PROGRESSIVE ODOUR MANAGEMENT PLAN

FOR HARVEST POWER RICHMOND

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Progressive Odour Management Plan (POMP)

1. INTRODUCTION

1.1. The Harvest Power Facility in Richmond

Harvest[1] owns and operates a 24-acre Composting and Energy Garden (Anaerobic Digester and Combined Heat and Power) Facility (the "Facility") on land owned by Port Metro Vancouver. The Facility is located in an urban area with 1.7 million people living within a 15 km radius in the surrounding six municipalities (Richmond, Vancouver, Surrey, Burnaby, Delta, and New Westminster). The Facility currently accepts yard waste, leaf waste, grass clippings, garden residue, tree trimmings, chipped shrubbery, agricultural waste, commercial food waste, residential food waste, wood waste, and other similar organic materials. Harvest also operates a de-packaging facility which allows us to handle organic waste in containers or packages. As such, the Facility plays an important role in the zero waste goals set by Metro Vancouver.

1.2. Purpose of Progressive Odour Management Plan

Harvest's corporate goal and aspiration is to operate Harvest and all its facilities as a good citizen and neighbour within its host communities. While odours are a natural by-product of the composting and anaerobic digestion processes, a properly designed and managed Facility need not emit objectionable odours that will disrupt the outside community. The purpose of this Progressive Odour Management Plan ("POMP") is to provide actionable guidance.

The methods and technology in this POMP are progressive in the sense they are designed to be continuously updated and improved. As problems or opportunities arise (to reduce odours), this method and technology can be changed. In this sense it is a living document. It follows the principles of ISO 14001 of "plan-do-check-adjust". Consequently this plan provides a process for evaluation, monitoring and correction, and a format for identifying parts of the Facility that may need adjustment to prevent and/or reduce odours. It shall also provide guidance to on-site operation personnel.

Recommendations contained herein are, in all cases, *options that may be considered as part of our overall approach.*

The POMP is part of Harvest Power's drive to achieve Good Utility Practice and as such our approaches and recommendations may invariably change from time to time.

The POMP is a tool to reduce potential emissions whilst maintaining effective composting operations. It seeks to balance, where practical, all aspects of our operations and is designed to assist Facility operators in how to manage and mitigate the potential emission of objectionable odours outside the boundary of its Facility. By operating the Facility with this goal in mind, we create a more sustainable

[1] The Facility is owned by Harvest Fraser Richmond Organics, Ltd., which does business in British Columbia as "Harvest."

future for this particular Facility, as well as reinforce our environmental commitment and reputation as a responsible, best-in-class operator.

Ultimately the aim is to minimize/eliminate nuisance odours (odours that cause problems for residents or businesses in the area). A number of means will be employed to achieve this.

1.3. Background: Composting and History of Odour Control

There is a common belief that odour signals a problem in the composting process. The grounds for this belief is that composting (which is a natural aerobic biological process) should not generate odours when properly practiced. Odour generation is, however, an inevitable result of the natural decomposition of organic matter, aerobically or otherwise – without decomposition it would not be possible to produce compost. Indeed, this has been recognized and acknowledged by world-wide experts in the composting arena: "Odorous compounds inherently form as raw organic materials decompose" (Haug; 2004).

Historically organic waste facilities have been largely reactive to odour emissions following a pattern of:

- Operating according to the current Air Emissions Approval GVU1078 (the "Approval") conditions with no formal odour prevention or control strategy.
- Reacting "if-and-when" odour complaints or regulatory enforcement requires a response.
- Investigating the event(s) and propose a fix to respond to the problem or complaint or citation.
- Adjusting practices accordingly.

The historical approach may be pragmatic, practical, and common in the industry but may be insufficient to prevent recurring problems. Especially for Harvest, which operates within a populous urban environment, the historical approach may also be inadequate to meet Harvest's aspiration to operate as a "good neighbor and citizen."

This **new protocol is designed to be pro-active** rather than reactive, and can be viewed as a self-regulating system. This new pattern of odour management is best described as:

- Operate so as to **minimize** the potential escape of offensive odours beyond the property line according to Approval conditions and a self-diagnostic and self-regulatory odour prevention and control strategy.
- Monitor and measure odour, odour causing compounds and conditions, and odour covariates (i.e. oxygen concentration) under a number of operating conditions, both scheduled and unscheduled, using quantitative methods.
- Evaluate measurements and respond by adjusting the Facility or the operating plan to prevent and minimize odours.
- Re-measure, re-evaluate, and adjust operations as necessary on an iterative basis.

1.4. Relationship of POMP and other pertinent regulations

This POMP is also developed to meet certain regulatory requirements. The current Air Emissions Approval GVU1078 issued by Metro Vancouver (the "Approval") directs Harvest to develop a Progressive Odour Management Plan to be submitted for review and comment by the District Director. This Plan requires details about activities surrounding prevention, accountability and progressive mitigation of odours that may arise from activities at the site.

- ***Prevention*** entails effective operation of the Facility. It can include the development of standard operating procedures to prevent release of odourants to the environment (*i.e*., preventative maintenance, leak detection and repair, feedstock handling, review of feedstocks *etc*.)
- ***Accountability*** outlines the expected interactions among operators, regulators and neighbors. It provides procedures for identification, notification and resolution of malodours. It can include the development of responsibility charts, contact info, response procedures to, operational challenges, response to odour complaints, communication plans etc.
- ***Progressive mitigation*** is a series of operational adjustments in a prioritized manner. It can include several levels of response covering self-detection, correction and reporting, implementation of new or changing of existing operational procedures, restriction of feedstocks and ultimately retrofitting of technologies or controls works if so required.

As expected, this POMP meets the requirements of B.C. Reg. 18/2002; Organic Matter Recycling Regulation, including amendments up to B.C. Reg. 198/2007 ("OMMR"): Division 2; Construction and Operation of Composting Facilities. OMMR has a requirement for plans and specifications that include an odour management plan which stipulates how air contaminants from the composting Facility will be discharged in a manner that does not cause pollution.

1.5. Relationship of POMP and operations procedures

This POMP is neither intended to explain the standard operating procedures ("SOPs") for the Facility nor replace the SOPs. Instead, it is meant to explain how those procedures in place at the time of writing have been designed to prevent and mitigate objectionable odours, and to suggest additional steps that might be considered if that does occur. The POMP and SOPs evolve constantly as Harvest seeks to achieve continuous improvements.

1.6. POMP Update

This POMP is the 3rd annual update, following the original edition of July 31, 2013. The Approval requires that subsequent editions of the POMP consider "recommended updates" to the POMP, which Harvest understands to refer to any recommendations if they are made by Metro Vancouver. Harvest and Metro Vancouver staff maintain an active and constructive dialogue around odour control on an ongoing basis, resulting in changes to Harvest's operations and monitoring practices (such as enhanced meteorological tracking).

2. PREVENTION

In order to minimize the development of conditions that could lead to odour problems, the material handling areas of the Facility and operating procedures have been designed based on the nature and quantity of materials to be received and stored, climatological factors, adjacent land use, topography, season and drainage controls. For example, an unturned, covered aerated static pile system ("CASP") discharging air from the compost cells through biofilters has been implemented in order to avoid the release of odours typical of windrow-turning forms of aeration; the primary screening plant has been enclosed and a biofilter installed; and a state-of-the-art anaerobic digestion Facility (Energy Garden) has been constructed to allow the processing of large quantities of the more odourous food wastes within enclosed, air-tight and gas-tight conditions.

2.1 Preventative compost operations

Accountability: General Manager Compost, Scott Kerr.

In-bound material is tipped at one of three locations, according to material type. Material types include pre- and post-consumer food waste, green waste, clean wood waste and other materials listed under the Facility's Solid Waste License (Greater Vancouver Sewerage and Drainage District License C-004, issued 1997, last amended May 8, 2015):

a. Green waste is normally tipped at the receiving area north of the CASP system. There is a second receiving area south of the CASP system for use during peak periods in spring and fall. Following tipping, loads are inspected for contaminants, including but not limited to plastic, glass, metal and treated wood. Loads are accepted and rejected in accordance with the Facility's determined feedstock specification. Very large contaminants are removed by excavator. Food waste loads (and loads with predominantly putrescible waste) are usually directed from the site entrance (scale house) to the receiving hall at the anaerobic digester (Energy Garden) (preventive measures for the processing of food waste in the Energy Garden are detailed further in this document).

b. Within not more than seven days, and typically within less than 48 hours of tipping, different material types are mixed depending upon type of feedstock with bulk density and moisture content being the primary considerations. Generally composting recommendations suggest that bulk density should be less than 1000 lbs/cu. yd. (0.67 tonnes/cbm) (Oshins, 2006). Historically, size reduction (grinding) was typically not used prior to mixing. Beginning in the summer of 2013, a shredding step has been added to produce smaller, more uniform size materials to facilitate more even and faster material degradation. The optimal moisture content depends on the feedstocks (e.g. particle size, degradability) and the stage of composting (Richard et al., 2002) with an optimal moisture range between 55-60% at the start of the process.

c. Mixed and prepared feedstock is placed as soon as is practically and prudently possible on top of the aeration piping using a loader or excavator. The Facility has been designed so as to accommodate peak flows based on seasonal variation. Pile height nominally varies between a minimum of approximately 3 meters to a maximum of 6 meters (or 8 meters between April 15-July 15 and October 15-December 15). In general, Facility operators keep pile heights as low as

possible, taking into account volume throughput requirements. The use of equipment on top of the piles is kept to an absolute minimum and usually restricted to within 1-2 days prior to cell deconstruction. From operational experience, any machinery driven on top of the pile surface should loosen material it has moved over upon completion of the work, such that no machine tracks are visible on the surface of the material. These steps minimize the risk of material compaction, which can lead to the creation of anaerobic pockets and odour.

d. A vacuum is induced below the pile by stainless steel blowers, which pull air through a network of perforated pipes from the pile to maintain aerobic conditions. These pipes (48 in total) were all replaced/repaired during Spring 2016, including regrading of the substrate. The system eliminates labor-intensive turning; reduces emissions sometimes associated with turning of compost; allows for proper control and homogeneous distribution of temperature and moisture maintenance through airflow adjustment and enables excellent odour control.

e. The forced negative aeration system removes large amounts of moisture in the form of vapor from the composting material. The rate of daily rainfall, even in winter, is minor in comparison with the amount of daily moisture transferred from composting material to vapor and transported through the air to the biofilters. Some liquid condenses in the aeration system and is periodically collected and re-applied to fresh inbound material, which has the capacity to absorb the liquid while remaining within the window of optimal moisture content. Should the compost operation start receiving drier material such as wood waste, a more permanent means of feedstock moisture conditioning would be explored. Given that current feedstock is primarily yard waste and source separated organics, the moisture content is considered to be optimal.

f. In a previous operational mode (prior to March 2013), hot compost air was pulled through the piles, potentially containing odourous compounds, and was diluted and cooled with fresh air by means of a fresh air vent at the far end of the common manifold. The intent of this action was to keep the biofilter at <40^{o}C. Opening the vent compromised negative pressure at each of the 24 perforated sparger pipes resulting in drastically diminished oxygen delivery to the compost. Without adequate oxygen supply, anaerobic conditions developed and elevated odour resulted from non-point source locations through the CASP. Currently (March 2013 - present), the fresh air intake on the end of the common manifold is kept closed. All of the air pulled through the common manifold comes through the compost pile and into the shared manifold. This exhaust air is between 40-60^{o}C and causes the biofilter media to operate at similar temperatures. We have concluded, through monitoring of inlet and outlet gases and qualitative odour evaluation that operating in an aerobic state in the compost pile and a thermophilic state in the biofilter is sufficient to treat odours to the spirit of the Approval. There is research in the literature body that supports the biochemistry of thermophilic biofilters. Many positive aeration CASPs rely on a compost cover which is at a similar temperature to the compost pile to treat odour. According to Engineered Compost Systems, a positive aeration system with a cap of compost would be as effective as biofilters in our situation. We expect that running the biofilter at higher temperatures will reduce its useful life by means of composting away the mass, creating more fine materials and that this will be evident by increasing pressure on the biofilter inlet. Inlet pressures and outlet gasses are being monitored weekly and quarterly in order to ensure that

the performance of the biofilters remain high and the media is replaced promptly when required, keeping the impact on the environment low.

g. The expected life of the biofilters is one - two years and the most recent rebuild was in Fall 2015 (NE and SW biofilters). The two remaining biofilters (EG and Screening Plant #1) are due to be replaced in Fall 2016.

h. Temperatures in the CASP are measured and recorded daily. Temperatures and O_2 concentrations in the sparger pipes are measured weekly. This allows for cell-by-cell analysis of conditions in the compost pile. Airflow is adjusted at the sparger valves to maintain aerobic conditions and optimal temperatures in the compost pile. This facilitates the identification and investigation of sub-optimal cells so the issue can be rectified before the material becomes anaerobic and causes odour problems.

i. There are two material flow streams at Harvest; the commercial stream is through the Energy Garden to the CASP and the municipal stream is directly onto the CASP. Residence time in the CASP is approximately 8-9 weeks for all material placed on the CASP. BC OMRR pathogen reduction process temperatures are generally reached within 5 days (3 days > 55^{o}C) and vector attraction reduction processes are reached in the next 14 days (14 days > 40^{o}C with average of 45^{o}C). The remaining days (day 19 onward) are for improved stabilization and maturity. Engineered Compost Systems indicated that improving our ability to mix feedstock by means of a large feedstock mixer, would bring the greatest improvements in compost quality and reduction in odour. We are grinding and mixing in one step with the Komptech Crambo and are getting good results and homogenous material.

j. Following the CASP, the organic stream is further cured (for an improvement in stability and maturity) in large windrow-like piles in order to improve quality and maturity. It is then screened to remove contaminants and “overs” (organic material with a particle size too large to be sold as a product). Material can be screened at any point using Screening Plant #1, which has a biofilter. Material screened with Screening Plant #2 must be 40 days old or have been tested and met conditions stipulated in the Approval under Source 08A to ensure it is not anaerobic at the time of screening. The commercial stream is screened when it is removed from the CASP at a trommel screen. As this screener does not have a biofilter, the material will meet the same conditions set out in the Approval for Screening Plant #2 (Source 08A).

k. Overs and middlings (both by-products having particle size >3/8”) are recycled back through the process and ground / composted until broken down to an appropriate particle size. Contaminants are disposed.

l. Compost is sold under the OMMR classification of “Class A not solely produced from yard waste.” The product is sold wholesale in bulk and periodically bagged for retail markets and is used in a variety of applications including agriculture, landscaping and horticulture, and erosion control.

2.2 Preventative Energy Garden Operations

Accountability: General Manager Energy Garden, Haydn Knowles.

Normally most food waste loads will be directed to the Energy Garden. Key odour management considerations are:

a. The Energy Garden receiving area is kept under negative air pressure, discharging air to a biofilter to prevent the escape of fugitive odours. Therefore, the doors to the receiving area are normally kept closed during routine operations with the exception of facilitating delivery trucks tipping, removal of digestate, movement of equipment and maintenance activities on the doors themselves.

b. The digestion process itself occurs under air-tight and gas-tight conditions and therefore should not result in the release of fugitive odours.

c. After approximately two weeks of residence time in the percolation tunnels, the digestate (spent feedstock) is removed from the tunnels and transported immediately to the CASP air floor. A woody bulking agent with high air space (such as mids) is then added on top of the digestate. This material allows air flow and ensures that the material becomes aerobic, which reduces odour production. Regular ground feedstock from the north tip is then loaded on top of the mids and all of the material is well mixed together.

In light of this design, excessive odours would most likely be caused by (a) leaving the doors opened for an excessive period of time, (b) a malfunction of the plant ventilation system, (c) degradation in the effectiveness of the biofilter, or (d) other deficiency in digester operations such as release through over-pressure valves. The occurrence of such odours should be promptly investigated. The permanent presence of trained operators allows for prompt action.

2.3 Site Wide Preventative Maintenance

Engines and equipment are subject to a comprehensive maintenance program that avoids break-downs and allow for material flow without bottlenecks or interruptions.

2.4 Site Wide Housekeeping

Harvest Power employees are trained and directed to maintain a clean site. Puddles are drained; waste is regularly removed from the site and organic material spilled by trucks incorporated into the cells or Energy Garden feedstock.

2.5 Depackaging Area

Our current Brokering Licence permits Harvest to operate a depackaging machine (Turbo Separator) which processes pre-consumer organic waste in containers or packages. The machinery associated with this is kept under partial cover but there may be storage of packaged goods outside. The area will be kept tidy and clean to minimize odours and vectors.

3 MEASUREMENT

3.1 Collecting data

Facility design and sound operating practices are only the first step to effective odour management. A pro-active approach requires regular monitoring and measurement of odours, followed by analysis, so that Facility operators can track the interaction of feedstock volume and composition variations, meteorological conditions, and operating practices in producing or mitigating odours. This section addresses measurement of odours, along with collection of other necessary data. The following section will address analysis.

This approach allows for correction of potentially odour-generating practices and testing of proactive measures to avoid odour generation.

3.2 Measuring odours

Currently, we are monitoring odour continually with operators on-site who notify their supervisors when they smell something out of the ordinary. Harvest also measures on-site odour using a portable dynamic olfactometer (Scentroid SM100 by IDES Canada). With this tool Odour Units (OU) are measured on site and monitored over time. One Odour Unit is defined as the minimum concentration of odour necessary for fifty percent of the population to perceive it.

a. The **Odour Unit (OU), detection threshold (DT) or dilution to threshold (D/T)**, is the theoretical minimum concentration of odourant stimuli necessary for perception in some percentage, normally 50 percent, of the population. Two types of thresholds can be evaluated, namely the detection threshold and the recognition threshold. In measuring environmental odours, which are complex mixtures and not pure compounds, the threshold cannot be expressed as a concentration level (i.e., parts per million or micrograms per cubic meter). Instead, threshold is expressed as a dilution-to-threshold ratio (D/T). A D/T ratio of 1,000, for example, means that one volume of odourous air requires 1,000 volumes of odour-free (dilution) air to reach detection threshold.

3.3. Odour measurement and monitoring protocol

Accountability: General Manager Compost, Scott Kerr

For this protocol, both Field and Laboratory analysis are used. Each time odours are measured the meteorological conditions are also recorded (wind direction, wind speed, temperature, precipitation, cloud cover, etc.).

Frequent and regular use of the Scentroid provides more data, more quickly, to enable Harvest operators to more rapidly assess the interaction of feedstock, operating practices, and meteorological conditions and thereby pursue continuous improvement.

While there is a current requirement in our Approval for quarterly odour testing, this does little in establishing the relationship between feedstock, processing methods, and odour. For this reason there

should be more emphasis placed on the Scentroid, as an important part of a feedback mechanism and odour management. Under this approach, third party laboratory testing would be reserved as a higher, or subsequent progressive step to be taken if, for example, other odour management techniques fail, complaints arise, and use of a third party would assist in providing independent data points.

The Facility has 4 to 8 pre-determined and standard observation locations on site and additional locations can be added depending upon the conditions at that time. A plan for periodic and event-driven off-site field sampling should also be developed, taking into account complaint history and meteorological conditions.

3.4 Complaint handling

Accountability: Regional Regulatory Compliance Officer, Greg Gillespie

An important source of data and feedback for plant operations is complaint data. Complaint information is provided from Metro Vancouver. Harvest maintains an odour complaint database that records the date, time and location of complaint, along with an odour description. Complaints are analyzed with respect to weather (i.e. wind direction) based on four local Ministry of Environment weather stations. Based on the observed factors, the complaint is classified as either *possibly* caused by Harvest or not.

In addition to receiving complaints through Metro Vancouver, HFRO established a Community Hotline in mid-March 2016 whereby community members could call Harvest directly and these calls are now included in the above analysis. This Hotline is also used by on-call/after-hours staff from Metro Vancouver and has resulted in improved communication and additional data for analysis.

3.5 Record-keeping

All reported odour incidences are summarized and recorded and kept in a database. Harvest has created a centralized digital repository, using cloud-based technology so that the data is readily available for purposes of evaluation and analysis. Specifically, management and operators can cross reference the location and timing of complaints with site activities to better understand specific activities that may contribute to off-site odours.

4 PROGRESSIVE MITIGATION

4.1 Review and evaluation protocol

Accountability: General Manager Compost, Scott Kerr; General Manager Energy Garden, Haydn Knowles

The evaluation process will yield conclusions based on performance measurements that can then be used to make corrections, improvements, and adjustments to both the Facility and the operating procedures. The intent of the evaluation process is to find odour sources and systematically minimize them through prevention, capture, and treatment.

The analysis of data collected allows Facility operators to establish correlations between various operational activities and weather conditions and to evaluate the efficiency of pro-active measures.

Factors to be considered during evaluation include feedstock receiving and initial processing, climatic factors that magnify or mitigate odours, scale of fugitive odours due to material handling, specific odour sources within the Facility, operational practices and schedules that generate odours. There are also mitigating factors that affect odour emission rates. They include wind and rain protection in the Facility design, material handling rates, topographic features at the Facility limit, vegetated greenbelts, and capture and control equipment (biofilters).

An odour risk meteorological forecasting system has been established with weather consultants and academics at UBC. Alerts are automatically emailed out each morning to those involved in managing on-site operations (General Manager Compost and Site Supervisor). If winds are forecasted to have a negative impact on our operations, i.e. our site falls within a high risk wind speed/direction 'window', operations can be managed in order to reduce the possibility of odour complaints. Activities with a higher risk of odour generation are scheduled to coincide with favourable winds (those outside of the problem wind window).

Evaluations should be conducted and statistically interpreted if/when there is a sudden spike in off-site objectionable odours, whether or not complaints are received.

Since the Approval has significant evaluation and reporting requirements, the Approval conditions drive this evaluation. Currently, the evaluations are conducted quarterly, upon the receipt of quarterly testing data for odours and for Volatile Organic Compounds (VOCs).

Any recommended changes should be documented in a Plan of Action.

4.2 Use of science and training

Harvest is committed to introduce new odour mitigation measures, or to revise existing mitigation measures, based on latest and rigorous science and within economic reasonably and cost-effective means.

Employees are encouraged to pursue professional development to stay acquainted with latest technology and practices.

4.3 Plan of Action: Facility and operations adjustment protocol

Accountability: General Manager Compost, Scott Kerr; General Manager Energy Garden, Haydn Knowles

Following the above-described measurement, analysis and evaluation steps, a Plan of Action will be developed to prioritize changes to both the built Facility (capital expenses) and operations (possible operating expense). Each adjustment to the Facility will include a schedule (target date) for completion, cost estimate, and benefit statement so a cost-benefit justification can be made. A list of possible progressive Facility changes to be considered and evaluated, based on circumstances, is set forth in Section 4.4 below.

Each adjustment will include a description of roles and responsibilities as well as any required changes to the operating plan for the Facility. Where it is appropriate, consultation with the relevant regulatory body will take place.

For example, any new equipment brought on site that may materially affect air emissions from a regulated source must be reported.

4.4 Odour mitigation measures

As described in earlier sections, this POMP is based on a data-driven, diagnostic approach. That is, when odour problems arise, the first step is to identify the source of the problem, collect data on the nature, extent, and severity of the problem, and use that data to help determine the possible cause(s). Based on such analysis, a variety of measures may be taken to either mitigate the production of odour at the source or to reduce its migration beyond the Facility boundaries.

Given the complexity of operations at the Facility and the daily and seasonal variation of feedstock inflows and operating conditions, a detailed "cookbook" that specifies each possible situation and how it should be addressed is neither practical nor advisable. Instead, this section sets forth a variety of mitigation steps that can be considered by the Facility operators as needed in response to problems.

The presence of nuisance odours identified by operators, neighbors or site inspectors initiates an escalating or progressive set of responses.

A. **Level One. Self-odour inspection and tactical correction.** For example, an operation may be suspended under certain weather conditions; odourous feedstock may be directed to the energy garden; biofilter blower speed can be increased or reduced, work shift hours may be increased to process material more promptly. The corrective actions may be temporary and situation-specific.

B. **Level Two. Operational Changes**. If Level One has not provided a durable elimination of the nuisance odour, operational changes such as reduction of pile height, increase in bulking agent and revamping of biofilters will be considered.

C. **Level Three. Capital Plant Adjustments.** If after implementing Level Two measures objectionable odour outside Facility boundaries still persists, more detailed odour identification action will be implemented and thorough retrofitting options will be considered (changes to equipment, new equipment, new biofilter material, removal of material into energy garden or alternative locations

For each potential odour source, the following table offers possible mitigation measures to be considered by Facility operators. The measures within each group are sequenced in rough approximation from easiest to implement (less expensive and/or less disruptive to operations) to more difficult to implement (more expensive and/or greater disruption). All and any mitigation measures will be assessed in terms of their anticipated technical effectiveness and associated costs in addressing the diagnosed cause of a specific odour problem.

Note that certain measures may require consultation, notification, or advance approval from the regulator.

4.4.1 Composting operation

Waste Receiving and Tipping Area (Approval Emission Source 04).

- ❑ Inspect incoming loads for odour and reject excessively odourous loads. Redirect to energy garden or incorporate immediately into cells
- ❑ Stockpile bulking agents as temporary cover for wet material or grassy material (or redirect to energy garden
- ❑ Reduce holding time (before incorporation into CASP or Energy Garden), especially for highly odourous materials and in warmer weather (above 27^{o}C).
- ❑ Restrict volume of inflows.
- ❑ Install temporary or permanent enclosed receiving area.

Feedstock

- ❑ Increase frequency of feedstock monitoring for moisture content, C:N ratio, bulk density, free air space and pH
- ❑ Amend feedstock to bring parameters to within BMPs guidelines, favouring lower odour risk at the expense of lower production (i.e. keep C:N at the high end of the BMP range).

Grinding

- ❑ Don't grind odourous material if it is suitable for being loaded onto the CASP as is and restrict grinding during unfavorable conditions if material must be ground
- ❑ Mist
- ❑ Enclose

CASPs – not including biofilters (Approval Emission Sources 05 and 06)

Loading Practices

- ❑ Alter pre-mixing protocols. Possibilities include:
    - o Acquire standard batch mixer (load/mix/empty)
    - o Acquire batch mixer and run in semi-plug-flow mode
    - o Lay out materials in windrows, then run through with straddle type windrow turner
- ❑ Expose pipe, re-chip, and red brush/over layer to replenish air floor each cell building
- ❑ Lower pile height

- Implement procedures for turning material to increase aeration
- Increase cover material, consider using finished compost as odour control cover

Unloading Practices

- Use sprinklers to water prior to unloading to reduce dust and odour
- Delay unloading if climatic conditions are unfavorable

Aeration System

- Inspect sparger pipes during pipe exposure between cell deconstruction and reconstruction
- Pump out any fluid at the pipe level or raise pipes if they have settled
- Rebuild air floor with chips, brush, overs
- Concentrate aeration on wet or poorly decomposed lines by adjusting valves from their standard position (as per consultant recommendations) which equilibrates vacuum across all sparger lines, to a temporary maximum (fully open) position.
- Modify the aeration system
    - Reconfigure piping layout (double the number of sparger pipes)
    - Regrade pipes to ensure adequate drainage and no flooding
    - Reassess holes along the length of the sparger pipe
    - Replace or augment aeration pipe system
    - Add blower fan capacity
- Temperature control. Attempt to maintain temperature below 75 C by manually adjusting sparger valves to concentrate airflow rather than evenly distribute airflow. Add water if necessary and maintain maximum airflow to dissipate heat through latent heat of vaporization and discharge as exhaust.
- Augment process controls
    - Automate damper controls through temperature feedback

Curing windrow management

- Build surge pile after curing to mitigate space restrictions and/or allow longer curing for piles.
- Force aeration
- Increase frequency of turning
- Build smaller windrows for increased aeration
- Plan operations based on weather forecasts

- ❑ Increase thickness of cover layer

Biofilters (Approval Emission Sources 03, 05, 06, 08)

- ❑ Remix media and supplement with new material
- ❑ Add media. Add 6" additional layer of compost, mids, or ground overs
- ❑ Replace media
- ❑ Add second stage polishing filter
- ❑ Eliminate biofilters by reversing aeration system to blow positive pressure and build and maintain moist covers on piles each batch
- ❑ Increase pest control to prevent rodent tunneling (emissions short circuits)

Primary Screener (Approval Emission Source 08)

- ❑ Time with weather conditions
- ❑ Check that material has been adequately cured
- ❑ Install chute off the end of the fines conveyor to prevent dispersal of dust and odours
- ❑ Cover conveyors and connect to enclosure to capture emissions and treat at biofilter

Auxiliary Screener (Approval Emission Source 08A)

- ❑ Minimize use of the Auxiliary Screener, relative to reliance on the (enclosed) Primary Screener.
- ❑ Check to ensure that material to be processed through the Auxiliary Screener has been adequately cured and meets conditions of the Approval.
- ❑ Schedule movement of material to the Auxiliary Screener during daytime and more unstable atmospheric conditions.
- ❑ Avoid moving material from curing to screening and avoid operating the Auxiliary Screener during times when meteorological conditions increase the probability of causing offsite odours such as warm and still night times, weekends and statutory holidays, atmospheric inversions, and constant wind speed and direction. See further discussion of meteorological conditions below.
- ❑ Collect data on odour measurements and reported off-site complaints, with timing and recorded operating hours of the Auxiliary Screener and meteorological conditions to determine more and less favorable operating protocols. Adjust operations (specifically, hours for movement of material from curing to the screener and actual operation of screener) accordingly and re-measure.
- ❑ Install temporary or permanent enclosure.
- ❑ Install chute off the end of the fines conveyor to prevent dispersal of dust and odours

Housekeeping

- Remove uncomposted material between cells and in the aisles
- Soak up / drain puddling water
- Wet down roads and other areas to minimize dust

Contingency

- Identify alternative facilities and/or equipment for unexpected deliveries or unexpected equipment failures

General operation management

- Increasing operating shifts to accommodate all material tipped throughout the working day hours

4.4.2 Energy Garden

Odourous emissions from the Energy Garden would normally originate in the Receiving Hall, which is operated under negative air pressure and controlled through the biofilter. Excessive odours would typically indicate degradation in effectiveness of the biofilter and addressed by the mitigation measures addressed under Biofilters. Odourous emissions can also originate from the opening of over-pressure valves. This does typically not occur under normal operational conditions. Reduction of the percolation rate and of the digester feeding can mitigate the emissions.

Doors to the Receiving Hall

- Ensure operators cover all hours during which loads are tipped so material is moved into the hall for processing as promptly as possible.
- Vinyl strip curtains could be installed on all or part of the door opening to reduce the escape of emissions

Tunnels

- Ensure unloading only happens early in the morning during times of atmospheric instability – a low risk condition for problem off-site odours
- Forced aeration could be installed in the tunnels to make the digestate aerobic and less odourous prior to unloading

Blowers & Biofilter

- Increase the air exchanges in the receiving hall, thereby increasing the negative pressure and reducing the fugitive odours escaping from the hall untreated

4.5 Implementation of the protocol

An Odour Management Team has been assembled for the Facility. This team includes the Regional Regulatory Compliance officer (Greg Gillespie), the General Manager Energy Garden (Haydn Knowles) and General Manager Compost (Scott Kerr). This team meets to review recent odour data, including complaints, on-site odour data, effectiveness of odour control methods, etc.

4.5.1 Re-evaluation

Each adjustment action plan should also include identification of specific measures that will be used to assess the effectiveness of the adjustment step, compare the odour situation before and after a measure has been implemented, along with timing and accountability for the re-measurement and re-evaluation.

4.5.2 Record keeping

Records of evaluations and Plans of Action should be kept so that they can be reviewed at least annually in connection with the update of the POMP. Again, it is recommended to use a central digital repository.

5. ODOUR COMPLAINTS

5.1 Review of Existing Data

Consultants to Harvest have advised that, in their experience, odour impacts from facilities with ground level sources tend to be ***lower*** during ***unstable*** atmospheric conditions. These conditions typically occur on sunny days, predominantly earlier in the morning when wind speeds tend to be lower. On the other hand, ***more stable*** atmospheric conditions tend to be correlated with ***greater*** odour impacts. From August 2015 to June 2016, these associations do not appear to be borne out by the actual time that complaints are received. Figure 1 shows that complaints were distributed throughout mid-day with high numbers during 'working' hours (9:00 – 17:00). Interestingly, numerous complaints were also received between the hours of 22:00 – 6:00 when the Facility is closed and no material is being moved on-site.

In the Lower Mainland, easterly and south-easterly winds are strongly associated with stable atmospheric conditions. This wind direction has the potential to strip odour from Harvest and transport it to the densely populated cities of Richmond and Vancouver. Given the geographic distribution of complainants and the predominant atmospheric conditions in the region, wind direction may in fact be a better indicator of atmospheric stability (and thus a better predictor of nuisance odour risk) than the time of day.

Higher atmospheric stability and easterly winds are quite well correlated as shown on the wind roses for the Facility (see figure 2). There is a predominance of easterly and southeasterly winds for Stability Classes 4-6 (Neutral to Moderately/Extremely Stable) and these are the wind directions most associated with odour complaints.

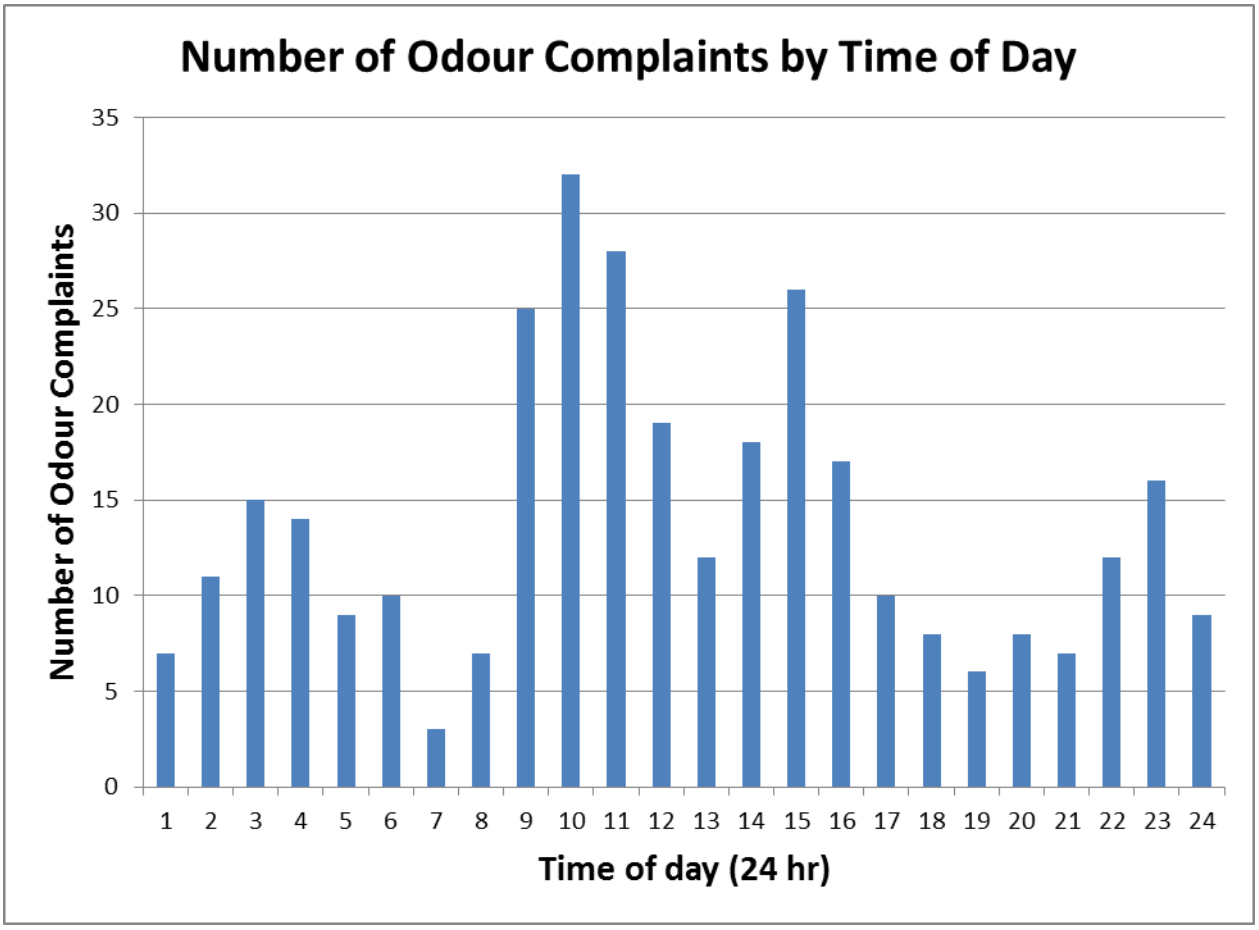


Figure 1: Total number of odour complaints received by time of day (Aug 2015 – July 2016)

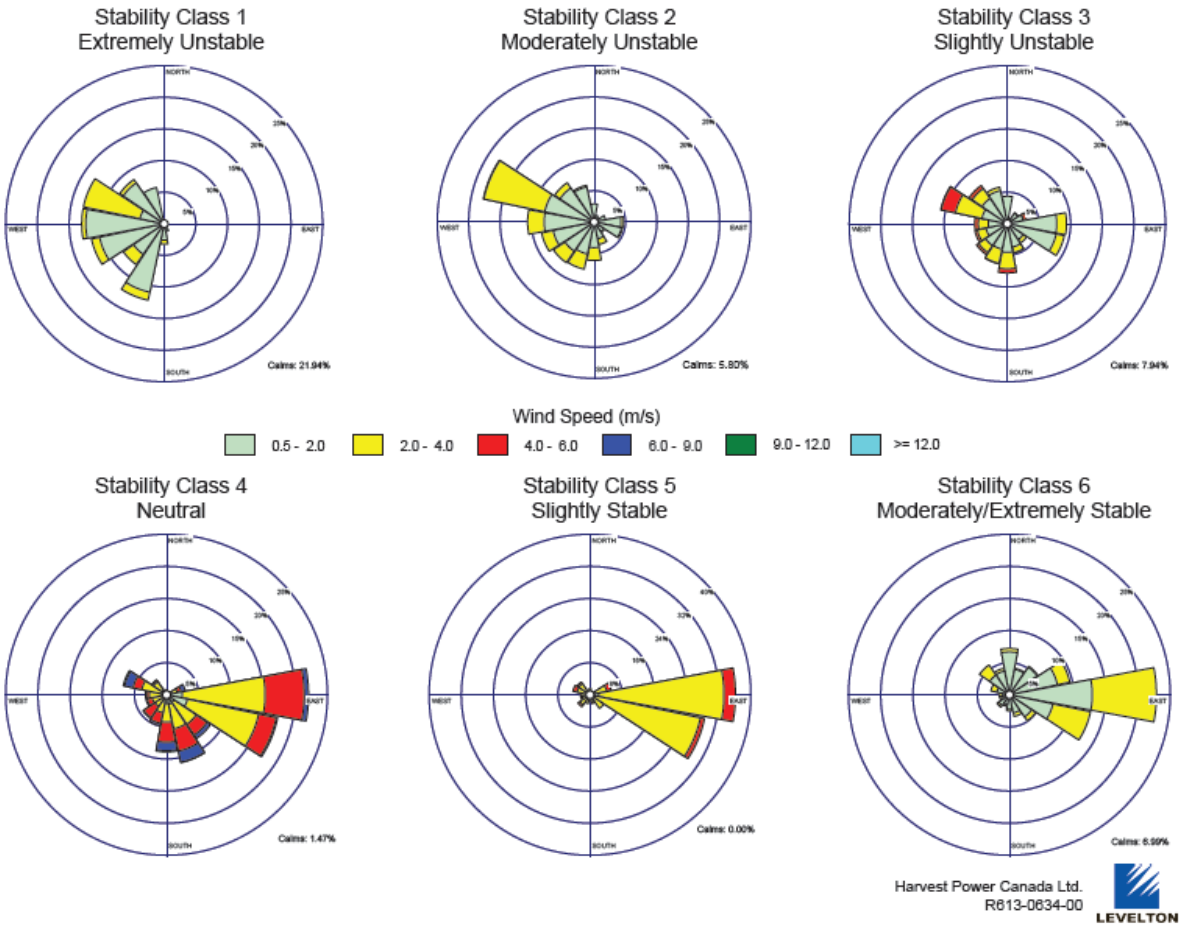
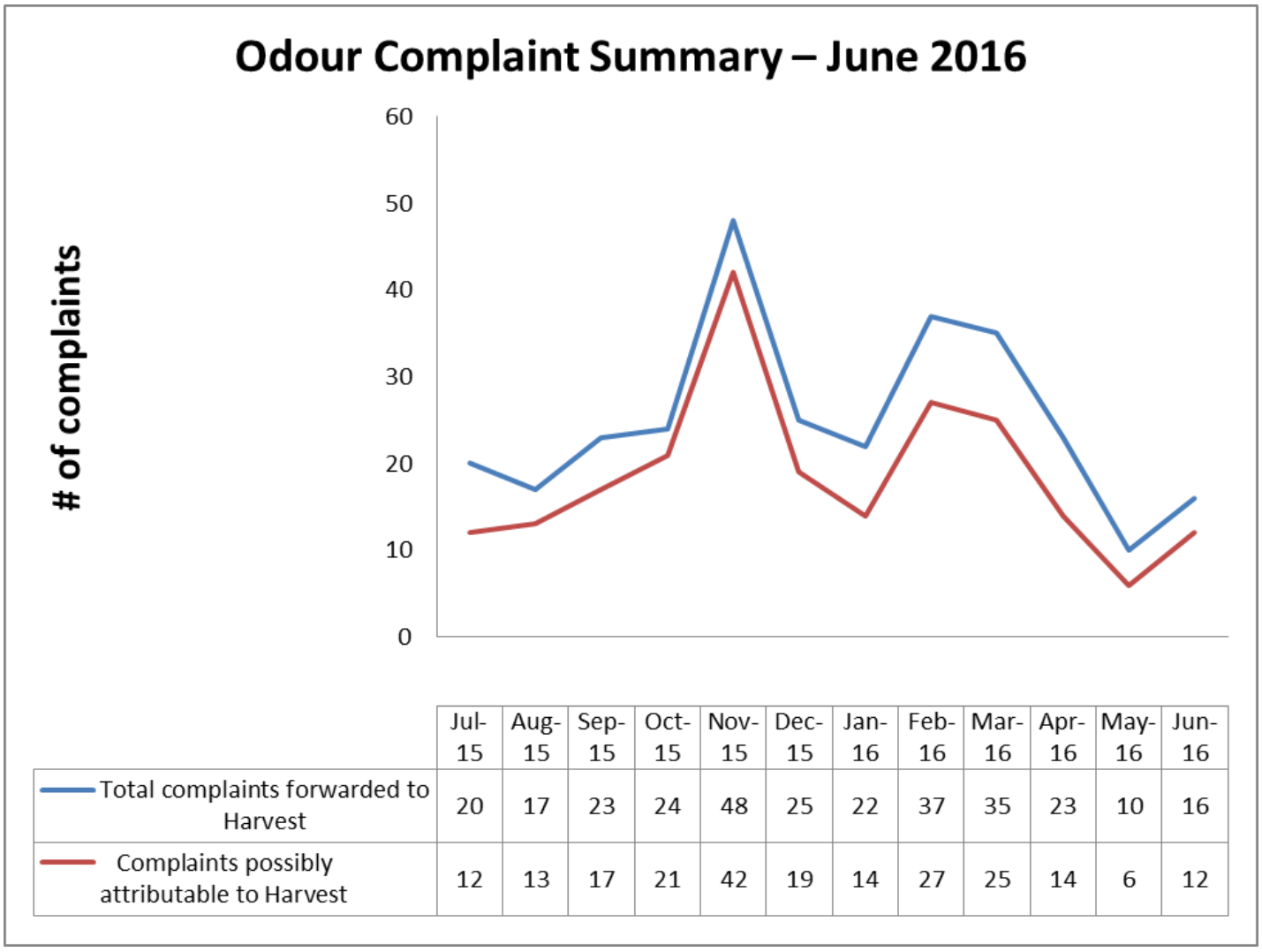


Figure 2: Wind direction by stability class

Frequency of odour complaints has varied considerably over the past year (August 2015 to June 2015) although complaints have been trending downward since February 2016. Historically odour complaints were analyzed based on the meteorological data from a single, on-site weather station. Since the beginning of 2014, weather data from four local Ministry of Environment weather stations[2] has been analyzed in establishing whether or not Harvest is a possible source of the odour. This increased reliance on regional data has led to increased confidence in the assignment of odour complaints.

Our analysis suggests that approximately 65-70% of total complaints received can possibly be attributed to Harvest, based on wind direction alone (see figure 3). Of note, Harvest tends to see a spike in odour complaints following any news reports on Harvest which was noticeable in both Q4 2015 (9 reports) and Q1 2016 (6 reports).

[2] Burnaby South, North Delta, Richmond South, YVR



	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16
Total complaints forwarded to Harvest	20	17	23	24	48	25	22	37	35	23	10	16
Complaints possibly attributable to Harvest	12	13	17	21	42	19	14	27	25	14	6	12

Figure 3: Number of odour complaints by month

5.2 Progressive Mitigation

Based on our investigation of the data and consultations with experts around odour science and operations, Harvest may consider the following options and measures for reducing any objectionable odours, should they occur:

1. Minimize use of the Auxiliary Screener, relative to reliance on the (enclosed) Primary Screener.
2. Check to ensure that material to be processed through the Auxiliary Screener has been adequately cured. The Approval specifies timing and oxygen requirements and these should be met, at a minimum.
3. Schedule movement of organic material during daytime and more unstable atmospheric conditions
4. Avoid moving material from curing to screening and avoid operating the Auxiliary Screener during times when meteorological conditions increase the probability of causing off-site odours such as warm and still night times, weekends and statutory holidays, atmospheric inversions, and constant wind speed and direction, especially from the east and south. During summer months, consider starting screening operations at dawn – though be careful to monitor odour impact and discontinue if complaints arise.
5. Correlate on-site odour measurements and reported off-site complaints, with timing, maturity of material to be screened, operating hours of the Auxiliary Screener and meteorological conditions to determine more and less favorable operating protocols. Adjust operations accordingly and re-measure.
    - The Odour Management Team should review this data at least monthly from July through September, or more frequently if necessary.
    - Thereafter, the Odour Management Team should determine an appropriate review schedule, based on experience.
    - Schedule review of available data and operational history as part of 2017 revision of this POMP.

6. Literature & Relevant Literature

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