

1995 Code of Practice MDS Calculation

$$\text{MDS} = [\text{\#of Head} \times \text{LSU Factor}]^{0.365} \times [0.12 \times \text{Basic Distance}] \times 1.14 \times 3.3$$

Basic Distance: varies for different MDS receptor categories:

Category 1 = 300

Category 2 = 400

Category 3 = 500

0.365 = exponent

1.14 = constant

3.3 = conversion factor (metres to feet)

The Application of the Minimum Distance Separation (MDS) for Siting Confined Feeding Operations in Alberta

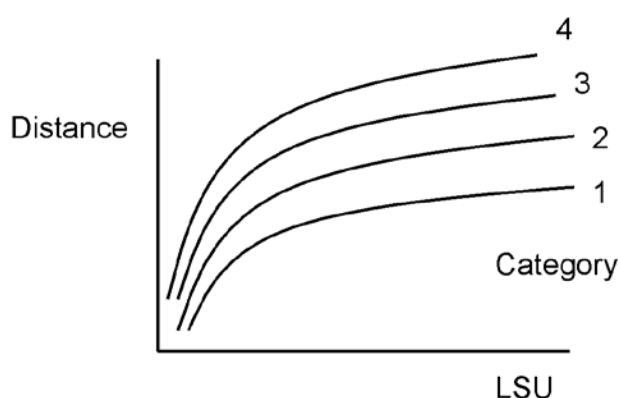
The purpose of this paper is to summarize the siting guidelines used and applied in Alberta over the last 20 years, with regards to Confined Feeding Operations (CFOs). The information was compiled from publications (both past and present) produced by Alberta Agriculture, Food and Rural Development as well as from consultations with staff (existing and retired) employed by the department. This paper outlines the changes to the Minimum Distance Separation (MDS) that occurred throughout the years.

Introduction

Under the amended Agricultural Operation Practices Act, the Minimum Distance Separation (MDS) is the method for siting all new or expanding confined feeding operations (CFOs). It is a setback or buffer established between a confined feeding operation and adjacent land uses to minimize odour nuisance. The MDS is measured from the outside walls of neighbouring residences (not property line) to the point closest to the applicant's livestock facility, manure storage facility, catch basin, feeding pen or barn, milking facility or compost area. Facilities associated with the livestock operation, such as feed handling areas, feed storage areas, office, water supply, land on which manure is spread, and grazing areas are not considered to be part of the livestock facility for the purposes of determining the MDS.

The Minimum Distance Separation (MDS) concept is based on the principle that odour will disperse over distance. As illustrated in the diagram below, as the number of animals (LSUs or livestock siting units) increases, so does the required distance. The MDS was developed to provide flexibility in the guidelines for siting different land uses in agricultural areas, thereby reducing potential conflicts. The MDS formula is derived from historical, documented Alberta field experience and observation relating to complaints from, and separation distances between, CFO facilities, the odour source, and their neighbours (odour receptors). Site specific factors in the MDS equation account for relative odour potentials of differing animal types, manure handling methods, number of animals, and the type of neighbouring land use. The neighbouring land use attempts to account for different sensitivities of neighbours by assuming that locations that are more densely or frequently occupied have a higher degree of sensitivity to odour nuisance. Category 1 applies to a low degree of sensitivity while Category 4 is used for a high degree of sensitivity.

Statistical analysis of the historical data yielded equations that could be used to reasonably predict how far CFOs should be located from potentially conflicting land uses to eliminate the majority (up to 95%) of odour related complaints.



Past Approaches for Siting Confined Feeding Operations

1. Confinement Livestock Facilities Waste Management Code of Practice (1973)

Land use conflicts relating to CFOs began to emerge in the early 1970's. There were only two pieces of legislation available to assess sites for new and expanding CFOs:

- Division 23 - Regulations Respecting the Keeping of Livestock and Poultry (of the Provincial Board of Health Regulations under the Public Health Act), and
- The Subdivision Regulations of the Planning Act.
Under Division 23, the required setback distances for feedlots and piggeries were 500 feet for farm areas and 1500 feet for non-farm areas. These siting requirements did not apply to poultry, dairies or other types of confined feeding operations. The areas in question were defined as follows:

Feedlot: Any land enclosed by a fence or other means which is used or intended for use for the purpose of feeding cattle in confinement.

Piggery: Any land, building or shelter used or intended for use for keeping pigs or hogs.

Non-farm Area: Any area (quarter section) that is subdivided into parcels of land less than 40 acres.

Farm Area: Any area not designated as a non-farm area.

Under the Planning Act, the Subdivision Regulations contained a clause that did not permit subdivisions within 1000 feet of a "livestock feeding operation".

The 1973 Code of Practice defined livestock operations as follows:

Confinement Livestock Facility: Any facility or mode of operation which confines 10 or more animal units in an enclosure or unclosed area for the purpose of feeding and rearing livestock.

Intensive Livestock Operation: Any confinement livestock facility capable of confining, rearing or feeding of more than 200 animal units in an enclosure where the space per animal unit is less than 4000 square feet.

An "animal unit" was defined as the relationship among various livestock species in terms of their potential to cause a pollution problem through the production of wastes.

To curb conflicts between agricultural and non-agricultural land use issues due to improper location, required and recommended "Isolation Distances" were introduced for the establishment of new and expanding livestock confinement systems. The distances were based on Division 23 and where 100 or more head of cattle were kept. Distances were measured from the nearest edge of the facility based on two categories:

1. Enclosures, buildings or corrals, and
2. Catch basins or lagoons.

The guidelines that applied were as follows:

Cities: Required distance - 3 miles (recommended 5 miles).

Urban Centres (population > 500): Required distance - 1 mile (recommended 3 miles).

Urban Centres (population < 500): Required distance - 1 mile (recommended 2 miles).

Public Place: Required distance - 1500 feet (recommended 1 mile).

Country Residence (non-farm): Required distance - 1500 feet (recommended ½ mile for enclosures, buildings and corrals, 1 mile for catch basins or lagoons).

Country Residence (farm): Required distance - 500 feet (recommended ½ mile for enclosures, buildings and corrals, 1 mile for catch basins or lagoons).

Surface Water: Required distance - 50 feet (recommended 300 feet for enclosures, buildings and corrals, 100 feet for catch basins or lagoons).

The voluntary Certificate of Compliance Program was introduced with the Code of Practice in 1973. It was designed to aid producers in their development plans, prevent nuisance conflicts, promote a good neighbour policy, and when given status by the local planning authority, prevent encroachment by non-agricultural development. Applications were reviewed and evaluated by Alberta Agriculture, Alberta Environment, the local Health Authority, and the Municipality/County. Each of these reviewing agencies had the power to impose conditions on the application. If an applicant was complying with all regulations and at a level of technology within the guidelines of good practice (as outlined in the Code of Practice) a Certificate of Compliance was jointly issued by Alberta Agriculture and Alberta Environment.

2. Confinement Livestock Facilities Waste Management Code of Practice (1982)

The Minimum Distance Separation (MDS) method was a tool introduced to Alberta to aid in the Certificate of Compliance program and replace the Isolation Distances previously used. The MDS equation was developed in Canada by the Province of Ontario and was based on the dispersion theory. The following quotes are from the Ontario Code of Practice (1976).

" - the intensity of odour from a livestock building or manure storage relates closely to separation distance. Odour intensity is affected by the kind of livestock, the feeding program, the moisture content of manure and the atmospheric conditions -"

"The MDS formulas have been developed to provide a consistent and fair technique to determine separation distances between non-compatible land uses. The formulas assess the environmental impact of establishing the proposed building, and evaluate existing commitment as compared to other alternatives."

Ontario's equation was modified to represent Alberta conditions. It was first introduced to Alberta in the 1982 Confinement Livestock Facilities Waste Management Code of Practice. The MDS formula used in 1982 is listed below, along with an explanation of each of its factors.

MDS = Factor A (species) x Factor B (size) x Factor C (degree of change) x Factor D (manure system) x Base Distance

Factor A - species factor

It acknowledged the fact that some species produce more odour than others. This factor provided relative source odour values based on species. These values evolved over time and were based on field experience and observation. This factor is closely related to Factor D. In the MDS calculation, Factor A combined with Factor D allowed for a precise consideration of livestock housing system and manure storage/handling methods for each common livestock type.

Factor B - size factor

This acknowledged that odour production was a function of operation size. The value was determined from a size curve based on the total number of Animal Units. The 1982 Code of Practice defined an animal unit as the number of animals required to generate 70 kg of nitrogen equivalent fertilizer per year. This is the amount of nitrogen required to produce an average crop from one acre of land.

Factor C - degree of change factor

This factor addressed the degree of change to a site or existing facility. It considered the odour generated by a CFO, who was there first, the perceived impact of a new operation in an area where none had existed, and the expansion of an existing operation. It was based on two principles:

1. Siting be more restrictive for new operations as a new CFO is viewed as an encroachment on an existing non-compatible land use and more likely to cause conflict. The 1.14 Initial Siting Factor in all MDS calculations applied to the establishment of new operations. It required an additional 14% buffer on the MDS requirement to offset the impact of a new operation on land where no CFO had previously existed. It was not to be interpreted as a license to expand. This was based on the assumption that once the operation became established in the area and good practices were followed, the operator would require less of an increase in MDS if he increased the size of his/her operation at a future date through the expansion factor. However, it was not a pre-approval or guarantee for an expansion.
2. The MDS will accommodate a certain degree of expansion for existing operations. These values ranged from 0.7 to 1.13 (percent increases from < 48 to 628 %). An increase in operation size of 700% or greater was automatically considered to be a new operation and the initial siting factor of 1.14 was applied.

It should be noted that the term expansion meant more animals, which required additional housing facilities and manure storage. For existing operations, the MDS came into play when a development permit was required. Development may mean remodeling, replacement or expansion. The expansion factor covered all three of these cases.

The following conditions were applied to further define the term "expansion".

- If the barn is being remodeled or rebuilt which represents a substantial capital investment, with no change to the number of animal units or type of livestock, a value of 0.7 is applied.
- If the barn is being remodeled or rebuilt which represents a substantial capital investment, with an increase in animal units, and also with or without a change in the type of livestock, increase the value of Factor C from the table by 0.10 but in no case use less than 0.7.
- If the additional housing was annexed to or separate from the existing facility, Factor C from the table will be applied.
- If the expansion to the operation occurs within 3 years of the initial or most recent expansion of the same operation, the percentage increase will be calculated as if all expansions within the preceding 3 years had occurred at the same time.

Factor D - manure system factor

This recognized the fact that the manure system has a bearing on odour production, especially its moisture content. Values ranged from 0.5 (e.g., poultry on litter) to 1.0 (e.g., liquid manure systems). Values for other types of systems were at the discretion of the approving authority.

Factor E - encroachment factor

The early version of the MDS included an elaborate Factor E grid that was the basis for the Reciprocal MDS (encroaching development on CFOs) and was initially developed for the Certificate of Compliance program. Values ranged from 0.8 for the development of a single residence on an existing parcel (less than 20 acres) to 2.0 for high density uses such as urban residential, high use recreational and institutional. In the late 80's it was starting to become apparent that the Code of Practice was moving toward becoming regulatory and many Municipalities/Counties insisted that the Certificate of Compliance be a condition of a development permit.

Base distances

The original base distance of 350 metres (1150') was chosen as a reasonable starting point. Alberta began with the same values Ontario used (1000') then modified them for Alberta conditions. Their intent was to recognize that not all neighbouring land uses are equal. The Subdivision Regulations used 1000 feet, and 350 metres fell within the range of the 500 and 1500 foot setback distances used in Division 23 of the Health Act. The additional base distances of 400, 500 and 800 metres were added to accommodate CFO siting requirements located adjacent to moderate and highly sensitive neighbouring land uses. The base distances applied in the 1982 Code of Practice are defined below.

- 350 metres - for the nearest or next nearest neighbours.
- 400 metres - for an area designated as industrial, low use recreational, or small scale country residential.
- 500 metres - for an area zoned or designated large scale country residential, high use recreational or commercial.
- 800 metres - for an area zoned or designated urban residential use or institutional.

The use of multiple base distances attempted to balance the source/receptor equation by recognizing the commitment and expectations of the receptor as zoning moved from a single residence rural setting to a higher intensity, large scale rural residential development where expectations were more urban than rural.

3. Code of Practice for the Safe and Economic Handling of Animal Manures (1995)

With each revision made to the Code of Practice and with the increase in operation size, the curves developed by the MDS equation were readjusted. Prior to 1995, the MDS curves did not accurately consider the dispersion of odour at increased distances. This was not an issue with small operations that required a relatively small distance separation. Therefore, in the 1995 Code of Practice the curves had to be readjusted as the slope extended too high up for very large piggery and feedlot operations. Alberta Health rescinded Division 23 with the advent of the upgraded Code and the move towards its use as a basis for CFO development. In all but small operations, the MDS was more stringent than the Health Regulations.

The development and refinement of the 1995 Code of Practice brought about a number of changes to the MDS equation. It used a base distance of 300 metres with two additional distances of 400 and 500 metres to allow for flexibility in siting near neighbouring land uses. The base distances were now referred to as "Categories" and were defined as:

Category 1: Low sensitivity neighbours (e.g., single residence).

Category 2: Moderate sensitivity neighbours (e.g., multi-parcel country residential, low use recreational).

Category 3: High sensitivity neighbours (e.g., large scale country residential development, high use recreational, etc.).

Other notable changes were:

- The combination of Factors A and D, and the Manure Unit Reciprocal into one unitless coefficient known as the Livestock Siting Unit (LSU),
- The option of applying the expansion factor to the point nearest the CFO or applying the MDS to the expanding portion of the development without using the expansion factor. This was introduced in the 1995 Code to handle relatively small expansions to large feedlots where the expansion would occur on the opposite side of the lot, away from the nearest neighbouring residence.
- The removal of Factor C.
- The initial siting factor of 1.14 as a permanent part in the MDS equation since all published tables can be applied to developments at new locations.
- The removal of Factor E.
- The introduction of the expansion factor table for expansion of existing livestock facilities.
- The equation calculating the MDS curves was updated to facilitate the trend towards larger operations.
- The introduction of pre-calculated MDS tables based on animal category and on total livestock siting units (Raw MDS).

Livestock Siting Unit (LSU)

The term Livestock Siting Unit (LSU) was introduced into the 1995 Code to simplify the MDS equation. Field experience showed that since each livestock production species utilized one predominant type of housing system, Factor D was redundant and could be combined with Factor A. Combining these factors along with the Manure Unit Reciprocal (1/Animal Units) produced an LSU Factor. Therefore, each livestock type has its own unique LSU factor. When multiplied by the number of animals, the number of Livestock Siting Units indicated its relative odour potential. This greatly simplified the determination and interpretation of the MDS by allowing the use of pre-calculated tables for each common livestock species.

LSU Factor = (Factor A) x (Factor D) x (MU Reciprocal)

Factor A: The relative nuisance of various livestock species.

Factor D: The contribution of the manure management system to the nuisance level.

MU Reciprocal: Takes into account the relative size of the animal, therefore the amount of manure produced (1/AU). A livestock manure unit is defined as the number of livestock needed to produce enough manure to meet the nitrogen requirements of one acre of crop land. For many species, 1000 lbs or 454 kg of live weight approximates a livestock manure unit. Therefore, the MU Reciprocal can be thought of as describing the relative contribution an individual animal makes in the generation of manure.

No. of LSUs = (No. of animals) x (LSU Factor)

For new operations the MDS calculation is:

$(\text{No. of LSUs})^K \times 0.12 \text{ (Constant)} \times 1.14 \text{ (Initial Siting Factor)} \times \text{Category Distance}$

For expanding operations the MDS calculation is:

$[(\text{No. of LSUs})^K \times 0.12 \text{ (Constant)} \times 1.14 \text{ (Initial Siting Factor)} \times \text{Category Distance}] \times \text{Expansion Factor (\% change in existing operation)}$

Expansion factor

The values applied to existing operations ranged from 0.6 to 1.0 (0 - 500 % increase in operation size).

Initial Siting factor

The initial siting factor of 1.14 became a permanent value in the MDS equation for both new operations and expanding operations.

Constant

The constant of 0.12 is part of the mathematical expression used to generate the curves used in odour dispersion for generating base distances and tolerances according to the number of animals.

Exponent (K)

The exponent K, like the constant, is part of a mathematical expression used to generate the curve used in odour dispersion for generating base distances and tolerances according to the number of animals. It had two values: 0.33 for poultry and 0.365 for all other species.

The 1995 Code of Practice contained pre-calculated tables for the LSU Factor and the MDS for specific types of animals (based on the number of animals). It also introduced the Raw MDS method. The Raw MDS is a calculation of the MDS for any category of livestock for a new location. This may involve singles species, several size categories of the same species or multiple/mixed species operations. The LSU Factor for each type of species was taken from the table then multiplied by the number of animals to determine the number of LSUs. These LSU numbers were added together to determine the total number of LSUs on the operation. Based on the total number of LSUs, a table containing the pre-calculated MDS values for the three different categories was used. The Raw MDS is equivalent to the MDS for new operations. The term "Raw" simply means that no expansion factor has been applied. All the MDS tables are actually Raw MDS tables since they assume that the operation is being sited at a new location.

All possible variables related to livestock design, siting and manure management are impossible to include in the MDS method, therefore the introduction of a variance to reduce the MDS was included. It allowed for new technological advances for reducing odours based on unique topography and/or micro-climate, visual screening, prevailing winds or unique management or technology.

4. Addendum to the 1995 Code of Practice for the Safe and Economic Handling of Animal Manure

The Addendum was printed in May, 1999 as an update to the 1995 Code of Practice to clarify areas of ambiguity regarding the definition of a CFO and determination of the MDS. Several new categories of species of animals were added to keep up with industry changes. As an example, the LSU values for Swine were expanded to address some of the new segregated housing systems being used. It also made a clearer distinction between liquid and solid manure housing systems.

With regards to expanding operations, the Expansion Factors were revised and made more stringent as some people were using the expansion factor as a loophole for development. These values still ranged from 0.6 to 1.0, however, the percent increase in operation ranged from < 29 to 300 %. Anything over a 300 % increase in operation size would be considered a new operation and therefore, no expansion factor would be applied.

The base distance of 800 metres originally introduced in the 1982 Code of Practice was reinstated into the document and referred to as Category 4. This was to provide protection to rural hamlets, villages, etc. that aren't protected with a surrounding development control zone or joint municipal plan. It was defined as "from boundary of rural hamlet, village or residential zoning".

5. 2000 Code of Practice for Responsible Livestock Development and Manure Management

The MDS formula in the 2000 Code of Practice didn't vary much from the 1995 Code or its Addendum. However, some refinements were made.

The LSU values for various species and operation types were greatly expanded to target the growing and diverse industry in Alberta. A key issue in this was distinguishing between solid or liquid manure storage systems.

The exponent K used in the MDS formula no longer had two different values. The value of 0.365 was used for all species (the value of 0.33 for poultry was dropped).

The Reciprocal MDS, initially developed for the Certificate of Compliance program to protect existing CFOs from urban or residential encroachment was removed.

Current Application in Alberta

Agricultural Operation Practices Act, Standards and Administration Regulation (2002)

Primarily based on the 2000 Code of Practice, this regulation came into effect on January 1, 2002 with the Natural Resources Conservation Board (NRCB) as the approving authority. Though it essentially remained the same, the MDS was refined to include the allowance for new and emerging technologies such as biofilters and lagoon covers. What did occur was a redefining of terminology that explained the formula. The MDS formulas are now defined as follows:

For new operations the MDS calculation is:

$$(\text{Odour Production})^K \times (\text{Odour Objective}) \times (\text{Dispersion Factor})$$

For expanding operations the MDS calculation is:

$$(\text{Odour Production})^K \times (\text{Odour Objective}) \times (\text{Dispersion Factor}) \times (\text{Expansion Factor})$$

Odour production

Is measured by Livestock Siting Units or LSUs. It is a compilation of factors which takes into account the number of animals or the size of the operation (not animal units), the nuisance value of the livestock species (Factor A), the technology of the production system or the manure

system (Factor B), and the amount of manure produced by the animals (MU Reciprocal).

Odour Production = No. of LSUs

No. of LSUs = (Factor A) x (Factor B) x (MU Reciprocal) x (No. of Animals)

Factor A: This is the nuisance value of the livestock species and addresses the fact that some species produce more odours than others.

Factor B: This value takes into consideration the type of manure system used on the operation and the effect that it has on reducing the odour nuisance level. As new technologies for reducing odour production evolve, this value can change. However, this information must be approved and proven to the NRCB, otherwise the values listed in the Standards are to be applied.

MU Reciprocal: This is the amount of manure produced by the animal and is expressed as 1/Animal Units. Animal Units are the factors applied to the species and are based on the number of animals needed to produce enough manure to meet the nitrogen requirements of one acre of crop land. For many different species, 454 kg (1000 lb) of live weight equals approximately one animal unit. Values for Animal Units can be found in the Matters Regulation.

Odour objective

This describes the sensitivity or assumed tolerance level of neighbouring land uses and is based on the four zoning Categories. The base distances based on the sensitivity of neighbouring land uses remained the same (300, 400, 500 and 800 metres) but the category definitions were redefined to better reflect the changing landscape. They are:

Category 1: Land zoned for agricultural purposes such as farmsteads, acreage residences, etc.

Category 2: Land zoned for non-agricultural purposes such as country residential, rural commercial businesses, etc.

Category 3: Land zoned as large scale country residential, high use recreational or commercial purposes as well as from the urban fringe boundary or land zoned as rural hamlet, village or town which has an urban fringe.

Category 4: Land zoned as rural hamlet, village or town without an urban fringe.

The Odour Objective is determined as follows:

Odour Objective = (Category Base Distance) x (Constant) x (Initial Siting Factor)

The Constant (0.12) and the Initial Siting Factor (1.14) remained the same. By multiplying these values by the Category Base Distance, the Odour Objectives for each Category are:

Category 1 = 41.04 metres

Category 2 = 54.72 metres

Category 3 = 68.40 metres

Category 4 = 109.44 metres

Dispersion factor

The Dispersion Factor can allow for a variance to the MDS based on unique climatic and topographic influences at the site that are proven to change the dispersion of odour. The conditions listed below must be proven to demonstrate a reduction and must be approved by the

NRCB. If there is no evidence of a reduction, a value of 1.0 will automatically be applied. Examples of new technologies that may be considered include:

Topography Factor: Unique topographical features at the site such as lower or higher elevation differences, surface roughness, etc.

Screening Factor: Natural or constructed screening such as crops, trees, undulating hills, valleys, shelterbelts, etc. which reduce the wind effects at the manure storage.

Micro-climate Factor: Meteorological data recorded at the site over an extended period of time may show a significant alteration in odour intensity or frequency occurrence in relation to neighbouring land use. These include temperature, humidity, wind direction and intensity.

Expansion factor

This is only applied to expanding operations that are increasing the size of the facility to store more manure or to accommodate more animals. This factor can only be determined and applied by the NRCB.

Exponent (K)

This value remains unchanged and is 0.365 for all species.

Summary

Odour nuisance is a subjective response. MDS is a tool to establish a buffer between a confined feeding operation or manure storage facility and a neighbouring residence to minimize the effects of odour.

MDS is a setback of "nuisance" factors predicated on the dispersion theory.

To a large extent the MDS was based on empirical data that has been developed by people with scientific training (engineers and land use planners), applied in several geographic areas in Canada, based on sound scientific principles (dispersion of gases and particulates over distance) and more recent studies that support the concept.

Comparison of Values

Comparison of MDS values for a new operation

As an example, consider a new, 600 Feeder Hog barn with a Category 1 classification. Values will be based on liquid manure.

1982 Code of Practice - MDS is 342 metres - base distance of 350 metres.

1995 Code of Practice - MDS is 316 metres - base distance of 300 metres

Addendum to the 1995 Code - MDS is 314 metres

2000 Code of Practice - MDS is 314 metres

2002 AOPA - MDS is 314 metres

Comparison of MDS values for an expanding operation

As an example, we will use an existing 600 Feeder Hog barn with a Category 1 classification that is expanding to 1800 feeders. Percentage of change is 200%. Values will be based on liquid manure.

1982 Code of Practice - MDS is 405 metres - base distance of 350 metres, expansion factor of 0.97

1995 Code of Practice - MDS is 377 metres - base distance of 300 metres, expansion factor of 0.8

Addendum to the 1995 Code - MDS is 424 metres, expansion factor of 0.9

2000 Code of Practice - MDS is 424 metres, expansion factor of 0.9

2002 AOPA - Expansion factor determined by NRCB

References

Historical Documents and Sources of Information

Confinement Livestock Facilities Waste Management Code of Practice, Alberta Agriculture and Alberta Environment, 1973.

Confinement Livestock Facilities Waste Management Code of Practice, Agdex 400/27-1, Alberta Agriculture and Alberta Environment, 1982.

How to Obtain Approvals for Developing Livestock Facilities, Agdex 721-6, Alberta Agriculture, 1984.

Code of Practice for the Safe and Economic Handling of Animal Manures, Agdex 400/27-2, Alberta Agriculture, Food and Rural Development, 1995.

Addendum to the 1995 Code of Practice for the Safe and Economic Handling of Animal Manures, Alberta Agriculture, Food and Rural Development, May 3, 1999.

Brian West, Westpeake Consulting Ltd.

Current Documents

Agricultural Operation Practices Act, Standards and Administration Regulation (AR 267/2001), January 1, 2002.

[https://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/epw2069](https://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw2069) (accessed on 2019-01-09)