus in animal feeds and increasing transport of manure from surplus areas to undersupplied areas. Manure programs also focused on reducing the ammonia emissions from agricultural activities as per an EU directive. Measures included requiring manure to be injected or incorporated, requiring covers for manure storages and requiring new livestock facilities to incorporate low emissions design. The result of the low emissions program was to increase the amount of nitrogen in manure by decreasing gaseous losses which further exacerbated the nitrogen surplus problem.

In 1998 the government realized that further measures would be required to eliminate the manure surplus ([Manure policy and MINAS, 2005](#)). To this end, they developed MINAS (mineral accounting system) which was a nitrogen and phosphorus accounting system for farms. The basis of MINAS was that nitrogen and phosphorus inputs had to equal outputs on each farm. Farmers were allowed a levy-free surplus which gradually declined from 1998 to 2003, encouraging farmers to reduce their nitrogen

and phosphorus inputs and to export surplus manure off the farm. On grassland, the annual levy-free surplus for nitrogen declined from 300 kilograms per hectare in 1998 to 140-180 kilograms per hectare in 2003. A fine was levied on farmers who had surplus nitrogen and phosphorus above the allowed 'levy-free surplus'; they could choose to pay the fine or reduce their surplus. The levies also increased from 1998 to 2003. In 2003, the average fine paid by pig and poultry farms was 15,000 to 25,000 Euros because of their limited land base and the lack of alternative disposal sites for their surplus manure.

This program was economically unsustainable for pig and poultry producers; 40% of these producers were unable to eliminate their surplus by 2003 while only 20% of dairy farmers still had a surplus in 2003. However, the program resulted in substantial reductions in the use of chemical fertilizer on farms. Reductions in the protein and phosphorus content of animal feed resulted in a 22% reduction in manure nitrogen and a 9% reduction in the amount of phosphorus in manure.

In terms of the MINAS program helping the country to meet water quality standards, the average nitrate concentration in shallow groundwater declined significantly from 134 mg/L in 1998 to 76 mg/L in 2000-2002. However, this still substantially exceeded the EU drinking water nitrate standard of 50 mg/L.

In a court decision in 2003 the European Union decided that the MINAS system did not meet the requirements of its *Nitrate Directive* of 1991 because it did not directly address the pollution of surface and ground water by requiring the application of nitrogen to be limited by crop requirements and soil residual nitrogen. As a result of this decision, and because the government determined that the program was both economically unsustainable for many producers and was an administrative burden, in 2003 the MINAS system was abandoned and replaced by a system more similar to those put in place in other EU countries such as the UK and Ireland.

The current program was put in place in 2004 and is called the '[Netherlands 3rd Action Program](#)'. It consists of a number of regulations designed to reduce the loading of nitrogen and phosphorus from agriculture to the country's surface and ground water. The whole of the country was designated a 'nitrate vulnerable zone' and manure storage and application regulations were developed to meet the requirements of the EU *Nitrate Directive*. The regulations apply to every farm in the country. These include:

- A prohibition on manure and fertilizer nitrogen application from September 1 to January 31 and the requirement for all farms to have 6 months of storage or demonstrate on a case-by-case basis that they have access to land that can, without risk of pollution, receive manure during the winter months. Fields planted to winter crops are allowed to apply some manure and fertilizer.
- Application of nitrogen from manure is limited to 170 kilograms per hectare per year.
- Application of phosphorus in all forms is limited to 41 kilograms per hectare on grassland and 32 kilograms per hectare on arable land (95 and 75 kilograms per hectare phosphate respectively). In some cases, this reduces the allowable application rate of nitrogen from manure to below 170 kilograms per hectare.
- Manure application must be done with low emissions techniques including injection and incorporation.

The calculation of the amount of nitrogen and phosphorus in manure for confined animal operations is based on the difference between the amount of these nutrients in the feed and the amount leaving the property in the 'products', less gaseous losses of ammonia from the system. It was found that basing the nutrient content on average manure values was less accurate. For grazed animals, the calculation is based on a nutrient balance that considers the amount of nutrients cycled during grazing as well as inputs and outputs. This is different from the system in place in the UK and Ireland where manure nutrient content is based either on 'book values' or on site-specific analytical values.

The calculation of nitrogen required by crops must consider the amount of soil residual nitrogen and the expected mineralization of nitrogen from the soil as well as crop requirements. Crop requirements are based on country-wide research-based standards for each crop.

2.14 Denmark

Like the Netherlands, Denmark has had nutrient management Action Plans in place since 1987 to address concerns about nitrogen and phosphorus loading of the land base and subsequent pollution of surface and groundwater. The goal of the country's first Action Plan in 1987 was to reduce nitrogen loading by 50% country-wide and the amount of phosphorus runoff from farmyards ([Action Plan 2004, Kronvang, date unknown](#)). Measures instituted to accomplish this included:

- 9 months manure storage capacity - recommended
- Limits on manure application rates
- Incorporation of manure within 12 hours
- Optimal use of nitrogen through appropriate application rates and crop rotations
- Mandatory green cover on fields over winter.

Additional measures were instituted in 1991 in the country's second Action Plan because it was clear that the 1987 measures were not sufficient to meet the nutrient reduction goals. These included:

- Mandatory 9 months storage capacity for all regulated farms.
- More stringent and fixed requirements for application of nitrogen in manure
- Farms required to document fertilizer application.
- Application of slurry prohibited from harvest to February.

There were several significant improvements from these measures. Between 1989 and 2004, the amount of nitrogen fertilizer used in Denmark declined from 400,000 to 200,000 tonnes, a 50% reduction. The amount of phosphorus fertilizer used on farms declined 65% from 40,000 to 18,000 tonnes. As well, the average level of nitrate-N in groundwater below sandy soils declined from 18 to 10 mg/L (equal to a decline of nitrate from 80 to 44 mg/L) ([Petersen, date unknown, Kronvang, date unknown](#)) .

Further measures were instituted in 2004 ([Action Plan](#)) in response to the EU's *Nitrate Directive* and Denmark's inability to meet nutrient reduction targets with the previously-established measures. The whole of the country was designated a nitrate vulnerable zone. The objectives of the third Action Plan of

2004 were to reduce excess phosphorus from agriculture by 50% relative to the use in 2001-2002 and to reduce nitrogen leaching by 13% over 2003 levels, both by 2015.

The 2004 rules applied to farms with both large numbers of animals and a high density, and which produced a minimum amount of manure. Livestock density on farms was also regulated so that the maximum density for new farms was, e.g., 195 dairy cows or 510 sows (farrow-to-finish) per 100 hectares of farm land.

The following measures were instituted in 2005:

- A tax on phosphorus in feed (4 Denmark Kroner or USD 0.74 per kilogram of P).
- A nitrogen quota system for farms.
- A 10% reduction in standard nitrogen application rates for crops.
- 50,000 hectares of crop-free buffer zones 10 metres wide along lake and river shores to reduce phosphorus runoff from agricultural sites.
- Annual reporting requirements for farms, and random inspections to ensure compliance. Subsidy payments linked to compliance with nutrient regulations.
- Enhanced odour guidelines and increased setback requirements to minimize odour complaints.

Denmark's current nutrient management strategy is based on limiting over-application of nitrogen in manure and fertilizer by requiring farms to adhere to a nitrogen budget. Manure nitrogen content and availability to crops are determined using standard values. Crop uptake is also based on standard values that vary depending on expected yield, soil type and irrigation rate. Phosphorus application is limited through a two-fold approach. The tax on phosphorus in feed brought onto the property encourages feed companies to reduce the level in feed. The system of crop-free buffers between cropped land and surface water will reduce runoff of phosphorus in soil and manure. Unlike many other jurisdictions, Denmark has not yet limited the application of phosphorus to farm land.

2.15 Scan of manure and nutrient management regulations in Asian jurisdictions

A brief internet search of Asian countries for regulations related to manure management found very little information and no useful material in English. The web search was conducted for manure and nutrient management regulations in China, Korea and Singapore as well as a general search for Asian information.

One reference was found that discussed the use of manure and other organic wastes in China ([OECD, 2006](#)). China appears to be focused on increasing the use of manure, chemical fertilizer and other organic wastes as a way to boost soil fertility and crop yields to ensure there is sufficient food to feed the country's population. The article made mention of surface water degradation due to overuse of manure and fertilizer but at this time it does not appear that the country is focusing on addressing surface and ground water pollution from manure and fertilizer.

No references containing information on manure or nutrient management in any other Asian countries were found.

3 Review of Nutrient Management Regulations (Table 1)

Most of the jurisdictions surveyed have instituted new regulations for nutrient management in the past 10 years. These new regulations are the only ones discussed in this document except as noted in the text.

3.1 Regulatory triggers (Table 1a)

Every jurisdiction surveyed has different criteria for determining which farms must comply with the regulations. These range from regulating all farms in the country (Ireland, Holland) to regulating only one type of farm in part of the state (California).

3.1.1 Canada

In Canada, nutrient management regulation is done at the provincial level. Alberta requires all livestock operations in the province to adhere to the new nutrient management regulations, and requires larger operations to adhere to slightly more stringent regulations. Manitoba will eventually require all farms in the province to comply with their new nutrient management regulations. Ontario regulates farms on the basis of 'nutrient units' produced by the farm, which is based on livestock numbers; farms producing more than 300 nutrient units per year are regulated where 1 dairy cow is assumed to produce 1 nutrient unit per year. Quebec regulates based on the phosphorus content of the manure, with farms that generate more than 1600 kilograms of phosphate per year under regulation.

3.1.2 United States

In the U.S., the Federal CAFO (confined animal feeding operation) rule requires all confined animal agriculture operations that meet the definition of a large or medium-sized CAFO to operate under a permit and to implement a nutrient management plan, with the goal of reducing point source pollution from agriculture. The administration of this rule is delegated to individual states which have developed new, more restrictive regulations to meet the requirements of the rule.

The federal definition of a CAFO is an AFO that meets the size definition of either a large or medium CAFO as outlined below. An AFO is an animal feeding operation where animals are confined for 45 days or more in any 12 month period and a crop or vegetation is not maintained on the confined area. Small AFO's (those with fewer numbers of animals than medium CAFO's as defined below) are not subject to the federal CAFO rule unless it has been determined on a case-by-case basis that they are significant polluters in which case they can be designated as a CAFO for regulatory purposes.

A large CAFO is defined as an animal feeding operation with animal numbers equal to or greater than:

- 700 mature cows, milked or dry,
- 1000 veal calves,
- 1000 cattle other than dairy cows, including heifers, steers, bulls and cow/calf pairs,
- 2,500 swine of 55 pounds or more,
- 10,000 swine of less than 55 pounds,
- 500 horses,
- 10,000 sheep or lambs,

- 55,000 turkeys
- 30,000 laying hens or broilers, if the facility uses a liquid manure handling system,
- 125,000 chickens (other than laying hens) if the facility uses other than a liquid manure handling system,
- 82,000 laying hens if the facility uses other than a liquid manure handling system,
- 30,000 ducks if the facility uses other than a liquid manure handling system,
- 5,000 ducks if the facility uses a liquid manure handling system.

A medium CAFO is defined as an animal feeding operation with:

- 200-699 dairy cows, milked or dry,
- 300 to 999 veal calves,
- 300 to 999 cattle other than dairy cows, including heifers, steers, bulls and cow/calf pairs,
- 750 to 2,499 swine of 55 pounds or more,
- 3,000 to 9,999 swine of less than 55 pounds,
- 150 to 499 horses,
- 3,000 to 9,999 sheep or lambs,
- 16,500 to 54,999 turkeys,
- 9,000 to 29,999 laying hens or broilers if the facility uses a liquid manure handling system,
- 37,500 to 124,999 chickens (other than laying hens) if the facility uses other than a liquid manure handling system,
- 25,000 to 81,999 laying hens, if the facility uses other than a liquid manure handling system,
- 10,000 to 29,999 ducks if the facility uses other than a liquid manure handling system,
- 1,500 to 4,999 ducks if the facility uses a liquid manure handling system.

Individual states have developed various strategies for meeting the CAFO rule. Texas, California and Washington State have chosen to regulate by commodity group as well as by size of operation. For instance, Texas has identified poultry farms as the main source of pollution from agriculture so have opted to regulate all state poultry operations as well as all CAFO's as per the Federal rule. CAFO poultry farms must comply with additional manure management regulations. California has identified dairy farms in the Central Valley region of the state as a significant contributor of nitrates in groundwater so the state has opted to regulate all dairy farms in that area of the state. Other CAFO's in the state have less stringent regulations to comply with. Washington State regulates all dairy farms and large CAFO's. Pennsylvania regulates on the basis of livestock numbers and density; farms with more than 8000 pounds of animals on-site and more than 2000 pounds of animals per acre are regulated, including non-production livestock such as horses and exotic animals. Non-regulated farms in Pennsylvania have to comply with much less rigorous standards based on a voluntary Code of Practice.

3.1.3 European Union

The EU passed into law its *Nitrates Directive* in 1991. This required all member states to institute measures to reduce the impacts of nitrates from agriculture on surface and ground water. Each member state was required to identify areas of the state that were vulnerable to impacts from

agriculture as ‘nitrate vulnerable zones’, and apply nutrient restrictions in those areas. As the result of this law, all member states have developed new manure management regulations in the past 5-10 years. Ireland and Holland have designated the whole country as a vulnerable zone, and regulations apply to all farms in those countries. The whole of Denmark is also designated as a vulnerable zone but it regulates only farms with greater than 10 livestock units (for example, more than 9 dairy cows) on 10 hectares. The UK has regulations that apply only to farms within the identified vulnerable zones; all others voluntarily comply with a Code of Practice.

3.2 Regulatory mechanisms and the role of Best Management Practices in regulating manure and nutrient management (Table 1b and 1d)

The role of Best Management Practices (BMP’s) varies widely with jurisdiction. Nutrient management requirements range from being entirely based on BMP’s to being wholly contained in legislation.

In Washington State, state regulations contain no standards or requirements for nutrient management. Each regulated farm is required to have a Nutrient Management Plan which must be based on federally-approved BMP’s and technical standards found in the National Research Conservation Service (NRCS) [Field Operations Technical Guidelines](#). These national standards are adapted by each state for their own conditions. Regulators in Washington State have opted to rely on federal standards and professional judgment rather than enshrining requirements in state legislation.

Alberta, Ontario and California have extensive sets of regulations that regulate all aspects of manure handling, storage and application. There is no requirement for Nutrient Management Plans to reference BMP’s as standards are contained in legislation. In Alberta and Ontario, voluntary BMP manuals are available for use by producers to supplement the regulations. Ireland and the UK also have enshrined nutrient management requirements in legislation and do not refer to BMP’s. Unregulated farms in the UK operate under a voluntary Code of Good Agricultural Practice which contains the same standards as the legislation.

Quebec, Pennsylvania, Texas and Holland all use a combination of regulations and BMP’s for their nutrient management programs. In these jurisdictions, legislation contains some standards for manure storage and application but some aspects of nutrient management are left up to professional judgment based on approved BMP’s. For instance, manure storage capacity may be regulated but manure application rates may be based on BMP’s and professional judgment.

Currently (2010), Manitoba requires large producers (>300 animal units) to operate under an approved Manure Management Plan and allows smaller producers to meet nutrient management requirements through either a Nutrient Management Plan or by adherence to the regulatory thresholds for soil phosphorus and nitrogen, and standards for manure storage and application. The nutrient management regulations are not yet fully phased in.

3.3 Regulation of nutrient application (Table 1c)

Of the twelve jurisdictions surveyed, seven regulate nutrient application based on nitrogen, three base it on maximum phosphorus application rates and two on both.

Of the jurisdictions that regulate the application rate of nitrogen, there are several different strategies. Alberta regulations contain soil standards for maximum soil nitrate-N and soil conductivity, above which manure cannot be applied to a site until the soil level declines. Ireland, the UK and Denmark adhere to the EU standard of 170 kilograms of nitrogen from manure per hectare per year, with slight variations to allow larger applications on a site-by-site basis but never higher than 250 kilograms per hectare. On regulated dairy farms in California, the application rate of nitrogen from all nutrient sources must not exceed 1.4 times crop uptake unless prescribed in a Nutrient Management Plan. Washington State and Pennsylvania require applications of manure to be based on the agronomic rate of nitrogen which is based on Best Management Practices contained in the Nutrient Management Plan.

Ontario, Quebec and Texas regulate nutrient applications based on phosphorus limits. Ontario sets maximum phosphorus application rates for each farm for a 5-year period which allows some flexibility to vary application rates from year to year provided the 5-year maximum is not exceeded. Although Ontario regulations stipulate that manure application must be based on 5 year phosphorus limits, manure application can presumably be made on the basis of nitrogen requirements within the 5 year period provided that the 5 year phosphorus limit is not exceeded. Quebec farmers are required to determine the phosphorus content of their manure and apply manure based on the soil phosphorus content and % saturation of phosphorus binding sites using standard crop uptake values that are written into the regulations. Texas regulates phosphorus additions to the soil in two sensitive watersheds in the state. Manure application is prohibited if the soil phosphorus level exceeds 200 mg/kg of plant-available phosphorus (based on the Mehlich III soil phosphorus test). In the rest of the state, the phosphorus application rate is set by the professional who prepares the required Nutrient Management Plan.

Pennsylvania and Washington State require a 'Phosphorus-index' to be run on fields where there is risk of runoff of manure constituents into surface water. While they regulate manure application based on nitrogen limits, on sensitive sites the result of the P-index will override the nitrogen application rate.

Holland and Manitoba regulate both nitrogen and phosphorus applications. In Holland, the maximum annual application of nitrogen is 170 kilograms per hectare, and phosphorus ranges from 32 to 41 kilograms per hectare depending on the crop type. New regulations in Manitoba which are not yet fully phased in will require all farms to limit their application of manure to either nitrogen or phosphorus requirements based on the soil phosphorus level. If the soil level is above the threshold level, manure application will be limited to 1-2 times the crop requirement for phosphorus until an upper level is reached above which no manure application will be allowed until the soil level declines sufficiently. If the soil level is below the threshold phosphorus level, manure application can be made based on meeting the crop's nitrogen requirement provided that soil residual nitrate does not exceed the allowable maximum.

3.4 Soil, manure, crop and water testing requirements (Table 1e)

There is considerable variability among jurisdictions in their approach to testing manure, soil, crop and water and the parameters that are required to be tested. Some jurisdictions require annual testing of some parameters, while others stipulate no required testing.

3.4.1 Manure

Annual testing: Quebec, Pennsylvania, Texas and California require annual or more frequent manure analysis with the results used to determine manure application rates. In Quebec, the phosphorus content of the manure, along with standard manure production values for each species, is used to determine the amount of phosphorus in the manure annually which determines the land base required for manure application. In the other jurisdictions, the manure nutrient content is used to calculate the allowable application rate of manure per year.

No manure testing required: In the European jurisdictions and Alberta, no manure testing is required. Instead, regulations contain standard manure nutrient values for each livestock type which are used to determine application rates. In the past, some European jurisdictions required manure test results to be used to determine manure application rates but found that there was so much variability in nutrient levels in manure that they now require farmers to use standard manure nutrient values written into legislation. In Holland, producers have the option of having their manure tested and if they can demonstrate that the nutrient content is lower than standard values in the legislation, they can use that value to determine their maximum application rate.

Other strategies: In Ontario, because the phosphorus application rate is based on a 5-year period, the manure is tested at the start of the 5-year period and that value is used to determine manure application rates. Alternatively, there are standard values contained in the regulations that must be used if manure testing is not done.

Washington has no requirement in their regulations for testing of manure. Washington's regulatory system is based on Nutrient Management Plans prepared by professionals; manure testing may be required in plans at the discretion of the professional.

3.4.2 Soil

Several jurisdictions surveyed require soil testing every 3-5 years of fields that are regularly manured (Alberta, Ontario, Quebec and California). Pennsylvania requires that all fields receiving manure or chemical fertilizer on farms that are required to operate under a Nutrient Management Plan be tested every 3 years.

Soil samples are required to be tested for the parameters on which application rate of manure is based; Alberta requires testing for soil nitrate and conductivity, in Quebec, phosphorus and % saturation of phosphorus binding sites.

The EU countries require no soil testing because the nitrogen application rate is set in legislation and does not consider the soil nitrogen content. It is assumed that by limiting the nitrogen application rate soils will not be oversupplied. In Holland, phosphorus application rates are legislated as well.

Washington State does not require soil testing but it may be included as a requirement in a Nutrient Management Plan at the discretion of the planner.

Texas is the sole jurisdiction that requires annual soil testing of all fields that will be receiving manure in the upcoming year, with test results used to determine the manure application rate.

3.4.3 Other testing – water and crop

Water: As part of its new nutrient management regulations for dairy farms (2007), California has instituted an extensive program of water sampling for dairy farms in the regulated area of the state, the Central Valley region. In order to assess the amount of off-site movement of nitrogen through leaching and runoff, and to determine if nutrient management measures are improving water quality, farmers are required to test all wells on site as well as tile drainage water annually for nitrate and conductivity. If groundwater at any of the testing sites exceeds 10 mg/L nitrate-N (43 mg/L nitrate), groundwater monitoring wells are required to be installed up and down gradient. Due to the large number of dairy farms in the regulated area, this program is being phased in over the next several years.

In addition, irrigation water must be tested annually for total nitrogen and conductivity. Storm water discharge from the farm yard and 30% of land application areas must be tested annually during the storm season for nutrients and conductivity.

Crop: California has also introduced crop analysis requirements as part of its new regulations. All crops must be tested at harvest for moisture content and the major nutrients nitrogen, phosphorus and potassium. Yield must be measured as well and from this information, crop uptake of nitrogen is calculated. The results of crop testing are used to determine crop requirements and manure application rates; application rates cannot exceed 1.4 times crop removal of nitrogen unless tissue testing demonstrates a greater need. This standard will be tightened if the nitrogen uptake studies that are currently in progress demonstrate that less nitrogen is required to meet crop needs.

3.5 Record keeping and reporting requirements (Table 1f)

All jurisdictions except Ontario and Manitoba require yearly recordkeeping by regulated farms. Recordkeeping requirements are very similar across jurisdictions and include (with minor variations depending on jurisdiction):

- Livestock numbers, manure production, manure storage capacity, results of manure testing.
- Land base used for manure application, manure and fertilizer application on each parcel of land, nutrient application rate per parcel, results of soil testing (if done).
- Crops grown with land area and yields for each field.
- Volume of manure exported from farm, receiving locations, signed agreements from third parties accepting manure.

Records are required to be kept for 5 years in most jurisdictions (3 years in Pennsylvania).

In addition to written records, California requires a monthly photo record of the fill height of all manure storages. Regulated farms in California and Texas must keep records of the weather in the 24 hour period before and after each manure application including records of any storm events that happened within the time period.

Some European jurisdictions (Ireland, Holland, Denmark) require farmers to keep records of feed concentrates and other feedstuffs brought onto the farm with the information used to determine the inputs of nitrogen and phosphorus to the farm.

Annual reports which are submitted to regulatory authorities are required in Washington State, Texas, California, Denmark and Ireland. The reports must contain the manure production and application information kept by farmers as well as the most current version of the Nutrient Management Plan and in some cases a fertilizing plan for the next year with proposed applications indicated. California requires an annual salt report, which identifies sources of salts at each farm and the measures in place to reduce salt use on the farm. Quebec requires an annual phosphorus report detailing how much phosphorus was produced in the manure, and where it was applied on the farm and at what rate.

3.6 Effectiveness of nutrient management regulations

3.6.1 Measuring the effectiveness of agricultural waste regulations – the Netherlands, Denmark and California

All of the regulations reviewed for this jurisdictional scan are new, with most having been fully phased in within the past 5 years. A few have not yet been completely phased in; in these jurisdictions, nutrient limiting strategies are still in the future for farmers. The new regulations typically replace earlier, less restrictive regulations or voluntary guidelines and are designed to improve either water or soil quality by limiting application rates of manure and fertilizer to crop requirements. With the exception of Holland and Denmark, no analysis was found of the effectiveness of any of the regulations reviewed for this report, possibly because they have been in place for such a short time.

Of all the jurisdictions surveyed, only Holland and Denmark have had comprehensive nutrient management programs in place for long enough to assess how effective the programs have been in improving water quality. These jurisdictions, partly as a result of water quality issues, and partly because of the EU's Nitrate Directive of 1991, have been gradually increasing the restrictions on manure and fertilizer application over the past 20 years. Both countries have extensive monitoring data for surface and ground water which have helped them to assess the effectiveness of their programs. The data show that the programs have been effective at improving both surface and ground water quality but that the improvements have not yet been sufficient to meet water quality objectives. The newest regulations, which are discussed in this report, were put in place to continue the process of improving water quality.

California conducted extensive water quality monitoring to assess the effectiveness of their old regulations, and based on the results, developed new, more stringent regulations. There were no similar analyses found for any other of the jurisdictions surveyed, although there may be some available that were not found in the general web search.

The Netherlands

In the Netherlands, programs have been in place since 1985 to reduce the country's manure surplus. Several different strategies for reducing the surplus were implemented between 1985 and 2004 when the current program was put in place (see Section 2.13 for more information).

The result of the various programs has been a general improvement in water quality throughout the country, with the most significant improvements occurring following the implementation of the MINAS

levy-free surplus system. During the period 1995 to 2002, the average nitrate level of shallow groundwater from monitoring stations around the country decreased from 134 to 76 mg/L. The nitrate level of surface water also declined. However, the average nitrate level of shallow groundwater was still well above the EU standard of 50 mg/L.

The level of phosphorus in surface water did not decline during this period despite a substantial reduction in the amount of phosphorus applied to agricultural land. The reason given for this is that agricultural soils throughout the country have high levels of phosphorus due to many years of over application of manure and fertilizer. Phosphorus loss occurs primarily through soil loss so occurs much more slowly than does loss of nitrate through leaching. It is expected that surface water phosphorus levels will remain high for a significant period of time.

Despite these measures, the country still had a significant manure nutrient surplus in 2004. Further more stringent measures were instituted in 2004 to try to eliminate the surplus and to further improve water quality.

Denmark

Denmark has had nutrient management programs in place since 1987 to address concerns about surface and groundwater degradation due to nutrient loading. In 1991 the first significant set of measures was introduced (see Section 2.14 for more information).

Following the implementation of these measures, there were significant improvements in nutrient application rates and water quality. Between 1989 and 2004, the amount of nitrogen fertilizer used annually in Denmark declined from 400,000 to 200,000 tonnes. The amount of phosphorus fertilizer used per year on farm declined 65% from 40,000 to 18,000 tonnes. The average level of nitrate-N in shallow groundwater below sandy soils declined from 18 to 10 mg/L (equivalent to a decline from 80 to 44 mg/L nitrate), and there was a 29% reduction in nitrogen concentration in monitored streams. As was observed in the Netherlands, there was only a slight reduction in the level of phosphorus in surface water (13%) due to the high phosphorus content of soils from many years of phosphorus surplus, and the relatively slow rate of loss through erosion.

Despite the measures implemented prior to 2004, the country did not meet its nutrient reduction targets. A suite of more stringent measures was instituted in 2004 to try to halve the phosphorus surplus and reduce nitrogen loss from agriculture by a further 15%.

California

California has new manure and nutrient management regulations as of 2007. These were developed in response to groundwater pollution that occurred while dairy farms and other confined animal facilities were regulated under California's earlier agricultural waste regulations, CCR Title 27.

In response to increasing concerns about pollution of shallow groundwater below dairy farms in the state, several reports were produced in 2003-2004 that assessed the effectiveness of the manure management regulation in force at that time ([Task 2 Report 2003](#)). Prior to 2007, the regulation in force

for management of agricultural waste was the California Code of Regulations (CCR) Title 27 which was intended to protect groundwater quality from discharges from confined animal facilities. The regulation provided minimum standards for the prevention of impacts to groundwater. The following were the basic regulatory standards:

- Manured areas must be managed to minimize the infiltration of water into underlying areas.
- Manure storages must be lined with materials with a minimum of 10% clay and less than 10% gravel.

Groundwater data from monitoring wells at ten dairy farms were reviewed as part of the assessment of CCR Title 27. At nine of ten dairy farms, groundwater nitrate concentration was substantially higher below one or more of crop land, corrals or the manure storage pond than at an up gradient site. Many samples exceeded the California groundwater standard of 44 mg/L nitrate substantially. Total suspended solids were also elevated in groundwater at most of the farms.

The report concluded that the Title 27 requirements were insufficient to protect groundwater under confined livestock facilities. One of the primary concerns was that the legislation did not consider variability in subsurface material that could influence the rate of movement of constituents to groundwater. Another concern was that the guidance on managing manured areas was not sufficiently prescriptive. California implemented new, more stringent regulations in 2007 to address these concerns. One of the requirements in their new legislation is that each dairy farm that has elevated nitrates on site must install monitoring wells at an up gradient site and under crop land, corrals and down gradient from manure storages. Water quality data must be submitted in the Annual Report. There are also new standards for manure storages that require them to be constructed with an impermeable base.

The new regulations were enacted in 2007, and are in the process of being phased in.

3.6.2 Compliance strategies

The following are some of the different compliance strategies noted in the regulations reviewed.

Identification and regulation of farms with highest impact on environment

Most jurisdictions surveyed apply their nutrient management regulations selectively. Several apply regulations only to very large operations (Ontario, Quebec) or those with high animal numbers and density (Pennsylvania, Denmark). Some jurisdictions regulate by commodity group, identifying the type of animal or operation that is most impacting the environment (Texas, California). This strategy should result in substantial improvements to the environment while minimizing administration costs.

Implementation of mandatory soil or water testing

Several jurisdictions require mandatory annual or periodic soil or water testing with the results required to be submitted to regulatory authorities as part of the Annual Report (Texas and California are the best examples of this). For jurisdictions that are regulating based on phosphorus, soil sampling provides an effective way for regulators to note whether application is excessive, and whether the Nutrient

Management Plan that the farm is operating under contains sufficiently stringent limits. Farmers can also immediately see whether they comply with standards found in legislation, and relate that back to their nutrient application program. For jurisdictions that are regulating based on nitrogen, water quality test results will quickly show whether nutrient application continues to be excessive; monitoring data from the EU has shown that nitrate levels in shallow groundwater decline within a few years of limiting nitrogen application to crop uptake only.

Requirement for Annual Report

Several jurisdictions require regulated farms to submit an Annual Report that contains records of various aspects of waste management including livestock on site, manure volumes produced and applied, crop yields, exports and imports of manure. This requirement should encourage farmers to maintain the required records and to apply manure at the prescribed rates.

Legislation of maximum allowable application rate of nutrients

The EU jurisdictions require farms to limit the application of nitrogen from manure to 170 kilograms per hectare per year (or slightly higher on a case-by-case basis). Manure nitrogen content determination is based on standard book values which are written into legislation. Combined with compulsory records on livestock numbers and available land base, it is possible to determine whether the operation has sufficient land base to meet the requirement.

Penalties and fines

Most jurisdictions have written into legislation varying levels of enforcement ranging from warnings to large fines. In the jurisdictions surveyed, this is the standard method of enforcing compliance.

4 Manure Application Requirements (Table 2)

Manure application restrictions are put in place to protect surface and ground water quality by keeping manure away from water sources, and requiring application of manure when it can be incorporated into the soil and the nutrients can be used by the crop on site. Increasingly manure application restrictions are also being instituted to reduce odour issues with neighbours. Application restrictions are legislated in all of the jurisdictions but one; Washington State has few restrictions in legislation but relies on professional judgment and federally-approved BMP's to provide equivalent protection of water quality.

The requirement to comply with application restrictions varies with jurisdiction. Some require all farms to comply while others apply the restrictions to large farms only, or increase the stringency of the restrictions as farm size increases. Application restrictions typically fall into several categories: periods where manure application is prohibited or restricted, application requirements, and setbacks from surface water, wells, other water features and from property boundaries.

4.1 Prohibited application period (Table 2)

Some jurisdictions (the European countries and Manitoba) have a legislated time period when manure application is not allowed. The typical prohibited period is October 1 of one year to January 31 of the

following year, requiring producers to have a minimum of 4 months storage capacity to accommodate manure produced during that time. The no-application period is generally related to the severity of winter conditions; California and Texas do not have winter application prohibitions. Pennsylvania allows winter application provided that, on bare land, manure is incorporated or injected. Manitoba prohibits manure application from November 10 of one year until April 10 of the following year (large operations only).

The U.K. and Holland prohibit the application of manures with a high proportion of available nitrogen (liquid manure and solid poultry manure) during winter months but allow application of other types of solid manure at any time. Other jurisdictions do not differentiate between manure types. The U.K. and Holland also have a longer prohibited period for sandy, loess and shallow soils.

4.2 Application requirements (Table 2)

The regulations scanned contain several different manure application limitations that are based on the site conditions during application. These site conditions are as follows:

- Most jurisdictions prohibit manure application on frozen or snow-covered ground.
- Several jurisdictions prohibit application when the ground is saturated or on land prone to flooding.
- Ireland prohibits application if heavy rain is predicted within 48 hours.
- The U.K. and Denmark require manure to be incorporated within 12-24 hours of application on bare land.

4.3 Application buffers and setbacks (Table 2)

All of the jurisdictions surveyed except Washington State have legislated manure application setbacks from water. These vary according to several factors including:

- Season of manure application (setbacks are typically larger for winter vs. summer applications),
- Slope of land and whether land slopes towards surface water (buffers increase as the slope of land increases until a maximum slope is reached beyond which no manure application is allowed),
- Presence or absence of a vegetated buffer (typically, the required setback is much narrower if there is a permanent, vegetated, unfertilized buffer between the application site and surface water),
- The type of well on the application site (setbacks from municipal wells are typically 100 to 200 m while setbacks from personal wells are 30-50 m).

Denmark has a unique approach to setbacks from surface water. It has put in place a program to establish 50,000 hectares of permanent vegetated buffers beside surface water throughout the country by 2015. These 10-metre wide buffers will be taken permanently out of agricultural production and the producers will be compensated for the loss of production.

5 Manure Handling and Storage Requirements

This section covers regulation of manure storage facilities, field storage of manure and management of confined outdoor feeding areas. Confined (or concentrated) outdoor feeding areas are included in this section because they are considered by most jurisdictions to be manure storage areas. Some or all of the storage requirements also typically apply to confined feeding areas.

5.1 Manure storage (Table 3)

5.1.1 General requirements (Table 3)

Manure storage capacity, siting and construction standards are found in the legislation of all but two of the jurisdictions surveyed, Pennsylvania and Washington. Both of these regulate manure management through federally-approved Best Management Practices interpreted by qualified professionals but have not put manure storage requirements into state legislation. The remaining 10 jurisdictions have regulatory standards for manure storage capacity, siting of storages and some have construction standards in legislation. In general, the standards apply to new and expanding large facilities; farms that existed prior to enactment of the legislation are grandfathered in. Existing farms in some jurisdictions have been given a time period to comply with storage requirements.

5.1.2 Required storage capacity (Table 3)

The required storage capacity varies widely between jurisdictions, from 6 weeks to 13 months, and depends on size of operation, livestock species, type of storage facility and area of the country where the farm is located. Existing large operations and new operations are most frequently required to comply with minimum storage requirements. In Ireland, pig and poultry facilities are required to have 6.5 months of storage capacity while other types of operations require less. As well, the storage capacity requirement depends on the area of the country where the farm is situated, reflecting climatic differences. In Manitoba, farmers with earthen structures are required to have larger storage capacity than those with other types of storages.

The typical required storage capacity is 6 – 9 months (all Canadian and European jurisdictions). Storages are typically required to be sized to contain all the runoff from the farmyards during the storage period plus the average rainfall accumulation during the period (for uncovered storages) as well as the manure produced on site.

Texas and California require manure storage facilities to be sized based on runoff during storm events; Texas requires storages to be sized to hold runoff from the farmyard during a 100-year, 24-hour storm event.

Some jurisdictions permit smaller capacity storages on a case-by-case basis for farms that demonstrate that they have sufficient land available to apply manure over the winter months with low environmental risk.

5.1.3 Siting standards (Table 3)

Seven jurisdictions have legislated siting standards for storages. These include setbacks from surface water, wells, tile drains and property boundaries. Standards vary widely but a typical setback from

water and property boundaries is 100 m. There are also restrictions on siting storages in flood zones, and required minimum depth to groundwater.

5.1.4 Constructions standards (Table 3)

There are a wide variety of construction standards for manure storages (see [Table 3](#) with links to appropriate legislation). Many jurisdictions require a permit for new or expanding manure storages which allows regulatory authorities to ensure that minimum construction standards are met. Many require new and expanding facilities to be engineer-designed. Some jurisdictions have embedded construction standards in legislation, mainly pertaining to materials permitted to be used to construct impermeable layers. Some have a legislated requirement that storages are inspected periodically by an engineer.

In their new regulations, Alberta has expanded the definition of manure storage to include confined outdoor feeding areas (including feedlots). These are now required to be constructed to the same standards as are required for manure storage facilities. A protective layer 2 meters in depth or a 50 cm impermeable liner is now required below new confined outdoor feeding areas to prevent leaching of manure constituents into groundwater.

5.2 Field storage requirements (Table 4)

Only 6 of the jurisdictions surveyed have regulations that specifically cover field storage of manure - Alberta, Manitoba, Ontario, Quebec, Ireland and the UK. U.S. regulations do not generally differentiate between field storage and stockpiling in the farm yard. Limited material was available in English on regulations in Denmark or Holland.

Field storage legislation from the four Canadian jurisdictions contains setbacks from surface water and wells, and maximum storage periods. The required setback from surface water and wells is typically 100 metres with some variation. Maximum storage time varied from 7 months in Alberta to 1 year in Ontario and 2 years in Quebec. Alberta, Manitoba and Ontario have legislated setbacks from neighbouring residences of 100 to 150 metres.

Additional field storage requirements are:

- Minimum depth of soil above bedrock (30 cm),
- Minimum distance above the groundwater table (0.9-1 m),
- Maximum slope of site where manure is field-stored (3-5%),
- Requirement for berms if runoff from piles is likely to occur.

There are minimal standards for field storage in the regulations from the 4 U.S. jurisdictions. The following 4 bullets outline how field storage is handled in the U.S. jurisdictions.

- Pennsylvania allows field storage of manure under emergency circumstances such as during long periods of inclement weather and as a temporary measure while farms are moving towards compliance with the new regulations. Manure cannot be field stored for longer than 60 days,

and state-approved best management practices must be used to select appropriate stockpiling sites and methods.

- In Texas legislation there is no specific reference to field storage. However, stockpiling of solid manure in the farm yard area is permitted. The regulations require that any runoff from stockpiled manure must be collected in the manure storage facility or the stockpile must be bermed to prevent runoff. Outdoor uncovered storage of poultry manure is limited to 30 days unless runoff is diverted to the manure storage.
- There is no specific reference to field storage in California. However, it is presumed that field storage is prohibited in practice by the new regulations because of the stated requirement that all runoff and leachate from manure storage areas must be collected and diverted to the manure storage facility. This would not be possible on a field storage site.
- The Washington State regulations contain no guidance on field storage. However, as with other aspects of nutrient and manure management, the state requires qualified persons to develop the required plans, and to reference standard BMP's and technical guidance. Field storage would therefore be at the discretion of the planner.

5.3 Management of confined (or concentrated) outdoor feeding areas (Table 5)

Confined outdoor feeding areas are considered manure storage areas by many jurisdictions and are required to meet some or all of the requirements for manure storages. There are a number of different strategies used by the surveyed jurisdictions for regulating confined outdoor feeding areas. These are summarized as follows:

- Some jurisdictions stipulate that all runoff from outdoor feeding areas must be collected and applied as a nutrient source (Ireland, Texas and California).
- Alberta applies the same regulations to outdoor confined feeding areas as to manure storage facilities and has made them subject to the same siting and construction standards as storages.
- Manitoba has a comprehensive list of regulatory requirements for outdoor feeding areas including setbacks from surface water, wells and property boundaries. A permit is required for large operations building a new outdoor feeding area. Manure must be removed from the feeding area annually.
- Pennsylvania requires that state-approved BMP's be included in each farm's Nutrient Management Plan to limit impacts from runoff from outdoor feeding areas.

6 Regulation of On-farm Disposal of Mortalities (Table 6)

In general, on-farm disposal of mortalities is acceptable in North America, and with a few exceptions, burial, composting and incineration are all considered acceptable options. In the European jurisdictions surveyed, on-farm disposal of mortalities is prohibited. No discussion was found as to why this prohibition exists. In these jurisdictions, on a case-by-case basis when there are no other alternatives, on-farm disposal is permitted under an approval. Mortalities are normally hauled away for rendering.

6.1 On-farm burial (Table 6)

Burial is permitted in 6 of the 12 jurisdictions surveyed (Pennsylvania, Washington State and the 4 Canadian jurisdictions). All jurisdictions have restrictions on the siting of burial pits, and some have volume restrictions. The typical required setback from surface water and wells ranges from 75 to 100 metres. Where restricted, maximum pit volume is limited to 500-2500 kilograms of mortalities per pit. All jurisdictions require a minimum layer of soil of 0.6 to 1 metre in depth on top of mortalities. Most jurisdictions restrict burial pits in flood plains and require them to be sited a minimum distance above bedrock and groundwater. Manitoba prohibits burial pits on farms with more than 300 animal units on site.

The European jurisdictions as well as California and Texas prohibit burial of mortalities. In very remote areas of Ireland and the U.K. it is permitted under approval; for these jurisdictions, no siting requirements were found.

6.2 On- farm composting of mortalities (Table 6)

In the North American jurisdictions, on-farm composting of mortalities is generally allowed without a permit provided that the facility does not cause pollution. It is prohibited in California and the European jurisdictions, and although it is allowed in Quebec, it is not common because of the unusual requirement for a rendering permit by those who would compost mortalities.

There are different operational requirements in each jurisdiction. Some of the requirements are as follows:

- Siting requirements: several jurisdictions require setbacks from surface water and property boundaries (typically 100 metres).
- Size restrictions: Ontario limits each composting site to 600 square meters, and 600 cubic meters of composting material.
- Operating requirements: Quebec requires mortality composting to be done in a roofed, impermeable-floored facility with primary and secondary bins, and requires that records are kept of mortalities composted. Alberta allows a maximum of 25% by volume of animal parts in each pile, and carcasses must be covered with a minimum of 15 cm of bulking agent.
- Species restrictions: Quebec allows composting of poultry and hog mortalities only. Washington State allows composting of beef and horse mortalities only.

6.3 On-farm incineration of mortalities (Table 6)

On-site incineration of mortalities is allowed in all North American jurisdictions surveyed except California. It is allowed under permit in the U.K. but is not common, and no mention was found of its use in Ireland, Holland or Denmark. On-farm incineration of mortalities is covered under agricultural waste legislation in some jurisdictions and under separate incineration legislation in other jurisdictions.

Alberta and Washington State require the operator to obtain a permit for on-farm incineration. Ontario, Manitoba, Quebec, Pennsylvania and Texas do not require a permit but require operators to comply with State or Provincial guidelines for incinerator operation. In these jurisdictions (with the exception

of Quebec), rules and guidelines for the operation of incinerators such as required operating temperatures, emissions testing etc. are found in separate incineration regulations. Quebec manure management legislation contains on-farm incineration standards. In Quebec, on-farm incineration without a permit is allowed provided that the incinerator is for 'inedible meat' only and burns less than 1 tonne per hour. No effort was made to locate and review incineration legislation beyond determining on-farm requirements.

7 Regulation of On-farm Composting of Manure and Other Agricultural Wastes (not mortalities) (Table 7)

Most jurisdictions surveyed allow on-farm composting of manure with no permit required and no siting or operational requirements. No regulations were found for California, Holland or Denmark. There are some variations in requirements from different jurisdictions as follows:

- Manitoba stipulates that on-farm manure composting facilities and the composting process used must be acceptable to regulatory authorities. This requirement applies only to farms with more than 300 animal units.
- Quebec restricts on-farm composting of 'farm products' to 500 cubic meters at one time. Higher volumes require a permit.
- Some jurisdictions allow off-farm agricultural wastes to be brought on- farm for composting without a permit provided that the resulting compost is used on-farm (Quebec and Washington State).
- Pennsylvania allows off-farm organic wastes to be brought on-farm for composting under permit; the state has a policy of promoting the composting of organic wastes.
- Ireland and U.K. allow on-farm composting of manure with no permit but do not allow any other organic wastes to be brought on-farm for composting because of strict EU regulations concerning the composting of organic wastes. Composting of any other wastes other than manure must be done in an approved facility.
- Washington State allows composted manure and other agricultural materials to be distributed off-farm provided that the volume of composting materials on site never exceeds 1,000 cubic yards, and the farm has an approved Nutrient Management Plan.

8 Odour Regulation (Table 8)

Of the jurisdictions surveyed, three have odour control regulations.

Texas is phasing in a requirement for all new and expanding livestock and poultry operations that are within a half mile of neighbours to apply for an air quality permit and submit an Odour Management Plan which outlines how odours, dust and other nuisances related to agriculture will be reduced. The state has developed odour assessment tools that assess the potential of a farm to cause nuisance odours. Factors that must be considered for poultry broiler operations include;

- Number of birds per cycle and length of cycle,

- Number of neighbours including schools, places of worship, healthcare facilities,
- Distance to property line,
- Number of incinerators on site,
- Vegetation between farm and neighbours,
- Topography of site.

If the operation appears likely to cause an on-going odour problem for neighbours, it must submit an odour control plan that is acceptable to regulatory authorities.

Pennsylvania has just phased in (2009) a requirement for new and expanding large operations to complete an assessment of the potential for nuisance odours from the operation and to submit an odour management plan for approval that outlines the odour BMP's that will be implemented on site to control odours. If the odour potential of the facility is deemed minor, Level 1 BMP's must be implemented. These are management-oriented measures. If the odour potential is extreme, Level 2 BMP's must be implemented. These are specialized, technology-based odour control measures such as covers on manure storages. The State has developed an odour site index to assist farmers in completing odour assessments.

Alberta has also recently implemented odour control legislation as part of its *Agricultural Operation Practices Act*. For new or expanding CFO's (see section 2.1 for the definition of a CFO) and manure storages at CFO's, an assessment must be made of the odour potential. The assessment is based on the species, manure volume and manure handling system as well as the type of land use neighbouring the operation (agricultural, country residential, commercial or village), and other factors. The result of the assessment is used to determine the required setback of the facility from neighbours with the minimum distance being 150 m. As well, near neighbours are required to be notified of new facilities and are given the opportunity to comment.

No regulatory requirements were found for any of the other jurisdictions surveyed. Mention was made of odour control in Denmark but no details were found.

9 Regulation of Emissions and Dust

Of the twelve jurisdictions surveyed, three were found to have some regulations concerning emissions and/or dust. There were no regulations found for nine of the jurisdictions, but in Texas there was reference to voluntary BMP's for dust control and in the U.K., reference to voluntary BMP's to reduce ammonia and greenhouse gas emissions from agriculture.

9.1 Reduction of volatile organic compounds from dairy farms

California is implementing regulations for control of volatile organic compounds (VOCs) from large dairy farms primarily in the San Joachin valley area where air quality is poor due to urban smog combining with VOC's. Studies are currently underway to assess which of the many proposed BMP's will be effective at reducing emission of VOC's from dairies. Large dairies (>1000-2000 cows, depending on area of the state) are required to be permitted for VOC emissions.

9.2 Reduction of ammonia emissions

Holland requires manure to be applied using low ammonia emission methods only. This includes injection or surface application only using a specialized applicator that can apply manure below the grass sward directly onto the soil surface for grassland applications, and incorporation of manure on arable land with the requirement that manure is no longer visible on the soil surface after incorporation. These measures are in response to an EU directive on reducing ammonia emissions. None of the other EU jurisdictions surveyed appear to have regulated these low emission manure application measures. The U.K. *Code of Good Agricultural Practice* contains BMP's for reducing ammonia emissions but these appear to be voluntary.

9.3 Dust control

Texas requires all confined animal facilities to operate under an Odour Control Plan which covers odours and dust. This plan outlines how the facility will operate to reduce dust from all aspects of the operation. It must cover all parts of the operation including feed mills and roadways into the facility.

10 Regulation of Emerging Technologies

Anaerobic digestion is the main emerging technology that is mentioned in the materials reviewed. A number of jurisdictions have or are developing standards for the operation of anaerobic digesters (Washington State, Ontario, California). Ontario and the U.K. have developed regulations for the land application of anaerobic digestate that considers it a nutrient source.

Ireland currently has a funding program in place for the on-farm demonstration of alternative waste disposal facilities that generate renewable energy but no discussion was found of projects funded to date ([Farm Waste Management Scheme web page](#)). Eligible systems include anaerobic and aerobic digestion, fluidized bed combustion as well as innovative systems that could have the potential to produce renewable energy.

Denmark has built several manure-based bio-gas plants, both on a regional and farm scale. No further information was found about how economically viable the plants are, whether they are operating commercially or experimentally, or how much manure is processed in them.

Holland exports approximately 20% of the nitrogen generated in manure in the country to other EU countries where there is a manure deficit, most of this as pelletized poultry manure. No specific reports were found on processes used.

11 Summary

This report contains a review of the agricultural waste management regulations in twelve jurisdictions in Canada, the U.S. and Europe. Various aspects of agricultural waste management were reviewed including nutrient management, manure storage and application requirements, on-farm disposal of mortalities and composting, control of odours and emissions from agricultural operations and regulation

of emerging technologies. The report was prepared to provide background information for the B.C. Ministry of Environment's review of the B.C. Agricultural Waste Control Regulation.

Most of the regulations reviewed have been brought into force within the past decade and many are not yet fully implemented. This suggests that issues relating to environmental degradation from agricultural waste are becoming critical throughout Europe, the U.S. and Canada at approximately the same time. European jurisdictions have been regulating agricultural waste and nutrient management since 1985-1990 when they acknowledged that manure surpluses in many areas were impacting water quality. The European jurisdictions surveyed have introduced more restrictive regulations recently because earlier legislation had not resulted in the desired improvements in water quality. The North American jurisdictions surveyed are now in the process of developing and implementing regulations that will improve manure storage and handling on-farm and nutrient management. In some jurisdictions (Texas, California) the new regulations are in response to water quality degradation due to agriculture. In other jurisdictions (Pennsylvania, Washington State and the Canadian jurisdictions) regulatory agencies are acting proactively to avoid water quality problems experienced elsewhere.

The strategies adopted by jurisdictions for nutrient management vary widely although the issues being addressed are very similar and the goal is the same - to maintain or improve environmental quality, with emphasis on surface and ground water quality. All of the jurisdictions surveyed regulate the application of nutrients to agricultural land although the strategies used to do this are different in each jurisdiction. Nutrient application regulations limit manure application based on nitrogen, phosphorus or both and in some instances, additional parameters, and application limits are based on maximum soil, crop or water nutrient levels, through the use of standards written into legislation or through the use of certified experts and best management practices. Manure application setbacks from water and neighbours have been written into legislation of all jurisdictions surveyed except Washington State.

All jurisdictions have introduced new regulations for manure storage, acknowledging that leaching and runoff from storage areas can cause pollution of surface and ground water. Strategies also vary widely, with some jurisdictions writing extensive siting and construction standards into legislation (Manitoba and Ontario) and others relying on professional judgment and approved best management practices (Pennsylvania, Quebec and Washington State). Most jurisdictions now have minimum storage capacity requirements based on conditions in their area. Most also have standards for field storage of manure and confined outdoor feeding areas to reduce the potential for leachate and runoff from these sites.

On-farm disposal of mortalities is changing as well. While burial continues to be the standard disposal option in many jurisdictions including Canada, on-farm composting is becoming more common due to concerns about groundwater impacts from burial sites. Some jurisdictions (Texas, California, the UK and Ireland) have banned on-farm burial. In those jurisdictions where it is still permitted, siting restrictions, volume limits and other requirements have been implemented.

In response to the increasing incidence of complaints about odours from large agricultural operations, several jurisdictions have implemented new regulations requiring farms to address odours (Alberta, Texas and Pennsylvania). The strategies for regulating odours vary. Texas now requires new and

expanding agricultural operations to demonstrate that they have measures in place to control odours. Pennsylvania requires producers to implement odour best management practices. Alberta producers are required to use odour assessments to determine the required setback of a new barn or manure storage from neighbours.

In terms of other impacts from agriculture, requirements for control of dust, volatile organic compounds and ammonia emissions were found in the regulations surveyed. Texas requires all poultry farms to have an approved plan to deal with dust produced by all aspects of the operation. California is in the process of regulating the emission of volatile organic compounds from dairy farms in the San Joachin valley and is assessing which management factors are most effective at reducing these compounds. Holland has legislated low ammonia emission manure storage and application methods in response to EU legislation requiring a reduction in ammonia emissions from agriculture.

There is increasing interest in technologies that can generate energy from agricultural wastes. Several jurisdictions (Ontario, California and Washington State) have implemented regulations for the operation of on-farm anaerobic digesters, and Ontario and the U.K. have introduced regulations requiring the digestate to be land-applied as a nutrient source. No other regulations for emerging technologies were found in the review. In the European jurisdictions there are several alternative energy programs underway as noted in Section 10.

12 List of References and Web Pages

12.1 Nutrient and manure management regulations by jurisdiction

(internet sites verified on February 15, 2010 or March 18, 2010)

Alberta

Alberta Agricultural Operations Practices Act Legislation. Alberta Agriculture website
[www.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/epw12498](http://www.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw12498)

Agricultural Operation Practices Act Reference Guide. 2009. Alberta Agriculture website
[www1.agric.gov.ab.ca/\\$Department/deptdocs.nsf/all/epw5592#AOPA](http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/epw5592#AOPA)

Agricultural Operation Practices Act (AOPA) Manure Characteristics and Land Base Code. Alberta Agriculture website [www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/ipc11026/\\$file/096-8.pdf](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/ipc11026/$file/096-8.pdf)

California

Waste Discharge Requirements General Order for Existing Milk Cow Dairies. California Regional Water Quality Control Board Central Valley Region web page. Order No. R5-2007-0035 (nutrient management regulations for dairies in Central Valley Region).
www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2007-0035.

Confined Animal Facilities web page. California Regional Water Quality Control Board Central Valley Region web page (guidance for dairy producers on meeting the waste management requirements in the General Oder). http://www.swrcb.ca.gov/rwqcb5/water_issues/dairies/index.shtml

Task 2 Report – Evaluate Title 27 Effectiveness to Protect Groundwater Quality (October 2003). California Regional Water Quality Control Board Central Valley Region Historical Dairy Program Information web page.
http://www.swrcb.ca.gov/rwqcb5/water_issues/dairies/historical_dairy_program_info/index.shtml

San Joachin Valley Air Pollution Control District Air Pollution Control Officer’s Revision of the Dairy VOC Emissions Factor January 2010. (permit requirements and guidance for dairies required to comply with VOC emissions regulations)
[www.valleyair.org/busind/pto/dpag/2010_VOC_Jan/Draft%20Dairy%20EF%20Report%20\(1-14-10\).pdf](http://www.valleyair.org/busind/pto/dpag/2010_VOC_Jan/Draft%20Dairy%20EF%20Report%20(1-14-10).pdf)

China

OECD. 2006. China in the Global Economy. Environment, Water Resources and Agricultural Policies: Lessons from China and OECD Countries. OECD Publishing.

http://books.google.ca/books?id=eWT_VCEEmMoC&pg=PA133&lpg=PA133&dq=%22manure+applicatio n%22+china+regulations&source=bl&ots=p1HXxGCpgo&sig=q1czMpYhTXyHpi9hOXqBdYzq1hM&hl=en&ei=l1t0S4nCKYyiswPzjIn7BQ&sa=X&oi=book_result&ct=result&resnum=8&ved=0CCUQ6AEwBw#v=onepage&q=&f=false

Denmark

Agreement on the Action Plan for the Aquatic Environment III 2005-2015 2 April 2004. Danish Ministry of the Environment website (most recent Danish nutrient management requirements)

www.vmp3.dk/Files/Filer/English%20version/engelsk_oversaettelse.pdf

Kronvang, Brian. Date unknown. Aarhus University National Environmental Research Institute. Reducing nutrient loading of the aquatic environment from agriculture: Management technologies and environmental information system. Power point presentation (additional information on nutrient management in Denmark) www.cemagref.fr/water-and-society/Documents/presentations/Session3/Kronvang.pdf

Petersen, Poul T. Date unknown. The Plant Directorate, District Arhus, Department of Environment. Control and regulation of the use of nitrogen in Danish agriculture. (power point presentation with additional information on nutrient management in Denmark)
[www.zm.gov.lv/doc_upl/pdir_english_presentation_\(long\)\(2\).ppt](http://www.zm.gov.lv/doc_upl/pdir_english_presentation_(long)(2).ppt)

European Union

Nitrates Directive 1991 – Act and summary of Act (EU web site)

http://europa.eu/legislation_summaries/environment/water_protection_management/l28013_en.htm

Ireland

S.I. No. 101 of 2009 European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2006. Ireland Department of Agriculture, Fisheries and Food website (Irish nutrient management regulations)

www.agriculture.gov.ie/media/migration/ruralenvironment/environment/nitrates/SI%20101-2009.pdf

Nitrates Information webpage, Ireland Department of Agriculture, Fisheries and Food (web page containing links to all nutrient management requirements for Irish farmers)

www.agriculture.gov.ie/ruralenvironment/environmentalobligations/nitrates/

‘Explanatory Handbook for Good Agricultural Practice Regulations’. Ireland Department of Agriculture, Fisheries and Food.

www.agriculture.gov.ie/media/migration/ruralenvironment/environment/nitrates/revisedhandbook2008.pdf

Farm Waste Management Scheme, Ireland Department of Agriculture, Fisheries and Food (web page with link to details of grant program for demonstration of on-farm waste processing facilities).

<http://www.agriculture.gov.ie/farmingsectors/dairy/farmwastemanagementscheme/>

Manitoba

Livestock Manure and Mortalities Management Regulation.

<http://web2.gov.mb.ca/laws/regs/pdf/e125-042.98.pdf>

Nutrient Management Regulation (Water Protection Act)

www.gov.mb.ca/conservation/envprograms/livestock/pdf/w065-062.08.pdf

Farm Practices Guidelines for Pig Producers in Manitoba (Ministry of Agriculture, Food and Rural Initiatives website). www.gov.mb.ca/agriculture/livestock/pork/bai02s00.html

Regulation of Manure Management in Manitoba (Ministry of Agriculture, Food and Rural Initiatives website) (summary of regulations) www.gov.mb.ca/agriculture/soilwater/soilmgmt/fsm01s04.html#reg

Poultry Manure Management Regulations (Ministry of Agriculture, Food and Rural Initiatives website) www.gov.mb.ca/agriculture/livestock/poultry/bba01s39.html?print

Netherlands (Holland)

Third Dutch Action Programme (2004-2009) Concerning the Nitrates Directive – web page, agriculture, nature and food quality ministry (nutrient management requirements for Holland)
www.minlnv.nl/portal/page?_pageid=116,1640360&_dad=portal&_schema=PORTAL&p_file_id=14109

Manure Policy and MINAS: Regulating nitrogen and phosphorus surpluses in agriculture of the Netherlands. OECD Environment Directorate Centre for Tax Policy and Administration Report COM/ENV/EPOC/CTPA/CFA(2004)67 Final 21-Jan-2005. (historical overview of manure surplus reduction policy in the Netherlands)
[www.oelis.oecd.org/olis/2004doc.nsf/LinkTo/NT000092E6/\\$file/JT00177386.PDF](http://www.oelis.oecd.org/olis/2004doc.nsf/LinkTo/NT000092E6/$file/JT00177386.PDF)

Ontario

Nutrient Management Act, Regulation and Protocols (Ministry of Agriculture, Food and Rural Affairs website) www.omafra.gov.on.ca/english/environment/laws.htm

Nutrient Management web page – links to regulations and guidance. (Ministry of Agriculture, Food and Rural Affairs website) www.omafra.gov.on.ca/english/agops/index.html

Nutrient Management Protocol (Ministry of Agriculture, Food and Rural Affairs website)
<http://omafra.gov.on.ca/english/nm/regs/nmpro/nmprotcj07.htm>

Pennsylvania

Act 38 Laws and Regulations – Nutrient Management Regulations and summary of regulations. Nutrient Management Program web page http://panutrientmgmt.cas.psu.edu/main_laws_regulations.htm

Nutrient Management Legislation in Pennsylvania: A summary of the new regulations 2006. Agronomy Facts #40, Pennsylvania Nutrient Management Program web page.
<http://pubs.cas.psu.edu/FreePubs/pdfs/uc111.pdf>

Pennsylvania Phosphorus Index, Pennsylvania Nutrient Management Program web page.
http://panutrientmgmt.cas.psu.edu/em_publications.htm#Phosphorus

Odour management program guidance (including approved odour BMP's)
www.agriculture.state.pa.us/portal/server.pt/gateway/PTARGS_0_2_24476_10297_0_43/http%3B/10.4

1.0.36/AgWebsite/ProgramDetail.aspx?name=Odor-Management-Program&navid=12&parentnavid=0&palid=24&

Quebec

Agricultural Operations Regulation, O.C. 695-2002 Développement durable, Environment et Parcs website (Ministry of Environment website) http://www.mddep.gouv.qc.ca/milieu_agri/agricole-en/index.htm

Texas

Subchapter B: Concentrated Animal Feeding Operations 321.31-321.47 (2007) Texas Commission on Environmental Quality website - rules for nutrient and manure management for CAFO's <http://www.tceq.state.tx.us/assets/public/legal/rules/rules/pdflib/321b.pdf>

Concentrated Animal Feeding Operations (CAFO) Water Quality General Permit. Texas Commission on Environmental Quality website <http://www.tceq.state.tx.us/nav/permits/cafo.html>

Poultry WQMP Program. Texas State Soil and Water Conservation Board website. Regulations and guidance for poultry producers in complying with water quality management plan program (nutrient management requirements) <http://www.tsswcb.state.tx.us/poultry>

Comprehensive Nutrient Management Plan Program. Texas State Soil and Water Conservation Board website (guidance for dairy producers required to prepare nutrient management plans in two high-risk watersheds) <http://www.tsswcb.state.tx.us/en/cnmp>

Water Quality Management Plan Certification Program. Texas State Soil and Water Conservation Program. Includes odour assessment requirements and tools for poultry producers. Texas Administrative Code Title 31, Part 17, Chapter 523, Rule 523.3 Water Quality Management Plan Certification Program. http://www.tsswcb.state.tx.us/files/docs/nps-wqmp/Poultry_WQMP_Rules.pdf

United Kingdom

The Nitrate Pollution Prevention Regulations 2008. Agriculture, England, Water, England Statutory Instrument 2008 No. 2349. www.opsi.gov.uk/si/si2008/pdf/uksi_20082349_en.pdf

Protecting our Water, Soil and Air: A code of good agricultural practice for farmers, growers and land managers. Department for Environment, Food and Rural Affairs website (voluntary code for unregulated farms) www.defra.gov.uk/foodfarm/landmanage/cogap/documents/cogap090202.pdf

USEPA

United States Environmental Protection Agency NPDES CAFO Rule and summary. United States Environmental Protection Agency website (U.S. government requirements for regulation of concentrated animal feeding operations) <http://cfpub.epa.gov/npdes/afo/cafofinalrule.cfm>

Washington State

Washington State Rule RCW 90.64 Dairy Nutrient Management Act. Washington State Department of Agriculture website (describes required elements of dairy Nutrient Management Plans)

(<http://agr.wa.gov/FoodAnimal/Livestock-Nutrient/LawsRules.aspx>)

Washington State NPDES CAFO Permit legislation, application forms and guidance. Washington State Department of Agriculture website <http://agr.wa.gov/FoodAnimal/Livestock-Nutrient/NPDESCAFOPermit.aspx>

Washington State NRCS Field Office Technical Guidelines (access to Washington State-specific USEPA technical standards and best management practices used for development of Nutrient Management Plans etc.) <http://efotg.nrcs.usda.gov/treemenuFS.aspx> (requires Java script to access)

General

Schmidt, Orlando. 2008. Assessment of Nutrient Management Beneficial Management Practices (BMP's) for Poultry Manure on High Fertility Fields in the Fraser Valley. Master's Thesis, Royal Roads University. April 2008

12.2 On-farm composting regulations and guidelines

Alberta Code of Practice for Compost Facilities – Alberta Environment.

www.qp.alberta.ca/documents/codes/COMPOST.pdf

Pennsylvania – Pennsylvania Department of Environmental Protection General Permit for On-farm Composting www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/compost_sum/GP-farm.htm

Quebec – Guidelines for the beneficial use of fertilizing residuals

www.mddep.gouv.qc.ca/matieres/mat_res-en/fertilisantes/critere/index.htm

UK – Guidance on the control of manure and digestive tract contents under the EU animal by-products regulation (EC 1774/2002) (information on the composting of manure on-farm)

www.defra.gov.uk/foodfarm/byproducts/documents/manureguidancev4.pdf

Washington State – On-farm composting of Livestock Mortalities (includes guidance on general on-farm composting) <http://www.ecy.wa.gov/pubs/0507034.pdf>

12.3 On-farm mortality disposal regulations

Alberta - Overview of the Destruction and Disposal of Dead Animals Regulation.

[www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/rsb10366](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/rsb10366)

California - Waste Discharge Requirements General Order for Existing Milk Cow Dairies. California Regional Water Quality Control Board Central Valley Region Order No. R5-2007-0035 (P 11).

www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2007-0035

Ireland – Notice to Farm Bodies regarding the operation of the Fallen Animal Scheme (mortality disposal)

Jurisdictional Scan of Agricultural Waste Management Regulations
April 9, 2010

www.agriculture.gov.ie/animalhealthwelfare/fallenanimals/fallenanimalscollectionscheme/noticetofarmbodiesregardingtheoperationofthesubsidyfortsetestingscheme/

Manitoba - Livestock Manure and Mortalities Management Regulation.

<http://web2.gov.mb.ca/laws/regs/pdf/e125-042.98.pdf>

Ontario – Deadstock Disposal regulation and guidance

www.omafr.gov.on.ca/english/livestock/deadstock/index.html

Pennsylvania – Livestock and Poultry Mortality Disposal in Pennsylvania.

<http://composting.cas.psu.edu/MortalityDisposal09.pdf>

Quebec – La valorisation ou l'élimination des carcasses d'animaux morts (Mortality disposal options).

www.mapaq.gouv.qc.ca/Fr/Productions/Services/carcassesanimauxmorts

Texas – poultry mortality disposal. Texas Administrative Code (TAC) Title 30, Chapter 335, Subchapter A,

Rule 335.25. [http://info.sos.state.tx.us/pls/pub/readtac\\$ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=335](http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=335)

UK – Disposing of animal by-products: fallen stock and other animal carcasses. Department for Environment, Food and Rural Affairs web page for mortality disposal options.

www.defra.gov.uk/foodfarm/byproducts/fallen/index.htm

Washington State - Disposal of Dead Animals Legislation WAC 246-203-121.

<http://apps.leg.was.gov/WAC/default.aspx?cite=246-203-121>

Washington State Livestock Disposal Manual.

<http://agr.wa.gov/FoodAnimal/AnimalHealth/docs/LivestockDisposalManual10709.pdf>

Table 1. Regulation of Nutrient Management

Table 1a. Regulatory Trigger

Jurisdiction	Which farms are regulated ? (farm size trigger)
Alberta	All agricultural operations regardless of size or density must comply with nutrient management standards.
Manitoba	All livestock farms in the province must comply with nutrient management regulations that limit manure application based on nitrogen and phosphorus application (this requirement will be phased in by 2013). Large operations (>300 animal units) must comply with manure storage requirements. (1 animal unit is the number of animals that produce 73 kilograms of nitrogen in a 12-month period and is equal to 0.5 dairy cow, 0.8 beef cow, 0.8 sows in a farrow- to- finish operation and 200 broilers).
Ontario	Farms generating greater than 300 nutrient units annually are required to operate under a Nutrient Management Strategy. If manure generated is applied on-site, these farms must also have an approved Nutrient Management Plan for manure application. A nutrient unit is the amount of nutrients that give the fertilizer replacement value of the lower of 43 kilograms of nitrogen or 55 kilograms of phosphate. 1 nutrient unit = 1 medium size dairy cow. Nutrient units delineated for all classes of livestock (Nutrient Management Protocol).
Quebec	All farms that produce a volume of manure containing more than 1600 kilograms of phosphate are regulated under the Agricultural Operations Regulation (2002). Farms without livestock that crop more than 15 hectares are also regulated if they import manure.
Pennsylvania	All CAO's (concentrated animal operations) are regulated. CAO defined as a farm with greater than 8000 pounds of livestock on site and more than 2000 pounds of livestock per acre. Includes all production livestock and poultry as well as non-production livestock such as horses.
Washington State	All large concentrated animal feeding operations (CAFO's) and all licensed dairies are regulated. Large CAFO's have more than e.g. 1000 beef animals or 2500 swine as per federal definition of CAFO.
Texas	Permits to operate are required by all poultry operations in the state and all other CAFO's (based on federal definition of CAFO). Permit requires nutrient management planning, review of manure storage and handling facilities and an odour management plan.
California	New agricultural waste control regulations (2007) apply to all dairy operations in the Central Valley Region of the state. Other CAFO's and dairy farms in the rest of the state are regulated under earlier less restrictive legislation.

Table 1a continued. Regulatory Trigger

Jurisdiction	Which farms are regulated ? (farm size trigger)
Ireland	Nutrient management regulations apply to all farms in the country as the entire country has been designated a nitrate vulnerable zone.
UK	All farms in designated 'nitrate vulnerable zones' as per EU Nitrate Directive are required to comply with ' Nitrate Pollution Prevention Regulations 2008 '. Other farms voluntarily comply with Code of Good Agricultural Practice that contains the same standards.
Netherlands (Holland)	The whole country has been designated as a nitrate vulnerable zone (as per the EU nitrate directive) so all farms in the country must adhere to nutrient management requirements.
Denmark	The entire country has been declared a nitrate vulnerable zone. All farms above a certain size and density must abide by manure and nutrient management regulations. Regulated size: greater than 10 livestock units and greater than 1.0 livestock units per hectare, producing greater than 25 tonnes of manure (Petersen, date unknown). 1 livestock unit = 0.85 dairy cows or 3 sow places.

Table 1b. Regulatory Mechanisms

Jurisdiction	Regulatory mechanism
Alberta	Nutrient management standards are contained in the Agricultural Operation Practices Act (2002) and regulations.
Manitoba	Large farms (> 300 animal units) must have a Manure Management Plan prepared for the farm annually and have it approved by regulatory authorities. All farms must comply with standards for manure and nutrient application contained in the 'Livestock manure and Mortalities Management Regulation (MR 52/2004) and the 'Nutrient Management Regulation (2008)'. Plans can be prepared by the farm owner or operator, or by a qualified professional that must be a professional agrologist registered to practice in Manitoba or a certified crop advisor.
Ontario	Regulated farms required to have a Nutrient Management Strategy and Plan prepared and comply with storage and application standards in the <i>Nutrient Management Act, Regulations and Protocol (2003)</i> .
Quebec	The 'Agricultural Operations Regulation' (2002) contains standards for manure storage and application which regulated farms must comply with. In addition, each farm must implement an 'Agro-Environmental Fertilization Plan' which contains manure use specifics and is signed by a professional agrologist registered in Quebec. The agrologist must make an annual inspection to confirm that fertilizer applications were made according to the specifications of the plan. New and expanding operations that generate more than 3200 kilograms of phosphate in manure annually must operate under a permit.
Pennsylvania	All CAO's are required to submit a Nutrient Management Plan to State regulatory authorities for approval. Plan must be prepared by a qualified specialist (can be the farmer if trained) and must list State-approved Best Management Practices to address deficiencies. Some manure application and storage standards were legislated in 2005 (Pennsylvania Nutrient Management Regulations: Act 38 of 2005)
Washington State	Large CAFO's must apply for a permit and have a state approved Nutrient Management Plan which is prepared by a qualified person and is based on state-approved best management practices and technical standards.
Texas	Federal technical standards and best management practices must be used in nutrient management planning. Only qualified and trained persons can prepare plans. Plans must be approved by state authorities. Large poultry CAFO's must adhere to additional legislated standards for manure management.
California	All dairies in the regulated area are required to implement a Nutrient Management Plan which has been prepared by a certified specialist (can be a range of specialists including Professional Soil Scientist or Agronomist, Certified Crop Advisor or Technical Service Provider). The plan specifies application rates of nutrients, and monitoring and reporting to demonstrate that the plan has been complied with. Annual monitoring results of well water and surface runoff water to be used to determine if application rates are excessive.

Table 1b continued. Regulatory Mechanisms

Jurisdiction	Regulatory mechanism
Ireland	The regulation titled ' Good Agricultural Practice for Protection of Waters 2009 ' contains standards for all aspects of manure handling and application.
UK	'Nitrate Pollution Prevention Regulations 2008' contains standards and limitations that control manure storage and land application as well as application of nitrogen fertilizer for farms in nitrate vulnerable zones. Other farmers must manage manure to avoid causing pollution from runoff or leaching.
Netherlands (Holland)	Legislation contains regulatory requirements for manure storage and application to meet the requirements of the EU nitrate directive.
Denmark	Regulations contain manure storage and application standards. Farm animal density is also regulated. On pig and poultry farms, the maximum permitted density is 1.7 livestock units per hectare, on cattle farms: 2.3 units per hectare (equivalent to 195 dairy cows or 510 sows per 100 hectares)

Table 1c. Regulated Nutrients

Jurisdiction	Regulated nutrients
Alberta	Manure application rate is nitrogen and conductivity limited. Act sets out maximum soil nitrate-N levels (maximum of 80-270 kg/ha of nitrate-N in top 60 cm depending on soil type) and soil conductivity levels (manure application limited to sites with E.C less than 4.0 dS/m, and must not increase E.C. more than 1 dS/m. New CFO applicants must demonstrate access to sufficient land base. Minimum land base requirements are set out in guidance material (AOPA Reference Guide).
Manitoba	Both nitrogen and phosphorus applications are limited (not fully in force until 2013) (Manure and mortalities Regulation, P26). If the soil phosphorus level (measured as sodium bicarbonate or Olsen-P) is: <60 ppm P, manure application is limited based on nitrogen application. 60-119 ppm P, manure application is limited to 2x crop removal of phosphate. 120-179 ppm P, manure application is limited to 1x crop removal of phosphate 180 ppm or greater, no application of manure without written consent of Manitoba Conservation. Farmers also have the option of applying up to 5x crop removal of phosphate provided that manure is not re-applied until the soil level has returned to pre-manure levels. If soil-P is less than 60 ppm, manure application is limited to the rate which does not leave residual nitrate of more than 30-140 pounds per acre depending on soil type. Soil nitrate at any time of year cannot exceed 2x the allowable residual nitrate.
Ontario	Total phosphorus application in manure is limited: Application of manure over 5 years must not supply more phosphorus than a) crop removal plus 390 kilograms phosphate or b) crop requirements plus 85 kilograms phosphate (Nutrient Management Regulation Sec.92).
Quebec	Application of manure and fertilizer is phosphorus-limited. Standard phosphorus application limits for individual crops and yields are provided in the AOR regulation Schedule 1. Application rate of phosphorus is based on soil phosphorus and degree of saturation of phosphorus binding sites in soil. Manure phosphorus level is determined by annual manure testing.
Pennsylvania	Nutrient Management Plan (NMP) is nitrogen-based and includes nitrogen from fertilizer, manure and grazed livestock. The Pennsylvania Phosphorus index is used to limit phosphorus application to crop requirements on fields where there is a high risk of phosphorus loss to surface water. No manure application or soil standards; NMP directs applications.
Washington State	Not legislated in state regulations. Nutrient Management Plan must demonstrate that manure is applied agronomically (it is assumed that applications are nitrogen limited). Phosphorus index applied to at-risk fields at the discretion of the plan writer.

Table 1c continued. Regulated Nutrients

Jurisdiction	Regulated nutrients
Texas	State legislation regulates soil phosphorus levels. For CAFO dairies in at-risk watersheds, manure application prohibited if soil plant available-P exceeds 200 ppm (Mehlich III soil test method)(CNMP Program). For other confined livestock operations, soil maximum P level set by qualified professional in Nutrient Management Plan. Annual soil and manure test results must be submitted for review and used to set application rates. In addition, sandy textured soils must be assessed for N leaching potential.
California	Nutrient application is nitrogen- based and is legislated at no more than 1.4 times predicted crop nitrogen removal (General Order Attachment C Page C-10). Higher rates are allowed if written into approved Nutrient Management Plan. Soil phosphorus and potassium levels must be monitored every 5 years by a certified specialist (there are a range of specialists qualified to write plans) and application rates reduced if soil levels are deemed to be too high at the discretion of the specialist.
Ireland	Nutrient application is nitrogen-limited. Maximum application rate of nitrogen in manure and other fertilizers is 170 kilograms per hectare per year as per the EU nitrate directive, up to a maximum of 250 kilograms per hectare per year for grazing-based farms with special permission.
UK	In nitrate vulnerable zones, manure application is nitrogen-limited. Annual application of nitrogen in manure must not exceed 170 kilograms per hectare averaged over the whole farm (as per the EU nitrate directive), and must not exceed 250 kilograms per hectare on individual fields. In unregulated areas, voluntary compliance with nitrogen application rates.
Netherlands (Holland)	Nitrogen and phosphorus applications are regulated. Nitrogen application from manure limited to 170 kilograms per hectare per year as per EU nitrate directive. Nitrogen inputs in manure, chemical fertilizer and soil residual nitrogen must be approximately equal to crop removal of nutrients. Maximum annual application of phosphorus per hectare(manure and chemical fertilizer): 41 kilograms P on grassland. 32 kilograms P on arable land.
Denmark	Manure application is regulated by nitrogen. Application of nitrogen in manure per hectare per year cannot exceed 140 kilograms for pig and poultry farms and 170-230 kilograms for other types of farm (based on EU nitrate directive requirements).

Table 1d. Role of Best Management Practices

Jurisdiction	Role of Best Management Practices
Alberta	Voluntary <i>Beneficial Management Practices: Environmental Manual</i> available for each main livestock commodity group.
Manitoba	No requirement for Best Management Practices to be included in Manure Management or Nutrient Management plans. Farm Practice Guidelines manuals that contain BMP's are available for pork, dairy and poultry producers.
Ontario	<i>Best Management Practices</i> manuals available for producers to be used on a voluntary basis
Quebec	The professional agrologist preparing the Agro-Environmental Plan is expected to use judgment in designing the manure storage and application protocol for the farm. No specific Best Management Practices referenced in the regulations.
Pennsylvania	State approved Best Management Practices must form the basis of Nutrient Management Plans.
Washington State	National technical guidelines and Best Management Practices must form the basis of Nutrient Management Plans unless state approval is obtained for alternate BMP's.
Texas	Federal technical standards and Best Management Practices adapted for Texas conditions by law must form the basis of Nutrient Management Plans.
California	No specific use of Best Management Practices is specified for development of Nutrient Management Plans. Plans must reference California State Extension Services crop yield and nutrient research values to determine application rates. Soil, manure and crop monitoring data to be used to determine application rates.
Ireland	All requirements for storage, handling and applying manure are contained in the new regulations. No best management practices found.
UK	Voluntary <i>Code of Good Agricultural Practice</i> in place for farms not within nitrate vulnerable zones.
Netherlands (Holland)	Voluntary <i>Code of Good Agricultural Practice</i> available for use by farmers.
Denmark	No discussion of Best Management Practices.

Table 1e. Soil, Manure, Crop and Water Testing Requirements

Jurisdiction	Soil and manure testing requirements
Alberta	For operations producing more than 500 tonnes of manure per year, soil testing required every 3 years for nitrate-N and conductivity (AOPA Reference Guide).
Manitoba	For large farms (>300 animal units) annual soil testing required with results submitted in the annual manure management plan (Livestock Manure and Mortalities Management Regulation P 34). For smaller farms (<300 animal units), soil and manure testing not stipulated in legislation (but soil test results are required to demonstrate that manure application sites do not exceed soil phosphorus and nitrogen standards in legislation). Annual testing of livestock water quality is required by farms with >300 animal units. Testing parameters not indicated.
Ontario	Soil and manure testing required once every 5 years (Nutrient Management Regulation Section 91).
Quebec	Annual testing of manure for total phosphorus and other parameters as deemed necessary in the plan. Soil testing for phosphorus and % saturation of phosphorus binding sites every 5 years (AOR Section 28-29).
Pennsylvania	Manure testing required annually (Act 38 Nutrient Management Summary). Soil testing required every 3 years.
Washington State	None specified in state legislation but may be required in Nutrient Management Plan at discretion of plan writer.
Texas	Annual soil testing of fields receiving manure is required as is annual testing of manure. Results of testing must be used to determine application rates (CAFO Rules Section 321.36).
California	Manure and waste water: twice per year analysis with results used to determine application rates and nitrogen budget for farm. (see General Order Page MRP 2. Monitoring Requirements) Soil: all fields in 2008 when program began, thereafter every 5 years to monitor soil phosphorus and potassium. Tissue: annually at harvest to determine nitrogen uptake by crop. Water: annual testing of water from each well on site, tile drainage, irrigation water and surface runoff during storm events to assess nutrient movement off property.
Ireland	No specific soil or manure testing required. Regulation sets out standard nitrogen values for manure and crops on which to base application rate of manure (S.I. 101 Regulation Tables). Optional soil test for soluble phosphorus if farmer does not want to use the soil phosphorus standard contained in the regulation. If farmer opts for soil phosphorus testing, this must be done every 4 years.
UK	No soil or manure testing required; standard manure nitrogen and volumes provided in regulations by species (Nitrate 2008 Regulation). Optional manure testing if farmer wishes to use site-specific manure nitrogen values.
Netherlands (Holland)	No required soil and manure testing. Farmers can opt to have manure analyzed for nitrogen if they wish to use standards other than those provided in the legislation.
Denmark	No discussion found of sampling requirements.

Table 1f. Record Keeping and Reporting Requirements

Jurisdiction	Record keeping and reporting
Alberta	All operations that produce or handle >500 tonnes of manure per year must keep records for 5 years. Records: manure production, amount applied to each field and amounts transferred off premises.
Manitoba	Large producers (>300 animal units) are required to submit a Manure Management Plan annually which is prepared by the farmer or an agrologist or other qualified person and contains the proposed application rates, times and sites for the year. No specific recordkeeping required by producers.
Ontario	All farms must keep a copy on hand of Nutrient Management Plan. They must keep records of annual updates to their Plan as required.
Quebec	Each regulated farm is required to keep records of the farm's phosphorus production and land application, and update the records annually. Farmers are also required to maintain records of manure and other fertilizers applied, rates and dates of application, and receiving land base as well as a record of any manure exported off the farm.
Pennsylvania	Regulated operations are required to keep records of manure production and application sites, crop yields, animal use of pastured areas and manure and soil test results for 3 years.
Washington State	All dairy operations are required to keep records that demonstrate agronomic application of nutrients. As of 2011, 5 years of records will be required. All CAFO's must submit an Annual Report to the state.
Texas	All confined livestock facilities must keep records for 5 years of: Soil sampling locations and analyses and manure analyses. Manure volumes applied to each field and weather conditions for 24 hours before and after application. 2 year record of off-site movement of manure. CAFO's must submit an Annual Report to regulatory authorities containing records plus evidence that manure storages maintain their integrity.
California	Regulated farms must keep 5 year records of manure application volumes and sites and movement off-site, crops and yields, all monitoring results and weather pre and post-application. Regulated farms are also required to keep a photo record of manure storage facilities monthly showing fill height. Annual report must contain manure production and application data, and results of all testing.

Table 1f continued. Record Keeping and Reporting Requirements

Jurisdiction	Record keeping and reporting
Ireland	<p>Farms must keep records for 5 years of livestock numbers, manure applications and amount exported off-site, storage type and capacity, land base used, quantity and type of feed concentrate fed to livestock, soil test results, and fertilizer requirements for farm.</p> <p>Annual Fertilizer Plan must be submitted to authorities. It must summarize nitrogen and phosphorus budget on farm – crop uptake, application in manure and fertilizer and any soil test values.</p>
UK	<p>Records must be kept of livestock numbers, manure volume and nitrogen content, imports and exports of manure, crops planted and land area receiving manure and chemical fertilizer. No time limit specified.</p>
Netherlands (Holland)	<p>Farms must keep records of manure production, imports and exports, and amount land applied as well as crop production and expected yield.</p>
Denmark	<p>Regulated farms must submit an Annual Report summarizing their nitrogen use on farm as well as a cropping and nitrogen use plan for the following year.</p>

Table 2. Manure Application Requirements

Jurisdiction	General guidelines for compliance	Prohibited manure application periods	Application buffers and setbacks	Application requirements
Alberta	Manure application requirements apply to all farms in Alberta.	None contained in legislation.	Setbacks: 150 m from neighbours if manure is not incorporated. 30 m from water wells. 30 m from surface water if manure is surface applied and incorporated within 48 hours. 10 m from surface water if manure is injected.	Application on frozen or snow-covered ground under permit only. Manure must be incorporated within 48 hours unless under permit.
Manitoba	Manure application requirements vary with size of operation – larger operations have more restrictive application requirements.	Winter manure application (Nov 10 – April 10) is prohibited for large operations (>400 animal units) and is being phased in for operations with 300-400 animal units. Smaller operations can apply manure during winter on land with a slope up to 12%.	Growing season setbacks: Required setbacks vary from 3 to 35 m depending on method of application and whether manure is incorporated, presence of vegetated buffer, and sensitivity of surface water next to application area. See Livestock Manure Regulation P 54 for details. Winter application setbacks: 150 m from surface water and wells if slope is <4%, increasing to 450 m up to 12% slope.	None found in legislation.

Table 2 continued. Manure Application Requirements

Jurisdiction	General guidelines for compliance	Prohibited manure application periods	Application buffers and setbacks	Application requirements
Ontario		Winter application (December 1 to March 31) permitted provided that setbacks are adhered to.	Setbacks: 100 m from a municipal well. 15 m from a drilled well with a casing extending 6 m into the ground. 30 m from all other wells. 13 m setback from surface water unless manure is incorporated or setback is vegetated. 150 m from surface water if slope is >25%. Surface water setbacks increase during winter (100 m on frozen ground, 200 m if slope >3%).	Winter: application prohibited on land prone to flooding. No surface application on frozen or snow-covered ground. Incorporation of manure required during winter.
Quebec	Farms must have sufficient land base available, either owned, leased or available by signed agreement, to apply all manure produced on farm based on phosphate limits.	No application of manure between October 1 and April 1 unless the application is approved by the Professional Agrologist who prepared the Agro-Environmental plan. If manure is applied during these months, it cannot be more than 35% of the manure produced on the farm.	Setbacks: 3 m from surface water unless a stricter standard is contained in municipal law. 1 m from agricultural ditches. Setbacks are measured from the high water mark.	No application of manure or frozen or snow-covered ground. No runoff from manure can enter surface water.

Table 2 continued. Manure Application Requirements

Jurisdiction	General guidelines for compliance	Prohibited manure application periods	Application buffers and setbacks	Application requirements
Pennsylvania	All regulated operations must comply with requirements.	None found in legislation.	Setbacks: Growing season: 100' from surface water or 35' with permanent vegetated buffer. Winter: Between Dec 15-February 28 or on frozen or snow covered ground, 100' from surface water and drainage systems and 25% minimum ground cover.	Fall manure application on bare fields: injection or incorporation only, or on established cover crop.
Washington State	None stipulated in legislation. Nutrient Management Plan to set out application requirements based on approved Best Management Practices.			
Texas	All CAFO's must comply with manure application requirements as well as all state poultry farms.	None found in legislation.	Setbacks: 100' from surface water and buffer area must be well vegetated. 150' to private wells 500' to public wells.	No manure application on frozen or snow covered ground.

Table 2 continued. Manure Application Requirements

Jurisdiction	General guidelines for compliance	Prohibited manure application periods	Application buffers and setbacks	Application requirements
California	All CAFO's must comply with manure application requirements as well as all dairy farms in phosphorus-impacted watersheds.	None found in legislation.	Setbacks: 100' from all surface water sources, wells, sinkholes, open tile line intake structures or a buffer vegetated with perennial plants of at least 35' wide. Setback must be doubled around drinking water wells in areas where groundwater forms the main drinking water supply.	No application of manure when soil is at or above field moisture capacity unless approved in Nutrient Management Plan. Manure can only be applied to fields that are cropped or grazed.
Ireland	All farms in country must comply with application requirements.	Application of any fertilizer including manure is prohibited from October 15 to January 31 (slight variations by area of the country and type of fertilizer).	Setbacks: 200 m to surface water or wells used by more than 500 persons. 100 m to surface water and wells used by more than 50 persons. 25 m from well on own property. 5-20 m from other surface water.	No manure application on saturated, flooded, snow covered, or frozen ground or if heavy rain is forecast within 48 hours.

Table 2 continued. Manure Application Requirements

Jurisdiction	General guidelines for compliance	Prohibited manure application periods	Application buffers and setbacks	Application requirements
UK	All farms in nitrate vulnerable zones must comply with application requirements. Other farms voluntarily comply.	Application of manure with high percentage of available N (liquid manure, solid poultry manure) prohibited on cropped land as follows: Sandy and shallow soils Aug 1 – Dec 31. Other soils: Oct 1 – Jan 15. Prohibited period is shorter for grassland.	Setbacks: 50 m from springs and wells. 10 m from surface water (with some exceptions).	No application on saturated, flooded, frozen or snow-covered ground. On bare soil, liquid manure and solid poultry manure must be incorporated within 24 hours.
Netherlands (Holland)	All farms in country must comply with application requirements.	Liquid manure and nitrogen fertilizer application prohibited: On all sandy and loess soils from September 1 to January 31. On clay and peat soils – arable land - from September 15 to January 31. Application of solid manure on clay and peat soils is permitted at any time.	Setbacks: 5 m from natural watercourses. Manure application prohibited on land with >7% slope unless erosion control practices in place. Manure application prohibited on land with >18% slope unless area in permanent grass.	No application of manure on frozen or snow covered ground except for application of solid manure on permanent grassland. Application of manure prohibited on saturated soil.

Table 2 continued. Manure Application Requirements

Jurisdiction	General guidelines for compliance	Prohibited manure application periods	Application buffers and setbacks	Application requirements
Denmark	All farms above the minimum size must comply with regulations.	Manure application prohibited from harvest to February except on grass and winter rape.	The government is establishing 50,000 hectares of crop-free buffers 10 m wide next to rivers and lakes by 2015. Buffers are designed to reduce phosphorus runoff to surface water. There will be no cropping or manure or fertilizer application in the buffer areas. Farmers are compensated for loss of production.	Manure must be incorporated within 12 hours if surface applied on arable land. Farms larger than 10 hectares in size must plant cover crops on arable fields over winter.

Table 3. Manure Storage Facility Requirements.

Jurisdiction	Capacity requirements	Siting standards	Construction standards
Alberta	<p>New and expanding CFO's (regulated farms) must meet siting and construction requirements for manure storages.</p> <p>Manure collection areas (e.g. feedlots) are also considered storages and must meet same requirements.</p> <p>Nine months storage required unless manure can be field-stored.</p> <p>Existing manure storages (in place prior to enactment of AOPA legislation in 2002) do not have to be upgraded to new standards.</p>	<p>>100 m from springs or wells unless protection is in place</p> <p>>30 m from surface water unless the land slopes away from the water source or a berm is in place.</p> <p>Areas prone to flooding must be avoided.</p> <p>Bottom of storage must be 1 m above the groundwater level.</p>	<p>Storages must be constructed of a protective layer (soil or rock) 2 m thick that meets hydraulic conductivity standards or an impermeable liner of minimum 50 cm thick.</p> <p>This is a requirement for feedlots as well as they are considered 'manure storages' in the regulations.</p>
Manitoba	<p>New and expanding operations must comply with storage requirements.</p> <p>Earthen storages must be sized to hold 400 days of manure production.</p> <p>Other types of storages must hold 250 days of storage.</p> <p>Existing manure storages: those in place prior to enactment of the new legislation (dates vary) do not have to be upgraded to meet new standards.</p>	<p>100 m from property boundaries, surface water, wells and sinkholes.</p> <p>Not in the 100 year flood plain unless there is flood protection at least 0.6 m above the 100 year flood level.</p>	<p>Extensive construction standards are found in the Livestock Manure and Mortalities Regulation P 49.</p> <p>New and expanding manure storages on poultry operations require a permit from Manitoba Conservation.</p>

Table 3 continued. Manure Storage Facility Requirements.

Jurisdiction	Capacity requirements	Siting standards	Construction standards
Ontario	<p>New and expanding farms required to have 240 days of storage for liquid manure unless manure hauled off the premises.</p> <p>Existing manure storages: those in place prior to enactment of the NMA do not have to meet new standards.</p>	<p>100 m from a municipal well. 30 m from other wells. All tile drains within 15 m must be removed. Cannot be sited in the 100 year flood zone.</p>	<p>The regulations require a hydro-geological investigation for any new manure storages for large operations. Regulations also contain extensive construction standards for impermeable layers. (Nutrient Management Regulation Part VIII)</p>
Quebec	<p>All regulated farms must have sufficient storage capacity to hold all manure produced during the no-application period (October 1 – April 1) unless the professional agrologist stipulates a shorter period in Agro-environmental plan.</p> <p>If manure is stored off-farm, a signed agreement must be on record with the property owner.</p> <p>No discussion of existing storages was found in legislation.</p>	<p>New manure storages must be situated at least 15 metres from surface water.</p>	<p>Storages must be impermeable for farms generating more than 3200 kilograms of phosphate per year in manure.</p>
Pennsylvania	<p>None stipulated but if winter application is required, producer must demonstrate that land suitable for winter application is available.</p>	<p>New storages must be sited 100' from surface water and 200' from property boundaries.</p>	<p>New storages must be engineer-approved.</p>
Washington state	<p>None embedded in state legislation but Nutrient Management Plan must reference approved BMP's that demonstrate that the manure collection and storage system will not pollute state waters.</p>		

Table 3 continued. Manure Storage Facility Requirements.

Jurisdiction	Capacity requirements	Siting standards	Construction standards
Texas	Storages for new and expanding CAFO's must be able to accommodate the 100-yr, 24-hour rain event. Existing storages: 25-year, 24-hour rainfall event.	500' from public wells. 150' from private wells. 100' to surface water for all new and expanding storage facilities at CAFO's.	Storages must be engineer-designed and inspected every 5 years. New and expanding large poultry operations must have covered storage facilities or limit outdoor storage to 30 days and collect runoff from site.
California	Manure storages must be designed to hold manure and waste water for time period between land application events (time not specified) plus all runoff from manure-affected areas for same period, and sufficient capacity to hold runoff from 25-year, 24-hour storm event.	None found in regulations.	Storages must be engineer-designed and certified to federal standards, or consist of a double 60 mil high density polyethelene liner with leachate collection system between the layers.
Ireland	Manure storage requirements: Cattle (dairy and beef): 16-22 weeks depending on area of the country. Pig farms (>100 pigs on site): 26 weeks. Poultry farms (>2000 poultry places): 26 weeks. Deer, goats, sheep: 6 weeks. Requirements apply to all farms - no exclusion for pre-existing storages.	None found in regulations.	No construction standards found in regulation.

Table 3 continued. Manure Storage Facility Requirements.

Jurisdiction	Capacity requirements	Siting standards	Construction standards
UK	<p>For farms in nitrate vulnerable zones: Pig and poultry farms: 6 month storage based on standard manure volume values in regulation (Oct 1 – April 1). Other livestock: 5 months (Oct 1 – March 1). Storages must also be sized to hold rainfall and runoff from storage period. If farm has access to ‘low-risk’ application sites where risk of runoff to surface water is low, amount of storage can be reduced accordingly. Farms outside of regulated zones must have 4 months of storage unless they have guaranteed access to appropriate land for winter application.</p>	<p>Solid manure storage sites must be either covered or on an impermeable surface. Storage facilities must be sited a minimum of 10 m from surface water or tile drains.</p>	<p>None contained in regulations. <i>Code of Good Agricultural Practice</i> stipulates that new storages must be impermeable.</p>

Table 3 continued. Manure Storage Facility Requirements.

Jurisdiction	Capacity requirements	Siting standards	Construction standards
Netherlands (Holland)	All farms are required to have 6 months of manure storage to carry them over the prohibited application period. Exceptions granted on a case-by-case basis if it can be demonstrated that an individual farm has land that can receive manure during the winter without risking impact to surface or ground water.	None found.	None found.
Denmark	All regulated farms must have a minimum of 9 months storage capacity.	None found.	None found.

Table 4. Requirements for Field Storage of Manure

Jurisdiction	Field storage requirements
Alberta	<p>Manure can be field-stored for no more than 7 months in one spot.</p> <p>Setbacks:</p> <p>150 m from neighbours.</p> <p>100 m from spring or well.</p> <p>30-90 m from surface water, longer setbacks are for land sloping towards water.</p> <p>Storage must be 1 m above the groundwater level and 25-yr flood level.</p>
Manitoba	<p>Field- stored manure must be land-applied prior to November 10 of each year.</p> <p>After use, a field storage area must not be re-used for at least 12 months and during that time must be cropped.</p> <p>Setbacks:</p> <p>100 m setbacks are required from surface water, wells, sinkholes and property boundaries.</p> <p>If necessary, berms must be constructed around field- stored manure to avoid runoff.</p> <p>Field stored manure must be stored in a way that does not cause pollution.</p>
Ontario	<p>Manure can be field-stored for no more than 300 days, depending on the manure composition and site characteristics (Nutrient Management Regulation Sec. 82-86 and Table).</p> <p>Setbacks:</p> <p>100 m from municipal wells.</p> <p>90 m from other wells.</p> <p>Must be sited with a minimum of 30 cm of soil above bedrock, and 90 cm of soil above groundwater.</p> <p>125 m setback from single residences and 250 m from residential areas.</p> <p>Slope of storage site must be < 3%.</p>
Quebec	<p>Manure cannot be stored more than 2 years on each field storage site.</p> <p>Setbacks:</p> <p>>150 m from farm buildings and permanent manure storages.</p> <p>>15 m from agricultural ditches.</p> <p>Storage sites must be located on vegetated ground.</p> <p>Field storage sites cannot be on areas with a slope >5%.</p> <p>No surface runoff can reach the pile.</p>

Table 4 continued. Requirements for Field Storage of Manure

Jurisdiction	Field storage requirements
Pennsylvania	Field storage of solid manure allowed for emergencies only such as during periods of inclement weather when storage facilities cannot be emptied. Identified particularly as an optional storage method during the period when farmers are implementing the new regulations. Field storage for maximum of 60 days in one place. BMP's must be used to select appropriate sites and pile configuration.
Washington State	None found in regulations; Nutrient Management Plans and other required plans must reference BMP's and technical standards from NRCS Field Office Technical Guidance .
Texas	No specific reference to field storage found in regulations. Manure stockpiles must be bermed to prevent runoff or covered with an impermeable layer unless they are located within the drainage collection area of the manure storage facility. Outdoor storage of poultry litter limited to 30 days unless pile is covered or bermed to collect runoff, or unless runoff from pile is collected in manure storage facility.
California	No specific reference to field storage found in regulations. It is presumed that field storage is prohibited because of the requirement for all runoff and leachate from manure storage areas to be collected and diverted to the manure storage facility which would preclude field storage.
Ireland	Setbacks: 250 m from well or surface water used for drinking water by more than 50 persons. 50 m from wells on own property. 20 m to lake shoreline. 50 m to limestone sinkhole. 10 m to other surface water.
UK	Maximum storage period: 12 months Poultry manure temporary storage piles must be covered. Setbacks: > 50 m from wells and springs. >10 m from surface water.
Netherlands (Holland)	None found in regulations.
Denmark	None found in regulations.

Table 5. Requirements for Management of Confined (or Concentrated) Outdoor Feeding Areas

Jurisdiction	Management of outdoor feeding areas
Alberta	Confined outdoor feeding areas are considered manure collection areas and are subject to same siting and construction requirements as manure storages. Grazing areas are excluded from this definition.
Manitoba	<p>A permit is required to build or expand a confined outdoor feeding area for pig farms with >10 animal units and other operations with >300 animal units.</p> <p>If the farm has >10 animal units, the feeding area must be sited 100 m from surface water, wells and property boundaries.</p> <p>Manure must be removed from feeding area annually except with permission from Manitoba Conservation.</p> <p>At the discretion of regulatory authorities, a collection basin may be required to collect runoff from feeding area.</p> <p>Basin must be designed to hold 7.5 to 15 cm of runoff from surface of feeding area.</p>
Ontario	Regulation contains setbacks and limits to access to surface water (Nutrient Management Regulation Part VII).
Quebec	Contaminated water from confined outdoor feeding areas must not enter surface water.
Pennsylvania	State approved Best Management Practices to be included in Nutrient Management Plan to prevent impacts on surface and groundwater. This can include various options such as collection of runoff in storage facility or maintenance of vegetated buffer to limit movement to surface water.
Washington State	<p>No specific discussion of confined outdoor feeding areas.</p> <p>If the operation is regulated (considered a CAFO), a Nutrient Management Plan is required.</p>
Texas	<p>Runoff from confined outdoor feeding areas must not enter surface water and cause pollution except in cases where rainfall exceeds required design capacity of storage. Runoff must be contained on the site and handled as manure.</p> <p>Storage facilities must be designed to accommodate runoff from confined outdoor feeding areas as well as manure.</p>
California	By law, all runoff containing manure from outdoor livestock pens must be diverted into manure storage and applied as a nutrient source.
Ireland	Runoff from confined livestock feeding areas must be collected to prevent runoff or infiltration of nutrients.
UK	<p>No regulatory requirements found.</p> <p><i>Code of Good Agricultural Practice</i> suggests that runoff from confined livestock areas should be managed to prevent pollution.</p>
Netherlands (Holland)	No regulations found.
Denmark	No regulations found.

Table 6. On-Farm Mortality Disposal Options and Requirements

Jurisdictions	General regulations	Burial	Composting	Incineration	Other
Alberta	Regulated under the <i>Destruction and Disposal of Dead Animals Regulation</i> under the <i>Livestock Diseases Act</i> .	Allowed with restrictions: Max. 2500 kilograms per pit Setbacks: 100 m from wells, water and neighbouring residences Varying setbacks from roads. 1 m soil on carcasses. Min. 1 m above groundwater table.	No permit required for on-farm mortality composting. Setbacks: 100 m from wells, water and neighbouring residences. Maximum of 25% by volume of animal parts in pile. Carcasses covered with minimum of 15 cm of bulking agent.	Allowed under permit from Alberta Environment under existing regulation or Code.	Natural disposal (surface disposal): Maximum of 1000 kilograms per site. 500 m setback from water, wells, and between sites. 400 m setback from roads and neighbouring residences.

Table 6 continued. On-Farm Mortality Disposal Options and Requirements

Jurisdictions	General regulations	Burial	Composting	Incineration	Other
Manitoba	Mortality disposal is regulated under the <u>Livestock Manure and Mortalities Management Regulation.</u>	On-site burial is not allowed on farms with > 300 animal units except with approval of regulatory authorities. For smaller operations, burial pits must be sited 100 m from surface water, wells and property boundaries, be constructed to prevent pollution and have a minimum of 1 m of soil covering mortalities.	Composting of mortalities is permitted on all farms. Requirements: 100 m setback of facility from surface water, wells and property boundaries. Composting facilities and process must be acceptable to Manitoba Conservation (but no stated requirement for a permit). Mortalities must be composted in a way that prevents pollution. No application of compost between Nov 10 and April 10.	Incineration of mortalities is acceptable in an incinerator operated in compliance with the <i>Incinerators regulation.</i>	None found.

Table 6 continued. On-Farm Mortality Disposal Options and Requirements

Jurisdictions	General regulations	Burial	Composting	Incineration	Other
Ontario	Disposal options, location requirements and management requirements outlined in Disposal of Dead Farm Animals regulation under the <i>Nutrient Management Act</i> .	Allowed with restrictions: Max. 2500 kilograms per pit. Min. 60 cm soil coverage Setbacks: 100 m to surface water 250 m to municipal wells 50 m to other wells 200 m to residential or commercial area 60 m between pits 6 m to drain tile Min. 90 cm above ground water Prohibited within 100 year flood plain.	Allowed without a permit. Sites must be less than 600 m ² in size and contain no more than 600 m ³ in carcasses and substrate.	Allowed. Incinerator must be approved under Canada Environmental Technology Verification Program. Must have secondary chamber running at min. 850 °C for 2 seconds.	Disposal vessels: in-ground leak-proof and impervious vessels for disposal of small livestock such as sheep when other options are not available. Anaerobic digestion: provided the digester is approved under the <i>Nutrient Management Act</i> .

Table 6 continued. On-Farm Mortality Disposal Options and Requirements

Jurisdictions	General regulations	Burial	Composting	Incineration	Other
Quebec	On-farm disposal of mortalities is regulated under ' le Reglement sur les aliments '.	On-farm burial is permitted provided that the following standards are complied with: Pits must be located: 75 m from surface water 150 m from any drinking water source or well. Pits cannot be located in a flood zone. The bottom of the pit must be above the ground water table and must be covered with caustic lime before use. Mortalities must be covered with a minimum of 2' of soil following burial.	On-farm composting of poultry and swine mortalities only. A 'rendering permit' is required to compost mortalities. Guidelines: Mortalities must be composted in a roofed, impermeable-floored building with bins for primary and secondary composting and there must be no access by animals to the facility. Records must be kept of the number of animals composted and dates. (In practice because of the high cost and difficulty of getting a rendering permit, most producers still use burial.)	On-farm incinerators are permitted. If the incinerator is for animal mortalities only and burns less than 1 tonne/hr, no authorization is required but the owner must notify the Environment ministry and provide a letter from a certified engineer that states that the incinerator complies with regulatory requirements. The proposed fate of the ash must also be indicated on the notification letter. For larger incinerators, a permit is required.	None found.

Table 6 continued. On-Farm Mortality Disposal Options and Requirements

Jurisdictions	General regulations	Burial	Composting	Incineration	Other
Pennsylvania	Regulated under the Domestic Animal Act .	Allowed with restrictions: 100' from surface water and wells, Not in 100-year flood zone. 2' of soil coverage over mortalities Recommended: Pits sited minimum 2' above bedrock and seasonal high water table.	On-farm composting allowed without permit. No guidance found.	Incineration of mortalities on-farm allowed. No permit required for on-farm incineration of mortalities.	None found.
Washington State	Regulated by State Regulation WAC 16-25-025 Routine Disposal (disposal information also found in Disposal Manual)	Allowed with restrictions: Setbacks: 300' from surface water and wells 300' from residences except owner 50' from property line Maximum of 1000 pounds per burial site 3' minimum coverage of mortality with soil Burial not allowed on properties less than 5 acres in size.	Composting of beef and horse mortalities allowed on farm without a permit provided that siting and management guidelines are followed and authorities are notified of intent to compost. Composting must not cause pollution.	Allowed in an approved incinerator or mobile air curtain incinerator. Permit required through the Dept. of Ecology.	Natural decomposition (surface disposal) allowed on private or state rangeland with permission of land owner. 1320' setback required from water, wells, roads and residences. Digestion allowed in an approved carcass digester.

Table 6 continued. On-Farm Mortality Disposal Options and Requirements

Jurisdictions	General regulations	Burial	Composting	Incineration	Other
Texas	State regulations allow composting and incineration as on-farm disposal options. Poultry mortality regulations found in Texas Administrative Code Title 30, Chapter 335	Burial is prohibited except in the case of catastrophic mortalities which must be permitted by the state (such as large-scale, higher than normal mortality due to a disease outbreak or disaster such as fire or flood).	No permit required for on-farm composting of mortalities from own property provided that general guidance is followed. If permit is required, it must contain information on composting procedures and demonstrate no environmental impact.	Permitted for poultry mortalities under state law. Must adhere to state regulations on incineration.	None found.
California	Rendering and landfiling in approved landfills are the only officially approved methods of mortality disposal. On-farm disposal is prohibited by law. In emergency situations, on a case-by-case basis, authorities will allow on-farm composting or burial. Regulations found in the General Order R5-2007-0035 P.11	Prohibited except in emergency situations (mass mortality due to disease or disaster).	Prohibited except in emergency situations.	Prohibited except in emergency situations.	None found.

Table 6 continued. On-Farm Mortality Disposal Options and Requirements

Jurisdictions	General regulations	Burial	Composting	Incineration	Other
Ireland	Mortalities (fallen animals) except in exceptional cases are disposed of through rendering plants (Fallen Animal Scheme). Subsidy for pick-up of bovine animals older than 48 months.	Prohibited except in rural areas where no access to rendering and only under license from local District Veterinary Office.	Not permitted due to EU animal by-products legislation and disease concerns.	No mention of this option found.	None found.
UK	Mortalities (fallen animals) except in exceptional cases are disposed of through rendering plants or other salvage operation. On-farm disposal not common (Fallen Animal webpage). Bovine animals older than 48 months must be sent to be tested for transmissible spongiform encephalopathy.	Prohibited except in very rural areas (such as islands) where there is no access to rendering.	Prohibited on farm.	Allowed on farm with regulatory approval provided that appropriate regulations are adhered to. Not common.	None found.
Netherlands	No regulations found (they may exist in Dutch but were not found in English).				
Denmark	No regulations found (they may exist in Danish but were not found in English).				

Table 7. Regulation of On-farm Composting

Jurisdiction	On- farm Composting
Alberta	On-farm composting of mortalities permitted under the <i>Destruction and Disposal of Dead Animals Regulation</i> . Composting of other agricultural wastes on farm not regulated although it is suggested that siting adhere to the ' Code of Practice for Compost Facilities ' (Environmental Protection). Off-farms sales may require a permit.
Manitoba	On- farm composting of manure is permitted. For large operations (>300 animal units), the composting facilities and process must be acceptable to Manitoba Conservation. For smaller operations, no approval is required for on-farm composting. For all operations, compost facilities must be sited 100 m from surface water, wells and property boundaries. Composting must be done in a way that prevents pollution. For large operations, winter application of composted manure is prohibited from Nov 10 to April 10.
Ontario	Regulation of on-farm composting of mortalities only. No regulations found that mention on-farm composting of manure.
Quebec	On-farm composting of manure and other farm products in volumes < 500 cubic metres at one time is allowed without authorization (Guidelines for the beneficial use of fertilizing residuals Section 14). Off-farm manure and farm products can be composted as well. Up to 150 cubic metres of non-agricultural plant residuals can also be composted on-farm at one time. Higher volumes require an authorization from Environment Ministry.
Pennsylvania	No permit required for composting of on-farm wastes. Composting on-farm of off-farm organic wastes allowed under permit from Pennsylvania Department of Environmental Protection to encourage recycling of organics.
Washington State	No permit required for on-farm composting with on- and off-farm agricultural materials if all compost is used on-farm. Off-farm distribution is allowed without a permit if volume on site is < 1000 yd ³ and farm has a Farm Management Plan.
Texas	Operations that are regulated through some type of permit (CAFO's, poultry operations and some dairies) who wish to compost their own manure on-farm must include composting in their Nutrient Management Plan. The plan outlines best management practices for on-farm composting. Other agricultural operations are not regulated.

Table 7 continued. Regulation of On-farm Composting

Jurisdiction	On- farm Composting
California	No regulations found for composting of agricultural waste. Composting of mortalities is prohibited.
Ireland	No permit required for on- farm composting of manure for use on site. Permit required and restrictions on composting of off- farm organic waste. Other organic wastes can only be composted in an approved composting facility.
UK	On-farm composting of manure requires no approvals. Composting of other waste products on- or off- farm must be done in an approved composting facility.
Netherlands (Holland)	No regulations found.
Denmark	No regulations found.

Table 8. Odour Regulations

Jurisdiction	Odour regulation
Alberta	New and expanding CFO's required to have assessment of odour potential of facility based on volume and characteristics of manure, composition of neighbourhood and other factors (AOPA Reference Guide). Results of assessment are used to determine the setback required from neighbours.
Manitoba	No regulations found. BMP's for odour control found in <i>Farm Practices Guidelines</i> .
Ontario	No regulations found.
Quebec	Odours are regulated at the municipal level. No regulations were found (they may be available only in French). A series of factsheets on reducing odours is available through the Ministry of Agriculture.
Pennsylvania	New or expanding large operations (concentrated animal operations or CAO's) are required to submit an Odour Management Plan. Potential for odour is evaluated using ' Odour Site Index '. If odour potential is high, the operation is required to implement approved odour Best Management Practices.
Washington State	None in state legislation.
Texas	All new and expanding confined animal facilities (no minimum size) must have an air quality permit which requires an odour control plan which outlines how odours, dust and other nuisances will be minimized. Odour potential is assessed using odour assessment tools and guidelines developed by the state. General required buffer from any confined animal facility to affected persons (non-residences included): 0.5 mile or 0.25 mile plus an approved odour control plan.
California	No regulations found.
Ireland	No regulations found.
UK	No regulations found. Code of Good Agricultural Practice contains suggestions for minimizing odours during manure storage and application.
Netherlands (Holland)	No regulations found.
Denmark	Odour is regulated by local government. Odour guidelines rewritten in 2004 to include new distance requirements (no further information found). In 2004 Action Plan, money committed for a research program to find ways to reduce odour nuisances through technological means such as biogas production or others.

Table 9. Regulation of Emissions and Dust

Jurisdiction	Emissions and dust
Alberta	No specific regulations. The issue is dealt with on a complaint basis.
Manitoba	No regulations found.
Ontario	No regulations found.
Quebec	No regulations found.
Pennsylvania	No regulations found.
Washington State	None in state legislation but BMP's for dust control and guidelines are available on a voluntary basis for feedlot owners.
Texas	Air emissions required to be controlled under an odour control plan required of all confined animal facilities (no minimum size). Dust from all aspects of the operation must be controlled including from associated facilities such as feed mills (Air Standard Permit, CAFO Rule Section 321.43).
California	No regulations for dust control found. Regional authorities in San Joachin valley area where air quality is poor require dairies with > 1000 milk cows to be permitted for volatile organic compound (VOC) emissions (> 2000 cows in other areas of the state). Studies are currently underway to evaluate effectiveness of farming practices in reducing VOC emissions (VOC emissions document).
Ireland	No regulations found.
UK	No regulations found. Code of Good Agricultural Practice contains suggestions for minimizing greenhouse gas emissions from farming operations and ammonia emissions but there are no requirements.
Netherlands (Holland)	Measures are in place to reduce ammonia emissions from farms. Land application of manure must be done using low emissions methods including: Surface application (on the soil surface, below the grass sward) or injection of manure into grassland. Surface application followed by incorporation on arable land with the requirement that manure is no longer visible on soil surface after incorporation.
Denmark	No discussion found of measures to reduce ammonia emissions although all EU countries are required to reduce emissions.