ODOUR SURVEY ANALYSIS
CHEMAINUS, BC

Prepared for:

Cowichan Valley Regional District
Recycling & Waste Management
Engineering Services Department
175 Ingram Street
Duncan, BC V9L 1N8

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TABLE OF CONTENTS

Page No.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS iii

EXECUTIVE SUMMARY iv

1.0 INTRODUCTION 1-1

2.0 REGULATION OF ODOURS 2-1
- 2.1 Ambient Odour Management Practices in Canada 2-3
- 2.2 British Columbia 2-3
- 2.3 Ontario 2-8
- 2.4 Manitoba 2-9
- 2.5 Quebec 2-10
- 2.6 Alberta 2-10

3.0 CHEMAINUS ODOUR SAMPLING SURVEY 3-1
- 3.1 Odour Frequency 3-7
- 3.2 Odour Intensity 3-8
- 3.3 Odour Descriptors 3-12
- 3.4 Summary of Offensive Odour Observations 3-16

4.0 PUBLIC ODOUR COMPLAINTS/OBSERVATIONS 4-1
- 4.1 Odour Complaint Information for May/June 2014 4-4
- 4.2 Odour Observations Diary - June 2014 4-7
- 4.3 CVRD Odour Complaint Follow-up - May/June 2014 4-7
- 4.4 Pulp Mill Odours 4-12

5.0 SUMMARY AND CONCLUSIONS 5-1
- 5.1 Defining Nuisance 5-2
- 5.2 Odour Complaints Compared to Operational Activities at Coast 5-4

6.0 REFERENCES 6-1

APPENDIX A: GENERAL APPROACHES TO THE REGULATION OF ODOURS A-1
- A.1 Annoyance and Complaint Criteria A-1
- A.2 Ambient Odour Detection, Intensity and Odorant Criteria A-6
- A.3 Episode-Duration-Frequency Criteria A-8
- A.4 Source Emission and Best Available Control Technology Criteria A-9
- A.5 Odour Dispersion Modelling A-9
- A.6 Community Annoyance Thresholds A-12

APPENDIX B: ODOUR DIARY IN VICINITY OF COAST ENVIRONMENTAL LIMITED FACILITY B-1

LIST OF TABLES

Page No.

S.1 Frequency of Observed Offensive Odours May/June 2014..... v
3.1 Predominant Odour Intensity at Sampling Locations (May-June 2014) 3-10
4.1 Monthly Number of Odour Complaints in 2013-2014 4-2
4.2 Time of Day for Odour Complaints..... 4-3
4.3 Odour Complaint Descriptors and Coast Activities During Chemainus Odour Survey Period 4-5
4.4 Odour Complaint Follow-up - May-June 2014 4-8
4.5 TRS Levels at Crofton Substation - May/June 2014 4-13
A.1 Examples of Odour Source Characterization Guidance A-4

LIST OF FIGURES

Page No.

3.1 Location of Odour Survey Stations 1-9 3-4
3.2 Location of Odour Survey Stations 10-18 3-5
3.3 Location of Specific Activities at Coast Environmental Limited..... 3-6
3.4 Frequency of Odour Presence at Sampling Locations (May-June 2014) 3-7
3.5 Predominant Odour Intensity at Sampling Locations (May-June 2014) 3-9
3.6 Frequency of Predominant Offensive Odours (May-June 2014)..... 3-11
A.1 Dose-response Relationship for Livestock in The Netherlands..... A-13

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

List of Acronyms	
BACT	Best Available Control Technology
CASA	Clean Air Strategic Alliance (Alberta)
CofA	Certificate of Approval
CVRD	Cowichan Valley Regional District
EAB	Environmental Appeal Board
FIDOL	Frequency, Intensity, Duration, Offensiveness and Location
FPB	Farm Practices Board
GVRD	Greater Vancouver Regional District
MAFF	Ministry of Agriculture, Farms and Fisheries
MOE	Ministry of Environment
OH	Odour hour
POI	Point of Impingement
PSCAA	Puget Sound Clean Air Agency, Washington, USA
WHO	World Health Organization
WWTP	Wastewater treatment plant
Contaminants	
DMS	Dimethyl sulphide
DMDS	Dimethyl disulphide
H_2S	Hydrogen sulphide
NH_3	Ammonia
TRS	Total reduced sulphur
Symbols, Measurements, and Abbreviations	
DDO	Dynamic dilution olfactometry
D/T	Dilutions to threshold
OU	Odour units
OU/m^3	Odour units per cubic metre
OU/s	Odour units per second
$\mu g/m^3$	Micrograms per metre cubed

EXECUTIVE SUMMARY

SENES Consultants (SENES) was retained by the Cowichan Valley Regional District (CVRD) to assist in designing an odour survey and to conduct an analysis of odour monitoring survey conducted in May and June 2014 collected by the CVRD in the community of Chemainus, British Columbia. This type of odour survey is intended to be used in identifying the magnitude of a community odour problem by systematically collecting and recording information on important odour variables such as the frequency, intensity, duration, offensiveness and location at which the odours occur.

The CVRD odour survey, which was mutually funded by the Municipality of North Cowichan and the CVRD, was initiated as a result of odour complaints lodged against the operation of the Coast Environmental Limited facility (Coast) located at 9401 Trans Canada Highway in Chemainus by members of the general public. Odour complaints from the general public against the Coast facility have originated from two main areas of the community: 1) the industrial park located immediately west of the Coast facility, and 2) from the residential areas of Chemainus village. Therefore, the odour survey was designed to include these areas. However, in order to rule out any potential for other sources of odour being confused with odours from the Coast facility, the odour survey was expanded to include locations in and around the community of Chemainus.

The CVRD conducted the odour sampling survey in the community of Chemainus from May 6th to June 28th, 2014. The survey consisted of having two surveyors retained by the CVRD conduct personal observations of odour intensity, odour description and meteorological parameters (i.e., wind speed and direction, temperature) at eighteen pre-defined locations.

Odours were detected during the majority of sampling observations in the survey at most of the sampling stations, regardless of whether the odours were pleasant or unpleasant. The survey results identified a number of odour issues in the community related to several sources of offensive odours, namely:

1. on River Road near the Plester farm;
2. on MacMillan Bloedel Fs Road between the Coast Environmental Ltd. facility and the Western Forest Products sawmill;
3. in the Chemainus industrial park along Smiley Road between MacMillan Bloedel Fs Road and Henry Road;
4. in Chemainus between the ferry terminal and Old Victoria Road; and
5. in the vicinity of the North Cowichan WWTP on Bare Point Road near the intersection Chemainus Road.

In the absence of a definition of what constitutes a nuisance odour within the context of the CVRD or North Cowichan's bylaws, or in the Province of British Columbia as a whole, it is necessary to consider how nuisance is defined in other jurisdictions. As one alternative, nuisance odour can be based on the World Health Organization (WHO) definition of a nuisance threshold as being that concentration at which less than 5% of the population experiences annoyance more than 2% of the time. The difficulty in applying this definition to the odours from the Coast facility is that the population in Chemainus is widely dispersed, and the population most affected by emissions from the Coast facility is composed of people who work in the industrial park and are present at that location for only part of the day. For this reason, the WHO definition has been interpreted to mean 5% of the population of workers in the industrial park being affected for more than 2% of the time that they are likely to be present at those businesses in the industrial park. If the results of the Chemainus odour survey are considered within this definition of a nuisance odour impact, then four of the five areas of Chemainus listed above would be considered to be experiencing nuisance odour impacts. The exception would be the location on River Road because farm odours are protected in British Columbia under the Farm Practices Protection (Right to Farm) Act under the Ministry of Agriculture, Food and Fisheries (MAFF). The provisions of the Right to Farm Act may also apply to odours experienced in Chemainus village if these odours are the result of normal farming practices.

Specifically, the frequency of offensive odours in the odour survey in each of the five areas listed above is summarized in Table S.1 below.

Table S.1 Frequency of Observed Offensive Odours in May/June 2014

Location		Frequency of Observed Offensive Odours
1	River Road near the Plester farm	46%
2	MacMillan Bloedel Fs Road	6.7%
3	Chemainus industrial park along Smiley Road	1.2 - 4.9%
4	Chemainus between the ferry terminal and Old Victoria Road	0.0 - 3.7%
5	North Cowichan WWTP on Bare Point Road	2.4%

The odour surveyors also noted the intermittent nature of most of the odour observations. The high frequency of odours classified as predominantly having 'barely noticeable' and 'noticeable' odour intensities were frequently accompanied by short-term wafts of higher intensity odours in

the ‘offensive/strong’ and 'very strong/offensive’ categories. The frequency of the predominant offensive odours exceeds the WHO threshold for nuisance impacts. However, the experience of individuals in the community who are exposed to the shorter duration peak offensive odour concentrations may not be reflected in the frequency of predominant ‘offensive odours’ determined during the odour survey. The short-term peak odour levels may be more closely related to community annoyance as expressed in terms of the number of odour complaints registered by the public than the frequency of average strong and offensive odours as determined in the Chemainus odour survey suggests. The predominant or average odour levels that were defined as offensive during the survey exceeds the 2% frequency level defined as the nuisance threshold by the WHO, but the odour complaint information indicates that members of the community experience offensive odours far more frequently because they are reacting to the short-term peak odours rather than the average or ‘predominant’ odour levels.

The analysis of the odour complaint data related to Coast indicates that there were relatively few occasions when odour complaints were registered in relation to process upsets or process maintenance issues. Most odour complaints appeared to be related to normal process operations at Coast such as:

- mixing compost feedstock;
- receiving feedstock into composting building;
- loading yard and garden into composting building;
- blending, turning or loading soil amendment into trucks;
- pumping out compost leachate tanks;
- gravity feeding from truck into septic holding tank or pumping out septic holding tank; and
- grinding yard and garden waste outside.

Overall, the frequency of predominant offensive odours during the odour survey was up to 4.9% of the time west of the Coast facility in the industrial park, all of which were attributed by the surveyors to the Coast facility. In addition, the frequency of predominant offensive odours during the odour survey was up to 6.7% of the time immediately north of the facility along MacMillan Bloedel Fs Road, of which 4.0% was attributed to the Coast facility and 2.7% was attributed to the Western Forest Products sawmill. Further, it was observed that more intense, short-term offensive odours in the industrial park and along MacMillan Bloedel Fs Road which were noted to occur during the survey also appeared to be related to the Coast operations. It can therefore be concluded that the normal operations at the Coast facility do pose a nuisance odour impact to the surrounding properties. However, the odour survey did not identify odours in Chemainus village that could have originated from the Coast facility. Instead, odour complaints from the village appeared to be related to nearby farm sources than to the Coast operations.

1.0 INTRODUCTION

SENES Consultants (SENES) was retained by the Cowichan Valley Regional District (CVRD) to assist in designing an odour survey similar to one that was completed near a composting facility in Central Saanich by the Capital Regional District in 2013 and to conduct an analysis of odour monitoring survey conducted in May and June 2014 collected by the surveyors in the community of Chemainus, British Columbia. This type of odour survey is intended to be used in identifying the magnitude of a community odour problem.

There are a number of monitoring methods that can be used by a regulator to address and tackle odour issues from an existing site. Reactive methods are used as a means of characterising the odour emissions from operations carried out on site and assessing the odour impact on local receptors. An odour survey such as the one completed for the CVRD (i.e., a sniff test) is the one of the main tools used by regulators to assess odour impact. Sniff Tests are designed for assessing the odour impact by recording some important variables such as the frequency, intensity, duration, offensiveness and location at which odours occur. They can be used to determine compliance with a facility's odour management plan, or to improve the quality of information available to the regulator about a community odour issue.

This study was a mutually funded by the Municipality of North Cowichan (North Cowichan) and the CVRD, and was initiated as a result of odour complaints lodged against the operation of the Coast Environmental Limited facility (Coast) located at 9401 Trans Canada Highway in Chemainus by members of the general public. Odour complaints from the general public against the Coast facility have originated from two main areas of the community: 1) the industrial park located immediately west of the Coast facility, and 2) from the residential areas of Chemainus village. Therefore, the odour survey was designed to include these areas. However, in order to rule out any potential for other sources of odour being confused with odours from the Coast facility, the odour survey was expanded to also include locations in and around the community of Chemainus.

The scope of the analysis of the odour survey data included the following items:

1. pre-survey and briefing on potential odour issues for the 18 locations used for the odour survey;
2. analysis of the odour monitoring data and the community odour complaint data collected by CVRD in 2013 and 2014;
3. review of proposed locations for odour sampling survey and procedures to be followed in conducting the survey;

4. an assessment whether public complaints of alleged odours from the Coast facility are a result of composting, soil remediation, waste water management or other recycling activities, based on correlation of existing odour survey data;
5. preparation of a report on the information obtained in the tasks listed above and discussion of any odour impacts from the operation of the Coast facility.

2.0 REGULATION OF ODOURS

The regulation of odours has been, and continues to be, one of the most challenging elements of air quality to address. The primary reason for this is that these nuisances are subjective in nature, and are often based on the personal feelings, perceptions and memories of the observer (McGinley et al. 2000). Also, people have differing sensitivities to different odours. An odour that is highly objectionable or noxious to one person may be barely noticeable by another. As a result, there is no universal threshold of exposure to odours that can be considered to be acceptable to all members of the population.

Another problem is that odours are typically viewed as a "nuisance", since exposure to them is disruptive to ones sense of personal well-being, but generally do not cause health effects (although many individuals experience health-based symptoms such as nausea, vomiting, headache, etc. due to exposure to odours). Therefore, nuisance odours tend to be treated differently in regulation than are other air contaminants.

As environmental legislation has evolved over the past several decades, many jurisdictions have developed different approaches to regulating odours. The B.C. Ministry of Environment (MOE) commissioned a comprehensive review of odour management policies and practices in anticipation of adopting some of the measures in this province (RWDI 2005). In that report, it was noted that bylaws which stipulate that sources must avoid causing a nuisance are the most common and oldest approach to managing odours. Such 'avoidance of nuisance' bylaws are based on either a vaguely defined concept of not creating a "nuisance" or on avoiding adversely affecting the "quality of life" of others in the community. The RWDI report notes that: *"The exact wording varies from jurisdiction to jurisdiction but essentially requires that odour from a facility will not result in a nuisance or cause pollution."* Other approaches to managing nuisance odours include:

- Setting ambient concentration objectives or standards for individual chemicals or groups of chemicals. For example, objectives are commonly defined for sulphur-bearing compounds such as hydrogen sulphide (H_2S), dimethyl sulphide (DMS), dimethyl disulphide (DMDS) and mercaptans which collectively are referred to as total reduced sulphur compounds (TRS). British Columbia has defined a TRS objective to control odorous emissions from pulp and paper mills as well as other sources of such compounds such as wastewater treatment plants. Several provinces have also defined objectives for ammonia. However, there are no defined objectives or standards for the many types of compounds (see Rosenfeld et al. 2007) likely to be emitted from composting operations.
- Ambient concentration limits for odours. At present, the Province of Ontario is the only jurisdiction in Canada that uses a numerical odour criterion (i.e., 1 odour unit per cubic metre as a 10-minute average) for managing odorous emissions, but even that criterion is

not an official limit (see discussion in Section 2.3). An attempt by Metro Vancouver to enforce such a criterion against a rendering plant in Vancouver failed after an appeal by the rendering plant operators before the Environmental Appeal Board.

- Odour episode duration-frequency criteria. This type of approach is used in Germany and in the State of Texas and relies on defined limits for frequency and persistent of odours in a community, based on observations made by duly appointed regulatory officers.
- Minimum separation distances. Many jurisdictions have defined buffer zones around sources of odour in order to avoid creating a nuisance odour problem in communities. The Organic Matter Recycling Regulation (OMRR) guidance suggests that permitting authorities consider a 100 metres distance sufficient for separation between a composting facility and a farm, and a minimum separation distance to residential properties of between 400 to 1000 metres. Many other jurisdictions in Canada and internationally have established similar minimum separation distance requirements for composting facilities, ranging from 250 m to 1600 m.
- Odour intensity scales. RWDI (2005) noted that several jurisdictions such as the Puget Sound Clean Air Agency (PSCAA) in Washington State, the State of Western Australia and Germany have used this approach. The PSCAA in Appendix A (Section A.1).
- Odour Index Scale. As noted by RWDI (2005), "*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. It differs from an odour intensity scale because it is a calculated value.*" No other jurisdictions have been identified that use this approach.
- Odour complaint criteria. Some jurisdictions have defined the minimum number of public complaints that need to be registered before an investigation is launched to determine if a source is creating a nuisance odour issue. These jurisdictions have also defined how complaints are verified and justified as valid.
- Quantitative emission criteria for odours or specified chemical compounds. Some jurisdictions have defined the amount of odour (in terms of odour units per second) or chemical compound (in terms of grams or kilograms per second) that a source can emit in its operations. This approach assumes that the emission rate can be quantified which, in the case of an odour emission rate, assumes the use of dynamic dilution olfactometry. In addition, the allowable emission rate may be determined based on odour dispersion modelling to ensure that off-site odours meet some pre-defined acceptable ambient odour concentration.
- Technology criteria. RWDI (2005) notes that many jurisdictions specify odour treatment controls and best management practices for specific industries or processes to ensure that odour emissions are kept to a minimum. This might include, for example, the use of properly designed aeration of compost piles and the collection and venting of air from compost facilities through a biofilter.

Appendix A provides more discussion of the different approaches that have been developed, how they are used to prevent, control and mitigate nuisance odours.

2.1 AMBIENT ODOUR MANAGEMENT PRACTICES IN CANADA

Canadian Federal legislation does not contain any regulations pertaining to the emissions of odours from industrial or agricultural facilities. Instead, the individual provinces and territories have a responsibility for odour emissions (Bokowa 2010).

The provinces of New Brunswick, Newfoundland and Labrador, Prince Edward Island, the Yukon and the Northwest Territories have no odour standards or policies, although Newfoundland and Labrador and New Brunswick have ambient air quality objectives or standards for odorous compounds such as hydrogen sulphide (H_2S) and/or ammonia (NH_3). Alberta also has ambient air quality objectives for H_2S and has initiated a review of odour management policies for possible future adoption (see Section 2.6 below). Nova Scotia, Manitoba, Saskatchewan and British Columbia also have no odour standards, but odour may be considered a contaminant in these four provinces. Manitoba tried to adopt numerical standards but ultimately revised its odour policy to use more qualitative approaches (see Section 2.8.2 below). British Columbia commissioned a review of odour management policies in 2005, but has not developed a formal policy since then. Similar to some of the other provinces, B.C. also has adopted ambient air quality objectives for Total Reduced Sulphur (TRS) compounds (expressed as H_2S), but Metro Vancouver is the only jurisdiction in B.C. that has tried to address odour in a formal manner.

2.2 BRITISH COLUMBIA

The Ministry of Environment (MOE) in British Columbia administers and regulates air quality issues, including odour issues, under the authority of the Environmental Management Act (EMA). In 2004, the MOE developed guidelines for the siting and operation of composting in support of the Organic Matter Recycling Regulation (OMRR). The guidelines (Forgie et al. 2004) were issued in 2004 *"to assist waste generators, the general public, qualified professionals ("QP"s), compost producers and/or facility owners ("dischargers" under the definitions of the OMRR) and Ministry staff in understanding and/or complying with the conditions established in Part 5 - Composting Facility Requirements of the OMRR."* The EMA and the OMRR are the two primary regulatory documents that govern odour management in B.C. as administered by the MOE.

In addition, the Ministry of Agriculture, Food and Fisheries (MAFF) is responsible for resolving odour issues related to farming under the Farm Practices Protection (Right to Farm) Act. Under

the Right to Farm) Act, persons who are aggrieved by any odour, noise, dust, or other disturbance resulting from a farm operation conducted as part of a farm business, may apply to the Farm Practices Board (FPB) for a determination as to whether the disturbance results from a normal farm practice. A complaint under the Right to Farm Act involves first determining whether or not the complainants are aggrieved by the actions of the farm or farmer, and secondly whether the grievance is the result of normal farm practices or not. If, after a hearing, the FPB is of the opinion that the odour, noise, dust, or other disturbance results from a normal farm practice, the complaint would be dismissed. If the practice is found to not be a normal farm practice, the FPB has authority to order the farmer to cease or modify that practice.

In 1972, the Provincial Government delegated authority for air quality management to the Greater Vancouver Regional District (GVRD). In 1993, the Greater Vancouver Regional District (GVRD; Metro Vancouver) prepared a working paper on odour management as part of its comprehensive planning process for air quality management in the region and in the Lower Fraser Valley as a whole (GVRD 1993). The report identified a number of management options, including:

1. Continuation of the existing policies of stipulating that there be *"no odour past the plant boundary such that the Air Quality Director determines that air pollution has occurred."* Suspected non-compliances would be investigated based on complaints received or at the discretion of the District staff.
2. Getting specific concentration limits for known odorous compounds from point source discharges.
3. Using a combination of odour sampling, olfactometry and dispersion modelling to determine whether odour concentrations emitted by a source constitute air pollution at or beyond the plant boundary.
4. Placing limits on permitted odour concentration emissions from point sources.
5. Setting quantitative odour concentration objectives or standards based on olfactometry.
6. Mandating Best Available Control Technology (BACT) or BACT-derived criteria for odorous emissions.
7. Using a combination of approaches.

In the end, the GVRD settled on using general regulatory language that prohibits off-site nuisance or annoyance conditions as determined by field inspectors for odour management within its jurisdiction. Subsequently, there were three specific cases which have helped to define odour regulation policy in the GVRD and the Lower Fraser Valley: 1) the Money's Mushroom case in 1997, 2) the Vane duck barn case in the Township of Langley in 2002, and 3) the West Coast reduction case in 2010. These cases are discussed below.

In 1997, the GVRD successfully prosecuted the operators of Money's Mushrooms, a large composting facility used to produce mushroom growing media, in Provincial Court in response to numerous odour complaints from the community. The prosecution was launched under the authority of GVRD Bylaw No. 725 which stated that an 'air contaminant' meant any substance, including an odorous substance, which caused or was capable of causing material discomfort to a person. As reported by RWDI (2005), the judge in this case defined "material discomfort" to mean more than merely unpleasantness, but had to include material physiological consequences (e.g., nausea, gagging, coughing, eyes watering, headaches, aggravation of existing asthma, etc.) or substantially altered or impaired the usefulness of the air. In determining whether or not the odorous emissions from Money's Mushrooms had caused material discomfort, the judge in the case considered the number of persons affected, the neighbourhood, the degree of physiological effect, length of time that the odour was present, consistency of the characteristics of the odour, the methodology for collection of odour incident records, and any bias in the collection of data. Furthermore, with respect to a challenge from Money's Mushrooms that odour was not a "substance," the court ruled that "*The presence of a substance in the environment can be established by odour*." Therefore, odour can be considered a substance with the same standing as any other emission (RWDI 2005).

In 2002, the Westcreek Citizens Society launched a case under the Right to Farm Act against a hobby farm operator in the Township of Langley. The farmer had established an intensive duck rearing operation and had plans to expand the operation. The decision of the FPB rendered in 2003 determined that the complainants were aggrieved by the odour emanating from the Vane duck farm. Furthermore, the FPB determined that the duck barn was a source of continuous odour of high intensity. The odor was of a sufficiently high intensity to adversely impact residents living within five km of the site. Furthermore, the FPB determined that the manure storage at the duck barn did not meet the definition of normal farm practice. Although the FPB agreed with the duck barn operator that it was consistent with normal farm practices to site a duck farm or a similar livestock operation on a small acreage. However, the FPB stated that duck farm or livestock operation must be of an appropriate size and must employ proper manure management practices. However, *"Where the duck farm or livestock operation is located on a small acreage, with neighbours in close proximity, practices producing intense odours which are proper and accepted on a larger acreage located in an area where other livestock operations are present are not appropriate or reasonable. In fact the combination of a small site and close neighbours leads to the conclusion that manure management practices should meet if not exceed the practises seen on larger operations sited on larger properties."*

In 2005, the British Columbia Ministry of Environment (formerly the Ministry of Water, Lands and Air Protection) commissioned a general review of odour management policies in other jurisdictions. The Steering Committee for the review included representatives from the MOE, MAFF, GVRD and Environment Canada. The objective of the report was to provide the

Ministry, the GVRD and the other members of the Steering Committee with recommendations for odour management approaches that would be effective in British Columbia (RWDI 2005). The review noted that, at the time, the GVRD had recently published a draft Odour Management Strategy that consisted of a comprehensive, six-level approach to resolve odour issues in that jurisdiction. The nature, severity, frequency and duration of specific odour problems, as indicated by the number of complaints and information gathered via inspection, determine the level of enforcement action. One of the recommendations of the review was that the province could adopt ambient odour criteria for design purposes and provide guidelines for odour impact assessments as a proactive measure to prevent new odour problems.

In response to hundreds of odour complaints from residents of the Grandview-Woodlands area of Vancouver in the period 2004-2007 in relation to emissions from a rendering plant operated by West Coast Reduction Ltd., Metro Vancouver began the process of developing a quantitative ambient odour objective (Robb 2007; Trask 2008). The operators of the rendering plant challenged permit amendments issued by Metro Vancouver (Metro Vancouver 2008) which would have required the facility to conduct periodic monitoring of their emissions in 'odour units' and to use dispersion modelling to evaluate the impact of those odour unit emissions on the surrounding community. In addition, the draft permit amendment would have required the facility to ensure that there were 'odour-free' periods of time on weekends and statutory holidays from the beginning of May to the end of September.

The proposed amendments to the plant's operating permit were challenged by West Coast Reduction Ltd. before the Environmental Appeal Board (EAB) of British Columbia. The decision of the EAB (EAB 2010) stated that:

- The Metro Vancouver District Director had no jurisdiction under the *Air Quality Management Bylaw* to amend the permit in the manner that he did. It was stated that the amendments were more likely an attempt to appease a relatively small number of individuals in the community who frequently complained about the odour.
- Although odour is capable of causing air pollution and may be subject to monitoring requirements, odour itself is not a "substance", and therefore does not fall within the definition of "air contaminant" in the *Bylaw* and the *Environmental Management Act,* and no legislation in the province has placed any specific numerical limits on odours.
- The District Director's imposition of odour limits, as measured in "odour units", as an enforcement tool was unreasonable and inappropriate because odour units are a subjective and imprecise measurement tool that have been developed based on data and assumptions that are not readily applicable to environmental odours, especially for the purposes of enforcement.

On that basis, the EAB rescinded the permit amendments issued for the plant. In 2013, West Coast Reduction Limited submitted an application for a permit amendment to the GVRD to authorize upgrades to emission control measures and procedures that would reduce odour emissions.

In 2011, Metro Vancouver adopted the Air Quality and Greenhouse Gas Management Plan which included the development and implementation of an odour management program, including an odour management regulation that would address key sources of odorous emissions, effective complaint management and communication processes. Under the proposed regulation, which was adopted as GVRD Air Quality Management Bylaw No. 1083 in 2013, Metro Vancouver charges a fee of $50 per billion odour units emitted.

In 2012, prior to adopting Bylaw 1083, Metro Vancouver proposed implementing specific rules based on how much odour was emitted, how many people would potentially be affected, and how offensive the odours could be. As part of the proposed odour regulation, composting facilities that process yard and other types of waste would have been regulated based on three categories, namely:

- **Low Risk Facilities:** Processing moderate quantities of non-putrescible yard waste (i.e., less than 10,000 cubic metres) would be classified as having a low potential for odorous emissions and would be authorised to emit air contaminants with minimal requirements.
- **Moderate Risk Facilities:** Processing more than 10,000 cubic metres of yard waste and/or less than 10,000 cubic metres of organic wastes would be classified as having a moderate odour emission potential and would be authorized provided that Best Management Practices were employed and substantial odour impacts were avoided. Such facilities would have been required to have a separation distance from urban areas (as defined by population density) greater than 500 metres but less than 1.5 km.
- **High Risk Facilities:** Facilities with a high potential for odour impacts, including rendering plants, animal feed plants, mushroom media composting facilities, intensive agricultural feedlot activities, anaerobic digesters processing non-agricultural waste and large composting facilities having more than 10,000 cubic metres bulk volume of compostable materials other than yard waste would have been required to obtain permits and pay fees based on the potential impacts of odorous emissions.

Facilities with a high risk potential for odour impacts would also have been required to estimate or measure their odorous emissions in accordance with the European Standard EN13725 and methods approved by the GVRD district director. High risk facilities would also be required to undertake dispersion modelling and population analysis in accordance with procedures approved by the district director to estimate odour impacts upon the community. In addition, Metro Vancouver proposed that high risk facilities would be required to pay an annual fee of $5/year

for every person that was estimated to experience 11 odour units or more (30-second average, 99.9%) of odour from the facility as determined by approved dispersion modelling analysis. A multiplier value of 11 would be specified in order to convert results predicted on a 1-hour average to a 30-second average, which better reflects the time scale on which odour impacts are experienced in the community (see discussion of odour dispersion modelling in Appendix A, Section A.6).

However, these provisions for low, moderate and high odour emitters were subsequently withdrawn by Metro Vancouver and not incorporated into Bylaw 1083. Consequently, the only stipulation in this bylaw is that odour emitters must pay a fee of $50 per billion odour units, this fee covering the cost for Metro Vancouver to deal with odour issues in the district.

2.3 ONTARIO

Ontario does not have a formal Odour Policy. Instead, potentially odorous facilities are addressed on a case-by-case basis, typically through the use of a maximum 1 OU (10-minute average) ambient performance limit in Certificates of Approval (CofA). This is applied on an *ad hoc* basis. Some CofA (air) for odorous facilities have no ambient odour performance limits, while others have limits greater than 1 OU on a 10-minute basis. The use of a 10-minute average was based on an informal survey completed by the MOE, which determined that people will tolerate an offensive odour for approximately 10 minutes before complaining. On this basis, the MOE made it an offence to exceed a 10-minute odour-based standard. With the exception of one municipality in Quebec (see Section 2.8.2) Ontario is the only province in Canada that uses such a numerical performance limit value based on odour units.

In 2005, the Ontario Ministry of Environment (MOE) announced that it would be developing an Odour Policy Framework, which would clarify requirements when industry applies to obtain a Certificate of Approval (air) and ensure the selection of appropriate odour abatement options. This would also potentially deal with odour complaints. The MOE released two position papers (March 2005, June 2006). The first outlined the proposed basis of the future Odour Policy, which was to include both odour-based contaminant Point of Impingement (POI) standards for compounds such as H_2S, TRS, etc., and ambient olfactometric-based criteria (i.e., in odour units). The second position paper discussed the application of FIDOL (Frequency, Intensity, Duration, Offensiveness and Location of the odour impact) factors in the proposed regulatory framework for odours. However, the regulated community had significant concerns about the subjective nature of this approach. As a result, the proposed Odour Policy Framework was not carried forward at that time. The odour-based POI standards, however, were included in a subsequent amendment to O.Reg. 419/05.

The MOE is still developing the policy, but it is likely to be based on some of the requirements of O.Reg. 419/05, which does currently have odour-based standards for individual contaminants. In these cases, the standards are typically based on a 10-minute averaging period, and apply *"where human activities regularly occur at a time when those activities occur"* at a frequency of 99.5% of the time. In order to provide consistency, it is likely that these requirements would be applied to any ambient olfactometric-based criteria developed as part of the broader Odour Policy Framework.

At present, there is relatively little consistency in the abatement approach used by the MOE to address odour issues at existing facilities. Abatement issues are the responsibility of the individual MOE District (local) Offices that govern specific geographical areas in Ontario. The approach taken depends greatly on the direct experience of the MOE Environmental Officer and the District Office in general. As a result, differing abatement requirements and time frames for compliance are often placed on facilities across the province, which is perceived by many to be inequitable treatment. Consequently, there is an urgent need for a "formal" odour policy in Ontario.

2.4 MANITOBA

The Manitoba Environment Act contains a provision to allow an odour nuisance clause to be included in environmental permits. The odour nuisance clause makes the proponent responsible for taking the necessary action to resolve odour nuisance complaints. It also enables enforcement action to be taken against them if the measures taken fail to resolve an ongoing odour nuisance problem. In particular, action can be taken if five or more complaints are received within a 90-day period from five different individuals who do not live in the same household.

Manitoba Conservation's (MC) "Odour Nuisance Management Strategy" states that "*members of the community affected by the odour nuisance should be the ones to decide what constitutes an unacceptable ambient odour level in their community.*" The community is considered to include those people who live, work or are present as members of the public in an area that is affected by the odour nuisance, excluding the property of the proponent (Manitoba Conservation, 1998).

Although Manitoba tried to implement a maximum acceptable odour guideline value of 2 OU in residential areas and 7 OU in industrial areas, the application of these guideline values proved to be unworkable, and the Odour Nuisance Management Strategy was revised in 2008. MC found it difficult to handle odour nuisances in a way which appropriately responded to the needs and concerns of stakeholders, including both citizens with odour complaints and developments undergoing environmental licensing (MC 2008). The subjective nature of odours made it difficult to measure ambient odours and to apply quantitative limits for control purposes.

In particular, the following problems were noted:

- the administration of the existing odour limits had proven difficult;
- the odour limits were questioned in several high profile situations as to whether or not they provided adequate protection;
- it became increasingly difficult to technically defend the odour limit criteria; and
- portable ambient monitoring equipment was not readily available for field use.

As a result, the previous strategy was revised, and includes community complaint criteria, rather than odour levels/measurement criteria as the measure of an odour nuisance. The ambient criteria are no longer used.

2.5 QUEBEC

The Province of Quebec has no formal odour management policy or program. However, in 2008, the Town of Boucherville (Town of Boucherville 2008), Quebec passed a by-law limiting odour impacts to:

10 OU/m^3 (4-minute average, 100^{th} percentile)
5 OU/m^3 (4-minute average, 98^{th} percentile)

The by-law also stipulates that any odour emission sampling analysis be conducted using the European EN13725 standard for DDO analysis of odour samples and that use of the AERMOD model is mandatory for any odour dispersion modelling analyses.

2.6 ALBERTA

The Province of Alberta has no odour management strategy related to the use of numerical odour units. However, in July 2014, the Clean Air Strategic Alliance (CASA), a multi-stakeholder group composed of representatives from industry, government and non-government organizations that provides strategies to assess and improve air quality for Albertans using a collaborative consensus process, issued a Request for Proposals to more effectively manage odours in Alberta. The objective of the proposed work is to undertake an inventory of odour prevention and mitigation tools used in Alberta and in other jurisdictions and then to assess this inventory of tools for applicability in an Alberta context. The work is to be completed by the end of 2014.

Apart from that, Alberta has adopted odour-based ambient air quality objectives of 14 $\mu g/m^3$ (1-hour average) and 4 $\mu g/m^3$ (24-hour average) for hydrogen sulphide.

3.0 CHEMAINUS ODOUR SAMPLING SURVEY

In response to complaints about offensive odours from businesses and residents in Chemainus in 2013, the CVRD expended considerable effort to try to work with the operators of the Coast facility in order to understand which, if any, operations at the facility might or were likely to contribute to off-site odours. Through consultations with SENES, the CVRD determined that, since the CVRD's representatives could not be present at the Coast facility or in the community on a frequent basis, an odour survey, essentially a 'sniff test', should be instigated in order to better understand the nature and magnitude of the odour issues in the community. A similar odour survey had been conducted by the Capital Regional District in 2013 in relation to a composting facility located in Central Saanich, and the success of that survey in obtaining a better understanding of the odour issues in that case suggested that a similar survey in Chemainus would assist the CVRD with the odour issues in this community as well.

The objective of the odour survey was to obtain a database of systematically collected information at pre-determined locations in the community which could be used to measure the frequency with which odours are detected, their relative degree of intensity and offensiveness, and a description of the odour (i.e., what does it smell like) to see if the odours could be identified with a particular source(s) or activity, located either at the Coast facility or elsewhere in the community. In addition, spot readings of wind speed and direction, as well as ambient air temperature, were noted at the survey locations. Initially, the CVRD considered limiting the survey to approximately a two week period, but the survey was extended to approximately two months in order to ensure that sufficient information was obtained.

The CVRD and North Cowichan conducted an odour sampling survey in the community of Chemainus from May 6th to June 27th, 2014. The time of day varied between 5:00 am and 24:00 am, although most of the observations were made between 8:00 am and 14:00 pm because this was the time of day, when unpleasant odours were most likely to occur, based on the odour complaint information.

The 18 pre-defined odour sampling stations used in the survey were as follows:

1) North Cowichan wastewater treatment plant (WWTP) on Bare Point Road in Chemainus;
2) the intersection of Croft Street and Oak Street;
3) the intersection of Daniel Street and Oak Street, near Askew Creek Wilderness Park;
4) the intersection of Victoria Road and McKay Street;
5) on Chapman Road approximately 450 m from Victoria Road and north of Plester Farm;
6) River Road near Askew Creek Drive;
7) River Road west of the Plester farm driveway and directly north of Coast;
8) The intersection of River Road and the Trans-Canada Highway;

9) MacMillan Bloedel Fs Road near the SE corner of the Western Forest Products mill;
10) Smiley Road approximately 600 m west of the Trans-Canada Highway, near the intersection of Smiley Road and River Road;
11) the intersection of Smiley Road and Barkley Place;
12) Smiley Road near TD Auto Repairs;
13) Smiley Road near Thermoproof Windows;
14) Smiley Road near Speed Sincher Inc. ;
15) the intersection of Smiley Road and Henry Road, near Seaward Kayaks;
16) Henry Road approximately 60 m east of the Trans-Canada Highway;
17) the southeast section of the Coast Environmental Ltd. property boundary, across the Trans-Canada Highway from Station 13;
18) the northwest section of the Coast Environmental Ltd. property boundary, near the intersection of Smiley Road and the Trans-Canada Highway.

During the survey, Station 7 near the Plester farm was sampled in two locations as Station 7a at the same location as Station 7 in May, and Station 7b located along River Road east of the Plester Farm driveway, on the north side of the road directly above Askew Creek. Odour observations in May were recorded at both locations simply as Station 7, but were recorded separately as Stations 7a and 7b in June. The station was added due to the identification of more frequent odours at this location compared with the location of Station 7a. However, observations of odours at Station 7b were only recorded when the surveyors detected an odour at this location, unlike at the other locations where records were made during all visits, regardless of whether or not an odour was present.

Figure 3.1 shows the locations of the odour survey sampling Stations 1-9, while Figure 3.2 indicates the locations of Stations 9-18. Also indicated on Figure 3.1 are the location of the North Cowichan WWTP, the Chemainus Farms Limited cow dairy farm (hereafter referred to as the Plester farm) and the Western Forest Products sawmill. Figure 3.2 indicates the location of several operations that may be potential sources of odour within the property of Coast Environmental Limited (Coast). These include:

1. a hydrocarbon contaminated soil treatment facility on the northern boundary of the Coast property;
2. a composting facility used for food waste, biosolid and yard and garden waste composting, with associated three biofilter beds;
3. a portable toilet cleaning station;
4. a sewage waste transfer station and storage tank used to consolidate and temporarily store sewage waste before trucking it to a waste water treatment facility; and,
5. construction and demolition waste processing (unlikely to be a large source of odour).

Figure 3.3 provides a view of the location of specific operations within the Coast property that are referred to in the analysis of the odour survey information. Although some or all of the operations at Coast property have been the subject of odour complaints and constitute the primary reason for conducting the odour sampling survey, the survey included sampling stations in other areas of Chemainus as well because there have been odour complaints from residents near the Chemainus village, in addition to the businesses and residents along Smiley Road in the Chemainus Industrial Park. In order to investigate other potential sources of odour that may contribute to these complaints, the odour survey sampling stations were located in the vicinity of the North Cowichan WWTP, in and around Chemainus village, in the vicinity of the Plester farm, at other industrial facilities west of the Trans-Canada Highway, and near to the Western Forest Products on MacMillan Bloedel Fs Road, immediately north of the Coast facility.

On most survey days, the odour survey was conducted following a sampling route starting at Station 1 near the North Cowichan WWTP and continuing on to follow the sampling stations sequentially in numerical order (i.e., Station 1, Station 2, Station 3, etc.). On some days, the survey route was altered, beginning at Stations 10-18, followed by sampling at stations 1-9 due to scheduling limitations.

The surveyor would spend approximately ten to fifteen minutes or more, depending on the degree of persistence or intermittency of the odours detected, at each station to determine whether or not any odours were detected, and if odours were noted, estimate the strength of the odour (i.e., its intensity) on a five point scale (as described in Sections 3.1 and 3.2 below), as well as try to identify the odour using ten odour descriptors (see Section 3.3). The surveyor would also take note of the wind speed and direction at the sampling location using a hand-held anemometer and survey tape and compass, as well as the ambient temperature. The second surveyor followed the same route as the first surveyor approximately 1.5 hours in order to determine whether the same or other odours were present and their characteristics. Sampling conducted at each station was treated as a single, independent sampling observation in the survey. If possible, the surveyors noted the most likely source of the odour based on its description and the wind direction at the sampling location. However, it was frequently not possible to identify a single source of odour in relation to Coast operations. For example, it was frequently difficult to differentiate odours from the Coast biofilter and compost tent, and on most occasions there were undertones of odours from what appeared to be several different sources of odour on the Coast property.

The total number of observations during the survey period ranged from 75 at Station 9 to 85 at Stations 14. During the odour survey, it was noted that odours were frequently present at the location of Station 7b. Therefore, these odours were recorded separately at a distinct location in June. There were 11 observations of odours at this location in May and 26 observations in June.

Figure 3.1 Location of Odour Survey Stations 1-9

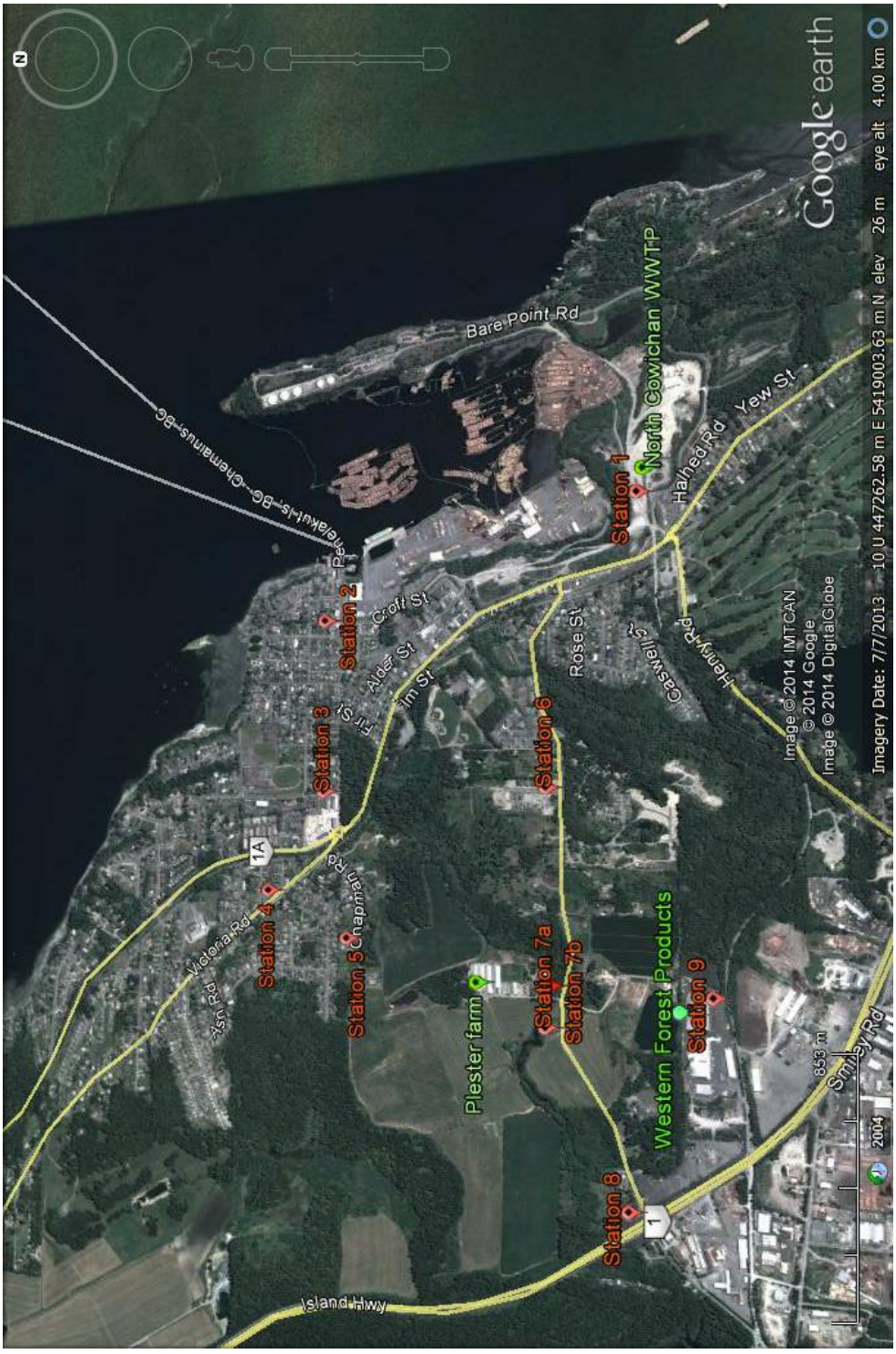


Figure 3.2 Location of Odour Survey Stations 9-18

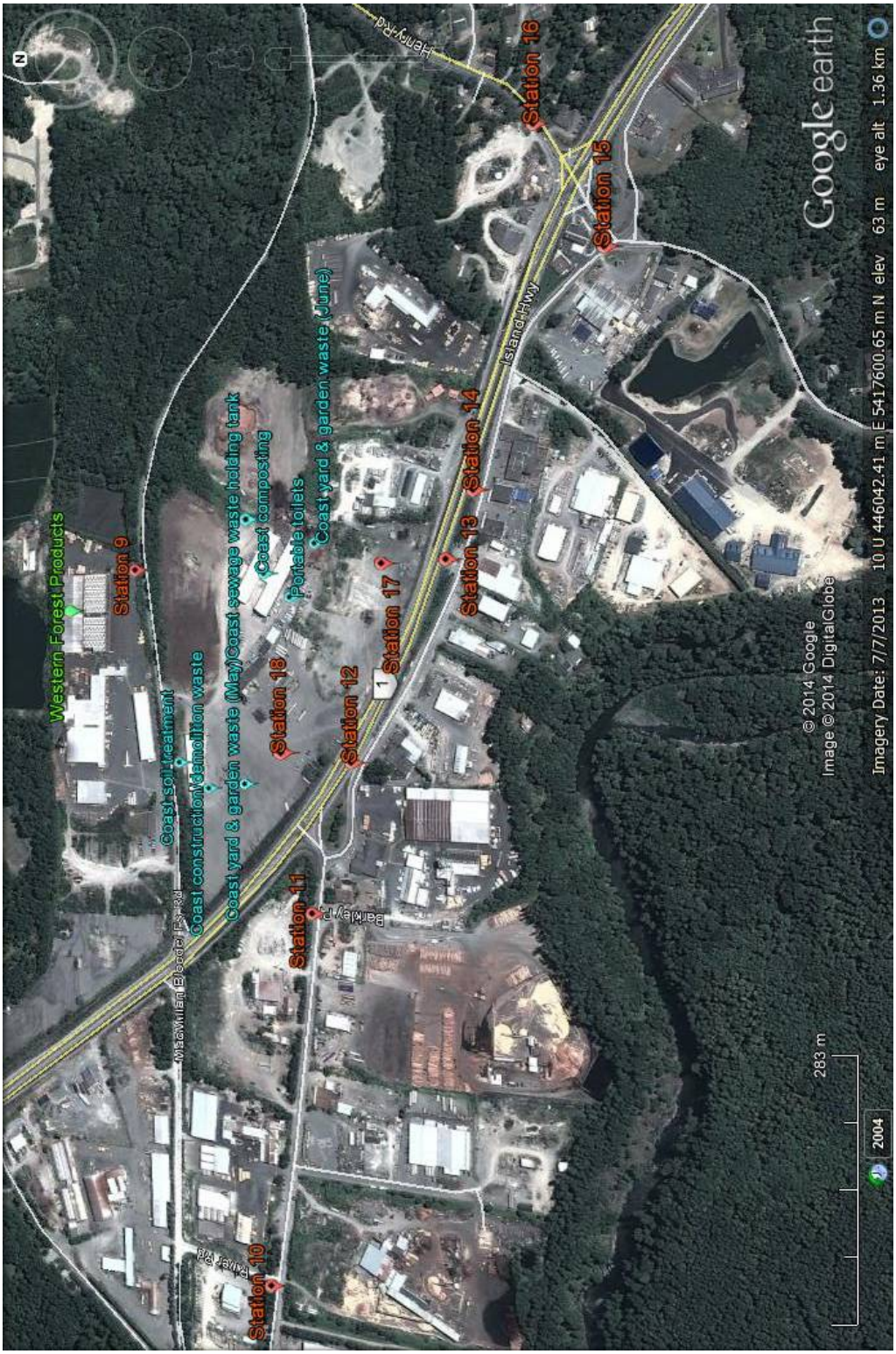
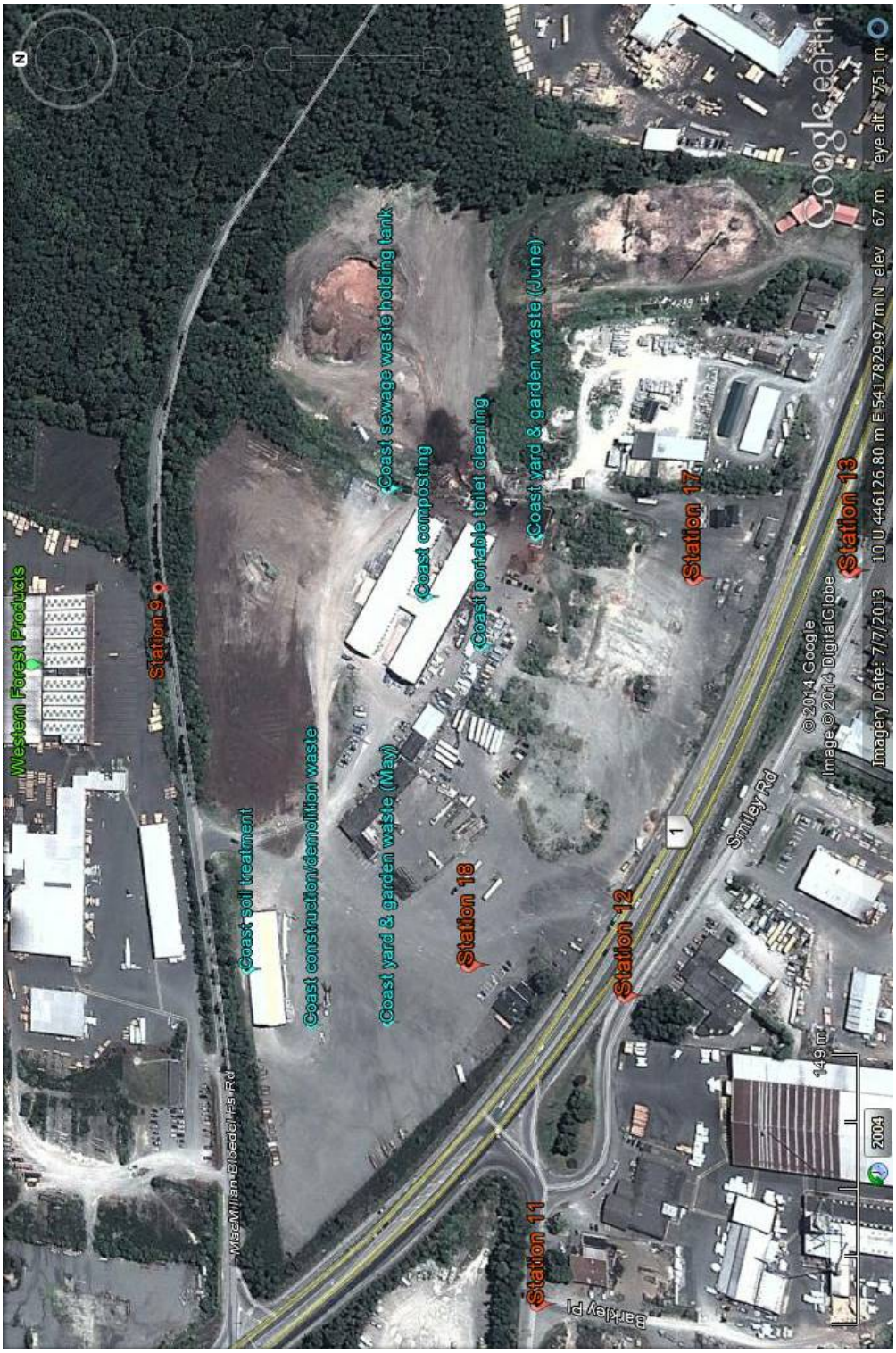


Figure 3.3 Location of Specific Activities at Coast Environmental Limited

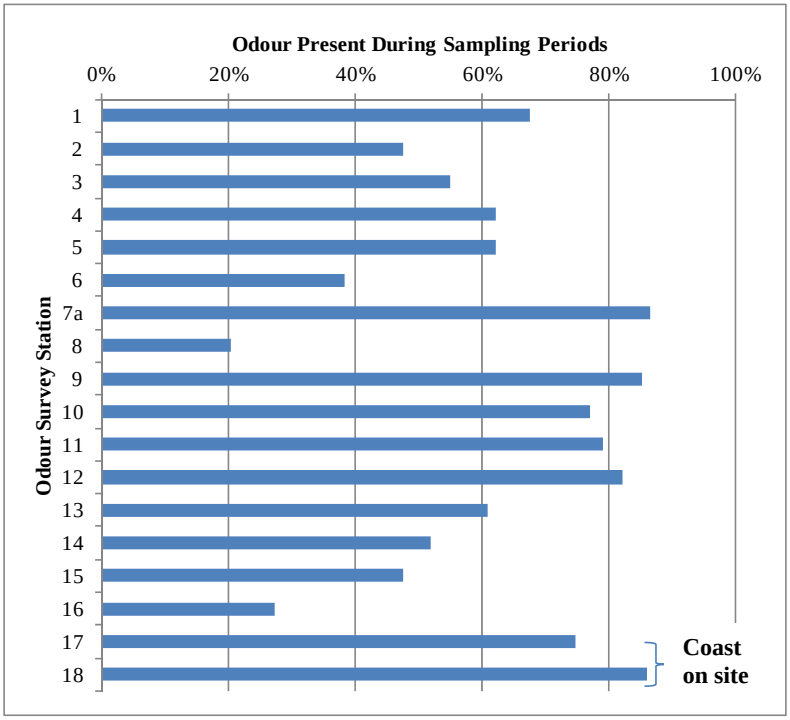


3.1 ODOUR FREQUENCY

Odours were detected during the majority of sampling observations at most sampling stations, regardless of whether those odours were pleasant or unpleasant. Figure 3.4 indicates the frequency with which odours were detected at each station during the survey. The lowest frequency of odours was 20% at Station 8 near the junction of River Road and the Trans-Canada Highway. The highest frequency of odours was 86% of the time at Station 7a. Note that because odours at Station 7b were only recorded when they were present, the frequency of odours at that station is not presented in Figure 3.4.

Along the MacMillan Bloedel Fs Road on the north side of the Coast facility, odours were detected 85% of the time, although as will be discussed below, many of these odours were attributable to the scent of wood from the Western Forest Products mill rather than from the Coast facility. Along Smiley Road opposite the Coast facility (Stations 11-14), odours were detected with a frequency ranging from 52% at Station 14 to 82% at Station 12, indicating a large difference in the frequency of odours over a fairly short distance. By comparison, odours at Station 16 on the south side of the Coast facility were only detected 27% of the time. In the vicinity of the North Cowichan WWTP treatment plant in Chemainus, odours were detected on 67.5% of the sampling periods.

Figure 3.4 Frequency of Odour Presence at Sampling Locations (May-June 2014)



3.2 ODOUR INTENSITY

When odours were present at a station, the odour intensity was subjectively determined on a five point scale ranging from 'pleasant' to 'very strong/offensive'. The surveyors recorded the predominant odour intensity during each sampling period, and made note of short-term peak odour intensities. Based on the surveyors' observations, high intensity odours typically lasted for only about 30 seconds, such that the predominant odour intensity recorded during the survey was generally much lower than the peak odour intensity over short-term periods. This is typical of most community odour issues, as is discussed in Appendix A. Public complaints about community offensive odours are often related to short-term peak odour concentrations than to the average odour levels over several minutes. On the other hand, as noted with respect to an informal survey conducted by the Ministry of Environment in Ontario, people will tolerate an offensive odour for approximately 10 minutes before complaining. For the analysis of odour intensity in Chemainus, the predominant odour intensity over the surveyor's sampling period was used to determine the frequency of offensive odours during the survey period.

Figure 3.5 indicates the frequency with which different predominant odour intensities were measured at each sampling station during the survey using the five point odour intensity scale. The frequency when no odours were recorded is also presented in Figure 3.5, and summarized in Table 3.1.

The survey determined that pleasant odours were most frequently identified at Station 4 in Chemainus on 35% of the samples. Pleasant odours were also sometimes detected at Stations 2, 3 and 5 from 10% to 23% of the time. The vast majority of the odours detected at most locations were rated as barely noticeable. The location with the most frequent odours that were rated noticeable or offensive was Station 7b near the Plester farm; however, as noted previously, odours were only recorded for Station 7b when they were noted at all. Therefore, the frequency of offensive odours at this station is greater than would be the case if the frequency of non-detectable odours were included. Very strong/offensive odours at this location were observed on 3.8% of the observation days when odours were present, while offensive/strong odours were reported on 42% of the survey days.

Figure 3.5 Predominant Odour Intensity at Sampling Locations (May-June 2014)

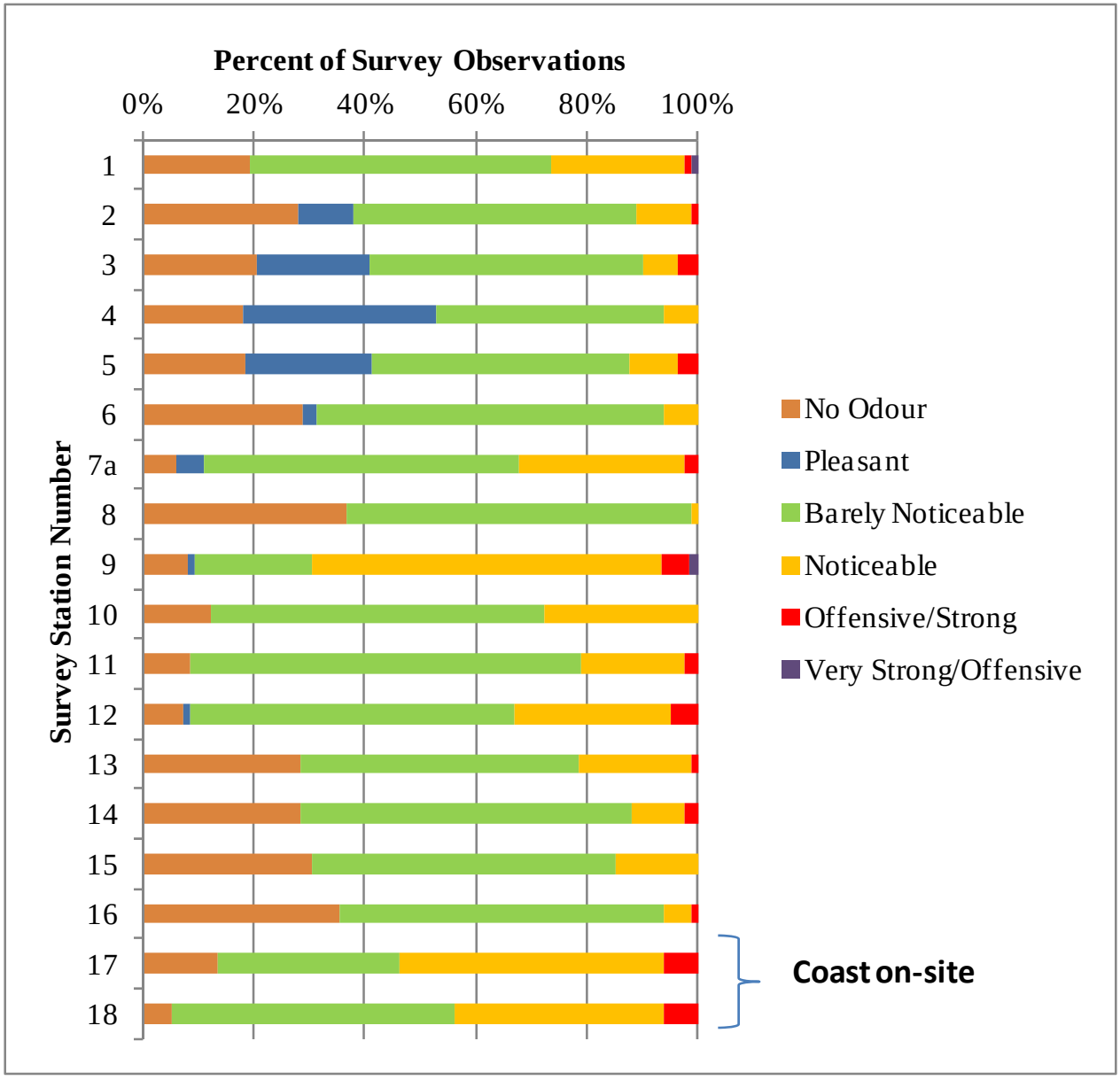


Table 3.1 Predominant Odour Intensity at Sampling Locations (May-June 2014)

Station	No. of Observations	Percent Frequency of Observations					
		No Odour	Pleasant	Barely Noticeable	Noticeable	Offensive/ Strong	Very Strong/ Offensive
1	83	19%	0%	54%	24%	1.2%	1.2%
2	82	28%	10%	51%	10%	1.2%	0.0%
3	83	20%	20%	49%	6%	3.6%	0.0%
4	83	18%	35%	41%	6%	0.0%	0.0%
5	82	18%	23%	46%	9%	3.7%	0.0%
6	80	29%	3%	63%	6%	0.0%	0.0%
7a	81	6%	5%	57%	30%	2.5%	0.0%
8	79	37%	0%	62%	1%	0.0%	0.0%
9	75	8%	1%	21%	63%	5.3%	1.3%
10	83	12%	0%	60%	28%	0.0%	0.0%
11	81	9%	0%	70%	19%	2.5%	0.0%
12	82	7%	1%	59%	28%	4.9%	0.0%
13	84	29%	0%	50%	20%	1.2%	0.0%
14	85	28%	0%	60%	9%	2.4%	0.0%
15	82	30%	0%	55%	15%	0.0%	0.0%
16	82	35%	0%	59%	5%	1.2%	0.0%
17	82	13%	0%	33%	48%	6.1%	0.0%
18	80	5%	0%	51%	38%	6.3%	0.0%

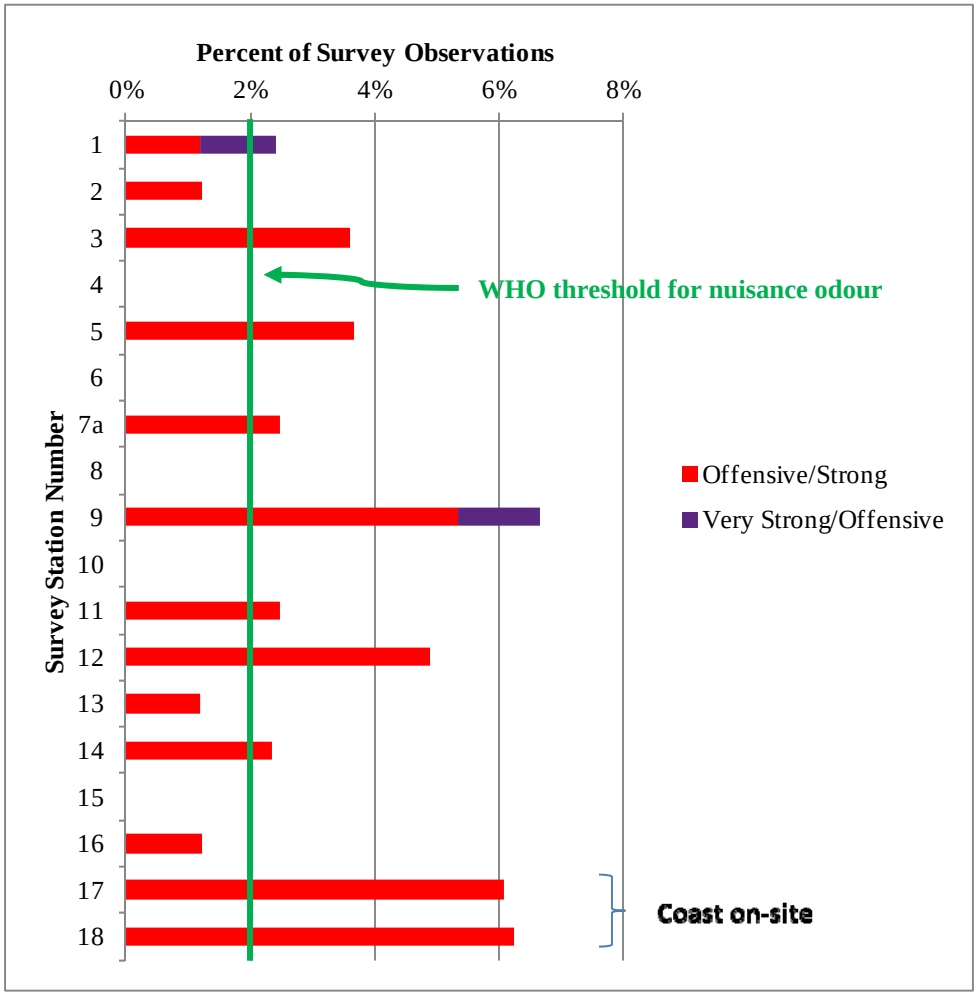
Figure 3.6 indicates the percentage of the survey observations at each station that were rated to be more than noticeable. The strongest and most offensive odours were reported at Station 1 near the North Cowichan WWTP, and at Station 9 between the Coast facility and the Western Forest Products mill. Very strong/offensive odours were most frequently observed at Station 7b on 3.8% of the survey observation days.

Due to the fact that non-detectable odours were not recorded for Station 7b which skews the frequency distribution in favour of offensive odours, this station is not included in Figure 3.6. Nevertheless, the odours at Station 7b ranked among some of the highest odour intensities during the odour survey.

The data indicate that no offensive odours were observed at Stations 4, 6, 8, 10 and 15. Offensive odours were most frequently noted at Station 9 during 6.7% of the odour observations. Of these, offensive odours from the Coast facility were responsible for the majority (i.e. 4.0%) of

the 6.7% offensive odour observations, while the remainder were attributed to the Western Forest Products sawmill. The second highest frequency of offensive odours (6.3%) was observed at Station 18, on the Coast facility site. However, offensive odours were also reported on 3.6% and 3.7% of the observations at Stations 3 and 5, respectively, in Chemainus. Along Smiley Road opposite the Coast facility west of the Trans-Canada Highway (Stations 11-14), offensive odours were observed from 1.2% of the time (Station 13) to 4.9% of the time (Station 12).

Figure 3.6 Frequency of Predominant Offensive Odours (May-June 2014)



Also indicated on Figure 3.6 is the World Health Organization (WHO) threshold level for nuisance odour impacts. The WHO defines a nuisance threshold as being that concentration at which not more than a small proportion of the population (less than 5%) experiences annoyance for a small part of the time (less than 2%) (WHO 2000). In the absence of an alternative

definition of a nuisance odour threshold, the WHO definition can be used as one alternative. Based on this definition, the predominant odours rated as offensive/strong or very strong/offensive were present more than 2% of the time during the odour survey at stations 1, 3, 5, 7a, 9, 11, 12 and 14. Because stations 17 and 18 are located on the Coast property, the WHO threshold does not apply to these two stations.

Overall, the surveyors noted the intermittent nature of most odour observations. The predominant barely noticeable and noticeable odour intensities presented in Figure 3.5 were frequently accompanied by short-term wafts of higher intensity odours in the offensive/strong and very strong/offensive categories. The highest frequency of short-term peak offensive odour intensities was reported at Stations 17 and 18 on the Coast property on six occasions at each station, and at Station 12 along Smiley Road on five occasions. Short-term peak offensive odours were also noted on three occasions at Station 13, with peak offensive odours also being noted at Stations 11 and 14 on one occasion each. Peak offensive odours were also noted on two occasions at Station 1, beside the North Cowichan WWTP plant and Station 5 beside the Plester farm, and on one occasion at Station 9 along MacMillan Bloedel Fs Road.

3.3 ODOUR DESCRIPTORS

The odours at each sampling site were evaluated on a 10-point scale using odour descriptors. The descriptor categories used by the surveyors were similar to those defined by the 'odour wheel' for the types of odorous compounds likely to be emitted from composting facilities as provided by Rosenfeld et al. (2007). The scale used by the surveyors was as follows:

1. Fecal/sewage/manure
2. Earthy/musty
3. Pine/mint/hay/lemon/eucalyptus
4. Sweet/garbage can/nail polish/solvent
5. Soap/fruit/citrus/green
6. Chemical/rubbery/shoe polish/glue/gasoline
7. Dead animal
8. Woody
9. Fishy/urine/ammonia
10. Rotten cabbage/egg/sulphur

Given the complexity of some of the odours emanating from the Coast facility and other odour sources, the surveyors were not always able to limit their use of descriptors to only one category from among these 10 categories of odour descriptors, and sometimes used two or more categories to describe an odour. In addition, there were frequent observations wherein more than one odour was present during the sampling period at a station, such that several categories might

be used during one observation. For example, when at a station in the industrial park, there may have been a dominant odour coming from a sawmill which was often described using a combination of categories 3 and 8, in addition to some lower intensity intermittent odours from Coast yard and garden waste processing that were recorded using categories 2 and 3, or where there seemed to be an odour from the Coast biofilter using categories 2 and 4. In addition, there may have been a single short-term scent of a vehicle exhaust odour (category 6) coming from a passing vehicle, or a machine shop. All categories of odour descriptors observed were recorded, and the information was subsequently analyzed to identify the most dominant (i.e., frequent) categories reported at each sampling station, and summarized as follows:

Station 1: Primarily category 1 (sewage/H_2S) odours from the North Cowichan WWTP, with occasional categories 8/3 (woody/pine) odours from the nearby Western Forest Products operation. Also, occasional categories 5/6 (citrusy chemical) odours together accompanied category 1 (sewage/H_2S).

Station 2: Primarily neutral odours. On occasion, low intensity odours were recorded including category 8/3 (woody/pine) odours from the nearby Western Forest Products in the Chemainus village harbour, with various other odours from the ocean, restaurants, a bakery, and a laundromat.

Station 3: Primarily neutral odours. Offensive category 1 (persistent/lingering manure odours, often with sharp, harsh and fecal-type properties). Category 1 was often accompanied by chemical undertones of category 9 (ammonia) or category 10 (sulphur). These odours were experienced most persistently late in the day or early in the morning. There were also noticeable and unpleasant skunk cabbage and musty-vegetation odours from nearby Askew Creek, and odours from road construction during a portion of the survey. In addition there were a variety of pleasant odours from garden plants and a bakery.

Station 4: Primarily neutral odours. Pleasant flowery odours from residential gardens – with occasional faint, but persistent/lingering category 1 (manure or fecal-type odours), with occasional chemical properties, the majority occurring near dusk or dawn.

Station 5: Primarily neutral or pleasant vegetation odours. Small hobby farm on Chapman Road was a source of barely noticeable category 2 (earthy/musty odours), while Plester Farm was a source of fairly frequent and persistent soft manure odours, with less frequent but strong/harsh manure odours with chemical properties as well.

Station 6: Primarily neutral odours, with some plant odours, and occasional variable odours of categories 8, 3 and 5 (wood and vegetation from nearby construction and

landscaping odours). One occurrence of category 3 (minty-hay, and rotten fruit-type odours). Occasional category 1 (manure-type) odours, ranging from barely noticeable - offensive.

Station 7a: Primarily noticeable and offensive category 1 (manure-type) odours from Plester farm, which could have some harsh, sharp, chemical undertones. Accompanied with less offensive categories 3 and 5 (hay and vegetation) type odours from surrounding fields.

Station 7b: Primarily offensive and persistent/lingering, category 1 (harsh/sharp fecal/manure) type odours, often accompanied by undertones of category 9 (ammonia) or category 10 (sulphur). While some manure wafts were similar to those from the Plester farm, observed at Station 7a, manure odours near Askew Creek were significantly more intense and complex – similar to the very strong/offensive odours found at station 3, 4 and 5. Less offensive odours noted here included category 2 (earthy/musty) odours and category 5 (vegetation-type) odours.

Station 8: Mainly neutral odours. No predominant odour; mixture of barely noticeable odours from plants (broom), car exhaust, and lumber, with an odour from Coast contaminated soils operation on one occasion

Station 9: Primarily category 8/3 (woody/pine) odours from Western Forest Products. Occasional odours, associated with SW to SE winds, category 2, 3, 4 (earthy/musty; pine; sweet, garbage can) odours from Coast facility which may be associated with the Coast soil remediation, biofilters, sewage/septic, yard and garden piles, soil amendment and other composting operations.

Station 10: Mostly category 8/3 (woody/pine lumber) odours, with noticeable and complex category 6 (chemical) or category 2 (musty) odours that may be associated with wood kiln emissions; only one instance of category 1 (sewage-like) odours.

Station 11: Mostly a mixture of lumber yard woody odours and plants (broom), but with three occasions where Coast yard & garden waste odours were noted, all associated with E or NE winds.

Station 12: Dominant odours were associated with various activities at Coast and consisted of categories 2 (earthy/musty), 3 (pine), and 4 (sweet, garbage can) odours in a range of intensities/dominance within the three categories, with category 1 (manure-type) odours and rancid or putrid odour also noted on occasion. Generally, winds from the E-NE brought odours which may have been associated with the Coast soil remediation

operations, biofilters, sewage/septic operations, soil amendment, and other composting operations. The dominant odour was considered to be attributable to yard and garden activities. Other occasional odours could have been sourced from lumber, vehicle exhaust, and other industrial activity from Smiley Road.

Station 13: Dominant odours were associated with various activities at Coast and consisted of categories 2 (earthy/musty), 3 (pine), 4 (sweet, garbage can) in a range of intensities/dominance within the three categories, with category 1 (sewage-type) odours or rancid odours sometimes noted. These odours may have been associated with Coast's soil remediation, biofilters, sewage/septic operations, soil amendment, and other composting operations. The dominant odour could have been attributable to yard and garden activities. A mixture of additional odours consisted of nearby vegetation (broom), lumber, vehicle exhaust, and other industrial activity from Smiley Road.

Station 14: Dominant odours were associated with various activities at Coast and consisted of categories 2 (earthy/musty), 3 (pine), and 4 (sweet, garbage can) odours in a range of intensities/dominance within the three categories, with category 1 (sewage) odours and rancid odour sometimes noted. Generally, winds from the NW brought odours which may have been associated with Coast's soil remediation, biofilters, sewage/septic operations, soil amendment, and other composting operations. The dominant odour could have been attributable to yard and garden activities. Various other odour sources include, lumber, vehicle exhaust, and other industrial activity from Smiley Road.

Station 15: Primarily noticeable category 6 (chemical) odours, including gasoline and vehicle exhaust odours, with occasional lumber odours, and citrusy chemical odour.

Station 16: Primarily a hydrocarbon-type odour from vehicles during periods of low wind speed and indefinite wind direction. No persistent odours of any kind.

Station 17: Wind gusts created an inconsistent, complex mixture of odours, at barely noticeable to highly offensive intensities, ranging from category 1 (fecal or sewage), category 2 (earthy/musty), category 3 (minty-hay/pine/eucalyptus), category 4 (sweet or hot garbage can odour), and category 8 (woody). After the yard and garden operations were moved closer to the composting tent in June, the dominant odour (categories 2,3,4) was Coast's yard and garden operations; however, odours may also have been associated with other sources such as the Coast's biofilters, sewage/septic operations, soil amendment, opening of tent doors, offloading of feedstocks and other composting operations.

Station 18: Complex mixture of barely noticeable to offensive odours, including category 1 (manure), category 2 (earthy/musty), category 3 (minty-hay/pine), category 4 (sweet or hot garbage can odour), category 6 (chemical), and category 8 (woody). The dominant odour for the first half of the survey in May was Coast's yard and garden operations, with hints odours of contaminated soils. After the yard and garden operations were moved closer to the composting tent in June, the dominant odour became categories 8/3 from the wood waste pile and categories 1/2 along with hydrocarbon odours from the contaminated soils tent. However, odours may also have been associated with Coast's biofilters, sewage/septic operations, soil amendment and other composting operations.

3.4 SUMMARY OF OFFENSIVE ODOUR OBSERVATIONS

The results of the odour survey indicate that there are a number of sources of offensive odours in Chemainus. The location of the most frequent offensive odours was at Station 7b on River Road east of the Plester farm driveway. Offensive, manure-type odours were noted on 46% of the observations at this location in June. However, because there are few residences or businesses located here, the odours do not contribute to odour complaints registered with the CVRD.

The location with the second highest frequency of offensive odours was Station 9 on MacMillan Bloedel Fs Road in between the Coast facility to the south and the Western Forest Products sawmill to the north. Although the majority of the survey observations reported woody type odours at this location, most of these observations were recorded as noticeable, but not offensive/strong. Offensive odours at this location were noted on 6.7% of the observations, and most frequently consisted of odours of sewage, yard & garden, contaminated soil, and biofilter odours related to the Coast facility. There were only two observations of woody odours from the lumber mill which were strong enough to be considered offensive. However, as with Station 7b, there are no residences or businesses at the location of Station 9, so these offensive odours are unlikely to result in odour complaints.

The third location with frequent offensive odours was at Station 3 near the intersection of Daniel Street and Oak Street in Chemainus, and at Station 5 on Chapman Road. Offensive odours were noted on 3.7% of the observations at both locations. At Station 3, the offensive odours consisted of strong manure or feces-types odours near the creek. The persistency of these odours and time of day when they occurred (late evening/early morning) and their similarity to odours detected at Station 7b near the Plester farm, plus the location of the farm above the Chemainus village, suggest that the odours around Askew Creek in Chemainus village are related to the odours near the Plester farm. At Station 5, the offensive, manure-type odours were attributed to manure spreading on Plester's farm on at least one occasion.

Offensive odours were noted on 4.7% of the observations at Station 12 on Smiley Road. The offensive odours were described as coming from the Coast yard and garden material, and at other times as coming from the Coast contaminated soils treatment facility. Manure/fecal waste odours were also noted. For the offensive odours from the yard and garden material, the odours were noted to vary in intensity over time from being barely noticeable to unbearable for short time periods, and completely gone after five minutes. Offensive odours from the yard and garden waste were present when the material was being moved or disturbed, as well as when it was sitting undisturbed.

Predominant offensive odours were also reported at Station 14 on Smiley Road on 2.4% of the survey observations, although occurrences of short duration offensive odours were also noted at this location for peak odour concentrations. However, although odours from the Coast biofilter and yard and garden material were noted on a number of occasions, predominant offensive odours from the Coast facility were only observed on one day during the survey, and these were described as resembling "garbage can odours on a hot day", although the surveyors were unable to determine which operations at the Coast facility (e.g., the biofilters, finished compost or a mix of several sources) were contributing to this odour. The intensity of the offensive odours on that day varied between barely noticeable to offensive/strong during the period of the observation. On other days, offensive odours were also present, but only for brief periods of time and were not judged to represent the predominant odour intensity.

It should be noted that offensive odours were also observed at Stations 11 and 13, but at a slightly lower frequency than at Stations 12 and 14. At Station 13, offensive odours were only observed on one occasion, and this was described as being an odour that came in short 'bursts', varying in intensity from barely noticeable to offensive/strong. Similarly, there was one observation of offensive odours at Station 16 which was described as a garbage can/food waste type of odour, which most likely came from the Coast facility since Station 16 was downwind of Coast at the time of the observation. Although noticeable odours related to the Coast facility were also reported at Station 11, the two occasions when odours were reported to be offensive/strong were reported as 'lumber' odours, and therefore unrelated to operations at Coast.

Offensive odours were also observed on 2.4% of the survey observations (i.e., 2 occasions) at the front gate of the North Cowichan WWTP in Chemainus. In both cases, the odour was ascribed to emissions from the sewage facility at the plant and very strong/offensive on one of the occasions.

4.0 PUBLIC ODOUR COMPLAINTS/OBSERVATIONS

The CVRD and North Cowichan have received odour complaints relating to Coast Environmental Ltd. operations since 2010. The majority of the complaints have been received via e-mail, containing various amounts of odour data. Therefore, and in preparation for this odour sampling survey, an online odour complaint form was developed to ensure that important odour data was included with each complaint (e.g., the time and location where the odour was noted). In addition, and on their own initiative, one business on Smiley Road maintained a calendar of perceived unpleasant odours for the month of June, 2014. This information has also been summarized and included in this report.

Between January and December 2013, there were a total of 78 odour complaints lodged against the Coast Environmental Ltd. facility by citizens employed or living in Chemainus. The 78 complaints were made by a total of 11 individuals, with one individual accounting for 40% of the complaints. The majority of these complaints came from citizens along Smiley Road across the Trans-Canada Highway from the Coast facility, and from Henry Road south of the Coast facility. One complaint was from a resident at Panorama Ridge, approximately 2 km NW of the Coast facility.

There were a total of 90 odour complaints registered in the first six months of 2014, more than the 78 complaints registered in all of 2013. If an odour incident is defined as one or more odour complaints in the same general location that are registered in the same one-hour period, then the 90 odour complaints registered between January and the end of June 2014 occurred during 69 discrete odour incidents. Up to four odour complaints in one day were registered on four dates:

February 28th
May 14th
June 5th
June 10th

A total of 14 individuals registered complaints in 2014, with five individuals accounting for 80% of the complaints in 2014. Seventy percent of the complaints were from locations in the business park along Smiley Road and 9% were from locations on Henry Road. Ten complaints came from locations in Chemainus village in close proximity to odour survey stations 2-5. Complainants' locations for the remainder of the complaints in 2014 could not be identified with certainty.

The total number of odour complaints registered by month in 2013 and the first six months of 2014 are listed in Table 4.1. Fifty-eight percent of the odour complaints in 2013 were registered

during the 3-month period of September-November 2013, while 51% of the complaints in 2014 were registered in May and June of 2014, which coincided with the odour survey period.

Table 4.1 Monthly Number of Odour Complaints in 2013-2014

Month	No. of Complaints	
	2013	2014
January	1	11
February	0	12
March	0	13
April	4	8
May	1	23
June	1	23
July	6	
August	6	
September	16	
October	13	
November	16	
December	7	
No date listed	7	

Table 4.2 lists the time of day when complainants indicated that odours were registered. The data indicate that 58% of the complaints reported in 2013 occurred between 10:00 am and 2:00 pm. In contrast, 30% of the odour complaints registered in 2014 occurred at either 9:00 am or 1:00 pm. Furthermore, odour complaints were registered earlier in the day (1:00 am and later in the day (after 10:00 pm) in 2014 than in 2013. The late evening (i.e., after 6:00 pm) and early morning (i.e., before 7:00 am) complaints were all registered from residential locations in Chemainus and appear to be unrelated to operations at Coast. As the complaints close to the Coast facility were registered by individuals working at the commercial/industrial properties in the area, the small number of early morning or late evening complaints in these locations is likely to be more indicative of the absence of people in the area to detect odours, than an indication of the presence or absence of odours.

Table 4.2 Time of Day for Odour Complaints

Time of Odour Complaint	No. of Complaints	
	2013	2014
1:00 am		2
2:00 am		0
3:00 am		0
4:00 am		1
5:00 am		0
6:00 am		0
7:00 am	0	5
8:00 am	2	3
9:00 am	5	15
10:00 am	10	8
11:00 am	16	4
12:00 am	10	6
1:00 pm	9	12
2:00 pm	6	7
3:00 pm	6	9
4:00 pm	3	7
5:00 pm	0	1
6:00 pm		0
7:00 pm		0
8:00 pm		1
9:00 pm		0
10:00 pm		1
No time specified	11	8

Although there were a few instances where specific events at the Coast facility were likely to have been the cause for off-site complaints such as a power failure in January 2013 which affected fans, a break in an exhaust hose while transferring a load to a tanker truck in June, offloading wastewater in October and a fire in the yard and garden waste material stored indoors which necessitated moving the material outdoors in November, the majority of odour complaints appear to be related to normal operations at the Coast facility. Most commonly in 2013, the activity noted on the Coast property at time of the odour complaint included, hauling, grinding or loading of yard and garden waste material. Attempts by Coast and CVRD staff to investigate on-site and off-site odours generally noted no odours present to confirm or validate the complaints.

In 2013, complainants described the odours in various ways, including:

Compost, septic compost, rotten compost
Garbage, hot garbage, garbage/pine, pine in hot garbage can
Fecal, dead things mixed with feces
Sickly sweet rotting fruit and dead animals

Some complainants also reported physical symptoms of headaches, nausea, and wanting to vomit, while one complainant mentioned that customers were unable to tolerate the odour and left the business establishment.

The vast majority of the odour complaints in 2014 related to the Coast facility occurred during normal facility operations and were not related to process upsets, with the exception of some problems with open or broken doors in January 2014 which could be classified as unrelated to normal operations. The odour complaints from residential areas in Chemainus village (near odour survey Stations 2-5) were all described as having a fecal, sewery or manure type odour, which suggests that these odours were related to manure from nearby farms, consistent with the odours observed during the odour survey late in the evening and early morning in May and June. The one complaint from a location west of the North Cowichan WWTP described the odours as similar to a burning tire, suggesting that open burning of material was cause of the odour rather than the municipal treatment plant.

During the January-April period in 2014, odours were described by complainants using phrases such as:

Garbage, dead fish, pine tree
Garbage, musty, piney, dead something
Human waste, dead animal & compost all rolled up into one
Pine, ammonia, human waste
Putrid, rancid stink
Sweet, fruity, sewery

Two complainants also referred to physical symptoms of “eye watering” and “burns back of throat”.

4.1 ODOUR COMPLAINT INFORMATION FOR MAY/JUNE 2014

Although the CVRD recoded odour descriptors prior to the odour sampling survey from complainants, and information on activity at the Coast facility which may have contributed to the odours, such information was often not provided or available. In conjunction with the odour

sampling survey, and as already mentioned, an online odour complaint form as well as an odour complaint response form were developed to ensure this information is available. Table 4.4 lists the information for some complaints in May and June 2014 to illustrate the type of information registered.

Table 4.3 Odour Complaint Descriptors and Coast Activities During Chemainus Odour Survey Period

Month	Time of Day	Odour Descriptor/ Effects of the Odour	Coast Activity
May 6th	10:00 am	Noticeable/unpleasant; fecal/sewery/manure	Screening compost, gravity feeding into septic transfer tank, fixing pump truck tanks, welding/fabrication
May 10th	9:00 to 10:00 am	Unbearable; rancid/putrid (yeast, sour milk/cheese, decay),sulfur/cabbage/garlic (rotten egg, skunk)	No activity at Coast
May 12th	1:00 pm	Noticeable/unpleasant;	Flipping Class A compost; blending soil amendment, pumping out septic transfer station, gravity feed into septic holding tank.
May 13th	8:00 am	Like an out-house	Odour reported in Chemainus village; unrelated to Coast
May 13th	9:30 am	Very unpleasant/offensive; fecal/sewery/manure	Flipping Class A compost, blending soil amendment, pumping out septic holding tank, gravity feed into septic holding tank.
May 14th	10:00 am, 10:45 am, 1:30 pm & 2:00 pm	Very unpleasant/offensive; pungent, disgusting; dead animal (putrid), fecal/ sewery/ manure, rancid/putrid (yeast, sour milk/cheese, decay), sulfur/cabbage/garlic (rotten egg, skunk)	Flipping, curing compost inside.
May 15th	12:00 pm	Very unpleasant/offensive; earthy, musty, moldy	Screening compost, loading yard & garden into composting building, gravity feed into septic holding tank.
May 15th	8:00 pm	Very offensive; smelled strongly like burning tires; had to close windows at night	Complainant close to North Cowichan WWTP, may also be related to open burning in area that could not be confirmed. Unrelated to Coast activity.
May 20th	3:00 pm	Noticeable/unpleasant; earthy, musty moldy	Screening compost, moving soil amendment out of storage building, pumping out septic transfer station
May 27th	7:45 am	Unbearable; absolutely disgusting; dead animal (putrid), fecal/sewery/manure, rancid/putrid (yeast, sour milk/cheese, decay)	Screening compost, pumping out septic holding tank.
May 27th	9:40 pm to 7:45 am following day	Very unpleasant/offensive; fecal/ sewery/ manure, rancid/putrid (yeast, sour milk/cheese, decay)	No information on Coast. Odour reported in Chemainus; unrelated to Coast.
May 29th	10:00 pm	Very unpleasant/offensive; fecal/ sewery/ manure	No information on Coast. Odour reported in Chemainus; unrelated to

Month	Time of Day	Odour Descriptor/ Effects of the Odour	Coast Activity
			Coast.
May 29th	1:30 pm	Very unpleasant/offensive; bakery (roasty, malty, buttery),earthy/musty/mouldy	Loading soil amendment into trucks, gravity feed into septic holding tank, screening compost.
May 30th	9:00 & 10:15 am	Very unpleasant/offensive; bakery (roasty, malty, buttery),earthy/musty/mouldy	Screening compost, moving soil amendment out of storage building, pumping out septic holding tank, grinding yard & garden waste.
May 30th	2:30 pm	Very unpleasant/offensive; rancid/putrid (yeast, sour milk/cheese, decay)	Mixing compost feedstocks, grinding yard & garden waste.
June 2nd	9:15 pm	Very unpleasant/offensive; fecal/sewery/manure, rancid/putrid (yeast, sour milk/cheese, decay)	No information on Coast. Odour reported in Chemainus village; unrelated to Coast
June 2nd	1:15 pm	Very unpleasant/offensive; earthy/ musty/moldy, rancid/putrid (yeast, sour milk/cheese, decay), sulfur/cabbage/garlic (rotten egg, skunk)	Screening compost, receiving compost feedstocks in composting building, moving soil amendment out of storage building, gravity feeding into septic holding tank, welding/fabrication.
June 4th	9:45 pm	Noticeable/unpleasant; nitrogen/ammonia (fishy, urine)	Odour reported in Chemainus village; unrelated to Coast.
June 5th	10:45 am to 3:00 pm	Very unpleasant/offensive to unbearable; vile, disgusting	Mixing composting feedstocks, receiving feedstocks in composting building, blending soil amendment, loading soil amendment into trucks, pumping out compost leachate tanks, gravity feeding into septic holding tank, welding/fabrication.
June 5th	9:30 pm	Very unpleasant/offensive; fecal/sewery/manure, nitrogen/ammonia (fishy, urine)	No information on Coast. Odour reported in Chemainus village; unrelated to Coast.
June 9th	No time listed	"Stink level 7 out of 10"; "Musty, sour garbage , pretty much smells like if you left your black garbage can out in the sun all day and opened the lid when you get home from work."	No information on Coast. (Complaint not submitted via complaint form).
June 10th	7:15 am to 5:30 pm	Unbearable; very unpleasant/offensive; earthy/musty/moldy, fecal/ sewery/ manure; rancid/putrid (yeast, sour milk/cheese, decay); "At least an 8 out of 10 according to staff"	No information on Coast (Complaint not submitted via complaint form).
June 12th	4:00 pm	Noticeable/unpleasant; bakery (roasty, malty, buttery),earthy/musty/moldy, fecal/sewery/manure	Mixing compost feedstocks, grinding yard & garden waste.
June 17th	9:45 am & 10:30 am	Unbearable; bakery (roasty, malty, buttery), earthy/musty/moldy, fecal/sewery/manure Noticeable/unpleasant; earthy/ musty/moldy, fecal/sewery/manure	Screening compost, loading yard & garden waste into composting building, loading soil amendment into trucks, grinding wood waste.
June 20th	1:00 pm & 4:00 pm	Unbearable; fecal/sewery/manure	Grinding yard & garden waste, fixing pump truck tanks.
June 23rd	2:30 pm & 2:45 pm	Unbearable; dead animal (putrid), fecal/sewery/manure, rancid/putrid	Screening compost, gravity feeding into septic transfer tank, grinding yard &

Month	Time of Day	Odour Descriptor/ Effects of the Odour	Coast Activity
		(yeast, sour milk/cheese, decay); dead things rolled in feces	garden waste

4.2 ODOUR OBSERVATIONS DIARY - JUNE 2014

One business located near the intersection of the Trans-Canada Highway and Henry Road maintained an odour diary for the month of June of the times and dates on which they experienced unpleasant odours. Their observations are presented in Appendix B.

The diary indicates that unpleasant odours were recorded on 17 of the 21 working days in June. All except one day had more than one individual who noted an unpleasant odour, with up to eight individuals noting such odours on June 9th, a day when there were odour complaints from two other businesses located along Smiley Road. Odour complaints from other businesses located in the area were received on 10 of the 17 days on which unpleasant odours were recorded in the diary.

4.3 CVRD ODOUR COMPLAINT FOLLOW-UP - MAY/JUNE 2014

During the odour survey conducted in May and June 2014, the surveyors attempted to respond to any odour complaints received by the CVRD as they were conducting the survey. The surveyors went to the complainant's location or the corresponding odour sampling station for the survey and noted any odours present using the methodology defined for the odour survey. The observations made on these occasions are listed in Table 4.4.

The odour surveyors responded to odour complaints or were at their odour sampling stations in the vicinity where odour complaints were made on 14 days during the 2-month odour sampling survey. The surveyors spent up to 20 minutes evaluating odours on each occasion, and over an hour on some occasions when both surveyors were present in the general area where a complaint was made.

Table 4.4 Odour Complaint Follow-up - May/June 2014

Date	Time of Odour Incident / Arrival Time	Time of Complaint / Duration @ Station	Intensity Level	Odour Descriptor Categories	Complainant Description / Source	Odour Persistence / Surveyor Notes	Coast Response Activity
5/12/14	*13:00*	*14:10*	*2*	*1*		*Persistent*	Flipping Class A compost, blending soil amendment, pumping out septic transfer station, gravity feeding into septic transfer tank
	14:25	15:00	Y-2	2,3	Coast - yard & garden pile	Intermittent	
	14:30	10:00	Y-2	2,4		Intermittent	
5/13/14	*9:30*	*9:49*	*3*	*1*		*Persistent*	Screening compost, grinding wood waste
	10:17	5:00	Y-2	2,3,4,8		Category 1 /../ too faint to be confirmed	
5/14/14	*10:00*	*10:05*	*3*	*7,10,rancid/ putrid*	*PUNGENT*	*Persistent*	Flipping curing compost
	10:35	12:00	N-1	N/A			
	10:38	7:00	N-1	N/A			
5/14/14	*10:45*	*10:54*	*3*	*7,2,1*		*On and off*	Flipping curing compost
	10:49	15	Y-2	3,4,8	Coast - yard & garden, and biofilter		
	10:51	4:00	Y-2	1,2,3,4,8		Intermittent, categories 2,4 strongest	
5/14/14	*11:50*	*Verbal*		*1*	*"It smells like poo!"*		No response (verbal complaint)
	11:50	4:00	Y-2	1,2,3,4,8		Intermittent; category 1 very faint	
	11:26	3:00	N-1	N/A		During survey time (complainent: odour arrived as soon as surveyor left).	

Complaint

Survey team followup

Y odour present (numbers equal odour intensity)

N no odour present (number equal odour intensity)

Date	Time of Odour Incident / Arrival Time	Time of Complaint / Duration @ Station	Intensity Level	Odour Descriptor Categories	Complainant Description / Source	Odour Persistence / Surveyor Notes	Coast Response Activity
5/15/14	*12:00*	*12:00*	*3*	*2*		*Persistent*	Screening compost, loading yard & garden into composting building, gravity feeding into septic transfer tank
	11:41	5:00	Y-2	1,2,4		Odour more intense close to HWY; corresponding survey time	
5/27/14	*7:45*	*10:37*	*4*	*7,1, rancid/ putrid (yeast, sour milk/ cheese, decay)*	*ABSOLUTELY DISGUSTING!!!!*	*On and off*	Screening compost, pumping out septic transfer station/ screening all day. Delivering soil loads throughout day as needed
	9:04	8:00	Y-2	2,3,4,6,8		1 waft burning plastic; category 2,4 intermittent; category 3,8 intermittent; corresponding survey time	
	11:55	15:00	Y-1	2,4,1		Odour w/ WNW wind, intermittent, wind mostly from E, tone 1 very faint, categories 2,4 dominant at intensity of 2	
	11:00	10:00	Y-1	2,3,4,8		Extremely inconsistent tone and intensity (Comes with NW wind). Started to rain and odour disappeared	
5/29/14	*13:30*	*13:34*	*3*	*2,bakery*		*Persistent*	Screening compost, loading soil amendment into trucks, gravity feeding into septic transfer tank
	13:47	10:00	Y-2	2,3,4,5,8	Broom, lumber	Max. intensity of 3, intermittent wind direction and speed	

Date	Time of Odour Incident / Arrival Time	Time of Complaint / Duration @ Station	Intensity Level	Odour Descriptor Categories	Complainant Description / Source	Odour Persistence / Surveyor Notes	Coast Response Activity
5/30/14	*10:15*	*10:13*	*4*	*2,bakery,rancid/putrid*		*Persistent*	Screening compost, moving soil amendment out of storage building, gravity feeding into septic transfer tank, grinding yard & garden
	10:28	15:00	Y-2	3,4		Caught slight waft of raw sewage for 3-4 seconds at 2 intensity.	
6/05/14	*10:45*	*10:42*	*3*	*2,1,rancid/putrid*		*Persistent*	Mixing feedstocks, dumping feedstocks into composting building, blending soil amendment, loading soil amendment into trucks, gravity feeding into septic transfer tank, welding/fabrication
	10:48	20:00	Y-1	3	Coast - yard & garden pile	Slight, hardly noticeable most of the time, w. some more noticeable wafts of musty, minty tones	
6/09/14	*9:40*	*Email*	*"7/10"*	*2,4,"sour"*	*"smells like if you left your garbage can out in the sun all day and opened the lid..."*		No response (email complaint)
	11:04	15:00	Y-2	2,3,4,8		Odour w/ NW wind, max. intensity of three, intermittent, wind mostly from E	
6/10/14	*7:15*	*8:46*	*4*	*2,1*		*Persistent*	No onsite activities
	9:00	11:00	Y-1	3,8,10		Faint waft of tones 3,8; two wafts of faint category 10 (marijuana)	
	9:09	10	Y-1	N/A		Pleasant smell from the rain	

Date	Time of Odour Incident / Arrival Time	Time of Complaint / Duration @ Station	Intensity Level	Odour Descriptor Categories	Complainant Description / Source	Odour Persistence / Surveyor Notes	Coast Response Activity
6/17/14	*9:45*	*9:53*	*4*	*2,1*		*Persistent*	Screening compost, loading yard & garden into composting building, loading soil amendment into trucks, grinding wood waste, moving soil amendment into remediation building
	9:41	8:00	Y-1	2,3,4,8		Faint wafts, max. intensity of two, mainly neutral	
6/20/14	*13:00*	*13:10*	*4*	*1*			Pumping out leachate tanks, gravity feeding into septic transfer tank, cleaning out pump truck tank, grinding yard & garden, fixing pump truck tanks
	13:45	10:00	Y-1	n/a			
6/23/14	*14:30*	*14:40*			*No odour tone intensity provided. Odour reported as worse 10 min prior to the surveyors arrival.*		No response (verbal complaint)
	14:42	10:00	Y-2	2,3,4		Strong waft marijuana odour (tone 10); categories 2,3,4 with NW wind, max. intensity of 3	
6/23/14	*14:45*	*15:02*	*4*	*7,1, rancid/ putrid*	*DEAD THINGS ROLLED IN FECES*	*Persistent*	Screening compost, Gravity feeding into septic transfer tank, grinding yard & garden
	15:09	10:00	Y-2	1,2,3,4		Intermittent; max. intensity of 3, stronger on E side of building	

In general, the surveyors noted that predominant odours were either barely noticeable or noticeable, but not offensive or strong, although the odour intensity was rarely constant such that brief periods of higher intensity were sometimes noted. The odours were judged to be intermittent rather than being present all the time. This would be expected at the low wind speeds reported during the observations because low wind speeds result in meandering winds with weak directional consistency. Offensive odours (i.e., intensity 3) were only observed on 4 occasions, but only for short periods of time during the observations. Therefore, the perception of the odours by surveyors was that the odours were less intense, offensive and persistent than is suggested by complainants' perceptions as reported in odour complaints listed in Table 4.4.

Consistent with the odour survey study findings of offensive odours at Coast's property boundary, it should also be noted that an observation by CVRD staff at 9:30 am on July 11th (unrelated to the odour survey) noted that a very offensive odour was present at the Coast property line near the Trans-Canada Highway. The wind at the time of the odour observations was <1.0 m/s blowing from the Coast facility towards Smiley Road. The odour was described as having a predominantly fecal/ sewage/ manure odour, with undertones of pine/ mint/ lemon/ eucalyptus odour which the CVRD staff associated with yard and garden waste. After discussing the matter with Coast staff and an inspection of the operations on Coast's property, the potential source(s) of the odour was suggested as being:

- delivery of composting feedstock (feedstock received in composting building);
- both man-door and truck doors open; and/or
- turning of indoor composting.

The same CVRD staff also noted that there was a strong on-site odour from the workshop and one of the biofilters. At 10:00 am, following the inspection of the operations, staff went back to the property boundary and noted that there were no longer any offensive on-site odours, only noticeable and intermittent odours of yard and garden waste as this material was being loaded into the composting building. As the odours were short lived, this odour incident may have been a result of turning of compost or compost feedstock delivery in combination with facility doors being open.

4.4 PULP MILL ODOURS

At the suggestion of the Ministry of Environment, Total Reduced Sulphur (TRS) concentrations greater than 5 ppb measured at the Crofton Substation were used as a potential indicator of offensive odours in the region during the time of the odour survey in May/June 2014. The pulp and paper mill operated by Catalyst Paper in Crofton is located approximately 7 km SE of the

Coast facility. There were a total of six incidents when the 5 ppb level was exceeded during this period, as listed in Table 4.5.

Table 4.5 TRS Levels at Crofton Substation - May/June 2014

Period Beginning		Period Ending		Maximum Concentration	
Date	**Time**	**Date**	**Time**	**ppb**	**Odour Complaints in Chemainus**
May 5th	1:00 am	unknown	unknown	5.5	none
May 11th	7:00 pm	May 12th	12:00 pm	5.9	none
May 30th	6:00 pm	May 31st	6:00 pm	7	Complaints prior to 6:00 pm on May 30th but not during period of elevated TRS levels
June 1st	1:00 am	June 1st	6:00 am	5.3	none
June 7th	12:00 pm	June 8th	12:00 pm	7.7	None
June 12th	3:00 pm	June 13th	7:00 am	5.2	One complaint on Smiley Road attributed to Coast operations

Only one odour complaint was received in Chemainus during the six periods of elevated TRS levels in Crofton. Because the complaint during a time when the surveys were not in the Chemainus, there was no possibility of follow-up of the complaint by surveyors. However, there were no other odour complaints in the Chemainus community that would indicate widespread offensive TRS odours in the community, and the location of the complainant close to the Coast facility would suggest that the odour complaint was related to that facility rather than to the Crofton pulp mill. Therefore, the TRS emissions from the Crofton pulp and paper mill were not contributors to any of the odours identified during the odour survey.

5.0 SUMMARY AND CONCLUSIONS

An odour monitoring survey was initiated by the Municipality of North Cowichan and the CVRD and was completed by the surveyors retained by the CVRD in Chemainus during May and June 2014. Odours were detected during the majority of sampling observations during the survey period, and at most of the sampling stations, regardless of whether the odours were pleasant or unpleasant. The survey results identified a number of odour issues in the community related to several sources of offensive odours, namely:

1. on River Road near the Plester farm;
2. on MacMillan Bloedel Fs Road between the Coast Environmental Ltd. facility and the Western Forest Products sawmill;
3. in the Chemainus industrial park along Smiley Road between MacMillan Bloedel Fs Road and Henry Road;
4. in Chemainus between the ferry terminal and Old Victoria Road; and
5. in the vicinity of the North Cowichan WWTP on Bare Point Road near the intersection Chemainus Road.

River Road near the Plester Farm

The highest frequency of predominantly offensive odours was observed on River Road in the vicinity of the Plester farm. The offensive odours at this location were primarily manure-type odours and were noted on 46% of the odour observations, and 2.6% of all observations during the survey. These farm odours are likely contributing to some of the odour complaints received from locations within Chemainus village during the first six months of 2014.

MacMillan Bloedel Fs Road

The location with the second highest frequency of offensive odours observed during the odour survey was on MacMillan Bloedel Fs Road between the Coast Environmental Ltd. facility and the Western Forest Products sawmill. Most of the odours observed at this location were woody odours from the sawmill. However, predominantly offensive odours were observed 6.7% of the time during the odour survey and all but two observations when the smell of lumber was considered to be strong enough to be considered offensive. The remaining offensive odours were attributed to the Coast facility and were described by the surveyors as possibly being associated with the Coast soil treatment, biofilters, sewage or yard and garden material odours, based on similar odours identified during the survey on-site at the Coast operations.

Chemainus Industrial Park – Smiley Road

Predominantly offensive odours were observed in the industrial park along Smiley Road with a frequency ranging from 1.2% to 4.9% of the time during the odour survey. The difference in the frequency of these offensive odours over short distances suggests that the source of the odours is

in close proximity to the odour observing stations and is subject to the fluctuation of wind direction. Offensive odours in this area were described as a mixture of earthy/musty odours, mixed with terpene-type odours which are suspected to be associated with Coast yard and garden waste processing operations. Other offensive odours that may also be associated with the Coast operation were those which were described as garbage odours, rancid or manure-type odours which may have been related to soil treatment, biofilters, sewage or compost odours, based on similar odours identified during the survey on-site at the Coast operations.

Chemainus – Ferry Terminal to Old Victoria Road

Although there were many pleasant odours observed within Chemainus village during the survey, occasionally faint to strong manure-type odours were also observed and the odour survey determined that predominantly offensive odours were present on up to 3.7% of the observations in this area (i.e., at Station 3). These locations in Chemainus village also correspond to the locations of 10 odour complaints received by the CVRD in 2014. Although these odours are most likely to have originated from the nearby farm, there should be follow up investigations to ensure that the odours do not emanate from the sewer grates or other potential sources in this location, specifically Askew Creek.

North Cowichan WWTP

Although the North Cowichan WWTP was identified as having offensive odours 2.4% of the time at the front of the plant, no odour complaint was received by the CVRD from the residential areas in the general vicinity of the plant. Nevertheless, some of the strongest and most offensive odours were recorded near the treatment plant during the odour survey and warrant further consideration.

5.1 DEFINING NUISANCE

In the absence of a definition of what constitutes a nuisance odour within the context of the CVRD or North Cowichan's bylaws, or in the Province of British Columbia as a whole, it is necessary to consider how nuisance is defined in other jurisdictions. As one alternative, nuisance odour can be based on the WHO definition of a nuisance threshold as being that concentration at which less than 5% of the population experiences annoyance more than 2% of the time. The difficulty in applying this definition to the odours from the Coast facility is that the population in Chemainus is widely dispersed, and the population most affected by emissions from the Coast facility is composed of people who work in the industrial park and are only present at that location for only part of the day. For this reason, the WHO definition has been interpreted to mean 5% of the population of workers in the industrial park being affected for more than 2% of the time that they are likely to be present at those businesses in the industrial park. In that context, the odour survey was conducted during those hours of the day when the workers in the

industrial park can be exposed to the odour and the frequency of offensive odours during the survey is representative of those work hours.

If the results of the Chemainus odour survey are considered within this definition of a nuisance odour impact, then four of the five areas of Chemainus listed above would be considered to be experiencing nuisance odour impacts. The exception would be the location on River Road because farm odours are protected in British Columbia under the Farm Practices Protection (Right to Farm) Act under the Ministry of Agriculture, Food and Fisheries (MAFF). The provisions of the Right to Farm Act may also apply to odours experienced in Chemainus village if these odours are the result of normal farming practices. Even if the odours at this location from the activities on the Plester farm are the source of the odours within Chemainus's residential areas (e.g., the Chemainus village), the odours could only be considered as a nuisance impact if the operational activities at the Plester farm do not follow 'normal farm practices'. The definition of what constitutes 'normal farm practice' is not explicitly defined in the Right to Farm legislation and is determined by comparison with what practices are used at other, similar farms.

The odour surveyors also noted the intermittent nature of most of the odour observations. The high frequency of odours classified as predominantly having 'barely noticeable' and 'noticeable' odour intensities were frequently accompanied by short-term wafts of higher intensity odours in the 'offensive/strong' and 'very strong/offensive' categories. The frequency of the predominant offensive odours exceeds the WHO threshold for nuisance impacts. However, the experience of individuals in the community who are exposed to the shorter duration peak offensive odour concentrations may not be reflected in the frequency of predominant 'offensive odours' determined during the odour survey. As discussed in Appendix A (Section A.2) of this report, the short-term peak odour levels may be more closely related to community annoyance as expressed in terms of the number of odour complaints registered by the public than the frequency of average strong and offensive odours as determined in the Chemainus odour survey suggests. The predominant or average odour levels that were defined as offensive during the survey exceeds the 2% frequency level defined as the nuisance threshold by the WHO, but the odour complaint information indicates that members of the community experience offensive odours far more frequently because they are reacting to the short-term peak odours rather than the average or 'predominant' odour levels.

This may explain the differences between the results of the odour survey in determining the magnitude of the odour issue related to Coast facility operations and the odour complaint record in 2013 and 2014. There were a total of 78 odour complaint received in 2013 and 90 odour complaints during 69 discrete odour incidents in 2014. Half of all complaints registered in 2014 were received in May and June during the period of the odour survey. The locations of 11

complainants in 2014 suggested that they were unrelated to the Coast operations, meaning that 88% of the complaints lodged were attributed to the Coast facility.

5.2 ODOUR COMPLAINTS COMPARED TO OPERATIONAL ACTIVITIES AT COAST

The analysis of the odour complaint data related to Coast indicates that there were relatively few occasions when odour complaints were registered in relation to known process upsets or process maintenance issues. Most odour complaints appeared to be related to normal process operations at Coast such as:

- mixing compost feedstock;
- receiving feedstock into composting building;
- loading yard and garden into composting building;
- blending, turning or loading soil amendment into trucks;
- pumping out compost leachate tanks;
- gravity feeding from truck into septic holding tank or pumping out septic holding tank; and
- grinding yard and garden waste outside.

With respect to the odour issues experienced in the vicinity of the Coast Environmental Ltd. facility in Chemainus, a large proportion of the odour complaints appear to be related to the processing of yard and garden waste material. A study by Hottenstein and Stevenson (2008) measured odour emissions from primary green waste composting in New Zealand and determined that emissions from such operations were considered annoying at concentrations of 6-10 OU/m^3 for 50% of an odour panel (composed of 12-14 individuals who had been tested to ensure that their sense of smell was in the range of the general population) exposed on a short-term basis (a sniff test). Odours from this type of operation were rated to be very annoying at concentrations at 12-21 OU/m^3 and unbearable at concentrations greater than 25 OU/m^3. If future odour investigations of the Coast operation are based on numerical odour assessment methods, the study by Hottenstein and Stevenson may provide useful indicators of what level of odour concentration can be considered to be unacceptable for neighbouring property owners.

Overall, the frequency of predominant offensive odours during the odour survey was up to 4.9% of the time west of the Coast facility in the industrial park, all of which were attributed by the surveyors to the Coast facility. In addition, the frequency of predominant offensive odours during the odour survey was up to 6.7% of the time immediately north of the facility along MacMillan Bloedel Fs Road, of which 4.0% was attributed to the Coast facility and 2.7% was attributed to the Western Forest Products sawmill. Further, it was observed that more intense, short-term offensive odours in the industrial park and along MacMillan Bloedel Fs Road which

were noted to occur during the survey also appeared to be related to the Coast operations. It can therefore be concluded that the normal operations at the Coast facility do pose a nuisance odour impact to the surrounding properties. However, the odour survey did not identify odours in Chemainus village that could have originated from the Coast facility. Instead, odour complaints from the village appeared to be related to nearby farm sources than to the Coast operations.

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APPENDIX A: GENERAL APPROACHES TO THE REGULATION OF ODOURS

The approaches used to address odours vary widely from jurisdiction to jurisdiction. In many cases, persistent community odour issues have lead to the development of regulations or "odour laws", which typically specify different "compliance determining criteria" depending on the overall approach.

In some jurisdictions the detection of odour in the ambient air is sufficient for an offence to have occurred, whereas in others it is necessary to demonstrate that there is an adverse effect from the odour for an offence to have occurred. The type of law based on the "nuisance" or "quality of life" grounds is the most common and oldest way to manage odour. In some jurisdictions there are complaint criteria for launching an investigation about odours and their nuisance (Bokowa 2010).

Many jurisdictions have quantitative ambient concentration criteria for individual contaminants that are odorous. For example, in Canada several provinces have standards for H_2S, ammonia and other compounds.

The general approaches used to manage odours are as follows (McGinley et al., 2000):

1. Annoyance criteria (subjective categories);
2. Complaint criteria (number of complaints);
3. Ambient odour detection threshold criteria;
4. Ambient odour intensity criteria;
5. Ambient odorant criteria (mass concentration);
6. Episode-duration-frequency criteria (odour hours);
7. Source emission criteria (threshold or mass concentration);
8. Best available control technology criteria.

The various approaches are not mutually exclusive and are sometimes combined. The following sections provide a discussion of these odour management methods.

A.1 ANNOYANCE AND COMPLAINT CRITERIA

Information derived from public complaints about odours can provide some information about the frequency, timing and total number of odour complaints in relation to the operations of a particular facility or operation which may indicate to a regulatory agency that there exists a potential community nuisance odour issue (Gibson and Collings 2009). Records about the time

of day when complaints occur can help to identify specific causes of the alleged nuisance. In addition, records of complaints can be used to provide evidence of an offensive odour or nuisance in subsequent legal proceedings in the event that a plant operator appeals a regulatory action taken against a facility, or a regulatory agency is required to defend itself for taking such actions.

The use of public annoyance and/or complaint criteria are generally based on the number of complaints that are made when odour episodes occur, and subjective descriptions by the complainants on the nature of the odour to establish a nuisance. However, experience has shown that the public tends not to register odour complaints until the odours reach a certain level in terms of strength and frequency of occurrence.

Annoyance criteria in regulations typically contain statements that define the conditions that constitute a nuisance. For example, Ontario uses the concept of adverse effect to define a nuisance.

An "adverse effect" is defined in the Ontario Environmental Protection Act (EPA), subsection 1(1) to mean any one or more of the following:

- Impairment of the quality of the natural environment for any use that can be made of it;
- Injury or damage to property or to plant or animal life;
- Harm or material discomfort to any person;
- An adverse effect on the health of any person;
- Impairment of the safety of any person;
- Rendering any property or plant or animal life unfit for human use;
- Loss of enjoyment of normal use of property;
- Interference with the normal conduct of business.

However, the experience in Ontario has been that it is often challenging to prove that any of the above conditions have occurred as a result of odorous emissions from a facility. This often leads to delayed enforcement actions, a lack of abatement actions and prolonged odour issues with surrounding communities.

Complaint criteria are typically based on a threshold of a minimum number of community complaints. In order to determine that a community annoyance or nuisance exists, the regulation or odour guideline generally contains specific criteria for complaints. In addition to the number of complaints, criteria for determining nuisance can be expressed in terms of the number of different households from which the complaints originate, and a timeframe within which the complaints must be received. Also, a minimum number of complaints may have to be verified

by the Regulatory Authority to be considered valid (McGinley et al. 2000). For example, the City of Des Moines, Iowa issues an 'odour alert' for an identified source or sources of odour if it receives (McGinley 2009):

- 10 independent odour complaints in a single 24-hour period;
- 5 odour complaints from independent 'households';
- 5 'verified' complaints against an identified source.

Such provisions are considered necessary because studies of community odour problems have revealed that complaints do not always correlate with odour intensities, and other factors such as the socio-economic status of a neighbourhood, the presence or absence of an active civic association, the degree of news media attention being given to the problem, and a sense of futility on the part of citizens (i.e., they give up and quit complaining) all contribute to the frequency of complaints. In a sensitized community where citizens have been exposed to an offensive odorant over a long period of time, a considerable emotional burden may contribute to the frequency of complaints from specific individuals such that a small number of complainants may account for a large proportion of the total number of complaints registered.

Hedonic tone is a description of the pleasantness or unpleasantness of an odour, and is sometimes used to determine or demonstrate that an odour is objectionable, and thus is perceived as a "nuisance". Table 2.1 list the types of odour emission sources based on odour tone as defined by the Texas Commission of Environmental Quality (TCEQ 2007).

Table A.1 Examples of Odour Source Characterization Guidance

(Source: TCEQ 2007)

Odour Source Characteristics			
Highly Offensive	**Offensive**	**Unpleasant**	**Not Unpleasant**
Blood drying operations	Landfill garbage/waste	Well-digested or chemically-treated sludge	Ketones, esters, alcohols
Sewage treatment primary sludge	Cattle lagoon cleanout	Cattle operation under best management practices	Fresh-cut grass or hay
Putrefying animals/fish	Confined hog/poultry operations under best management practices	Waste-activated sludge processes	Normal coffee roasting
Hide processing	Decaying silage/composting	Water-based painting	Normal food preparation
Rancid grease	Unprocessed rendering plant material and wastewater	Gasoline, diesel fuel	Bakery
Hydrogen sulphide (H2S) gas from landfills, sewers, leachate, pulp and paper mills, etc.	Typical grease trap odour	Diesel exhaust	Perfume
Mercaptans (e.g., natural gas additive odorant)	Waste burning (rubber, plastic, tires, other wood materials)	Asphalt odours	Spice packaging
	Failing or improperly operated septic systems	Burned coffee/food	Winery
	Organic products such as auto body paint[1] and styrene (fibreglass, cultured marble manufacturing)	Brush/wood burning	
		Ammonia	
		Chlorine	

Note:

[1]At low concentrations, organic products such as auto body paint and styrene used in fibreglass and cultured marble operations would not normally be considered to have offensive odors. However, because of a person's potential physical response to these products at higher concentrations (where most complaints concerning these products occur), TCEQ generally consider them to have offensive characteristics.

The TCEQ also uses a series of charts to define the frequency, intensity, duration and offensiveness (referred to as the FIDO system) of ambient odours tied to the offensiveness rankings to determine whether or not a nuisance odour violation has occurred.

However, assigning a Hedonic Tone to a perceived odour by an observer is subjective, as it relies on the personal feelings and perceptions of the observer. Other jurisdictions use a standard categorical scale of odour descriptions (called an Odour Character) to describe the nature of an odour, which can be used to more definitively determine the "objectionableness" of the odour. This is a more objective approach since it relies on a standard set of descriptors that is applied by the observer (McGinley et al. 2000). It is however, still based on the demonstration of a nuisance.

One such example is the recently defined Odor Complaint and Response Enforcement Process adopted by the Puget Sound Clean Air Agency (PSCAA 2010) in Washington State. According to the PSCAA, it is *"unlawful for any person to cause or allow the emission of any air contaminant in sufficient quantities and of such characteristics and duration as is, or is likely to be, injurious to human health, plant or animal life, or property, or which unreasonably interferes with enjoyment of life and property."* If a Control Officer or duly authorized representative of the PSCAA is required to assess an odour from any facility, the assessment is based on an evaluation using a five-point scale, namely:

Level 0 - no odour detected;
Level 1 - odour barely detected;
Level 2 - odour is distinct and definite, and any unpleasant characteristics recognizable;
Level 3 - odour is objectionable enough or strong enough to cause attempts to avoid it;
Level 4 - odour is so strong that a person does not want to remain present.

The PSCAA may take enforcement action if:

- a Control Officer or duly authorized representative of the PSCAA determines that an odour is at or exceeds Level 2 on this scale;
- the PSCAA receives an affidavit from a person making a complaint that demonstrates that they have experienced air contaminant emissions in sufficient quantities and of such characteristics and duration so as to unreasonably interfere with their enjoyment of life and property; and
- the source of the odour has been identified and documented.

Many jurisdictions use such nuisance-based approaches rather than concentration-based limits to regulate/control/abate odours. However, the explicit conditions that establish whether or not a nuisance exists are not easily defined. Many of the terms used to define a nuisance are subjective and open to interpretation. Also, because of the transient nature of odours, it is often difficult for Regulatory Authorities to verify or validate them. This can result in problems for both members of the public and/or owners and operators of facilities.

Since this approach is typically applied after objectionable odours occur, rather than as a preventative measure, nuisance approaches generally only provide a last resort for impacted individuals or communities to restore enjoyment of their property. Target limits (as offered by the other approaches) provide industries with a basis to design facilities with the aim to minimize impact. This also shifts part of the focus from odour abatement to odour prevention.

A.2 AMBIENT ODOUR DETECTION, INTENSITY AND ODORANT CRITERIA

Quantitative odour impact criteria are not ambient air quality standards. Instead, such criteria provide a scientifically-derived benchmark for making informed decisions in the planning, design, environmental management and regulation of sources of odour emission. These criteria are generally based on measurements or samples collected in the field or at the source (for subsequent use in dispersion modelling) to provide a direct indication of ambient odour levels at specific locations, or ambient concentrations predicted using source emission information and air dispersion models.

Ambient odour detection criteria are based on dynamic dilution olfactometry (DDO), which uses the human nose as a sensor by comparing an odour sample at various levels of dilution with odour free air. The diluted sample is presented to a panel of assessors (called an odour panel) using an olfactometer in an odour-free room or laboratory, through ports from which the assessors must sniff. The dilution level at which 50% of the odour assessors can just detect the odour is set as the odour detection threshold for the sample. The number of dilutions required to reach this level determines the odour concentration (in OU or OU/m^3) in the original sample. For example, if nine volumes of odour free air are added to one volume of sample, the odour concentration in the sample is 10 OU.

A study conducted for the California Air Resources Board concluded that for unpleasant odours the threshold of annoyance is at approximately 5 times the threshold of detection (D/T), which would be interpreted as 5 odour units (OU). California's South Coast Air Quality Management District states that at 5 D/T people become consciously aware of the presence of an odour, and that at 5-to-10 D/T odours are strong enough to evoke registered complaints (Mahin 2003). Therefore, 5 OU is generally referred to as the complaint threshold (numerically equivalent to 5 OU/m^3).

Use of this type of approach means that the detection threshold of 1 OU/m^3 can only be perceived in an odour-free environment, such as in a laboratory. Therefore, a perceived odour concentration in the field must be higher than 1 OU/m^3 to be distinguished against the background concentration. This must be considered when collecting field measurements because background ambient air is not odour free. Nicell (1994) assumes an odour concentration of

3 OU/m^3 to allow for discrimination, and one of 5 OU/m^3 for unmistakable perception (Schauberger et al. 2006).

Direct odour measurements can also be collected in the field using scentometers, or field olfactometers such as a Nasal Ranger®. However, any odour law that specifies an ambient odour threshold (D/T, Z, DT, RT, odour units, etc.) must also specify acceptable measurement methods that can be used to demonstrate compliance (i.e., field olfactometer, scentometer, or laboratory olfactometer) (McGinley et al. 2000). However, all of these methods ultimately rely on subjective human sensory assessment (i.e., the human nose). In the United States, some state regulatory agencies allow use of such measurement methods while others prohibit their use for enforcement purposes.

Some jurisdictions use odour intensity criteria instead of ambient odour concentrations to assess odour impacts. Odour intensity can be measured objectively using an Odour Intensity Referencing Scale (OIRS), which compares the intensity of the odour in the ambient air to the odour intensity in a series of concentrations of a reference odorant (McGinley et al. 2000). N-butanol is commonly used as a reference odorant. A series of a number of descending liquid reference standards of n-butanol are prepared using the serial dilution technique, and are numbered from in increasing concentration. The number of different concentrations in the reference scale ranges from 5 to 12, depending on the type of scale used. The liquid concentration in each sample can be related to the air or odour concentration by a power law relationship (Steven's Law). Hedonic tone is also sometimes used in conjunction with odour intensity measurements to determine whether a potential odour impact has occurred.

Standard methods for performing odour intensity testing are outlined in ASTM E544 "Standard Practice for Referencing Suprathreshold Odour Intensity". A number of different scales can be used, each having a different number of points, and a different progression of odour concentration. As a result, it is extremely important for odour intensity-based standards and guidelines to reference either the equivalent n-butanol concentration or report the acceptable OIRS number along with the scale range and starting point (McGinley et al. 2000).

Many jurisdictions also set ambient threshold levels of individual odorants or odorous compounds such as H_2S, ammonia, and many others, to prevent odour issues from occurring. However, this approach is only generally successful where the odorous emissions are largely the result of the single compound in question. In most cases, odours are commonly the result of a release of several odorous compounds in combination. Use of a single indicator compound in odour assessments can result in a significant underestimation of the total odour concentration, resulting in annoyance and complaints (Drew et al. 2007).

There is evidence in the published scientific literature of the additivity of odours, especially at low odour concentrations. A recent study on this subject by Kim and Park (2008) shows that the best correlations between quantitative measurements of odorant concentrations and direct odour measurement through olfactometry are for the sum of the odour quotients (i.e., summing the ratios of odorant concentration to threshold for each compound in the mixture) and the sum of the odour intensities based on suprathreshold olfactometry. Therefore, it should be possible to estimate the odour concentration for a mixture of odorous compounds by sampling the concentration of individual compounds using a gas chromatograph. However, some odorous compounds such as mercaptans, dimethyl sulphide, and dimethyl disulphide are more difficult to quantify, making it problematic to apply this methodology in practice.

Selection of the ambient odour concentration, intensity or odorant criteria to apply is typically a balance between reducing annoyance due to odours to an acceptable level at an acceptable cost. Odour emissions are typically episodic in nature, and are characterized by periods of high emission rates interspersed with periods of low emissions. It has frequently been noted that it is the short-term high concentration peaks that result in annoyance in the surrounding population. Therefore, selection of an appropriate averaging time upon which to apply ambient criteria is extremely important. Experience indicates that modelling emissions over shorter averaging periods (i.e., less than 1 hour) better matches the pattern of observed odour incidents, likely as a result of capturing peak concentrations (Drew et al. 2007). Experience has also shown that it is frequently the fluctuations from the mean concentration and not the actual mean itself that determine how odour is perceived (Best et al. 2001). While a single peak may not result in annoyance, repeated high peaks at times of high exposure could be missed by using longer term (i.e., 1 hour) averages. Also, it is unlikely that an odour will be a nuisance until it is detectable for certain periods of time, typically longer than three minutes (Simms et al. 1999). The use of short term averaging times is therefore of greater value in predicting the likely nuisance impact of an odour source and in framing appropriate regulatory controls.

A.3 EPISODE-DURATION-FREQUENCY CRITERIA

A limited number of jurisdictions use this approach to manage odours. Germany, in particular has a well-developed system that uses this approach and is purported to be successful. The approach is based on limiting a combination of the number of times, length and sometimes maximum concentration that may occur in a given year. Since odour can be intermittent and occur on a short-term basis (e.g., 5 minutes), and dispersion models typically use hourly meteorology to predict 1-hour average concentrations, dispersion modelling may not accurately predict the length and related severity of an odour episode. A person's sense of smell has the ability to detect short periods of odour, such as one minute or less. A number of short periods (one-minute to three-minute periods) of perceived odour may constitute an odour episode to an observer. Therefore, the actual duration of odour episodes should be considered in regulation or

management approaches in addition to the number of odour episodes that may occur in a specified time period. However, this must be based on record keeping by observers, such as citizen complaint calls, citizen notes or logbooks, or air pollution inspector observations and data collection (McGinley et al. 2000).

This approach generally uses the concept of Odour Hours (OH) to establish acceptability criteria. These include definitions of Odour Hour (i.e., three 10-minute periods of excess odour in one hour, or one 15-minute period of excess odour in one hour) and set limits on the number of Odour Hours that may occur within specified time periods (i.e., maximum 2 OHs per day, maximum 8 per week, maximum 36 per month). Community input in the development of such approaches is integral to the program's success.

A.4 SOURCE EMISSION AND BEST AVAILABLE CONTROL TECHNOLOGY CRITERIA

The remaining odour management approaches place limits on the odour emission rates from certain sources or specify specific control measures to be installed on certain sources. These approaches are essentially the same as those used for standard air pollutants, with the exception that odour emission rates are measured using source samples that are analyzed by dynamic dilution olfactometry. Odour emission rate information can subsequently be used with air dispersion models to predict potential ambient odour concentration levels and potential impacts in the community.

A.5 ODOUR DISPERSION MODELLING

The use of an odour dispersion model is almost a mandatory requirement for odour assessments for facility emissions. The reasons for this are that it is extremely difficult to anticipate when and where odours will occur in order to conduct an odour sampling program in a community adjacent to an odour source. Because odours from most sources occur infrequently and are intermittent when present, a lot of time, effort and cost can be expended on such a sampling program without having much to show for the expenditure unless the odour impacts are present all the time. Moreover, nuisance odours can result in complaints from the general public at concentrations below 10 D/T and most regulatory odour standards, guidelines or benchmarks are set at levels of 1 D/T to 10 D/T. However, odour panels used to evaluate odour samples cannot accurately determine odour concentrations <10 D/T. Therefore, it is necessary to use dispersion models to calculate predicted odour concentrations below this level.

Inevitably, the question arises as to which dispersion models are best suited to predicting odour concentrations. Unfortunately, unless the dispersion model has been developed specifically for modelling odours, it is unlikely to accurately predict the concentrations experienced by the community. None of the available regulatory dispersion models are particularly well-suited to

odour modelling because they have generally been developed for other purposes. The most fundamental problem stems from the fact that regulatory dispersion models are designed to use mass emissions rates (e.g., grams per second) to calculate mass concentrations (e.g., micrograms per cubic metre) downwind from the source. The use of odour emission rates in terms of odour units per second is treated as being analogous to a mass emission rate. **However, the odour unit is actually a measure of the perception of the odour, not of the mass of the odorant present, especially when dealing with odour mixtures of many compounds.**

For example, the addition of a relatively small amount of mercaptan to a larger amount of H_2S can completely change the perception of the strength of the odour mixture out of proportion to the mass concentration of each of the two compounds. Because some compounds in an odour mixture may be highly reactive, the very character of the odour plume may change as the plume is transported downwind, a process that is not replicated in any dispersion modelling analysis. Therefore, although air dispersion models treat odour emission rates (OU/s) as being analogous to mass emission rates (g/s), and predicted odour concentrations (OU/m^3) as analogous to mass concentrations ($\mu g/m^3$), the simulation of odour dispersion is not really the same thing as the simulation of mass dispersion of a contaminant.

One of the other primary issues related to odour dispersion modelling versus modelling of other air pollutants is the question of averaging time. Contaminant concentrations downwind of an emission source decrease with sampling time due to increased meander of the emission plume as it is transported downwind. Most regulatory dispersion models have been developed to predict air contaminant concentrations over averaging periods of 1 hour and regulatory criteria are based on 1 hour, or multiples of hourly averages (e.g., 3 hours, 8 hours, or 24 hours). Since a person's reaction to an offensive odour occurs within 30 seconds, and since most regulatory criteria for odour concentrations are based on averaging periods of 3-to-10 minutes, 1-hour average odour concentrations predicted by dispersion models must be converted to shorter averaging periods in order to determine their degree of potential offensiveness and/or compliance with regulatory limits for odour impacts.

Instantaneous sensing of odour means that plume meander will result in odour impacts, especially during periods of very light winds when such meandering may be quite pronounced. It has been reported that various experiments have demonstrated that the perceived odour response is not linearly related to the concentrations of the odorous compound (Best et al. 2001). Instead: *"Odour response may be more related to the general characteristics of fluctuations of concentrations away from the mean value, rather than just the value of the peak concentration".*

According to Turner (1994), studies completed in 1958 and 1959 reported that the decrease in concentration follows a one-fifth power law with sampling time for sampling periods from 3 seconds to about half an hour. Therefore, the scaling factor *(f)* that is most frequently used to

convert predicted 1-hour average odour concentrations to shorter time periods is the one-fifth power law equation:

$$f(t,t_0) = (t_0/t)^{0.2}$$

where (t) is the averaging time of interest (in minutes), and
(t_0) is the averaging time consistent with the dispersion rates used to obtain the mean 1-hour odour concentration from the dispersion model

The value of 0.2 in the exponent of the equation only applies to neutral atmospheric stability (Pasquill-Gifford Stability Classes C and D), and must be adjusted for unstable and stable conditions. Not all odour modelling studies make that adjustment, which may explain some of the differences reported between predicted and observed odour concentrations. For example, the Ministry of Environment in Ontario uses an exponent value of 0.28 for peak-to-mean conversions of 1-hour to 10-minute average odour concentrations, while the Town of Boucherville in Quebec mandates the use of 0.25 for conversions to 4-minute average concentrations.

This scaling factor has been applied to all types of odour emission sources even though the relationship was first determined for elevated sources (i.e., stacks) at the height of release, and may not be applicable to emissions from ground-level area sources (e.g., primary sedimentation tanks, secondary clarifiers, etc.). Turner noted that other studies have reported that the ratios of peak-to-mean concentrations are much higher than those given by the above power law equation where observations are made at heights considerably different from the height of release from an elevated stack, or at distances further from the axis of the plume. Furthermore, at considerable distances from the source, the peak-to-mean ratios may approach the value of 1, and can vary considerably depending on the stability of the atmosphere and the type of terrain that the plume is passing over. For example, barriers in the path of the plume (e.g., walls, vegetation breaks) may alter the turbulence of the plume and change the peak-to-mean ratios compared to those that would exist in unobstructed flow over the same distance.

Despite the many limitations in the use of dispersion models, various regulatory dispersion models are used for estimating odour concentrations around sources because, as noted above, ambient odour sampling programs are difficult to implement and cannot provide data at the low concentrations needed for comparison to regulatory odour impact criteria. Regardless of which model is used, it is important to keep in mind that the results from any model are only as good as the information used as input to the model (e.g., emission rates, meteorology, land use data, etc.). **In the end, no amount of modelling is sufficient if the members of the affected community still complain about an odour nuisance, even though the modelling analysis indicates that the established ambient standards, guidelines or objective levels are being attained.**

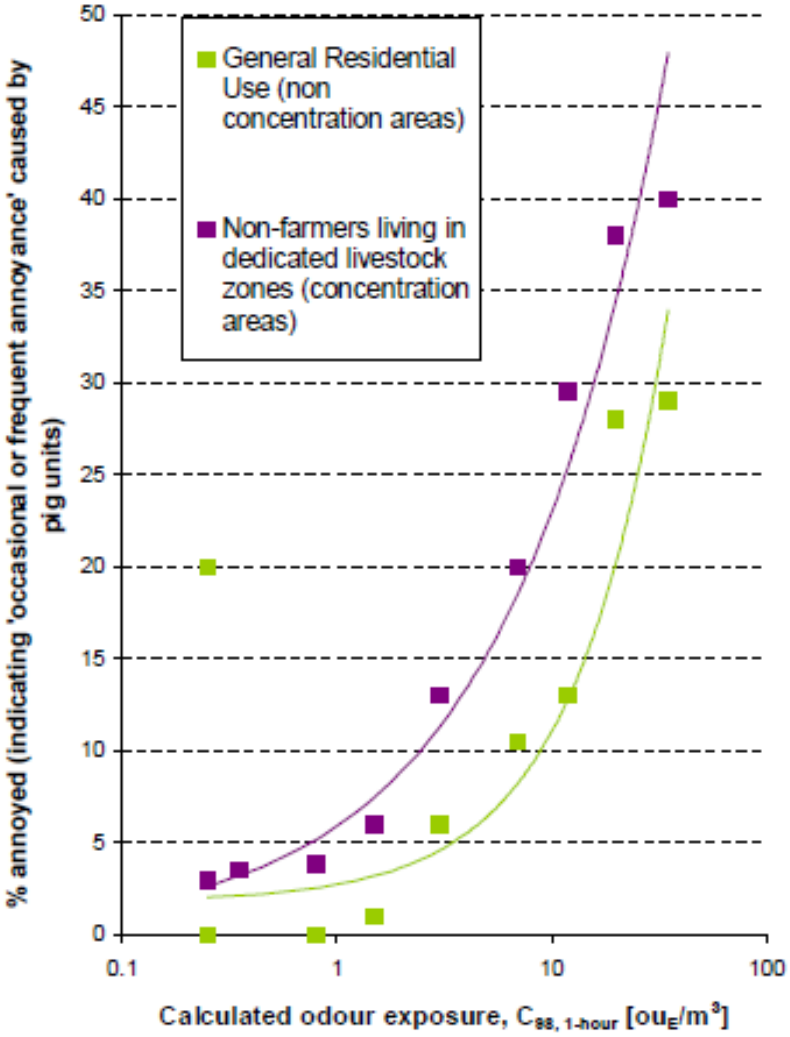
A.6 COMMUNITY ANNOYANCE THRESHOLDS

Based on the experience of most regulatory jurisdictions, the magnitude of any numerical ambient odour criterion should be set based on an annoyance threshold or annoyance criteria. However, this threshold is not necessarily easy to define. According to Nicell (2009), a 1 OU concentration represents a condition where there is a balance between those that may be impacted to some degree and those that are not. By definition this is the level at which 50% of the population can just detect the odour. Thus, the odour concentration at this level is above the personal threshold of the other 50% population, which means that half of the population is impacted to some degree. Also, odour response curves from typical compounds such as n-butanol, n-butyl acetate, octane, etc. show that 10% of the population have personal thresholds that are 5 times lower than the overall population threshold. Therefore, at the 1 OU level, 10% of the population experiences the odour at a level that is at least 5 times their personal thresholds, which corresponds to the "complaint threshold" for these individuals. Thus, Nicell contends that even at 1 odour unit, 10% of the population could be considered to be in a state of annoyance.

Many jurisdictions use an annoyance criterion or an odour complaint threshold of 5 OU, which is 5 times the odour detection threshold of 1 OU. The value of 5 OU has been in common practice for over 25 years. There is some justification for this value from a community odour survey of livestock odours in The Netherlands, cited by the Environment Agency (2007) and reproduced in Figure A.1. The data indicates that approximately 5% of the general population living in areas without livestock operations (i.e., non-concentration areas) would be annoyed at a level of 5 OU (1-hour average, 98^{th} percentile). The results for pig rearing odours in The Netherlands is consistent with research conducted in the United Kingdom on odours from wastewater treatment plants in which odour complaints were correlated with modelled odour impacts from nine plants. In the latter study, only 3% of the odour complaints were recorded in areas where odour concentrations were at levels $\leq$5 OU (1-hour average, 98^{th} percentile). On that basis, the use of an annoyance level of 5 OU would also be consistent with the World Health Organization's definition of a nuisance threshold as being that concentration at which not more than a small proportion of the population (less than 5%) experiences annoyance for a small part of the time (less than 2%) (WHO 2000).

A series of experiments conducted by Stowell et al. (2008) in the vicinity of an intensive swine rearing operation in Nebraska using a mask scentometer to measure instantaneous odour levels also indicated that while the threshold for any degree of annoyance appears to be between 2 and 15 OU, the threshold for consequential annoyance (i.e., that level of annoyance which is likely to cause a change in behaviour or activity level, and instilling some memory of the odour event) falls between 7 and 31 OU. On this basis, Stowell et al. concluded that candidate thresholds for odour annoyance and consequential odour annoyance could be set at 2 OU and 7 OU, respectively.

Figure A.1 Dose-Response Relationship for Livestock Odours in The Netherlands
(reproduced from Environment Agency 2007)



APPENDIX B: ODOUR DIARY IN VICINITY OF COAST ENVIRONMENTAL LIMITED FACILITY

Date - June	Time of Day	No. of people noting an odour
1		
2	13:00	2
3	7:30	5
4	8:30	2
5	13:30	4
	19:00	2
6	8:00	6
7		
8		
9	8:00	8
10		4
11	9:00	5
12	3:29	5
	15:00	1
13	3:30	6
14		
15		
16	3:30	4
17	9:15	7
18	16:13	4
19		
20		
21		
22		
23	9:15	2
	15:00	6
24	9:30	5
25	9:50	3
26		
27	10:15	3
28		
29		
30		

Note:

Grey-shaded cells refer to weekends when no employees were present to make observations.

Yellow-shaded cells refer to dates on which odour complaint were received from other businesses.