

# **Managing Air Emissions from Confined Feeding Operations in Alberta**

**A report to the CASA Board from the  
CFO Project Team**

March 2008

## Acknowledgements

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The CFO Project Team gratefully acknowledges Alberta Agriculture and Rural Development and Alberta Environment for their financial support for this project.

All members of the CFO team showed remarkable dedication and commitment to the challenges presented by this work. The volunteer time given to the project by individuals and by organizations was significant.

## About CASA

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The Clean Air Strategic Alliance (CASA) is a non-profit association composed of stakeholders from three sectors – government, industry and non-government organizations such as health and environmental groups. All CASA groups and teams, including the board of directors, make decisions and recommendations by consensus. These recommendations are likely to be more innovative and longer lasting than those reached through traditional negotiation processes. CASA's vision is that the air will be odourless, tasteless, look clear and have no measurable short- or long-term adverse effects on people, animals or the environment.

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## Acronyms and Abbreviations

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AAAQOSAC	Alberta Ambient Air Quality Objective Stakeholder Advisory Committee
AARD	Alberta Agriculture and Rural Development (formerly Alberta Agriculture and Food)
AOPA	<i>Agricultural Operation Practices Act</i>
AQO	Air Quality Objective
BATEA	Best Available Technology that is Economically Achievable
BMP	best management practices
CASA	Clean Air Strategic Alliance
CFO	Confined Feeding Operation
EPEA	<i>Environmental Protection and Enhancement Act</i>
FAQs	frequently asked questions
FIDO	frequency, intensity, duration and offensiveness
H <sub>2</sub> S	hydrogen sulphide
ILWG	Intensive Livestock Working Group
NPRI	National Pollutant Release Inventory
NRCB	Natural Resources Conservation Board
NH <sub>3</sub>	ammonia
PM	particulate matter (includes PM <sub>2.5</sub> and PM <sub>10</sub> )
ppm	parts per million
ppb	parts per billion
TRS	total reduced sulphur
US EPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

## **Executive Summary and Recommendations**

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In response to a statement of opportunity presented by the Intensive Livestock Working Group and Alberta Agriculture and Rural Development, the CASA Board established the CFO project team in September 2005. The CASA consensus process was viewed as a beneficial way to address stakeholder concerns.

The goal of the CFO project team was to develop a strategic plan to improve the management of air emissions from existing and future CFOs in Alberta and to improve relationships between stakeholders. In developing the plan, the team was to consider the following principles:

- continuous improvement and pollution prevention to protect air quality;
- prevention of short and long-term adverse effects on human, animal and ecosystem health due to air emissions; and
- assurance that air quality recommendations maximize social, economic, environmental and health benefits and minimize social, economic, environmental and health costs.

Among the substances emitted by CFOs into the air, the team identified five priority substances: ammonia, hydrogen sulphide, volatile organic compounds, particulate matter, and bioaerosols/pathogens. It was agreed that odour is a priority issue, recognizing that there are fundamental differences between odour and the priority substances.

The team undertook a great deal of work in subgroups to compile and assess information on emissions, health effects, potential management mechanisms, and approaches taken by other jurisdictions to address these issues. The subgroups produced detailed reports that enhanced the knowledge base of the project team and provided much of the necessary information for the strategic plan. The subgroups also suggested recommendations to the project team. All of the recommendations were considered and many became part of the project team's strategic plan.

The CFO project team strived to develop a common understanding of stakeholder concerns related to CFOs. The project team agreed that stakeholder relationships around the table were improved over the course of the team's work. Greater understanding, combined with the information gathered, enabled the team to reach consensus on the following recommendations. The recommendations are a package on which the team has full stakeholder support, and should therefore be considered in their entirety.

### **Recommendation 1: Development of a New Emissions Inventory**

The CFO project team recommends that

The Government of Alberta, led by Alberta Agriculture and Rural Development, with support from Alberta Environment and advice from a multi-stakeholder group formed for this purpose, compile an inventory for CFO air emissions in Alberta based on the US EPA National Air Emissions Monitoring Study, with the inventory to be completed by March 31, 2011.

### **Recommendation 2: Source Apportionment**

The CFO project team recommends that

Alberta Environment, with support from Alberta Agriculture and Rural Development and the intensive livestock industry, conduct specific studies in areas with CFOs, using suitable source apportionment methods to estimate the contribution of CFO emissions of the five priority substances relative to other sources of these emissions. These studies are to be completed by December 31, 2010.

### **Recommendation 3: Monitoring for Ammonia, H<sub>2</sub>S, PM and VOCs**

The CFO project team recommends that:

Alberta Agriculture and Rural Development:

- a) develop, with input from all stakeholders, an ambient monitoring plan for ammonia, H<sub>2</sub>S, PM and VOCs to determine current ambient levels around CFOs. The plan will include timelines, budget, methodology (with reference to the Air Monitoring Directive), and responsibilities;
- b) undertake ambient air monitoring of ammonia, H<sub>2</sub>S, PM and VOCs around CFOs, based on the above plan, beginning in 2008; and
- c) submit a status report by March 31, 2009, with a final report on results to be submitted by March 31, 2010 to CFO project team stakeholders and the Alberta Ambient Air Quality Objectives Stakeholder Advisory Committee.

### **Recommendation 4: The 24-hour AQO for Ammonia:**

The CFO project team recommends that:

The Alberta Ambient Air Quality Objective Stakeholder Advisory Committee defer its decision on a 24-hour ambient objective for ammonia until April 2009, at which time the AAAQOSAC will determine if they have sufficient information from the ambient air monitoring study on which to base a decision.

### **Recommendation 5: Management Mechanisms Research Plan**

The CFO project team recommends that:

Alberta Agriculture and Rural Development and the CFO industry develop a plan to submit to the Government of Alberta and research agencies for funding to do a study to quantify the reductions in priority emissions and odour, and any other benefits, from frequent manure removal, manure application, and moisture management.

### **Recommendation 6: Paper Study on Potential Management Mechanisms**

The CFO project team recommends that:

Alberta Agriculture and Rural Development lead a paper study on the following five management mechanisms, to assess their potential to favourably affect emissions, ambient air quality, nutrient recovery, and other potential benefits, and report back to CFO project team stakeholders by March 31, 2009, at which time consideration will be given as to where the research might be applied.

- Biocovers
- Bottom loading
- Shelterbelts
- Composting
- Dust palliatives

### **Recommendation 7: Odour Management Plan Template**

The CFO project team recommends that:

The CFO industry develop an odour management plan template for use by operators in the intensive livestock industry. The plan will be based on economic feasibility, scientific evidence of odour reductions, and new technology, specifically best available technology economically achievable (BATEA), and will be ready for use by January 2009.

### **Recommendation 8: Managing Odour in Problem Areas**

The CFO project team recommends that:

The CFO industry work with operators in problem areas to develop a site specific odour management plan. The Government of Alberta will provide resources (expertise, skills, knowledge) to assist with plan development and implementation. Problem areas will be identified using information from the NRCB and the industry. In working with operators, the industry and government may want to consider measuring odour around CFOs.

### **Recommendation 9: Improving Communications**

The CFO project team recommends that:

The NRCB and Alberta Agriculture and Rural Development work with all involved parties to develop a plan by March 31, 2009 to improve communications and relationships among stakeholders regarding information related to CFOs. The following are areas where attention should be focused to improve communications and stakeholder relationships:

- Alternative dispute resolution processes,<sup>1</sup>
- Communications between agencies and Government of Alberta departments, and
- Communications between the NRCB and complainants.

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<sup>1</sup> Alternative dispute resolution (now referred to as Appropriate Dispute Resolution by the Energy Resources Conservation Board) includes a variety of options available to the concerned parties to manage disputes, such as direct negotiation between the affected parties, facilitation, third-party mediation, arbitration, and public hearings. ADR aims to help people explore and understand each other's interests and develop acceptable solutions together by creating an environment that supports respectful discussion. The solutions generated by the parties reflect their respective interests and are often solutions that would not have been arrived at individually. For more information, visit the ERCB's website at [http://www.ercb.ca/portal/server.pt/gateway/PTARGS\\_0\\_0\\_314\\_246\\_0\\_43/http%3B/ercbContent/publishedcontent/publish/ercb\\_home/public\\_zone/ercb\\_process/appropriate\\_dispute\\_resolution\\_adr/](http://www.ercb.ca/portal/server.pt/gateway/PTARGS_0_0_314_246_0_43/http%3B/ercbContent/publishedcontent/publish/ercb_home/public_zone/ercb_process/appropriate_dispute_resolution_adr/)

**Recommendation 10: Evaluating the Strategic Plan**

The CFO project team recommends that:

The CASA secretariat reconvene the CFO team in January 2011 to:

- a) review the implementation status and outcomes of recommendations made in this report,
- b) assess the success of these activities, and
- c) make any further recommendations, if needed, to reduce air emissions from CFOs in Alberta related to this strategic plan.



# 1 Confined Feeding Operations in Alberta

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Confined feeding operations (CFOs) are defined as fenced or enclosed land or buildings where livestock are confined for the purposes of growing, sustaining, finishing or breeding by means other than grazing, and any other building or structure directly related to that purpose, but does not include residences, livestock seasonal feeding and bedding sites, equestrian stables, auction markets, race tracks or exhibition grounds (AOPA, Section 1).

In Alberta, a CFO is generally thought of as beef feedlots, hog operations, dairy operations, and chicken, turkey and egg operations. As of 2004, Alberta had approximately 212 feedlots with over 1000 head capacity, 1200 hog operations, 800 dairy operations, 285 broiler operations, 40 hatching egg operations, 59 turkey operations, and 170 table egg operations dispersed throughout the province.<sup>2</sup> Statistics Canada's 2001 Agricultural Census estimated that Alberta had the following numbers of animals, but numbers depend on which definition of CFO is used. For example, there are beef cattle included in the numbers below that are not on CFOs. Most of the dairy cattle, pigs, sheep and poultry would be on CFOs.

- Dairy cattle: 84,044
- Beef cattle: 6,531,157
- Pigs: 2,027,533
- Sheep: 307,302
- Poultry: 2,907,377

Although CFO operations are located throughout the province, some types of CFOs concentrate in certain geographical areas because of access to meat processing plants and natural resources, such as water and fertile soil for growing crops for animal feed. The feedlot industry, for example, is located mainly south of Calgary and the swine industry is located mainly along the Highway 2 corridor.

Alberta Agriculture and Rural Development (AARD) is responsible for legislation and associated environmental regulations for all livestock operations in Alberta, to ensure that they meet the needs of the livestock industry and the public. The *Agricultural Operation Practices Act* (AOPA) was enacted on January 1, 2002, launching a new standard for management of Alberta's livestock industry. AOPA was amended in 2004 and again in 2006 to provide further clarification of the requirements for the livestock sector. The purpose of AOPA is to ensure that the province's livestock industry can grow to meet the opportunities presented by local and world markets in an environmentally sustainable manner.

AARD is responsible for AOPA and takes a lead role in providing extension services, information materials and technology transfer of applied research related to AOPA. The Natural Resources Conservation Board (NRCB) administers AOPA and reports to the Minister of Sustainable Resource Development. Under AOPA, the NRCB reviews and processes applications for new and expanding CFOs, and is also responsible for addressing public complaints, compliance monitoring and enforcement of permit conditions and AOPA. The Farmer's Advocate of Alberta, which is independent of the NRCB, deals with nuisance cases, such as odour or dust resulting from agricultural operations that comply with the legislation. If the dispute cannot be resolved, a party involved in the dispute may submit a written request for the Minister of Agriculture and Rural

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<sup>2</sup> Source: November 2004 Statement of Opportunity presented to the CASA Board; figures compiled by the Intensive Livestock Working Group.

Development to establish a Practices Review Committee to determine if the operation uses generally acceptable practices.

## 1.1 CFOs and Air Quality

An important issue facing existing, expanding and new CFOs relates to public concerns about odour and dust. These arise from nuisance complaints as well as from concerns about the impact of odour and dust on the health of workers, neighbours and local communities. Questions have also arisen about the impact of specific CFO air emissions, including ammonia, hydrogen sulphide, volatile organic compounds, particulate matter and endotoxins, on human and animal health and on air and environmental quality.

CFO emissions are generally diffuse, arising from point and non-point sources,<sup>3</sup> such as feeding pens, lagoons or land after manure application. The emissions arise from the animals themselves, manure, and buildings, and include dust from roads and cropping. Odour emissions from livestock are complex and comprise over 160 compounds. Odour is difficult to quantify and individual reactions to odour are highly variable and hard to predict. These conditions make it very difficult to assess the impacts of odours, resolve odour concerns and implement effective odour controls.

As the CFO industry grew, there was a recognized need to more effectively address a) public concerns about air quality related to CFOs, and b) land use conflicts arising due to Alberta's rapid economic growth.<sup>4</sup> Implementing reasonable, scientifically sound air management practices by CFOs will improve air quality and protect human, animal and environmental health, improve relations between livestock producers and local communities, and ensure the economic prosperity of Alberta's livestock industry. A desire emerged to address CFO air quality issues in a collaborative process involving major affected stakeholders to:

- identify CFO air quality concerns,
- develop an understanding of each other's interests,
- identify common interests, and
- identify and implement innovative solutions that meet common goals and reduce concerns.

In November 2004, the Intensive Livestock Working Group (ILWG)<sup>5</sup> and Alberta Agriculture and Rural Development<sup>6</sup> presented a statement of opportunity to CASA to proactively address CFO air quality concerns in a collaborative process. The CASA Board approved the formation of a working group to develop terms of reference for a project team. These terms of reference were approved by the Board in September 2005 and the CFO Project Team was formed.

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<sup>3</sup> Point sources are stationary and the emissions released can be traced back to a single identifiable location. Non-point sources describe emissions from spatially diffuse and/or numerous sources that can only be measured or estimated using the accumulation of point sources.

<sup>4</sup> The Government of Alberta is conducting extensive work and consultations to develop an integrated Land Use Framework for the province, and is looking at land use conflicts in detail.

<sup>5</sup> The ILWG is an ad hoc committee that addresses common issues facing livestock producers in Alberta. Members include the Alberta Beef Producers, Alberta Cattle Feeders' Association, Alberta Chicken Producers, Alberta Egg Producers, Alberta Hatching Egg Producers, Alberta Milk Producers, Alberta Pork, and Alberta Turkey Producers.

<sup>6</sup> Then called Alberta Agriculture, Food and Rural Development.

## **2 The CASA Confined Feeding Operations Project Team**

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The goal of the CASA CFO Project Team was to work within the CASA consensus process to develop a strategic plan to improve the management of air emissions from existing and future CFOs in Alberta and to improve relationships between stakeholders. In developing the plan, the team considered the following principles:

- continuous improvement and pollution prevention to protect air quality;
- prevention of short and long-term adverse effects on human, animal and ecosystem health due to air emissions; and
- assurance that air quality recommendations maximize social, economic, environmental and health benefits and minimize social, economic, environmental and health costs.

The project team included members from across the industry, as well as representatives of various government departments and agencies, and community and non-government organizations. A list of current and former team members appears in Appendix A and the team's terms of reference are in Appendix B.

Recognizing the amount of work to be done, particularly in relation to gathering the information noted in key task area #5, the team agreed early in the process to form subgroups to focus on specific aspects of its task. After agreeing on the priority substances to be addressed (see section 3), the team established the following four subgroups:

- Emissions Inventory Subgroup
- Health Effects Subgroup
- Jurisdictional Review Subgroup
- Management Mechanisms and Stakeholder Concerns Subgroup

The subgroups completed a very substantial amount of work in assembling their information and presenting it to the team, and each subgroup prepared a draft document for the team to use as background in producing its final report. The team accepted these reports as information but did not reach consensus on all the content in each report. The subgroups' work has been incorporated into this report to the extent that the team reached consensus on the subgroup material.

### **2.1 Concerns Related to CFOs and Air Quality**

Most public environmental concerns in Alberta related to CFO air quality have focused on beef feedlots and hog barns. These concerns have received much attention in recent years from policy makers, the media, environmental groups, local residents, and agricultural producers. It is important to identify concerns so that management mechanisms can be developed to address them.

Stakeholders identified a wide range of concerns for the team to consider. Concerns were expressed about the possible health impacts on residents, employees and livestock from CFO emissions, as well as potential impacts on environmental sustainability. Quality of life for those living near CFOs was also noted as a concern. Generally, it was felt there was a need to consider stakeholder relationships and public perception of the industry. Other stakeholders were concerned about possible impacts on the industry and the costs and benefits associated with the strategic plan. The team tried to address these concerns collaboratively with the recommendations contained in this document.

### 3 Priority Substances and Related Air Issues

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Early in the team's work, members identified five priority substances that are related to CFOs and air quality. Odour was also identified as a priority issue that required the team's attention. These five priority substances were included in the emissions inventory and were also the focus of the work on health effects. Emissions refer to the release of pollutants into the air from a source. Ambient air quality refers to the state of air quality in the surrounding environment. The priority substances were discussed in regards to both emissions and ambient levels. These substances are:

- Ammonia
- Hydrogen Sulphide
- Volatile Organic Compounds
- Particulate Matter
- Bioaerosols/pathogens

#### 3.1 Ammonia

At atmospheric pressure, ammonia ( $\text{NH}_3$ ) is a colourless gas, which is lighter than air and has a strong, penetrating odour. Ammonia has an odour threshold of 5 ppm. Alberta Environment's 1-hour Ambient Air Quality Objective for ammonia is  $1,400 \mu\text{g}/\text{m}^3$  (2,000 ppb) and is based on odour perception. There is presently no 24-hour objective.

#### 3.2 Hydrogen Sulphide and Reduced Sulphur Compounds

Hydrogen sulphide ( $\text{H}_2\text{S}$ ) is formed by microbial decomposition of sulphur-containing organic compounds under anaerobic and aerobic conditions.  $\text{H}_2\text{S}$  is a Reduced Sulphur Compound (RSC). RSCs are generally characterized by strong odours at relatively low concentration. The most common substances within the RSC family that are emitted from industrial sources are: hydrogen sulphide, methyl mercaptan, dimethyl sulphide, and dimethyl disulphide. In some locations in Alberta, ambient monitoring shows that most TRS is made up of  $\text{H}_2\text{S}$ , but the amount of  $\text{H}_2\text{S}$  in TRS varies depending on nearby sources. Alberta Environment's 1-hour Ambient Air Quality Objective for hydrogen sulphide is  $14 \mu\text{g}/\text{m}^3$  (10 ppb) based on odour perception, and the 24-hour Ambient Air Quality Objective is  $4 \mu\text{g}/\text{m}^3$  (3 ppb).

#### 3.3 Volatile Organic Compounds

Volatile Organic Compounds (VOCs) are organic compounds that vaporize easily at room temperature. They readily participate in atmospheric photochemical reactions. They include a range of chemical compounds, all of which contain at least one carbon atom (excluding carbon dioxide and carbon monoxide). VOCs emitted from anthropogenic and biogenic sources react in the troposphere in the presence of  $\text{NO}_x$  and sunlight to form ozone. Alberta Environment has Air Quality Objectives for five VOCs: 2-ethylhexanol, ethylbenzene, isopropanol, toluene, and xylene.

#### 3.4 Particulate Matter

Particulate Matter (PM) is an unusual air pollutant in that it is defined by its physical structure rather than its chemical identity. PM is categorized by its size (diameter), although most PM is highly irregular in shape. The most common classifications are  $\text{PM}_{10}$  (coarse PM), which includes particles

smaller than 10 µm in aerodynamic diameter, and PM<sub>2.5</sub> (fine or respirable PM), which includes particles smaller than 2.5 µm in diameter. Particles can be emitted directly from anthropogenic and natural sources. When PM is directly emitted, it is referred to as primary particulate. However, PM can also be formed as a result of chemical transformations involving other air pollutants. For example, oxides of nitrogen or sulphur (NO, NO<sub>2</sub> and SO<sub>2</sub>) can react with ammonia (NH<sub>3</sub>) to form ammonium nitrate or ammonium sulphate. Particles formed in this way are referred to as secondary particulate. Alberta has adopted a one-hour ambient air quality objective for PM<sub>2.5</sub> of 80 µg/m<sup>3</sup> as well as a 24 hour objective of 30 µg/m<sup>3</sup>.

### **3.5 Bioaerosols/Pathogens**

Bioaerosols include microorganisms such as bacteria, viruses, fungi and actinomycetes, as well as biochemical compounds (e.g., endotoxins, mycotoxins) that are uniquely associated with microorganisms.

### **3.6 Odour**

The team had many discussions about odour and whether or how it should be addressed. Members agreed that:

- Odour is a natural result of livestock production,
- Odour from livestock production constitutes a nuisance, and
- Odour is a priority issue, recognizing that there are fundamental differences between odour and the priority substances.

Section 7 of this report looks at odour in detail.

## 4 Emissions and CFOs

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### 4.1 CFOs as Sources of Priority Substances

#### **Ammonia**

Livestock operations are a major contributor of ammonia emissions. Ammonia is produced inside livestock buildings, in open feedlots, in manure storage facilities, during manure handling and treatment and when manure is applied to soils. The major sources for atmospheric emissions of ammonia in Alberta, in order of output, are: agricultural activities (animal feedlot operations and other activities), biomass burning (including forest fires), fertilizer plants, fossil fuel combustion, and accidental releases.

#### **Hydrogen Sulphide and Total Reduced Sulphur**

Hydrogen sulphide forms when manure is stored under anaerobic conditions,<sup>7</sup> such as liquid manure. It can also arise from shallow barn gutters, pits, outdoor storage holding tanks, and earthen manure storage facilities. Hydrogen sulphide is heavier than air, soluble in water, and can accumulate in underground pits and unventilated areas of livestock buildings.

#### **Volatile Organic Compounds (VOCs)**

A large number of VOCs have been identified in manures. These are generated by the partial breakdown of feed materials by the anaerobic bacteria in an animal's digestive tract. Many of the resultant compounds are highly odorous, the most important of these being volatile fatty acids, indolics, phenolics and sulphur compounds.

#### **Particulate Matter (PM)**

Primary PM sources from CFOs include feed, bedding materials, dry manure, unpaved surfaces within the boundaries of the CFO (e.g., feed alleys and pens), animal dander, poultry feathers, animal activity, animal housing buildings and exhaust fans, mineral and organic material from soil, manure, and water droplets generated by high-pressure liquid sprays.

#### **Bioaerosols and Pathogens**

Many sources of bioaerosols are man-made, such as those generated by sewage and animal waste disposal facilities. In animal houses, bioaerosols are produced from animals, feed, bedding, and feces. The cell debris and microbial organisms become airborne to form bioaerosols, which originate from animal respiration, skin, fur, feathers and manure.

### 4.2 Emissions Inventories

The team reviewed existing emissions inventories for the priority substances. An emissions inventory is an accounting of pollutant emissions released into the air over a given period of time for a given political or geographical region. An emissions inventory may include emissions from both human and natural sources.

An emissions inventory generally summarizes the amount and types of pollutants released into the air, as defined by the objectives of the inventory. Emissions inventories are used for planning,

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<sup>7</sup> That is, in the absence of oxygen.

assessment and research. A CFO emissions inventory would establish a baseline or benchmark for emissions in Alberta at a given point in time. This information could then be used to:

- Determine if emission levels have changed over time,
- Compare trends in emissions,
- Compare CFO emissions to those of other industries,
- Facilitate prioritization of emissions management and potential improvements to future inventories, and
- Develop air quality models for the province of Alberta.

The Emissions Inventory Subgroup reviewed numerous approaches and models used in developing several emissions inventories in western Canada and in the US to determine their applicability to estimating emissions of the priority substances from CFOs in Alberta. The methodology and assumptions used to compile the various inventories were particularly scrutinized. The subgroup recommended that the team use three approaches to estimate emissions for Alberta: the US EPA Ammonia Inventory, the Alberta Agriculture and Food Emissions Inventory and the Carnegie Mellon University Ammonia Model. These approaches were chosen due to the availability and reliability of the data. The results of the three approaches are summarized below in Table 1.<sup>8</sup>

Different methodologies yielded different estimates as seen in Table 1. However, the variation in the estimates was not considered significant.

**Table 1: Estimated air emissions from CFOs in Alberta**

<b>Methodology</b>	<b>Total Estimated Emissions</b>
US EPA Ammonia Inventory (2004)	Ammonia: 167,954 tonnes
Alberta Agriculture and Food Emissions Inventory (2001)	<ul style="list-style-type: none"> <li>• Ammonia: 124,675 tonnes</li> <li>• H<sub>2</sub>S/TRS: 4,012 tonnes</li> <li>• Particulate Matter: 19,539 tonnes</li> </ul>
Carnegie Mellon University Ammonia Model (2001)	Ammonia: 181,069 tonnes

At present, there is no estimated amount of bioaerosols from CFOs in Alberta. The estimated distribution of CFO emissions across Alberta is highest in southern Alberta and lowest in northern Alberta for ammonia, H<sub>2</sub>S/TRS and particulate matter.

#### **4.2.1 A New Emissions Inventory**

Various limitations and uncertainties became apparent to the team during its review of existing inventories and methodologies. The team recognizes that more work is needed to develop and test methods for estimating emissions, but believes this work is important and should proceed in a timely manner.

#### **Recommendation 1: Development of a New Emissions Inventory**

The CFO project team recommends that

The Government of Alberta, led by Alberta Agriculture and Rural Development, with support from Alberta Environment and advice from a multi-stakeholder group formed for this

<sup>8</sup> The methodologies and studies reviewed are described in the Emissions Inventory Subgroup’s report. We may or may not want to provide a reference to the report, depending on how the subgroup reports are handled.

purpose, compile an inventory for CFO air emissions in Alberta based on the US EPA National Air Emissions Monitoring Study, with the inventory to be completed by March 31, 2011.

### 4.3 CFO Air Emissions Compared with Other Industries

The team was also asked to compare air emissions from CFOs with those from other regional and provincial sources, and to look at source apportionment as a way to understand the contribution of CFOs to ambient air quality. The information shown in the table below represents the best estimates available from the National Pollutant Release Inventory (NPRI) database. Agricultural sources are treated as “open sources,” as opposed to the point source data available for other industries. Notably, agricultural emissions using the NPRI approach are significantly lower than estimates by other methods. The table below shows the relative contributions of agricultural and non-agricultural industries to total VOC, ammonia and PM emissions in Alberta.

**Table 2: Estimated emissions of priority substances from agriculture and other industries in Alberta**

	Ammonia*	Hydrogen sulphide	Total PM	VOCs	Pathogens/ Bioaerosols
Agriculture (Animals)	80,865.5	N/A	118,543	116,941	N/A
Agriculture Tilling and Wind Erosion	0	N/A	506,778	0	N/A
Total industrial sources <sup>9</sup>	12,092	N/A	63,037.6	370,085	N/A

\* All emissions in tonnes

*Source: Adapted from the NPRI database (Environment Canada) 2005. Data for hydrogen sulphide and pathogens/bioaerosols was not available.*

#### 4.3.1 Source Apportionment

Source apportionment is a method that identifies the relative contributions of different sources to ambient air quality concentrations. CFOs are only one source of the priority substances emitted into the ambient air. To ensure that appropriate management mechanisms are developed and implemented for this and other sectors, it is essential to know where the emissions are coming from.

#### **Recommendation 2: Source Apportionment**

The CFO project team recommends that

Alberta Environment, with support from Alberta Agriculture and Rural Development and the intensive livestock industry, conduct specific studies in areas with CFOs, using suitable source apportionment methods to estimate the contribution of CFO emissions of the five priority substances relative to other sources of these emissions. These studies are to be completed by December 31, 2010.

<sup>9</sup> Total industrial sources does not include transportation, incineration, CFOs or other miscellaneous sources.



## 5 Effects of Emissions from CFOs

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The Health Effects Subgroup spent a great deal of time gathering information on the effects of the priority substances and odour on human, animal and ecological health. The goal was to obtain credible science-based information to help it develop a strategic plan to manage emissions from CFOs in Alberta. The project team accepted the World Health Organization's definition of health, which is, "A state of complete physical, mental and social well being and not merely the absence of disease or infirmity," but did not reach agreement on how this definition could be incorporated into the CFO strategic plan.

At a high level, many studies provided information on the health effects of the priority substances, however, there were limitations on the studies that have been done; for example, in some studies environmental monitoring and clinical assessments were not performed, and confounding aspects (such as the comparability of the study populations) were not considered or weighed.

It was a challenge to determine what the association is, if any, between CFO emissions and public health effects. Views differ, even among experts and in the literature, and trying to compare and assess the impacts of different emissions from operations with different kinds and numbers of livestock, and different climate, management practices and other conditions is very challenging. One way to simplify the association between health effects and CFO emissions is to focus on the proximity to CFOs, but even with this approach there are many contextual variables, acting together, that determine whether effects will occur.

There is little research on the health effects of animals in CFOs as these effects relate to air quality. Studies reviewed by the team were conducted in both laboratory experiments and in a typical CFO. Findings within a CFO may not be as accurate due to the difficulty of isolating and measuring particular gases. Although little formal research has been done, agricultural producers have refined and improved their practices over time based on their knowledge, experience and daily observations. For example, when decreased growth rate is noticeable and may be due to air quality, producers have added technology, such as ventilation and management practices such as removing manure from the barn, to improve air quality. Quality care for the animals is crucial to the sustainability of the livestock industry.

Given the challenges above, the team did conclude that there could be health effects related to air emissions from CFOs. The sections below provide a short summary of the health effects associated with the five priority substances and odour. The described effects can occur irrespective of the source of the exposure.

### 5.1 Ammonia

Ammonia (NH<sub>3</sub>) dissolves readily in water to form ammonium hydroxide, which is corrosive. As a result, it can irritate the skin and mucous membranes of the body such as the eyes, throat, and lungs with severity of effects depending on the level of exposure. The effects, depending on the concentration, range from severe burns of the skin and eye to wheezing, coughing, nasal and bronchial discharge, upper way obstruction, bronchospasm and lung edema. Because NH<sub>3</sub> is rapidly metabolized by the body, it is a local rather than systemic irritant. Exposure effects are localized at the site of the air-body interface, such as at the surface of eye, skin or respiratory system. Human

health effects can be reversible or irreversible depending on the exposure concentration and duration of exposure.

In general, the health effects following chronic inhalation exposure of animals to ammonia include nasal irritation, lung inflammation, reduced olfactory acuity, and lethargy. Animal studies have also demonstrated reduced immune response and increased respiratory tract susceptibility to bacterial infection.<sup>10</sup>

### **5.1.1 24-Hour Ambient Air Quality Objective for Ammonia**

In 2000, a multi-stakeholder workshop recommended that Alberta Environment's Ambient Air Quality Objective Stakeholder Advisory Committee should review the ambient air quality objective (AQO) for ammonia. Following the review by the Committee's ammonia subgroup, the one-hour AQO did not change, but a new 24-hour objective for ammonia of 200 µg/m<sup>3</sup> was proposed, based on a health effects threshold. The primary intent was to address emissions from industries other than CFOs (e.g., fertilizer manufacturing).

Shortly after the 60-day period for public comments ended, Alberta Environment received concerns from the livestock industry and Alberta Agriculture and Rural Development about the proposed objective. Although the subgroup reconvened with new representatives from the livestock industry, they could not reach consensus on a 24-hour objective. The Advisory Committee retained the 1-hour ammonia objective, but decided to ask the CFO project team to consider this matter and agreed to defer a decision on a 24-hour or annual AQO for ammonia until the CFO team completed its work.

The project team appreciates the opportunity to provide input on this important matter. The team notes the limited data regarding emissions from CFOs since, to date, there has been little ambient air monitoring in the vicinity of CFOs in Alberta. Despite variable factors, it is unknown whether a CFO would ever exceed the proposed 24-hour objective and more definitive information is needed on ammonia emissions and levels. Monitoring for ammonia in the vicinity of CFOs would provide the information needed to determine if there is an impact from the CFO industry on ambient air quality. If ambient emissions turn out to be higher than expected, discussions may be needed on potential CFO management mechanisms. The CFO project team is also aware that the CASA Ambient Monitoring Strategic Plan team is assessing the ambient monitoring program in Alberta to enable trends analysis and regional comparisons.

Recommendations to address ammonia monitoring appear in section 5.5.

## **5.2 Hydrogen Sulphide and Reduced Sulphur Compounds**

At low concentrations H<sub>2</sub>S is primarily an eye and respiratory tract irritant. At high concentrations, it is neurotoxic and as concentration or exposure time increases, H<sub>2</sub>S exposure effects are more serious and include eye damage, lung edema, unconsciousness and death. Information on the effects of low concentrations of H<sub>2</sub>S on animals is limited, but experimental studies have shown effects such as irritation of eyes and mucous membranes. Higher levels create signs of stress, breathing problems and ultimately death at very high concentrations.

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<sup>10</sup> WBK 2002 Assessment Report on Ammonia for Developing an Ambient Air Quality Guideline. Volume I. WBK & Associates Inc. Prepared for Alberta Environment. March 2002.

### 5.3 Volatile Organic Compounds (VOCs)

Like hydrogen sulphide, total reduced sulphur compounds, and ammonia, VOCs are odourous compounds and exposure to VOCs can result in a health effect. It can be difficult to study the health effects of VOCs and studies need to be interpreted with caution because it is difficult to determine VOC levels. One study (Schiffman 1998; in Johnston and Weibel 2006<sup>11</sup>) identified four ways by which VOCs can adversely affect humans.

- VOCs can irritate eyes, nose, throat and cause headaches and drowsiness.
- VOCs can produce reversible or irreversible effects in organs and tissues (beyond simple irritation).
- VOCs can affect neuro-chemical activity which can impair mood and performance.
- Odours from VOCs can trigger memories that can affect cognitive function, altering one's emotional state and mood.

### 5.4 Particulate Matter (PM)

Health impacts of particulate matter generally depend on particle size. A number of studies of human health have been done, but the effects of dust on animals are difficult to quantify because of the different sizes, what the dust carries with it and where the dust is from. As the amount of PM increases, odours generally increase as odour particles can attach to PM particles.

In humans, the preferential deposition of coarser PM (PM<sub>10-2.5</sub>) in the upper airways (nose, throat and tracheobronchial area) is associated with irritation and inflammation of the upper respiratory tract, including aggravation of asthma. The presence of particulates of biological origin in PM<sub>10-2.5</sub> may predispose sensitized individuals to an allergic response, independent of asthma.

Inhaled fine PM (PM<sub>2.5</sub>) can penetrate deep into the lungs and be distributed via the blood throughout the body. Exposure to PM<sub>2.5</sub> may be associated with decreased lung function as well as increases in:

- Mortality for respiratory and cardiovascular causes,
- Hospital admissions and emergency room visits for respiratory and cardiovascular reasons,
- Pneumonia and aggravation of chronic obstructive pulmonary disease,
- Aggravation of asthma, and
- Symptom presentation for cough association with lower and upper respiratory effects.

### 5.5 Monitoring for Ammonia, H<sub>2</sub>S, PM and VOCs

The project team recognizes the value and importance of monitoring ambient air quality. Information gained through ambient air quality monitoring can give us an idea of the concentrations of particular compounds that people are exposed to, and it also supports reporting on the state of the environment. The team reiterates the need for more ambient air quality information to be collected in the vicinity of CFOs.

#### **Recommendation 3: Monitoring for Ammonia, H<sub>2</sub>S, PM and VOCs**

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<sup>11</sup> Johnston, Tom and Weibel, Amber. 2006. Industrial Hog production and the Hog-barn Neighbourhood Effect in Lethbridge County, Alberta. *Western Geography*, 15/16, pp. 53-67.

The CFO project team recommends that:

Alberta Agriculture and Rural Development:

- a) develop, with input from all stakeholders, an ambient monitoring plan for ammonia, H<sub>2</sub>S, PM and VOCs to determine current ambient levels around CFOs. The plan will include timelines, budget, methodology (with reference to the Air Monitoring Directive), and responsibilities;
- b) undertake ambient air monitoring of ammonia, H<sub>2</sub>S, PM and VOCs around CFOs, based on the above plan, beginning in 2008; and
- c) submit a status report by March 31, 2009, with a final report on results to be submitted by March 31, 2010 to CFO project team stakeholders and the Alberta Ambient Air Quality Objectives Stakeholder Advisory Committee.

#### **Recommendation 4: The 24-hour AQO for Ammonia:**

The CFO project team recommends that:

The Alberta Ambient Air Quality Objective Stakeholder Advisory Committee defer its decision on a 24-hour ambient objective for ammonia until April 2009, at which time the AAAQOSAC will determine if they have sufficient information from the ambient air monitoring study on which to base a decision.

## **5.6 Bioaerosols and Pathogens**

Bioaerosols can adversely affect human health by inhalation, skin and/or eye contact or ingestion. Because exposures occur to complex mixtures of pathogens, toxins, allergens and chemicals, a wide range of human health effects are associated with exposure to bioaerosols, including infectious diseases, acute toxic effects, allergies and cancer.<sup>12</sup> Respiratory symptoms and lung function impairment are the most widely studied and probably among the most important health effects associated with bioaerosols. The effect of bioaerosols on animals is unclear because of variations in CFO management, construction and the difficulty in quantifying amounts.

## **5.7 Odour**

Studies indicate that CFO odours do extend into surrounding areas at levels that may disrupt quality of life. Some stakeholders were of the view that odour from CFOs can have health effects, while others did not believe there is definitive proof of such a connection. There was no consensus on the team whether the effects of odour are psychosocial or psychological in origin. Similarly, there is no consensus in the scientific literature on this question as studies have been done that appear to support both points of view. Along with other issues, this is an information gap.

## **5.8 Effects of Multiple CFOs**

Although not explicitly part of the team's terms of reference, some members noted that the expansion of the intensive livestock industry has meant a growing number of operations, which contributed to greater concentrations of CFOs in some parts of Alberta. This could have implications for residents who live near a number of CFOs.

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<sup>12</sup> Douwes, J., P. Thorne, N. Pearce, and D. Heederik. 2003. Bioaerosol Health Effects and Exposure Assessment: Progress and Prospects. *Ann. Occup. Hyg.* 47(3):187-200.

As noted in the original statement of opportunity to CASA, the intensive livestock industry has recognized that an important issue facing existing, expanding and new CFOs relates to public concerns about odour and dust – from nuisance complaints as well as concerns about the impact of odour and dust on the health of workers, neighbours and local communities. Questions have also arisen about the impact of specific CFO air emissions on air and environmental quality. These concerns hold true for both individual CFOs and multiple CFOs in an area.

A number of studies have looked at the impacts on health and quality of life of communities near multiple CFO developments. Some stakeholders believe that those living in close proximity to CFOs can face unique health challenges and impacts on their quality of life. However, there are many variables to consider, symptoms are not always consistent, and proximity to CFOs is not usually the only determining factor.

## 6 Management Mechanisms

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Part of the mandate of the CFO project team was to develop a strategic plan to improve the management of air emissions from existing and future CFOs in Alberta. This involved compiling a list of stakeholder concerns and identifying technologies and management practices that have the potential to mitigate, reduce, minimize or eliminate emissions from CFOs in Alberta. Much of this work was done by the Management Mechanisms and Stakeholder Concerns Subgroup, which then recommended a short list of priority mechanisms for the team to consider.

Confined feeding operators in Alberta have implemented and are applying a range of management mechanisms. Management mechanisms are adopted for a variety of reasons including economics, production efficiencies, environmental benefits and reduction in nuisance for neighbours. Barriers to adoption can include the cost of new technology, extra labour required and potential negative consequences on other parts of the production system. Not all management mechanisms will be appropriate for the current production system, and technology advancements may be required before such mechanisms can be implemented. Operator awareness and knowledge of particular management mechanisms could also be an obstacle.

### 6.1 Current Efforts to Reduce Emissions

Over the last few years, Alberta Agriculture and Rural Development has put in place provincial environmental regulations that establish standards for all CFOs. Industry and government have also:

- Worked to increase producer awareness of beneficial management practices that can be implemented on farm to reduce CFO air emissions (e.g., Beneficial Environmental Management Practice manuals, Environmental Farm Plans, conferences focusing on manure management and CFO air emission issues).
- Conducted numerous literature reviews to better understand the sources of agriculture emissions, including the impact of CFO air emissions on environmental quality and human and animal health.
- Worked to identify the source of emissions from livestock operations and to identify practical, cost-effective technologies that can be applied on farm to reduce air emissions.
- Undertaken research in areas where gaps in knowledge have been identified; e.g., impacts of barn air emissions on hog and poultry workers, accurate measurement of odour, odour dispersion modeling, methods to reduce odours, sources of dust emissions and methods to reduce dust, measurement of greenhouse gases and methods to reduce greenhouse gas emissions. New research information has been shared with producers through government and industry newsletters, websites, and workshops.

Land use planning is one important mechanism for reducing conflict among land uses. Minimum distance separation (MDS) and municipal development plans are the primary planning tools now in use. The application and calculation of MDS is specified in AOPA, and approvals may not be issued or amended unless the MDS for the operation complies with AOPA. Specifically, “the minimum distance separation must not be less than 150 m as of the date the application is received by an approval officer of the Board.”<sup>13</sup> The MDS is measured from the outside walls of neighbouring residences (not property line) to the point closest to manure storage facilities or manure collection

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<sup>13</sup> Alberta Regulation 267/2001, *Agricultural Operation Practices Act*, Standards and Administration Regulation, Part 1.

areas. It is calculated in metres, with different equations for new and expanding operations. Because the MDS is mainly concerned with addressing nuisance impacts including odour, the calculations include factors related to odour production, odour dispersion, and overall odour objective. Some stakeholders have suggested that increasing the MDS would help alleviate odour concerns and complaints.

The tables below show the extent to which many of the current management mechanisms have been adopted.

According to the 2006 Census of Agriculture (Table 3), over 30,700 farms are producing manure in Alberta. Most of the manure is used on the farms that produce it. Less than 0.05% of farms sells or gives away manure.

**Table 3: Number of farms reporting production or use of manure**

Total number of farms producing or using manure	Manure applied on the agricultural operation	Manure sold or given to others	Manure bought or received from others	Other manure (composted, dried, processed, stored, etc)
30,723	18,581	1,423	565	13,901

Adapted from Statistics Canada. *2006 Census of Agriculture*.

Manure handling practices have changed over time. As shown in Table 4, fewer farms (73%) are a) applying manure through irrigation, and b) surface-applying liquid manure without incorporation (77%). More farmers are injecting liquid manure than 10 years ago.

**Table 4: Historical summary of manure application**

Manure Application Using:	1995 Farms Reporting (Hectares)	2000 Farms Reporting (Hectares)	2005 Farms Reporting (Hectares)	% change 1995-2005
Solid spreader	17,091 (389,798)	14,988 (419,206)	10,571	-38 %
Irrigation system	95 (4,388)	49 (1,969)	26 (1,582)	-73% (-64%)
Liquid spreader (surface)	1,704 (68,832)	1,345 (76,684)	385 (23,154)	-77% (66%)
Liquid spreader (injected)	141 (12,372)	230 (17,000)	844 (76,255)	498% (516%)

The tables below are adapted from Statistics Canada's 2001 Farm Environment Management Survey. Table 5 indicates that little treatment of stored manure occurs on Alberta farms. Composting is the primary treatment used.

**Table 5: Treatment of stored manure, 2001**

Aeration	Additives	Filtrating Marsh	Composting	Drying	Other Treatments	None
Share of farms with livestock (%)						
3.5	0.8	0.2	60.2	18.2	4.8	27.8

This table relates to nutrients, not necessarily odour.

The odour control measures identified in Table 6 are not widely used on Alberta farms. Over two-thirds of farms use no odour-specific odour control methods. Of those that implement some form of odour control, wind barriers are most commonly used.

**Table 6: Control of odours from livestock buildings, 2001**

Wind barriers	Filters on fans	Other	Total odour control methods	No livestock buildings	No odour control methods
Share of farms with livestock (%)					
10.9	2.4	3.2	<b>16.5</b>	18.8	66.8

Most farms in Alberta spread manure in spring (42%) and fall, as shown in Table 7 below.

**Table 7: Seasonal application of manure, 2001**

Winter	Spring	Summer	Fall
Share of farms with livestock (%)			
8.9	41.9	26.8	58.4
Share of manure produced on farms with livestock (%)			
3.2	30.8	21.1	44.9

Table 8 reflects the extent to which beneficial management practices for manure management had been implemented in 2001.

**Table 8: Beneficial management practices for manure management, 2001**

Fully implemented	Partially implemented	Not available in my region	Not relevant for my farm	Unfamiliar with beneficial management practices
Share of farms with livestock (%)				
12.5	0.9	0.8	27.8	49.9
Share of manure produced on farms with livestock (%)				
25.0	12.5	0.7	10.1	51.7

These tables indicate various levels of adoption of available management mechanisms. Although Table 3 shows many operators are using various methods for treating their stored manure, Table 8 shows that many operators are not familiar with beneficial management practices. While some mechanisms are being used, the potential emissions reductions still need to be documented. Also, work is needed to determine the optimal management mechanisms and practices associated with them (e.g., frequency of manure removal).

### 6.1.1 Government-sponsored Initiatives

The Canada-Alberta Farm Stewardship Program<sup>14</sup> provides eligible producers in Alberta with financial and technical assistance to develop and implement beneficial management practices (BMPs). Eligible producers are those who have completed an Environmental Farm Plan and have received a *Statement of Completion*. There are 26 BMP categories and the total funding per producer

<sup>14</sup> More information on this program can be found at <http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1182886480906&lang=e>.



for all categories is capped at \$50,000. The share of the project that can be cost-funded under the program is either 30% or 50% up to a maximum amount per BMP category (category cap versus program cap). Approximately 3300 projects have been approved for a total of \$16.5-million. Of those, 2800 projects have been completed and \$12-million has been paid out.

Two practices that would reduce odour from CFOs were eligible for funding under the program: lagoon covers and liquid manure injectors. There was very limited uptake for these categories, with fewer than 10 projects in the entire province. The reasons for limited uptake could be the result of limited economic or regulatory incentives for producers to implement these BMPs.

The Government of Alberta has also initiated a program to stimulate bio-energy development, giving the Alberta livestock industry an opportunity to provide feedstock supply (manure) for biogas production. Biogas is created through the fermentation of organic feedstock, including manure, food processing waste or various plants. Bio-digesters convert manure to gas, which can then be used to generate heat and/electricity. Government grants are available through the Bio-refining Commercialization and Market Development Program and the Bio-Energy Infrastructure Development Program to encourage the growth of the bio-energy industry.<sup>15</sup> In 2007/2008, nine projects worth \$2-million were funded through these programs.

### **6.1.2 Industry-sponsored Initiatives**

Industry is also working to increase the uptake of beneficial practices by operators. The Alberta Livestock Industry Development Fund sponsors projects to address environmental issues faced by CFOs. There are three categories of projects: educational workshop and meetings, development of educational tools, and research and development of technology.

Educational workshops and meetings are used to update industry participants on the latest research findings regarding CFO air emissions and community health. They also aim to build an understanding of issues and provide input into how future research and projects can address the issues. The educational tools developed include fact sheets, FAQs, a manual, and other accessible documents of compiled research. Projects on research and development of technology study the effectiveness of manure management tools that address air quality and nuisance issues. Specific research projects include the development of a prototype low draft-low disturbance deep manure injection tool in partnership with Alberta Agriculture and Rural Development, evaluation of biological treatment to reduce odour and gaseous emissions, investigation technologies, and approaches to reduce nitrogen content in manure.

## **6.2 Increasing the Uptake of Beneficial Management Mechanisms**

Through its research and discussions, the team recognized that there are large gaps in information and, in reality, the suite of available management mechanisms is limited. Information gaps are deep and wide in terms of effectiveness, costs, possible synergistic effects, co-benefits, and actual starting points for emissions reductions. Much more information is needed to be able to select and apply the most appropriate management mechanism(s); it is difficult to quantify the benefits of various management mechanisms, there will always be tradeoffs and it is impossible to reduce emissions to zero. It might also be necessary to use more than one technology to solve a problem; e.g., ammonia

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<sup>15</sup> Source: <http://www.energy.gov.ab.ca/BioEnergy/bioenergy.asp>

emissions come from different sources and each source may need a different technique. Also, different mechanisms may be needed for each substance. Each substance category might require different mechanisms, and even within each category a range of approaches may be needed.

### **6.2.1 Management Mechanisms Research**

The Management Mechanisms and Stakeholder Concerns Subgroup was tasked with generating a list of recommended management mechanisms for consideration by the Project Team. The subgroup first identified the stakeholder concerns related to CFOs to be considered when developing management mechanisms. The next step was to develop an extensive list of all management mechanisms that have the potential to reduce any or all of the priority substances. All 48 management mechanisms considered included information on the following criteria: affected substances; potential reduction; practicality; cost and benefit and; information or knowledge gaps. Furthermore, the management mechanisms were categorized according to the source of emissions or concern.

The subgroup then prioritized the management mechanisms. Industry, non-government organizations and public service members of the subgroup worked in their caucuses to review the matrix and prioritize the management mechanisms in their order of preference, documenting any procedures or criteria they used to rate the various mechanisms. The subgroup reviewed the lists and collaboratively developed a short list of eight management mechanisms<sup>16</sup> to recommend to the CFO project team that it thought had the most promise for reducing air emissions from CFOs in Alberta:

- Frequent manure removal
- Manure application
- Moisture management
- Biocovers
- Bottom loading
- Shelterbelts
- Composting
- Dust palliatives

The team agreed with this list, noting that Alberta has more experience with the first three mechanisms. Although these mechanisms may be in place on some CFOs, the potential benefits from their implementation have not been quantified. Knowing the actual impacts on emissions, odour and other health or environmental benefits would be very helpful and research studies to gather this information are needed. To gather the required information, such studies would entail talking to experts, among other things.

#### **Recommendation 5: Management Mechanisms Research Plan**

The CFO project team recommends that:

Alberta Agriculture and Rural Development and the CFO industry develop a plan to submit to the Government of Alberta and research agencies for funding to do a study to quantify the reductions in priority emissions and odour, and any other benefits, from frequent manure removal, manure application, and moisture management.

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<sup>16</sup> See Appendix C for a description of these management mechanisms.

The remaining five mechanisms on the short list have not been used to the same extent as the others, and require preliminary research to assess their potential impacts. This work could be accomplished via a “paper study” (as opposed to a field or laboratory study), in which researchers gather information by reviewing the literature and interviewing experts to assess experiences to date with the application of these mechanisms. The results of such research could then be used to consideration the possible application of these mechanisms in Alberta.

**Recommendation 6: Paper Study on Potential Management Mechanisms**

The CFO project team recommends that:

Alberta Agriculture and Rural Development lead a paper study on the following five management mechanisms, to assess their potential to favourably affect emissions, ambient air quality, nutrient recovery, and other potential benefits, and report back to CFO project team stakeholders by March 31, 2009, at which time consideration will be given as to where the research might be applied.

- Biocovers
- Bottom loading
- Shelterbelts
- Composting
- Dust palliatives

## 7 Odour Management

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### 7.1 Current System for Managing Odours from CFOs in Alberta

The Natural Resources Conservation Board (NRCB) is responsible for responding to odour complaints from CFOs in Alberta. On average, the NRCB receives 900 odour complaints each year, with the number varying with time of year and the type of operations.

In responding to odour complaints, the NRCB must balance three mandates under AOPA: to protect the environment, to reduce nuisances to neighbours, and to ensure the industry can grow. Eight NRCB inspectors respond to odour complaints in the province. The NRCB follows two decision trees, which are used to assess and decide if a complaint needs follow-up; these are presented in Appendix D. The process is designed to ensure that all new complaints are addressed as consistently as possible and responses to re-occurring complaints may be dependent on past history and inspector knowledge. The team is aware of the NRCB's policy on responding to complaints, but some members felt that this approach is not always followed.

When a person phones with an odour complaint, the individual is asked to provide information such as time, weather conditions, have they smelled it before, etc. If the inspector decides the complaint should be investigated, an inspection of the operation is done and assessed against applicable permit conditions and legislative requirements', using the FIDO approach (Frequency, Intensity, Duration and Offensiveness of the odour) and is subjective. It is entirely olfactory as odours are not measured by mechanical or chemical means. The inspector decides if the situation needs follow up or if the odour is due to generally accepted agricultural practice, in which case no action is taken. The Minister of Alberta Agriculture and Rural Development, through the Office of the Farmers' Advocate, may create a practice review committee to determine if the operation is following generally accepted agricultural practices. Operations following generally accepted agricultural practices are not subject to civil action regarding nuisance.

After a complaint is made and the NRCB investigates, the complainant is no longer directly involved in the investigation process. However, the NRCB will keep the complainant informed and inspectors will attempt to call a complainant within 24 hours to acknowledge the complaint, discuss the incident and collect additional information. The complainant will be contacted when the situation has been resolved, unless they request not to be contacted. Often, information from the operator is all that is needed to resolve the issue. For example, when manure is being spread odours are natural and expected and the inspector may decide there is little to be gained by driving to the manure application site.

The NRCB does not get involved with health concerns and cannot, by law, collect health information. If a person feels their health has been affected, the NRCB encourages that they should contact their regional health authority or go to their doctor or hospital.

## **7.2 Improving the Current Odour Management Approach**

To assist the team in recommending an approach to address odour, the Odour Small Group was formed to review odour management frameworks in place in other jurisdictions, specifically the state of Minnesota in the US and New South Wales, Australia. In comparing Alberta's approach to managing odour with these jurisdictions, the Odour Small Group identified what it viewed as gaps in Alberta's current system. It was felt that odour management needed to better address land use planning issues and the complaint process needed to ensure better communications with local residents prior to new or expanding CFO development. The team has attempted to address at least some of these concerns through recommendations 7-9 below.

A key issue with odour is trying to reduce the subjectivity associated with odour assessments, and make the assessment more objective. A better system for measuring odour should also be implemented. Some stakeholders are concerned that odour problems are not being resolved using the current system, but acknowledge that having no odour is not realistic. There are many challenges in dealing with odour, including differences between old and new operations, weather, and numerous other factors.

Members considered whether an odour management plan should be a required part of a CFO application. If so, it then becomes mandatory and enforceable. The team agreed not to make such a recommendation; the recent amendments to AOPA make it unlikely that further changes would be considered at this time.

The team members agree that odour issues affect relationships between stakeholders. Since part of the team's mandate was to identify ways to improve stakeholder relationships, it was important to address the odour issue.

### **7.2.1 Odour Management Plans**

Both the NRCB and Alberta Agriculture and Rural Development have indicated they will work with operators who want to pilot or test management mechanisms on a voluntary basis to help them manage odour. AARD currently helps operators with nutrient management and other plans as part of their best management practices. The intensive livestock industry has developed knowledge and expertise regarding odour management and the team supports the wider application of this information.

#### **Recommendation 7: Odour Management Plan Template**

The CFO project team recommends that:

The CFO industry develop an odour management plan template for use by operators in the intensive livestock industry. The plan will be based on economic feasibility, scientific evidence of odour reductions, and new technology, specifically best available technology economically achievable (BATEA), and will be ready for use by January 2009.

### **7.2.2 Managing Odour in Problem Areas**

The team acknowledged that most CFOs manage their odours properly and are not the cause of most complaints. As well, the team has recognized that it is not realistic to expect there to be no odour from CFOs. Nevertheless, there are some areas where odour concerns and complaints are frequent

and the team believes that these warrant additional effort on the part of the industry and Alberta Agriculture and Rural Development.

### **Recommendation 8: Managing Odour in Problem Areas**

The CFO project team recommends that:

The CFO industry work with operators in problem areas to develop a site specific odour management plan. The Government of Alberta will provide resources (expertise, skills, knowledge) to assist with plan development and implementation. Problem areas will be identified using information from the NRCB and the industry. In working with operators, the industry and government may want to consider measuring odour around CFOs.

### **7.2.3 Improving Communications**

The team identified concerns regarding communications, part of which is simply getting the word out about the processes that involve or affect CFOs and their neighbours. The NRCB, AARD and industry have developed various types of fact sheets and other information pieces, but in many areas, these do not appear to have been well-circulated. Experiences suggest that communications among all parties, including between government agencies, during the complaint resolution process could be improved. Because of their essential roles, the team thought the NRCB and AARD should lead efforts to improve communications.

### **Recommendation 9: Improving Communications**

The CFO project team recommends that:

The NRCB and Alberta Agriculture and Rural Development work with all involved parties to develop a plan by March 31, 2009 to improve communications and relationships among stakeholders regarding information related to CFOs. The following are areas where attention should be focused to improve communications and stakeholder relationships:

- Alternative dispute resolution processes,<sup>17</sup>
- Communications between agencies and Government of Alberta departments, and
- Communications between the NRCB and complainants.

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<sup>17</sup> Alternative dispute resolution (now referred to as Appropriate Dispute Resolution by the Energy Resources Conservation Board) includes a variety of options available to the concerned parties to manage disputes, such as direct negotiation between the affected parties, facilitation, third-party mediation, arbitration, and public hearings. ADR aims to help people explore and understand each other's interests and develop acceptable solutions together by creating an environment that supports respectful discussion. The solutions generated by the parties reflect their respective interests and are often solutions that would not have been arrived at individually. For more information, visit the ERCB's website at [http://www.ercb.ca/portal/server.pt/gateway/PTARGS\\_0\\_0\\_314\\_246\\_0\\_43/http%3B/ercbContent/publishedcontent/publish/ercb\\_home/public\\_zone/ercb\\_process/appropriate\\_dispute\\_resolution\\_adr/](http://www.ercb.ca/portal/server.pt/gateway/PTARGS_0_0_314_246_0_43/http%3B/ercbContent/publishedcontent/publish/ercb_home/public_zone/ercb_process/appropriate_dispute_resolution_adr/)

## 8 Jurisdictional Review

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The CFO team's Jurisdictional Review Subgroup was charged with providing information to the team on policy tools that could be used to address air quality concerns related to CFOs in Alberta. The subgroup reviewed and assembled a great deal of information about CFO and livestock policy tools in other jurisdictions. They considered the extent to which the policy and implementation tools could be applied in Alberta and tried to assess the effectiveness of the tools. The subgroup derived numerous consensus conclusions from their work that they forwarded to the Project Team. The recommendations of the strategic plan reflect these conclusions.

The subgroup observed that other jurisdictions have created policy tools specific to their situation, considering climatic conditions of the area and a host of other variables related to socio-economics, the environment, equity, timing, and the jurisdiction's overall approach to policy implementation. Further, those jurisdictions that are perceived as leaders in addressing air emissions from CFOs have also tended to use a suite of policy tools along with frameworks that bring all the tools together and that are supported by financial incentives. Many tools are available from which to choose the most appropriate for Alberta, including the use of enforcement; best management practices; voluntary codes; management plans; market-based instruments; financial assistance; research and development; technology; education programs; and partnerships between government, industry, and NGOs. This mix of tools and implementation mechanisms could apply to all priority substances and odour, but not all tools can be applied equally or in the same manner to substances and odours. The team is recommending further research in Alberta to identify the most appropriate management mechanisms for CFOs in this province (recommendations 5 and 6).

Approaches to dealing with odour also vary from one jurisdiction to another; Germany, for example, uses various approaches to measure and respond to odour issues. The team has made three recommendations to help move forward on odour issues and improve stakeholder relationships (recommendations 7-9).

It was very difficult to assess the effectiveness of some jurisdictions' suite of tools in meeting their goals. Part of the difficulty is how others measure effectiveness in the absence of clear indicators and goals specifically for CFOs. The project team proposes a method for evaluating the strategic plan represented by the recommendations in this report (recommendation 10).

Jurisdictions that have air quality standards may use ambient or emissions standards that were not specifically designed for CFO emissions. The subgroup did not find any point-source standards and measurements for CFOs in other jurisdictions. Ambient standards can apply to CFOs, but they also include emissions from other industries. The team has sought to address some of these matters in recommendations 1 through 4.

The subgroup did not find many examples of processes to address air cumulative effects from CFOs in other jurisdictions, but it was not a specific focus of the subgroup's search for policy tools.

Other jurisdictions have recognized the importance of environmental and land use planning in affecting air quality generally. In Alberta, various related processes are underway, including those listed below, but no other organization is specifically addressing air quality for CFOs:

- Ambient air quality objectives (AAQO) for H<sub>2</sub>S, (some) VOCs, Ammonia, and PM; there are no AAQOs for bioaerosols and odour.

- The proposed Environment Sustainability Act and its associated pilot projects to assess cumulative effects.
- Land use framework.
- Integrated Watershed Management planning, which will affect location of CFOs.
- CASA Clean Air Strategy.



## **9 Evaluating the Strategic Plan**

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The team agreed a key part of a strategic plan is evaluating which parts worked well and where possible improvements could be made. In addition, the subgroup reports will be made available for background information upon request when the team reconvenes.

### **Recommendation 10: Evaluating the Strategic Plan**

The CFO project team recommends that:

The CASA secretariat reconvene the CFO team in January 2011 to:

- a) review the implementation status and outcomes of recommendations made in this report,
- b) assess the success of these activities, and
- c) make any further recommendations, if needed, to reduce air emissions from CFOs in Alberta related to this strategic plan.

## Appendix A: Project Team Members

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Jennifer Allan	CASA
Humphrey Banack	Wild Rose Agricultural Producers
Ann Baran	Southern Alberta Group for the Environment
Bob Barss	Alberta Association of Municipal Districts and Counties
Laura Blair	Alberta Environment
Maureen Elko	Chinook Health Region
Paul Hodgman	Alberta Pork
Ahmed Idriss	Alberta Environment
Bruce Inch	Prairie Farm Rehabilitation Association
Martha Kostuch	Prairie Acid Rain Coalition
Doris Ludlage	Alberta Poultry Producers
Stuart McKie	Alberta Pork
Jim McKinley	Natural Resources Conservation Board
Usha Mulukutla	Calgary Health Region
Rients Palsma	Alberta Milk
Denis Sauvageau	Friends of an Unpolluted Lifestyle
Carrie Selin	Intensive Livestock Working Group
Barbara Shackel-Hardman	Alberta Agriculture and Rural Development
Rich Smith	Alberta Beef Producers
Karina Thomas	Alberta Health and Wellness
Jim Turner	Natural Resource Conservation Board
Len Vogelaar	Alberta Beef Producers and Alberta Cattle Feeders Association
Ross Warner	Society for Environmentally Responsible Livestock Operations
Kevin Warren	Parkland Airshed Management Zone, Peace Airshed Zone Association
Brian Wiens	Environment Canada
Brenda Woo	Health Canada
Mike Zemanek	Alberta Health and Wellness

### Observers

Atta Atia	Alberta Agriculture and Rural Development
Doug Beddome	NRCB
Kris Chawla	Alberta Agriculture and Rural Development
Ike Edeogu	Alberta Agriculture and Rural Development

### Former Team Members

Ron Axelson	Alberta Cattle Feeders Association
Carol Bettac	Agriculture and Agri-Food Canada
Kerra Chomlak	CASA
Matthew Dance	CASA
Shannon Hall	Agriculture and Agri-Food Canada
Bill Hume	Environment Canada
Phyllis Kobasiuk	Alberta Association of Municipal Districts and Counties
Norm Lowe	Town of Bentley/ Alberta Urban Municipalities Association
Alex MacKenzie	Alberta Health and Wellness
Debra Mooney	Alberta Health and Wellness
Eugene Wauters	Alberta Association of Municipal Districts and Counties
Kim Williams	Alberta Pork

## Members of the Emissions Inventory Subgroup

The members of the Emissions Inventory Subgroup worked extensively to consider the methodologies and approaches of emissions inventories. Their work was quite technical and required considerable effort and shared learning by all members. This work became a key component of the strategic plan.

Atta Atia	Alberta Agriculture and Rural Development
Ann Baran	Southern Alberta Environmental Group
Rob Bioletti	Alberta Environment
Matthew Dance	Clean Air Strategic Alliance
Ahmed Idriss	Alberta Environment
Jim McKinley	Government of Alberta
Kevin McLeod	Clean Air Strategic Alliance
Debra Mooney*	Alberta Health and Wellness
Usha Mulukutla	Calgary Health Region
Bob Myrick*	Alberta Environment
Rients Palsma*	Alberta Milk
Carmen Rieder	Consultant
Barbara Shackel-Hardman*	Alberta Agriculture and Rural Development
Rich Smith	Alberta Beef Producers
Ross Warner	Society for Environmentally Responsible Livestock Operations
Kevin Warren	Parkland Airshed Management Zone & Peace Airshed Zone Association
Eugene Wauters	Alberta Association of Municipal Districts
Brian Wiens	Environment Canada

\* Denotes corresponding member

## Members of the Health Effects Subgroup

The Health Effects Subgroup met frequently and amassed considerable information regarding the human and animal health effects associated with the priority substances. This subgroup's efforts were considerable and provided the rationale and information for much of the strategic plan and final report

Jennifer Allan	CASA
Ann Baran	Southern Alberta Group for the Environment
Laura Blair	Alberta Environment
Kerra Chomlak	CASA
Martha Kostuch	PARC
Debra Mooney	Alberta Health and Wellness
Usha Mulukutla	Calgary Health Region
Carrie Selin	Alberta Milk
Dennis Stefani	Calgary Health Region
Karina Thomas	Alberta Health and Wellness
Brenda Woo	Health Canada

## **Members of the Jurisdictional Review Subgroup**

The members of the Jurisdictional Review Subgroup undertook the daunting task of collecting information about policies related to the air emissions of CFOs worldwide. The members provided valuable examples for the Project Team throughout the development of the strategic plan.

Jennifer Allan	CASA
Laura Blair	Alberta Environment
Kerra Chomlak	CASA
Jim McKinley	NRCB
Denis Sauvageau	Friends of an Unpolluted Lifestyle
Carrie Selin	Alberta Milk
Barb Shackel-Hardman	Alberta Agriculture and Rural Development
Rich Smith	Alberta Beef Producers
Ross Warner	Society for Environmentally Responsible Livestock Operations

## **Members of the Management Mechanisms and Stakeholder Concerns Subgroup**

The members of the Management Mechanisms and Stakeholder Concerns Subgroup collected extensive information on numerous management mechanisms before recommending eight priority mechanisms which became important elements of the strategic plan. The shared understanding of stakeholder concerns that developed between members also helped the team move forward and come to consensus on the strategic plan.

Atta Atia	Alberta Agriculture and Rural Development
Humphrey Banack	Wild Rose Agricultural Producers
Ann Baran	Southern Alberta Group for the Environment
Kerra Chomlak	CASA
Ike Edeogu	Alberta Agriculture and Rural Development
Jim McKinley	Natural Resources Conservation Board
Rients Palsma	Alberta Milk
Denis Sauvageau	Friends of an Unpolluted Lifestyle
Carrie Selin	Alberta Milk
Barb Shackel-Hardman	Alberta Agriculture and Rural Development
Rich Smith	Alberta Beef Producers
Ross Warner	Society for Environmentally Responsible Livestock Operations

## **Appendix B: Terms of Reference**

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Final - September 22, 2005

### **Background:**

At the Nov. 24, 2004 meeting, the CASA Board of Directors received a statement of opportunity submitted jointly by Alberta Beef Producers, Alberta Cattle Feeders Association, Alberta Chicken Producers, Alberta Egg Producers, Alberta Hatching Egg Producers, Alberta Milk, Alberta Pork, Alberta Turkey Producers and Alberta Agriculture, Food and Rural Development to proactively address confined feeding operations air quality concerns in a collaborative process. By consensus, the CASA board agreed to form a working group to scope the issues and develop terms of reference for a CASA project team to develop an air quality strategic plan for confined feeding operations.

### **Goals of the Project Team:**

The CASA Confined Feeding Operations Project Team will work within the CASA consensus process to develop a strategic plan to improve the management of air emissions from existing and future CFOs in Alberta and to improve relationships between stakeholders.

In developing the plan, the team will consider the following principles:

- continuous improvement and pollution prevention to protect air quality;
- prevention of short and long-term adverse effects on human, animal and ecosystem health due to air emissions; and
- assurance that air quality recommendations maximize social, economic, environmental and health benefits and minimize social, economic, environmental and health costs.

### **Key Tasks for the Project Team:**

1. Create mutual understanding of the CASA process.
2. Improve stakeholders' understanding of air quality issues related to CFOs.
3. Develop a project team workplan and budget, and secure the resources to carry out the work plan.
4. Revisit the project team's workplan on a regular basis to ensure progress.
5. Gather information related to air quality issues in the areas of :
  - a. proposed and existing legislation in Alberta and in other jurisdictions;
  - b. management mechanisms in Alberta and other jurisdictions, and any existing information on the associated social, economic, environmental and health costs and benefits, which could include but are not limited to:
    - i. guidelines;
    - ii. codes of practice; and/or;
    - iii. best and/or beneficial management practices.
  - c. current and predicted emissions and ambient concentrations;
  - d. emissions inventories and a comparison of CFO air emissions to other regional and provincial air emissions;

- e. source apportionment to understand the contribution of CFOs to ambient concentrations;
  - f. effects of emissions;
  - g. scientific facts and data on air emissions and health effects;
  - h. observational information
  - i. methods to minimize air emissions and any existing information on the associated social, economic, environment and health costs and benefits;
  - j. technologies to monitor, measure and predict air emissions and ambient concentrations;
  - k. information about stakeholders concerns; and
  - l. other related initiatives (CASA frameworks, other processes).
6. Identify information gaps and work to fill those gaps, by using internal and external resources or by making recommendations for future work.
  7. Based on determined needs, conduct risk analyses.
  8. Identify and assess components of an air quality strategic plan. (The plan may or may not include the following, but they will be considered by the team. Plus, in developing the plan, the team will consider the information gathered in task 5, and base the plan on that information.)
    - a. future emission targets/goals/objectives;
    - b. monitoring of emissions and ambient concentrations;
    - c. current and predicted emissions and ambient concentrations;
    - d. emissions inventories and a comparison of CFO air emissions to other regional and provincial air emissions;
    - e. source apportionment to understand the contribution of CFOs to ambient concentrations;
    - f. standards, regulations and guidelines (taking into consideration other industries in Alberta);
    - g. other management mechanisms;
    - h. methods to encourage the implementation of the strategic plan;
    - i. reporting and information sharing;
    - j. roles and responsibilities;
    - k. scale of application (e.g. regional, local and/or provincial approaches);
    - l. timelines (e.g. short- and/or long- term requirements);
    - m. evaluation of the plan;
    - n. research;
    - o. technology development and transfer;
    - p. education;
    - q. evaluation of air emissions from CFOs and their impacts, in order to determine and prioritize actions
    - r. assessment of the associated social, economic, environmental and health costs and benefit of the strategic plan;
    - s. risk analyses
    - t. mechanisms for building and maintaining stakeholder relationships; and
    - u. other (as agreed to by the project team).
  9. Consider the need for, and possible approaches to communication and/or consultation with the public.

10. Evaluate the project team's achievement of its goal and make recommendations for subsequent process(es).
11. Develop a final report and recommendations to the CASA board, including a plan for tracking the implementation of the strategic plan and reporting to CASA board on the implementation of the plan.

### **Timelines:**

The project team will work towards the following milestones, and will revisit these milestones intermittently.

- Status reports to CASA Board – quarterly
- Interim report to confirm direction and progress with CASA Board – June 2006
- Final report and recommendations – June 2007

### **Budget:**

The team will develop a budget that is aligned with their workplan. Funds for project team work are expected to come from stakeholders around the table. AENV has already contributed \$15,000 revenue to this team account.

### **Membership:**

The following organizations will be represented on the CFO Project Team.

Agriculture and Agri-Food Canada  
Alberta Agriculture, Food and Rural Development  
Alberta Association of Municipal Districts and Counties  
Alberta Beef Producers and Alberta Cattle Feeders' Association  
Alberta Environment  
Alberta Health and Wellness  
Alberta Milk  
Alberta Pork  
Alberta Poultry Producers  
Alberta Sheep Producers (corresponding member)  
Alberta Urban Municipalities Association  
Calgary Health Region  
Chinook Health Region  
Environment Canada  
Farmers Advocate (corresponding member)  
Friends of an Unpolluted Lifestyle  
Health Canada  
Intensive Livestock Working Group  
Natural Resources Conservation Board  
Parkland Airshed Monitoring Zone  
Prairie Acid Rain Coalition  
Society for Environmentally Responsible Livestock Operations  
Southern Alberta Environmental Group  
Wild Rose Agricultural Producers

## **Appendix C: Summary of Priority Management Mechanisms**

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The team identified eight priority management mechanisms that should be further examined. Each is described briefly below.

### **Frequent Manure Removal**

This management mechanism may be applied to indoor (barn) or outdoor (feedlot pens) animal housing facilities. It requires an increased number of manure removal activities from a facility by scrapping, flushing or some other practice. It only addresses the removal of manure from the facility but does not address how the manure is handled once removed from the facility. Compared to other animal housing management mechanisms, frequent manure removal is considered to be relatively cheap mechanism. Furthermore, it targets manure, which is the primary source of emissions. If technology is not used (e.g., scrappers), it may require increased use of labour.

### **Manure Application, specifically band spreading with rapid incorporation and/or manure injection**

Band spreading refers to the application of manure just above the ground surface through a series of trailing pipes. Manure is released right at the ground surface where the mean wind speed is zero or approaching zero. This helps keep the emissions localized to the application site and is best followed by immediate incorporation. Unlike manure injection, band spreading is considered to be a cheaper practice to mitigate the release and transportation of emissions from manure applied on land. It is probably also a technique to which CFO operators can easily adapt. The AOPA contains specific requirements for the application of manure (section 24).

### **Moisture Management**

The aim of this management mechanism is to control moisture content of manure in feedlot pens or manure litter. Means through which this may be achieved include installing proper drainage systems (e.g., minimum pen slope requirements as noted in the Agricultural Operation Practices Act and Regulations), minimizing opportunities for spills to occur, and others. However, issues related to practicality and the costs of implementing such a mechanism do not seem to be well defined.

### **Biocovers**

The use of biocovers to mitigate emissions from manure storage facilities involves the application of biodegradable organic matter on the surface of such facilities. Organic matter includes material such as wheat straw, barley straw and oat straw. Since these materials are often readily available to CFO producers, it helps to keep the cost of this management mechanism low compared to some of the other mechanisms in the category of manure storage facilities.

### **Bottom Loading**

This management mechanism refers to filling manure storage facilities below the manure surface. By loading the facilities below the surface, splashing or agitation of manure is avoided and the release of highly concentrated emissions into the air is minimized. The Agricultural Operation Practices Act and Regulations (AOPA) requires CFOs to install bottom loaded manure storage facilities.



## **Shelterbelts**

Unlike other management mechanisms on this list, shelterbelts do not deal with the source of the emissions, but rather the aftermath. However, unlike other management mechanisms that also target emissions from the source, this mechanism has a number of potential benefits.

- As emissions leave the animal housing facility, the trees in a shelterbelt force the air into the upper atmosphere where additional mixing and dilution are expected to occur. In some cases, such as low wind speed days, emissions from the housing facilities may be trapped in the foliage of the trees preventing further dispersion downwind.
- The presence of trees around a housing facility can reduce the “wind chill” effect on the facility. This implies that energy requirements to counter heat losses will also be reduced, and may result in energy savings.
- A shelterbelt may improve the aesthetics of a farm site, thereby placing housing facilities out-of-sight. This may have a psychological benefit that results in fewer complaints.

## **Composting**

Composting is an aerobic process that facilitates rapid microbial decomposition of organic matter (e.g., manure) into a stable end product. Compost is intended to provide several benefits including stabilization of organic matter in the manure, destruction of pathogens and weed seeds, improved nutrient quality; it is also a good soil conditioner. The key to the success of this management mechanism is to ensure that the conditions required for the aerobic decomposition to occur are adequately met. These conditions include the correct proportions in a mixture of a nitrogen source (e.g., manure) and a carbon source (e.g., wheat straw), proper moisture content, porosity, oxygen availability, temperature and acidity. Often it is the effort (cost, time, labour) associated with meeting these requirements that is the drawback to the adoption of composting as a manure treatment practice.

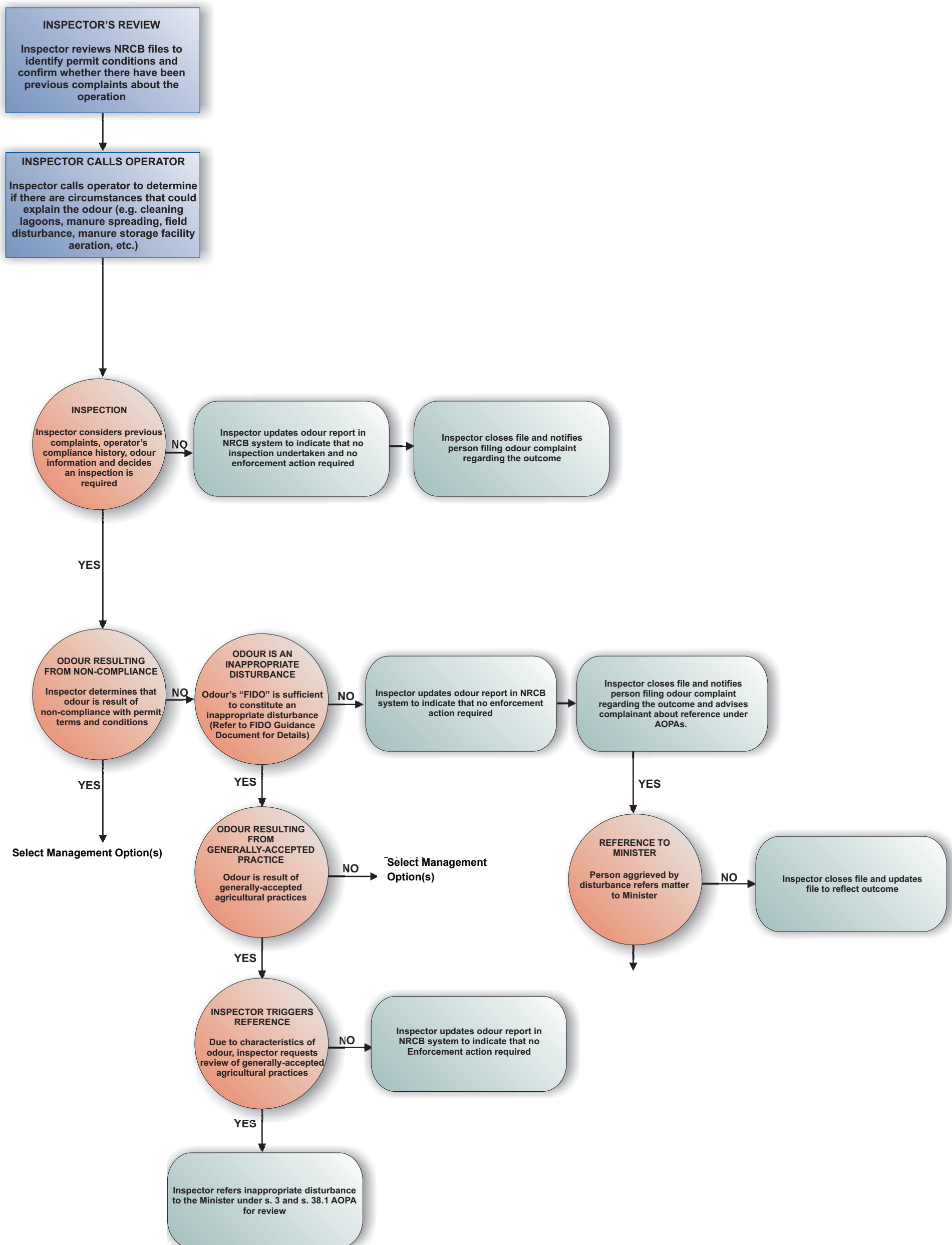
## **Dust Palliatives for roadway management**

This management mechanism focuses on mitigating the emission of particulate matter from road surfaces as a result of truck traffic to and from CFOs. A number of dust palliatives, including water, are used to keep dust levels low. It seems that there are advantages and disadvantages of using any of these palliatives.

## **Appendix D: NRCB Decision Trees for Responding to Odour Complaints**

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# INSPECTORS' ODOUR ASSESSMENT PROCESS



# INSPECTORS' ODOUR ASSESSMENT PROCESS (Generally Accepted Practice)

