GOOD PRACTICES GUIDE FOR ODOUR MANAGEMENT IN ALBERTA

FROM PREVENTION AND MITIGATION TO ASSESSMENT AND COMPLAINTS

CASA

This guide is made possible thanks to the hard work and commitment of the members who sat on the Clean Air Strategic Alliance Odour Management Project Team and these task groups:

Complaints Task Group
Enforcement and Role of Regulation Task Group
Health Task Group
Odour Assessment Task Group
Prevention and Mitigation Task Group

The reports produced from their work are the basis of this guide.

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CASA welcomes feedback on the usefulness and content of this guide. Please provide comments to CASA by email at **casa@casahome.org**.

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About This Guide

This guide outlines good practices related to odour management and was developed to serve as a reference on odour issues and their management. The guide is not intended to offer specific odour management recommendations or regulatory requirements. It does provide information that can guide the development of such recommendations or requirements. Organizations are responsible for knowing the odour-related regulations and requirements that affect their operations.

The content in this guide was extracted from the following reports, which were prepared for the Clean Air Strategic Alliance (CASA) through task groups formed by the CASA Odour Management Team:

- *Odour and Health Backgrounder*
- *Odour Complaints in Your Area: A Guide for Developing an Odour Complaint Process*
- *Report to the Clean Air Strategic Alliance Odour Management Team Enforcement/Role of Regulation Task Group* which was prepared by RWDI AIR Inc.
- *Review of Odour Assessment Tools and Practices for Alberta* which was prepared by Millennium EMS Solutions Ltd., and Environmental Odour Consulting
- *Review of Odour Prevention and Mitigation Tools for Alberta* which was prepared by Pinchin Ltd.

As such, this guide represents a compilation and summary of key information from more comprehensive "topic specific" documents. While much of the source information was developed with Alberta in mind, the information included in this guide is considered to be generally applicable to a broad range of odour-related issues. The reports are available online at casahome.org for those who wish to explore any of the topics or tools in more depth, review the charts and tables, or consult the references and source documents.

A glossary has also been provided to define terms that are used in the context of this guide (see page 87).

BACKGROUND

The issue of odour management came to the attention of the Clean Air Strategic Alliance through its government, non-government and industry stakeholders. Various odour management issues have been identified by CASA project teams and stakeholders over the years and, in September 2012, the CASA Board agreed to establish a multi-stakeholder working group to further screen and scope the issue and draft a project charter. The Odour Management Working Group, formed in January 2013, designed a process that would assist a larger group of stakeholders to engage in a focused discussion to advance odour management in Alberta. The working group obtained regular feedback from its sector members and this input was incorporated into the project charter. The CASA Board approved the charter in March 2013 and established the Odour Management Project Team (the OMT).

The team's work was divided into seven cross-cutting topics, recognizing that some issues may be addressed under more than one topic. The OMT formed task groups to examine five of these topics in detail: Health, Complaints, Odour Assessment, Prevention and Mitigation, and Enforcement and the Role of Regulation. Each task group also advised the OMT on the remaining two topics—Continuous Improvement and Education, Communication and Awareness—as these topics pertained to the mandate of the OMT.

The five task groups included members of the OMT as well as individuals from other key stakeholder groups. Consultants were also engaged to assist in compiling and analyzing information. The OMT provided direction to each task group through a work plan and ongoing feedback as the tasks were undertaken. The final reports from each task group were presented to the OMT for review and acceptance, and the information was incorporated, as appropriate, in this guide.

CONTENT OVERVIEW

Odours are one of the most common air quality complaints and can directly and indirectly affect health and quality of life. Odour-related conflicts often arise when residential and recreational activities and industrial, municipal, agricultural and/or commercial activities converge. Odour complaints often necessitate odour management activities.

Odours and their sources are diverse and managing them is often not an easy undertaking. Understanding how odours are perceived is an important first step. While preventing odours is desirable, it is not always possible, and it becomes important to understand the tools and approaches that can be used to assess, mitigate and manage odours and odour concerns.

This guide explains some of the most commonly used tools in odour management and provides guidance on the general situations and circumstances in which the tools may be most effective. The following topics are covered:

Understanding Odour

Odours can be a significant contributor to air pollution and air quality concerns. Offensive odours may have adverse effects on peoples' lives and well-being, and can result in conflicts between the public and the facilities or activities generating the odours. An important step in managing odour is developing an understanding of its properties, frequency and duration of occurrence, sources, and impact on health and well-being.

Odour Prevention and Mitigation

Prevention and mitigation can be described as a suite of tools used to prevent or lower odorant emissions or reduce the occurrence of adverse odour effects. Prevention refers to actions or solutions that avert the creation of odours, such as material substitution. Mitigation techniques are more commonly used and target odours after they are generated. There are various prevention and mitigation tools that can be used depending on the circumstance and their selection is often guided by odour assessment tools.

Odour Assessments

Odour assessments are conducted for a variety of reasons, and the tools used to conduct the assessment will depend on its purpose. There are a wide variety of odour assessment tools and approaches available and there is no one standard method or approach for conducting an odour assessment. There are a number of elements to an assessment (e.g., source odour measurements, dispersion modelling, ambient air testing and monitoring) and an odour assessment may include a combination of these elements.

Odour Management

Odour management involves the application of the appropriate tools to understand and effectively manage odour. There are many approaches for managing odours, and there are challenges in determining the best option for controlling odour impacts that arise from the wide range of odour sources and the varied and qualitative nature of odour perception and response. Odour sensitivity varies among people, as does the level of annoyance associated with an odour. Consequently, most jurisdictions use multiple approaches when considering and addressing odour, and no one odour management approach is capable of covering all situations.

Odour Complaints

Receiving, understanding and effectively addressing odour complaints is a very important part of odour management, and it includes managing the public's expectations about odours. There are several factors that need to be considered in developing processes for handling the complaints, managing the relationship with callers and gathering necessary information for complaint follow-up.

ABOUT THIS SECTION

THE BASICS ABOUT ODOUR, HOW IT IS PERCEIVED AND THE EFFECTS IT CAN HAVE

This section provides an overview on odour, how it is perceived and the effects it can have. The information was summarized from these reports:

- *Odour and Health Backgrounder* which was prepared by the CASA OMT Odour and Health Task Group for the Clean Air Strategic Alliance.
- *Report to the Clean Air Strategic Alliance Odour Management Team Enforcement/Role of Regulation Task Group* which was prepared for the Clean Air Strategic Alliance by RWDI AIR Inc.
- *Review of Odour Assessment Tools and Practices for Alberta* which was prepared for the Clean Air Strategic Alliance by Millennium EMS Solutions Ltd., and Environmental Odour Consulting.
- *Review of Odour Prevention and Mitigation Tools for Alberta* which was prepared for the Clean Air Strategic Alliance by Pinchin Ltd.

The full reports, which include more detailed information and all references cited, are available online at **casahome.org**.

Understanding Odour

Odour can be a significant contributor to air quality and pollution concerns. Offensive odours may have adverse effects on peoples' lives and well-being, and can result in conflicts between the public and the facilities or activities generating the odours.

Managing odour is complicated by the fact that the sensation caused by mixtures of odorants is subjective and technically difficult to measure and quantify. The adverse effects of odour can vary significantly based on the sensitivity of the people experiencing the odour. Personal sensitivity to and acceptability of odours depends on the environment where the odour is detected and may change over time.

Odour is recognized during the process of breathing. It is the sensation that results when olfactory receptors in the nose are stimulated by particular chemical compounds in gaseous form (called odorants). (McGinley et al., 2000a; St. Croix Sensory, 2003). A single odorant stimulus (e.g., hydrogen sulphide or chlorine) may be readily recognizable and easy to describe. However, a person's olfactory system may not recognize the individual odorants in a mixture of multiple odorants (e.g., odour from a landfill).

Odour sensation depends on the nature and concentration of the substances that interact with the olfactory receptors. Odours generated by the food and cosmetic industries, which are generally pleasant, are often referred to as aromas or fragrances, respectively. Terms such as malodour, stench or stink refer to unpleasant odours.

Due to olfactory adaptation, some of the odours that individuals are familiar with, such as their own body odour or typical household odours, are less noticeable to them than external or infrequently encountered odours (Wolfe et al., 2014). Sensitivity to odour and the ability to distinguish odours weaken quickly during continuous exposure or adaptation, but recover rapidly after the stimulus is removed. However, conditions such as prolonged or frequent exposure to an odour may increase an individual's sensitivity to that odour, and even pleasant odours, such as those from baking or coffee, may become offensive.

Characterizing Odour – FIDOL Factors

To completely describe the nuisance characteristics of an odour, five factors (commonly referred to as "FIDOL") are generally considered:

- Frequency (the number of times an odour is detected during a specific time period)
- Intensity (a person's perception of the concentration or strength of the odour)
- Duration (the period of time in which the odour remains detectable)
- Offensiveness or hedonic tone of the odour (pleasantness or unpleasantness)
- Location of the odour

FREQUENCY

Generally, the more frequently an odour is detected, the greater the potential to lead to an odour complaint. The time an odour occurs can also be important. An odour that occurs when there is a greater likelihood of people being exposed to it is more likely to lead to a nuisance complaint. The same odour that occurs while people are not present is less likely to lead to a nuisance complaint.

INTENSITY

The intensity of an odour is related to the odorant concentration or the concentration of the compounds involved. It is also related to a person's perception of the odour's strength. Intensity is the relationship that exists between perception and concentration, but it is not proportional. A large increase in concentration may lead to only a small increase in a person's perception of intensity, or vice versa. The intensity of an odour is not a measure of its character, quality, offensiveness or hedonic tone.

DURATION

The duration of odour impact refers to how long an odour event lasts and, along with frequency, provides an overall odour exposure time metric. Duration depends on factors such as the variation over time of the odorous emissions from the source(s) and meteorological conditions, which can have a strong influence on the duration of an odour event. For example, stable meteorological conditions, which can be more common at night, may lead to events of longer duration. Long periods of continuous odour exposure can have two widely different effects—adaptation or sensitization. Adaptation is where the perceived odour intensity decreases with repeated or continuous exposure. Sensitization is where perceived intensity increases with repeated or continuous exposure.

OFFENSIVENESS

The offensiveness, or hedonic tone, of an odorant is related to its perceived pleasantness or unpleasantness. This is the most subjective of the FIDOL factors, as it depends on the individual and their response to a specific odour. A person living and working in an agricultural area may be more tolerant and less sensitive to agricultural odorants than a person living in an urban environment. Of note, offensiveness is not directly related to odour intensity or concentration.

LOCATION

The location of an odour may affect the perceived offensiveness of an odour, especially when an odour would not normally be expected in a given location. In addition, ensuring good odour control and adequate separation between odour-generating activities and odour-sensitive receptors is important.

Of these FIDOL factors, offensiveness is primarily subjective in nature and difficult to measure—it is also one of the key drivers for complaints. A "non-offensive" odour can be acceptable to a community despite relatively high frequency, intensity and duration. However, a pleasant odour might become offensive after frequent or long exposure.

Frequency and duration, both of which depend on wind direction and the nature of the odour source, need to be considered together when assessing an existing or potential odour issue. Odour sources may be continuous, (e.g., from agricultural, municipal and industrial facilities), intermittent (e.g., spreading of waste on land), or a single event (e.g., due to an accident, a process upset or a disruption in normal operations; bacterial growth in water bodies; or animal decomposition on land).

Properties of Odour

The following properties are generally considered when assessing odours:

- Concentration of the odour (based on the dilution with odour-free air required to reach a certain response point)
- Odour intensity (strength of the odour sensation)
- Odour persistence (another measure of odour intensity)
- Hedonic tone (general classification, such as pleasant or unpleasant)
- Character (descriptors such as "fishy" or "chemical")

ODOUR CONCENTRATION

Odour concentration refers to the number of dilutions required for an odorant sample to reach the odour detection threshold value (ODTV) or the odour recognition threshold value (ORTV) (St. Croix Sensory, 2003). Odour concentration is the most common parameter for quantifying odours and is usually expressed based on the ODTV in preference to the ORTV.

Odour unit (OU) is another unit of measurement for the concentration of odour in an air sample and is similar to ODTV. An OU is defined as the number of times that an odour sample must be diluted with odour-free air so that 50% of a trained odour panel can just detect the presence of the odour (ASTM, 2002; CEN, 2003). For example, if it is determined that an odorous air sample needs to be diluted 620 times to be just detected, the odour concentration is 620 OU.

Very low concentrations of odorants in air can be challenging to measure using chemical methods. Mixtures of chemicals can have an odour threshold that cannot be predicted based on the thresholds of the individual odorants in the mixture. Therefore, the use of human noses—olfactometry—is the most reliable way to measure odour concentrations. In olfactometry, the sample is diluted to the level where it is just detectable or recognizable by odour panelists. Typical odour panels are composed of six to twelve panel members and are intended to be representative of the population in general. A diluted odorous sample and odour-free air (as a reference) are presented separately from sniffing ports to a group of panelists, who perform the evaluations in an odour-free room. The responses of the panelists over a range of dilution settings are used to calculate the concentration of the odour (OU or ODTV). Portable olfactometers are available for field measurement of odour concentrations but these have some limitations in terms of sensitivity and reproducibility.

ODOUR INTENSITY

Odour intensity is the perceived strength of an odour at a given concentration. Some odours and odorants, even at low concentrations or when they are just detectable (i.e., at threshold concentration), are perceived as being strong (i.e., have a high intensity). Odorants with this property are commonly associated with naturally unpleasant odours (DEFRA, 2010), such as hydrogen sulphide (rotten eggs) and skatole (feces). When odorants are mixed, the resulting odour intensity is generally not simply the sum of the intensities of the individual odorants. Therefore, the overall odour intensity of mixtures of odorants cannot be calculated with high certainty. However, in some cases (e.g., for modelling assessments), summing of components may be the only feasible way to estimate total odour effects.

ODOUR PERSISTENCE

Odour persistence is used to characterize the decrease in intensity of an odour as it is increasingly diluted with nitrogen or filtered air (Ouellette et al., 2006). Therefore, odour persistence is a function of odour intensity. The result is that some odorants and odours linger even after being diluted with large volumes of fresh air, while others dissipate very quickly. For example, hydrogen sulphide and pig manure odour are more persistent than ammonia and dairy manure odour, respectively (Ouellette et al., 2010).

HEDONIC TONE

Hedonic tone is a subjective measure of the pleasantness or unpleasantness of an odour. The hedonic tone is independent of the odour character and is often ranked on a nine-point scale ranging from extremely unpleasant to neutral to extremely pleasant (Pullen, 2007; VDI, 1994).

The hedonic tone of an odorant can be evaluated by panelists who are exposed to it for a controlled intensity and duration. The degree of pleasantness or unpleasantness is then determined by the panelists' experience and emotional associations to the odorants.

ODOUR CHARACTER

Odour character uses common descriptors such as "fruity," "chemical," "moldy," "soapy," "floral" and "sweet" to describe odour. Examples of descriptors for specific odorants that have distinctive odours include ammonia (cleaning fluid), trimethylamine (fishy), phenol (medicinal), skatole (fecal), toluene (solvent/hydrocarbon) and hydrogen sulphide (rotten eggs). Odour panelists describe character using a descriptor from a standard list or in their own words.

Odour Thresholds

Several threshold metrics may be used to characterize the concentration of odours. For odorant mixtures, the odour threshold values are expressed as OUs; however, odour thresholds for single chemicals may be expressed as micrograms per cubic metre (µg/m^3) or parts per million by volume/parts per billion by volume (ppmv/ppbv). In mixtures, if one odorant is dominating an odour effect and there are no synergistic effects with other chemical odorants, the odour threshold for that odorant may be used to assess and mitigate the overall effects of odour. The following four thresholds are common odour recognition and response metrics:

Odour Detection Threshold Value (ODTV) – The concentration at which 50% of a population, based on the results from an olfactory experiment using an odour panel, would be expected to detect the odorant (VDI, 1994).

Odour Recognition Threshold Value (ORTV) – The concentration at which 50% of a population, based on the results from an experimental odour panel, would be expected to recognize the odour (VDI, 1994). People might describe the odour, for example, as rotten eggs or cabbage (for sulphur compounds), or fishy (for amines).

Odour Offensiveness Threshold Value (OFTV) – The concentration at which 50% of a population, based on the results from an experimental odour panel, would be expected to indicate that the odour is offensive over a short period of exposure (Bokowa, 2008b).

Odour Complaint Threshold Value (OCTV) – The concentration at which 50% of a population, based on the results from an experimental odour panel, would be expected to complain about an odour if exposed to the odour for a short time period (Bokowa, 2008a).

Another odour threshold is the "nuisance threshold level," which the World Health Organization (WHO, 2000) defines as the concentration at which not more than a small proportion of the population (less than 5%) experiences annoyance for a small part of the exposure time (less than 2%) to an odour. Odour issues resulting from nuisance effects may arise when:

- Odour sources change with limited warning or planning.
- Best management practices related to odour control are not used.
- Urban areas encroach on existing odour sources or odour sources encroach on existing urban areas.

Characteristics of Odour Episodes

Factors that affect odour episodes include odorant emission rates, odour character, meteorological conditions, terrain near the source, and the odour sensitivity of the people involved. In addition, more subjective factors, such as the frequency of odour detection, air quality expectations, and the hedonic tone of the odour, determine whether a person may be concerned about an odour after it has been detected.

Typically, an odour episode is annoying before concern is expressed in the form of a complaint. Annoyance resulting from odour episodes is most likely to occur in residential areas where annoying odours are not expected. While the reason for an odour complaint may simply be annoyance at the unpleasantness of the odour, other issues may also contribute, such as physical response to the odour (e.g., nausea) and/or aversion to and/or interruption of normal activities (e.g., avoidance of certain areas).

Types of Odour Sources

The type of the odour source influences how odours are formed, transferred and/or released into, and behave in the environment. Facilities should have a good understanding of their odour sources and how different mitigation and prevention tools may be used to reduce or eliminate odour releases and impacts.

POINT SOURCES

Point sources are single entity, easily identifiable sources that generally have well defined exhaust parameters (velocity, temperature, odour rate). They can be elevated or located at ground level. A stack is the most common and familiar type of point source. Common examples of point sources include:

- Electricity generation sources, such as stacks associated with coal-fired power plants, biomass generation, gas-fired generation and co-generation.
- Major stack and vent sources at refineries, oil sands processing and upgrading facilities, steam-assisted gravity drainage (SAGD) facilities and gas plants. These sources include steam generators, flares and furnaces.
- Major stack sources at forest products facilities including oriented strand board (OSB) plants, sawmills, and pulp and paper mills.
- Incinerator stacks at municipal waste management facilities.
- Major stack sources at chemical and manufacturing plants.

FUGITIVE EMISSIONS

Fugitive emissions are unintended or peripheral emissions from a variety of sources. Fugitive emissions can be associated with:

- Small oil and gas facilities, well site and trans-loading facilities.
- Rail car or truck loading and unloading activities.
- Doors and windows in enclosed operations.
- Recycling or composting facilities.
- Storage or treatment piles, ponds and lagoons.
- Piping flanges, valves, pumps and other equipment at various heights within industrial facilities such as oil refineries, gas plants and petrochemical plants.

AREA SOURCES

Area sources are two dimensional sources without a physical height. The surface dimensions are known; however, the odour emission is diffusive and may not be uniform or well understood. Sewage lagoons and tailings ponds are examples of area sources.

VOLUME SOURCES

Volume sources are similar to area sources, but they have a known height dimension. Odour emanating from a volume source can be diffusive, non-uniform and hard to determine. A building with windows, vents or other openings housing an odorous process, can be a volume source. An industrial complex, such as a refinery or chemical processing plant, can be considered and assessed as a volume source. Common examples of volume sources include:

- Refineries and chemical processing plants.
- Small businesses such as retail outlets, dry cleaning facilities and garages.
- Agricultural production and secondary agricultural processing facilities.

LINE SOURCES

Line sources are long and narrow sources and this type of source is not common. Vehicle exhaust from roadways can be classified as a line source.

MULTI-SOURCES

Multi-sources are a collection of different sources within a group, facility or study area. A complex facility or collection of industries with many individual sources can be composed of roadways, tanks, piping and stacks. This source relates to places where there are multiple sources operating and the cumulative effect needs to be considered.

Most facilities will have a combination of source types. The use of a multi-source emission and dispersion model may prove beneficial when managing odours on a larger scale. Generating an inventory of odorous sources is a key component of odour assessment and management.

SOURCES OF ODOURS: EXAMPLES

Odorous emissions can be associated with a variety of sources. The following sections provide some examples.

Municipal Solid Waste Management

The collection, transfer and long-term storage of municipal solid waste (MSW) are among of the most common sources of odorants and go back throughout human history. Today, the management of MSW typically starts with the collection of household waste by trucks, which take it to transfer stations or to long-term storage facilities (e.g., landfills). In some areas, typically rural, residents drop off waste at transfer stations; whereas, urban waste is collected and taken to larger facilities. Once MSW is concentrated at a transfer station or landfill, odour management typically becomes a key concern. While fairly common, the key odour-causing components of the MSW management system are also fairly localized, most often at the working face of the landfill and leachate collection systems.

Municipal Wastewater Treatment

Municipal wastewater treatment includes the collection and treatment of wastewater from homes, businesses and potentially the treated wastewater from some industrial operations. While odour may potentially be generated from all components of the wastewater collection system, it is odours at the wastewater treatment facilities that tend to result in complaints. Wastewater treatment systems include mechanical treatment plants and sewage lagoons. Odour management at wastewater facilities is a significant concern in many municipalities, often exacerbated by the location of these facilities in low lying areas to take advantage of the gravity-drainage in the sewer networks. While common, since almost every community above a certain size has a municipal wastewater system, the key odour-causing components of the wastewater management system are also typically localized.

Composting

Composting of residential organic waste, sewage sludge and agricultural waste has become a growing trend in recent years. It encompasses everything from residential composting bins to large-scale composting operations at MSW facilities. Odours tend to be similar in character to traditional MSW facilities, but can be more concentrated due to the increased concentration of organic matter in the waste relative to traditionally mixed MSW streams. Depending on the method used, composting can represent large area sources.

Agricultural Operations

Similar to MSW management, odorants from agricultural operations have been a part of human society since the beginning of civilization. The primary odour issue with agricultural operations revolves around the generation, collection, storage and/or eventual application/use of animal waste. Facilities that have no animal husbandry component may still rely on the application of animal waste-based nutrients for crop production, which is often associated with odour complaints. Facilities that have an animal husbandry operation (e.g., hog farms) will generate waste that must be stored for some period of time and which has odour generation potential. Where there are large areas dedicated to agriculture, odorants from these operations can best be described as both sporadic and relatively de-centralized.

Food Production

Food production facilities encompass a large variety of operations, such as abattoirs, meat packing plants, grain and feed mills, large industrial-scale bakeries and dairy processing plants. Given the widely varied nature of this category, it is difficult to generalize about odour sources other than to note that the presence of these facilities both in the urban and rural landscape often results in odour issues, even from seemingly non-offensive operations such as bakeries and coffee roasting.

Oil and Gas Operations

Odorants from the oil and gas industry vary widely in character, depending on the nature of the operation. Sour gas production generates odorants related to total reduced sulphur compounds, while heavy oil operations may generate odorants related to aromatic hydrocarbon compounds. Although the sources of odour associated with this industry may be located throughout a geographic region, the major sources of odorants tend to be very localized, centred on sources at central processing or product storage facilities (e.g., tank vents and process exhausts) and open storage or holding ponds (e.g., tailings ponds).

Forestry and Pulp and Paper Industries

Odorants from forest products and pulp and paper mills are, for the most part, due to hydrogen sulphide and reduced sulphur compounds released as by-products of the pulping process. Additional, but relatively minor, odorants from the lumber industry can include the cutting of wood at sawmills.

Chemical Industries

The chemical industry is composed of companies that produce industrial chemicals and convert raw chemical feedstock into multiple products. Because of the large variation in chemicals and processes involved, odorant emissions from these facilities can vary greatly. Volatile organic compounds (VOCs) can be the source of odour for many of these industries, although reduced sulphur compounds can also be associated with chemical manufacturing, storage and handling.

Transportation

Where there are large transportation networks, transportation-related activities can be a potential source of odorants. Stationary facilities such as railway stations, airports or gas stations can also be an odour source. Transportation-related loading and unloading facilities, depending on the materials being handled, are another potential odour source.

Factors Affecting Odour Dispersion

Terrain and meteorological conditions affect the way odour disperses. Hills, valleys and trees, for example, all have an impact on odour emissions. Likewise, weather conditions such as temperature, humidity and wind play a role in the movement of odour. The interaction between the terrain and meteorological conditions further affects the dispersion of odour.

TERRAIN

Landscape characteristics influence the dispersion of odour emissions and the concentration of odours received by potential receptors (i.e., people). Dispersion of odour emissions is inhibited if the emission source is located in a valley or a depression, but enhanced if the emission source is located on high ground or the emission point is located well above the ground. Due to the physical barriers they create, valleys can channel winds and, therefore, emissions. This may result in high concentrations of an odour emission being channeled for a long linear distance, rather than dispersing. Obstacles can either positively or negatively influence odorant dispersion. For example, tree cover can reduce odour concentration by enhancing dispersion (reducing odour concentration) and providing surfaces for deposition of odorants or by restricting dispersion in the canopy (due to reduced wind speeds).

METEOROLOGY

Meteorology influences odour episodes in two ways—by altering odorant emission rates or releases and by determining the atmospheric transport, dilution/dispersion of odour emissions.

Temperature and Humidity

Factors such as ambient temperature and humidity affect the perception of odour. Higher temperatures and humidity increase the likelihood of detection. During precipitation, the concentration of odour is generally reduced. The volatility of odorants increases during warm weather, and odour emissions from open tanks, ponds and storage piles will increase during summer months, leading to increased odour potential during this season. Odour emissions from other sources such as industrial processes may also increase if the process is affected by warm weather. Other reasons for increased odour detection in summer include the opening of windows and doors at facilities and an increase in the number of people outdoors.

Wind Speed and Direction

To detect odour, the odour source must be located upwind; therefore, wind direction is a key factor in odour potential. Odour emissions from open tanks and storage piles may be increased by higher wind speeds but this effect is somewhat balanced by increased dilution and, in some cases, improved atmospheric dispersion.

Mixing Height

Mixing height (mixing depth), inversions and atmospheric stability can affect dispersion of odorous emissions.

Mixing heights vary by season and depend on wind speed, temperature and cloud cover. Mixing heights are generally lower in winter. Shallow mixing heights mean that ground-level emissions, such as those from area sources, cannot easily penetrate to the more unstable (better mixed) layers above the ground-level mixing height. The most intense odours typically occur in stable conditions with light winds that inhibit the mixing of odour plumes. Usually higher wind speed causes an increase of the mixing height due to mechanical turbulence. However, mixing height is often dominated by surface heat flux and in cold temperatures the mixing height may be relatively low or zero. Tall stacks emitting odorants above the mixing height result in reduced ground level odour.

Odour Impacts

Managing odours can be complex. This is because odour is a sensation that can be caused by a single odorant or by a complex mixture of odorants. It is subjective in nature, and therefore, difficult to measure and characterize. Various techniques have been developed to measure odorants; however, such instruments measure only the concentrations of different odorants. Measured concentrations are then compared to odour threshold values for the individual odorants which are developed using human odour panels. For complex mixtures of odorants, it is very difficult to predict the resultant odour concentration, intensity, hedonic tone and characteristics. Therefore, the best instrument for measuring odour is still the human nose. Some individuals have far more sensitive senses of smell and will detect an odorant at much lower concentrations than others. In addition, one person may find an odour objectionable while another may not (e.g., roasting coffee or malt from a brewery).

The possible impacts of odours range from simply detecting an odour to a public nuisance or, at elevated concentrations, a health concern or hazard. Most odours are believed to constitute a public nuisance rather than a health hazard (Bates and Caton, 2002). However, a number of physiological manifestations from offensive odours have been reported in published literature, including nausea, vomiting, headache, loss of appetite, sleeplessness, upset stomach and throat irritation (see Odour and Health on page 16).

Odour and Health

The sense of smell is one of the most primal human senses, with a powerful and direct connection to the brain, and it is no surprise that odour can impact a person's actual or perceived sense of well-being.

Olfaction, the mechanism that allows people to smell, relies on two essential processes. Volatile chemicals in the air (odorants) bind to olfactory receptors that extend into the nasal passage from special olfactory neurons in the nasal lining (epithelium). Those olfactory receptors signal the brain, which then makes associations with a person's surroundings and between the odour and their past experiences. Our noses contain roughly 400 different types of receptor neurons, each sensitive to specific types of odorants.

The nasal lining also contains trigeminal neurons, which transmit information on temperature, pressure and pain, and also respond to noxious stimuli. Individual volatile chemicals can trigger olfactory neurons or trigeminal neurons, but odours often trigger both simultaneously.

Stimulation of trigeminal neurons by odorants can cause irritant effects, while stimulation of olfactory neurons by odorants can cause nuisance effects. Some odorants can stimulate both types of neurons, causing both effects.

- Irritant effects (e.g., watery eyes) are a bodily reaction to trigeminal nerve stimulation.
- Nuisance effects (e.g., insomnia) are tied to the perception of odour, with no mechanistically understood cause. While the reason why certain odours cause nuisance effects is not fully understood, the resulting symptoms are nevertheless real.

Odours can also affect a person's health physically (e.g., nausea), psychologically (e.g., stress) and socially (e.g., embarrassment).

That said, there are challenges in studying the relationship between odour and health. Different people experience odours in different ways—a nuisance smell to one may be undetectable or pleasant to another. It is also difficult to measure odours in an objective way. These two factors make it challenging to assess the health effects caused by odours.

Most people are not able to identify or quantify the chemicals in something that they smell. Likewise, different people experience and describe symptoms in different ways—symptoms that do not always point to specific medical conditions.

Current knowledge of chemical toxicity is based on chemical-by-chemical assessment. The usefulness of chemical-by-chemical assessment is limited in the case of odours because it is possible that the chemical mixtures in an odour may interact in unexpected ways. Until the ways that volatile chemical mixtures affect human health are better understood, it is important to respond to odour complaints by assessing the presence of chemicals in the environment to identify potential health effects.

TRACKING RESPONSES TO ODOURS

Keeping records is an important tool in helping people understand how odours may be affecting their health. Memory can be unreliable over the long term, so it is important to write down a description of the odour, the conditions in which it was experienced and any health effects/symptoms (which may or may not be related to the odour). The symptoms provide good information for health professionals and descriptions of the odour help odour investigators.

The Symptom and Odour Tracking Tool on the next page is available in two formats. The copy in this guide is for handwritten entries. The same form can also be completed online (casahome.org) and then printed and/or stored electronically.

Symptom and Odour Tracking Tool

If this is an emergency, call 911. This form is for non-emergency situations only. Use this form to record any symptoms that you think are related to an odour you have noticed. Bring the completed form to appointments with your healthcare professional to help with the diagnosis and treatment of the symptoms or underlying conditions. Once completed, this form contains personal health information: it is your responsibility to protect your information appropriately.

ABOUT THIS FORM:

Add a new individual record for each day that you experience an odour event that you associate with a symptom. Additional symptoms and odours can be added to each individual record if required (e.g., I smelled manure and rotten eggs in the same day, had a headache followed by trouble sleeping).

INDIVIDUAL RECORD - SYMPTOM AND ODOUR

Intensity Scale - Symptoms

0 = Did not experience the symptom
1 = Experienced the symptom very mildly
2 = Experienced the symptom mildly
3 = Experienced the symptom moderately
4 = Experienced the symptom severely
5 = Experienced the symptom very severely

Intensity Scale - Odours

0 = Did not notice the odour
1 = Very weak (barely noticeable)
2 = Weak (mildly noticeable)
3 = Moderate (obvious)
4 = Strong (very noticeable)
5 = Very strong (overwhelming)

SYMPTOM DETAILS	SYMPTOM DESCRIPTION AND OTHER RELEVANT INFORMATION
Date:	
Time:	
Location *(e.g., home, work)*:	
Intensity *(0-5)*:	
Did the symptoms come and go during the day?	

ODOUR DETAILS	ODOUR DESCRIPTION AND OTHER RELEVANT INFORMATION
Date:	
Time:	
Location *(e.g., home, work)*:	
Intensity *(0-5)*:	
Did the odour come and go during the day?	

This tool is intended to assist individuals in recording details of their health in relation to odour exposure. This form is not intended to be medical advice nor is it intended to replace interaction with your physician.

Symptom and Odour Tracking Tool

SYMPTOM DETAILS	SYMPTOM DESCRIPTION AND OTHER RELEVANT INFORMATION
Date:	
Time:	
Location *(e.g., home, work)*:	
Intensity *(0-5)*:	
Did the symptoms come and go during the day?	

ODOUR DETAILS	ODOUR DESCRIPTION AND OTHER RELEVANT INFORMATION
Date:	
Time:	
Location *(e.g., home, work)*:	
Intensity *(0-5)*:	
Did the odour come and go during the day?	

SYMPTOM DETAILS	SYMPTOM DESCRIPTION AND OTHER RELEVANT INFORMATION
Date:	
Time:	
Location *(e.g., home, work)*:	
Intensity *(0-5)*:	
Did the symptoms come and go during the day?	

ODOUR DETAILS	ODOUR DESCRIPTION AND OTHER RELEVANT INFORMATION
Date:	
Time:	
Location *(e.g., home, work)*:	
Intensity *(0-5)*:	
Did the odour come and go during the day?	

This tool is intended to assist individuals in recording details of their health in relation to odour exposure. This form is not intended to be medical advice nor is it intended to replace interaction with your physician.

Notes

ABOUT THIS SECTION

ODOUR PREVENTION AND MITIGATION TOOLS

This section provides an overview of odour prevention and mitigation tools. The information was summarized from *Review of Odour Prevention and Mitigation Tools for Alberta* which was prepared for the Clean Air Strategic Alliance by Pinchin Ltd.

The full report, which includes more detailed information and all references cited, is available online at **casahome.org.**

The full report also includes case studies for:

- A Municipal Waste Management Facility
- A Secondary Food Processing Facility
- The Development of Odour Guidance from a Multi-stakeholder Group

Prevention and Mitigation

Prevention and mitigation can be described as a suite of tools to prevent or lower odorant emissions or reduce the occurrence of adverse odour effects.

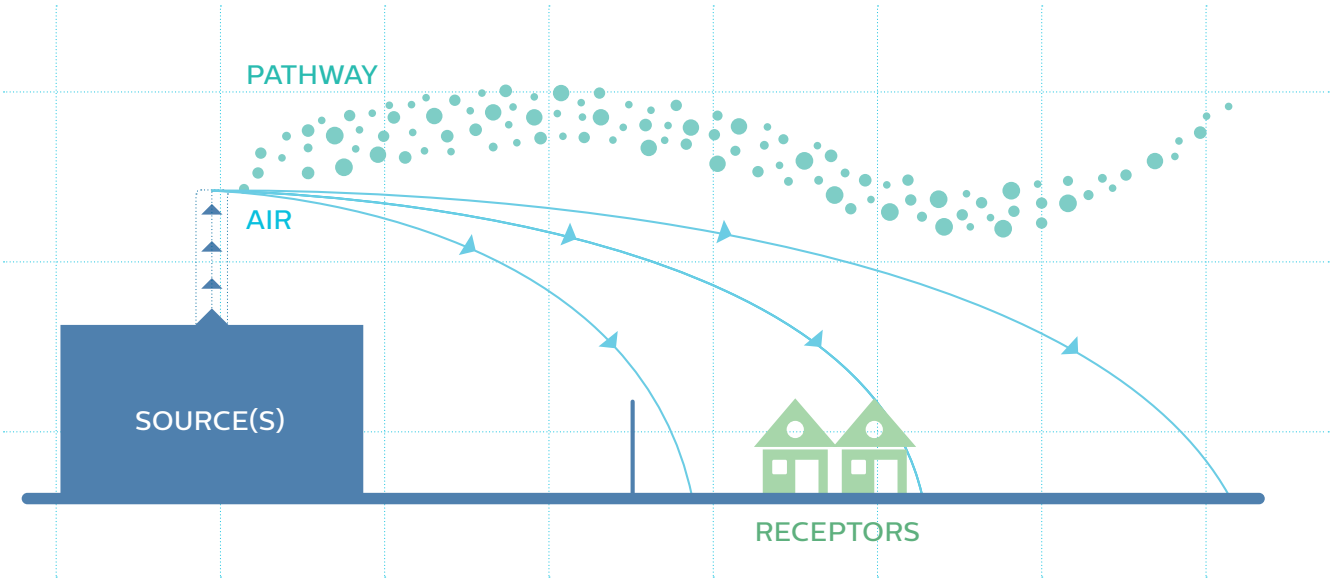
- Prevention refers to actions or solutions that avert the creation of odours.
- Mitigation techniques are more commonly used to target odours after they are generated.

SOURCE-PATHWAY-RECEPTOR MODEL

To effectively study and manage odours, an understanding of how odours are created, transported and affect humans is required. One common model used to study odours is the Source-Pathway-Receptor (SPR) conceptual model, which generally traces how substances move from an origin to a final destination. This model can apply to various materials and different media and it has been used in environmental studies such as impact, health and environmental assessments.

The nature of the source determines and defines how and where the odour is released into the environment. The odorants will travel through an air pathway, carried by wind that may pass by a fence, trees and/or other objects. Finally, individuals at places where people dwell, work, learn and meet become the receptor, and they may or may not be adversely affected by the odorants. All three components of the model must be linked for a potential odour exposure or adverse effect to occur (DEFRA, 2007).

Prevention techniques block the linkages in the model, while mitigation options reduce the severity of the adverse effect.



PLAN, DO, CHECK AND ACT MODEL

The Plan, Do, Check and Act (PDCA) model is a basic management principle, which allows for the good management and improvement of products and systems. It provides a framework for improvement and its cyclic nature can be self-regulating (IAQM, 2014). The PDCA model can be adopted for environmental management systems related to air quality, specifically odour prevention and mitigation. Planning documents, such as prevention and mitigation plans (PMP), should be "living" documents that are constantly evaluated and adjusted as needed (Bull et al., 2014; DEFRA, 2006).

Generally, the four phases are:

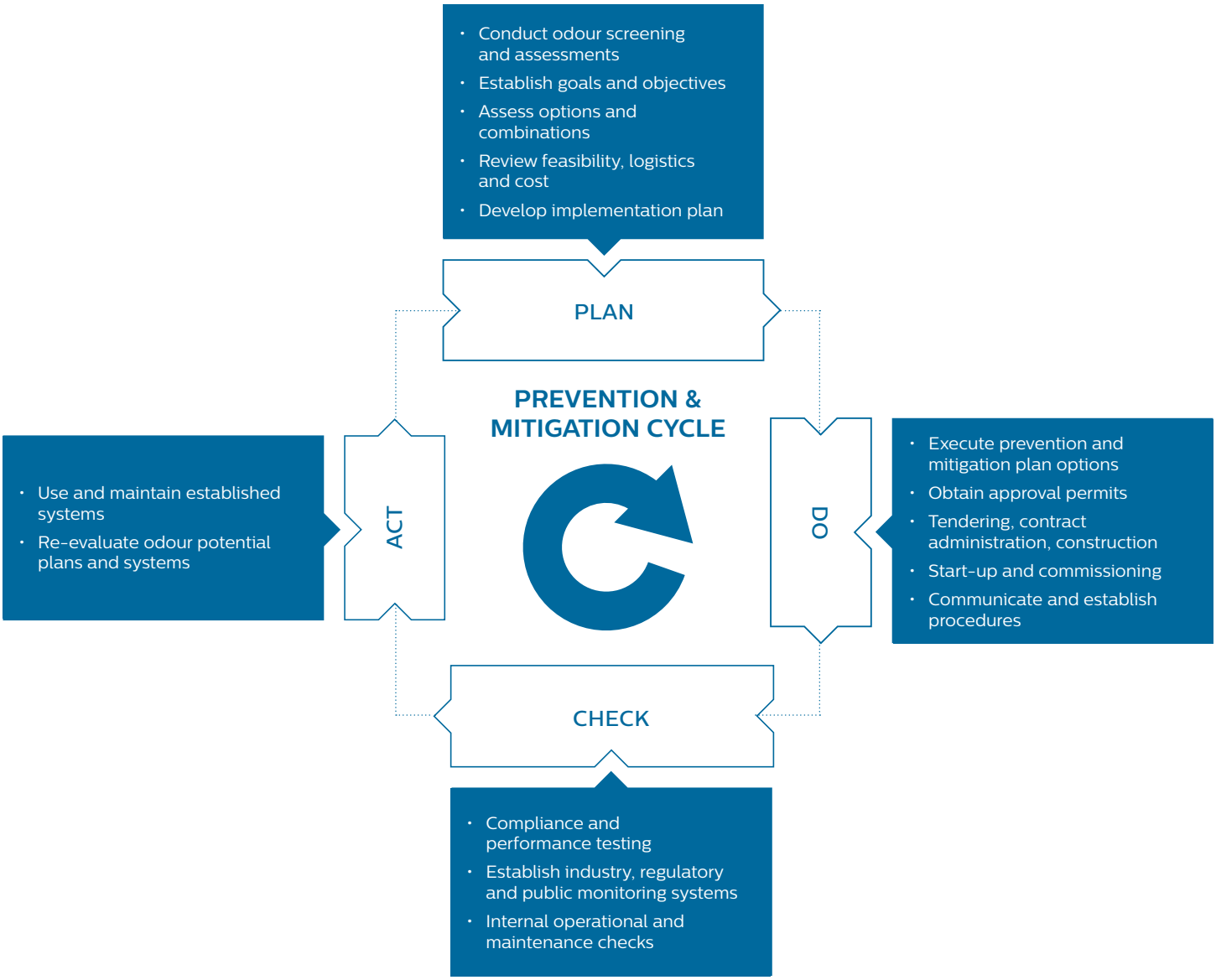
Plan – includes initial discovery, screening and assessment of the odour potential of the site or facility, and then establishing appropriate goals and objectives. Review of possible options, scenarios and their probability to reduce adverse effects will lead to the adoption of a plan to move forward.

Do – involves implementing the adopted plan and installing or establishing the prevention and mitigation tools and monitoring requirements.

Check – ensures systems are commissioned according to requirements during implementation. Establish and use the monitoring systems and internal checks to evaluate the systems.

Act – involves maintaining and re-evaluating the odour potential, plans and systems. Act and improve as needed.

See Figure 1 (on pages 31-32) to view how the PDCA model fits with the tools described in this section.



Prevention and Mitigation Tools

Tools for odour prevention and mitigation must be established based on a goal and associated objectives. The suite of prevention and mitigation tools listed in this guide have been divided into general categories and summarized below. More detailed descriptions of the tools are available in the full report *Review of Odour Prevention and Mitigation Tools for Alberta* which is available online at **casahome.org**.

Tools can target specific parts of the Source-Pathway-Receptor model (see Figure 2 on page 33) or be implemented at several locations. Many of the tools target the source of odours and can work better for different types of sources (point, line, area, volume and multi sources).

LAND USE AND PLANNING DEVELOPMENT

Land use and planning development is a pathway tool, which generally works by setting a minimum pathway distance or buffer zone between potential odour sources and sensitive receptors. This tool is mainly preventative and applies to all types of sources. Effective application of land use and development planning tools require the participation and active engagement of multiple stakeholders who often have conflicting goals. Establishing planning protocols and conditions to the individual nature of the odour at a site or facility is complex and requires skill (DEFRA, 2010).

BENEFITS	CONSIDERATIONS
· As a prevention tool, can drastically reduce or eliminate potential for adverse odour effects · Limits the risk of conflicting land uses or changes in land use	· Multi-stakeholder process with conflicting goals · Buffer zones and set back distances may not be suitable for densely developed areas · Due to the nature of odour, cases may still require other tools

SITE MANAGEMENT

Site management is a key consideration that can prevent and mitigate odour sources from planned or existing facilities (Anderson et al., 2003). Some of the major considerations for overall site management include:

Existing, modified or proposed sites

Existing, modified or proposed sites can all benefit from prevention and mitigation planning; however, each requires slightly different approaches. Existing and modified sites may have a more limited selection of feasible prevention options compared to proposed sites as land use designations have already been assigned and the sites may be located in densely populated areas. Proposed sites generally have more and easier opportunities to apply prevention techniques; however, in such cases the exact composition and offensiveness of potential odour sources may be unknown, as there is no historical data.

The nature of odorant

Combinations of odour intensity, duration, frequency and character all have an influence on the potential to create an adverse effect (see FIDOL factors on page 8). With knowledge of the odour nature and receptor response, appropriate prevention and mitigation goals can be set and suitable combinations of prevention and mitigation options can be reviewed.

Regulatory regime

Odours causing an adverse effect are prohibited under legislation. Defining when odour effects occur is not an easy task. It is important to characterize the problem (perhaps using FIDOL factors) to identify a potential impact, and then set measurable goals and objectives in prevention and mitigation planning. Facilities should approach the problem knowing that the threshold for adverse effects may be an unknown or a moving target and that planning and implementation can take several iterations.

RAW MATERIALS, FORMULATION, PROCESS AND OPERATIONAL MODIFICATIONS

Raw materials, formulation, process and operational modifications are prevention techniques with the objective of stopping or reducing the creation of odorants. They can apply equally to all types of processes and source types. Simple operational modifications, such as improved housekeeping and minimizing leaks, can result in good management improvements for area, volume and line sources. Knowledge and review of the facility process flows and operations is required to identify possible opportunities while minimizing impacts to facility production.

BENEFITS	CONSIDERATIONS
· Prevention techniques can drastically reduce or eliminate the potential for odour · Operational/maintenance modifications can be simple and easy to implement	· Material substitutions can require expensive and time consuming trials · Process changes may affect the quality of products

MANAGEMENT PLANNING GROUPS AND GUIDES

Management planning groups and guides are a prevention tool that can be used at any type of source. This tool refers to the organization and benefits of common interest groups and development of best management practices. Management planning groups can take various forms, such as regulatory committees, industry groups, non-governmental organizations and community-based groups. At the same time, it is common to have these management groups and bodies publish guides and documentation on process, air emissions, permitting requirements, innovation in technology and regulation changes.

BENEFITS	CONSIDERATIONS
· Collects and provides practical knowledge from various sources · Guides are targeted at specific industries, processes or operations and provide relevant information · Implementation of tools developed by management planning groups are typically proven to be effective and more universally accepted by regulators and the general public	· Does not directly prevent or mitigate odour emissions unless effectively implemented · Material may take time to be published and can become dated over time · Can be general in nature leaving interpretation and detailed planning at the discretion of the user

ESTABLISHING COMMUNITY AND NEIGHBOURHOOD RELATIONS

Establishing good community and neighbourhood relations is a prevention and mitigation tool that can be used at the receptor to adjust the sensitivity and tolerance of the community to odour. Attempts to solve odour nuisance issues often over-emphasize technical solutions. One underestimated aspect of odour management is public opinion within the local community regarding the facility. A negative outlook from the surrounding neighbours may diminish any benefits obtained from using prevention and mitigation tools. Engaging the community in two-way dialogue fosters cooperation and trust. An actively engaged and informed community may lead to more realistic expectations about odours (Longhurst et al., 2004). The community itself can also become a valuable source of qualitative data, providing information to be used when assessing other prevention and mitigation tools (Anderson et al., 2003).

BENEFITS	CONSIDERATIONS
· Creates a partnership, rather than an adversarial environment · Applicable for proposed and existing facilities · Can provide additional qualitative data for other tools	· Each community is different, requiring a custom approach and relations plan · Difficult to evaluate effectiveness · Does not directly reduce odour emission or transmission

ATMOSPHERIC DISPERSION OPTIMIZATION AND PATHWAY BUFFERING

Atmospheric dispersion optimization and pathway buffering will affect odour as it travels through the pathway between the source and the receptor. Optimizing discharge parameters is a mitigation technique used at the source that will affect the pathway through which the odour will disperse and dilute. Improved dispersion measures are most often implemented to reduce impacts of wind-induced turbulence caused by buildings and structures in the vicinity of the odorous discharge. Shelterbelts and artificial windbreaks are environmental barriers or pathway buffers that modify the pathway and change the amount of dispersion and dilution as the air moves. Trees and shrubs of varying heights, contained within multiple rows, provide dispersion and dilution, erosion and snow protection, and wildlife habitat, while reducing wind-related energy losses and enhancing landscapes.

Atmospheric Dispersion and Source Optimization

BENEFITS	CONSIDERATIONS
· Straightforward, low maintenance and effective tool for point sources · Typically more economical than other engineering control tools · Applicable for proposed and existing facilities	· Typically not economical or feasible for area, volume and line sources · Potential negative visual perception and reaction from surrounding land users

Shelterbelts and Artificial Windbreaks

BENEFITS	CONSIDERATIONS
· Simple and natural solution · Additional benefits include energy conservation, wildlife habitat, reduced erosion and landscape enhancement · Can be implemented with permanent or temporary (portable) installations	· Can require large area to properly implement (length and width) · Shelterbelts can take a long time to fully develop and become effective · Only practical for low level sources

REAL-TIME DOWNWIND MONITORING

Real-time downwind monitoring is a prevention and mitigation tool if the monitored parameters are representative of the odour and frequently monitored (real-time), and if appropriate action levels are established. “Real-time” refers to continuous and near instant reporting of monitoring results. With near instantaneous knowledge of odorants, alerts can be provided and corrective actions can be quickly taken to reduce the potential for the odour effect to become more significant. Corrective actions can be built into operating procedures and further automated to interact with the facility processes.

BENEFITS	CONSIDERATIONS
· Provides early warning alerts and allows economic use of other prevention and mitigation tools · Can be implemented as part of an odour assessment or monitoring program · Can provide additional qualitative data for other prevention and mitigation tools	· Requires site specific calibration and odour assessment · May require specialized knowledge to operate and maintain · Does not directly prevent or reduce the odorants and can be costly to implement and maintain

ENGINEERING CONTROLS

Engineering controls are put in place at the source of the Source-Pathway-Receptor model to mitigate odour emissions before they are released to the atmosphere and travel towards receptors. Since there are many odorous substances, a variety of different types of engineering controls are available which use physical, chemical and biological principles to mitigate odours. Engineering source controls are sometimes referred to as "end of pipe" or "back end" solutions, which signify their deployment at the end of process units. Engineering controls are divided into five broad categories and include (but are not limited to):

Absorption systems

Absorption scrubbers, sometimes referred to as wet scrubbers, use a scrubbing liquid that is sprayed or showered within the odour-bearing gases. The odorous compounds then dissolve or react with the liquid and are removed from the liquid agent (Anderson et al., 2003). Types of absorption equipment and wet scrubbers include plate absorbers, venture absorbers, packed towers, tray towers and spray towers (DEFRA, 2010; Davis, 2000).

BENEFITS	CONSIDERATIONS
· Proven and effective for soluble odorous contaminants and for use within certain sectors · Can handle a wide concentration range of odorous contaminants · Are suitable for humid applications · Can handle gas streams with particulate matter	· Creates a liquid waste stream, which must be treated and disposed of · Requires ongoing maintenance and expertise to properly operate · Some liquid solutions themselves have undesirable odours · Not suited for high temperature sources

Adsorption systems

Contaminants get attached to the adsorption component through the pores of the material and are removed. Some common adsorption scrubbers use activated carbon or aluminum pellets because of their highly porous surfaces (DEFRA, 2010). Some adsorbents can be desorbed and reused (Anderson et al., 2003).

BENEFITS	CONSIDERATIONS
· Proven and effective over a wide range of contaminants · Particularly suited for low temperature, low contaminant concentration or mass loading gas streams · Media can be specifically chosen for the odorants and multimedia systems are available · Equipment and components are simpler and the systems are easier to operate · Can be used as a concentrator ahead of thermal oxidation or condensation solvent recovery	· Media becomes loaded and has to be replaced or regenerated periodically · Not suitable for odour streams containing excess water, grease, oil or particulate matter since surfaces of the media can become clogged · May not be suitable for high contaminant concentration applications due to high replacement or regeneration requirements, unless used as a concentrator ahead of other control technologies · Not suitable for high temperature application · Regeneration stream requires further treatment

Biological

Treatment systems with biological components use micro-organisms to break down odorous compounds and reduce odour releases. Biological components can be sprayed into the odorous air stream; however, the most common systems pass the air stream through a porous support media where the micro-organisms establish a population. This self-sustaining system allows for many different biological species and support media as long as the media does not degrade. Support materials include soil, wood chips, inorganic porous minerals and calcified seaweed (DEFRA, 2010).

BENEFITS	CONSIDERATIONS
· Self-sustaining system over an extended period of time · Applicable to water soluble bio-degradable contaminants · Has the potential for high removal efficiencies · Relatively low operating costs	· May not respond quickly to frequent or wide fluctuations in contaminant concentrations · Not effective with high contaminant concentration streams · Requires higher residence time, large areas and competent workers to maintain · Requires watering to maintain moist environment for bacterial growth. · Not tolerant to high temperatures, pesticides and other poisons

Thermal

Thermal systems consist of several different methods aimed at oxidizing odorous compounds with the addition of heat and combustion. Thermal oxidation converts odorous compounds into water and carbon dioxide (Anderson et al., 2003). Thermal systems can include thermal oxidizers, catalytic thermal oxidizers, recuperative thermal oxidizers and regenerative thermal oxidizers (Rafson, 1998; Davis, 2000).

BENEFITS	CONSIDERATIONS
· Highly effective at converting odorous compounds · Odorous compounds are converted within short residence times · Waste heat can be recovered for pre-heating incoming odorous gas and other uses in the facility · Particularly applicable to higher concentration hydrocarbon-based streams · Applicable to a wide range of contaminants	· High capital costs if energy recovery technology is included · Energy costs are high for low contaminant concentration streams, especially if energy recovery is not employed · Catalytic systems can exhibit varying conversion efficiencies on some contaminants and certain contaminants can be a catalyst inhibitor or poison · Catalyst requires regeneration or replacement over time · Improperly executed thermal system can create more toxic chemicals and/or odorants

Condensation

Condensation is a somewhat special technique applicable to innately hot gases, where odorants are removed and transferred into a liquid stream by lowering temperatures. It is typically used as part of hydrocarbon systems within petroleum applications, but applicable to other hot, high volatile organic compound sources.

BENEFITS	CONSIDERATIONS
· Potential to reuse recovered product · Mostly applicable to high VOC concentrations in gas steams at lower temperatures · Can be coupled with adsorption technologies Typically low to moderate capital cost	· Relatively small range of use and application · Typically requires special electrical and additional safety considerations due to concentrated VOC levels · Requires qualified operating personnel and operating costs can be substantial · If recovered solvent is not reused, then hazardous waste disposal will be required

TABLE 1: COMPARISON OF ENGINEERING CONTROLS (ADAPTED FROM DEFRA, 2010)

ODOUR-EMITTING PROCESS	ABSORPTION	ADSORPTION	BIOLOGICAL	THERMAL OXIDATION	CONDENSATION
Sewage Treatment	✓✓	✓✓	✓✓✓	✓	–
Food Processing and Kitchens	✓✓✓	✓	✓✓✓	✓	✓
Paints and Solvents	✓✓	✓✓	✓	✓✓✓	✓✓
Animals and Livestock	✓✓	✓	✓✓✓	–	–
Industrial/ Chemical Processes	✓✓	✓✓	✓	✓✓✓	✓✓
Oil and Gas	✓✓	✓✓	✓	✓✓✓	✓✓✓
Storage and Spills	✓✓✓	✓✓✓	✓	✓	–

✓✓✓ Common, typically used and established

✓✓ Use may be limited to specific process and scale

✓ Rare usage and limited research

MASKING AND NEUTRALIZING AGENTS

Masking and neutralizing agents are sprayed, mixed and applied to odorous liquids, surfaces or gases to mitigate adverse odour effects. These agents act in the form of a mitigation tool or can be used for the prevention of odour releases at the source. Agents that are applied directly to the odorous substance or source can mask, inhibit and prevent odour releases from being created or leaving the source. Surface treatments are mainly used in livestock facilities, bio-waste facilities and composting sites where the sources have large surface areas and agents can be applied with ease (Jacobs et al., 2007). When applied to odorous gases, agents act as mitigation tools to reduce the odour impact.

BENEFITS	CONSIDERATIONS
· Reduces offensive odours and releases a more pleasant smelling odour · Depending on the substance used, this tool is easy to implement · Typically applicable to area and volume sources and some selective point sources	· Efficiency of masking and neutralizing agents can vary with meteorological conditions · After prolonged exposures to treatment agents, the smells of the deodorizers and agents may become offensive to some people. · Combining masking agents with certain chemicals can result in more offensive odours · Typically does not work well on sources with low contact residence time, such as point sources

RECEPTOR-BASED TOOLS

Receptor-based tools are typically used for multi-sources and require the cooperation of various parties to properly implement. Receptor tools can be used reactively as the “last chance” to resolve odour issues or proactively by progressive planning groups. Some receptor tools include restricting the receptor land uses, warning signage, agreement clauses and receptor mitigation. There is limited research and case studies on the use of these tools and even less information about their effectiveness.

Notes

Odour Prevention and Mitigation Charts and Tools

The following charts provide guidance on the factors to consider when determining the potential for odours and the planning and measures that should be considered to prevent or mitigate odours. Table 2 outlines Prevention and Mitigation Planning and Implementation steps. For many of these steps, the odour assessment tools outlined in Odour Assessments would be used.

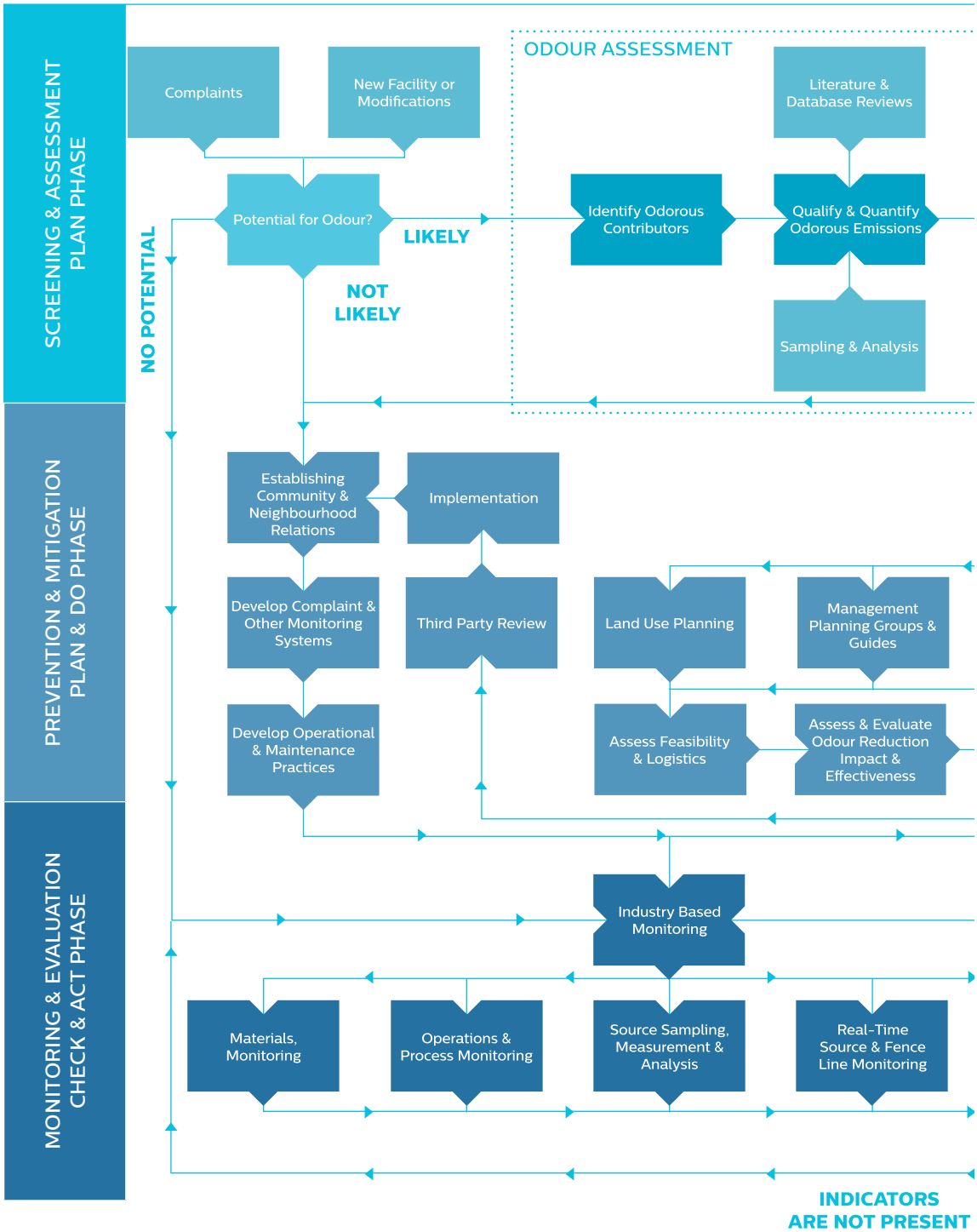
TABLE 2 - GUIDELINE FOR PLANNERS, REGULATORS AND FACILITY OPERATORS

ODOUR IMPACT POTENTIAL

SOURCE INFLUENCE	• Is industry sector known to have odorous emissions? • Are there odorous processes? • Are odorous materials used?	• Is there a history of odour complaints from the existing site/facility? • What is the operating schedule of the facility, processes and sources?
PATHWAY INFLUENCE	• What is the separation distance between sources and existing/future sensitive receptors? • What is the terrain elevation of the sources and receptors?	• What are the terrain features between the sources and receptors? • What are the general meteorological conditions for the local area?
RECEPTOR INFLUENCE	• Is there a progression of receptor sensitivity versus distance from odour sources? • What is the receptor sensitivity progression from the odour sources? • Are receptors transient or schedule sensitive (e.g., commercial, offices, places of worship, public spaces)?	• Are receptors housing or places with sleeping quarters? • Are receptors hypersensitive, health vulnerable or otherwise considered more vulnerable? • Are there active community groups, history of complaints or other legacy issues with surrounding neighborhoods?
SOURCE MEASURES	• Is the site location suitable with respect to surrounding land uses? • Have the site, facilities and sources been strategically located? • Has an odour management plan been adopted or developed for the site, facilities and sources, as applicable? • Are qualified personnel involved with the development, implementation, monitoring and maintenance of the plan? • Have process odours been adequately captured into point sources, where appropriate? • Have point odour sources been controlled and effectively dispersed into the atmosphere, as appropriate?	• Have surface, volume and line odour sources been minimized, contained, located, masked or otherwise controlled, as appropriate? Have fugitive emissions been minimized, contained, located, masked or otherwise controlled as much as possible? • Is there an ambient odour or odorous compound monitoring system in place for predictive or event monitoring and alarms? • Is there a complaints recording and reporting system in place? • Who are the personnel responsible for monitoring, recording and reporting complaints, events and alarms? • Are there mechanisms in place for community and regulator communications?
PATHWAY MEASURES	• Who is involved with the local land use planning? • Is there an opportunity to address the planning process with respect to separation distance between existing or future odour source(s) and existing or future sensitive receptors?	• Can the pathway between odour sources and receptors be altered or buffered (e.g., berms, trees, foliage, masking application)?
RECEPTOR MEASURES	• Are there current land use plans in place? • Is there an opportunity to address the permitting and licensing process with respect to types of sensitive land uses surrounding existing or future industrial facilities?	• Are there community liaison groups or representatives to provide feedback on the planning, permitting and licensing process, on the impact of existing odour sources or on the perceived impact of future odour sources?

Notes

FIGURE 1 : PREVENTION AND MITIGATION PLANNING AND IMPLEMENTATION



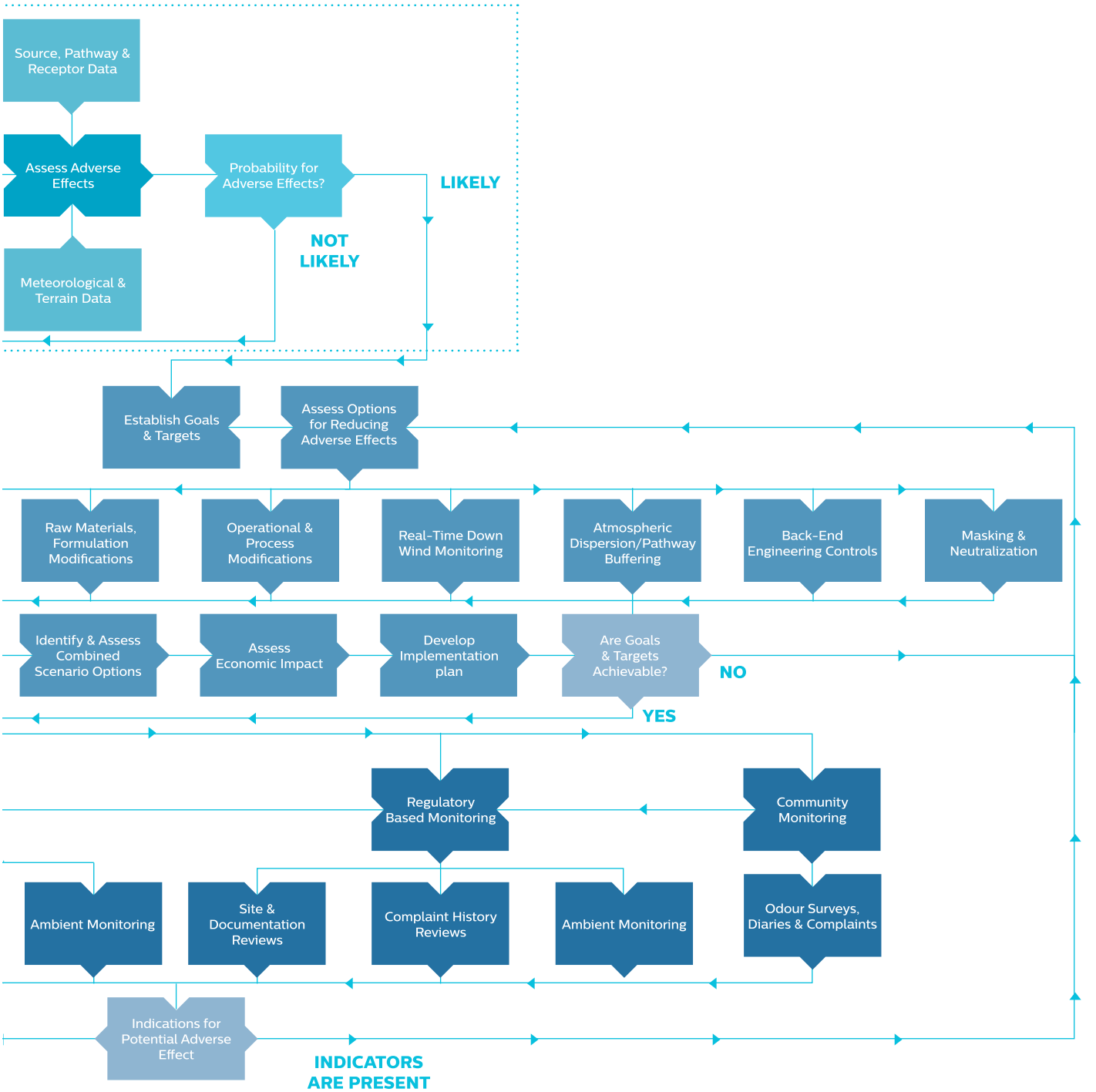

Source, Pathway & Receptor Data
Assess Adverse Effects
Probability for Adverse Effects?
LIKELY
NOT LIKELY
Meteorological & Terrain Data
Establish Goals & Targets
Assess Options for Reducing Adverse Effects
Raw Materials, Formulation Modifications
Operational & Process Modifications
Real-Time Down Wind Monitoring
Atmospheric Dispersion/Pathway Buffering
Back-End Engineering Controls
Masking & Neutralization
Identify & Assess Combined Scenario Options
Assess Economic Impact
Develop Implementation plan
Are Goals & Targets Achievable?
NO
YES
Regulatory Based Monitoring
Community Monitoring
Ambient Monitoring
Site & Documentation Reviews
Complaint History Reviews
Ambient Monitoring
Odour Surveys, Diaries & Complaints
Indications for Potential Adverse Effect
INDICATORS ARE PRESENT

Figure 2 - Prevention & Mitigation Tools

COMMUNITY, INDUSTRIAL & REGULATORY RELATIONS

LAND USE PLANNING

SOURCE	PATHWAY	RECEPTOR
Staged Industrial Zoning, Negotiated & Restricted Uses	Increased/ Dedicated Buffer Zones	Staged Receptor Zoning, Negotiated & Restricted Uses
Management Planning & Best Practice Guides	Improved Atmospheric Dispersion	Warning Signage, Agreement Clauses
Product Reformulation & Materials Substitution	Shelterbelts & Artificial Windbreaks	Engineering Controls, Receptor Arrangements
Administrative & Operational Modifications	Fenceline Masking & Neutralizing	
Process Modification		
Back-end Engineering Controls		
Source Masking & Neutralizing		

Notes

ABOUT THIS SECTION

ODOUR ASSESSMENT TOOLS AND PRACTICES

This section provides an overview of the types of odour assessment tools and practices. The information was summarized from *Review of Odour Assessment Tools and Practices for Alberta* which was prepared for the Clean Air Strategic Alliance by Millennium EMS Solutions Ltd., and Environmental Odour Consulting.

The full report, which includes more detailed information and all references cited, is available online at **casahome.org**.

Types of Odour Assessments

Odour assessments are generally performed to:

- Verify and investigate odour complaints.
- Comply with conditions outlined in operating/industrial permits, including the verification of emissions.
- Determine compliance with odour legislation.
- Assess long-term odour exposure levels in an area.
- Rank potential odour sources for mitigation purposes.
- Determine background odour concentrations before building a new facility.
- Determine the off-site odour impact from existing operations.
- Determine the expected changes in off-site odours resulting from new facilities, expansion of existing facilities or other operational changes.

How an odour assessment is performed will depend on its purpose. For instance, if the purpose is to assess compliance with an industrial permit then a measurement of source emissions might be required. If the purpose is to investigate odour complaints or to verify compliance with an existing ambient air quality standard, then the assessment may require ambient air monitoring. Other considerations include assessments associated with existing, proposed, modified, or expanding facilities or operations. In some cases, odour assessments may combine a number of different approaches.

There is no standard method for odour assessments. They may include one or more assessment components (e.g., source odour measurements, dispersion modelling, ambient air testing and monitoring).

Odour assessments may also vary in level of detail, which will depend on factors specific to the situation being assessed (e.g., risk of odour impact, proximity of receptors, the scale of the proposed activity, nature of the proposed development and its potential odour sources).

- Screening assessments typically involve simple, low-cost approaches designed to identify some general characteristics of a potential or existing odour issue. Examples include non-analytical methods such as source inventories, complaint reviews, ambient measurements (such as some types of integrative monitors) or screening dispersion models.
- Detailed assessments are designed to provide more data and a more rigorous understanding of the problem, and could involve olfactometry, continuous emission measurements or advanced dispersion models.

As part of an odour assessment, an odour baseline establishes odour concentrations prior to development or activity changes that may result in changed odour emissions. It should also survey the locations of sensitive receptors in the area, such as residences, schools and recreational facilities. Results from the odour baseline, along with the changed emission profile of the facility or activity, may affect the design of the facility or nature of the activity with respect to process conditions, odour control equipment, or emission siting and timing.

The following approaches might be used for conducting odour assessments:

Ambient odour assessment: Includes off-site odour monitoring techniques such as real-time ambient odour olfactometry monitoring, community odour surveys, electronic noses, continuous or semi-continuous monitoring for specific compounds or groups of compounds, odour mapping, investigation of community responses to surveys, or subjective odour event diaries.

Source odour assessment: Includes odour and/or specific odorant measurement/estimation at potential odour sources at the facility and determination of odour emissions rates for each source. The emission rates are then used to predict off-site odour concentrations, generally using dispersion modelling assessment. The odour sources can be a point source (such as a stack or vent), an area source (such as a lagoon or pond) or a fugitive source (such an open door or truck loading area involving odorous material). The odour emission rates determined for the potential sources at the facility can be used in dispersion modelling to predict off-site odour or specific compound concentrations at residences or other sensitive receptors such as schools, parks and community centres.

Inventory assessment (of facility materials and odour emission sources): Includes assigning nominal odorous emissions to typical sources, based on published measurements at similar facilities with a similar scale of operations. This approach can be undertaken where odour emissions cannot be directly measured.

Dispersion modelling assessment: Includes modelling analysis to predict off-site odour concentrations or concentrations of odourants at selected sensitive receptors. This method addresses all meteorological conditions and provides more spatial information than ambient air monitoring alone.

Assessments can be made for existing or new facility activities or changes in activities.

For existing activities, an assessment would include:

- Documenting past odour events and/or odour complaints (if any).
- Determining sources and potential causes of odour releases.
- Ranking potential odour sources to aid in odour management.
- Predicting or monitoring ambient odour levels.

Assessments of new activities could include comparison of ambient odour or odour emissions at a similar existing facility to predict odour impact. In addition, the odour background in the area selected for the new operations could be assessed. Assessment of odour potential at new facilities typically involves a dispersion modelling assessment, with emissions often based on engineering estimates or standard sources such as those provided on the U.S. EPA AP-42 website.

Assessments for modified facilities, which include expansion or process alterations, could begin with the assessment of the existing odour emissions to provide baseline information. The predicted new emissions from the process changes can be determined from the baseline and estimated odour emission changes through the emission inventory approach and dispersion modelling approach.

ASSESSMENTS BASED ON AMBIENT MONITORING

Ambient monitoring approaches to odour can be considered as objective or subjective.

- In an objective assessment, odour is typically established by ambient measurement using techniques, protocols or analytical methods that are repeatable.
- In a subjective assessment, the feelings of an odour observer's liking, pleasure, acceptance and valuation are expressed (often called hedonic tone).

Objective Techniques

Ambient air odours can be assessed using a variety of objective methods such as:

- Ambient odour sampling at specific locations, usually downwind of a potential odour source, followed by odour panel evaluation on the collected samples to determine the odour concentrations (in OUs).
- Ambient monitoring using portable olfactometers or

other sensory-based monitoring devices.

- Ambient odour intensity measurements determined through olfactometry.
- Ambient sampling or monitoring for specific odorants (such as hydrogen sulphide, reduced sulphur compounds, ammonia, volatile hydrocarbons and amines) with comparison of measurements to odour thresholds.
- Continuous monitoring either for specific odorants or for odour (Thermo Fisher Scientific, 2011).

Subjective Odour Investigations

Subjective odour investigations are often conducted by residents in the vicinity of odour sources, but can also be conducted by regulators, operators or consultants. Subjective measurements are typically part of complaint data collection procedures. Subjective investigations include:

- Community odour surveys/observations performed in the vicinity of (particularly downwind from) potential odour sources using experienced and trained community members (McGinley, 1995; Brancher and de Melo Lisboa, 2014).
- Odour diaries compiled by facilities or residents. Diaries provide a means to record short-term odour episodes and to show changes and trends in odour impacts.
- Sensory observations, where one or more trained individuals observe odour at locations that are not necessarily downwind from potential odour sources. This method provides direct data on the frequency of "odour hours" at receptor points and odour exposure levels over the long term.

ASSESSMENTS BASED ON SOURCE SAMPLING

To estimate odour emissions from sources, representative odour samples are collected from potentially significant sources. These sources may be selected based on the experiences of facility personnel, information about the facility operations or the expected performance of odour control equipment. Samples are evaluated in the laboratory by an odour panel to determine odour concentrations, which are later used together with measured or estimated source volumetric flow rates to estimate the odour emission rates.

Typical sources contain a mixture of compounds and it is very rare that only one or a few compounds are responsible for odour detection or complaints. Therefore, the characterization of odorant emission sources based on odour units that can be used for modelling is generally the most appropriate method for odour assessment.

For all types of sources, samples collected for total odour analysis should be evaluated for Odour Detection Threshold Value (ODTV), Odour Offensiveness Threshold Value (OFTV), Odour Complaint Threshold Value (OCTV) and Odour Recognition Threshold Value (ORTV) using dynamic olfactometry with an odour panel (see page 11).

Source sampling may also be used for sampling specific compounds such as ammonia and hydrogen sulphide. Samples are analyzed by analytical methods. Once measured, that information and emission rate data can be used calculated as input for dispersion modelling. Predicted off-site concentrations of the specific odorant may be compared with the limits or correlated with the ODTV for that compound to estimate the total odour concentration expressed in units of OU. The use of ODTV values based on current and reproducible methodologies, with the application of a safety factor, is prudent in this case.

INVENTORY ASSESSMENT

Where emission measurements are not available or are difficult or impossible to directly measure, alternative means of estimating emissions and assessing odour can be used. Two examples of this approach are the use of emission factors for specific sources from established publications (such as the U.S. EPA 2014a) or emission estimates for entire facilities that can be scaled based on production. This approach should be used with caution and only when there is confidence that the emission factors and/or scaling approaches are applicable to the odour being assessed.

For example, this kind of assessment might be used for facility amendments due to changes to operations. In this case, amended emissions and sources can be compared to original emissions and sources. If emissions and sources are not significantly changing, then the potential for increased odours is unlikely and there may be no need for additional assessment using other methods. If emissions are increasing, scaling can be used to assess the potential for increased odours based on current ambient odour levels.

ASSESSMENTS BASED ON DISPERSION MODELLING

A common approach for facility odour assessment is source sampling with dispersion modelling analysis to predict off-site odour concentrations or concentrations of odorants at selected sensitive receptors. This method is used because it addresses meteorological conditions and provides more spatial information than ambient air monitoring alone. This method can be used to assess different emission and control scenarios. Odour source sampling is the estimation of odour emissions from potential odour sources at the facility. Three basic approaches can be used to model odorants from multiple sources:

- **Exposure to individual chemicals –** modelling each odorant separately. Comparisons are made to individual odour thresholds, and assessments of odour potential are made on this basis. In terms of the odour assessment, the use of a single-odorant-by-single-odorant approach can underestimate the frequency of odour detection (Cometto-Muniz et al., 2004).
- **Aggregate exposure –** using total odour emissions in odour units per second (OU/s). Odorants predicted at lower concentrations (at or below threshold levels) when aggregated may generate observed odour (Kim and Park, 2008). Odours are calculated as emissions (OU/s), modelled directly and then processed as a single compound (total odour).
- **Aggregate exposure –** modelling individual chemicals and summing their odour potential. The predicted concentrations of odorants are divided by their respective odour thresholds, and the resultants in OU are summed over all odorants modelled.

Generally, the second and third approaches are expected to be more conservative as they account for all odorants in the mixture. Nonetheless, for industrial processes, knowledge of the contribution to odour of individual odorants can be important to the management and reduction of odour. Predicted odour concentrations derived from dispersion modelling are used to assess odour potential by comparing with ambient air quality odour criteria.

Odour Assessment Tools and Practices

The following section provides a brief overview of different types of assessment tools. More detailed descriptions of all the tools are included in the full report (*Review of Odour Assessment Tools and Practices for Alberta*), which is available online at casahome.org.

As noted earlier, there is no standard method for odour assessments and assessments may include one or more components.

SOURCE SAMPLING AND MEASUREMENT

Potential odour sources may be sampled for total odours and/or specific odorants such as ammonia, hydrogen sulphide, mercaptans, amines, ketones and aldehydes. Sampling methods vary based on the nature of the odorants, the analysis method and sampling purpose, and the source type (e.g., point, area or volume) being sampled. Acceptable sampling methods may also vary by jurisdiction.

Source sampling involves collection of gaseous samples, using specialized sampling procedures, and evaluation of the samples to determine either the odour detection threshold values (for odour) or the concentrations of odorants. These methods are used, in conjunction with volumetric flow rates, to calculate odour or specific odorant emission rates.

POINT SOURCE METHODS

Lung Sampling Method

Lung sampling methods involve sample collection in a sample container (like a Tedlar bag), with subsequent sample analysis. This method is less common and less accurate for sources with high odorant or moisture concentrations. Special precautions should be taken to avoid condensation and adsorption during sampling, including storage of the samples at a temperature sufficient to prevent condensation and timely analysis.

Dilution Sampling Method

The dilution sampling method is used to collect samples with high odour concentrations that exceed the upper operating limit of the olfactometer, or if condensation of either moisture or odorants could occur in the sampling bag between sample collection and evaluation.

AREA SOURCE METHODS

In the three area source sampling methods included in this section, air containing odour or odorants is drawn from a surface and collected in a container. The odour or odorant concentration is determined by analysis and the emission rate is estimated on the basis of the sample collection characteristics (flow rates). The methods described here are ways to direct samples from the surface to a collection device.

Flux Chamber Sampling Method

The flux chamber is used to collect odour samples from area sources such as the surface of solid or liquid material (U.S. EPA, 1986; Zarra et al., 2012). In this method, a small domed chamber is placed over a selected part of the surface and then sealed. Valves on the upper surface of the dome allow sweep gas to enter the dome and the odour sample to exit the dome into a sample collector (e.g., Tedlar bag, canister, impinger). The collected sample is then analyzed.

Wind Tunnel Sampling Method

The wind tunnel sampling method (Wang et al., 2001) is similar to the flux chamber sampling method and is used to collect odour samples from solid or liquid surfaces. Instead of a domed chamber, a wind tunnel with an elongated box shape is used.

Static Hood Sampling Method

This method is commonly used for active surface sources such as biofilters and aeration tanks (VDI, 2011). In this technique, the sample over a surface is drawn up through a small stack. The stack is fitted with a sampling port and samples are taken for analysis using point source sampling methods (i.e., lung or dilution methods).

VOLUME SOURCE SAMPLING

Quantifying odour emissions from volume sources (e.g., valves, pump flanges, doors, windows, process areas and truck loading/unloading) is challenging. There can be numerous fugitive emissions within a facility. In some cases, emitted substances can be trapped within cavities associated with air flow near buildings or structures.

The usual approach for sources of this nature is to use lung sampling techniques coupled with quantitative analysis to determine the odour or odorant concentration near the source. Then dispersion modelling is used to estimate emission rates from the source of fugitive emissions.

Another approach is to cover the fugitive source and treat it as a point source. Remote sensing can also be used to measure the concentration in situ. When coupled with knowledge of the flow characteristics in the area of measurement, the emission rate can be determined. As above, dispersion models can be used in reverse, to estimate emission rates from the remotely sensed measurement.

AMBIENT ODOUR MONITORING

Ambient odour monitoring for measuring odour levels is usually carried out downwind of odour sources, but may also be conducted upwind, to confirm the contribution of background sources. Several methods of ambient odour monitoring are described below.

Ambient Sampling

Ambient sampling for odour assessment is typically conducted using lung sampling techniques (with the sample collection done in ambient air rather than within a source such as a stack). Lung sampling techniques are used to collect samples that are subsequently analyzed using analytical or non-analytical assessment methods.

Portable or Field Olfactometry

A portable olfactometer, such as Nasal Ranger or Scentroid, directly determines the odour concentration in the ambient air without having to collect a sample in a container. The portable olfactometer, which is basically a portable dilution device, is used by one person at a time. The diluted sample is presented to the odour observer using a face mask and the observer indicates whether an odour can be detected at each dilution. The results are used to calculate the detection threshold, which is the number of dilutions needed to make the odour in ambient air non-detectable.

Community Surveys

A community odour survey is the evaluation of odour by experienced and trained community observers (not trained field inspectors) in a structured observation session. The odours are rated using a standard intensity scale at prescribed locations. Training is conducted by odour measurement specialists. The community odour survey can be an effective alternative or supplement to source testing for odour, particularly in cases where there are a number of potential odour sources that can affect a community, where sources are difficult to sample, or when sources are expected to vary with meteorological conditions.

ANALYTICAL

Electronic Nose

The electronic nose is a sensing system consisting of an array of sensors that undergo a physical change (e.g., temperature change, mass change, resistance change) when their surface makes contact with a range of volatile compounds. The responses of the sensors to the compounds is digitally recorded. Through pattern-recognition statistical models, the odour associated with that signal pattern is identified, much like the brain will process information transmitted from the olfactory receptors in the human nose.

Continuous Monitoring

Continuous monitors typically measure concentration for individual odorants every few seconds and record the data as one-minute average values. There are no intermediate steps and the gas sample is analyzed directly by the continuous emission monitor. Continuous monitors measure odorant concentration either at the source or in ambient air.

Emissions

Continuous source monitors are frequently installed at facilities, particularly at combustion facilities, to monitor emissions, which may include odorants. Odorants may be monitored as individual compounds (e.g., hydrogen sulphide) or as groups (e.g., total hydrocarbons). Continuous source monitors can be installed on stacks to monitor emissions immediately before they are discharged to the environment.

Ambient

Technology that is similar to continuous emission monitoring is used to continuously measure concentrations of specific gases in ambient air, typically in communities or outside the fencelines of industrial facilities. Continuous monitors provide automated operation and fast instrument response, and can store many measured values.

Air Quality Health Index

The Air Quality Health Index (AQHI) is an example of an ambient monitoring program (fine particulate matter, ozone, nitrogen dioxide, sulphur dioxide, carbon monoxide, hydrogen sulphide and total reduced sulphur) set up to relay health-related information to the public (ESRD, 2014a). Comparisons of individual hourly pollutant concentrations are compared to air quality objectives and, based on a compilation of comparisons, the AQHI is calculated. The AQHI was designed to be an air quality index, not an odour index, but does include special community-based odour and visibility messaging when specific thresholds are exceeded.

Semi-Continuous Monitoring

Semi-continuous monitors measure concentrations over many minutes to hours (as compared to continuous monitors, which typically measure concentrations over seconds). Semi-continuous monitoring involves subsequent steps such as the separation of odorants by a gas chromatograph and detection by a suitable detector. The time required to obtain successive measurements is dependent on the time required to separate the odorants by the gas chromatograph.

Intermittent/Integrated Monitoring

Intermittent monitoring refers to the time frame in which sample collection is completed, and usually involves collection for a finite period of time that can range from a few minutes, hours or a day, depending on the application.

Most methods for determining concentrations of odorants in a gas stream at source, on an intermittent or integrated basis, involve the use of adsorbent tubes or impinger solutions to collect and concentrate the compounds prior to analysis. The monitoring methods can be used for whole-air samples for olfactometry or for specific odorants.

Passive Monitoring

Passive or diffusive sampling relies on the unassisted molecular diffusion of gases through a diffusive surface onto an adsorbent. Unlike active (pumped) sampling, passive samplers require no electricity, have no moving parts, and are simple to use (no electricity, pump operation or calibration). After sampling, the adsorbed gases are desorbed from the adsorbent using solvents or thermal desorption. Most commercially available passive/diffusive samplers offer lower sampling rates and limited sampling capacity. As a result, sensitivity can suffer during the short-term sampling required for odour assessments (due to low diffusion rates). Exposure periods to accumulate sufficient sample on the sampler adsorbent are too long to be useful for odour assessments, even as a screening tool.

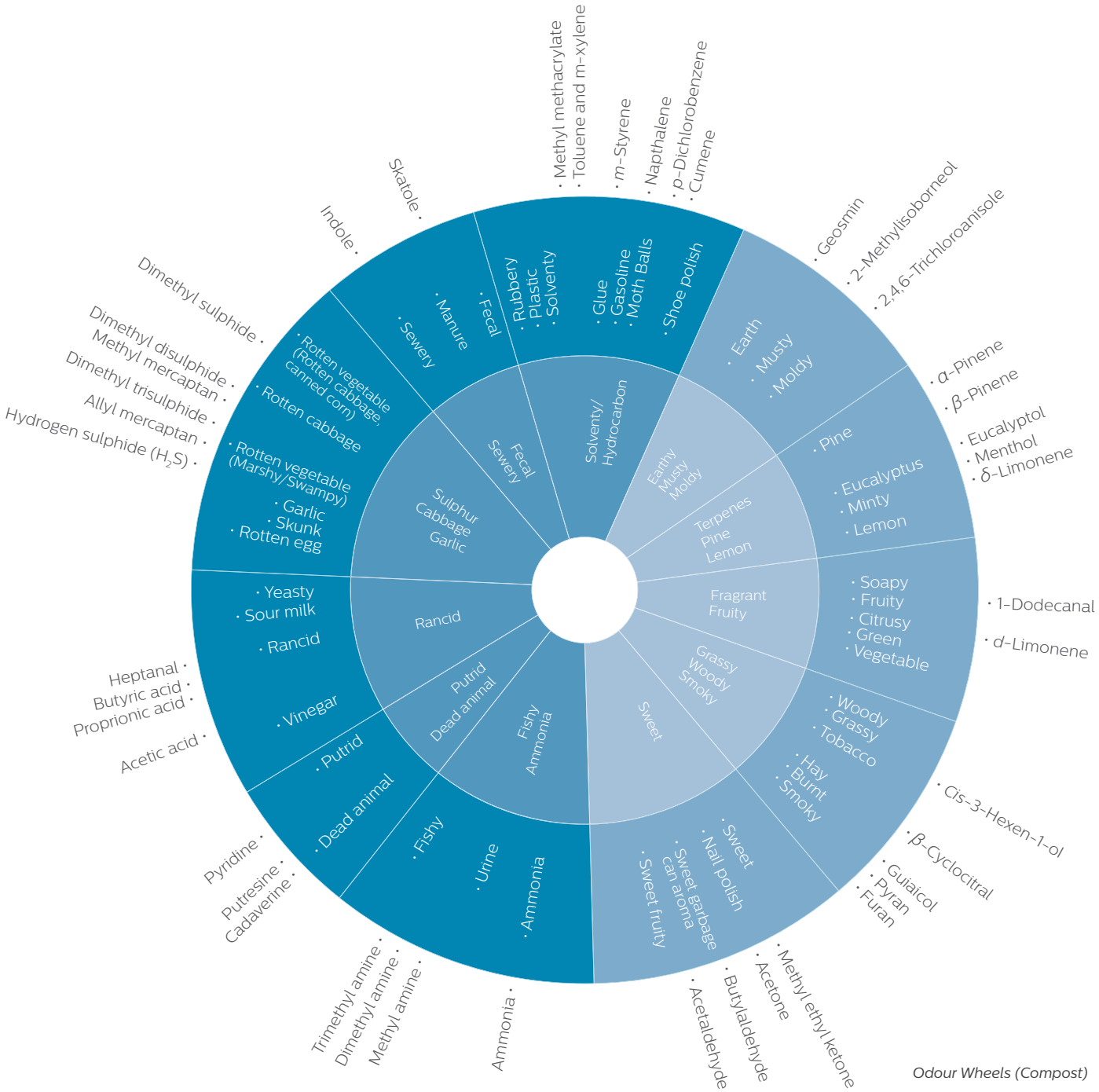
NON-ANALYTICAL

Triangular Odour Bag Method

The Odour Index is commonly used in Japan to quantify the intensity of odours, and is defined as: Odour Index = 10 x log (Odour Concentration). Odour concentration is determined using the Triangular Odour Bag Method (JME, 2006). The panelists identify the one bag with odour (two more bags have blanks), and the odorant is gradually diluted until it becomes impossible to identify the sample bag. The odour index is based on this final dilution.

Odour Descriptor Wheel

Numerous standard odour descriptor lists are available to use as referencing vocabulary. General categorical descriptors (e.g., earthy, fruity) are at the center of the wheel and more specific descriptors are placed towards the wheel rim. A large number of "standard descriptor lists" are available and can be tailored for specific industries or industry mixes. An example of the odour wheel is provided below (from Rosenfeld et al., 2007).



Odour Wheels (Compost)

Revised from Rosenfeld, et.al, Water Science & Technology, Vol 55 No 5, PP 345-347

Categorical Scale Analysis

Odour character is a nominal (categorical) scale of measurement and requires sensory (subjective) methods compared with odour detection threshold value determinations (objective). Sensory methods include odour intensity and hedonic tone. Determination of sensory parameters is most useful for samples that are collected undiluted at a receptor (rather than at an emission source) and then evaluated by an odour panel without dilution.

Olfactometry

Olfactometry is considered the best available approach for measuring odours directly, to objectively quantify the perception of odours as, in many cases, the detection limits of analytical instruments for individual or multiple odorants are higher (worse) than the human nose (Pandey et al., 2012). In olfactometry, the odour sample is diluted with odour-free air, according to precise ratios, to determine odour concentrations using an odour panel.

Community Odour Assessment

Community surveys can do more than provide information on nominal odour levels. They are valuable sources of descriptive data that can be used in odour descriptor wheel analysis and categorical scale analysis.

Odour Diary

An odour diary is a record of odour (and especially odour episodes) by individuals living near sources. Typically diaries are kept by those experiencing odour annoyances. Characteristics of the odour are recorded such as intensity, character, duration and pleasantness. Date and time of the odour episode should also be recorded.

DISPERSION MODELLING FOR ODOUR AND ODORANTS

Modelling Types

Odour models can be classified according to their working principles (Olesen et al., 2005):

- Gaussian plume models assume that dispersion takes place in odorant plumes with specific geometry (Gaussian distribution). This kind of model is sometimes called a “lighthouse” model where the plume moves from the source in the direction of the wind, independently in each hour.
- Gaussian puff models assume the odorant is emitted as series of puffs. This allows each puff to travel a curved path as the wind direction changes.
- Lagrangian particle models assume the release of a large number of individual virtual particles whose fate is followed and summarized. According to the Lagrangian approach, virtual particles follow a wind field modified by turbulence.
- Computational Fluid Dynamics (CFD) models are sophisticated codes for fluid dynamics and transport problems, based on numerical solution of the governing fluid flow and dispersion equations (Pope, 2004). These models are useful for near-field application in the vicinity of buildings and complex structures. CFD models could be used for odour modelling but they are complicated (Prata et al., 2014) and, therefore, they are rarely, if ever, used for odour assessments.
- In Eulerian models, emissions are assigned to grids rather than to specific geographic coordinates. Eulerian models were typically designed for long range transport and include complex chemistry. They do not track odorant plumes from specific sources. As such, they are best suited for regional modelling rather than odour assessments.

Model Input Requirements

To run dispersion models for odour assessments, the following inputs are generally required:

- Emission and source parameters, including nearby buildings
- Meteorological data
- Terrain data
- Land use characteristics

There are several sources of uncertainty and limitations associated with odour modelling which are described in more detail in the full report (*Review of Odour Assessment Tools and Practices for Alberta*), which is available online at casahome.org.

TREND ANALYSIS

Trend analysis for patterns in odour data could take the following forms:

- Temporal trends in odour concentrations or odour character measured at specific locations
- Identification of potential upwind source regions based on measurements at one or more locations
- Spatial trends in odour concentrations or odour character

Odour Assessment 'Tools Use' Guide

PURPOSE

The "Understanding Odour" and "Odour Assessments" information in this Good Practices Guide provides context and options on odour issues and their assessment. The purpose of the following odour assessment "Tools Use" Guide is to help determine which specific odour assessment options should be considered in which circumstances. It is recommended that the user reads background material prior to using this guide to gain a better understanding of its content:

- Section 2 and Section 3 of *Review of Odour Assessment Tools and Practices for Alberta*, which is available online at casahome.org
- "Understanding Odour" (see page 8) and "Odour Assessments" (see page 36) in this guide

USING THE 'TOOLS USE' GUIDE

The following approach is suggested:

1. Identify the purpose of the odour assessment using the chart on the following page.
2. Review the suggested steps in the assessment for the selected odour assessment purpose.
3. For each step, examine the matrix of tool options in Tables 3 and 4 on pages 47-50 for that step and identify the possible tools that meet your needs.

As a simplified example, if the purpose is to verify an odour complaint, choose a non-analytical assessment tool as a first step. An odour wheel may confirm that the "strong solvent smell" complaint may be due to toluene or xylene emissions. A follow-up ambient measurement program at the location of the complaint could involve the collection of a number of canister samples followed by laboratory analysis for the odorants of interest (and others). The resultant odorant concentrations and frequency of high concentrations could be compared to established odour thresholds. If the measurements suggest that a specific source may be responsible for the observations, a source measurement program may be appropriate. At each step, the guide offers options based on such factors as cost, the type of source, and whether odour or odorants is the issue. A glossary has been provided at the end of this guide (see page 87) to assist with understanding terms and acronyms.

Note: Depending on the nature of the odour issue, a more robust assessment plan may be required which may involve more and/or different steps than suggested here.

HOW WILL THE RESULTS BE INTERPRETED?

There is a wide range in the information output from the various tools, and the interpretations may vary just as widely. For example, the output of a continuous ambient monitor will be a series of concentration measurements for an odorant (such as H_2S). The data can be compared to odour detection thresholds, or summarized to establish frequencies of observations above thresholds. When coupled with wind data measured simultaneously, a likely direction from which odorants emanate may be determined. As a second example, the information output of an odour wheel is the identification of a possible odorant (e.g., H_2S) based on the characteristics of the odour (e.g., rotten eggs) as determined by an individual. In many cases, the addition of a dispersion modelling step will provide greater understanding of the issue, by identifying odour or odorant hot-spots or conditions under which high odour is predicted, that might not be identified by monitoring alone.

WHO SHOULD USE THE GUIDE?

This guide is primarily intended for non-experts who are looking for general guidance on the steps that should be considered to address different types of odour issues and management considerations. This could include representatives of municipalities dealing with odour complaints, industry wishing to change their operations, communities with odour concerns, provincial government and regulators.

PURPOSE OF ODOUR ASSESSMENT	SUGGESTED STEPS
To verify and investigate odour complaints	1. Non-analytical assessment 2. Ambient sampling and measurement 3. Source sampling and measurement
To comply with conditions outlined in operating/industrial permits	1. Source sampling and measurement 2. Ambient sampling and measurement
To determine compliance with odour legislation	1. Source sampling and measurement 2. Ambient sampling and measurement
To assess long-term odour exposure levels in an area	1. Non-analytical assessment 2. Ambient sampling and measurement
To rank potential odour sources for mitigation purposes	1. Source sampling and measurements (OU or individual compounds)
To determine background odour concentrations before building a new facility	1. Ambient sampling and measurement
To determine the off-site odour impact from existing operations	1. Non-analytical assessment 2. Ambient sampling and measurement
To determine the expected changes in off-site odours resulting from new facilities, expansions of existing facilities or other operational changes.	1. Source sampling and measurement 2. Ambient sampling and measurement 3. Dispersion modelling

Section 6 of **Review of Odour Assessment Tools and Practices for Alberta** *provides more detail about costs, accuracy, ease of use, limitations and other factors about each tool. The full report is available online at* ***casahome.org***

Table 3

TOOL TYPE	TOOL	ODOUR EPISODE CHARACTERIZATION								LEVEL OF DETAIL	TARGET	
		FREQUENCY		INTENSITY		DURATION		OFFENSIVE	LOCATION SENSITIVITY		ODORANT(S)	ODOUR
		High	Low[a]	High	Low	Long	Short					
SOURCE												
Point Source - Analytical	CEMS	✓	✓	N/A	N/A	✓	✓	N/A	N/A	High	✓	N/A
	Semi-continuous	✓	✓	N/A	N/A	✓	✓	N/A	N/A	High	✓	N/A
	Intermittent/integrated	✓	N/A	✓[c]	✓[c]	✓	N/A	N/A	N/A	High	✓	✓
Point Source - Sample Collection[d]	Grab bag/canister	✓	N/A	✓[c]	✓[c]	✓	N/A	N/A	N/A	High	✓	✓
Area Source - Sample Collection[d]	Flux Chamber	✓	✓[e]	✓[c]	✓[c]	✓	✓	N/A	N/A	N/A	✓	✓
	Wind Tunnel	✓	✓[e]	✓[c]	✓[c]	✓	✓	N/A	N/A	N/A	✓	✓
	Static Hood	✓	✓[e]	✓[c]	✓[c]	✓	✓	N/A	N/A	N/A	✓	✓
Volume Source - Analytical	Remote Sensing	✓	✓	N/A	N/A	✓	✓	N/A	N/A	Medium	✓[f]	N/A

[a] *Low frequency odour events are those occurring only a few times each year. High frequency events occur more often but the characterization is subjective.*

[b] *Under the assumption that the source emits uniformly.*

[c] *Source emission estimates are needed for new or modified facilities prior to construction. However, they would typically be provided by engineering estimates rather than measurements.*

[d] *This tool or technique collects a sample or facilitates the collection of a sample. This sample must be analyzed separately using appropriate non-analytical or analytical laboratory techniques. Non-analytical tools are discussed below. The range of laboratory analytical techniques that could be applied to sample collections is broad, application dependent, and beyond the scope of this document.*

[e] *Only if the sampling equipment underlying the method is operated continuously or semi-continuously, as the method only acts as a means to direct the sample to a collection device.*

[f] *Generally, remote sensing devices have higher detection limits than other methods.*

✓ *The tool is applicable.*
N/A: The tool is not applicable.

Table 3 Continued

TOOL TYPE	TOOL	COST	SOURCE TYPE					APPLICATION		FACILITY TYPE		QUANTIFIABLE
			POINT	AREA	VOLUME	LINE	MULTI-SOURCE	SOURCE	AMBIENT	EXISTING	PLANNED	
SOURCE												
Point Source - Analytical	CEMS	$$$$	✓	✓[b]	✓[b]	✓[b]	N/A	✓	N/A	✓	N/A[c]	✓
	Semi-continuous	$$$	✓	✓[b]	✓[b]	✓[b]	N/A	✓	✓	✓	N/A	✓
	Intermittent/integrated	$$	✓	✓[b]	✓[b]	✓[b]	N/A	✓	✓	✓	N/A	✓
Point Source - Sample Collection[d]	Grab bag/canister	$	✓	✓[b]	✓[b]	✓[b]	N/A	✓	✓	✓	N/A	✓
Area Source - Sample Collection[d]	Flux Chamber	$$	N/A	✓	N/A	N/A	N/A	✓	N/A	✓	N/A	✓
	Wind Tunnel	$$	N/A	✓	N/A	N/A	N/A	✓	N/A	✓	N/A	✓
	Static Hood	$$	N/A	✓	N/A	N/A	N/A	✓	N/A	✓	N/A	✓
Volume Source - Analytical	Remote Sensing	$$$	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓

[a] *Low frequency odour events are those occurring only a few times each year. High frequency events occur more often but the characterization is subjective.*
[b] *Under the assumption that the source emits uniformly.*
[c] *Source emission estimates are needed for new or modified facilities prior to construction. However, they would typically be provided by engineering estimates rather than measurements.*
[d] *This tool or technique collects a sample or facilitates the collection of a sample. This sample must be analyzed separately using appropriate non-analytical or analytical laboratory techniques. Non-analytical tools are discussed below. The range of laboratory analytical techniques that could be applied to sample collections is broad, application dependent, and beyond the scope of this document.*
[e] *Only if the sampling equipment underlying the method is operated continuously or semi-continuously, as the method only acts as a means to direct the sample to a collection device.*
[f] *Generally, remote sensing devices have higher detection limits than other methods.*
✓ *The tool is applicable.*
N/A: The tool is not applicable.

Table 4

TOOL TYPE	TOOL	ODOUR EPISODE CHARACTERIZATION								LEVEL OF DETAIL	TARGET	
		FREQUENCY		INTENSITY		DURATION		OFFENSIVE	LOCATION SENSITIVITY		ODORANT(S)	ODOUR
		High	Low	High	Low	Long	Short					
AMBIENT												
Analytical	Continuous	✓	✓	N/A	N/A	✓	✓	N/A	High	High	✓	N/A
	Semi-continuous	✓	✓	N/A	N/A	✓	✓	N/A	High	High	✓	N/A
	Intermittent/Integrated	✓	N/A	✓[c]	✓[c]	✓	N/A	N/A	High	High	✓	✓
	E-Nose	✓	✓	✓[c]	N/A	✓	✓	N/A	Medium	Medium	N/A	✓
	Passive	✓	N/A	N/A	N/A	✓	N/A	N/A	Low	Low	✓	N/A
	Remote Sensing	✓	✓	N/A	N/A	✓	✓	N/A	Multiple	Medium	✓	N/A
Sample Collection[d]	Grab bag/canister	✓	N/A	✓[c]	✓[c]	✓	N/A	N/A	High	High	✓	✓
NON-ANALYTICAL												
	Odour Index	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Low	Low	N/A	✓
	Odour Wheel	N/A	N/A	N/A	N/A	N/A	N/A	✓	Low	Low	N/A	✓
	Categorical Scale	N/A	N/A	N/A	N/A	N/A	N/A	✓	Low	Low	N/A	✓
	Field-based Olfactometry	N/A	N/A	✓	N/A	N/A	N/A	✓	Medium	Low	N/A	✓
	Lab-based Olfactometry	N/A	N/A	✓	✓	N/A	N/A	✓	High	High	N/A	✓
	Community Survey	N/A	N/A	N/A	N/A	N/A	N/A	✓	Low	Low	N/A	✓
	Odour Diary	N/A	N/A	N/A	N/A	N/A	N/A	✓	Low	Low	N/A	✓
DISPERSION MODEL												
	Gaussian Puff (CALPUFF)	✓[b]	✓	N/A	N/A	✓	✓	N/A	Medium	High	✓	✓
	Gaussian (AERMOD)	✓[b]	✓	N/A	N/A	✓	✓	N/A	Medium	High	✓	✓

[a] *A community survey can quantify frequency of detection, for example, but is not used to quantify odour concentration or intensity.*

[b] *Standard model output includes worst case (i.e., low frequency) occurrences. Hourly predictions are available with additional analysis.*

[c] *Odour intensity can be determined based on olfactometry assessment of samples collected using this method.*

[d] *This tool or technique collects a sample or facilitates the collection of a sample. This sample must be analyzed separately using appropriate non-analytical or analytical laboratory techniques. The range of laboratory analytical techniques that could be applied to sample collections is broad, application dependent, and beyond the scope of this document.*

✓ *The tool is applicable.*

N/A: The tool is not applicable.

Table 4 Continued

TOOL TYPE	TOOL	COST	SOURCE TYPE					APPLICATION		FACILITY TYPE		QUANTIFIABLE
			POINT	AREA	VOLUME	LINE	MULTI-SOURCE	SOURCE	AMBIENT	EXISTING	PLANNED	
AMBIENT												
Analytical	Continuous	$$$	N/A	N/A	N/A	N/A	N/A	N/A	✓	✓	N/A	✓
	Semi-continuous	$$	N/A	N/A	N/A	N/A	N/A	N/A	✓	✓	N/A	✓
	Intermittent/Integrated	$$	N/A	N/A	N/A	N/A	N/A	N/A	✓	✓	N/A	✓
	E-Nose	$$	N/A	N/A	N/A	N/A	N/A	N/A	✓	✓	N/A	✓
	Passive	$	N/A	N/A	N/A	N/A	N/A	N/A	✓	✓	N/A	✓
	Remote Sensing	$$$	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓
Sample Collection[d]	Grab bag/canister	$	N/A	N/A	N/A	N/A	N/A	N/A	✓	✓	N/A	✓
NON-ANALYTICAL												
	Odour Index	$	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A
	Odour Wheel	$	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A
	Categorical Scale	$	✓	✓	✓	✓	✓	✓	✓	✓	N/A	N/A
	Field-based Olfactometry	$$	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓
	Lab-based Olfactometry	$$	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓
	Community Survey	$$$	✓	✓	✓	✓	✓	✓	✓	✓	N/A	✓[a]
	Odour Diary	$	✓	✓	✓	✓	✓	N/A	✓	✓	N/A	N/A
DISPERSION MODEL												
	Gaussian Puff (CALPUFF)	$$$	✓	✓	✓	✓	✓	N/A	✓	✓	✓	✓
	Gaussian (AERMOD)	$$	✓	✓	✓	N/A	✓	N/A	✓	✓	✓	✓

[a] *A community survey can quantify frequency of detection, for example, but is not used to quantify odour concentration or intensity.*
[b] *Standard model output includes worst case (i.e., low frequency) occurrences. Hourly predictions are available with additional analysis.*
[c] *Odour intensity can be determined based on olfactometry assessment of samples collected using this method.*
[d] *This tool or technique collects a sample or facilitates the collection of a sample. This sample must be analyzed separately using appropriate non-analytical or analytical laboratory techniques. The range of laboratory analytical techniques that could be applied to sample collections is broad, application dependent, and beyond the scope of this document.*
✓ *The tool is applicable.*
N/A: The tool is not applicable.

Notes

ABOUT THIS SECTION

APPROACHES FOR MANAGING ODOURS

The following information was summarized from *Report to the Clean Air Strategic Alliance Odour Management Team Enforcement/Role of Regulation Task Group* which was prepared for the Clean Air Strategic Alliance by RWDI AIR Inc.

The full report, which includes more detailed information and all references cited, is available online at **casahome.org.**

Odour-related regulation and associated enforcement of these regulations is one of many odour management tools. For enforcement to effectively resolve or prevent odour issues, it must be based on a set of comprehensive and appropriate regulations and is generally the least preferred/desirable option for managing and addressing odour issues. Regulation in the context of this guide refers to any law, bylaw, rule, code, standard, objective or other order prescribed by a government authority (federal, provincial or municipal) that regulates or guides conduct and provides oversight with respect to odours. While CASA reviewed odour regulation, no specific recommendations regarding regulatory approaches or regulatory requirements related to odour were made as this was beyond its mandate. The approach was, therefore, to assess possible regulatory options for odour management in Alberta, and to provide the results of this work to the Government of Alberta without any specific comments or recommendations. The following information is, therefore, a summary of regulatory considerations and possible options for formally managing odours in Alberta.

Regulatory-related Odour Management

There are many regulatory approaches for managing odours. This is partially the result of difficulties in finding a single best option for controlling or managing odour issues, which are often site specific and unique in nature due to the varied and qualitative nature of perception of odour. Odour detection, along with the annoyance level associated with an odour, also varies among people. For these reasons, almost all jurisdictions have multiple approaches when considering and managing odour. Not any one approach will cover all aspects of odour management that are likely to be encountered.

There are a number of general considerations for any potential regulatory-based odour management framework:

- Clarity is essential to the selection of a suitable odour management approach. If the approach is not clear and well-defined, it will be difficult to implement and will not work once put to a legal test.
- Good relationships between facilities and surrounding residents are a significant benefit, and should be promoted where possible, regardless of the odour management approach selected.
- The development of best practices guides are highly recommended for various categories of facilities to avoid potential odour issues, or to help identify solutions if/or when issues do arise.
- Cumulative effects from neighbouring facilities, as well as location-specific geography and meteorological conditions, can be an issue and must be recognized.
- Certain combinations of geography and meteorological conditions may also exacerbate odour issues, and should be considered in the siting process for new facilities or developments near existing facilities.
- No one approach will apply to all situations or industries and, therefore, some flexibility is critical. Implementing more than one approach is likely beneficial, as it can help deal with a wider variety of situations, giving both facilities and the regulator additional options.

Regulatory approaches for managing odours can be classified as being related to specifying ambient odour levels, acceptable odour emission levels, or possibly a combination of the two. Fundamentally, the components of any of these approaches break down into a series of eight ambient-based and two emission-based regulatory systems.

Ambient-based

1. Avoidance of nuisance law
2. Ambient concentration criteria for individual chemicals (units of $\mu g/m^3$ or ppm)
3. Ambient concentration criteria for odour (units of OU, OU/m^3, OUE/m^3 or D/T)
4. Episode duration-frequency (units of odour-hours)
5. Minimum separation distances (units of distance)
6. Odour intensity scales
7. Odour index
8. Complaint criteria

Emission-based

1. Quantitative emission criteria (units of concentration or flow rate)
2. Technology criteria

> *These approaches are not mutually exclusive and are often used in combination within a single odour management program.*

AVOIDANCE OF NUISANCE LAWS

This type of law is based on either "nuisance" or "quality of life" narrative standards and essentially requires that odour from a facility not result in a nuisance. In many jurisdictions, the only regulation related to odour is a nuisance law while all other aspects of the odour management program are simply guidelines that are not enforceable.

STRENGTHS

Applicable to Pre-existing Sources:

- Can be applied to already existing facilities.

Acknowledges Receptors[a]:

- Odour issues are a problem only where there are human receptors.
- Focus is on sources of concern only (i.e., if a source has not raised concern with receptors, no time or money is invested into an investigation).
- Can focus investment (both financial and time) in areas where odour concerns are predominant.

Not Specific to Individual Source:

- Can be applied to all sources.

Well-established Practices:

- Odour regulations in 42 of the 50 states in the United States are of this type (Epstein and Freeman, 2004).
- Nuisance laws in Europe date back to late 19th century (Van Harreveld, 2005).

WEAKNESSES

Contradicting Legislation:

- May conflict with existing legislation.

Quantification:

- Different smells affect different people in different ways.
- Each facility would need to be considered as unique.
- Legal hearings may increase since "nuisance" and "quality of life" may be interpreted differently by the parties in conflict.

Public Relations:

- Once relied on for enforcement, public relations may break down.
- Quantifying impacts may take time, leading to receptors being exposed to additional effects on quality of life

Future Projects:

- Hard to determine what is perceived as "quality of life" when in planning stage.
- Land use (and thus receptors) may change over time affecting what is considered a nuisance..

CONSIDERATIONS

Sources:

- Could be applied to all sources (with the exception of perhaps agricultural).

Combined Application:

- Quite often combined with Complaint Criteria Method.

Sample Jurisdictions:

- Ontario; New South Wales, Australia.

Enforceability:

- A legal test must be established to determine what constitutes a "nuisance."
- The steps to enforce with policy and law must be clear.
- The time-frame for solving issues must be clear for all parties.

Clarity:

- Requires definition of "nuisance" and "quality of life."
- Legislation should be clear with respect to odour.
- This would include factors such as frequency, intensity and annoyance potential.

[a] *Receptors are locations where general public would notice a smell*

AMBIENT CONCENTRATION CRITERIA FOR INDIVIDUAL CHEMICALS

Many jurisdictions in North America and elsewhere in the world have quantitative ambient concentration criteria for individual odorous chemicals. The regulatory status of these criteria ranges from guidelines or objectives to enforceable standards.

Dispersion modelling used to predict concentrations of a compound usually considers hourly averaging times. A human nose, though, can pick up an odour in seconds. Averaging time for measurements of many odorants usually fall between these two extremes. This leads to a unique issue when comparing odorous substance measurements with ambient background criteria.

STRENGTHS

Quantifiable:

- Out of all methods arguably the most quantifiable.
- Odour thresholds are known for many compounds.
- Ambient concentrations can be measured and quantified.
- Concentrations can be predicted with dispersion modelling.

Proactive Management:

- Dispersion modelling can be used to predict concentrations and measures can be taken before a facility is built.
- Monitoring of multiple compounds can be conducted. As odour thresholds are approached, facilities can take proactive measures to mitigate problems.
- Can be used for urban planning, and planning for future facilities.

Temporal Resolution:

- Many compounds can be measured continuously, leading to multiple measurements over time.
- Can study times of day, meteorological conditions, etc. that can lead to odour and proactively manage emissions.

Familiarity to Alberta:

- Alberta Ambient Air Quality Objectives currently includes three substances because of odour, (including carbon disulphide, ammonia and hydrogen sulphide).

WEAKNESSES

Capturing Odour:

- Odour compounds are not necessarily additive. They can react with each other giving higher or lower odour thresholds than individual chemicals.
- Although individual compounds may be below their respective odour threshold, odour may still be present.
- Would be hard to quantify (without direct monitoring) for sources that are variable due to organic matter (e.g., landfills, composting, agricultural).
- Hard to quantify with monitoring in areas with large number of sources producing similar compounds.

Measurements:

- Some chemicals may pose an odour concern even when concentrations are below detection limit of instrumentation.
- There are hundreds of compounds that are considered to be odorous (AIHA, 2012), and not all can measured (e.g., cost prohibitive).

Consideration of Receptors:

- Even if no human receptors are present or receptors report no odours, facilities would still be required to uphold legislation.

CONSIDERATIONS

Sources:

- Works well for sources with known emission rates, especially those already reporting to the government, such as oil and gas facilities, pulp and paper mills, chemical plants and power plants.

Jurisdictions:

- Ontario; Quebec; New South Wales, Australia.

Sampling Methods:

- There are costs associated with measurements.
- Frequency of sampling period and averaging period must be considered.
- Minimum monitoring requirements must be defined.
- Preventative monitoring may provide a good community relations tool, while reactive monitoring may come under more scrutiny.

Odour Thresholds:

- Definition of odour threshold would need to be considered. Reported odour thresholds can range by several orders of magnitude (AISA, 2012).
- There are hundreds of odour causing compounds; how would legislation work when it would be impossible to measure/consider all?

AMBIENT CONCENTRATION CRITERIA FOR ODOUR

Odour is commonly measured using an odour panel, which consists of a number of specially trained personnel. The European, Australian and American standards are the most commonly used for odour panel measurements. The general concept behind these methods is to dilute air samples with known amounts of odour-free air using an olfactometer or scentometer. The most diluted samples are presented to the odour panel first. Less dilute samples are gradually presented to the panel until 50% of the panel can detect an odour. This is defined as the odour detection threshold.

STRENGTHS

Well Established Methods:

- Two primary standards have been developed for measurements of odour:
  1. ASTM International E679-04: Standard Practice for Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentrations Series Method of limits.
  2. European Union Standard EN13725:2003: Air Quality Determination of Odour Concentration by Dynamic Olfactometry.

Proactive Measures:

- If odour emission rates can be estimated, odour units can be modelled using dispersion modelling.
- Can aid in urban planning around new or expanded facilities.

Quantifiable:

- With use of odour panels, a well-established quantifiable odour can be determined.
- Can be used as a tool for reactive responses (e.g., from complaints).

Classifies Odour:

- Is applicable to a large range of odorants.
- Can be used for complex odours (i.e., more than one odorant).
- Related to odour intensity as perceived by human sense of smell.

WEAKNESSES

Future Planning:

- Many times more difficult to determine odour emissions before a facility is built and thus, to proactively model OU concentrations.

Uniqueness of Samples:

- Samples are not always continuous.
- Coordination between time of day, meteorological conditions, location, etc., can influence if odours are detected or not.
- Odours from different facilities with different character of odours may result in odours even though an individual facility may not.

Costs:

- Suitable odour testing facilities (e.g., odour panels) may not exist locally, and must either be established and trained with standardized programs, or the samples must be sent to other jurisdictions for testing.
- Cost to send samples to an odour panel can be high, as the panel usually consists of at least six people.

Sample Degradation:

- Sample can degrade with respect to time, temperature, humidity, etc., and are time sensitive.
- Window of optimal testing may factor into cost.

CONSIDERATIONS

Sources:

- Can be useful for existing and new facilities (in some cases).
- Reactive measurements could be used with all types of facilities.

Jurisdictions:

- Saskatchewan, Europe (majority of countries), Australia (all provinces), Korea, Colorado, Connecticut.

Sampling Methods:

- Frequency of sampling period and averaging period must be considered.
- Minimum monitoring requirements must be defined.
- Preventative monitoring may provide a good community relations tool, while reactive monitoring may come under more scrutiny.
- Coordination of sampling time vs. introducing it to the panel.

EPISODE DURATION-FREQUENCY

Germany has a unique system for assessing whether a nuisance odour is significant. This system considers not only the intensity of an odour, but also its duration and frequency. The existing odour impact in the field is assessed, using a systematic process, and is added to the predicted odour impact of a new or modified facility. The total odour impact is compared with imission limit values, which are relative frequencies of odour-hours. It is permissible for odours to occur more frequently in industrial or commercial areas.

The word "imission" is used in the sense of influence of air pollutants, in this case odour, on humans. This establishes an active view of air pollutants influencing receptors, in contrast to the passive view of receptors being exposed to air pollutants. If this semantic difference is ignored, imission can be interpreted as exposure (Germany, 2003).

STRENGTHS	WEAKNESSES	CONSIDERATIONS
Considers Type of Sources: · Takes into consideration other issues besides intensity that may trigger complaints (e.g., a bakery, although it may emit odours, would likely not raise as many complaints as other industries). · Considers intensity, duration, location and frequency. **Proactive Management:** · A systematic process for predicting odour impacts on new and/or modified facilities is in place in Germany. · Can be used for future planning of the facility and/or urban planning.	**Quantification:** · Some subjective analysis including what is considered. **Labour-intensive:** · It can take up to six months to take all variables into consideration. · Would not work for short-term complaints. · Costs associated with the method can be high. **Uniqueness of Protocol:** · Only used in Germany, therefore, not as well tested in other environments. · Reference material would be only from one country (i.e., harder to determine what works/does not work elsewhere).	**Sources:** · Could be applied to all sources including oil and gas facilities, pulp and paper mills, chemical plants, refineries and power plants. · Good at distinguishing impact from different types of facilities. **Jurisdictions:** · Germany. **Choosing Limits** · Duration and frequency would have to be defined along with what would be termed acceptable. · Length of an investigation with monitoring would need to be determined, weighing in such factors as cost and exposure, and taking enough time to obtain all necessary measurements. · Germany distinguishes limits for different zones. Zoning may need to be considered (industrial vs. residential).

MINIMUM SEPARATION DISTANCES

Many jurisdictions manage nuisance, including odours, using minimum separation distances or buffer zones, especially for the agricultural sector. Minimum separation distances tend to be either fixed or variable, depending on a number of factors. In general, minimum separation distances are applied to agricultural sources, sewage treatment plants and composting.

STRENGTHS

Future Planning:

- Once source is established, urban planning would be straightforward as to where and where not to build.
- Facilities would be able to quickly decide if expansions could/could not occur.

WEAKNESSES

Pre-existing Sources:

- Would be hard, if not impossible, to implement for sources and facilities that are already established and minimum separation distances are not currently met.

Influence of Surrounding Environment:

- Does not take into consideration meteorological conditions that may cause odour issues downwind, while a receptor upwind may not notice an odour.
- Complex terrain (such as in the foothills and mountains) may affect the dispersion of odours that would not be considered in the minimum separation distance method.

Source Upgrades:

- Would not take into consideration technology investments that a source may implement to reduce odours.

Capturing Odour:

- Separation distances would not necessarily alleviate all odour issues.
- Over-conservative distances would impede future projects and developments around the sources that may not be necessary.

CONSIDERATIONS

Sources:

- Can be applied to new sources.
- Used in many jurisdictions for agricultural sources, sewage treatment and composting.
- Would not be able to implement for existing sources that do not meet separation distance since source is established.
- If separation distance had previously been established, expansion of an existing facility may be limited.

Jurisdictions:

- Alberta (for agricultural sector), Ontario (for agricultural sector), South Australia (most if not all sectors).

Standardizing All Sources:

- In a number of jurisdictions, odour issues related to agriculture are handled by a different department or ministry than other industrial or municipal sources of odour.
- Modification to include all sources would have to be taken into account.
- Determination of how to adjust legislation for all sources would be needed.
- Consideration of all types of sources would have to be determined.

ODOUR INTENSITY SCALES

A number of jurisdictions have developed semi-quantitative odour intensity scales to assist field personnel when they are investigating an odour complaint. This allows field staff to make a determination about the intensity of an odour without having special training on the use and calibration of certain equipment (such as portable digital olfactometer training) or sending an odour sample to a laboratory for olfactometric testing. Training focuses on being able to implement a scale for odour intensity. The main advantage of this approach is its simplicity.

STRENGTHS

Simplicity:

- Semi-quantitative intensity scale.
- Used to assist field personal when investigating an odour complaint.
- Allows field staff to make immediate determination regarding intensity of odour.

Cost:

- Cost efficient compared to other measuring techniques.
- Multiple points can be assessed with little time and effort.
- Little to no special training.
- Does not require taking a sample for further analysis and does not incur associated laboratory costs.

Source Appointment:

- In an area of multiple sources, this method may be able to pinpoint odorous source.

WEAKNESSES

Subjective:

- Smell is unique to an individual (i.e., something strong to one may be moderate or below odour threshold to another).
- Dependent on time of day and location.
- If exposed to higher odour intensities earlier, may reduce odour detection of field personnel later in the day.
- May be hard to hold up in a court of law.

Distances:

- Supporting large areas may be difficult.
- Deploying field personnel out in the field as soon as a complaint is issued may be difficult, especially in remote areas.

Uniqueness of Samples:

- Determinations are not always continuous.
- Coordination between time of day, meteorological conditions, location, etc., can influence if odours are detected or not.

CONSIDERATIONS

Sources:

- Can be applied to all sources.
- Good for existing facilities.

Combined application:

- Often used jointly with complaint criteria.

Jurisdictions:

- Western Australia; New Jersey; Japan; Korea; Wellington, New Zealand; Texas.

Sampling Methods:

- Preventative monitoring may provide good community relations tool, while reactive monitoring may come under more scrutiny.
- Required frequency of measurements would need to be established and/or possible follow up measurements after a complaint is filed.

Streamlining for All Sources:

- Would have to consider how to merge existing procedures/methods or have procedures differ between source types.
- There may be situations where one department would oversee odour measurements and pass it to other departments, depending on the nature of the odour.

ODOUR INDEX

The "Odour Index" is used in Japan to quantify the intensity of odours. The odour index is equal to ten times the log of the odour concentration (i.e., Odour Index = 10 x log [Odour Concentration]). The odour concentration is measured using the Triangular Odour Bag Method in which a panel of six or more people are given a set of three bags, one with a sample in it and two with odour-free air. Panel members are asked to choose the odorous bag. The odorant is gradually diluted and tested until it becomes impossible to identify the bag with odour. The odour index is calculated based on the dilution rate at which the panel can no longer correctly identify the odorous bag. In the case of liquid samples, flasks are used instead of bags. The method also identifies how members of the panel should be selected, how samples should be gathered and how test results should be calculated.

STRENGTHS

Quantifiable:

- With use of odour panels, a well-established quantifiable odour can be determined.
- Can be used as a tool for reactive responses (e.g., from complaints).

Locations:

- Could be used to quantify odours in locations such as inside buildings.

Classifies Odour:

- Applicable to large range of odorants.
- Can be used for complex odours (i.e., more than one odorant).
- Related to odour intensity as perceived by human sense of smell.

WEAKNESSES

Future Planning:

- May not be able to predict odours for future projects and planning.

Uniqueness of Samples:

- Samples are not always continuous.
- Coordination between time of day, meteorological conditions, location, etc., can influence if odours are detected.

Costs:

- Suitable odour testing facilities (e.g., odour panels) may not exist locally, and must either be established with standardized training programs, or the samples must be sent to other jurisdictions for testing.
- Costs to send samples to an odour panel can be high, as the panel usually consists of at least six personnel.

Sample Degradation:

- Sample can degrade due to time, temperature, humidity, etc., and are time sensitive.
- Window of optimal testing and may factor into cost.

Uniqueness of Method:

- Only used in Japan, therefore, not as well tested as other methods in different environments.
- Reference material would be only from one country (i.e., harder to determine what works/does not work elsewhere).

CONSIDERATIONS

Sources:

- Can be used for all sources.
- Can be used for future planning of different types of sources.

Jurisdictions:

- Japan.

Sampling Methods:

- Frequency of sampling period and averaging period must be considered.
- Preventative monitoring may provide a good community relations tool, while reactive monitoring may come under more scrutiny.
- Coordination of sampling time vs. introducing it to the panel.

Choosing Limits:

- What would be considered acceptable vs. threshold detection of the panel?

Training:

- Limited globally trained individuals.
- Training for odour panel required to use this method.

COMPLAINT CRITERIA

Most jurisdictions have a system in place for responding to odour complaints. In many cases, there is a policy to respond to all complaints. In some jurisdictions, complaint criteria are expressed in terms of a minimum threshold number of complaints required before an investigation is launched or an odour is considered a nuisance. Other jurisdictions also have complaint hotlines that are staffed by the regulatory agencies or an answering service with staff trained to ask the complainants certain questions used in complaint documentation and reporting. Some jurisdictions have regulations or guidelines for how the regulator will respond to complaints. Other jurisdictions also clearly set out how they will determine whether a complaint is justified or verified. Typically, once a complaint is deemed to be credible, organizations follow their investigation procedures.

STRENGTHS

Applicable to Existing Sources:

- Can be applied to already existing facilities.

Acknowledges Receptors:

- Gives power to public.
- Focuses on areas where receptors are located.
- Focus on sources of concern only (i.e., if a source has not raised concern with receptors, no time or money is invested into an investigation).
- Can focus investment in areas (both financial and time) where odour concerns are predominant.

Not Specific to Individual Source:

- Can be applied to all sources.

Well Established Practice:

- Most jurisdictions have a system in place for responding to odour complaints.

WEAKNESSES

Quantifiable:

- Different people react to odours at different thresholds.
- Hard to distinguish what is acceptable/not acceptable for different people.

Public Relations:

- Once relied on for enforcement, receptors may become hostile towards source owner.
- Verifying impacts may lead to receptors being exposed to even longer effects.
- Lawsuits may result if disagreements arise between complainant and source owner on what constitutes an odour.

Preventative Legislation:

- This method is reactive.
- May be seen as “band-aid” solution which doesn’t solve the problem.

CONSIDERATIONS

Sources:

- Applied to all sources, quite often industry based.
- Usually combined with other methods to quantify.

Jurisdictions:

- Many cities have bylaws associated with odour complaints. (e.g., Metro Vancouver).
- Alberta for agricultural sources (NRCB).

Involvement and Method of Reporting:

- Some jurisdictions use an odour diary for public receptors to record details over a certain amount of time. Others use online reporting forms and/or toll-free numbers.
- Once a complaint is issued, the next step must be identified.
- Some jurisdictions respond to each complaint, others require all complaints to be logged, but not necessarily acted upon.
- Some require a minimum threshold of complaints before an investigation is launched.

Streamlining for All Industries:

- Since there are already procedures for some agencies with respect to odour complaints, it is important to decide how to implement for all sources.
- There may be situations where one department would oversee odour measurements and pass it to other departments, depending on the nature of the odour.

QUANTITATIVE EMISSION CRITERIA

Some jurisdictions have quantitative emission criteria for either odour or for specific chemicals. Unlike ambient criteria, which were in two distinct formats, the format of the emission criteria appears to be different for each jurisdiction. In general, these criteria limit the emissions of odorants or specific chemicals at the source, and are essentially in-stack emission limits.

STRENGTHS

Measurements:

- Stack testing is common for a number of contaminants and adding additional testing for odour standards could be included.

WEAKNESSES

Capturing Odour:

- Emission rates do not necessarily equal odour issues.
- Although high emissions may be recorded, meteorological conditions, temperatures, surrounding terrain, etc., can influence the dispersion of the emissions.
- Does not take into account where receptors are located or if an odour issue would occur in public places.

Inclusion of All Sources:

- Would be hard to do for an individual complaint or for an agricultural operation where emissions may be more spread out in both area and time.
- Emission rates may be difficult to measure from non-point sources (e.g., agricultural sources).
- Would be hard to quantify for sources that are variable due to organic matter content (e.g., landfills, composting, agricultural).
- Hard to quantify with monitoring in areas with large number of sources producing similar compounds.

CONSIDERATIONS

Sources:

- Would be limited to facilities that have point source emissions. For example, electricity generation, pulp and paper mills, chemical industry, transportation.
- Would be more beneficial in new facilities.

Jurisdictions:

- Japan, Korea, Switzerland, Bay Area Air Quality Management District (California, USA).

Sampling Methods:

- Frequency of sampling period and averaging period must be considered.
- Preventative monitoring may provide good a community relations tool, while reactive monitoring may come under more scrutiny.
- Averaging time would need to be considered.

Odour Thresholds:

- Some jurisdictions measure directly OU or D/T; others measure compound concentration.
- There are hundreds of odour causing compounds. Would need to know how legislation would prioritize them when it is impossible to measure/ consider all of them.
- Measurements must relate back to odour detection at the public receptors.

TECHNOLOGY CRITERIA

Many jurisdictions have requirements for new or existing facilities to implement state-of-the-science control technology or similar approaches that specify required levels of odour treatment controls or best management practices. These requirements are mostly qualitative in nature. Although most jurisdictions do not stipulate which technologies or management practices must be used, some jurisdictions do specify control technologies or management practices for different types of facilities.

Examples of odour control technologies that could be considered as best management practices include vent gas collection and treatment, vent gas condensation, chemical treatment, biological treatment, adsorption, incineration and dispersion (the last step in an odour control process). A typical control system for heated heavy oil tanks would include a vapour recovery unit and destruction unit such as flare, incinerator or thermal oxidizer.

STRENGTHS	WEAKNESSES	CONSIDERATIONS
Proactive: · Allows for best practices to occur on site. · Minimizes potential for odour complaints by addressing emissions on site and at the source. **Clear Direction:** · Industry would know minimum standards before the planning stages.	**Capturing Odour:** · Even with precautions, odour may still be an issue. · Additional technology may not affect potential for odour issues, but will likely have financial impact to companies. · Meteorological conditions, temperatures, surrounding terrain, etc., can influence the dispersion of the emissions. · Does not take into account where receptors are located or if an odour issue would occur in public places.	**Sources**: · May be more applicable to large facilities (due to cost to individual facilities). · Easier to implement for common facilities where multiple technology control measures already exist. · Easier to implement for new facilities **Jurisdictions:** · Netherlands; Colorado; Wellington, New Zealand. **Definitions:** · What is considered best control technology? · How would this change over time? **Defining Limits:** · Criteria for technology would need to be defined. · Cost/benefit analysis required. · Some form of change management required as odour criteria evolve or new technology becomes available.

Notes

ABOUT THIS SECTION

ODOUR COMPLAINTS IN YOUR AREA: A GUIDE FOR DEVELOPING AN ODOUR COMPLAINT PROCESS

This section is intended to provide guidance and advice related to odour complaint management. It outlines the factors that should be considered when developing processes for handling complaints, managing the relationship with the caller and gathering necessary information for an investigation. Please note, this section is not a field manual for odour investigations.

The examples and references to legislation and provincial agencies in this section are based on Alberta. Other jurisdictions may customize legislation, agencies and other information as appropriate.

The information is from *Odour Complaints in Your Area: A Guide for Developing an Odour Complaint Process*.

The full report, which includes more detailed information and all references cited, is available online at **casahome.org**.

Preparing for Odour Complaints

If an organization's operations or activities may result in odour complaints, there is a lot that can be done to begin managing the public's expectations about odours before an odour complaint is received.

PUBLIC COMMUNICATION

Giving the public information about odour management and the odour complaint process can go a long way to managing public expectations about odours and what can be done to address them. An organization can:

- Provide a way for the public to access general information about odours and odour management, such as a web page or phone line.
- Explain how and where the public can report an odour.
- Be open and transparent about the complaint process.
- Provide current information to the public, if there are known odour concerns, and if the information is appropriate to be shared. Let the public know the issue has been reported and what steps are being taken to address it.
- Ensure the organization has a policy that clearly states what employees can and cannot say.
- If needed, provide the caller with the phone number to the government's Coordination and Information Centre (CIC): 1-800-222-6514. One of the CIC's many roles is to serve as a contact point for spills and complaints, including odour complaints, for Alberta Environment and Parks and the Alberta Energy Regulator.

Sample information is provided in "Reporting Odours in Your Community" later in this section.

MEDIA RELATIONS

Create a media relations strategy well before it is needed. In the event of a widespread or potentially harmful odour, there may be media inquiries. Ensure employees know the policy on speaking to media and who is authorized to do so.

TRAINING

Organizations should have odour investigation processes in place that meet their needs. This may include special training for investigators and for the employees receiving complaints from the public.

Training for the employees who take calls from members of the public, can help them establish a constructive dialogue and manage expectations of callers who have odour complaints. They should know how to:

- Stay calm when interacting with an upset caller.
- Be able to listen without interrupting.
- Complete the Odour Complaint Form.
- Answer questions about why information on the form is needed.
- Explain the next steps in the process.
- Understand the boundaries about what they may and may not say to a caller. It is important not to speculate about the source of an odour.
- Stay up to date with current odour concerns so they can inform callers, if that is appropriate.

LEGISLATION

Before collecting information, review the legislation and regulations pertaining to your industry as well as legislation and regulations about the collection, use and disclosure of personal information. Put policies in place for the storage and retention of records and ensure your employees understand their responsibilities under all legislation that may apply to your organization.

COORDINATING WITH LOCAL AGENCIES/ORGANIZATIONS

Responding to an odour complaint will mean different things to different organizations depending on the nature and status of local industries and activities and if the setting is rural or urban. It may be necessary to coordinate an investigation and response with other organizations and/or provincial agencies. It is important to do some initial work to determine:

- When the organization will be responsible for investigating the complaint.
- Under what circumstances the investigation will be passed to another organization or how the work involved in the investigation will be shared.
- Who is to call the complainant back within the specified timelines, especially if the complainant did not give permission to share their contact information.

Understanding these factors will help organizations develop a seamless and transparent response process for callers with odour complaints.

Handling an Odour Complaint Call

Effectively interacting with callers and getting relevant information is an important part of the odour investigation process.

If organizations receive odour complaint calls, but are not always responsible for investigating, they may find it valuable to follow a referral process (see Referring the Caller to Another Organization on page 68).

Organizations should be aware of local industries and natural or seasonal occurrences that may contribute to the volume and types of complaints. Organizations should work with local partners to create a list of potential odour sources/activities along with the types of odours commonly associated with these sources and/or activities. This way, when a caller makes an odour complaint it can be dealt with more effectively.

COMMUNICATING WITH CALLERS

One important aspect of dealing with odour complaints is to ensure the caller feels they are being listened to and are not being dismissed.

- Thank them for calling.
- Collect the relevant details.
- Listen to them without interrupting.
- Tell them what the next step is or refer them to the appropriate organization.
- Let them know when they may receive follow-up information, if appropriate.

In that initial conversation it is important to gather the information outlined on the Odour Complaint Form (see Sample Odour Complaint Form on page 75), even if the caller believes they know where the odour is coming from. It will help determine if they are correct.

If this is one of several complaints about the same odour, collect the information anyway, as it may help pinpoint the source if it is unknown. Let the caller know that the organization is aware of the situation and provide the current status, if information is available and if it is appropriate to do so.

Remember that all complaints are valid. The caller felt it was important enough to take the time to make a complaint. It may seem urgent to them even if it does not require an urgent response (see Triaging the Complaint on page 72).

REPEAT COMPLAINANTS

A person may call repeatedly about the same odour.

- Ask whether the odour is the same intensity as previously reported or if it is worse.
- Let them know the current status of the investigation (if the information is available and it is appropriate).
- Assure them that the information was passed on to the appropriate group or person.
- Let them know that some odour complaints take time to investigate.
- Ask if they would like a follow-up call when more information is available.

It is possible that repeat callers may be frustrated and use abusive or inappropriate language on the call. Organizations should develop a policy on managing abusive callers and ensure employees know how to manage these calls.

An organization may receive multiple calls from different people about the same odour. This may influence the investigation of the complaint (see Multiple Complaints on page 72).

EMERGENCY OR HEALTH CONCERNS

If at any point during the conversation the caller indicates the odour is causing health problems, advise them to call:

- Their family doctor.
- Health Link Alberta (811).
- 911 (for emergencies only).

If it is an emergency, have them hang up and seek medical attention. They can call back after the emergency is dealt with.

There may be signs that the caller's health is being impacted even if they have not specifically said so. For example, their voice, behaviour or speech may be affected. While organizations do not want to put themselves in the position of asking health questions, they may wish to suggest the caller contact their doctor if they are feeling unwell.

If at any point during the conversation it is suspected natural gas may be the problem (rotten egg odour), advise the caller to leave the area immediately and then call 911.

REFERRING THE CALLER TO ANOTHER ORGANIZATION

Organizations may not be responsible for investigating particular types of odour complaints. In these cases, referring the caller to the appropriate organization or agency may help reduce the caller's frustration by reducing the number of times they need to repeat information.

The Odour Complaint Decision Tree and corresponding call log (see page 78) are tools to help determine if the caller is reporting the odour to the correct organization and, if not, to redirect them appropriately. This is a high-level process that should be customized, as appropriate.

CUSTOMIZING THE ODOUR COMPLAINT FORM

The Odour Complaint Form (see page 75) captures information commonly needed to investigate an odour complaint. Depending on the organization or industry, organizations may wish to customize the form to better meet their needs or record keeping requirements. In particular, ensure any legal language is specific to the organization and industry.

COMPLETING THE ODOUR COMPLAINT FORM

Explain to the caller that the questions being asked are necessary to investigate their complaint. Gather as much information as the caller is able to provide.

If the caller is not cooperating or answering the questions, do not speculate. Simply collect any information given.

The Odour Complaint Form collects information that will help with investigation of an odour:

- Caller information
- Odour description
- Frequency and duration
- Intensity
- Weather conditions
- Alleged source of the odour
- Odour reported before
- Additional comments or information
- Action taken

Caller Information

Ask for the caller's name and phone number.

- The decision to collect an email address is up to each individual organization. It is generally not needed unless the organization intends to respond in writing.
- Explain that the information will be used to follow up with additional questions, if needed, as the complaint is investigated.
- Callers may choose to remain anonymous.
- If they choose to remain anonymous, explain that they still need to identify the general location where they smelled the odour. For example, if they are in a city, what neighbourhood? If they are rural, what town or part of the county/municipality?
- If they choose to remain anonymous, advise that they may not be able to receive follow-up information about their complaint.
- It is important to have a system in place to track complaints, such as reference numbers. If the organization uses reference numbers to track complaints, the number can be provided to callers so they can call in for an update.

Callers may ask how the organization will use their name and number. Assure them that the collection, use and disclosure of personal information is in accordance with privacy legislation.

Odour Description

Give the caller the opportunity to describe the odour in their own words before offering a list of words for them to choose from. Phrases such as "It's kind of like..." may indicate the caller is a little unsure and it may be helpful to offer them some comparison words to help narrow down the odour.

A wide range of odours have been included on the form. Organizations may choose to customize this list based on their location or industry. For example, use bold font for the most commonly reported odours.

Script: Please describe the odour. What does it smell like? (Check all described by caller)

CHEMICAL	EARTHY	FRUITY	OFFENSIVE	FLORAL
☐ Acidic ☐ Bleach ☐ Glue ☐ Mothballs ☐ Nail polish ☐ Paint-like ☐ Petroleum/ gasoline ☐ Plastic ☐ Rubbery ☐ Solvent ☐ Tar ☐ Turpentine ☐ Vinegar ☐ Varnish	☐ Grassy ☐ Hay ☐ Musty ☐ Mouldy ☐ Mushroom ☐ Peat-like ☐ Pine ☐ Swampy ☐ Woody ☐ Yeast	☐ Citrus ☐ Fermented ☐ Fruity ☐ Over ripened fruit	☐ Garbage ☐ Garlic/onion ☐ Rancid ☐ Sour milk ☐ Sweet & sour ☐ Rotten eggs ☐ Rotting meat ☐ Rotting vegetables ☐ Skunk ☐ Urine ☐ Vinegar ☐ Vomit ☐ Yeast	☐ Flowers ☐ Fragrant ☐ Herbal ☐ Perfume ☐ Spicy
SMOKY	**MEDICINAL**	**FECAL**	**PUTRID**	**FISHY**
☐ Burnt plastic/ rubber ☐ Coffee-like ☐ Exhaust ☐ Grass smoke ☐ Wood smoke	☐ Alcohol ☐ Ammonia ☐ Menthol ☐ Urine ☐ Vinegar	☐ Manure ☐ Septic ☐ Sewer	☐ Burning carcasses ☐ Dead animal ☐ Decay ☐ Rotting	☐ Dead fish ☐ Perm solution
☐ Other *(describe)*				

Frequency and Duration

Callers may be reporting an odour upon first experiencing it or it may have been a problem for a while.

The Odour Complaint Form will collect information on:

- When the caller first experienced the odour.
- Whether it is constant or comes and goes.
- What time of day it is noticeable.

This information is important as it may help narrow down the source by matching odour occurrence to specific activities in industry or the community.

Intensity

Use the following categories to help the caller describe the intensity. Read all the options to the caller.

Script: I'm going to give you three options to help determine the strength of the odour. Please choose the one that best describes your experience. (Check one)

- ☐ Faint: The odour is barely detectable: you need to stand still and inhale while facing into the wind to notice it.
- ☐ Moderate: The odour is easily detected while walking and breathing normally but it is not overpowering.
- ☐ Strong: The odour is penetrating; you can't get away from it and it can easily be detected at all times.

Weather Conditions

Weather conditions can affect odour dispersion and intensity. Knowing the conditions can help in the investigation of an odour complaint.

Ask the caller about their local weather at the time they noticed the odour (which may also be at the same time as the call).

GENERAL CONDITIONS	CLOUD COVER	WIND SPEED	WIND DIRECTION
☐ Dry ☐ Rainy ☐ Foggy ☐ Snowy	☐ Clear ☐ Light clouds ☐ Scattered clouds ☐ Overcast	☐ None/light ☐ Steady ☐ Strong ☐ Gusting	Which direction is the wind coming from?

Alleged Source of the Odour

The caller may know or suspect they know the source of the odour. It is still important to collect the information on the Odour Complaint Form to help confirm the source and determine the extent of the problem.

Inform the caller that they may also report the odour directly to the organization involved, and provide them with the name and contact information (if available) of the correct person or agency to call. Explain that many organizations prefer to receive this information directly so that they can act more quickly to address the situation.

Odour Reported Before

Ask if they have reported the odour before and if so, to whom. This may help to coordinate with another agency who may already have started an investigation into the odour.

If they have reported the odour before, ask if they have a tracking or reference number to help locate the previous complaint information.

Additional Comments or Information

Ask the caller if there is any other information they would like to add. Don't ask leading questions about any specific topic as this may create unrealistic expectations about what can or cannot be addressed. However, sometimes additional information offered by the caller may be helpful to the investigation.

Possible information to capture would include:

- Offensiveness: The caller may use words about how unpleasant the odour is (not to be confused with the description of the odour).
- Extent: How widespread is the odour? For example, is it only noticeable when near the alleged source?
- Health concerns: The caller may mention the odour is causing them to feel ill. Don't ask any health questions. Advise them to call their family doctor, Health Link Alberta (811) or 911 (for emergencies only), as appropriate. Suggest they use the Symptom and Odour Tracking Tool (see page 17) to record information.
- Caller's expectations: The caller may state what their desired outcome is. Simply make note of this but do not promise any particular result.

Follow-up

If the caller provided their contact information:

- Ask if they would like to receive a follow-up call to let them know the status of their complaint or what steps were taken.
- If the organization is comfortable with providing responses in writing, offer them an option to receive follow-up by email or mail. If this option is offered, ensure there is a place on the form to collect this information.

Develop policies and procedures for handling follow-up. Here are some things to consider:

- Who will call the complainant back and in what time-frame?
- Will follow-up be provided in writing or only by phone?
- Will the complainant be provided with a reference number or phone number if they want to check on the status of their complaint?
- What mechanism will be used to track complaints if the complainant calls to check on the status of the investigation?
- How will the complaint information be filed and stored so it can be accessed as needed?

Action Taken

For the purposes of accountability and record keeping, it is important to record what action was taken as a result of the call.

If the organization uses reference numbers to track complaints, record the number here. If appropriate, provide this number to the caller. This may reassure the caller that their complaint has been documented, and it gives them a way to follow up on their complaint if they do not want to leave a phone number.

SHARING PERSONAL INFORMATION

Organizations have a responsibility to ensure the collection, use and disclosure of personal information is in accordance with privacy legislation.

- Ask the caller if their contact information can be shared with the person who will be investigating the complaint. If the organization is required to report to another agency, ask if the contact information can be passed on to investigators from another agency if it is required.
- If they do not give permission to share their contact information, let them know the complaint information will still be given to the appropriate person. This may or may not affect their ability to receive a follow-up call if they request one.
- Be prepared to answer questions about which agency will receive their personal information.

The Odour Complaint Form can be customized to specifically name the legislation that each organization must follow (e.g., Freedom of Information and Protection of Privacy Act, Personal Information Protection Act). In Alberta, for example, more information is available from the Office of the Information and Privacy Commissioner of Alberta (oipc.ab.ca).

ENDING THE CALL

Thank the caller for reporting the odour.

Let the caller know that some odour complaints take time to investigate.

Let the caller know what the next step will be, such as forwarding the information to an investigator or contacting another agency.

If they would like a follow-up call, let them know when they should expect to hear something about the status of their complaint (see Initial Response to Odour Complaints on page 72).

TRIAGING THE COMPLAINT

Once an odour complaint has been made, the person who logged the complaint must decide how it should move forward to ensure an appropriate level of response. For example, should someone be called in on the weekend or at 3 a.m. or is it fine to wait for normal business hours?

To help guide these decisions, develop a matrix or flowchart. For example, a Level 1 event might be investigated through normal workplace activity, a Level 2 event might require some additional resources or quicker action, and a Level 3 event would require immediate action.

If proceeding with this type of model, determine what circumstances trigger a move from a Level 1 complaint to Level 2 or Level 3. Triggers might include:

- Multiple calls about the same odour.
- Reports of health concerns.
- An unusual odour that cannot be attributed to normal local activity.
- Environmental concerns.
- Detection of odours that could signal a serious or dangerous situation.
- The time the odour was noticed. (Did it happen a week ago or is it happening now?)
- Access to the alleged source.

> *Be aware of any special protocols for certain types of odours or odours detected in specific locations.*

MULTIPLE COMPLAINTS

Organizations may receive multiple complaints about the same odour. In addition to being a factor in triaging the call, multiple complaints can provide other data that may be helpful in the investigation.

- Multiple calls from various locations can help determine the geographic extent of the problem. This may also help determine the source.
- Organizations can compare the data collected from the calls to identify patterns, such as the time of day the odour was noticed.

If it is allowed within your communication policies, you can collect the data and let callers know the organization is aware of the situation and is already investigating.

Initial Response to Odour Complaints

Initial response refers to the first contact back to the complainant after they have made an odour complaint. The initial response is not intended to provide the complainant with an answer or results of an odour investigation. It is a touch point to let them know the status of their complaint and what the next steps are.

In cases where the caller has chosen to remain anonymous or does not wish to receive a follow-up call, the initial response is the call when they make the complaint.

Providing an initial response helps the complainant feel they have been heard and that the organization is taking their complaint seriously.

DEVELOP A FRAMEWORK FOR HANDLING THE INITIAL RESPONSE

It is important to develop a protocol for an organization's initial response. Here are some factors to consider:

- Within what time frames will an initial response be provided? A good practice followed by many organizations is to provide an initial response within 24 hours and no later than 48 hours.
- Who will call the complainant back? Consider situations where the complainant has not allowed their contact information to be shared with anyone but the person who took the initial call.
- What training will be provided to employees who answer calls from the public? What information do they need to provide as an initial response if it is required of them?
- If employees are expected to answer questions from the public, how will they be kept updated about the progress of an investigation? What limits are placed on the information they are allowed to share?
- What if the investigation activities cannot be completed or are delayed? How will the complainant be informed about this situation?
- What broader communication channels are in place to address a situation where multiple complaints about the same odour are coming in?

Investigation Response to Odour Complaints

This investigation response section focuses on good practices for investigating complaints. This is not a "how to" or field manual for investigating odours, but rather an overview of factors to consider in developing an investigation process.

UPDATING THE COMPLAINANT

Keeping someone updated about the status of their complaint sounds simple, but there are many factors to consider.

If the complainant has requested a follow-up call, ensure they get one within the timelines given during the initial response. Other questions an organization needs to ask include:

- If the investigation is long and complex, how often will the complainant be contacted?
- If the organization is investigating with another agency or has passed on the information, who ensures follow-up is done?
- Who is authorized to speak to the complainant?
- What are the limits on the information that can be shared?

At a minimum, if a follow-up is requested, the complainant should be contacted at the conclusion of the investigation or if safety concerns delay the investigation or prevent it altogether. Follow up with the complainant even if there is no new information.

SAFETY CONCERNS

The safety of investigators is a primary consideration in an odour investigation plan. Policies and procedures related to working alone, managing confrontation, equipment and vehicle safety, and other workplace situations will enhance on-the-job safety.

A number of factors could prevent or delay an odour investigation, such as weather, wildfires, confrontational/dangerous people or animals, dangerous substances or inaccessible physical locations. Develop strategies to help investigators mitigate these risks.

In these cases, it is also important to let the complainant know if the investigation will be delayed.

ALTERNATIVE DATA SOURCES

The information gathered on the Odour Complaint Form provides a place to start the investigation. However, it is possible that not all information will be provided or the complainant may be mistaken about some information. This happens because most people are not trained in odour detection and investigation.

It is important to be aware of the alternative data sources in the area. Here are some of the common sources to become familiar with:

- Where is the nearest meteorological station?
- Is there access to specialized monitoring equipment?
- What are the local industries and which of their activities can cause odour?
- Is there access to historical investigative reports?
- What local or seasonal events trigger odour?

Each of these sources can provide valuable information; however, they are merely tools that should be combined with an investigator's experience and knowledge to reach a conclusion about the source of an odour.

RECORDS MANAGEMENT

Every organization should have a records management policy to guide decision about what records should be kept, how they should be stored and protected, and how long they should be retained.

Certain records are subject to provincial and/or federal legislation and this varies by industry. An organization's records management policy should take those legal requirements into consideration and employees should be informed of their responsibilities.

Specific policies are needed to protect personal information as part of a record storage and archiving system.

Keep records readily available until they are no longer needed (for example, the complaint investigation is concluded).

Consider implementing a system to collect and record complaints data for trending and analysis purposes.

CONCLUSION

Developing and implementing an odour complaint process can help an organization manage complaints efficiently. Providing training to staff and managing calls from the public in a respectful and knowledgeable way can enhance an organization's reputation. Ensuring compliance with all relevant legislation can minimize legal situations. If an odour complaint process is not in place, the time to develop one is now.

Notes

Odour Complaint Form

	REFERENCE NUMBER:
CALL DATE:	**CALL TIME:** / **CALL RECEIVED BY:**
CALLER NAME: *(MAY REMAIN ANONYMOUS)*	**PHONE NUMBER:**
LOCATION WHERE YOU EXPERIENCED THE ODOUR:	

ODOUR DESCRIPTION *(CHECK ALL DESCRIBED BY CALLER)*

CHEMICAL	EARTHY	FRUITY	OFFENSIVE	FLORAL
☐ Acidic	☐ Grassy	☐ Citrus	☐ Garbage	☐ Flowers
☐ Bleach	☐ Hay	☐ Fermented	☐ Garlic/onion	☐ Fragrant
☐ Glue	☐ Musty	☐ Fruity	☐ Rancid	☐ Herbal
☐ Mothballs	☐ Mouldy	☐ Over ripened fruit	☐ Sour milk	☐ Perfume
☐ Nail polish	☐ Mushroom		☐ Sweet & sour	☐ Spicy
☐ Paint-like	☐ Peat-like		☐ Rotten eggs	
☐ Petroleum/ gasoline	☐ Pine		☐ Rotting meat	
☐ Plastic	☐ Swampy		☐ Rotting vegetables	
☐ Rubbery	☐ Woody		☐ Skunk	
☐ Solvent	☐ Yeast		☐ Urine	
☐ Tar			☐ Vinegar	
☐ Turpentine			☐ Vomit	
☐ Vinegar			☐ Yeast	
☐ Varnish				

SMOKY	MEDICINAL	FECAL	PUTRID	FISHY
☐ Burnt plastic/ rubber	☐ Alcohol	☐ Manure	☐ Burning carcasses	☐ Dead fish
☐ Coffee-like	☐ Ammonia	☐ Septic	☐ Dead animal	☐ Perm solution
☐ Exhaust	☐ Menthol	☐ Sewer	☐ Decay	
☐ Grass smoke	☐ Urine		☐ Rotting	
☐ Wood smoke	☐ Vinegar			

☐ Other *(describe)*:

FREQUENCY AND DURATION

WHEN DID YOU FIRST NOTICE THE ODOUR?

Date:	Time:	☐ Don't know/No answer

HOW OFTEN HAVE YOU NOTICED THE ODOUR? HOW LONG DOES IT LAST?

☐ One time	Start time:	End time:	☐ More than once a week
☐ Continuous since	Date:	Time:	☐ Once or twice per month
☐ Daily	Time of day:		☐ Other

INTENSITY *(HOW STRONG IS THE ODOUR?)*

☐ Faint: Odour is barely detectable; you need to stand still and inhale while facing into the wind to notice it.

☐ Moderate: Odour is easily detected while walking and breathing normally but it is not overpowering.

☐ Strong: Odour is penetrating; you can't get away from it and it can easily be detected at all times.

☐ No answer.

WEATHER CONDITIONS *(WHEN YOU NOTICED THE ODOUR)*

GENERAL CONDITIONS	CLOUD COVER	WIND SPEED	WIND DIRECTION	
☐ Dry ☐ Rainy ☐ Foggy ☐ Snowy	☐ Clear ☐ Light clouds ☐ Scattered clouds ☐ Overcast	☐ None/light ☐ Steady ☐ Strong ☐ Gusting	Which direction is the wind coming from?	☐ Don't know/No answer

ALLEGED SOURCE OF THE ODOUR *(IF KNOWN)*

HAVE YOU REPORTED THIS ODOUR BEFORE?

☐ No	☐ Yes. If yes, who and when:

ADDITIONAL COMMENTS OR INFORMATION:

The odour investigators may have additional questions. May I give your contact information to our investigators or those of another agency?	☐ No	☐ Yes *(ensure contact information is complete)*
Would you like a follow up call?	☐ No	☐ Yes *(ensure contact information is complete)*

If yes, date follow up call was made:

ACTION TAKEN:

☐ Referred caller to:	
☐ Sent complaint for investigation to:	
☐ Other:	

NOTES FROM FOLLOW UP CALL:

The collection, use and disclosure of personal information on this form is in accordance with Alberta's privacy legislation.
Odour Complaint Form adapted from the Natural Resources Conservation Board Odour Report Form

ODOUR COMPLAINT DECISION TREE AND CALL LOG

REFERENCE GUIDE

The decision tree and call log are part of a referral process that may be used as a stand-alone tool or as part of an overall complaints management program. Therefore, some of the information in this section may have been referenced in the Odour Complaints section of this guide.

Odour Complaint Decision Tree and Call Log

ABOUT THE ODOUR COMPLAINT DECISION TREE AND ODOUR COMPLAINT CALL LOG

The Odour Complaint Decision Tree outlines a referral process that is intended to help organizations collect information about odour complaints received by phone and determine the next steps to be taken.

The decision tree and corresponding call log are tools to help determine if the caller is reporting the odour to the correct organization and, if not, to redirect them appropriately. This is a high-level process that should be customized, as appropriate. Each organization may have its own procedures to follow if an odour is reported and if it is their responsibility to investigate.

> *These tools are not intended to collect the comprehensive information required to conduct an odour investigation. They simply help to direct the caller to the correct organization for their complaint.*

COMMUNICATING WITH CALLERS

One important aspect of dealing with odour complaints is to ensure the caller feels they are listened to and are not being dismissed.

- Thank them for calling.
- Collect the relevant details.
- Listen to them without interrupting.
- Tell them what the next step is or refer them to the appropriate organization.

In that initial conversation it is important to gather the information outlined on the Odour Complaint Call Log (see sample call log on page 83), even if the caller believes they know where the odour is coming from. It will help determine if they are correct.

If this is one of several complaints about the same odour, collect the information anyway as it may help pinpoint the source if it is unknown. Let the caller know that the organization is aware of the situation and tell them the current status, if that information is available and if it is appropriate to do so.

REPEAT COMPLAINANTS

The same person may call repeatedly about the same odour.

- Ask as to whether the odour is the same intensity as previously reported or if it is worse.
- Let them know the current status of the investigation (if the information is available and it is appropriate to do so).
- Assure them that the information was passed on to the appropriate people.
- Let them know that some odour complaints take time to investigate.

It is possible that callers may be frustrated and use abusive or inappropriate language on the call. Ensure employees are aware of the organization's policies on managing abusive callers.

USING THE DECISION TREE

The Odour Complaint Decision Tree is a high-level process. Organizations should take the time to customize this tool to suit their needs.

An odour complaint will mean different things to different organizations depending on factors such as local industries and activities and if the location is rural or urban.

- Organizations using this odour identification process will need to be aware of the local industries and natural or seasonal occurrences that may affect the volume and types of complaints. Please work with local partners to create a list of potential odour sources and activities along with the types of odours commonly associated with these sources and activities. This will make it easier to direct a caller with and odour complaint.
- For industry-specific organizations, this decision tree and call log may be simplified to include odour information relevant to each organization. If an organization refers specific types of odours to different areas within the organization, it may be useful to include a flowchart that describes where these complaints are to be directed.
- Recognize which calls about odours that are not due to the operation. The decision tree may be used to redirect these calls.
- Some organizations, such as municipalities, may have several possible sources for an odour.

Example 1

The following example shows how a rural municipal office might customize the decision tree based on the industries in the area.

MANURE ODOURS	ROTTEN ODOURS	ODOUR	ODOUR
Possible sources: · ABC Plant · XYZ Ranch	Possible sources: · Sour oil and gas company ABC	Possible sources:	Possible sources:
Contact: · ABC Plant: 000-000-0000 · XYZ Ranch: 000-000-0000 · NRCB: 1-866-383-6722	Contact: · Company ABC: 000-000-0000 · AER: 1-800-222-6514	Contact:	Contact:

Example 2

The following example shows one way the decision tree could be customized for use within an organization. If a caller reports one of these four odours, the organization begins an investigation within its own operation before referring the caller to another agency.

REALLY BAD SMELL (SKUNK): METHYL MERCAPTANS	ROTTEN EGG SMELL: H_2S	ROTTEN VEGETABLES: DIMETHYL DISULPHIDE	ROTTEN CABBAGE: DIMETHYL SULPHIDE
Possible sources: · Stripper gas system · LVHC un-scrubbed NCGs · Chip bin · Foul condensate release · Turpentine release	Possible sources: · Kiln · Recovery boilers · Acid cleaning	Possible sources: · Scrubber LVHC vents · Chip bin vent · DNCG vent · Condensates or biodegradation in ponds	Possible sources: · Scrubber LVHC NCG vent · Chip bin vent · Dilute NCGs vent · Condensates or biodegradation in ponds

COMPLETING THE ODOUR COMPLAINT CALL LOG

Explain to the caller that you will be asking a couple of questions to help better direct follow-up on their call.

CALLER NAME AND PHONE NUMBER

Asking for the caller's name and number is optional, and may be collected on the call log if an organization plans to follow up on the complaint. If a caller is simply going to be given the phone number for another agency, it may not be necessary to collect this information.

If this information is collected, ensure its collection, use and disclosure complies with the appropriate privacy legislation.

IDENTIFYING THE LOCATION

Ask for the location where the caller noticed the odour. For example, if they are in a city, what neighbourhood? If they are rural, what town or part of the county/municipality?

DESCRIBING THE ODOUR

Give the caller the opportunity to describe the odour in their own words before offering a list of words for them to choose from. Phrases such as "It's kind of like..." may indicate the caller is a little unsure and it may be helpful to offer them some comparison words to help narrow down the odour.

A wide range of odours have been included on the form. Organizations may choose to customize this list based on their location or industry. For example, use bold font for the most commonly reported odours.

Script: Please describe the odour. What does it smell like? (Check all described by caller)

CHEMICAL	EARTHY	FRUITY	OFFENSIVE	FLORAL
☐ Acidic ☐ Bleach ☐ Glue ☐ Mothballs ☐ Nail polish ☐ Paint-like ☐ Petroleum/ gasoline ☐ Plastic ☐ Rubbery ☐ Solvent ☐ Tar ☐ Turpentine ☐ Vinegar ☐ Varnish	☐ Grassy ☐ Hay ☐ Musty ☐ Mouldy ☐ Mushroom ☐ Peat-like ☐ Pine ☐ Swampy ☐ Woody ☐ Yeast	☐ Citrus ☐ Fermented ☐ Fruity ☐ Over ripened fruit	☐ Garbage ☐ Garlic/onion ☐ Rancid ☐ Sour milk ☐ Sweet & sour ☐ Rotten eggs ☐ Rotting meat ☐ Rotting vegetables ☐ Skunk ☐ Urine ☐ Vinegar ☐ Vomit ☐ Yeast	☐ Flowers ☐ Fragrant ☐ Herbal ☐ Perfume ☐ Spicy
SMOKY	**MEDICINAL**	**FECAL**	**PUTRID**	**FISHY**
☐ Burnt plastic/ rubber ☐ Coffee-like ☐ Exhaust ☐ Grass smoke ☐ Wood smoke	☐ Alcohol ☐ Ammonia ☐ Menthol ☐ Urine ☐ Vinegar	☐ Manure ☐ Septic ☐ Sewer	☐ Burning carcasses ☐ Dead animal ☐ Decay ☐ Rotting	☐ Dead fish ☐ Perm solution
☐ Other *(describe)*				

SOURCE OF THE ODOUR

The caller may know where the odour is coming from, such as a specific plant or a particular lake.

Ask if they have contacted any other organizations about this odour.

If they have not, let them know they can report the odour directly to the organization, and provide them with the name and contact information (if available). Explain that many organizations prefer to receive this information directly so that they can act more quickly to address the situation.

NEXT STEPS

If they don't wish to contact the organization directly, or if they have already reported the odour to the organization and they do not seem satisfied with the response, give them the number to the appropriate government agency.

If the organization receiving the call is responsible for addressing the odour complaint, tell the caller the report will be forwarded to the appropriate investigator.

If the caller is being referred to another organization, provide the name and number of the appropriate organization based on the information collected on the Odour Complaint Call Log.

If it is not clear who should handle the investigation, provide the number for Alberta Environment and Parks (1-800-222-6514).

Explain to the caller that they may be asked some of the same questions again. The organization to which they are being referred will have their own methods for collecting data.

The caller may mention the odour is causing them to feel ill. Don't ask any health questions. Advise them to call their family doctor, Health Link Alberta (811) or 911 (for emergencies only), as appropriate. Suggest they use the Symptom and Odour Tracking Tool (see page 17) to record information.

CLOSING THE LOOP

Thank the caller for reporting the odour.

Let them know that some odour complaints take time to investigate.

Odour Complaint Decision Tree

Odour complaint call comes in

Complete the Odour Complaint Call Log

Is the source of the odour known?

YES → Refer the caller to the appropriate organization or agency or follow your organization's odour complaint process

NO

Is your organization responsible for follow-up?

YES → Follow your organization's odour complaint process

NO

Refer the caller to the appropriate organization or agency

If at any time the caller indicates the odour is causing physical symptoms or illness, advise them to call:

- Their family doctor
- Health Link Alberta (811)
- 911 (for emergencies only)

CHEMICAL/ PETROLEUM ODOURS	MANURE/SEWER ODOURS	ROTTEN ODOURS	ODOUR
Possible sources: · Manufacturing · Refineries · Oil & gas operations	Possible sources: · Agriculture	Possible sources: · Sour oil and gas operations · Pulp mill	Possible sources:
Contact: Local Organization AER/AEP	Contact: Local Organization Municipality NRCB	Contact: Local Organization AER/AEP	Contact:

Customize the boxes as appropriate for your local industries and activities.

- Alberta Energy Regulator (AER)
  1-800-222-6514
- Alberta Environment and Parks (AEP)
  1-800-222-6514
- Natural Resources Conservation Board (NRCB)
  1-866-383-6722
- 311 Calgary or 311 Edmonton

Odour Complaint Call Log *(To be used with referral to another organization)*

CALLER NAME: *(OPTIONAL)* **PHONE NUMBER:** *(OPTIONAL)*

CALL DATE: **CALL TIME:**

LOCATION WHERE CALLER EXPERIENCED THE ODOUR:

ODOUR DESCRIPTION *(CHECK ALL DESCRIBED BY CALLER)*

CHEMICAL

- ☐ Acidic
- ☐ Bleach
- ☐ Glue
- ☐ Mothballs
- ☐ Nail polish
- ☐ Paint-like
- ☐ Petroleum/ gasoline
- ☐ Plastic
- ☐ Rubbery
- ☐ Solvent
- ☐ Tar
- ☐ Turpentine
- ☐ Vinegar
- ☐ Varnish

EARTHY

- ☐ Grassy
- ☐ Hay
- ☐ Musty
- ☐ Mouldy
- ☐ Mushroom
- ☐ Peat-like
- ☐ Pine
- ☐ Swampy
- ☐ Woody
- ☐ Yeast

FRUITY

- ☐ Citrus
- ☐ Fermented
- ☐ Fruity
- ☐ Over ripened fruit

OFFENSIVE

- ☐ Garbage
- ☐ Garlic/onion
- ☐ Rancid
- ☐ Sour milk
- ☐ Sweet & sour
- ☐ Rotten eggs
- ☐ Rotting meat
- ☐ Rotting vegetables
- ☐ Skunk
- ☐ Urine
- ☐ Vinegar
- ☐ Vomit
- ☐ Yeast

FLORAL

- ☐ Flowers
- ☐ Fragrant
- ☐ Herbal
- ☐ Perfume
- ☐ Spicy

SMOKY

- ☐ Burnt plastic/ rubber
- ☐ Coffee-like
- ☐ Exhaust
- ☐ Grass smoke
- ☐ Wood smoke

MEDICINAL

- ☐ Alcohol
- ☐ Ammonia
- ☐ Menthol
- ☐ Urine
- ☐ Vinegar

FECAL

- ☐ Manure
- ☐ Septic
- ☐ Sewer

PUTRID

- ☐ Burning carcasses
- ☐ Dead animal
- ☐ Decay
- ☐ Rotting

FISHY

- ☐ Dead fish
- ☐ Perm solution

☐ Other *(IF KNOWN)*

SOURCE OF THE ODOUR *(IF KNOWN):*

HAVE YOU REPORTED THIS ODOUR TO ANOTHER ORGANIZATION?

☐ No ☐ Yes. If yes, who and when:

ACTION TAKEN:

☐ Referred caller to: ☐ Sent complaint for investigation to: ☐ Other:

CALL RECEIVED BY: **PHONE:**

SAMPLE HANDOUT

INFORMATION FOR MEMBERS OF THE COMMUNITY

Organizations may wish to provide some general information to the public about reporting odours. A generic public information sheet has been provided. The information can be used on websites, in a community newsletter, as a handout or in any other way you connect with the public in the area. The information can be customized by adding local phone numbers or information about where people can get updates if there is a major incident (if this is relevant to the industry or area)

Reporting Odours in Your Community

If you are troubled by an odour in your community, do you know where to report it? Do you know how to describe it?

BEFORE YOU CALL, HAVE THE FOLLOWING INFORMATION READY	
LOCATION	Where you were when you noted the odour
DESCRIPTION	Words you would use to describe the odour
FREQUENCY	Dates and times you noticed the odour
DURATION	How long the odour was noticeable
WEATHER	Conditions when you noticed the odour

WHERE TO CALL

If you smell natural gas (rotten eggs), leave the immediate area. Once safely away, call 911.

For other odours, if you know the source, you can call the organization directly. This will help your complaint to be acted on more quickly. Or you can call one of the following provincial or municipal numbers:

- **Alberta Energy Regulator (AER)**
  1-800-222-6514
- **Alberta Environment and Parks (AEP)**
  1-800-222-6514
- **Natural Resources Conservation Board (NRCB)**
  1-866-383-6722
- **311 Calgary or 311 Edmonton**
  Municipal for Edmonton and Calgary

Here are some words used to describe odours. Which matches the odour you're reporting?

CHEMICAL

- ☐ Acidic
- ☐ Bleach
- ☐ Glue
- ☐ Mothballs
- ☐ Nail polish
- ☐ Paint-like
- ☐ Petroleum/ gasoline
- ☐ Plastic
- ☐ Rubbery
- ☐ Solvent
- ☐ Tar
- ☐ Turpentine
- ☐ Vinegar
- ☐ Varnish

EARTHY

- ☐ Grassy
- ☐ Hay
- ☐ Musty
- ☐ Mouldy
- ☐ Mushroom
- ☐ Peat-like
- ☐ Pine
- ☐ Swampy
- ☐ Woody
- ☐ Yeast

FRUITY

- ☐ Citrus
- ☐ Fermented
- ☐ Fruity
- ☐ Over ripened fruit

OFFENSIVE

- ☐ Garbage
- ☐ Garlic/onion
- ☐ Rancid
- ☐ Sour milk
- ☐ Sweet & sour
- ☐ Rotten eggs
- ☐ Rotting meat
- ☐ Rotting vegetables
- ☐ Skunk
- ☐ Urine
- ☐ Vinegar
- ☐ Vomit
- ☐ Yeast

FLORAL

- ☐ Flowers
- ☐ Fragrant
- ☐ Herbal
- ☐ Perfume
- ☐ Spicy

SMOKY

- ☐ Burnt plastic/ rubber
- ☐ Coffee-like
- ☐ Exhaust
- ☐ Grass smoke
- ☐ Wood smoke

MEDICINAL

- ☐ Alcohol
- ☐ Ammonia
- ☐ Menthol
- ☐ Urine
- ☐ Vinegar

FECAL

- ☐ Manure
- ☐ Septic
- ☐ Sewer

PUTRID

- ☐ Burning carcasses
- ☐ Dead animal
- ☐ Decay
- ☐ Rotting

FISHY

- ☐ Dead fish
- ☐ Perm solution

☐ Other *(describe)*:

If at any time the odour is causing physical symptoms or illness, call:

- Your family doctor
- Health Link Alberta (811)
- 911 (for emergencies only)

ABOUT THIS SECTION

GLOSSARY

ACRONYMS

REFERENCES

Glossary

Terms in this glossary are collected from the following reports, all of which are available online at **casahome.org**.

Review of Odour Assessment Tools and Practices for Alberta

Review of Odour Prevention and Mitigation Tools for Alberta

These terms have been defined in the context of the terms used in this guide and may not exactly conform to other common definitions for each term.

ADAPTATION *(Odour/Olfactory)*		The temporary, normal inability to distinguish a particular odour after a prolonged exposure to the odour. Sometimes called habituation.
AEROBIC		Biological processes that require oxygen or are conducted in the presence of oxygen.
ANAEROBIC		Biological processes that do not require oxygen or are conducted in the absence of oxygen sources. Some anaerobic processes are known to produce intense offensive odours.
ANALYTICAL		A monitoring method that is quantitative and repeatable and where a single instrument collects and analyzes a sample.
APPLICATION		An indication of whether the tool is appropriate for source or ambient assessments. For example, a continuous emission monitor is appropriate only for source odour emission rate estimation, not an ambient assessment, while remote sensing techniques are generally applicable to both kinds of assessments.
AREA SOURCE		A surface emitting source that can be solid (e.g., compost) or liquid (e.g., ponds, tanks).
CATEGORICAL SCALE		A means of systematically categorizing odour (hedonic tone and intensity) by means of a ranking scale, often from 0-5 or 0-7.
CHARACTER		An odour description which relates the odour to general categories and provides a scale on how intensely the odour matches the general category. The different categories often include floral, fruity, vegetable, earthy, offensive, fishy, chemical and medicinal.
COMMUNITY SURVEY		Community questionnaires to establish perception of odours within an area of investigation.
CONTINUOUS EMISSION MONITOR	**CEM**	A monitor typically used to measure air quality and odorants in the stacks of combustion sources.
CONTINUOUS MONITORING		Real time monitoring of air quality for individual or classes of compounds usually every few seconds and recorded and reported as average values over a 1 to 5 minute interval.
DETECTION TO THRESHOLD	**D/T**	A measure of the number of dilutions needed to make the odorous ambient air “non-detectable.”
DIFFUSIBILITY		A measure of the volatility of odorants which reflects the ability to reach the olfactory receptors in the human nose.
DILUTION FACTOR		The ratio between sample flow or volume after dilution (total sample volume) and the flow or volume of the odorous gas (undiluted sample volume).
DURATION		The length of time the odour is perceived in each occurrence. Short duration may be a few minutes. Long duration could refer to hours or days, although duration is relative.

DYNAMIC DILUTION		Dilution which is achieved by mixing two known flows of gas—odorous sample and neutral gas, respectively.
ELECTRONIC NOSE	**E-nose**	An instrument that attempts to reproduce the human olfactory system using sensors.
FACILITY TYPE		Existing or planned facilities.
FATIGUE *(Odour)*		A decrease in sensitivity to an odour caused by a repetitive process of making and recording odour observations (note: not caused by adaption to an odour).
FIDOL		An odour assessment framework that considers the characteristics of frequency, intensity, duration, offensiveness and location.
FLUX CHAMBER		A device to isolate a surface area for collecting gaseous emissions. Nitrogen is usually used as a sweep gas.
FREQUENCY *(As it Relates to Assessment)*		The rate at which odorant or odour can be assessed corresponding to the tool type. For example, a continuous emission monitor may sample and analyze odorants every few seconds. Ambient grab samples are usually made infrequently, perhaps once a week, and so are not likely to collect a sample during an infrequent odour event.
FUGITIVE EMISSIONS		Unintended emissions from any openings, such as doors, windows, trucks waiting to load or unload odorous materials, valves, flanges, pumps, ponds and storage piles. Fugitive emissions can be parts of point, area or volume sources.
GAUSSIAN MODEL		A model in which plumes are assumed to have dimensions based on bell-shaped curves.
GRAB BAG/CANISTER		A means of collecting a whole-air sample.
HEDONIC TONE		A subjective measure of the pleasantness or unpleasantness of an odour.
HYDROCARBON		Chemical term describing an organic compound which contains hydrogen and carbon. These compounds are typically associated with certain processes and industries and some are very odorous.
INTEGRATIVE SAMPLING		The collection of samples at regular and specified time periods for a specified duration (e.g., for one hour or one day), also known as composite sampling.
INTENSITY		A characteristic of odour that describes the perceived strength and is rated by an odour assessor using a numerical system.
INTERMITTENT SAMPLING *(As Used in this Guide)*		The use of containers, such as canisters, sample bags, adsorbent tubes or impinger solutions, to collect and concentrate the compounds prior to analysis.
JAPANESE ODOUR INDEX	**OI_J**	A standardized dimensionless value that is a logarithmic function of odour concentration. See Odour Concentration.
LEVEL OF DETAIL		A determination of whether a method can be used to provide a high level of detail for odour assessments, or is useful as an indication of potential (e.g., a medium or low level of detail) which may require a subsequent more detailed confirmatory assessment. In this guide, detail refers to the number of odorants that can be addressed with a single measurement.
LINE SOURCE		An odour source which is long and narrow. This type of source is not common, however vehicle exhaust from roadways can be classified as a line source.

LOCATION SENSITIVITY		An accounting for the type of land use and the nature of human activities. These factors determine the sensitivity of the receiving environment to odour.
MONITORING		The use of an instrument monitor or measuring device to observe changes in concentration of odour or odorants that may occur over time.
MULTI-SOURCE		A facility, activity, location or operation which includes different odour sources such as point, area, volume and line.
NUISANCE		An adverse effect or impairment resulting from an odour. The type of impairment is related to circumstances that cause annoyance, loss of enjoyment and inconvenience.
OBJECTIVE		Quantifiable through repeatable measurement.
ODORANT		A specific gaseous compound that causes the sensation of odour.
ODOUR CONCENTRATION		A dimensionless dilution ratio that is reported as the number of odour units in a cubic metre of gas at standard conditions. It is the threshold concentration at which an odour can be detected by 50% of a trained odour panel.
ODOUR COMPLAINT THRESHOLD VALUE	**OCTV**	The concentration at which 50% of a population, represented by the odour panel, will complain about an odour, as determined over a short time period.
ODOUR DETECTION THRESHOLD VALUE	**ODTV**	The concentration at which 50% of a population, represented in an olfactory experiment by an odour panel, would be expected to detect the odorant.
ODOUR DIARY		A tool used for odour assessment, where an observer records the nature of odour and other characteristics on a regular basis and during odorous events.
ODOUR EPISODE CHARACTERIZATION		A description of an odour episode based on the FIDOL framework.
ODOUR INTENSITY		Perceived strength of an odour when detected by a recipient. See Categorical Scale.
ODOUR OFFENSIVENESS THRESHOLD VALUE	**OFTV**	The concentration at which 50% of a population, represented by the odour panel, indicates that the odour is offensive, as determined over a short time period.
ODOUR PANEL		A group of assessors who are qualified to judge samples of odorous gas using dynamic olfactometry.
ODOUR PERSISTENCY		A measure of how an odour's intensity decreases as the concentration of the odorant decreases (i.e., as the odorant is diluted, such as downwind from an odorant source).
ODOUR RECOGNITION THRESHOLD VALUE	**ORTV**	The concentration at which 50% of a population represented by the odour panel recognizes the odour.
ODOUR UNIT	**OU**	One odour unit is the amount of odour present in one cubic metre of odorous gas (under standard conditions) at the panel threshold.
ODOUR WHEEL		A means of documenting various odour characters in a circular chart, along with chemicals that are consistent with each character.
OFFENSIVENESS		The level of unpleasantness or disagreeability of an odour.
OLFACTOMETER		An apparatus in which a sample of odorous gas is diluted with neutral gas in defined ratio and presented to panelists (assessors).

OLFACTOMETRIC ANALYSIS		The presentation to odour panel members of a sufficiently complete set of diluted samples to calculate the odour concentration for a sample.
OLFACTOMETRY		Measurement of the response of assessors to olfactory stimuli.
PASSIVE MONITORING *(As Used in this Guide)*		Passing a fixed volume of odorant through a glass tube packed with an adsorbent material. Determination of the concentration for a specific odorant relies on the change of colour of the adsorbent material when it is exposed to the compound.
POINT SOURCE		A type of source which is confined and has well-defined exhaust parameters (velocity, temperature, odour rate). They are single entity and easily identifiable. They can be elevated or located at ground level.
PORTABLE OLFACTOMETER		A portable instrument capable of measuring odour concentration in the ambient air without collection of the sample and transportation to a laboratory.
PREVAILING WINDS		The predominant wind direction at a certain location over a certain time period.
QUANTIFIABLE		An indication of whether a tool can provide quantifiable results (odour emission rates, odour concentrations or other numerical output), as opposed to documentation of sensory perceptions.
RECEPTOR MODELLING		A method for determining the sources of air pollution based on air monitoring data. Receptor models use odorant (or odour) measurements at an individual monitoring site (the receptor) to calculate the relative contributions from major sources to the pollution/odour at that site.
REMOTE SENSING		The acquisition of information about odour without making physical contact with the odour plume.
RESIDENCE TIME *(As Used in this Guide)*		The duration that a specialized process requires to be completed.
SAMPLING		The process of obtaining representative information on the typical characteristics of an odour source by means of the collection of a suitable volume fraction of effluent or ambient air.
SEMI-CONTINUOUS MONITORING		Measuring concentrations over minutes to hours.
SENSITIVE RECEPTOR		An odour receptor with the potential to be adversely affected by exposure to odours. Residential and certain institutional land uses (hospitals, care facilities, schools, places of worship) are typically considered as sensitive receptors.
STATIC HOOD		Isolates a part of a gaseous emitting surface and directs the gases into the hood outlet duct for the odour sample collection.
SUBJECTIVE		Based on feelings of an odour observer of liking, pleasure, acceptance, and valuation.
TARGET		The target of the assessment, or capability of the method, and its appropriateness for individual odorants, groups of odorants or odour.
VOLATILE ORGANIC COMPOUNDS	**VOC**	Organic chemicals with high vapor pressure at room temperature.
VOLATILITY		A fundamental parameter for assessing the capacity of a substance to be an odorant. See Diffusibility.
VOLUME SOURCE		A source of diffuse emissions from a volume (as opposed to a surface or a point). Examples are buildings and plant process areas.
WIND TUNNEL		A device to isolate a surface area for collecting gaseous emissions with the capability to regulate the air velocity inside the device.

Acronyms

AQHI	Air Quality Health Index
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
ASTM	American Society for Testing and Materials
CASA	Clean Air Strategic Alliance
CEM	Continuous Emission Monitor
CFD	Computational Fluid Dynamics
CIC	Coordination and Information Centre (Alberta)
DEFRA	Department of Environment, Food, and Urban Affairs (United Kingdom)
D/T	Detection to Threshold
ESRD	Alberta Environment and Sustainable Resource Development (now called Alberta Environment and Parks)
FIDOL	Frequency, Intensity, Duration, Offensiveness and Location
H_2S	Hydrogen sulphide
m	Metre
m^3	Cubic metre
m^3/s	Cubic metres per second
MSW	Municipal solid waste
NRCB	Natural Resources Conservation Board (Alberta)
OCTV	Odour Complaint Threshold Value
ODTV	Odour Detection Threshold Value
OFTV	Odour Offensiveness Threshold Value
OI_J	Japanese Odour Index
OMT	CASA Odour Management Team
ORTV	Odour Recognition Threshold Value
OU	Odour unit
PDCA	Plan-Do-Check-Act
ppb	Parts per billion
ppbv	Parts per billion by volume
ppm	Parts per million
ppmv	Parts per million by volume
SAGD	Steam-assisted gravity drainage
SPR	Source-Pathway-Receptor
$\mu g/m^3$	Micrograms per cubic metre
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
VDI	Verein Deutscher Ingenieure
VOC	Volatile organic compound
WHO	World Health Organization

References

This guide was compiled using information from the following reports:

Any specific references to reports or source documents within the text of this guide is available in these report and can be accessed online at casahome.org.

Health Task Group

Backgrounder on Odour and Health

Symptom and Odour Tracking Tool

Complaints Task Group

Alberta Odour Complaints Overview

Odour Complaints in Your Area: A Guide for Developing an Odour Complaint Process

Odour Complaint Referral Process

Odour Assessment Task Group

Review of Odour Assessment Tools and Practices for Alberta. Prepared for the task group by Millennium EMS Solutions Ltd., and Environmental Odour Consulting. 2015.

CASA Odour Assessment Guide

Prevention and Mitigation Task Group

Review of Odour Prevention and Mitigation Tools for Alberta. Prepared for the task group by Pinchin, Ltd. 2015.

Enforcement and the Role of Regulation Task Group

Report to the Clean Air Strategic Alliance Odour Management Team, (Enforcement/Role of Regulation Task Group: Final Report). Prepared for the task group by RWDI AIR Inc. 2015.

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