



# COMOX VALLEY WATER POLLUTION CONTROL CENTRE

COMOX, BC

ODOUR ASSESSMENT\_DRAFT

RWDI # 1904012

October 16, 2019

## SUBMITTED TO

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## EXECUTIVE SUMMARY

RWDI was retained by the Comox Valley Regional District (CVRD) to conduct an odour assessment for the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC. The odour assessment included the measurement of odour sources at the CVWPCC which were then used to calculate emission rates input into a dispersion model to predict off-site odours due to the facility operations. The methodology and results of the odour sampling programs is discussed in separate memos (RWDI, 2019a & 2019b). This report discusses the results of the odour modelling.

The CVWPCC is a secondary level wastewater treatment plant that provides improved wastewater treatment to the City of Courtenay, the Town of Comox, the Department of National Defence and the K'omoks First Nation. The plant is located east of the Town of Comox in a rural area adjacent to the Salish Sea.

This study was a continuation of a series of studies performed by RWDI since 2015. The purpose of this assessment was to assess the impact of recent mitigation measures to reduce off-site odours which are negatively impacting the neighboring community. The mitigation strategies used by CVWPCC include adding an activated charcoal polisher downstream of the current wet scrubber system and, covering the Primary Clarifier (determined to be a major source of odour in a previous study) and routing its emissions to the current scrubbing system.

In addition to the current configuration, two additional scenarios were modelled: (a) current configuration with the stack removed (i.e., release at building height), and (b) a mitigation scenario, where it was assumed that the bioreactors are covered, and emissions are directed through the scrubber for removal. The removal efficiency for this scenario was based on the recently measured efficiency of the scrubber and polisher.

The results showed that the current configuration successfully reduced odour exceedances from the scrubber/stack system. Also, it was predicted that removing the stack and releasing at the building height will adversely affect the predicted off-site odour levels. The modelling results for the mitigation scenario (b), with the secondary bioreactors covered, showed that the applying this measure will successfully eliminate odour exceedances at the sensitive receptors.



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# 1 INTRODUCTION

RWDI was retained by the Comox Valley Regional District (CVRD) to conduct an odour assessment for the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC (the facility). The assessment consists of two parts: (a) an odour sampling program that includes the collection of samples at several emission points throughout the facility and analysis of those samples by an odour panel located in Mississauga, Ontario; and (b) odour modelling, to predict the impact of the facility operations on off-site odour levels using the results of the sampling program and advanced dispersion modelling.

The methodology and results of the odour sampling programs are provided in two separate memos (RWDI, 2019a & 2019b). This current report presents the assessment approach, and, provides a discussion of the results of the odour modelling assessment.

## 1.1 Project Description and Background

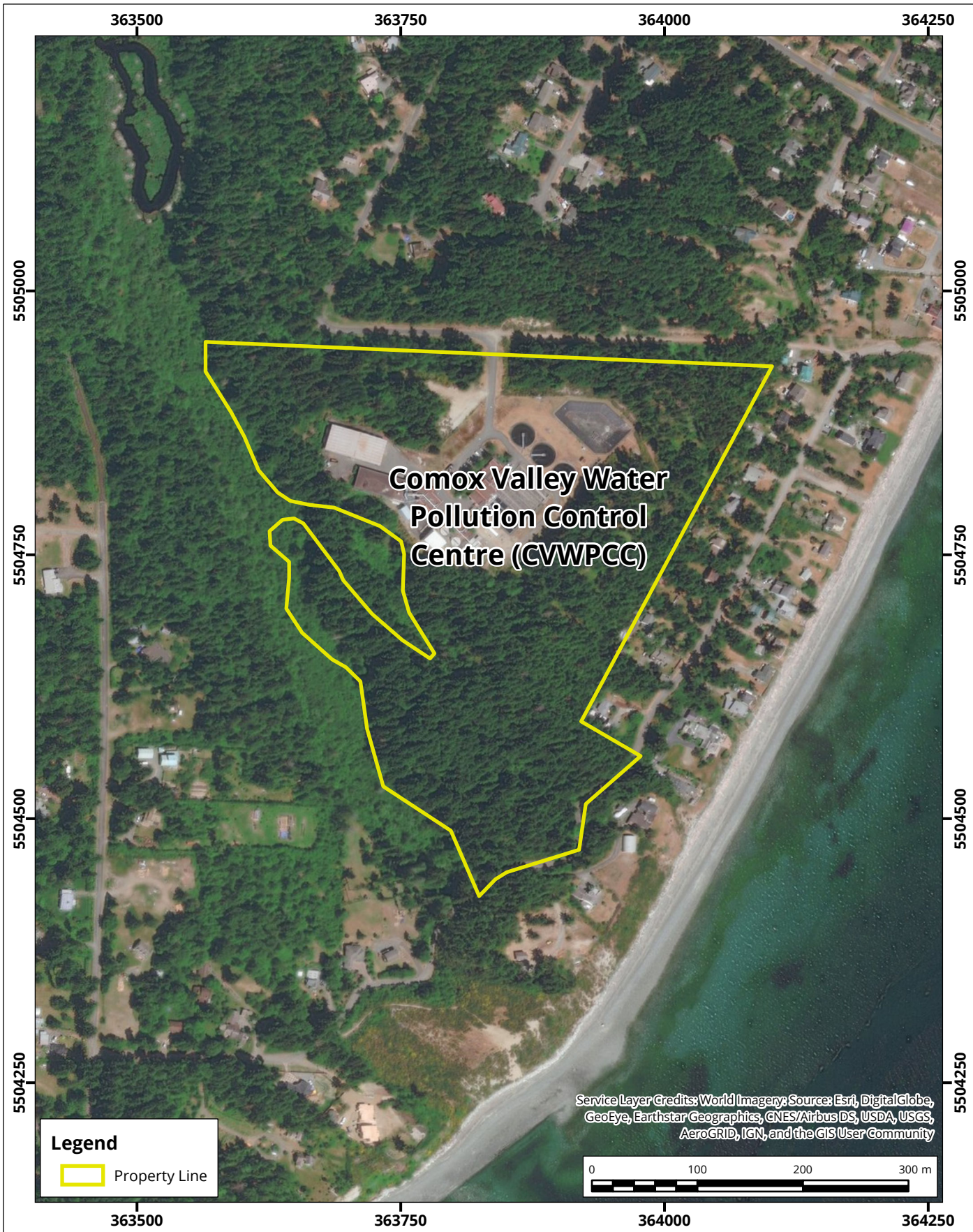
The CVWPCC is a secondary level wastewater treatment plant that provides improved wastewater treatment to the City of Courtenay, the Town of Comox, the Department of National Defence and the K'omoks First Nation. The plant is located east of the Town of Comox in a rural area adjacent to the Salish Sea (Figure 1 Figure 1).

Soon after start-up in 1984 the CVRD began to receive odour complaints related to plant operation. These complaints tended to be from residents along Curtis Road where odours are more frequent, especially on evenings in the late summer or early fall when certain weather conditions (off-shore wind) prevail.

RWDI has performed a number of assessments since 2015 including site observations in January 2015, additional assessments in the Spring of 2015, odour and hydrogen sulfide site measurements in August 2016 and numerical odour modelling with mitigation analysis in Fall of 2016. The results of all these assessments were compiled in a full odour assessment report in March 2017 (RWDI, 2017).


The mitigation study in 2016 suggested that the best mitigation strategy is to install a bio-filter type system on the scrubber stack, since the model predicted that it has the largest impact on odour. However, even with additional control on the stack, the site would still have significant odour impacts associated with the primary clarifiers and the bioreactors. RWDI further recommended that the bioreactor tanks be covered and vented through the scrubber stack with an improved control efficiency.

Since then, the CVWPCC has taken mitigation measures to reduce the odour impact of their operations. An activated carbon polisher on the stack downstream of the existing wet chemical scrubber has been installed. In addition, the primary clarifiers have been covered and has been tied into the existing odour control collection system. The bioreactors and secondary clarifiers remain uncovered.



**Comox Valley Water  
Pollution Control  
Centre (CVWPCC)**

**Legend**

 Property Line

Service Layer Credits: World Imagery; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map Document: C:\Users\djh\OneDrive - ROWAN WILLIAMS DAVIES & IRWIN INC.\GIS Temp\1904012\1904012\_Comox\_Odour.aprx

**Site Map**

Map Projection: NAD 1983 UTM Zone 10N  
Comox Valley Water Pollution Control Centre - Comox, B.C.



|                            |           |
|----------------------------|-----------|
| Drawn by: DJH              | Figure: 1 |
| Approx. Scale: 1:5,000     |           |
| Date Revised: Jul 26, 2019 |           |



Project #: 1904012



## 1.2 Objectives

The main objective of this assessment is to predict the off-site odour levels from the operations of the CVWPCC and to review the effectiveness of the applied mitigation measures on ambient odour levels.

This report provides modelled maximum ambient odour levels resulting from the current configuration of the facility at several sensitive receptors around the CVWPCC property, and, compares them with the values from the previous study. In addition, frequency of exceedances from odour unit (OU) thresholds of 1 OU, 2 OU and 5 OU are provided to better understand the overall effect on off-site odours.

Two additional scenarios were also modelled and compared: (a) current configuration with the stack removed (i.e., release at building height), and (b) a modified configuration to explore the mitigation strategy of covering the secondary bioreactor and directing its emissions through odour control infrastructure.

The parameters, meteorological data, and CALPUFF modelling used in this assessment were similar to the ones used in the previous dispersion model.

## 2 MODELLING APPROACH

A dispersion model study was conducted to determine the off-site areas that could be influenced by odour from the CVWPCC. The modelling was conducted using the CALPUFF regulatory dispersion model (version 7.2.1). CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal, and is the recommended model under the *British Columbia Air Quality Dispersion Modelling Guideline* (AQDMG, BC MOE, 2015).

As there is currently no odour standard in British Columbia, odour standards from Ontario's Ministry of the Environment, Conservation and Parks have been referenced (MECP, 2016). The MECP requires that a 10-minute odour-based standard is exceeded less than 0.5% of the time which corresponds to approximately 44 hours per year. The Ontario standard is similar to the methodology proposed by Metro Vancouver in *Odour Management Framework, A Guide to Odour Management in Metro Vancouver* (Metro Vancouver, 2017).

Similar to the previous study, the calendar year of 2014 was selected for the model year as it originally represented the most recent year for which the BC MOE meteorological data required for use in the model study were available from the nearest monitoring station. This allows for a direct comparison of the results of this study to the previous ones, and a better understanding of the effects of the applied mitigation measures.

The ISC-type meteorological data file (one year of hourly single point meteorology) was used as input to the CALPUFF dispersion model to predict the maximum odour levels resulting from estimated emissions. To understand the contribution of various sources, emissions sources were modelled separately. The total contribution from all sources was also modelled.

It should be noted that numerical modelling is a conservative approach. The emission factors input into the model are obtained using reasonably conservative assumptions were applicable. Model results represent the worst-case meteorological conditions that occurred during the modelling period.

## 2.1 Odour Source Characterization

Five (5) odour sources (Figure 2) were input to the model as follows:

- one point source to represent the scrubber/stack;
- one area source to represent the secondary bioreactor; and,
- three area sources to represent the secondary clarifiers.

Note that the primary clarifiers are now covered, tied into the existing odour control collection system and routed to the scrubber stack for removal. Therefore, the primary clarifiers are not included in the model. Any unremoved emissions are captured in the estimated emissions from the stack.

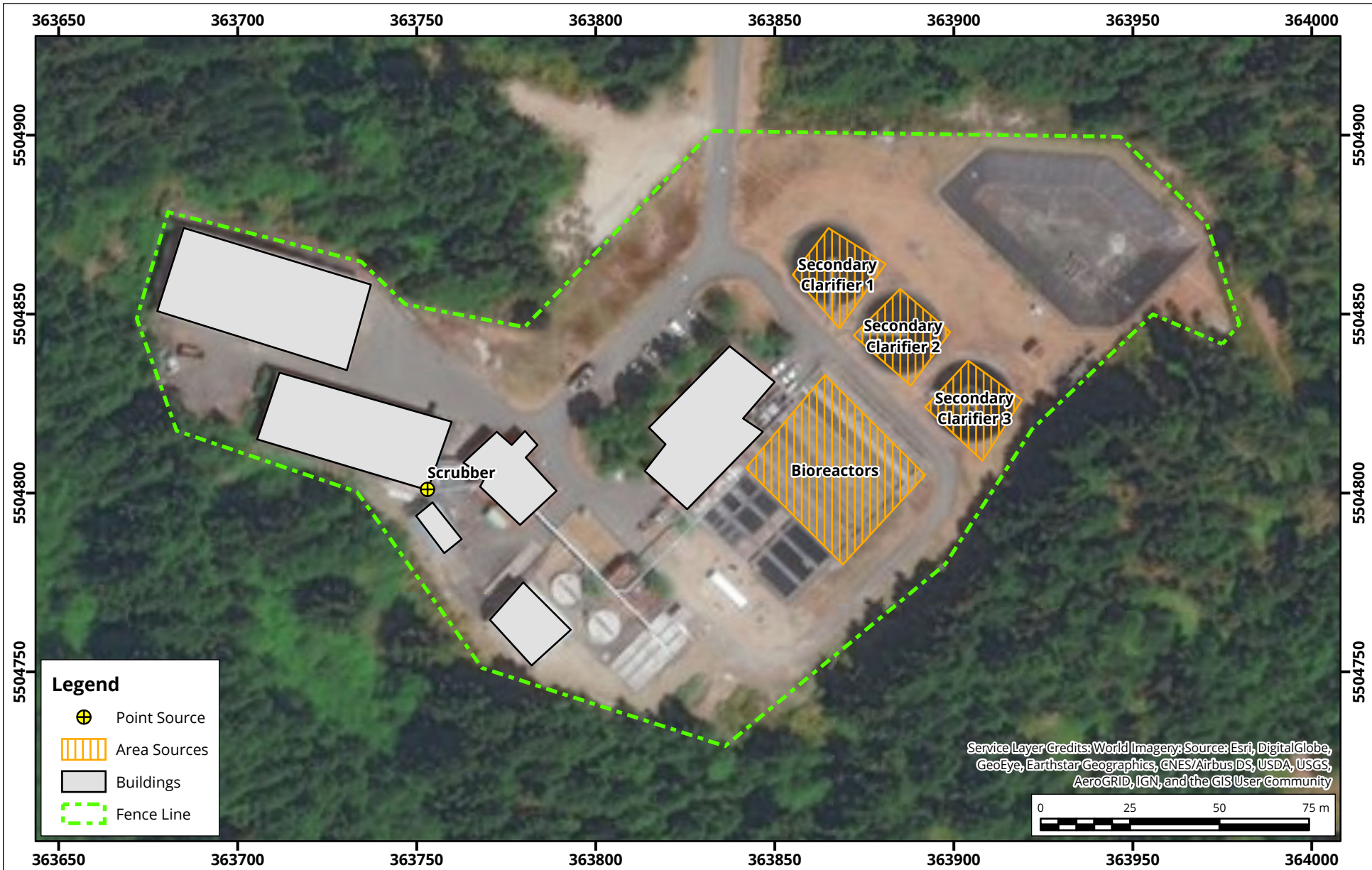
The scrubber stack height (17 m from the ground) and the stack inner diameter (1 m) were provided by CVWPCC. The exit velocity (23.30 m/s) and exit temperature (11°C) were estimated based on measurements during the sampling performed in June 2019. Clarifiers and bioreactors were modelled as area sources; the release height for all area sources was estimated to be 1 m from the ground, and surface areas were estimated from the exposed surface of each bioreactor and clarifier.

Emission rates are expressed in Odour Units per second (OU/s). An odour unit is defined as the amount of odorant that when dispersed in a cubic metre of clean air would be detectable to 50% of the population.

The emission rates for the scrubber stack and the secondary bioreactor are based on onsite odour sampling completed on September 19, 2019 by RWDI and analyzed by Environmental Odour Consulting Corporation, in Oakville Ontario. Details of the testing and analysis results are contained in Appendix A and Appendix B. The secondary clarifiers were not sampled this year, and emission rates from the previous study (RWDI, 2017) were used.

For scenario (b), it was considered that the secondary bioreactor is covered, and its emissions are routed to the scrubber stack for removal. Therefore, emission rate of the secondary bioreactor source was set to zero for this scenario. The removal efficiency of the scrubber system was calculated using an average of removal efficiencies based on odour sampling performed on June 20 (RWDI, 2019a), odour sampling performed on September 19 (RWDI, 2019b), and the total reduced sulphur sampling performed on September 4, 2019 (RWDI, 2019b). The unremoved portion of odours from the bioreactors were added to the odour emission rate of the scrubber in scenario (a).

Modelled emission rates are provided in Table 1.



## Modelled Sources and Buildings

Map Projection: NAD 1983 UTM Zone 10N

Comox Valley Water Pollution Control Centre - Comox, B.C.

True North



Drawn by: DJH

Figure: 2

Approx. Scale: 1:1,500

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**Table 1: Modelled Emission Rates**

| Emission Source       | Source Type    | Surface Area (m <sup>2</sup> ) | Emission Flux (OU/s/m <sup>2</sup> ) | Emission Rate (OU/s) |
|-----------------------|----------------|--------------------------------|--------------------------------------|----------------------|
| Scrubber/Stack        | Point          | -                              | -                                    | 3,051 <sup>1</sup>   |
|                       |                |                                |                                      | 3,287 <sup>2</sup>   |
| Secondary Bioreactors | Area           | 1320.0                         | 1,26 <sup>1</sup>                    | 1,663 <sup>1</sup>   |
|                       |                |                                | 0.0 <sup>2</sup>                     | 0.0 <sup>2</sup>     |
| Secondary Clarifier 1 | Area           | 368.5                          | 0.0888                               | 32.5                 |
| Secondary Clarifier 2 | Area           | 366.0                          | 0.0888                               | 32.5                 |
| Secondary Clarifier 3 | Area           | 382.0                          | 0.0888                               | 32.5                 |
| All Sources           | Point and Area | 2436.5                         | -                                    | 4,812 <sup>1</sup>   |
|                       |                |                                |                                      | 3,385 <sup>2</sup>   |

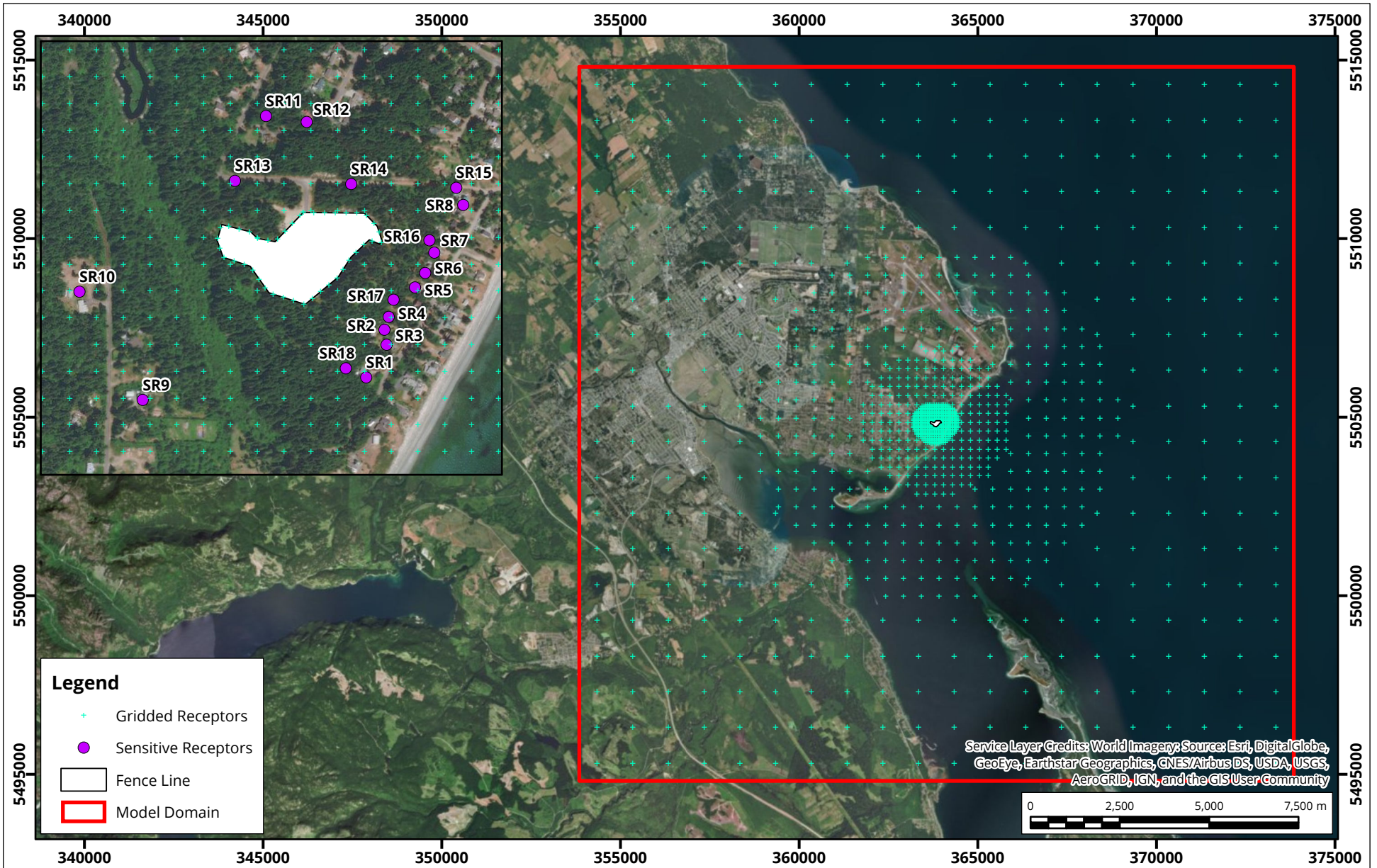
Notes: Primary clarifiers have been recently covered and emissions are routed to the scrubber emissions.  
 1. Presents emissions for current configuration; and scenario (a) = current configuration with a low (6.6 m) stack height  
 2. Presents emissions for mitigation scenario (b): current configuration with the secondary bioreactors covers and emissions routed to the scrubber stack

## 2.2 Meteorological Data

Meteorological data file from the previous study was used in this assessment. Meteorological information for CALPUFF was provided using a single station ISC-type meteorological data file. This was developed from measurements for the model period of 2014 from the Courtenay station that is part of the BC MOE network of stations. As per the BC AQDMG the mixing heights were derived using the ‘plume+1’ approximation and surface meteorological data.

## 2.3 Model Domain

In accordance with the BC AQDMG, a 20 km by 20 km CALPUFF model domain shown in Figure 3, was selected to capture the effects of facility operations on ambient odour levels. Model predictions are reported at discrete receptor locations within this domain.



## Receptors and Modelling Domain

Map Projection: NAD 1983 UTM Zone 10N

Comox Valley Water Pollution Control Centre - Comox, B.C.

True North



Drawn by: DJH | Figure: 3

Approx. Scale: 1:150,000

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## 2.4 Receptors

Receptor locations were chosen in accordance with BC AQDMG. Local elevation data were used to determine receptor elevations so that topography in the area of the facility is properly represented. Terrain elevations for all other receptors included as input to the CALPUFF model were extracted from 1:50,000 scale Canadian Digital Elevation Data obtained from GeoGratis.

Receptor spacing for the Cartesian grid is as follows:

- 20-m spacing along the terminal fence line;
- 50-m spacing within 500 m of the terminal;
- 250-m spacing within 2 km of the terminal;
- 500-m spacing within 5 km of the terminal; and
- 1,000-m spacing for the remainder of the study area.

Twelve special receptors were identified as the nearest residences in various directions from the CVWPCC property boundary and were used in the previous modelling. For this study, 6 additional receptors were added at the CVWPCC property boundary. Locations of all sensitive receptors are shown in Figure 3. Please note that the Ontario odour guideline does not apply at the property line. The guideline applies at sensitive odour receptors, in this case the residences.

## 2.5 Post-processing of Model Results

Post-processing of hourly model results was conducted to determine required results for comparison with odour standards. Model results are expressed as odour units (OU) and represent worst-case values over the 1 year of meteorological data.

The modelled concentrations were converted from 1-hour based averages to a 10-minute averaging time (typical for odour assessments) using a 1.65 conversion factor as per the Ministry of the Environment, Conservation and Parks (MECP), formerly Ontario Ministry of Environment and Climate Change, guidance document Methodology for Modelling Assessments of Contaminants with 10-Minute Average Standards and Guidelines (MECP, 2016). Frequencies of exceedances from the 1 OU, 2 OU and 5 OU thresholds are also calculated.

## 3 MODEL RESULTS

Numerical modelling is a conservative approach, it represents the worst-case scenario and is the preferred protocol in Ontario by the MECP and other jurisdictions. This is currently the only guideline value in any Canadian jurisdiction, so it has been used in this study, though strictly speaking it does not apply. It also is only meant to be applied at critical receptors such as residences and is not applied at the fence line.

### 3.1 Current Configuration

Isopleths showing the maximum predicted 10-minute average odour levels are presented in Figure 4. The maximum odour levels were predicted to occur at the property as expected. The area where maximum odour level was predicted to be greater than 1 OU extends ~1 km from the CVWPCC. The MECP odour guideline allows for the odour levels to exceed the 1OU threshold for 0.5% of times or 44 hours per year. Isopleths showing the frequency of exceedance from the 1 OU threshold are presented in Figure 5.

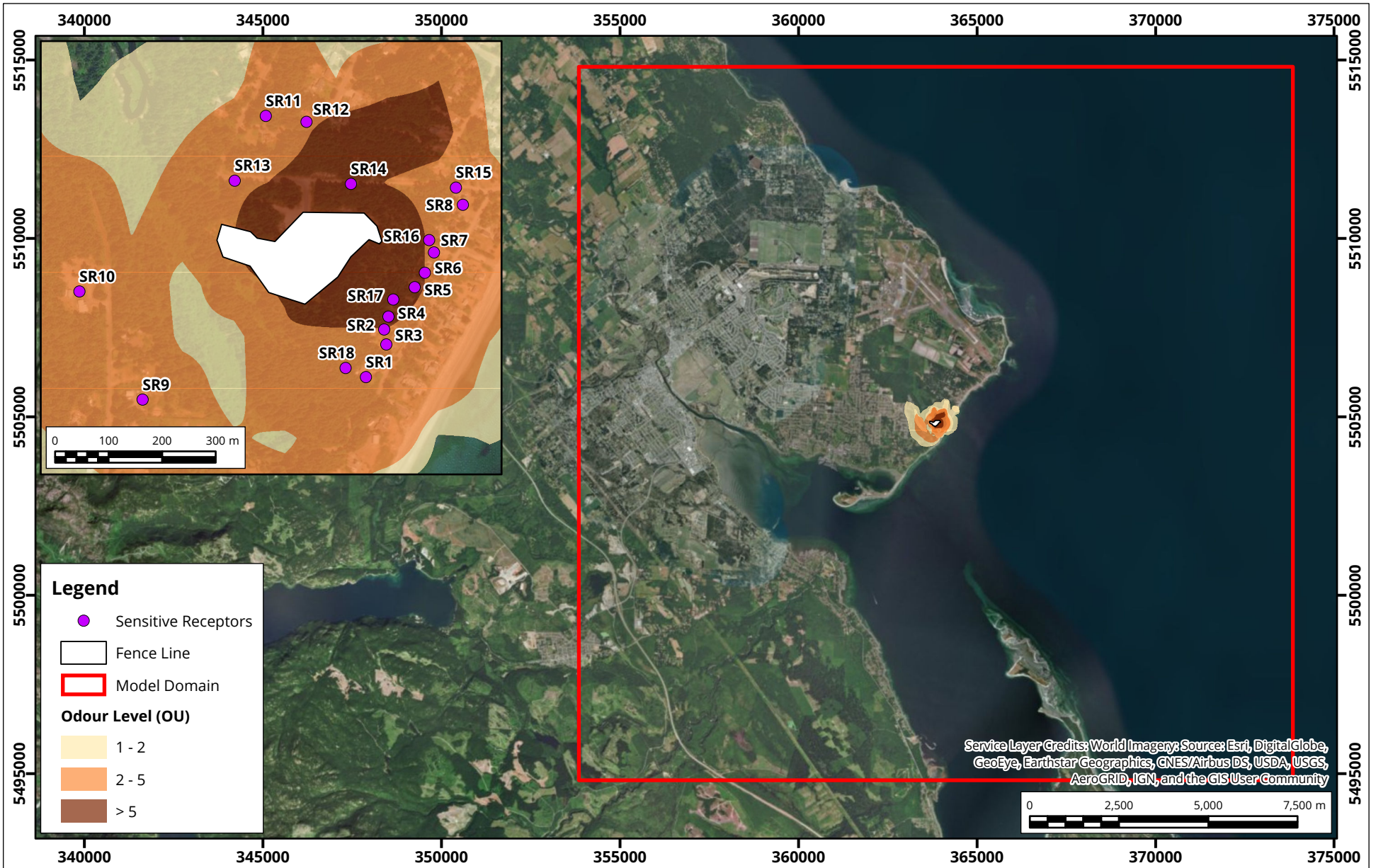
Maximum predicted 10-minute average odour levels and the frequency of exceeding the 1OU and 5 OU thresholds at all sensitive receptors are presented in Table 2. Results from the previous study are also presented for comparison. At all sensitive receptors except SR1, SR18 and SR9, the frequencies of exceedance from the 1 OU threshold were greater than the MECP guideline of 0.5% or 44 hours per year. At 2 OU, the exceedance percentage of 0.5% was exceeded for 10 sensitive receptors. At 5 OU the exceedance percentage of 0.5% was exceeded for only 2 sensitive receptors. The sensitive receptor with the greatest predicted odour level is SR14 to the north of the facility.

### 3.2 Additional Scenarios

In addition to the current configuration of the facility, 2 additional scenarios were modelled: (a) current configuration with the stack removed (i.e., release at building height), and (b) a modified configuration where it was assumed that the secondary bioreactor is covered, and its emissions are redirected to the scrubber/polisher and released through the stack. The modelling results for these additional scenarios are also shown in Table 2. Removal of the stack, resulted in an increase of the off-site odour levels, while covering the bioreactors and mitigating their emissions through the scrubber resulted in reduced off-site odour levels.

For the existing configuration, compared to the previous modelling results, maximum predicted odour levels were decreased for all sensitive receptors. This is mainly attributed to the mitigation measures applied by the CVWPCC; with the addition of the activated carbon polisher to the scrubber stack, the emission rates from the stack were reduced significantly. In addition, the primary clarifier was covered and therefore not present in this round of modelling.

To better understand the effect of each source on the off-site odour levels, and also to evaluate the effectiveness of the applied mitigation measures, maximum contribution of each source to odour levels are presented in Table 3. As can be seen in Table 3, the secondary bioreactor has the highest impact on the off-site odour levels. Also, removing the stack, or removing the scrubber, will adversely affect the odour levels.



## Maximum Predicted Odour Levels for the Current Facility Configuration

Map Projection: NAD 1983 UTM Zone 10N

Comox Valley Water Pollution Control Centre - Comox, B.C.

True North



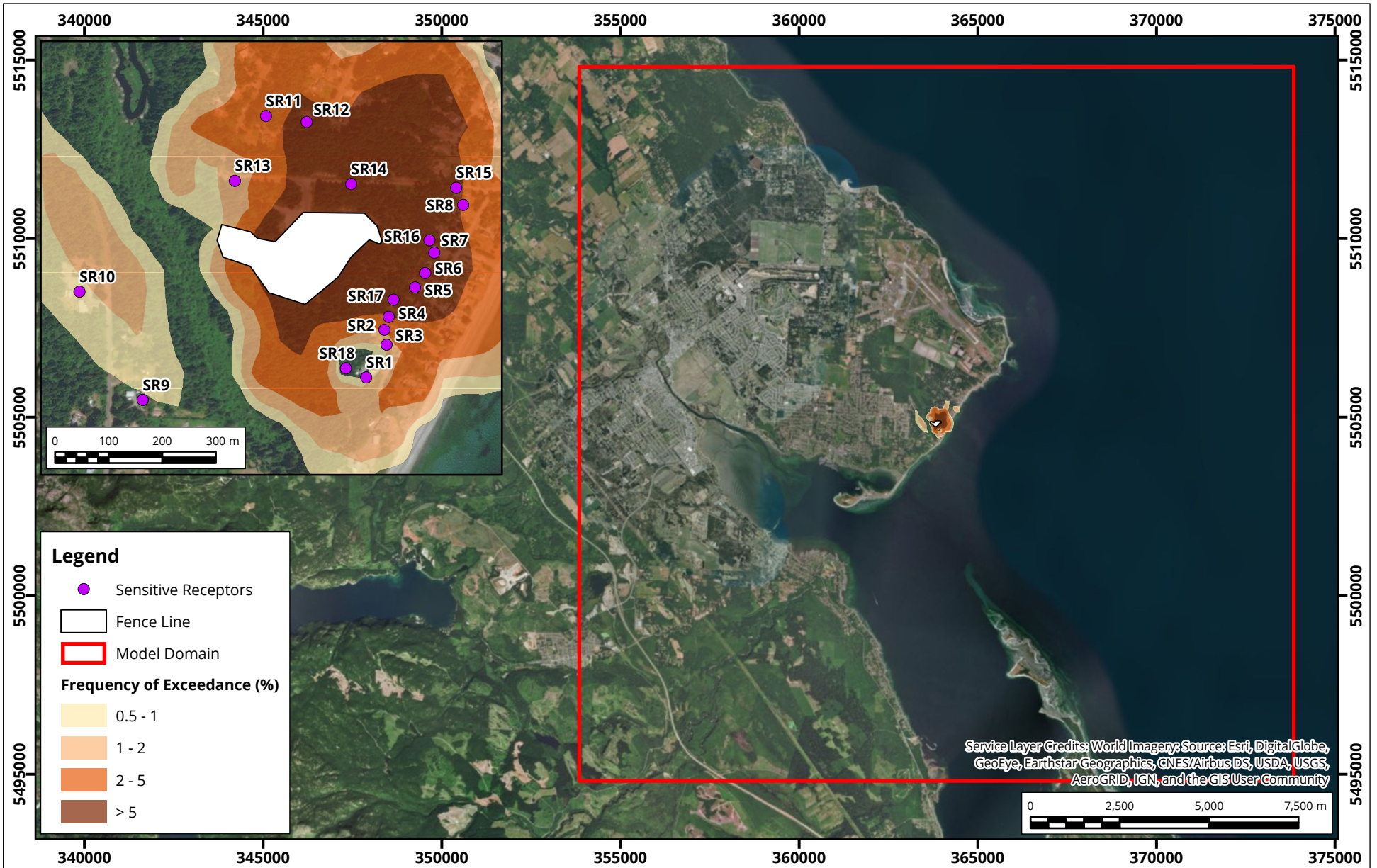
Drawn by: DJH | Figure: 4

Approx. Scale: 1:150,000

Date Revised: Oct 8, 2019

Project #: 1904012





## Frequency of Exceedances from 1 OU Threshold for the Current Facility Configuration



|                           |           |
|---------------------------|-----------|
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| Approx. Scale: 1:150,000  |           |
| Date Revised: Oct 8, 2019 |           |



Map Projection: NAD 1983 UTM Zone 10N

Comox Valley Water Pollution Control Centre - Comox, B.C.

Project #: 1904012



**Table 2: Maximum Predicted Odour Levels at Sensitive Receptors based on 10-minute averaging period and Frequency of Exceedance from 1 OU, 2 OU and 5 OU Thresholds**

| Sensitive Receptor | Lat     | Lon      | Previous Model |                              | Odour Level (OU) |              |              | Frequency of 1 OU Exceedance (%) |              |              | Frequency of 2 OU Exceedance (%) |              |              | Frequency of 5 OU Exceedance (%) |              |              |
|--------------------|---------|----------|----------------|------------------------------|------------------|--------------|--------------|----------------------------------|--------------|--------------|----------------------------------|--------------|--------------|----------------------------------|--------------|--------------|
|                    |         |          | Odour Level    | Freq. of 1 OU Exceedance (%) | Current config.  | Scenario (a) | Scenario (b) | Current config.                  | Scenario (a) | Scenario (b) | Current config.                  | Scenario (a) | Scenario (b) | Current config.                  | Scenario (a) | Scenario (b) |
| SR1                | 363.95  | 5504.593 | 5.45           | 4.1                          | 1.33             | 1.33         | 0.32         | 0.15%                            | 0.16%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR2                | 363.984 | 5504.683 | 6.8            | 13.7                         | 5.01             | 5.01         | 0.37         | 1.82%                            | 2.04%        | 0.00%        | 0.59%                            | 0.61%        | 0.00%        | 0.01%                            | 0.01%        | 0.00%        |
| SR3                | 363.988 | 5504.654 | 5.9            | 10.8                         | 3.75             | 3.76         | 0.35         | 0.82%                            | 0.88%        | 0.00%        | 0.13%                            | 0.14%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR4                | 363.992 | 5504.707 | 8.5            | 16.3                         | 6.12             | 6.13         | 0.38         | 4.58%                            | 5.19%        | 0.00%        | 2.04%                            | 2.13%        | 0.00%        | 0.10%                            | 0.10%        | 0.00%        |
| SR5                | 364.041 | 5504.762 | 11.1           | 18.4                         | 4.95             | 5.71         | 0.40         | 9.08%                            | 9.52%        | 0.00%        | 4.41%                            | 4.90%        | 0.00%        | 0.00%                            | 0.07%        | 0.00%        |
| SR6                | 364.06  | 5504.789 | 10.6           | 17.3                         | 4.74             | 5.55         | 0.41         | 8.53%                            | 8.84%        | 0.00%        | 4.01%                            | 4.65%        | 0.00%        | 0.00%                            | 0.06%        | 0.00%        |
| SR7                | 364.077 | 5504.827 | 10.0           | 15.9                         | 4.17             | 4.94         | 0.48         | 7.39%                            | 7.69%        | 0.00%        | 3.24%                            | 3.88%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR8                | 364.131 | 5504.916 | 9.7            | 11.7                         | 2.94             | 3.45         | 0.59         | 3.73%                            | 4.27%        | 0.00%        | 0.46%                            | 0.90%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR9                | 363.533 | 5504.551 | 4.57           | 0.8                          | 3.35             | 3.36         | 0.38         | 0.46%                            | 0.46%        | 0.00%        | 0.08%                            | 0.08%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR10               | 363.415 | 5504.753 | 5.22           | 2.6                          | 3.28             | 3.29         | 0.40         | 0.86%                            | 0.89%        | 0.00%        | 0.24%                            | 0.24%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR11               | 363.763 | 5505.082 | 6.54           | 11.4                         | 2.55             | 2.55         | 0.45         | 3.07%                            | 3.20%        | 0.00%        | 0.19%                            | 0.19%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR12               | 363.839 | 5505.07  | 7.7            | 15.6                         | 6.27             | 6.27         | 0.47         | 7.04%                            | 7.18%        | 0.00%        | 4.60%                            | 4.60%        | 0.00%        | 0.92%                            | 0.92%        | 0.00%        |
| SR13               | 363.705 | 5504.96  | -              | -                            | 3.71             | 3.71         | 0.51         | 1.46%                            | 1.46%        | 0.00%        | 0.40%                            | 0.40%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR14               | 363.922 | 5504.955 | -              | -                            | 7.18             | 7.18         | 0.50         | 10.27%                           | 10.79%       | 0.00%        | 8.58%                            | 8.60%        | 0.00%        | 2.44%                            | 2.45%        | 0.00%        |
| SR15               | 364.118 | 5504.947 | -              | -                            | 2.91             | 3.46         | 0.59         | 7.39%                            | 7.84%        | 0.00%        | 1.60%                            | 2.00%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR16               | 364.068 | 5504.85  | -              | -                            | 4.40             | 5.27         | 0.57         | 7.42%                            | 7.76%        | 0.00%        | 3.44%                            | 3.93%        | 0.00%        | 0.00%                            | 0.03%        | 0.00%        |
| SR17               | 364.001 | 5504.738 | -              | -                            | 6.41             | 6.55         | 0.42         | 8.90%                            | 9.35%        | 0.00%        | 5.09%                            | 5.61%        | 0.00%        | 0.49%                            | 0.51%        | 0.00%        |
| SR18               | 363.912 | 5504.61  | -              | -                            | 1.53             | 1.53         | 0.32         | 0.21%                            | 0.21%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |

Notes: Scenario (a) = current configuration with a low (6.6 m) stack height  
Scenario (b) = current configuration with the secondary bioreactors covers and emissions routed to the scrubber stack



Table 3: Odour Levels and Frequencies of Exceedance Resulting from each Individual Source

| Sensitive Receptor | Odour Levels (OU) |             |                       |                      | Frequency of Exceedances from 1 OU |             |                       |                      |
|--------------------|-------------------|-------------|-----------------------|----------------------|------------------------------------|-------------|-----------------------|----------------------|
|                    | 17 m Stack        | 6.6 m Stack | Secondary Bioreactors | Secondary Clarifiers | 17 m Stack                         | 6.6 m Stack | Secondary Bioreactors | Secondary Clarifiers |
| SR1                | 0.37              | 0.76        | 1.27                  | 0.07                 | 0.00%                              | 0.00%       | 0.11%                 | 0.00%                |
| SR2                | 0.40              | 1.21        | 4.94                  | 0.11                 | 0.00%                              | 0.02%       | 1.75%                 | 0.00%                |
| SR3                | 0.39              | 1.09        | 3.73                  | 0.08                 | 0.00%                              | 0.02%       | 0.79%                 | 0.00%                |
| SR4                | 0.40              | 1.10        | 6.06                  | 0.26                 | 0.00%                              | 0.01%       | 4.26%                 | 0.00%                |
| SR5                | 0.42              | 1.32        | 4.85                  | 0.35                 | 0.00%                              | 0.15%       | 8.31%                 | 0.00%                |
| SR6                | 0.43              | 1.26        | 4.27                  | 0.30                 | 0.00%                              | 0.13%       | 7.74%                 | 0.00%                |
| SR7                | 0.43              | 1.17        | 3.66                  | 0.25                 | 0.00%                              | 0.15%       | 6.70%                 | 0.00%                |
| SR8                | 0.53              | 1.25        | 2.54                  | 0.16                 | 0.00%                              | 0.07%       | 2.79%                 | 0.00%                |
| SR9                | 0.36              | 0.40        | 3.18                  | 0.17                 | 0.00%                              | 0.00%       | 0.42%                 | 0.00%                |
| SR10               | 0.37              | 0.68        | 3.10                  | 0.18                 | 0.00%                              | 0.00%       | 0.79%                 | 0.00%                |
| SR11               | 0.49              | 1.29        | 2.43                  | 0.18                 | 0.00%                              | 0.10%       | 2.83%                 | 0.00%                |
| SR12               | 0.48              | 1.42        | 5.91                  | 0.36                 | 0.00%                              | 0.11%       | 6.77%                 | 0.00%                |
| SR13               | 0.50              | 0.64        | 3.66                  | 0.25                 | 0.00%                              | 0.00%       | 1.36%                 | 0.00%                |
| SR14               | 0.45              | 1.61        | 6.80                  | 0.38                 | 0.00%                              | 0.33%       | 9.95%                 | 0.00%                |
| SR15               | 0.56              | 1.33        | 2.53                  | 0.16                 | 0.00%                              | 0.18%       | 6.40%                 | 0.00%                |
| SR16               | 0.45              | 1.33        | 3.91                  | 0.26                 | 0.00%                              | 0.19%       | 6.50%                 | 0.00%                |
| SR17               | 0.42              | 1.23        | 6.33                  | 0.42                 | 0.00%                              | 0.07%       | 8.16%                 | 0.00%                |
| SR18               | 0.37              | 0.68        | 1.46                  | 0.08                 | 0.00%                              | 0.00%       | 0.19%                 | 0.00%                |



## 4 CONCLUSIONS AND RECOMMENDATIONS

RWDI was retained by the Comox Valley Regional District (CVRD) to conduct an odour assessment for the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC. A dispersion model was used to assess the impact of recent mitigation measures used by CVWPCC which included adding an activated charcoal polisher downstream of the current wet scrubber system and covering the primary clarifiers which are tied in with the current scrubbing system.

The results of the odour sampling part of the assessment were presented in two separate memos (RWDI, 2019a & 2019b), and were used in the current dispersion modelling. The model results show that the mitigation measures successfully reduced the off-site odour impact from the scrubber/stack.

One additional scenario for the stack/scrubber was modelled to estimate the impacts of the scrubber and stack height on off-site odour predictions. The results showed that decreasing the stack height will adversely affect the off-site odour levels, and therefore, it is not recommended.

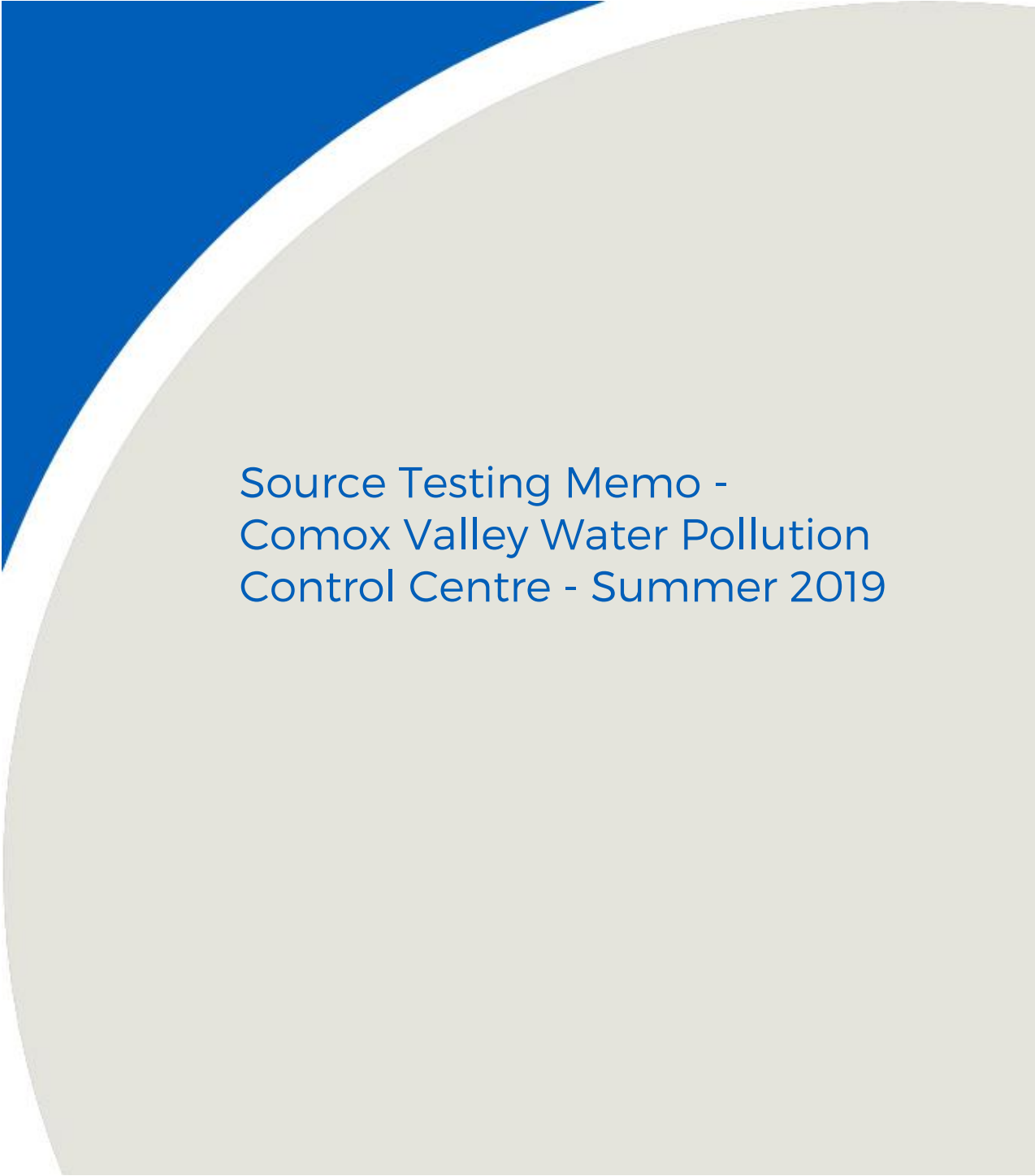
In addition, a mitigation scenario was modelled to investigate a mitigation measure where the secondary bioreactors are covered, and their emissions are rerouted to the scrubber stack for removal. Modelling results predicted that applying this measure will successfully eliminate odour exceedances at the sensitive receptors.



## 5 REFERENCES

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- Ministry of the Environment, Conservation and Parks (MECP, formerly Ministry of the Environment and Climate Change). 2016. Technical Bulletin: Methodology for Modelling Assessments of Contaminants with 10-Minute Average Standards and Guidelines. (<https://www.ontario.ca/page/methodology-modelling-assessments-contaminants-10-minute-average-standards-and-guidelines-under-o-reg>) Accessed: July 25, 2019.
- Metro Vancouver. 2017. Odour Management Framework: A Guide to Odour Management in Metro Vancouver. (<http://www.metrovancouver.org/services/air-quality/AirQualityPublications/Framework-ConsultationontheDevelopmentofanExpandedRegulatoryApproachtoManagingOdourinMetroVancouver.pdf>) Accessed July 25, 2019.
- RWDI. 2017. Comox Valley Water Pollution Control Center, Odour Assessment, March 30, 2017.
- RWDI. 2019a. Source Testing Memo - Comox Valley Water Pollution Control Centre - Summer 2019, July 2019.
- RWDI. 2019b. Source Testing Memo - Comox Valley Water Pollution Control Centre - September 2019, October 2019.

## APPENDIX A

A large decorative graphic on the left side of the page, featuring a blue triangle in the top-left corner and a large, light-grey semi-circle that overlaps the triangle and extends across the page.

Source Testing Memo -  
Comox Valley Water Pollution  
Control Centre - Summer 2019



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Vancouver BC Canada  
V6H 3V9

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E-mail: [solutions@rwdi.com](mailto:solutions@rwdi.com)

## MEMORANDUM

|              |  |                            |  |
|--------------|--|----------------------------|--|
| <b>DATE:</b> | 2019-07-31   | <b>RWDI Reference No.:</b> | 1904012  |
| <b>TO:</b>   | Zoe Berkey   | <b>EMAIL:</b>              | <a href="mailto:zberkey@comoxvalleyrd.ca">zberkey@comoxvalleyrd.ca</a> |
| <b>FROM:</b> | Matthew Sawycky  | <b>EMAIL:</b>              | <a href="mailto:matthew.sawycky@rwdi.com">matthew.sawycky@rwdi.com</a> |
| <b>CC:</b>   | John DeYoe   | <b>EMAIL:</b>              | <a href="mailto:john.deyoe@rwdi.com">john.deyoe@rwdi.com</a>           |
| <b>CC:</b>   | William Clarke   | <b>EMAIL:</b>              | <a href="mailto:william.clarke@rwdi.com">william.clarke@rwdi.com</a>   |
| <b>RE:</b>   | <b>Source Testing Memo - Comox Valley Water Pollution Control Centre - Summer 2019<br/>Comox, BC</b> |                            |  |

Zoe,

Please find this memorandum for methodology and results from testing at the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC (the facility).

RWDI conducted sampling at the facility on June 17<sup>th</sup> and 18<sup>th</sup>, 2019. Samples were collected for laboratory analysis of:

- odour,
- ammonia,
- chlorine and,
- sulfur compounds (list of sulfur compounds tested can be seen in Appendix A)

### **Odour Emissions Sampling Methodology**

As RWDI has the previous odour sampling results, August 2016, only sampling on the upgraded odour control system was completed. Engineering and design changes since August 2016 include the elimination of the prior open primary clarifiers, and an addition of an activated carbon polisher, after the wet chemical scrubber.

Sampling the upgraded odour control system was conducted to provide odour unit (OU) values for subsequent dispersion modelling to be conducted.



Sampling was conducted at:

1. odour control inlet (3 samples)
2. odour control outlet (3 samples)
3. odour control outlet, with scrubber turned off (3 samples)
4. bioreactor sampling (3 samples)

### **Inlet and Outlet Sampling**

The odour samples were collected through pre-existing sample ports, located at the inlet and outlet of the odour control unit using a lung sampler. The lung sampler utilizes a large container with an airtight lid and two air line fittings. A Tedlar bag is inserted into the container and a sample line is connected to the Tedlar bag. A vacuum is then applied to the cavity in the container which, through pressure differential, draws the sample air into the Tedlar sample bag; the sample bag was filled at a rate of less 5 L/min.

### **Flux Chamber Sampling**

Sampling at the bioreactor was conducted using a flux chamber.

Odour emissions from the waste water surface were measured using a floating flux chamber. The flux chamber is 40.6 cm in diameter; and approximately 35 cm high, and constructed of 14-gauge stainless steel, as per the designer's specifications outlined in Ontario Stack Testing Code Method ON-6. All interior and exterior fittings are constructed from odour neutral material being stainless steel and all lines were made from Teflon tubing with some variance at connections. The flux chamber is equipped with ports: one for sweep gas line and one for sample line. The chamber is fitted with a floatation device to hold it on top of the surface.

Ultra high purity nitrogen gas was used as the sweep gas, which was metered into the chamber at a constant rate of 5 litres per minute. The sweep gas was allowed to run through the chamber for 30 minutes prior to sample collection.

The odour samples were collected through a sample port on the flux chamber into a Tedlar bag using a lung sampler. The sample bag was filled at a rate of less 5 L/min in order to not significantly affect the equilibrium of the chamber.



## Odour Sample Analysis

Once collected, the samples were air shipped to Pinchin Ltd. Environmental Consulting, in Mississauga Ontario, for analysis by an eight-member odour panel within 24-hours of testing. The panel is tested prior to the odour analysis and the members are screened to have normal odour sensitivity. Details about the odour panel methodology are contained in Appendix B: Odour Evaluation Report from Pinchin Ltd.

Once the odour concentration of the samples has been determined, the odour flux rate is calculated. The sweep gas rate is used to calculate the odour flux rate based on the total air movement into the chamber. The formula that was used to calculate the odour flux rate is as follows:

$$\text{Odour Flux Rate} \left( \frac{\text{ou}}{\text{s} \cdot \text{m}^2} \right) = \frac{\text{Odour Concentration} \left( \frac{\text{ou}}{\text{m}^3} \right) \cdot \text{Sweep Rate} \left( \frac{\text{m}^3}{\text{s}} \right)}{\text{Area of flux chamber} (\text{m}^2)}$$

The odour flux rates from the bioreactor were simply averaged and the flux rate was applied to the total surface area of the bioreactor clarifiers.

## Chemical Compounds Sampling Methodology

At the request of CVWPCC, sampling was conducted for ammonia, chlorine and sulfur compounds. Sampling locations were requested by CVWPCC and included:

1. the inlet of bioreactor 1
2. the inlet of bioreactor 2 and,
3. the effluent outlet.

### Ammonia

Ammonia collection was conducted using ALS laboratory supplied silica tube media. Air was drawn from the flux chamber through the sample media at 200mL/min for 20 minutes, using a GilAir pump to collect the sample.

### Chlorine

Chlorine collection was conducted using ALS laboratory supplied cassette media. Air was drawn from the flux chamber through the sample media at 1L/min for 20 minutes, using a GilAir pump to collect the sample



## **Sulfur Compounds**

Sulfur compounds collection was conducted using ALS laboratory supplied vacuum canister media. Air was drawn from the flux chamber into the vacuum canister media at 300mL/min for 20 minutes to collect the sample

## **Chemical Analysis**

Ammonia, Chlorine and Sulfur media was sent to ALS Environmental in Burnaby BC for analysis. Details about the analysis methodology are contained in Appendix C: Certificate of Analysis, ALS Environmental.

## **Odour Results**

The testing program was completed on June 18<sup>th</sup>, 2019, using the techniques described in the methodology section. The odour lab results are summarized in Table 1; the complete laboratory analysis report can be found in Appendix B, a summary of results table provided by Pinchin Ltd. can be found in Appendix D. Field notes from the sampling program can be found in Appendix E.



**Table 1: Odour Laboratory Analysis Sample Results**

| Location                          | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Odour Emission Rate (OU/s) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/s) | Average (OU/m <sup>2</sup> /s) |
|-----------------------------------|-----------------|-----------------|--------------------------------|----------------------------|---|----------------|--------------------------------|
| <b>Odour Control Inlet Test 1</b> | 3514            | 1 : 1           | 3514                           | 37346.42                   | N/A   |                |                                |
| <b>Odour Control Inlet Test 2</b> | 3222            | 1 : 1           | 3222                           | 34243.07                   | N/A   | 32570.95       | N/A                            |
| <b>Odour Control Inlet Test 3</b> | 2485            | 1 : 1           | 2458                           | 26123.36                   | N/A   |                |                                |
| <b>Outlet Scrubber ON Test 1</b>  | 806             | 1 : 1           | 806                            | 8566.08                    | N/A   |                |                                |
| <b>Outlet Scrubber ON Test 2</b>  | 958             | 1 : 1           | 958                            | 10181.52                   | N/A   | 10649.15       | N/A                            |
| <b>Outlet Scrubber ON Test 3</b>  | 1242            | 1 : 1           | 1242                           | 13199.84                   | N/A   |                |                                |
| <b>Outlet Scrubber OFF Test 1</b> | 1611            | 1 : 1           | 1611                           | 17121.54                   | N/A   |                |                                |
| <b>Outlet Scrubber OFF Test 2</b> | 1611            | 1 : 1           | 1611                           | 17121.54                   | N/A   | 18202.04       | N/A                            |
| <b>Outlet Scrubber OFF Test 3</b> | 1916            | 1 : 1           | 1916                           | 20363.04                   | N/A   |                |                                |
| <b>Bioreactor Test 1</b>          | 1045            | 5 : 1           | 5225                           | N/A                        | 3.36  |                |                                |
| <b>Bioreactor Test 2</b>          | 2485            | 5 : 1           | 12425                          | N/A                        | 7.98  | N/A            | 7.54                           |
| <b>Bioreactor Test 3</b>          | 3514            | 5 : 1           | 17570                          | N/A                        | 11.29   |                |                                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.



## Chemical Results

The testing program for ammonia (NH<sub>3</sub>), chlorine (Cl) and sulfur compounds was completed on June 17<sup>th</sup>, 2019, using the techniques described in the methodology section. The lab results are summarized in Table 2 through 4; the complete laboratory analysis report can be found in Appendix C. Field notes from the sampling program can be found in Appendix E.

**Table 2: Ammonia Analysis Sample Results**

| Location           | Start Time | End Time | Ammonia (as NH <sub>3</sub> ) ppm | Ammonia (as NH <sub>3</sub> ) µg |
|--------------------|------------|----------|-----------------------------------|----------------------------------|
| Bioreactor 1 Inlet | 13:34      | 13:54    | < 0.36                            | < 1.0                            |
| Bioreactor 2 Inlet | 14:36      | 14:56    | < 0.36                            | < 1.0                            |
| Effluent Outlet    | 15:46      | 16:06    | 0.40                              | 1.1                              |
| Detection Limit    |            |          | <b>0.36</b>                       | <b>1.0</b>                       |

**Table 3: Chlorine Analysis Sample Results**

| Location           | Start Time | End Time | Chlorine ppm | Chlorine mg/m <sup>3</sup> |
|--------------------|------------|----------|--------------|----------------------------|
| Bioreactor 1 Inlet | 13:34      | 13:54    | < 0.086      | < 0.25                     |
| Bioreactor 2 Inlet | 14:36      | 14:56    | < 0.086      | < 0.25                     |
| Effluent Outlet    | 15:46      | 16:06    | < 0.086      | < 0.25                     |
| Detection Limit    |            |          | <b>0.086</b> | <b>0.25</b>                |



**Table 4: Sulfur Analysis Sample Results**

| Sulfur Compounds                 | Detection Limit | Units             | Bioreactor 1 Inlet | Bioreactor 2 Inlet | Effluent Outlet |
|----------------------------------|-----------------|-------------------|--------------------|--------------------|-----------------|
| n-Butyl mercaptan                | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| n-Butyl mercaptan                | 15              | ug/m <sup>3</sup> | <15                | <15                | <15             |
| Butyl(t) mercaptan               | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Butyl(t) mercaptan               | 15              | ug/m <sup>3</sup> | <15                | <15                | <15             |
| Carbon Disulfide                 | 2.0             | ppb(V)            | <2.0               | <2.0               | <2.0            |
| Carbon Disulfide                 | 6.2             | ug/m <sup>3</sup> | <6.2               | <6.2               | <6.2            |
| Carbonyl sulfide                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Carbonyl sulfide                 | 9.8             | ug/m <sup>3</sup> | <9.8               | <9.8               | <9.8            |
| Diethyl disulfide                | 2.0             | ppb(V)            | <2.0               | <2.0               | <2.0            |
| Diethyl disulfide                | 10              | ug/m <sup>3</sup> | <10                | <10                | <10             |
| Diethyl Sulfide                  | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Diethyl Sulfide                  | 15              | ug/m <sup>3</sup> | <15                | <15                | <15             |
| Dimethyl disulfide               | 2.0             | ppb(V)            | 6.2                | <2.0               | <2.0            |
| Dimethyl disulfide               | 7.7             | ug/m <sup>3</sup> | 23.8               | <7.7               | <7.7            |
| Dimethyl sulfide                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Dimethyl sulfide                 | 10              | ug/m <sup>3</sup> | <10                | <10                | <10             |
| 2,5-Dimethylthiophene            | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| 2,5-Dimethylthiophene            | 18              | ug/m <sup>3</sup> | <18                | <18                | <18             |
| Ethyl mercaptan                  | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Ethyl mercaptan                  | 10              | ug/m <sup>3</sup> | <10                | <10                | <10             |
| Ethyl Methyl Sulfide             | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Ethyl Methyl Sulfide             | 12              | ug/m <sup>3</sup> | <12                | <12                | <12             |
| 2-Ethylthiophene                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| 2-Ethylthiophene                 | 18              | ug/m <sup>3</sup> | <18                | <18                | <18             |
| Hydrogen Sulfide                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Hydrogen Sulfide                 | 5.6             | ug/m <sup>3</sup> | <5.6               | <5.6               | <5.6            |
| Isobutyl Mercaptan               | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Isobutyl Mercaptan               | 15              | ug/m <sup>3</sup> | <15                | <15                | <15             |
| Isopropyl Mercaptan              | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Isopropyl Mercaptan              | 12              | ug/m <sup>3</sup> | <12                | <12                | <12             |
| Methyl mercaptan                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Methyl mercaptan                 | 7.9             | ug/m <sup>3</sup> | <7.9               | <7.9               | <7.9            |
| 2-Methylthiophene                | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| 2-Methylthiophene                | 16              | ug/m <sup>3</sup> | <16                | <16                | <16             |
| 3-Methylthiophene                | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| 3-Methylthiophene                | 16              | ug/m <sup>3</sup> | <16                | <16                | <16             |
| Propyl mercaptan                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Propyl mercaptan                 | 12              | ug/m <sup>3</sup> | <12                | <12                | <12             |
| Tetrahydrothiophene              | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Tetrahydrothiophene              | 14              | ug/m <sup>3</sup> | <14                | <14                | <14             |
| sec-Butyl Mercaptan + Thiophene  | 6.0             | ppb(V)            | <6.0               | <6.0               | <6.0            |
| sec-Butyl Mercaptan + Thiophene  | 21              | ug/m <sup>3</sup> | <21                | <21                | <21             |
| Total Reduced Sulfur (22) as H2S | 18              | ppb(V)            | <18                | <18                | <18             |
| Total Reduced Sulfur (22) as H2S | 25              | ug/m <sup>3</sup> | <25                | <25                | <25             |



Comox Valley Water Pollution Control Centre  
Comox Valley Regional District  
RWDI #1904012  
JULY 31, 2019

If you have any questions regarding these results, we would be happy to discuss them with you at any time in the future.

A handwritten signature in blue ink, appearing to read 'Matthew Sawycky', is positioned below the text. The signature is fluid and cursive.

Matthew Sawycky, B.Sc.  
Senior Project Manager

## APPENDIX A

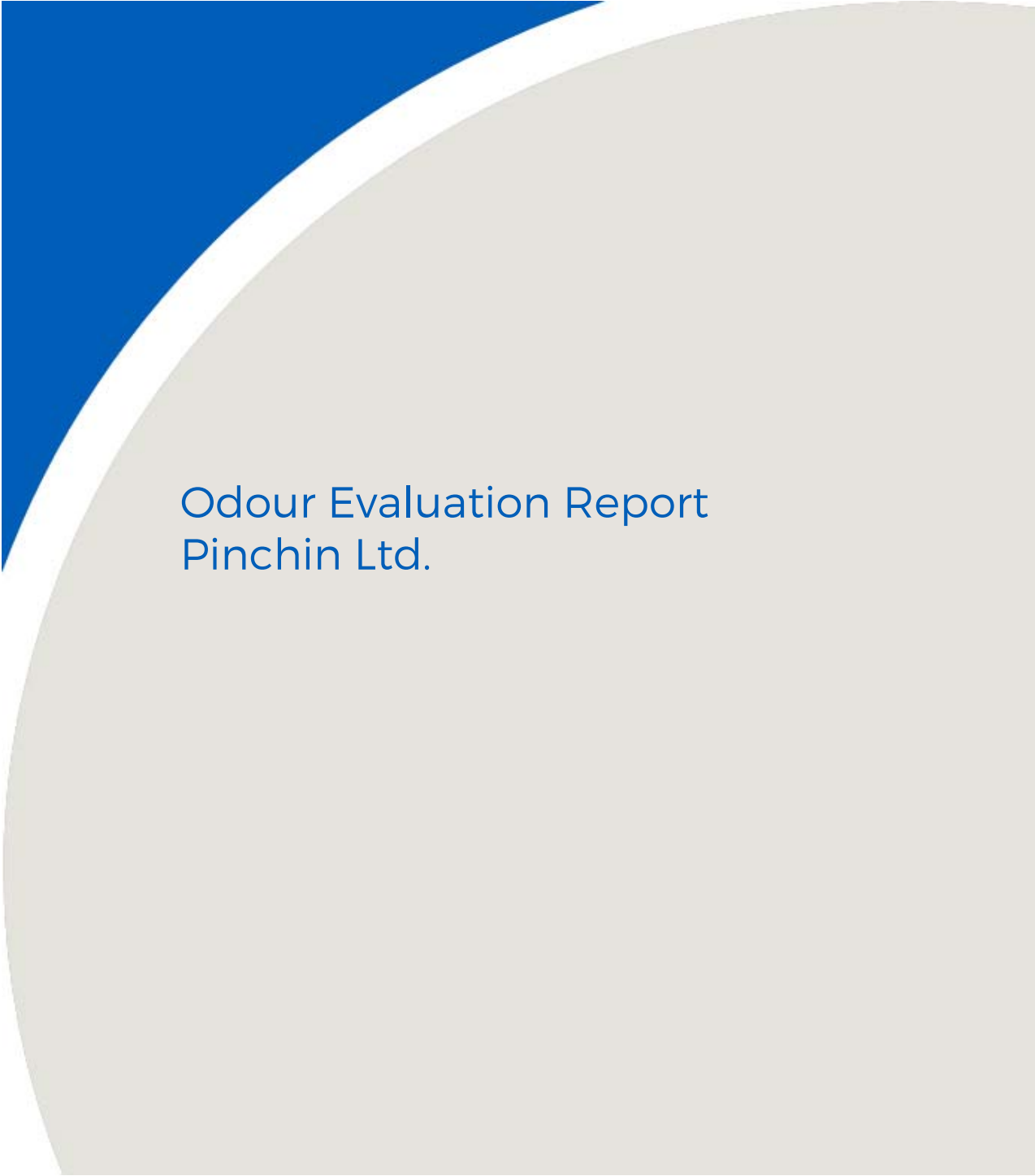
A large decorative graphic on the page. It features a blue triangle in the top-left corner, a white curved line separating it from a large light-grey area, and the text 'Sulfur Compound Test List' centered within the grey area.

### Sulfur Compound Test List

## ALS Environmental Sulfur Compound Analysis List

| Synonym                                       | RL Units | RL Units          |
|---|----------|-------------------|
|   | ppb(V)   | µg/m <sup>3</sup> |
| n-Butyl mercaptan                             | 4        | 14.8              |
| Butyl(t) mercaptan                            | 4        | 14.8              |
| Carbon Disulfide                              | 2        | 6.2               |
| Carbonyl sulfide                              | 4        | 9.8               |
| Diethyl disulfide                             | 2        | 10.0              |
| Diethyl Sulfide                               | 4        | 14.8              |
| Dimethyl disulfide                            | 2        | 7.7               |
| Dimethyl sulfide                              | 4        | 10.2              |
| 2,5-Dimethylthiophene                         | 4        | 18.4              |
| Ethyl mercaptan                               | 4        | 10.2              |
| Ethyl Methyl Sulfide                          | 4        | 18.4              |
| 2-Ethylthiophene                              | 4        | 18.4              |
| Hydrogen Sulfide                              | 4        | 5.6               |
| Isobutyl Mercaptan                            | 4        | 14.8              |
| Isopropyl Mercaptan                           | 4        | 12.5              |
| Methyl mercaptan                              | 4        | 7.9               |
| 2-Methylthiophene                             | 4        | 16.1              |
| 3-Methylthiophene                             | 4        | 16.1              |
| Propyl mercaptan                              | 4        | 12.5              |
| Tetrahydrothiophene                           | 4        | 14.4              |
| sec-Butyl Mercaptan + Thiophene               | 6        | 21.5              |
| Total Reduced Sulfur (22) as H <sub>2</sub> S | 4        | 5.6               |

## APPENDIX B

A decorative background featuring a large, light grey circular shape on the right side, partially overlapping a blue triangular shape on the left. The text is centered within the grey area.

# Odour Evaluation Report Pinchin Ltd.



FINAL

# Odour Evaluation Report

2470 Milltower Court  
Mississauga, ON  
L5N 7W5

Prepared for:

**Matthew Sawycky**  
RWDI  
60 Southgate Drive  
Guelph, Ontario, N1G 3W6

June 19, 2019

Pinchin File: 202859-061919



**Issued to:** RWDI  
**Contact:** Matthew Sawycky

**Issued on:** June 19, 2019  
**Pinchin file:** 202859-061919  
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---

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---

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## APPENDICES

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## 1.0 EVALUATION SAMPLE & TIMING SUMMARY

Pinchin Ltd. (Pinchin) was contracted to determine the detection threshold (DT) of air samples submitted to Pinchin's Odour Laboratory located in Mississauga, Ontario. The particulars of the odour panel were as follows:

|   |                                   |
|---|-----------------------------------|
| <b>Client Name:</b>                             | RWDI                              |
| <b>No. of Samples Delivered:</b>                | Twelve (12) samples               |
| <b>Date Samples Received:</b>                   | June 19, 2019                     |
| <b>Condition of the Sample Bags on Arrival:</b> | No leaks or condensation detected |
| <b>Session A</b>                                |                                   |
| <b>No. of Samples Analyzed:</b>                 | Eight (8)                         |
| <b>Date of Odour Panel Analysis:</b>            | June 19, 2019                     |
| <b>Time of Odour Panel Analysis:</b>            | 9:06 – 10:46 AM                   |
| <b>Session B</b>                                |                                   |
| <b>No. of Samples Analyzed:</b>                 | Four (4)                          |
| <b>Date of Odour Panel Analysis:</b>            | June 19, 2019                     |
| <b>Time of Odour Panel Analysis:</b>            | 10:47 – 11:38 AM                  |

## 2.0 METHODOLOGY

### 2.1 Laboratory Methodology

All samples were evaluated in accordance with the Ministry of the Environment, Conservation and Parks "Ontario Source Testing Code" (OSTC), Version #3, June 2010 (Part G, Method ON-6), using an AC'SCENT International triangular forced-choice, ascending concentration, dynamic dilution Olfactometer. A listing of Standard Practices to which the evaluations conform is provided in Appendix II.

The AC'SCENT Olfactometer was calibrated according to the manufacturer's guidelines on the day of sample evaluation. The CHEMFLUOR® PTFE tubing through which the odour sample is presented to the panellists was replaced prior to the assessment session. All sample delivery lines were purged continuously with odour free air between sample presentations.

A panel of eight trained assessors was employed in the evaluation of the odour samples. Each panel is screened for accuracy and repeatability following the procedures outlined in British Standard, BS EN 13725:2003, "Air quality – Determination of odour concentration by dynamic olfactometry", utilizing 50 ppm n-butanol calibration gas prior to sample evaluation. The geometric mean of the individual threshold estimates for 50 ppm n-butanol was determined to be between 20 and 80 ppb/v.

The odour samples were presented to the panellists using the "triangular forced-choice" method, described by ASTM E679-04, "Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits". Each panellist evaluated the odour by "sniffing" the diluted odour samples presented by the Olfactometer. At each dilution level, the panellist "sniffed" three sample presentations, two of which were blank, odour free samples and one that contained the odorous air. The panellist was then asked to identify which of the three presentations was different from the other two by recording a "guess", "detect" or "recognize" response as defined by ASTM E679-04.

A "guess" response was recorded when the assessor could not distinguish between any of the presentations. A "detect" response was recorded when the assessor could differentiate the odorous sample from the two blanks, and "recognize" was recorded when the assessor could identify and describe the odorous sample.

As per BS EN 13725:2003, each sample assessment began with the Olfactometer diluting the odorous sample to sub-detection levels. The odour sample and two blanks were then presented to one panellist, who "sniffed" the three presentations and recorded their response. The concentration of odorous gas was then doubled and re-presented to the same assessor with two blanks. Again, the assessor "sniffed" the three presentations and recorded their response. The process continued with the concentration of odorous gas increasing until the panellist had correctly detected the odour in at least two consecutive presentations as described by BS EN 13725:2003. The process was repeated for each panellist until all samples were evaluated.

Sample analysis was conducted "blind"; neither the panellist nor the test administrator knew which port would deliver the odour sample. Panellist's results were recorded and analyzed using AC'SCENT DataSense Olfactometry software integrated with the Olfactometer. The software incorporates an Access database program designed specifically for olfactometry laboratories and is compatible with international olfactometry standards including BS EN 13725:2003 and ASTM E679-04.

As part of laboratory Quality Assurance and Quality Control (QAQC), test results were retrospectively screened in accordance with BS EN 13725:2003. As the standard requires, each assessor's individual threshold estimate ( $Z_{ITE}$ ) was compared to the panel's average threshold, with the ratio between the individual threshold estimate and the panel average threshold represented as  $\Delta Z$ . Assessors having a  $\Delta Z$  greater than 5.0 or lower than -5.0, were eliminated from the results. The purpose was to exclude panel

members that showed deviant responses due to health factors or specific hypersomia or anosmia for the odour of the analyzed sample. Where screening was required, both the screened and unscreened results were provided.

## 2.2 Odour Evaluation Parameters

### 2.2.1 Odour Threshold Values – Detection Threshold (DT)

The detection threshold (DT) is the dilution ratio at which 50% of the panellists correctly detected the odour. DT, as defined by ASTM E679-04, is synonymous with the MOE Draft definition of an odour threshold value ( $ED_{50}$ ) and the BS EN 13725:2003 definition of odour concentration ( $C_{OD}$ ). That is, the DT represents the amount of dilution required for the odour to be just detectable. Since DT values are dimensionless, pseudo-dimensions of odour units per unit volume (i.e. odour units per cubic metre ( $ou/m^3$ )) are often used for reporting purposes.

In accordance with BS EN 13725:2003, individual threshold estimates ( $Z_{ITE}$ ) were calculated as the geometric mean of the lowest dilution ratio where the odour could not be detected and the dilution ratio at which the panellist correctly detected the odour. Where a detection response could not be established at the Olfactometer's dilution limit, it was assumed that the panellist would have detected the odour at a dilution ratio half that of the limit, and the  $Z_{ITE}$  was calculated. The sample odour concentration ( $C_{OD}$ ) was then calculated as the geometric mean of the  $Z_{ITE}$  values.

## 3.0 RESULTS

The odour threshold value results for detection threshold (DT) are presented in Table 1. Where appropriate, the DT values have been adjusted for field pre-dilution reported by the client. The adjusted DT values are recorded as  $DT_{NET}$ . Datasheets are provided in Appendix I.



Table 1 – Odour Threshold Value Results

Client: RWDI Test Reference No.: A202859-0619191  
Pinchin Project No.: 202859 Evaluation Date: 19-Jun-19  
Client Project No.: 1904012

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1563 | Bioreactor T1                | 5 :1               | 9:06 - 9:14 AM     | 1045      | 5225              |          |
| PO19-202859-S1564 | Bioreactor T2                | 5 :1               | 9:15 - 9:25 AM     | 2485      | 12425             |          |
| PO19-202859-S1565 | Bioreactor T3                | 5 :1               | 9:27 - 9:39 AM     | 3514      | 17570             |          |
| PO19-202859-S1566 | Outlet Scrub Off T1          | 1 :1               | 9:40 - 9:51 AM     | 1611      | 1611              |          |
| PO19-202859-S1567 | Outlet Scrub Off T2          | 1 :1               | 9:52 - 10:05 AM    | 1611      | 1611              |          |
| PO19-202859-S1568 | Outlet Scrub Off T3          | 1 :1               | 10:06 - 10:18 AM   | 1916      | 1916              |          |
| PO19-202859-S1569 | Outlet Scrub On T1           | 1 :1               | 10:19 - 10:32 AM   | 806       | 806               |          |
| PO19-202859-S1570 | Outlet Scrub On T2           | 1 :1               | 10:34 - 10:46 AM   | 958       | 958               |          |



Table 2 – Odour Threshold Value Results

Client: RWDI

Test Reference No.: B202859-0619191

Pinchin Project No.: 202859

Evaluation Date: 19-Jun-19

Client Project No.: 1904012

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1571 | Outlet Scrub On T3           | 1 :1               | 10:47 - 11:00 AM   | 1242      | 1242              |          |
| PO19-202859-S1572 | Inlet Scrub On T1            | 1 :1               | 11:01 - 11: 12 AM  | 3514      | 3514              |          |
| PO19-202859-S1573 | Inlet Scrub On T2            | 1 :1               | 11:13 - 11:25 AM   | 3222      | 3222              |          |
| PO19-202859-S1574 | Inlet Scrub On T3            | 1 :1               | 11:26 - 11:38 AM   | 2485      | 2485              |          |

**Odour Evaluation Report Nomenclature**

DT Detection Threshold

DT<sub>NET</sub> Detection Threshold adjusted for field dilution

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J:\202000s\0202859.000 RWDI,650Woodlawn,ENVNS,ODPNL\Odour Lab\2019\June 19, 2019\202859-061919 RWDI Odour Report.docx

Template: 14852 – Report Template for Detection Threshold Determination - September 19, 2014

**APPENDIX I**  
**Odour Evaluation Data Sheets**  
**Pinchin File: 202859-061919**  
**(12 Pages)**

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                                  |                                  |
|------------------------------------|----------------------------------|----------------------------------|
| <b>Sample Information</b>          |                                  | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1563</u> | Field No. : <u>Bioreactor T1</u> | Sampling Time : _____            |
| Description : <u>5:1</u>           | Sample Collector : <u>RWDI</u>   | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        | 2.57   | 2.57  |       |
| 14853-961 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 14853-1231 1    |        |        |        |        |        | 1      | 2      | 2      | 6      | 6      |        |        |        |        | 3.17   | 2.57  |       |
| 14853-956 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-946 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-954 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |

Sample Comments :

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

Response Key:

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.17  | 3.02  | 0.00 |
| Std. Dev.      | 0.28  | 0.32  | 0.00 |
| Threshold      | 1,477 | 1,045 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                                  |                                  |
|------------------------------------|----------------------------------|----------------------------------|
| <b>Sample Information</b>          |                                  | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1564</u> | Field No. : <u>Bioreactor T2</u> | Sampling Time : _____            |
| Description : <u>5:1</u>           | Sample Collector : <u>RWDI</u>   | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66.846 | 33.423 | 16.712 | 8.356  | 4.178  | 2.089  | 1.045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-961 1     |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        |        | 4.07   | 3.47  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        | 3.77   | 3.17  |       |
| 14853-1231 1    |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77   | 3.47  |       |
| 14853-956 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        |        | 4.07   | 3.47  |       |
| 14853-954 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.66  | 3.40  | 0.00 |
| Std. Dev.      | 0.32  | 0.14  | 0.00 |
| Threshold      | 4,556 | 2,485 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1565 Field No. : Bioreactor T3 Sampling Date : 6/18/2019  
 Description : 5:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-961 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 2018-6 1        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-1232 1    |        |        |        | 1      | 2      | 2      | 6      | 6      |        |        |        |        |        |        | 3.77   | 3.17  |       |
| 14853-1231 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-956 1     |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        |        | 4.07   | 3.47  |       |
| 14853-946 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-954 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.70  | 3.55  | 0.00 |
| Std. Dev.      | 0.21  | 0.21  | 0.00 |
| Threshold      | 4,969 | 3,514 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1566 Field No. : Outlet Scrub. Off T1 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-961 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77   | 3.47  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1232 1    |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-1231 1    |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-956 1     |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-946 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77   | 3.47  |       |
| 14853-954 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.36  | 3.21  | 0.00 |
| Std. Dev.      | 0.32  | 0.19  | 0.00 |
| Threshold      | 2,278 | 1,611 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |   |                                  |
|------------------------------------|---|----------------------------------|
| <b>Sample Information</b>          |   | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1567</u> | Field No. : <u>Outlet Scrub. Off T2</u> | Sampling Time : _____            |
| Description : <u>1:1</u>           | Sample Collector : <u>RWDI</u>          | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66.846 | 33.423 | 16.712 | 8.356  | 4.178  | 2.089  | 1.045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-961 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1231 1    |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-956 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-954 1     |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

Sample Comments :

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**  
 1 = Incorrect Guess  
 2 = Correct Guess  
 5 = Incorrect Detection  
 6 = Correct Detection  
 7 = Incorrect Recognition  
 8 = Correct Recognition

|                      |          |          |          |
|----------------------|----------|----------|----------|
| <b>Final Results</b> |          |          |          |
|                      | <b>G</b> | <b>D</b> | <b>R</b> |
| Avg. Log Value       | 3.24     | 3.21     | 0.00     |
| Std. Dev.            | 0.14     | 0.11     | 0.00     |
| Threshold            | 1,757    | 1,611    | 1        |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-203859-S1568 Field No. : Outlet Scrub. Off T3 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-961 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 2018-6 1        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-1232 1    |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 14853-1231 1    |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        | 3.77   | 3.17  |       |
| 14853-956 1     |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        | 3.77   | 3.17  |       |
| 14853-946 1     |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-954 1     |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.51  | 3.28  | 0.00 |
| Std. Dev.      | 0.25  | 0.28  | 0.00 |
| Threshold      | 3,222 | 1,916 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1569 Field No. : Outlet Scrub. On T1 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-961 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 2018-6 1        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1232 1    |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1231 1    |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 14853-956 1     |        |        |        |        |        | 1      | 1      | 2      | 6      | 6      |        |        |        |        | 2.87   | 2.57  |       |
| 14853-946 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-954 1     |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.98 | 2.91 | 0.00 |
| Std. Dev.      | 0.16 | 0.19 | 0.00 |
| Threshold      | 958  | 806  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1570 Field No. : Outlet Scrub. On T2 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66.846 | 33.423 | 16.712 | 8.356  | 4.178  | 2.089  | 1.045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        | 2.57   | 2.57  |       |
| 14853-961 1     |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1231 1    |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-956 1     |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 14853-946 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-954 1     |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D    | R    |
|----------------|-------|------|------|
| Avg. Log Value | 3.13  | 2.98 | 0.00 |
| Std. Dev.      | 0.30  | 0.28 | 0.00 |
| Threshold      | 1,355 | 958  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1571 Field No. : Outlet Scrub. On T3 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-961 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 2018-6 1        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1232 1    |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1231 1    |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77   | 3.47  |       |
| 14853-956 1     |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        | 3.47   | 2.87  |       |
| 14853-946 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-954 1     |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n./a  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.28  | 3.09  | 0.00 |
| Std. Dev.      | 0.28  | 0.21  | 0.00 |
| Threshold      | 1,916 | 1,242 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1572 Field No. : Inlet Scrub ON T1 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-961 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 2018-6 1        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-1232 1    |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-1231 1    |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-956 1     |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-954 1     |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.55  | 3.55  | 0.00 |
| Std. Dev.      | 0.21  | 0.21  | 0.00 |
| Threshold      | 3,514 | 3,514 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                                      |                                  |
|------------------------------------|--------------------------------------|----------------------------------|
| <b>Sample Information</b>          |                                      | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1573</u> | Field No. : <u>Inlet Scrub ON T2</u> | Sampling Time : _____            |
| Description : <u>1:1</u>           | Sample Collector : <u>RWDI</u>       | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-961 1     |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        |        | 4.07   | 3.77  |       |
| 2018-6 1        |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-1231 1    |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-956 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-954 1     |        |        |        | 2      | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.55  | 3.51  | 0.00 |
| Std. Dev.      | 0.31  | 0.25  | 0.00 |
| Threshold      | 3,514 | 3,222 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019  
 Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                                      |                                  |
|------------------------------------|--------------------------------------|----------------------------------|
| <b>Sample Information</b>          |                                      | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1574</u> | Field No. : <u>Inlet Scrub ON T3</u> | Sampling Time : _____            |
| Description : <u>1:1</u>           |                                      | Sample Collector : <u>RWDI</u>   |
|                                    |                                      | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66.846 | 33.423 | 16.712 | 8.356  | 4.178  | 2.089  | 1.045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-961 1     |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        |        | 4.07   | 3.47  |       |
| 2018-6 1        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-1231 1    |        |        |        | 1      | 1      | 5      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-956 1     |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-954 1     |        |        |        | 2      | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

Sample Comments :

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**  
 1 = Incorrect Guess  
 2 = Correct Guess  
 5 = Incorrect Detection  
 6 = Correct Detection  
 7 = Incorrect Recognition  
 8 = Correct Recognition

| Final Results  | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.51  | 3.40  | 0.00 |
| Std. Dev.      | 0.30  | 0.21  | 0.00 |
| Threshold      | 3,222 | 2,485 | 1    |

**APPENDIX II**  
**Odour Evaluation Quality Assurance**  
**Pinchin File: 202859-061919**  
**(1 Page)**

## ODOUR EVALUATION QUALITY ASSURANCE

- Odour evaluations conducted at the Pinchin Odour Laboratory conform to the procedures outlined in the Ministry of the Environment, Conservation and Parks “Ontario Source Testing Code” (OSTC), Version #3, June 2010 (Part G, Method ON-6) and are in accordance with ASTM (American Society for Testing and Materials) Standard Practice E679-04, Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series of Limits.
- The AC’SCENT® Dynamic Dilution Forced-Choice Triangle Olfactometer complies with all aspects of the ASTM E679-04 standard as well as the operational requirements of the British Standard, BS EN 13725:2003, “Air quality – Determination of odour concentration by dynamic olfactometry”.
- The detection threshold values are reported as defined by ASTM E679-04 and BS EN 13725:2003.
- Assessors are selected and trained in accordance with BS EN 13725:2003.
- The Pinchin Odour Laboratory is managed based on the requirements of the International Organization for Standardization (ISO) International Standard ISO 17025:2005, “General requirements for the competence of testing and calibration laboratories”.
- Samples are consumed during the evaluation and all sample bags are destroyed 48 hours after transmittal of the Preliminary Odour Evaluation Results, unless otherwise specified.

## APPENDIX C

A large decorative graphic on the page. It features a blue triangular shape in the top-left corner, a white curved line separating it from a large light-grey circular area, and a white curved line separating the grey area from the rest of the page.

Certificate of Analysis  
ALS Environmental



RWDI AIR INC.  
ATTN: Matthew Sawycky  
#280 - 1385 West 8th Avenue  
Vancouver BC V6H 3V9

Date Received: 19-JUN-19  
Report Date: 09-JUL-19 13:10 (MT)  
Version: FINAL

Client Phone: 604-730-5688

## Certificate of Analysis

Lab Work Order #: L2295084  
Project P.O. #: 1904012-1000-100  
Job Reference:  
C of C Numbers: 17-830387  
Legal Site Desc:

Joanne Lee  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                            |                                | Sample ID    | L2295084-7                      | L2295084-8                      | L2295084-9                          |  |  |
|----------------------------|--------------------------------|--------------|---------------------------------|---------------------------------|-------------------------------------|--|--|
|                            |                                | Description  | Air                             | Air                             | Air                                 |  |  |
|                            |                                | Sampled Date | 17-JUN-19                       | 17-JUN-19                       | 17-JUN-19                           |  |  |
|                            |                                | Sampled Time | 13:58                           | 15:00                           | 16:06                               |  |  |
|                            |                                | Client ID    | CANISTER 01400-0326-BIOREACT T1 | CANISTER 01400-0003-BIOREACT T2 | CANISTER 01400-0373-EFFLUENT CH. T3 |  |  |
| Grouping                   | Analyte                        |              |                                 |                                 |                                     |  |  |
| <b>CANISTER</b>            |                                |              |                                 |                                 |                                     |  |  |
| <b>Sulfur Compounds</b>    | n-Butyl mercaptan (ppb(V))     | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | n-Butyl mercaptan (ug/m3)      | <15          | <15                             | <15                             |                                     |  |  |
|                            | Butyl(t) mercaptan (ppb(V))    | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Butyl(t) mercaptan (ug/m3)     | <15          | <15                             | <15                             |                                     |  |  |
|                            | Carbon Disulfide (ppb(V))      | <2.0         | <2.0                            | <2.0                            |                                     |  |  |
|                            | Carbon Disulfide (ug/m3)       | <6.2         | <6.2                            | <6.2                            |                                     |  |  |
|                            | Carbonyl sulfide (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Carbonyl sulfide (ug/m3)       | <9.8         | <9.8                            | <9.8                            |                                     |  |  |
|                            | Diethyl disulfide (ppb(V))     | <2.0         | <2.0                            | <2.0                            |                                     |  |  |
|                            | Diethyl disulfide (ug/m3)      | <10          | <10                             | <10                             |                                     |  |  |
|                            | Diethyl Sulfide (ppb(V))       | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Diethyl Sulfide (ug/m3)        | <15          | <15                             | <15                             |                                     |  |  |
|                            | Dimethyl disulfide (ppb(V))    | 6.2          | <2.0                            | <2.0                            |                                     |  |  |
|                            | Dimethyl disulfide (ug/m3)     | 23.8         | <7.7                            | <7.7                            |                                     |  |  |
|                            | Dimethyl sulfide (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Dimethyl sulfide (ug/m3)       | <10          | <10                             | <10                             |                                     |  |  |
|                            | 2,5-Dimethylthiophene (ppb(V)) | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | 2,5-Dimethylthiophene (ug/m3)  | <18          | <18                             | <18                             |                                     |  |  |
|                            | Ethyl mercaptan (ppb(V))       | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Ethyl mercaptan (ug/m3)        | <10          | <10                             | <10                             |                                     |  |  |
|                            | Ethyl Methyl Sulfide (ppb(V))  | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Ethyl Methyl Sulfide (ug/m3)   | <12          | <12                             | <12                             |                                     |  |  |
|                            | 2-Ethylthiophene (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | 2-Ethylthiophene (ug/m3)       | <18          | <18                             | <18                             |                                     |  |  |
|                            | Hydrogen Sulfide (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Hydrogen Sulfide (ug/m3)       | <5.6         | <5.6                            | <5.6                            |                                     |  |  |
|                            | Isobutyl Mercaptan (ppb(V))    | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Isobutyl Mercaptan (ug/m3)     | <15          | <15                             | <15                             |                                     |  |  |
|                            | Isopropyl Mercaptan (ppb(V))   | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Isopropyl Mercaptan (ug/m3)    | <12          | <12                             | <12                             |                                     |  |  |
|                            | Methyl mercaptan (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Methyl mercaptan (ug/m3)       | <7.9         | <7.9                            | <7.9                            |                                     |  |  |
|                            | 2-Methylthiophene (ppb(V))     | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | 2-Methylthiophene (ug/m3)      | <16          | <16                             | <16                             |                                     |  |  |
| 3-Methylthiophene (ppb(V)) | <4.0                           | <4.0         | <4.0                            |                                 |                                     |  |  |
| 3-Methylthiophene (ug/m3)  | <16                            | <16          | <16                             |                                 |                                     |  |  |
| Propyl mercaptan (ppb(V))  | <4.0                           | <4.0         | <4.0                            |                                 |                                     |  |  |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                         |   | Sample ID    | L2295084-7                      | L2295084-8                      | L2295084-9                          |  |  |
|-------------------------|---|--------------|---------------------------------|---------------------------------|-------------------------------------|--|--|
|                         |   | Description  | Air                             | Air                             | Air                                 |  |  |
|                         |   | Sampled Date | 17-JUN-19                       | 17-JUN-19                       | 17-JUN-19                           |  |  |
|                         |   | Sampled Time | 13:58                           | 15:00                           | 16:06                               |  |  |
|                         |   | Client ID    | CANISTER 01400-0326-BIOREACT T1 | CANISTER 01400-0003-BIOREACT T2 | CANISTER 01400-0373-EFFLUENT CH. T3 |  |  |
| Grouping                | Analyte                                   |              |                                 |                                 |                                     |  |  |
| <b>CANISTER</b>         |   |              |                                 |                                 |                                     |  |  |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  | <12          | <12                             | <12                             |                                     |  |  |
|                         | Tetrahydrothiophene (ppb(V))              | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                         | Tetrahydrothiophene (ug/m3)               | <14          | <14                             | <14                             |                                     |  |  |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  | <6.0         | <6.0                            | <6.0                            |                                     |  |  |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   | <21          | <21                             | <21                             |                                     |  |  |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) | <18          | <18                             | <18                             |                                     |  |  |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  | <25          | <25                             | <25                             |                                     |  |  |
| <b>Miscellaneous</b>    | Batch Proof ID                            | 181025.121   | 181105.232                      | 181025.126                      |                                     |  |  |
|                         | Canister ID                               | 01400-0326   | 01400-0003                      | 01400-0373                      |                                     |  |  |
|                         | Pressure on Receipt (in Hg)               | 0.4          | -1.8                            | 0.4                             |                                     |  |  |
|                         | Regulator ID                              | N/A          | N/A                             | N/A                             |                                     |  |  |

# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                    |                | Sample ID    | L2295084-1                          | L2295084-2                          | L2295084-3                              | L2295084-4                            | L2295084-5                            |
|--------------------|----------------|--------------|-------------------------------------|-------------------------------------|---|---------------------------------------|---------------------------------------|
|                    |                | Description  | Air                                 | Air                                 | Air                                     | Air                                   | Air                                   |
|                    |                | Sampled Date | 17-JUN-19                           | 17-JUN-19                           | 17-JUN-19                               | 17-JUN-19                             | 17-JUN-19                             |
|                    |                | Sampled Time | 13:34                               | 14:36                               | 15:49                                   | 13:34                                 | 14:36                                 |
|                    |                | Client ID    | TUBE<br>78654000032-<br>BIOREACT T1 | TUBE<br>78654000039-<br>BIOREACT T2 | TUBE<br>78654000036-<br>EFFLUENT CH. T3 | CASSETTE T1-<br>BIOREACTOR 1<br>INLET | CASSETTE T2-<br>BIOREACTOR 2<br>INLET |
| Grouping           | Analyte        |              |                                     |                                     |   |                                       |                                       |
| <b>MISC.</b>       |                |              |                                     |                                     |   |                                       |                                       |
| <b>Field Tests</b> | Air volume (L) | 3.98         | 3.98                                | 3.98                                | 20                                      | 20                                    |                                       |

# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                    | <b>Sample ID</b><br><b>Description</b><br><b>Sampled Date</b><br><b>Sampled Time</b><br><b>Client ID</b> |    |  |  |  |
|--------------------|--|----|--|--|--|
|                    | L2295084-6<br>Air<br>17-JUN-19<br>15:49<br>CASSETTE T3-<br>EFFLUENT<br>CHANNEL                           |    |  |  |  |
| Grouping           | Analyte  |    |  |  |  |
| <b>MISC.</b>       |  |    |  |  |  |
| <b>Field Tests</b> | Air volume (L)   | 20 |  |  |  |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                                 |                        | Sample ID    | L2295084-1                          | L2295084-2                          | L2295084-3                              |  |  |
|---------------------------------|------------------------|--------------|-------------------------------------|-------------------------------------|---|--|--|
|                                 |                        | Description  | Air                                 | Air                                 | Air                                     |  |  |
|                                 |                        | Sampled Date | 17-JUN-19                           | 17-JUN-19                           | 17-JUN-19                               |  |  |
|                                 |                        | Sampled Time | 13:34                               | 14:36                               | 15:49                                   |  |  |
|                                 |                        | Client ID    | TUBE<br>78654000032-<br>BIOREACT T1 | TUBE<br>78654000039-<br>BIOREACT T2 | TUBE<br>78654000036-<br>EFFLUENT CH. T3 |  |  |
| Grouping                        | Analyte                |              |                                     |                                     |   |  |  |
| <b>TUBE</b>                     |                        |              |                                     |                                     |   |  |  |
| <b>Anions and<br/>Nutrients</b> | Ammonia (as NH3) (ppm) | <0.36        | <0.36                               | 0.40                                |   |  |  |
|                                 | Ammonia (as NH3) (ug)  | <1.0         | <1.0                                | 1.1                                 |   |  |  |

## Reference Information

### Test Method References:

| ALS Test Code   | Matrix   | Test Description                         | Method Reference**       |
|---|----------|--|--------------------------|
| <b>AIR VOLUME-ED</b>  | Misc.    | Air volume (L)                           | HYGIENE METHOD           |
| NOTE: When air concentrations of analytes are reported, they are based on air sampling information (air volume, sampling time, sampling flow rate) supplied by the client.  |          |  |                          |
| <b>CAN-DATA-WT</b>  | Canister | Canister Information                     | EPA TO-15                |
| Batch Proof ID, Canister ID, Pressure on Receipt, Regulator ID.   |          |  |                          |
| <b>NH3-ED</b>   | Tube     | Ammonia                                  | NIOSH 6015md-Colorimetry |
| The silica gel from the tube is desorbed with 0.2% sulfuric acid in ultra high purity water. Ammonia is determined using the automated phenate colorimetric method. Samples are not field blank corrected.  |          |  |                          |
| <b>REDUC-SULF-22-SCD-WT</b>   | Canister | 22 Reduced Sulfur Compounds by GC-SCD    | ASTM D5504               |
| This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.   |          |  |                          |
| Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.   |          |  |                          |
| <b>TRS-22-SCD-WT</b>  | Canister | Total Reduced Sulfur as H2S              | ASTM D5504               |
| This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.   |          |  |                          |
| Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.   |          |  |                          |
| <b>TRS22-SUM-CALC-WT</b>  | Canister | Total Reduced Sulfur as H2S (22 Comp'ds) | ASTM D5504               |
| This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. A volume of air sample is transferred from the canister to a preconcentrator system where the analytes are trapped & focused. The analytes are then thermally desorbed into a GC-SCD for analysis. Test results are not blank corrected unless indicated by a qualifier. Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager. |          |  |                          |

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location                           |
|----------------------------|---|
| WT                         | ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA |
| ED                         | ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA |

### Chain of Custody Numbers:

17-830387

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



**ANALYTICAL REPORT**  
**Amended-20190709**

Report Date: July 09, 2019

Joanne Lee  
ALS Environmental  
8081 Lougheed Hwy  
Burnaby, BC V5A 1W9  
CANADA

Phone: 604-253-4188 x 3220

E-mail: Joanne.Lee@alsglobal.com

Workorder: **34-1918441**

Client Project ID: L2295084  
Purchase Order: NA  
Project Manager: Jessica Helland

**Analytical Results**

|                              |                           |   |                     |                                      |
|------------------------------|---------------------------|---|---------------------|--------------------------------------|
| Sample ID: <b>L2295084-4</b> |                           | Collected: 06/17/2019   |                     |                                      |
| Lab ID: 1918441001           |                           | Received: 06/25/2019  |                     |                                      |
| <b>Method: NIOSH 6011</b>    |                           | <b>Media:</b> SKC 225-9006, Cleaned silver membrane filter, black poly cassette |                     | <b>Instrument:</b> IC05              |
|                              |                           | <b>Sampling Info:</b> Air Volume 20 L   |                     | <b>Analyzed:</b> 07/02/2019 (242677) |
| <b>Analyte</b>               | <b>Result (ug/sample)</b> | <b>Result (mg/m³)</b>   | <b>Result (ppm)</b> | <b>RL (ug/sample)</b>                |
| Chlorine                     | <5.0                      | <0.25   | <0.086              | 5.0                                  |

|                              |                           |   |                     |                                      |
|------------------------------|---------------------------|---|---------------------|--------------------------------------|
| Sample ID: <b>L2295084-5</b> |                           | Collected: 06/17/2019   |                     |                                      |
| Lab ID: 1918441002           |                           | Received: 06/25/2019  |                     |                                      |
| <b>Method: NIOSH 6011</b>    |                           | <b>Media:</b> SKC 225-9006, Cleaned silver membrane filter, black poly cassette |                     | <b>Instrument:</b> IC05              |
|                              |                           | <b>Sampling Info:</b> Air Volume 20 L   |                     | <b>Analyzed:</b> 07/02/2019 (242677) |
| <b>Analyte</b>               | <b>Result (ug/sample)</b> | <b>Result (mg/m³)</b>   | <b>Result (ppm)</b> | <b>RL (ug/sample)</b>                |
| Chlorine                     | <5.0                      | <0.25   | <0.086              | 5.0                                  |

|                              |                           |   |                     |                                      |
|------------------------------|---------------------------|---|---------------------|--------------------------------------|
| Sample ID: <b>L2295084-6</b> |                           | Collected: 06/17/2019   |                     |                                      |
| Lab ID: 1918441003           |                           | Received: 06/25/2019  |                     |                                      |
| <b>Method: NIOSH 6011</b>    |                           | <b>Media:</b> SKC 225-9006, Cleaned silver membrane filter, black poly cassette |                     | <b>Instrument:</b> IC05              |
|                              |                           | <b>Sampling Info:</b> Air Volume 20 L   |                     | <b>Analyzed:</b> 07/02/2019 (242677) |
| <b>Analyte</b>               | <b>Result (ug/sample)</b> | <b>Result (mg/m³)</b>   | <b>Result (ppm)</b> | <b>RL (ug/sample)</b>                |
| Chlorine                     | <5.0                      | <0.25   | <0.086              | 5.0                                  |

**Comments**

**Workorder: 1918441**

Report amended to correct air volume per client request. No raw data was changed.



# ANALYTICAL REPORT

**Amended-20190709**

Workorder: **34-1918441**

Client Project ID: L2295084

Purchase Order: NA

Project Manager: Jessica Helland

## Comments

**Quality Control: NIOSH 6011 - (HBN: 242677)**

The LCS/LCSD and all field samples were media blank corrected with the LMB result.

## Report Authorization (/S/ is an electronic signature that complies with 21 CFR Part 11)

| Method     | Analyst                               | Peer Review                                |
|------------|---------------------------------------|--|
| NIOSH 6011 | /S/ Nadjla Borges<br>07/02/2019 15:49 | /S/ Christopher Winter<br>07/02/2019 16:15 |

## Laboratory Contact Information

ALS Environmental  
960 W Levoy Drive  
Salt Lake City, Utah 84123

Phone: (801) 266-7700  
Email: als@alst.com  
Web: www.alst.com

## General Lab Comments

The results provided in this report relate only to the items tested.  
Samples were received in acceptable condition unless otherwise noted.  
Samples have not been blank corrected unless otherwise noted.  
This test report shall not be reproduced, except in full, without written approval of ALS.

ALS provides professional analytical services for all samples submitted. ALS is not in a position to interpret the data and assumes no responsibility for the quality of the samples submitted.

All quality control samples processed with the samples in this report yielded acceptable results unless otherwise noted.

ALS is accredited for specific fields of testing (scopes) in the following testing sectors. The quality system implemented at ALS conforms to accreditation requirements and is applied to all analytical testing performed by ALS. The following table lists testing sector, accreditation body, accreditation number and website. Please contact these accrediting bodies or your ALS project manager for the current scope of accreditation that applies to your analytical testing.

| Testing Sector      | Accreditation Body (Standard) | Certificate Number  | Website   |
|---------------------|-------------------------------|---|---|
| Environmental       | PJLA (DoD ELAP)               | L17-506   | <a href="http://www.pjllabs.com">http://www.pjllabs.com</a>   |
|                     | PJLA (ISO 17025)              | L17-507-R1  | <a href="http://www.pjllabs.com">http://www.pjllabs.com</a>   |
|                     | Utah (TNI)                    | UT00953   | <a href="http://lams.nelac-institute.org/search">http://lams.nelac-institute.org/search</a>   |
|                     | Nevada (TNI)                  | UT00953201-1  | <a href="https://ndep.nv.gov/water/lab-certification">https://ndep.nv.gov/water/lab-certification</a>   |
|                     | Iowa (TNI)                    | IA# 376   | <a href="http://www.shl.uiowa.edu/labcert/idnr/">http://www.shl.uiowa.edu/labcert/idnr/</a>   |
|                     | Kansas                        | E-10416   | <a href="http://www.kdheks.gov/envlab/disclaimer.html">http://www.kdheks.gov/envlab/disclaimer.html</a>   |
|                     | Oklahoma (TNI)                | IJ# 9980  | <a href="http://www.deq.state.ok.us/CSDnew/labcert.htm">http://www.deq.state.ok.us/CSDnew/labcert.htm</a>   |
| Texas (TNI)         | T104704456-18-9               | <a href="https://www.tceq.texas.gov/assets/public/compliance/compliance_support/qa/txnelap_lab_list.pdf">https://www.tceq.texas.gov/assets/public/compliance/compliance_support/qa/txnelap_lab_list.pdf</a> |   |
| Industrial Hygiene  | AIHA (ISO 17025 & AIHA IHLAP) | 101574  | <a href="http://www.aihaaccreditedlabs.org">http://www.aihaaccreditedlabs.org</a>   |
|                     | DOECAP-AP                     | L18-606   | <a href="http://www.pjllabs.com">http://www.pjllabs.com</a>   |
|                     | Washington                    | C596  | <a href="https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Laboratory-Accreditation">https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Laboratory-Accreditation</a> |
| Dietary Supplements | PJLA (ISO 17025)              | L17-507-R1  | <a href="http://www.pjllabs.com">http://www.pjllabs.com</a>   |



## ANALYTICAL REPORT

**Amended-20190709**

Workorder: **34-1918441**

Client Project ID: L2295084

Purchase Order: NA

Project Manager: Jessica Helland

### Definitions

LOD = Limit of Detection = MDL = Method Detection Limit, A statistical estimate of method/media/instrument sensitivity.

LOQ = Limit of Quantitation = RL = Reporting Limit, A verified value of method/media/instrument sensitivity.

ND = Not Detected, Testing result not detected above the LOD or LOQ.

NA = Not Applicable.

\*\* No result could be reported, see sample comments for details.

< Means this testing result is less than the numerical value.

() This testing result is between the LOD and LOQ and has higher analytical uncertainty than values at or above the LOQ.



Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com



L2295084-COFC

COC Number: 17 - 830387

Page of

|   |   |   |  |  |   |                              |  |             |   |   |  |
|---|---|---|--|--|---|------------------------------|--|-------------|---|---|--|
| <b>Report To</b><br>Contact and company name below will appear on the final report                        |   | <b>Report Format / I</b>  |  | <b>Contact your AM to confirm all E&amp;P TATs (surcharges may apply)</b>  |   |                              |  |             |   |   |  |
| Company:  | RWDI  | Select Report Format:   | <input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> TABLET / PDA (OPTIONAL)  | Regular (R) <input checked="" type="checkbox"/> Standard TAT if received by 3 pm - business days - no surcharges apply |   | EMERGENCY                    |  |             |   |   |  |
| Contact:  | Matthew Sawycky   | Quality Control (QC) Report with Report   | <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO                                  | Priority (Business Days)   | 4 day [P4-20%]  | 1 Business day [E - 100%]    |  |             |   |   |  |
| Phone:  | 604-730-5688 ext-2639   | <input checked="" type="checkbox"/> Compare Results to Criteria on Report - provide details below if box checked              |  | 3 day [P3-25%]   | Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] |                              |  |             |   |   |  |
| Company address below will appear on the final report   |   | Select Distribution:  | <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX | 2 day [P2-50%]   |   |                              |  |             |   |   |  |
| Street:   | 1385 w 8 <sup>th</sup> ave (Suite 280)  | Email 1 or Fax:   | Matthew.Sawycky@RWDI.com   | Date and Time Required for all E&P TATs:   |   | dd-mmm-yy hh:mm              |  |             |   |   |  |
| City/Province:  | Vancouver / BC  | Email 2:  | eric.christensen@rwdi.com  | For tests that can not be performed according to the service level selected, you will be contacted.                    |   |                              |  |             |   |   |  |
| Postal Code:  | V6H 3V9   | Email 3:  |  | <b>Analysis Request</b>  |   |                              |  |             |   |   |  |
| Invoice To  | Same as Report To <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO           | <b>Invoice Distribution</b>   |  | Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below   |   |                              |  |             |   |   |  |
|   | Copy of Invoice with Report <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO | Select Invoice Distribution:  | <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX |  |   |                              |  |             |   |   |  |
| Company:  |   | Email 1 or Fax:   | Matthew.Sawycky@rwdi.com   | <b>NUMBER OF CONTAINERS</b>  | Ammonia   | Chlorine                     | Reduced Sulfur   |             |   |   |  |
| Contact:  |   | Email 2:  |  |  |   |                              |  |             |   |   |  |
| <b>Project Information</b>  |   | <b>Oil and Gas Required Fields (client use)</b>   |  |  |   |                              |  |             |   |   |  |
| ALS Account # / Quote #:  |   | AFE/Cost Center:  | PO#  |  |   |                              |  |             |   |   |  |
| Job #:  |   | Major/Minor Code:   | Routing Code:  |  |   |                              |  |             |   |   |  |
| PO / AFE:   | 1904012-1000-100  | Requisitioner:  |  |  |   |                              |  |             |   |   |  |
| LSD:  |   | Location:   |  |  |   |                              |  |             |   |   |  |
| ALS Lab Work Order # (lab use only):  |   | ALS Contact:  | Sampler:   |  |   |                              |  |             |   |   |  |
| ALS Sample # (lab use only)   | Sample Identification and/or Coordinates (This description will appear on the report)           | Date (dd-mmm-yy)  | Time (hh:mm)   |  |   |                              |  | Sample Type |   |   |  |
|   | Tube 7865400032 - BioReact T1   | 15-Jun-19   | 13:34  |  |   |                              |  | Air         | 1 | X |  |
|   | Tube 7865400039 - BioReact T2   | 17-Jun-19   | 14:36  | Air  | 1   | X                            |  |             |   |   |  |
|   | Tube 7865400036 - Effluent ch. T3   | 17-Jun-19   | 15:49  | Air  | 1   | X                            |  |             |   |   |  |
|   | Cassette T1 - Bio Reactor 1 inlet   | 17-Jun-19   | 13:34  |  | 1   | X                            |  |             |   |   |  |
|   | Cassette T2 - Bio Reactor 2 inlet   | 17-Jun-19   | 14:36  |  | 1   | X                            |  |             |   |   |  |
|   | Cassette T3 - Effluent Channel  | 17-Jun-19   | 15:49  |  | 1   | X                            |  |             |   |   |  |
|   | Canister 01400-0326 - Bio React T1  | 17-Jun-19   | 13:58  |  | 1   | X                            |  |             |   |   |  |
|   | Canister 01400-0003 - Bio React T2  | 17-Jun-19   | 15:00  |  | 1   | X                            |  |             |   |   |  |
|   | Canister 01400-0373 - Effluent ch. T3   | 17-Jun-19   | 16:06  |  | 1   | X                            |  |             |   |   |  |
| <b>Drinking Water (DW) Samples<sup>1</sup> (client use)</b>   |   | <b>Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)</b> |  | <b>SAMPLE CONDITION AS RECEIVED (lab use only)</b>   |   |                              |  |             |   |   |  |
| Are samples taken from a Regulated DW System?<br><input type="checkbox"/> YES <input type="checkbox"/> NO |   |   |  | Frozen   | <input type="checkbox"/>  | SIF Observations             | Yes <input type="checkbox"/> No <input type="checkbox"/> |             |   |   |  |
| Are samples for human consumption/ use?<br><input type="checkbox"/> YES <input type="checkbox"/> NO       |   |   |  | Ice Packs  | <input type="checkbox"/>  | Ice Cubes                    | <input type="checkbox"/>                                 |             |   |   |  |
|   |   |   |  | Cooling Initiated  | <input type="checkbox"/>  | Custody seal intact          | Yes <input type="checkbox"/> No <input type="checkbox"/> |             |   |   |  |
|   |   |   |  | INITIAL COOLER TEMPERATURES °C   |   | FINAL COOLER TEMPERATURES °C |  |             |   |   |  |
|   |   |   |  |  |   | 22                           |  |             |   |   |  |
| <b>SHIPMENT RELEASE (client use)</b>  |   | <b>INITIAL SHIPMENT RECEPTION (lab use only)</b>  |  | <b>FINAL SHIPMENT RECEPTION (lab use only)</b>   |   |                              |  |             |   |   |  |
| Released by:  | Eric Christensen  | Date:   | 2019-06-19   | Time:  | 12:00   | Received by:                 | HA   |             |   |   |  |
|   |   |   |  |  |   | Date:                        | 6/19   |             |   |   |  |
|   |   |   |  |  |   | Time:                        | 11059  |             |   |   |  |

**SAMPLES ON HOLD**

SUSPECTED HAZARD (see Special Instructions)

60 NORTHLAND ROAD, UNIT 1  
WATERLOO, ON N2V 2B8

Phone: (519) 886-6910

Fax: (519) 886-9047

Toll Free: 1-800-668-9878



L2295084-COFC

Chlorine Cassettes

A - Canister/Tube/Gas Bag

Page \_\_\_ of \_\_\_

3:00 pm or Saturday / Sunday begin the next day.

|               |                   |                                     |                             |                          |
|---------------|-------------------|-------------------------------------|-----------------------------|--------------------------|
| DATE REQUIRED | SERVICE REQUESTED | Rush 3 day (100%)                   | <input type="checkbox"/>    |                          |
|               | 10 day (regular)  | <input checked="" type="checkbox"/> | Rush 2 day (200%)           | <input type="checkbox"/> |
|               | Rush 5 day (50%)  | <input type="checkbox"/>            | Rush 1 day (300%) - Enquire | <input type="checkbox"/> |

COMPANY NAME: **RWDI**  
OFFICE: **Vancouver**  
PROJECT MANAGER: **Matthew Sawycky**  
PROJECT #: **1904012-1000-100**  
PHONE: **604-730-5688** FAX: **604-2639**  
ACCOUNT #:  
QUOTATION #: **1904012-1000-100**

REGULATION  
CRITERIA  
OTHER INFORMATION

REPORT FORMAT/DISTRIBUTION  
EMAIL: \_\_\_\_\_ FAX: \_\_\_\_\_ BOTH: \_\_\_\_\_  
SELECT: PDF DIGITAL BOTH  
EMAIL 1: **Matthew.Sawycky@rwdi.com**  
EMAIL 2: \_\_\_\_\_

|  |          |  |                                       |
|--|----------|--|---------------------------------------|
| TUBE AIR VOLUME - L <input checked="" type="checkbox"/> or m <sup>3</sup> <input type="checkbox"/> | Chlorine | ANALYSIS REQUEST                       |                                       |
|  |          | STARTING PRESSURE - Pre-Sampling ("Hg) | ENDING PRESSURE - Post Sampling ("Hg) |
|  |          | COLLECTION TIME (HRS)                  |                                       |

All rush work requires lab approval before sample submission

SUBMISSION #:  
ENTERED BY:  
DATE/TIME ENTERED:  
BIN #:  
Field Conditions (Rain/Wind/Dust/Odour) Field PID Reading  
LAB ID

| Sample Date/Time |       | Canister or Tube ID#<br>(e.g. 060000-XXXX or G0XXXXXXSVI) | Regulator Serial #<br>CS1200-XXXX or GXX | Matrix Type | SAMPLE DESCRIPTION TO APPEAR ON REPORT | TUBE AIR VOLUME | STARTING PRESSURE | ENDING PRESSURE | COLLECTION TIME | FIELD CONDITIONS | LAB ID |
|------------------|-------|---|--|-------------|--|-----------------|-------------------|-----------------|-----------------|------------------|--------|
| 17-Jun-19        | 13:34 | T-1   |  |             | Bio-reactor 1 inlet                    | 20              | X                 |                 |                 | clear & sunny    |        |
| 17-Jun-19        | 14:36 | T-2   |  |             | Bio-reactor 2 inlet                    | 20              | X                 |                 |                 | "                |        |
| 17-Jun-19        | 15:39 | T-3   |  |             | effluent channel                       | 20              | X                 |                 |                 | "                |        |

SPECIAL INSTRUCTIONS/COMMENTS

SAMPLED BY: **Eric Christensen**  
RELINQUISHED BY: **Eric Christensen**

This Chain of Custody Form is only to be used for Air Quality Samples

Matrix Type: **Soil Gas Vapour (SG) WWTP water Ambient Air = AA 16:00**

Indoor Air = IA  
Industrial Hygiene = IH

RECEIVED BY: **HA**  
RECEIVED AT LAB BY:  
DATE & TIME: **2019-06-17 12:00**  
DATE & TIME: **2019-06-19**

SAMPLE CONDITION AS RECEIVED

FROZEN   
COLD   
COOLING INITIATED   
AMBIENT

MEAN TEMP: **22**

OBSERVATIONS: Yes  No   
If yes, add SIF

Notes

- Quote number must be provided to ensure proper pricing
- TAT may vary dependent on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs.
- Any known or suspected hazards relating to a sample must be noted on the chain of custody in comments section.

# AIR SAMPLING MEDIA REQUEST FORM



BR# 246457

|                       |                                       |                     |               |
|-----------------------|---------------------------------------|---------------------|---------------|
| CLIENT:               | RWDI / Comox Valley Regional District | CLIENT EXPECT DATE: | 06/13/2019    |
| CLIENT CONTACT:       | Matthew Sawycky (RWDI)                | ORDER TAKEN BY:     |               |
| CLIENT PROJECT:       | 1904012-1000-100                      | ORDER DATE:         | 06/14/2019    |
| DELIVERY TO:          |                                       | QUOTE #:            |               |
| TELEPHONE NUMBER:     | 604-730-5688 ext. 2639                | ORDER FILLED BY:    | RS            |
| SHIP TO/ATTENTION OF: |                                       | DATE COMPLETED:     | June 13, 2019 |

Shipping Method:  Ground: (4 business days to Western Canada, 2 business days to Winnipeg)  Express: (2 business days to Western Canada, 1 business day to WP)

External Courier

ALS Drivers:

Pickup at ALS Warehouse:

TAT Information: (select one)

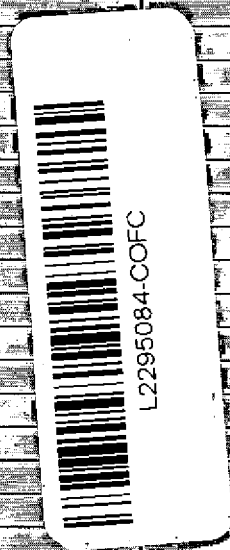
|  |                  |                |
|--|------------------|----------------|
| <input checked="" type="radio"/> Regular TAT | 10 Business Days | No surcharge   |
| <input type="radio"/> 5-day                  | 5 Business Days  | 50% surcharge  |
| <input type="radio"/> 3-day                  | 3 Business Days  | 100% surcharge |
| <input type="radio"/> 2-day                  | 2 Business Days  | 200% surcharge |
| <input type="radio"/> 1-day                  | 1 Business Day   | 300% surcharge |

ALL TAT except Regular requires Prior Confirmation

**Completion of all Sections is Mandatory**

1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawlspace; **OH&S** - Industrial, Commercial, Residential  comment: **Waste Water treatment Plant**
  2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**
  3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**
- This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:                 | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-------------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                         | 24 hr           |          |                           | 01400-0003 ✓                   |  |                             |
|                                     | 12 hr           |          |                           | 01400-0326 ✓                   |  |                             |
|                                     | 8 hr            |          |                           | 01400-0593 ✓                   |  |                             |
|                                     | 4 hr            |          |                           |                                |  |                             |
|                                     | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters                 |                 |          |                           |                                |  |                             |
| 1.4L Canister                       | 1 hr            |          |                           |                                |  |                             |
|                                     | 20 mins         |          |                           |                                |  |                             |
|                                     | 10 mins         |          |                           |                                |  |                             |
| Number of Canisters                 |                 | 3        |                           |                                |  |                             |
| Bottle Vacs                         | 1 hr            |          |                           |                                |  |                             |
|                                     | 20 mins         |          |                           |                                |  |                             |
|                                     | 10 mins         |          |                           |                                |  |                             |
| Number of Canisters                 |                 |          |                           |                                |  |                             |
| Passive CarboPak X Tubes            |                 |          |                           |                                |  |                             |
| Diffusive Caps                      |                 |          |                           |                                |  |                             |
| Active SVI Tubes                    |                 |          |                           |                                |  |                             |
| Concentration Tube for SVI (yrs/no) |                 |          |                           |                                |  |                             |



| Other Sampling Supplies  | ID # | Quantity | Additional Information & Special Instructions or Requests   |
|--|------|----------|---|
| Pressure Gauge   |      |          | 3 canisters for reduced sulfur<br>3 adapters tedlar to canister<br><br>Note: No pressure gauges or MFC included w/ canisters. |
| Caplok Tool  |      |          |   |
| Canister Stands  |      |          |   |
| Valve Adaptor for Soil Vapour  |      |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS <input type="checkbox"/> |      |          |   |
| Chargeable Supplies  |      |          |   |
| Duplicate Sampler - \$40 ea / \$25 tube  |      |          |   |
| Teflon Tubing  |      |          |   |
| - Total length _____   |      |          |   |
| - Length per section _____   |      |          |   |
| \$3 per foot / \$6 per N+F set   |      |          |   |
| Siloxane Kit - \$45 each   |      |          |   |

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client.)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$850.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00



# THERMAL DESORPTION INFORMATION

HA  
6/19



L2295084-COFC

ALS File

1246457

|                |                        |
|----------------|------------------------|
| Date Returned: |                        |
| QC Check:      | <i>JK</i><br>Jun 13/19 |

(To be filled out by ALS upon return of samples to ALS)

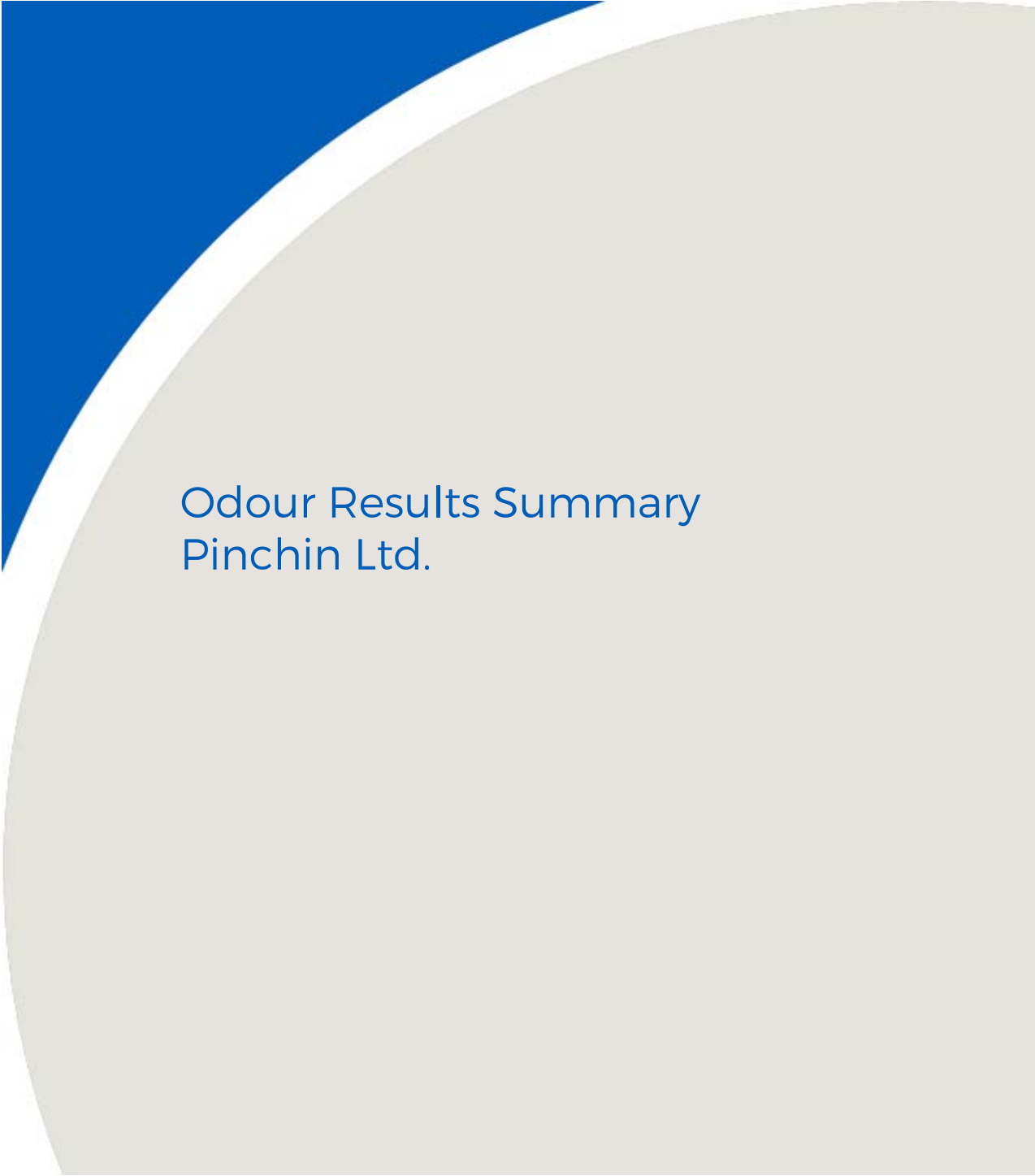
| 1. Sampling Supplies (To be filled out by ALS)                       |   |   |                 |
|--|---|---|-----------------|
| Company Name/Location:   | Comox Valley Regional District / RWDI   | Project/Job No:   | Not supplied    |
| Pump Requested By:   | Zoe Berkley   | Date of Request:  | June 13/19      |
| ALS Account Manager:   | Brent Mack  | Pump(s) Prepared By:  | <i>JK</i>       |
| # of Pumps (TD x 1 @ 1L/min):  | 1   | Date Required @ Shipping:   | June 14/19 noon |
| # of Pumps (TD x 1 @ 200mL/min):                                     | 1   | Flow Verification Tubes <u>1</u>                                      | Other           |
| Other Supplies Provided: 3 cassettes (chlorina) <u>1</u> tube cutter | Lithium-ion Battery Charger<br>Splitters & Tubing<br>Alkaline Battery Adapter | Pelican Case (Single)<br>Pelican Case (Multiple)<br>Additional Pumps: |                 |
| TD Tubes : 6 SG tubes for NH3  |   |   |                 |

| 2. Flow Rates (Flow rates before and after - ALS, flow rates in-situ - Client) |  |   |                                     |  |
|--|--|---|-------------------------------------|--|
| Pump ID  | Pump flow before sampling (mL/min) - ALS | Pump flow after sampling (mL/min) - ALS | Pump Flow in situ (mL/min) - CLIENT | Notes  |
| 1. 012473  | A 199<br>B                               | A<br>B                                  | A<br>B                              | ✓  |
| 2. 012471  | A 1006<br>B                              | A<br>B                                  | A<br>B                              | no moisture trap + low flow adaptor attached to achieve the 1L/min rate. |
| 3.   | A<br>B                                   | A<br>B                                  | A<br>B                              |  |
| 4.   | A<br>B                                   | A<br>B                                  | A<br>B                              |  |

If in-situ flow measurements have been provided, these will be used for all air concentrations calculations.

| 3. Sample Information (To be filled out by Client) |                  |        |                     |                 |                           |   |   |                          |
|--|------------------|--------|---------------------|-----------------|---------------------------|---|---|--------------------------|
| TD Tube Serial #                                   | Client Sample ID | Pump # | Sampling Time (min) | Date/Time       | Elevated Levels Expected? |   |   | Recvd @ Lab              |
|  |                  |        |                     |                 | Y                         | ? | N |                          |
| 1 7865400032                                       | Bio. React. T1   | 12473  | 20 min              | June 17 1:34 pm | X                         |   |   | ✓                        |
| 2 7865400039                                       | Bio React. T2    | 12473  | 20 min              | June 17 2:36 pm | X                         |   |   | ✓                        |
| 3 7865400036                                       | Effluent Ch. T3  | 12473  | 20 min              | June 17 3:49 pm |                           |   | X | ✓                        |
| 4 786500031  |                  |        |                     |                 |                           |   |   | ✓                        |
| 5 7865400038                                       |                  |        |                     |                 |                           |   |   | ✓                        |
| 6 7865400035                                       |                  |        |                     |                 |                           |   |   | ✓                        |
| 7  |                  |        |                     |                 |                           |   |   |                          |
| 8  |                  |        |                     |                 |                           |   |   |                          |
| 9  |                  |        |                     |                 |                           |   |   |                          |
| 10   |                  |        |                     |                 |                           |   |   |                          |
| 11   |                  |        |                     |                 |                           |   |   |                          |
| 12 7679700166                                      |                  |        |                     |                 |                           |   |   | Flow Verification tube ✓ |

## APPENDIX D

A decorative background featuring a large, light grey circular shape on the right side, partially overlapping a blue triangular shape on the left side. The text is centered within the grey area.

### Odour Results Summary Pinchin Ltd.

### Odour Evaluation Results

Client:                     RWDI                    

Test Reference No.:                     A202859-0619191                    

Pinchin Project No.:                     202859                    

Evaluation Date:                     19-Jun-19                    

Client Project No.:                     1904012                    

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1563 | Bioreactor T1                | 5 :1               | 9:06 - 9:14 AM     | 1045      | 5225              |          |
| PO19-202859-S1564 | Bioreactor T2                | 5 :1               | 9:15 - 9:25 AM     | 2485      | 12425             |          |
| PO19-202859-S1565 | Bioreactor T3                | 5 :1               | 9:27 - 9:39 AM     | 3514      | 17570             |          |
| PO19-202859-S1566 | Outlet Scrub Off T1          | 1 :1               | 9:40 - 9:51 AM     | 1611      | 1611              |          |
| PO19-202859-S1567 | Outlet Scrub Off T2          | 1 :1               | 9:52 - 10:05 AM    | 1611      | 1611              |          |
| PO19-202859-S1568 | Outlet Scrub Off T3          | 1 :1               | 10:06 - 10:18 AM   | 1916      | 1916              |          |
| PO19-202859-S1569 | Outlet Scrub On T1           | 1 :1               | 10:19 - 10:32 AM   | 806       | 806               |          |
| PO19-202859-S1570 | Outlet Scrub On T2           | 1 :1               | 10:34 - 10:46 AM   | 958       | 958               |          |

Client:                     RWDI                    

Test Reference No.:                     B202859-0619191                    

Pinchin Project No.:                     202859                    

Evaluation Date:                     19-Jun-19                    

Client Project No.:                     1904012                    

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1571 | Outlet Scrub On T3           | 1 :1               | 10:47 - 11:00 AM   | 1242      | 1242              |          |
| PO19-202859-S1572 | Inlet Scrub On T1            | 1 :1               | 11:01 - 11: 12 AM  | 3514      | 3514              |          |
| PO19-202859-S1573 | Inlet Scrub On T2            | 1 :1               | 11:13 - 11:25 AM   | 3222      | 3222              |          |
| PO19-202859-S1574 | Inlet Scrub On T3            | 1 :1               | 11:26 - 11:38 AM   | 2458      | 2458              |          |

<sup>\*</sup>DT<sub>net</sub> - Results have been adjusted for field dilution  
Presentation Flow Rate = 20 litres per minute

## APPENDIX E

A decorative graphic on the left side of the page. It features a solid blue right-angled triangle in the top-left corner. A large, light grey circle overlaps the triangle and extends across the middle and bottom of the page. The text 'Field Notes' is centered within the grey circle.

Field Notes

# — Odour Sampling Field Data —

Client: Comox Odour Survey  
 Project #: 1904012  
 Sample Locations: Bio Reactor  
 Date: June 18 2019  
 Dilution Gas: Nitrogen

| Dilution # | Sample I.D.   | Sample Pressure<br><del>100</del> | Motive Pressure<br>"H2O | Field Dilution | Flux in. Flux Scr. Pool |                  |                  | Time ON | OFF  | Tedlar Bag QA      |            |
|------------|---------------|-----------------------------------|-------------------------|----------------|-------------------------|------------------|------------------|---------|------|--------------------|------------|
|            |               |                                   |                         |                | Eductor Temp<br>°F      | Probe Temp<br>°F | Stack Temp<br>°F |         |      | Moisture?<br>(Y/N) | Leak Check |
| 1          | T1 Bioreactor | 1 LPM                             | 2.1                     | 5 LPM          | 73.6                    | 74.3             | 71.2             | 8:23    | 8:28 | N                  | ✓          |
|            | T2 Bioreactor | 1 LPM                             | 2.1                     | 5 LPM          | 73.6                    | 74.3             | 71.2             | 8:33    | 8:38 | N                  | ✓          |
|            | T3 Bioreactor | 1 LPM                             | 2.1                     | 5 LPM          | 73.6                    | 74.3             | 71.2             | 8:45    | 8:50 | N                  | ✓          |
| 2          |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
|            |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
| 3          |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
|            |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
| 4          |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
|            |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
| 5          |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
|            |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |

Comments

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# RWDI AIR Inc. Odour Sampling Datasheet

Date: June 18 2019  
 Wind Direction: ~~W~~ N  
 Wind Speed: 17 Km/h

Client: Comox  
 Location: Inlet/Outlet of Scrubber

PST

| Sample No.   | Sample Location    | Dilution | Sample Time | Tedlar Bag QA |            | Comments |
|--------------|--------------------|----------|-------------|---------------|------------|----------|
|              |                    |          |             | Moisture?     | Leak Check |          |
| T1 Outlet    | Outlet Scrub. off  | -        | 7:25        | NO            | ✓          |          |
| T2 Outlet    | Outlet Scrub. off  | -        | 7:35        | NO            | ✓          |          |
| T3 Outlet    | Outlet Scrub. off  | -        | 7:43        | NO            | ✓          |          |
| T1 inlet     | Inlet Scrubber ON  | -        | 9:09        | NO            | ✓          |          |
| T2 inlet     | Inlet Scrubber ON  | -        | 9:20        | NO            | ✓          |          |
| T3 inlet     | Inlet Scrubber ON  | -        | 9:30        | NO            | ✓          |          |
| T1 Outlet ON | Outlet Scrubber on | -        | 09:44       | No            | ✓          |          |
| T2 Outlet ON | Outlet Scrubber on | -        | 09:54       | NO            | ✓          |          |
| T3 Outlet ON | Outlet Scrubber on | -        | 10:04       | NO            | ✓          |          |
|              |                    |          |             |               |            |          |
|              |                    |          |             |               |            |          |
|              |                    |          |             |               |            |          |
|              |                    |          |             |               |            |          |

— NH<sub>3</sub>, Cl, and Canister Sampling Field Data —

Client: Comox WWTP  
 Project #: 1904012  
 Sample Locations: T1 (Inlet of Bioreactor 1)  
                           T2 (Inlet of Bioreactor 2)  
                           T3 (Effluent Outlet)  
 Date: 17-Jun-19  
 Dilution Gas: Nitrogen

T1  
T2  
T3

| Dilution # | Sample I.D. | LPM                               |                                   | Field Dilution | Eductor Temp °F | Probe Temp °F | Ambient       | Time ON | OFF   |
|------------|-------------|-----------------------------------|-----------------------------------|----------------|-----------------|---------------|---------------|---------|-------|
|            |             | Sample Pressure #H <sub>2</sub> O | Motive Pressure "H <sub>2</sub> O |                |                 |               | Stack Temp °F |         |       |
| 1          | IAQ Tube #1 | .2 LPM                            | 2.4                               | 5 LPM          | 68.2            | 80.0          | 71.6          | 13:34   | 13:54 |
|            | Filter #1   | 1 LPM                             | 2.4                               | 5 LPM          | 68.2            | 80.0          | 71.6          | 13:34   | 13:54 |
|            | Can # 00955 | .3 LPM                            | 2.4                               | 5 LPM          | 68.2            | 80.0          | 71.6          | 13:35   | 14:00 |
| 2          | IAQ Tube #2 | .2                                | 2.0                               | 5 LPM          | 81.8            | 74.2          | 75.2          | 14:36   | 14:56 |
|            | Filter #2   | 1                                 | 2.0                               | 5 LPM          | 81.8            | 74.2          | 75.2          | 14:36   | 14:56 |
|            | Can # 103   | .3                                | 2.0                               | 5 LPM          | 81.8            | 74.2          | 75.2          | 15:00   | 15:05 |
| 3          | IAQ Tube #3 | .2                                | 2.2                               | 5 LPM          | 69.0            | 64.3          | 75.2          | 15:46   | 16:06 |
|            | Filter #3   | 1                                 | 2.2                               | 5 LPM          | 69.0            | 64.3          | 75.2          | 15:46   | 16:06 |
|            | Can # 6353  | .3                                | 2.2                               | 5 LPM          | 69.0            | 64.3          | 75.2          | 16:10   | 16:15 |
| 4          |             |                                   |                                   |                |                 |               |               |         |       |
| 5          |             |                                   |                                   |                |                 |               |               |         |       |

Comments

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## APPENDIX B

A large decorative graphic on the page. It features a blue triangular shape in the top-left corner, separated from a large, light-grey circular shape by a white curved line. The text is centered within the grey circle.

Source Testing Memo -  
Comox Valley Water Pollution  
Control Centre - September 2019



RWDI  
Suite 280, 1385 West 8th Avenue  
Vancouver BC Canada  
V6H 3V9

Tel: +1.604.730.5688  
E-mail: [solutions@rwdi.com](mailto:solutions@rwdi.com)

## MEMORANDUM

|              |   |                            |  |
|--------------|---|----------------------------|--|
| <b>DATE:</b> | 2019-10-04  | <b>RWDI Reference No.:</b> | 1904012  |
| <b>TO:</b>   | Zoe Berkey  | <b>EMAIL:</b>              | <a href="mailto:zberkey@comoxvalleyrd.ca">zberkey@comoxvalleyrd.ca</a> |
| <b>FROM:</b> | Matthew Sawycky   | <b>EMAIL:</b>              | <a href="mailto:matthew.sawycky@rwdi.com">matthew.sawycky@rwdi.com</a> |
| <b>CC:</b>   | John DeYoe  | <b>EMAIL:</b>              | <a href="mailto:john.deyoe@rwdi.com">john.deyoe@rwdi.com</a>           |
| <b>CC:</b>   | William Clarke  | <b>EMAIL:</b>              | <a href="mailto:william.clarke@rwdi.com">william.clarke@rwdi.com</a>   |
| <b>RE:</b>   | <b>Source Testing Memo - Comox Valley Water Pollution Control Centre - September 2019<br/>Comox, BC</b> |                            |  |

Zoe,

Please find this memorandum for methodology and results from testing at the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC (the facility).

RWDI conducted sampling at the facility on September 4<sup>th</sup>, 2019 for laboratory analysis of odour and total reduced sulfur (TRS), and September 19<sup>th</sup> for laboratory analysis of odour.

### Odour Emissions Sampling Methodology

#### September 4, 2019

Upon receipt of the odour value results collected in June, it was speculated that recent changes to the facilities operations prior to the sampling program may have resulted in higher than normal values. RWDI was commissioned to re-sample odour at the facility in early September.

Sampling was conducted to provide odour unit (OU) values as a comparison to June collected values and for subsequent dispersion modelling to be conducted.

Sampling was conducted at 3 points along each bioreactor pond, for a total of 6 samples.

#### September 19, 2019

CVWPCC expressed concern that collected OU analysis conducted on samples taken during the day may not be representative of OU values during the evening period, as the majority of residential



complaints are received in the evening hours. RWDI visited the facility to replicate the sample locations taken on September 4<sup>th</sup> during evening operations.

Sampling was conducted at the same 3 points along each bioreactor pond, for a total of 6 samples.

### **Flux Chamber Sampling**

Sampling at the bioreactor was conducted using a flux chamber.

Odour emissions from the waste water surface were measured using a floating flux chamber. The flux chamber is 40.6 cm in diameter; and approximately 35 cm high, and constructed of 14-gauge stainless steel, as per the designer's specifications outlined in Ontario Stack Testing Code Method ON-6. All interior and exterior fittings are constructed from odour neutral material being stainless steel and all lines were made from Teflon tubing with some variance at connections. The flux chamber is equipped with ports: one for sweep gas line and one for sample line. The chamber is fitted with a floatation device to hold it on top of the surface.

Ultra high purity nitrogen gas was used as the sweep gas, which was metered into the chamber at a constant rate of 5 litres per minute. The sweep gas was allowed to run through the chamber for 30 minutes prior to sample collection.

The odour samples were collected through a sample port on the flux chamber into a Tedlar bag using a lung sampler. The sample bag was filled at a rate of less 5 L/min in order to not significantly affect the equilibrium of the chamber.

### **Scrubber Outlet Sampling**

The odour samples were collected through a pre-existing sample port, located at the outlet of the odour control unit using a lung sampler. The lung sampler utilizes a large container with an airtight lid and two air line fittings. A Tedlar bag is inserted into the container and a sample line is connected to the Tedlar bag. A vacuum is then applied to the cavity in the container which, through pressure differential, draws the sample air into the Tedlar sample bag; the sample bag was filled at a rate of 5 L/min.

### **Odour Sample Analysis**

The samples collected on September 4<sup>th</sup> were air shipped to Pinchin Ltd. Environmental Consulting, in Mississauga Ontario, for analysis by an eight-member odour panel within 24-hours of testing (September 5, 2019). Details about the odour panel methodology are contained in Appendix A: Odour Evaluation Report Pinchin Ltd.



Pinchin Ltd. Environmental Consulting was unable to conduct any odour sampling during the week of September 16, so an alternate accredited laboratory was used.

The samples collected on September 19<sup>th</sup> were air shipped to Environmental Odour Consulting Corporation, in Oakville Ontario, for analysis by an eight-member odour panel within 24-hours of testing (September 20, 2019). Details about the odour panel methodology are contained in Appendix B: Odour Evaluation Report Environmental Odour Consulting Corporation.

Once the odour concentration of the samples has been determined, the odour flux rate is calculated. The sweep gas rate is used to calculate the odour flux rate based on the total air movement into the chamber. The formula that was used to calculate the odour flux rate is as follows:

$$\text{Odour Flux Rate} \left( \frac{\text{ou}}{\text{s} \cdot \text{m}^2} \right) = \frac{\text{Odour Concentration} \left( \frac{\text{ou}}{\text{m}^3} \right) \cdot \text{Sweep Rate} \left( \frac{\text{m}^3}{\text{s}} \right)}{\text{Area of flux chamber} (\text{m}^2)}$$

The odour flux rates from the bioreactor were simply averaged and the flux rate was applied to the total surface area of the bioreactor clarifiers.

## Total Reduced Sulfur Sampling Methodology

TRS sampling was conducted, in triplicate, at the inlet to the scrubber and at the exit of the scrubber. Sampling values were used to calculate the scrubber and polisher efficiency in reducing TRS.

Sulfur compounds collection was conducted using ALS laboratory supplied vacuum canister media. Air was drawn from the flux chamber into the vacuum canister media to collect the sample.

## Chemical Analysis

Total reduced sulfur collection media was sent to ALS Environmental in Burnaby BC for analysis. Details about the analysis methodology are contained in Appendix C: Certificate of Analysis, ALS Environmental.

## Odour Results

The testing programs were completed on September 4<sup>th</sup> and 19<sup>th</sup>, 2019, using the techniques described in the methodology section. The odour lab results are summarized in Table 1 and 2; the complete laboratory analysis reports can be found in Appendix A and B. Field notes from the sampling program can be found in Appendix D.



**Table 1: Odour Laboratory Analysis Sample Results – September 4, 2019**

| Location                | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Sample Time (24hr) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/m <sup>2</sup> /s) |
|-------------------------|-----------------|-----------------|--------------------------------|--------------------|---|--------------------------------|
| Bioreactor Test 1 - out | 108             | 1 : 1           | 108                            | 08:14              | 0.07  | 0.47                           |
| Bioreactor Test 2 - mid | 198             | 1 : 1           | 198                            | 08:35              | 0.13  |                                |
| Bioreactor Test 3 - in  | 1892            | 1 : 1           | 1892                           | 09:00              | 1.22  |                                |
| Bioreactor Test 4 - out | 181             | 1 : 1           | 181                            | 09:25              | 0.12  | 0.71                           |
| Bioreactor Test 5 - mid | 236             | 1 : 1           | 236                            | 09:50              | 0.15  |                                |
| Bioreactor Test 6 - in  | 2918            | 1 : 1           | 2918                           | 10:14              | 1.87  |                                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.

**Table 2: Odour Laboratory Analysis Sample Results – September 19, 2019**

| Location           | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Sample Time (24hr) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/m <sup>2</sup> /s) | Odour Emission Rate (OU/s) | Average (OU/s) |
|--------------------|-----------------|-----------------|--------------------------------|--------------------|---|--------------------------------|----------------------------|----------------|
| Bioreactor 1 - out | 282             | 1 : 1           | 282                            | 21:15              | 0.18  | 1.26                           | N/A                        | N/A            |
| Bioreactor 1 - mid | 475             | 1 : 1           | 475                            | 21:35              | 0.31  |                                | N/A                        | N/A            |
| Bioreactor 1 - in  | 5061            | 1 : 1           | 5061                           | 21:52              | 3.25  |                                | N/A                        | N/A            |
| Bioreactor 2 - out | 318             | 1 : 1           | 318                            | 22:10              | 0.20  |                                | N/A                        | N/A            |
| Bioreactor 2 - mid | 492             | 1 : 1           | 492                            | 22:25              | 0.32  |                                | N/A                        | N/A            |
| Bioreactor 2 - in  | 5142            | 1 : 1           | 5142                           | 22:43              | 3.30  |                                | N/A                        | N/A            |
| Scrubber out 1     | 145             | 1 : 1           | 145                            | 20:20              | N/A   | N/A                            | 2654.03                    | 3050.61        |
| Scrubber out 2     | 172             | 1 : 1           | 172                            | 20:28              | N/A   | N/A                            | 3148.23                    |                |
| Scrubber out 3     | 183             | 1 : 1           | 183                            | 20:40              | N/A   | N/A                            | 3349.57                    |                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.



## Total Reduced Sulfur Results

The testing program for total sulfur compounds was completed on September 4<sup>th</sup>, 2019, using the techniques described in the methodology section. The lab results are summarized in Table 3; the complete laboratory analysis report can be found in Appendix C. Field notes from the sampling program can be found in Appendix D.

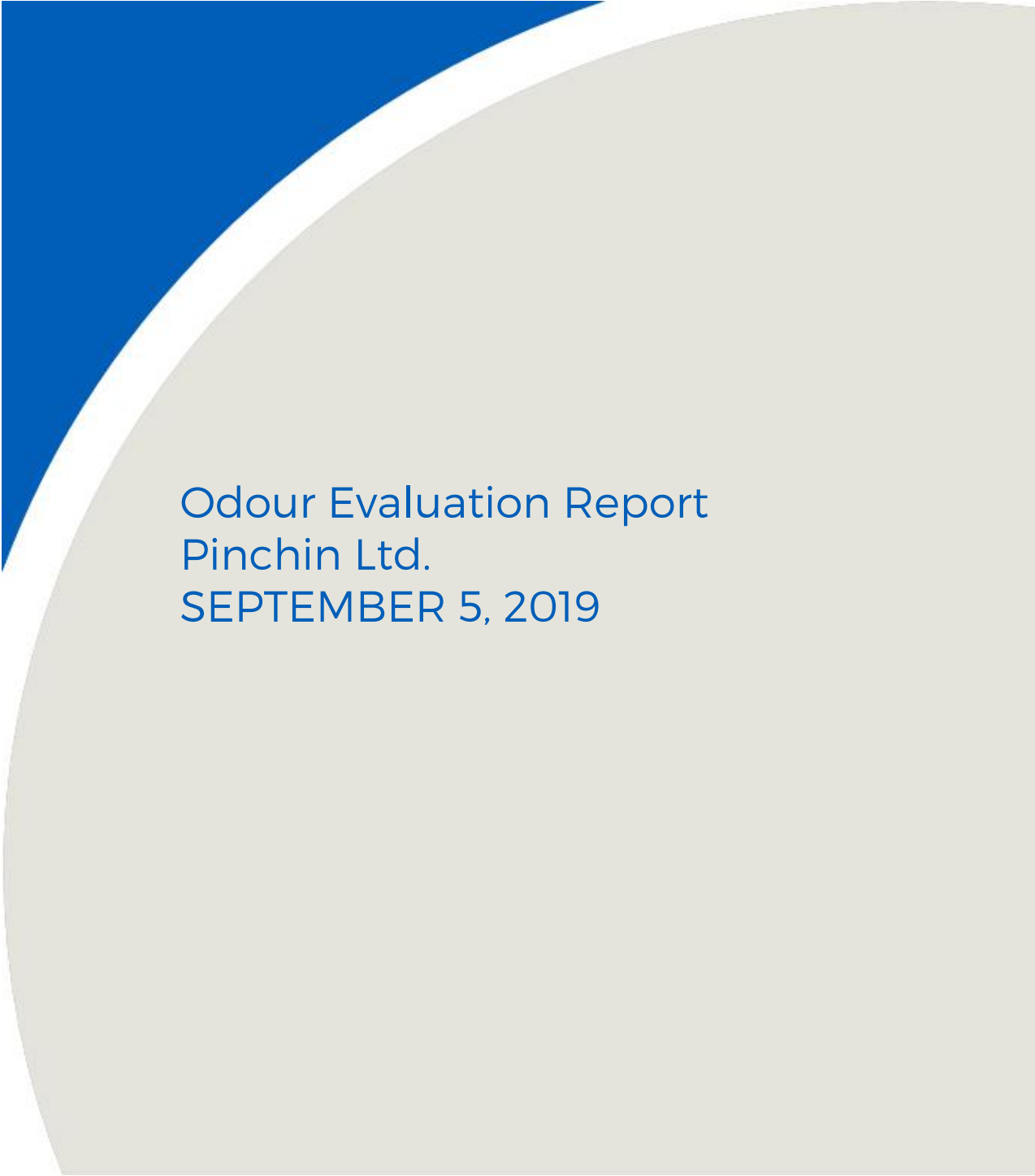
**Table 3: Total Reduced Sulfur Analysis Sample Results**

| Location          | H <sub>2</sub> S (ppb(V)) | H <sub>2</sub> S (ppb(V))<br>Average | H <sub>2</sub> S (ug/m <sup>3</sup> ) | H <sub>2</sub> S (ug/m <sup>3</sup> ) |
|-------------------|---------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| Scrubber Inlet 1  | 2570                      | 2956.7                               | 3590                                  | 4126.7                                |
| Scrubber Inlet 2  | 3490                      |                                      | 4870                                  |                                       |
| Scrubber Inlet 3  | 2810                      |                                      | 3920                                  |                                       |
| Scrubber Outlet 1 | 19                        | 19.7                                 | 26                                    | 26.3                                  |
| Scrubber Outlet 2 | 19                        |                                      | 27                                    |                                       |
| Scrubber Outlet 3 | 18                        |                                      | 26                                    |                                       |
| <b>Efficiency</b> | <b>99.4%</b>              |                                      |                                       |                                       |

If you have any questions regarding these results, we would be happy to discuss them with you at any time in the future.

Matthew Sawycky, B.Sc.  
Senior Project Manager

## APPENDIX A

A large decorative graphic on the left side of the page, featuring a blue triangle in the top-left corner and a large, light grey semi-circle that overlaps the triangle and extends across the page.

Odour Evaluation Report  
Pinchin Ltd.  
SEPTEMBER 5, 2019



FINAL

# Odour Evaluation Report

2470 Milltower Court  
Mississauga, ON  
L5N 7W5

Prepared for:

**John DeYoe**  
RWDI  
600 Southgate Drive  
Guelph, Ontario N1G 4P6

September 27, 2019

Pinchin File: 202859-090519



**Issued to:** RWDI  
**Contact:** John DeYoe

**Issued on:** September 27, 2019  
**Pinchin file:** 202859-090519  
**Issuing Office:** 2470 Milltower Court,  
Mississauga, ON L5N 7W5

---

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## APPENDICES

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## 1.0 EVALUATION SAMPLE & TIMING SUMMARY

Pinchin Ltd. (Pinchin) was contracted to determine the detection threshold (DT) of air samples submitted to Pinchin's Odour Laboratory located in Mississauga, Ontario. The particulars of the odour panel were as follows:

|   |                                   |
|---|-----------------------------------|
| <b>Client Name:</b>                             | RWDI                              |
| <b>No. of Samples Delivered:</b>                | Six (6)                           |
| <b>Date Samples Received:</b>                   | September 5, 2019                 |
| <b>Condition of the Sample Bags on Arrival:</b> | No leaks or condensation detected |
| <b>No. of Samples Analyzed:</b>                 | Six (6)                           |
| <b>Date of Odour Panel Analysis:</b>            | September 5, 2019                 |
| <b>Time of Odour Panel Analysis:</b>            | 9:21 – 10:50 AM                   |

## 2.0 METHODOLOGY

### 2.1 Laboratory Methodology

All samples were evaluated in accordance with the Ministry of the Environment, Conservation and Parks "Ontario Source Testing Code" (OSTC), Version #3, June 2010 (Part G, Method ON-6), using an AC'SCENT International triangular forced-choice, ascending concentration, dynamic dilution Olfactometer. A listing of Standard Practices to which the evaluations conform is provided in Appendix II.

The AC'SCENT Olfactometer was calibrated according to the manufacturer's guidelines on the day of sample evaluation. The CHEMFLUOR® PTFE tubing through which the odour sample is presented to the panellists was replaced prior to the assessment session. All sample delivery lines were purged continuously with odour free air between sample presentations.

A panel of eight trained assessors was employed in the evaluation of the odour samples. Each panel is screened for accuracy and repeatability following the procedures outlined in British Standard, BS EN 13725:2003, "Air quality – Determination of odour concentration by dynamic olfactometry", utilizing 50 ppm n-butanol calibration gas prior to sample evaluation. The geometric mean of the individual threshold estimates for 50 ppm n-butanol was determined to be between 20 and 80 ppb/v.

The odour samples were presented to the panellists using the “triangular forced-choice” method, described by ASTM E679-04, “Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits”. Each panellist evaluated the odour by “sniffing” the diluted odour samples presented by the Olfactometer. At each dilution level, the panellist “sniffed” three sample presentations, two of which were blank, odour free samples and one that contained the odorous air. The panellist was then asked to identify which of the three presentations was different from the other two by recording a “guess”, “detect” or “recognize” response as defined by ASTM E679-04.

A “guess” response was recorded when the assessor could not distinguish between any of the presentations. A “detect” response was recorded when the assessor could differentiate the odorous sample from the two blanks, and “recognize” was recorded when the assessor could identify and describe the odorous sample.

As per BS EN 13725:2003, each sample assessment began with the Olfactometer diluting the odorous sample to sub-detection levels. The odour sample and two blanks were then presented to one panellist, who “sniffed” the three presentations and recorded their response. The concentration of odorous gas was then doubled and re-presented to the same assessor with two blanks. Again, the assessor “sniffed” the three presentations and recorded their response. The process continued with the concentration of odorous gas increasing until the panellist had correctly detected the odour in at least two consecutive presentations as described by BS EN 13725:2003. The process was repeated for each panellist until all samples were evaluated.

Sample analysis was conducted “blind”; neither the panellist nor the test administrator knew which port would deliver the odour sample. Panellist’s results were recorded and analyzed using AC’SCENT DataSense Olfactometry software integrated with the Olfactometer. The software incorporates an Access database program designed specifically for olfactometry laboratories and is compatible with international olfactometry standards including BS EN 13725:2003 and ASTM E679-04.

As part of laboratory Quality Assurance and Quality Control (QAQC), test results were retrospectively screened in accordance with BS EN 13725:2003. As the standard requires, each assessor’s individual threshold estimate ( $Z_{ITE}$ ) was compared to the panel’s average threshold, with the ratio between the individual threshold estimate and the panel average threshold represented as  $\Delta Z$ . Assessors having a  $\Delta Z$  greater than 5.0 or lower than -5.0, were eliminated from the results. The purpose was to exclude panel members that showed deviant responses due to health factors or specific hyperosmia or anosmia for the odour of the analyzed sample. Where screening was required, both the screened and unscreened results were provided.

## 2.2 Odour Evaluation Parameters

### 2.2.1 Odour Threshold Values – Detection Threshold (DT)

The detection threshold (DT) is the dilution ratio at which 50% of the panellists correctly detected the odour. DT, as defined by ASTM E679-04, is synonymous with the MECP Draft definition of an odour threshold value ( $ED_{50}$ ) and the BS EN 13725:2003 definition of odour concentration ( $C_{OD}$ ). That is, the DT represents the amount of dilution required for the odour to be just detectable. Since DT values are dimensionless, pseudo-dimensions of odour units per unit volume (i.e. odour units per cubic metre ( $ou/m^3$ )) are often used for reporting purposes.

In accordance with BS EN 13725:2003, individual threshold estimates ( $Z_{ITE}$ ) were calculated as the geometric mean of the lowest dilution ratio where the odour could not be detected and the dilution ratio at which the panellist correctly detected the odour. Where a detection response could not be established at the Olfactometer's dilution limit, it was assumed that the panellist would have detected the odour at a dilution ratio half that of the limit, and the  $Z_{ITE}$  was calculated. The sample odour concentration ( $C_{OD}$ ) was then calculated as the geometric mean of the  $Z_{ITE}$  values.

## 3.0 RESULTS

The odour threshold value results for detection threshold (DT) are presented in Table 1. Where appropriate, the DT values have been adjusted for field pre-dilution reported by the client. The adjusted DT values are recorded as  $DT_{NET}$ . Datasheets are provided in Appendix I.



Table 1 – Odour Threshold Value Results

Client: RWDI

Test Reference No.: 202859-090519

Pinchin Project No.: 202859

Evaluation Date: 5-Sep-19

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1933 | Comox 1                      | 1 :1               | 9:21 - 9:36 AM     | 108       | 108               |          |
| PO19-202859-S1934 | Comox 2                      | 1 :1               | 9:37 - 9:49 AM     | 198       | 198               |          |
| PO19-202859-S1935 | Comox 4                      | 1 :1               | 9:50 - 10:03 AM    | 181       | 181               |          |
| PO19-202859-S1936 | Comox 5                      | 1 :1               | 10:04 - 10:14 AM   | 236       | 236               |          |
| PO19-202859-S1937 | Comox 3A/3B                  | 1 :1               | 10:16 - 10:36 AM   | 1892      | 1892              |          |
| PO19-202859-S1938 | Comox 6A/6B                  | 1 :1               | 10:37 - 10:50 AM   | 2918      | 2918              |          |

**Odour Evaluation Report Nomenclature**

DT Detection Threshold

DT<sub>NET</sub> Detection Threshold adjusted for field dilution

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J:\202000s\0202859.000 RWDI,650Woodlawn,ENVNS,ODPNL\Odour Lab\2019\Sept 5, 2019\202859-090519 - RWDI Odour Report for Detection Threshold.docx

Template: 14852 – Report Template for Detection Threshold Determination - September 19, 2014

**APPENDIX I**  
**Odour Evaluation Data Sheets**  
**Pinchin File: 202859-090519**  
**(6 Pages)**

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019  
 Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                            |                                 |
|------------------------------------|----------------------------|---------------------------------|
| <b>Sample Information</b>          |                            | Sampling Date : <u>9/4/2019</u> |
| Lab No. : <u>PO19-202859-S1933</u> | Field No. : <u>Comox 1</u> | Sampling Time : _____           |
| Description : <u>1:1</u>           |                            | Sample Collector : <u>RWDI</u>  |
|                                    |                            | Sample Source : <u>unknown</u>  |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |  |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|--|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |  |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |  |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |  |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |  |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |  |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |  |
| 14853-665 1     |        |        |        |        |        |        |        | 2      | 1      | 1      | 1      | 6      | 6      |        |   | 1.96  | 1.96  |  |
| 2018-1 1        |        |        |        |        |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |   | 2.26  | 1.96  |  |
| 14853-917 1     |        |        |        |        |        |        |        |        | 1      | 1      | 1      | 1      | 6      | 6      |   | 1.66  | 1.66  |  |
| 14853-671 1     |        |        |        |        |        |        |        |        | 2      | 1      | 1      | 6      | 6      |        |   | 1.96  | 1.96  |  |
| 14853-719 1     |        |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |   | 2.26  | 2.26  |  |
| 14853-1232 1    |        |        |        |        |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |   | 2.26  | 1.96  |  |
| 14853-946 1     |        |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |   | 2.26  | 2.26  |  |
| 14853-1903 1    |        |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |   | 2.56  | 2.26  |  |

**Sample Comments :**

|   |            |
|---|------------|
| <b>Specific Chemical Concentration Data</b> |            |
| Chemical :                                  | <u>N/A</u> |
| Concentration (ppm) :                       | _____      |

**Response Key:**  
 1 = Incorrect Guess  
 2 = Correct Guess  
 5 = Incorrect Detection  
 6 = Correct Detection  
 7 = Incorrect Recognition  
 8 = Correct Recognition

|                      |             |             |             |
|----------------------|-------------|-------------|-------------|
| <b>Final Results</b> |             |             |             |
|                      | <b>G</b>    | <b>D</b>    | <b>R</b>    |
| Avg. Log Value       | <u>2.15</u> | <u>2.03</u> | <u>0.00</u> |
| Std. Dev.            | <u>0.28</u> | <u>0.21</u> | <u>0.00</u> |
| Threshold            | <u>140</u>  | <u>108</u>  | <u>1</u>    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1934 Field No. : Comox 2 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |

| Assessor/Round |   |  |  |  |  |  |  |   |   |   |   |   |  |  | Log G | Log D | Log R |
|----------------|---|--|--|--|--|--|--|---|---|---|---|---|--|--|-------|-------|-------|
| 14853-665      | 1 |  |  |  |  |  |  | 2 | 2 | 6 | 6 |   |  |  | 2.86  | 2.26  |       |
| 2018-1         | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-917      | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-671      | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-719      | 1 |  |  |  |  |  |  | 1 | 2 | 1 | 6 | 6 |  |  | 1.96  | 1.96  |       |
| 14853-1232     | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-946      | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.56  | 2.56  |       |
| 14853-1903     | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.56  | 2.56  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.37 | 2.30 | 0.00 |
| Std. Dev.      | 0.28 | 0.19 | 0.00 |
| Threshold      | 236  | 198  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019  
 Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                            |                                 |
|------------------------------------|----------------------------|---------------------------------|
| <b>Sample Information</b>          |                            | Sampling Date : <u>9/4/2019</u> |
| Lab No. : <u>PO19-202859-S1935</u> | Field No. : <u>Comox 4</u> | Sampling Time : _____           |
| Description : <u>1:1</u>           |                            | Sample Collector : <u>RWDI</u>  |
|                                    |                            | Sample Source : <u>unknown</u>  |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60.782 | 32.882 | 16.577 | 8.254  | 4.127  | 2.064  | 1.031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        | 2.86  | 2.26  |       |
| 2018-1 1        |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-917 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-671 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-719 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-1232 1    |        |        |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        | 2.86  | 2.26  |       |
| 14853-946 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-1903 1    |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.41 | 2.26 | 0.00 |
| Std. Dev.      | 0.28 | 0.00 | 0.00 |
| Threshold      | 257  | 181  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1936 Field No. : Comox 5 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 2018-1 1        |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        | 2.56  | 2.26  |       |
| 14853-917 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-671 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-719 1     |        |        |        |        |        |        |        | 1      | 2      | 1      | 6      | 6      |        |        | 2.26  | 2.26  |       |
| 14853-1232 1    |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.56  | 2.56  |       |
| 14853-946 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.56  | 2.56  |       |
| 14853-1903 1    |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        | 2.86  | 2.56  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.45 | 2.37 | 0.00 |
| Std. Dev.      | 0.23 | 0.16 | 0.00 |
| Threshold      | 281  | 236  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1937 Field No. : Comox 3A/3B Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |
| 2018-1 1        |        |        |        | 1      | 1      | 5      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-917 1     |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        | 3.47  | 2.86  |       |
| 14853-671 1     |        |        |        |        | 1      | 2      | 5      | 6      | 6      |        |        |        |        |        | 2.86  | 2.86  |       |
| 14853-719 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-946 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47  | 3.16  |       |
| 14853-1903 1    |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.47  | 3.28  | 0.00 |
| Std. Dev.      | 0.32  | 0.32  | 0.00 |
| Threshold      | 2,918 | 1,892 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1938 Field No. : Comox 6A/6B Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60.782 | 32.882 | 16.577 | 8.254  | 4.127  | 2.064  | 1.031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 2018-1 1        |        |        |        | 2      | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-917 1     |        |        |        | 1      | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-671 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-719 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-946 1     |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |
| 14853-1903 1    |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

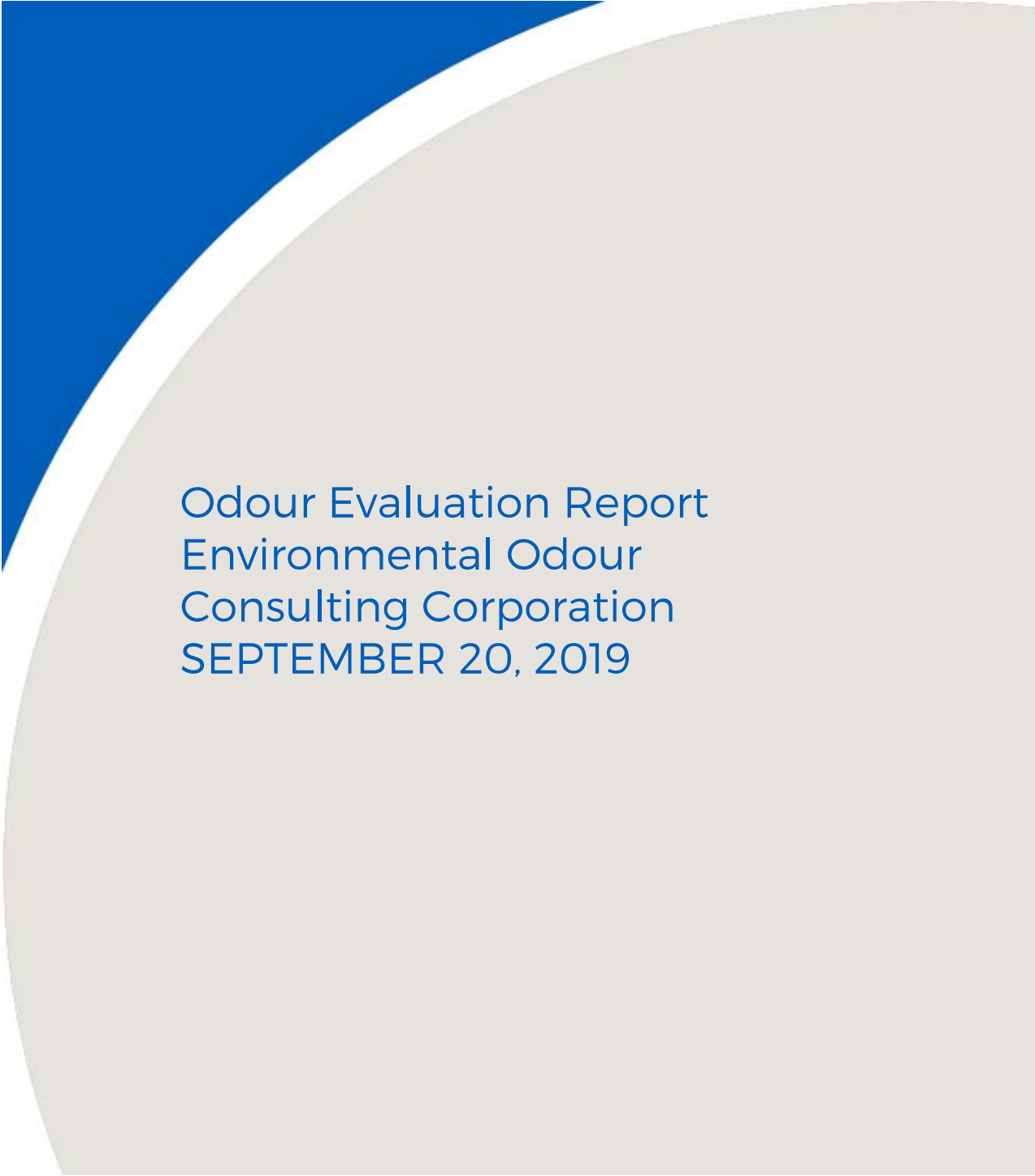
|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.50  | 3.47  | 0.00 |
| Std. Dev.      | 0.25  | 0.23  | 0.00 |
| Threshold      | 3,182 | 2,918 | 1    |

**APPENDIX II**  
**Odour Evaluation Quality Assurance**  
**Pinchin File: 202859-090519**  
**(1 Page)**

## ODOUR EVALUATION QUALITY ASSURANCE

- Odour evaluations conducted at the Pinchin Odour Laboratory conform to the procedures outlined in the Ministry of the Environment, Conservation and Parks “Ontario Source Testing Code” (OSTC), Version #3, June 2010 (Part G, Method ON-6) and are in accordance with ASTM (American Society for Testing and Materials) Standard Practice E679-04, Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series of Limits.
- The AC’SCENT® Dynamic Dilution Forced-Choice Triangle Olfactometer complies with all aspects of the ASTM E679-04 standard as well as the operational requirements of the British Standard, BS EN 13725:2003, “Air quality – Determination of odour concentration by dynamic olfactometry”.
- The detection threshold values are reported as defined by ASTM E679-04 and BS EN 13725:2003.
- Assessors are selected and trained in accordance with BS EN 13725:2003.
- The Pinchin Odour Laboratory is managed based on the requirements of the International Organization for Standardization (ISO) International Standard ISO 17025:2005, “General requirements for the competence of testing and calibration laboratories”.
- Samples are consumed during the evaluation and all sample bags are destroyed 48 hours after transmittal of the Preliminary Odour Evaluation Results, unless otherwise specified.

## APPENDIX B

A large decorative graphic on the left side of the page, featuring a blue triangle in the top-left corner and a large, light grey semi-circle that overlaps the triangle and extends across the page.

Odour Evaluation Report  
Environmental Odour  
Consulting Corporation  
SEPTEMBER 20, 2019

# Report

## Odour Panel Evaluation

### **Report to:**

RWDI Air Inc.  
650 Woodlawn Road West  
Guelph, Ontario  
N1K 1B8  
Mr. Matthew Sawycky  
E-mail: Matthew.Sawycky@RWDI.com  
Phone: 519 823 1311

### **Prepared by:**

#### ***EOC Environmental Odour Consulting Corporation***

Anna H. Bokowa, M.Sc.  
*President*  
Tel: (647) 988-5814  
Bokowa.anna@environmentalodourconsulting.com

**Date of the Report**  
October 1, 2019  
12 pages, 2 Appendices

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## 1. INTRODUCTION

EOC Environmental Odour Consulting Corporation (EOC) was contracted by RWDI Air Inc. (RWDI) to perform an odour evaluation on samples delivered to EOC.

One batch of nine (9) samples was shipped from Vancouver via Air Canada FedEx. On September 20, 2019, samples were picked up from the Air Canada Cargo Centre located at 2580 Britannia Rd E, Mississauga, ON. All samples were evaluated on September 20, 2019.

All evaluations for odour detection threshold value (ODTV) were performed according to the European standard EN13725: 2003 (with exceptions) and Ontario Ministry of the Environment Method ON-6 using dynamic olfactometry with eight screened panelists.

All samples were in good condition upon delivery.

## 2. METHODOLOGY

The evaluations were based on the European Standard EN 13725:2003 with the exception that each sample was introduced once to the panel members and eight panel members were used for all evaluations. Odour evaluations were also completed in accordance to the Ontario Ministry of the Environment's Method ON-6 "Determination of Odour Emission from Stationary Sources."

The EOC olfactometer is capable to perform evaluations using either the Triangular Forced Choice Method, or the Binary Forced Choice Method. For the Forced Choice Method; the panelist is presented with two or three ports (Triangular, Binary), of which one panelist presents the diluted sample and the other(s) neutral gas. The sample is presented randomly over the two or three ports. The panelist is asked to indicate the port with the sample. The panelist is also asked if his/her choice was a guess, inkling or if they were certain. By combining the chosen results and the indicated level of certainty, the response is classified as false or true. The odour evaluation procedure requires the first sample to be presented to the panelist at the dilution that will be below the detection threshold. Therefore, the several initial presentations to the panelists require the panelist to select one port by guessing. Each panelist observes an odour sample in the ascending concentration series (increasing concentration). For this program, a Binary Forced Choice Mode was chosen for odour evaluations. Each sample bag was evaluated by eight panelists with the option that for each dilution, each of the 8 panelists were asked to indicate their responses. Therefore, each panelist was introduced to the same dilution steps. Also, the same step between dilutions was used (1.51) for evaluation of all the samples.

The panelists' responses were recorded by computer software and were processed to determine the odour detection threshold value (ODTV) for each sample. The ODTV is a dilution factor and therefore has no units. For convenience, however, the ODTV may be expressed in odour units (ou).

A screened odour panel was used for all evaluations. They were tested for odour sensitivity using n-butanol as a reference gas. All panelists were within the normal range according to the European Standard EN 13725:2003 (20-80 ppb n-butanol). All panelists were included in the evaluations.

All screening data for the day of evaluation are presented in Appendix 1.

### **3. QUALITY CONTROL MEASURES AND CALIBRATION DATA**

EOC provided extensive quality control measures for the evaluations. These included, but were not limited to:

- Keeping constant dilution steps between analysis of the samples from the same source.
- Each sample bag was evaluated by eight panelists with the option that for each dilution each of the 8 panelists were asked to indicate their responses (each panelist was exposed to the same dilution).
- The EOC olfactometer is calibrated by the manufacturer against carbon monoxide at all used ports. The calibrations are within the limits of EN13725 standard.
- The EOC olfactometer is checked before each use for consistent volumetric flow rates at each “sniff port.”
- EOC panelists are screened using European Method EN; 13725 with n-butanol and they are within the range of that standard- all screening data are provided in the report.
- EOC panelists are trained to avoid any odorous products such as perfumes and scented lotions.
- EOC panelists are advised and trained to avoid coffee or spicy food one hour before a session.
- EOC makes sure that the sessions for the odour panel evaluations are not too long.
- EOC provides frequent breaks to avoid any panelist’s fatigue.
- All panelists’ data are computer recorded.

### **4. RESULTS**

Table 1 shows the results for odour detection threshold values for samples evaluated on September 20, 2019.

Appendix 1 shows the screening data for the panel used during the program.

All calibration data for the olfactometer are presented in Appendix 2.

Prepared by:



Anna H. Bokowa, M.Sc.  
President, Environmental Odour Consulting

**Table 1: Odour Detection Threshold Values- September 20, 2019**

| <b>Client<br/>Description</b> | <b>EOC<br/>Sample<br/>Identification</b> | <b>ODTV<br/><br/>ou</b> |
|-------------------------------|--|-------------------------|
| Scrubber Out 1                | A001                                     | 145                     |
| Scrubber Out 2                | A002                                     | 172                     |
| Scrubber Out 3                | A003                                     | 183                     |
| Bioreactor 1 Outlet           | A004                                     | 282                     |
| Bioreactor 2 Outlet           | A005                                     | 318                     |
| Bioreactor 1 Mid              | A006                                     | 475                     |
| Bioreactot 2 Mid              | A007                                     | 492                     |
| Bioreactor 1 Inlet            | A008                                     | 5061                    |
| Bioreactor 2 Inlet            | A009                                     | 5142                    |

## **APPENDIX 1**

### **Panelist's Screening Data**

**(1 page)**

| Panelist No | Panelist ID | n- butanol ppb Test 1 | n- butanol ppb Test 2 | n- butanol ppb Test 3 | n- butanol ppb Test 4 | n- butanol ppb Test 5 | n- butanol ppb Test 6 | n- butanol ppb Test 7 | n- butanol ppb Test 8 | n- butanol ppb Test 9 | n- butanol ppb Test 10 | n- butanol ppb Test 11 | n- butanol ppb Test 12 | n- butanol ppb Average |
|-------------|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|
| Panelist 1  | P201        | 55                    | 47                    | 48                    | 55                    | 57                    | 48                    | 47                    | 56                    | 51                    | 43                     | 56                     | 58                     | 52                     |
| Panelist 2  | P202        | 32                    | 47                    | 48                    | 42                    | 43                    | 32                    | 36                    | 32                    | 38                    | 33                     | 42                     | 44                     | 39                     |
| Panelist 3  | P205        | 24                    | 27                    | 24                    | 24                    | 25                    | 32                    | 27                    | 24                    | 38                    | 25                     | 32                     | 25                     | 27                     |
| Panelist 4  | P208        | 42                    | 47                    | 48                    | 42                    | 43                    | 48                    | 47                    | 42                    | 38                    | 43                     | 42                     | 44                     | 44                     |
| Panelist 5  | P210        | 24                    | 27                    | 24                    | 24                    | 25                    | 24                    | 27                    | 24                    | 29                    | 25                     | 24                     | 25                     | 25                     |
| Panelist 6  | P212        | 42                    | 47                    | 48                    | 42                    | 43                    | 32                    | 47                    | 42                    | 38                    | 43                     | 42                     | 44                     | 43                     |
| Panelist 7  | P213        | 32                    | 36                    | 32                    | 32                    | 33                    | 32                    | 36                    | 32                    | 38                    | 33                     | 32                     | 33                     | 33                     |
| Panelist 8  | P216        | 55                    | 47                    | 56                    | 55                    | 57                    | 56                    | 47                    | 42                    | 51                    | 57                     | 56                     | 58                     | 53                     |

### Panelists Screening Data- September 20, 2019

| Panelist No | Panelist ID | n- butanol ppb 20-Sep-19 |
|-------------|-------------|--------------------------|
| Panelist 1  | P201        | 56                       |
| Panelist 2  | P202        | 32                       |
| Panelist 3  | P205        | 32                       |
| Panelist 4  | P208        | 42                       |
| Panelist 5  | P210        | 24                       |
| Panelist 6  | P212        | 42                       |
| Panelist 7  | P213        | 32                       |
| Panelist 8  | P216        | 56                       |

## **APPENDIX 2**

### **Calibration Data**

**(3 pages)**

## Certificate of Calibration- Olfactometer SC300

Date of Calibration: September 18, 2019

Device Description: Olfactometer SC300

Calibration Conditions: T: 22.5°C ± 2°C P: 750 psi ± 1 psi

Diluting Air Flow:

| Set Point<br>(ml/min) | Measured<br>(ml/min) | Difference % | MFC<br>used |
|-----------------------|----------------------|--------------|-------------|
| 10000                 | 10040                | 0.4          | MFC 3       |
| 12000                 | 12095                | 0.8          | MFC 3       |
| 15000                 | 14925                | 0.5          | MFC 3       |
| 18000                 | 18160                | 0.9          | MFC 3       |
| 20000                 | 20010                | 0.1          | MFC 3       |

Acceptable limit is within 2%. Acceptable error limit in accordance to EN13725 is 10%.

Measured using Gas collection method

Uncertainty of Measurement: ±0.5% based on a confidence of probability of greater than 95%.

Dilutions:

| <i>Settings</i> | <i>Measured</i> | <i>Difference %</i> | <i>MFC</i> |
|-----------------|-----------------|---------------------|------------|
| 12              | 12.4            | 3.3                 | MFC 2      |
| 16              | 16.3            | 1.9                 | MFC 2      |
| 32              | 32.5            | 1.6                 | MFC 2      |
| 64              | 67.3            | 5.1                 | MFC 2      |
| 128             | 121             | 5.5                 | MFC 2      |
| 256             | 264             | 3.1                 | MFC 1      |
| 512             | 502             | 1.9                 | MFC 1      |
| 1024            | 1029            | 0.5                 | MFC 1      |
| 2048            | 2071            | 1.1                 | MFC 1      |
| 4096            | 4344            | 6.1                 | MFC 1      |
| 8192            | 8746            | 6.8                 | MFC1       |
| 16384           | 16078           | 1.9                 | MFC1       |
| 32768           | 35684           | 8.9                 | MFC1       |

Acceptable error limit in accordance to EN13725 is 20%.

Measured using Tracer gas calibration method with certified CO calibration gas cylinders and Carbon Monoxide analyzer.

## Velocity Readings: September 20, 2019

| <b>Test No</b> | <b>Port A<br/>Velocity<br/>m/s</b> | <b>Port B<br/>Velocity<br/>m/s</b> |
|----------------|------------------------------------|------------------------------------|
| Test 1         | 0.314                              | 0.315                              |
| Test 2         | 0.312                              | 0.313                              |
| Test 3         | 0.310                              | 0.316                              |
| Test 4         | 0.314                              | 0.314                              |
| Test 5         | 0.310                              | 0.312                              |
| Test 6         | 0.312                              | 0.310                              |

## APPENDIX C

A decorative graphic on the left side of the page, featuring a blue triangle at the top left and a large, light grey curved shape that overlaps the blue triangle and extends downwards and to the right.

Certificate of Analysis  
Total Reduced Sulfur  
ALS Environmental



RWDI AIR INC.  
ATTN: Matthew Sawycky  
#280 - 1385 West 8th Avenue  
Vancouver BC V6H 3V9

Date Received: 05-SEP-19  
Report Date: 17-SEP-19 18:29 (MT)  
Version: FINAL

Client Phone: 604-730-5688

## Certificate of Analysis

Lab Work Order #: L2341651  
Project P.O. #: NOT SUBMITTED  
Job Reference: 1904012  
C of C Numbers: 17-762085  
Legal Site Desc:

Rojina Ghavami  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company



# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                            | <b>Sample ID</b><br><b>Description</b><br><b>Sampled Date</b><br><b>Sampled Time</b><br><b>Client ID</b> | L2341651-6<br>SUMP<br>04-SEP-19<br>13:30<br>COMOX OUT #3 |  |  |  |
|----------------------------|--|--|--|--|--|
| Grouping                   | Analyte  |  |  |  |  |
| <b>CANISTER</b>            |  |  |  |  |  |
| <b>Sulfur Compounds</b>    | n-Butyl mercaptan (ppb(V))   | <4.0   |  |  |  |
|                            | n-Butyl mercaptan (ug/m3)  | <15  |  |  |  |
|                            | Butyl(t) mercaptan (ppb(V))  | <4.0   |  |  |  |
|                            | Butyl(t) mercaptan (ug/m3)   | <15  |  |  |  |
|                            | Carbon Disulfide (ppb(V))  | 2.2  |  |  |  |
|                            | Carbon Disulfide (ug/m3)   | 6.9  |  |  |  |
|                            | Carbonyl sulfide (ppb(V))  | 14.2   |  |  |  |
|                            | Carbonyl sulfide (ug/m3)   | 34.8   |  |  |  |
|                            | Diethyl disulfide (ppb(V))   | <2.0   |  |  |  |
|                            | Diethyl disulfide (ug/m3)  | <10  |  |  |  |
|                            | Diethyl Sulfide (ppb(V))   | <4.0   |  |  |  |
|                            | Diethyl Sulfide (ug/m3)  | <15  |  |  |  |
|                            | Dimethyl disulfide (ppb(V))  | <2.0   |  |  |  |
|                            | Dimethyl disulfide (ug/m3)   | <7.7   |  |  |  |
|                            | Dimethyl sulfide (ppb(V))  | <4.0   |  |  |  |
|                            | Dimethyl sulfide (ug/m3)   | <10  |  |  |  |
|                            | 2,5-Dimethylthiophene (ppb(V))   | <4.0   |  |  |  |
|                            | 2,5-Dimethylthiophene (ug/m3)  | <18  |  |  |  |
|                            | Ethyl mercaptan (ppb(V))   | <4.0   |  |  |  |
|                            | Ethyl mercaptan (ug/m3)  | <10  |  |  |  |
|                            | Ethyl Methyl Sulfide (ppb(V))  | <4.0   |  |  |  |
|                            | Ethyl Methyl Sulfide (ug/m3)   | <12  |  |  |  |
|                            | 2-Ethylthiophene (ppb(V))  | <4.0   |  |  |  |
|                            | 2-Ethylthiophene (ug/m3)   | <18  |  |  |  |
|                            | Hydrogen Sulfide (ppb(V))  | <4.0   |  |  |  |
|                            | Hydrogen Sulfide (ug/m3)   | <5.6   |  |  |  |
|                            | Isobutyl Mercaptan (ppb(V))  | <4.0   |  |  |  |
|                            | Isobutyl Mercaptan (ug/m3)   | <15  |  |  |  |
|                            | Isopropyl Mercaptan (ppb(V))   | <4.0   |  |  |  |
|                            | Isopropyl Mercaptan (ug/m3)  | <12  |  |  |  |
|                            | Methyl mercaptan (ppb(V))  | <4.0   |  |  |  |
|                            | Methyl mercaptan (ug/m3)   | <7.9   |  |  |  |
|                            | 2-Methylthiophene (ppb(V))   | <4.0   |  |  |  |
| 2-Methylthiophene (ug/m3)  | <16  |  |  |  |  |
| 3-Methylthiophene (ppb(V)) | <4.0   |  |  |  |  |
| 3-Methylthiophene (ug/m3)  | <16  |  |  |  |  |
| Propyl mercaptan (ppb(V))  | <4.0   |  |  |  |  |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                         |   | Sample ID    | L2341651-1           | L2341651-2  | L2341651-3  | L2341651-4   | L2341651-5   |
|-------------------------|---|--------------|----------------------|-------------|-------------|--------------|--------------|
|                         |   | Description  | SUMP                 | SUMP        | SUMP        | SUMP         | SUMP         |
|                         |   | Sampled Date | 04-SEP-19            | 04-SEP-19   | 04-SEP-19   | 04-SEP-19    | 04-SEP-19    |
|                         |   | Sampled Time | 13:30                | 13:30       | 13:30       | 13:30        | 13:30        |
|                         |   | Client ID    | COMOX IN #1          | COMOX IN #2 | COMOX IN #3 | COMOX OUT #1 | COMOX OUT #2 |
| Grouping                | Analyte                                   |              |                      |             |             |              |              |
| <b>CANISTER</b>         |   |              |                      |             |             |              |              |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  | <12          | <12                  | <12         | <12         | <12          | <12          |
|                         | Tetrahydrothiophene (ppb(V))              | <4.0         | <4.0                 | <4.0        | <4.0        | <4.0         | <4.0         |
|                         | Tetrahydrothiophene (ug/m3)               | <14          | <14                  | <14         | <14         | <14          | <14          |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  | <6.0         | <6.0                 | <6.0        | <6.0        | <6.0         | <6.0         |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   | <21          | <21                  | <21         | <21         | <21          | <21          |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) | 2570         | 3490                 | 2810        | 19          | 19           | 19           |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  | 3590         | 4870                 | 3920        | 26          | 27           | 27           |
| <b>Miscellaneous</b>    | Batch Proof ID                            | 181212.301   | 181105.13100<br>0001 | 190610.109  | 181121.231  | 181121.202   | 181121.202   |
|                         | Canister ID                               | 01400-0008   | 01400-0384           | 01400-0121  | 01400-0412  | 01400-0051   | 01400-0051   |
|                         | Pressure on Receipt (in Hg)               | 0.8          | 0.8                  | -11.4       | 1.0         | 0.8          | 0.8          |
|                         | Regulator ID                              | N/A          | N/A                  | N/A         | N/A         | N/A          | N/A          |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping                | Analyte                                   | Sample ID  | Description | Sampled Date | Sampled Time | Client ID    |
|-------------------------|---|------------|-------------|--------------|--------------|--------------|
|                         |   | L2341651-6 | SUMP        | 04-SEP-19    | 13:30        | COMOX OUT #3 |
| <b>CANISTER</b>         |   |            |             |              |              |              |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  | <12        |             |              |              |              |
|                         | Tetrahydrothiophene (ppb(V))              | <4.0       |             |              |              |              |
|                         | Tetrahydrothiophene (ug/m3)               | <14        |             |              |              |              |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  | <6.0       |             |              |              |              |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   | <21        |             |              |              |              |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) | 18         |             |              |              |              |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  | 26         |             |              |              |              |
| <b>Miscellaneous</b>    | Batch Proof ID                            | 181105.104 |             |              |              |              |
|                         | Canister ID                               | 01400-0037 |             |              |              |              |
|                         | Pressure on Receipt (in Hg)               | 0.2        |             |              |              |              |
|                         | Regulator ID                              | N/A        |             |              |              |              |

## Reference Information

**Test Method References:**

| ALS Test Code   | Matrix   | Test Description  | Method Reference** |
|---|----------|---|--------------------|
| <b>CAN-DATA-WT</b>  | Canister | Canister Information<br>Batch Proof ID, Canister ID, Pressure on Receipt, Regulator ID. | EPA TO-15          |
| <b>REDUC-SULF-22-SCD-WT</b>   | Canister | 22 Reduced Sulfur Compounds by GC-SCD   | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.</p> <p>Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p> |          |   |                    |
| <b>TRS-22-SCD-WT</b>  | Canister | Total Reduced Sulfur as H2S   | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.</p> <p>Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p> |          |   |                    |
| <b>TRS22-SUM-CALC-WT</b>  | Canister | Total Reduced Sulfur as H2S (22 Comp'ds)  | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. A volume of air sample is transferred from the canister to a preconcentrator system where the analytes are trapped &amp; focused. The analytes are then thermally desorbed into a GC-SCD for analysis. Test results are not blank corrected unless indicated by a qualifier. Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p>  |          |   |                    |

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location                           |
|----------------------------|---|
| WT                         | ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA |

**Chain of Custody Numbers:**

17-762085

**GLOSSARY OF REPORT TERMS**

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



# AIR SAMPLING MEDIA REQUEST FORM



Grey sections are for INTERNAL USE ONLY

BR# 253764 - Pls ship EXPRESS tomorrow -confirm delivery date pls

|                               |   |                     |                |
|-------------------------------|---|---------------------|----------------|
| CLIENT:                       | Comox Valley Regional District  | CLIENT EXPECT DATE: | 09/03/2019     |
| CLIENT CONTACT:               | Zoe Berkey  | ORDER TAKEN BY:     | J. Pearson     |
| CLIENT PROJECT:               |   | ORDER DATE:         | 08/27/2019     |
| DELIVERY TO:                  | 445 Brent Road, Comox, BC V9M 3V9   | QUOTE #:            |                |
| TELEPHONE NUMBER:             |   | ORDER FILLED BY:    | LB1            |
| SHIP TO/ATTENTION OF:         |   | DATE COMPLETED:     | 08/28/2019     |
| Shipping Method: (Select one) | <input checked="" type="radio"/> Ground: (4 business days to Western Canada, 2 business day to Winnipeg)<br><input type="radio"/> Express: (2 business days to Western Canada, 1 business day to WP)<br><input checked="" type="radio"/> External Courier | Tracking Number:    | 7760 9894 4739 |

ALS Drivers:   
Pickup at ALS Waterloo:

TAT Information: (select one)

|  |                  |                |
|--|------------------|----------------|
| <input type="radio"/> Regular TAT      | 10 Business Days | No surcharge   |
| <input checked="" type="radio"/> 5-day | 5 Business Days  | 50% surcharge  |
| <input type="radio"/> 3-day            | 3 Business Days  | 100% surcharge |
| <input type="radio"/> 2-day            | 2 Business Days  | 200% surcharge |
| <input type="radio"/> 1-day            | 1 Business Day   | 300% surcharge |

ALL TAT except Regular requires Prior Confirmation

**Completion of all Sections is Mandatory**

1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawspace; **OH&S** - Industrial, Commercial, Residential comment: ADAPTOR BAG TO CAN

2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**

3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**

This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:               | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-----------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                       | 24 hr           |          |                           |                                |  |                             |
|                                   | 12 hr           |          |                           |                                |  |                             |
|                                   | 8 hr            |          |                           |                                |  |                             |
|                                   | 4 hr            |          |                           |                                |  |                             |
|                                   | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters _____         | 30 mins         |          |                           |                                |  |                             |
| 1.4L Canister                     | 1 hr            |          |                           |                                |  |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters _____         |                 |          |                           |                                |  |                             |
| Bottle Vacs                       | 1 hr            |          |                           |                                |  |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters _____         |                 |          |                           |                                |  |                             |
| Passive CarboPak X Tubes          |                 |          |                           |                                |  |                             |
| Diffusive Caps                    |                 |          |                           |                                |  |                             |
| Active SVI Tubes                  |                 |          |                           |                                |  |                             |
| Calibration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |

| Other Sampling Supplies   | ID #                                  | Quantity | Additional Information & Special Instructions or Requests |
|---|---------------------------------------|----------|---|
| Pressure Gauge  |                                       |          | 6XTedlar to canister adapters for reduced sulphur .       |
| Caplok Tool   |                                       |          |   |
| Canister Stands   |                                       |          |   |
| Valve Adaptor for Soil Vapour   |                                       |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS | <input type="checkbox"/>              |          |   |
| Chargeable Supplies   |                                       |          |   |
| Duplicate Sampler - \$40 can/\$25 tube                                  |                                       |          |   |
| Teflon Tubing   |                                       |          |   |
| -Total length _____ ft  | without nuts and ferrules             |          |   |
| -Length per section _____ ft - \$3 per foot / \$6 per N+F set           | with nuts and ferrules (single end)   |          |   |
|   | with nuts and ferrules (double ended) |          |   |
| Siloxane Kit - \$45 each  |                                       |          |   |



L2341651-COFC

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client.)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$350.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00

# AIR SAMPLING MEDIA REQUEST FORM



Grey sections are for INTERNAL USE ONLY

BR# 253757

|                       |   |                     |            |
|-----------------------|---|---------------------|------------|
| CLIENT:               | RWDI - c/o Comox Valley Regional District | CLIENT EXPECT DATE: | 08/30/2019 |
| CLIENT CONTACT:       | Matthew Sawycky                           | ORDER TAKEN BY:     |            |
| CLIENT PROJECT:       |   | ORDER DATE:         | 08/27/2019 |
| DELIVERY TO:          | 445 Brent Rd, Comox, BC V9M 3V9           | QUOTE #:            |            |
| TELEPHONE NUMBER:     |   | ORDER FILLED BY:    | JW Lopez   |
| SHIP TO/ATTENTION OF: | Zoe Berkey                                | DATE COMPLETED:     |            |

Shipping Method:  Ground: (4 business days to Western Canada, 2 business days to Winnipeg)  Express: (2 business days to Western Canada, 1 business day to WP)  External Courier

Tracking Number:

ALS Drivers:   
 Pickup at ALS Westport:

TAT Information: (select one)  
 ALL TAT except Regular requires Prior Confirmation

|                                   |                  |                |
|-----------------------------------|------------------|----------------|
| <input type="radio"/> Regular TAT | 10 Business Days | No surcharge   |
| <input type="radio"/> 5-day       | 5 Business Days  | 50% surcharge  |
| <input type="radio"/> 3-day       | 3 Business Days  | 100% surcharge |
| <input type="radio"/> 2-day       | 2 Business Days  | 200% surcharge |
| <input type="radio"/> 1-day       | 1 Business Day   | 300% surcharge |

QC'd JR  
 Sep 03/19

**Completion of all Sections is Mandatory**


1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawlspace; **O&HS** - Industrial, Commercial, Residential comment: Commercial Indoor Air

2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**

3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**

This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:               | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-----------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                       | 24 hr           |          |                           |                                |  |                             |
|                                   | 12 hr           |          |                           |                                |  |                             |
|                                   | 8 hr            |          |                           |                                |  |                             |
|                                   | 4 hr            |          |                           |                                |  |                             |
|                                   | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters               |                 |          |                           |                                |  |                             |
| 1.4L Canister                     | 1 hr            |          | reduced sulfur            | 01400-0384                     | -30                                      |                             |
|                                   | 20 mins         |          |                           | 01400-0121                     | -30                                      |                             |
|                                   | 10 mins         |          |                           | 01400-0008                     | -30                                      |                             |
|                                   | 4 mins          |          |                           | 01400-0051                     | -30                                      |                             |
| Number of Canisters               |                 | 6        |                           |                                |  |                             |
| Bottle Vacs                       | 1 hr            |          |                           | 01400-0421                     | -30                                      |                             |
|                                   | 20 mins         |          |                           | 01400-0037                     | -24                                      |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters               |                 |          |                           |                                |  |                             |
| Passive CarboPak X Tubes          |                 |          |                           |                                |  |                             |
| Diffusive Caps                    |                 |          |                           |                                |  |                             |
| Active SVI Tubes                  |                 |          |                           |                                |  |                             |
| Calibration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |

| Other Sampling Supplies  | ID # | Quantity | Additional Information & Special Instructions or Requests   |
|--|------|----------|---|
| Pressure Gauge   |      |          | <br>L2341651-COFC |
| Caplok Tool  |      |          |   |
| Canister Stands  |      |          |   |
| Valve Adaptor for Soil Vapour  |      |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS <input type="checkbox"/> |      |          |   |
| Chargeable Supplies  |      |          |   |
| Duplicate Sampler - \$40 each/\$25 tube  |      |          |   |
| Teflon Tubing  |      |          |   |
| - Total length _____   |      |          |   |
| - Length per section _____   |      |          |   |
| \$3 per foot / \$6 per N+F set   |      |          |   |
| Siloxane Kit - \$45 each   |      |          |   |

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
 6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$850.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00

## APPENDIX D

A decorative graphic on the left side of the page. It features a solid blue right-angled triangle in the top-left corner. A large, light grey circle overlaps the triangle and extends across the middle and bottom of the page. The text 'Field Notes' is centered within the grey circle.

Field Notes

Sept 4 2019  
Comox WWTP  
Start Purge 5 lpm  
@ 8:04  
Sample 1  
"COMOX 1"  
at outlet of Bioreactor  
5 lpm Dwyer 10 psi del  
Sampling 8:14 to 8:20

COMOX 2  
purging start at 8:25  
Mid Point of Bioreactor  
A  
Sampling 8:35 - 8:45

Comox 3  
purging start @ 8:50  
taken at the inlet of  
Bioreactor A

Sept 4 2019  
COMOX 4  
outlet of bioreactor C  
purging starts @ 9:15  
Sampling 9:25-35

COMOX 5  
mid section of  
Bioreactor C purge  
at 9:39  
sampling 9:50-10:00

COMOX 6  
inlet of Bioreactor C  
purging @ 10:02  
sampling 10:14-10:24

MATT 5  
WILL C

SEPTEMBER 19 Comox

|              |   |         |
|--------------|---|---------|
| SCRUBBER OUT | 1 | 820 pm  |
| SCRUBBER OUT | 2 | 828 pm  |
| SCRUBBER OUT | 3 | 840 pm. |

|            |   |     |         |
|------------|---|-----|---------|
| BIOREACTOR | 1 | IN  | 915 pm  |
| BIOREACTOR | 1 | MID | 938 pm  |
| BIOREACTOR | 1 | OUT | 952 pm  |
| BIOREACTOR | 2 | OUT | 1010 pm |
| BIOREACTOR | 2 | MID | 1025 pm |
| BIOREACTOR | 2 | IN  | 1043 pm |

POSSIBLE  
MIXED LABELS  
~~\*SOME~~ TIMES CORRECT  
POSSIBLE ORDER CHANGE



RWDI  
Suite 280, 1385 West 8th Avenue  
Vancouver BC Canada  
V6H 3V9

Tel: +1.604.730.5688  
E-mail: [solutions@rwdi.com](mailto:solutions@rwdi.com)

## MEMORANDUM

|              |   |                            |  |
|--------------|---|----------------------------|--|
| <b>DATE:</b> | 2019-10-04  | <b>RWDI Reference No.:</b> | 1904012  |
| <b>TO:</b>   | Zoe Berkey  | <b>EMAIL:</b>              | <a href="mailto:zberkey@comoxvalleyrd.ca">zberkey@comoxvalleyrd.ca</a> |
| <b>FROM:</b> | Matthew Sawycky   | <b>EMAIL:</b>              | <a href="mailto:matthew.sawycky@rwdi.com">matthew.sawycky@rwdi.com</a> |
| <b>CC:</b>   | John DeYoe  | <b>EMAIL:</b>              | <a href="mailto:john.deyoe@rwdi.com">john.deyoe@rwdi.com</a>           |
| <b>CC:</b>   | William Clarke  | <b>EMAIL:</b>              | <a href="mailto:william.clarke@rwdi.com">william.clarke@rwdi.com</a>   |
| <b>RE:</b>   | <b>Source Testing Memo - Comox Valley Water Pollution Control Centre - September 2019<br/>Comox, BC</b> |                            |  |

Zoe,

Please find this memorandum for methodology and results from testing at the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC (the facility).

RWDI conducted sampling at the facility on September 4<sup>th</sup>, 2019 for laboratory analysis of odour and total reduced sulfur (TRS), and September 19<sup>th</sup> for laboratory analysis of odour.

### Odour Emissions Sampling Methodology

#### September 4, 2019

Upon receipt of the odour value results collected in June, it was speculated that recent changes to the facilities operations prior to the sampling program may have resulted in higher than normal values. RWDI was commissioned to re-sample odour at the facility in early September.

Sampling was conducted to provide odour unit (OU) values as a comparison to June collected values and for subsequent dispersion modelling to be conducted.

Sampling was conducted at 3 points along each bioreactor pond, for a total of 6 samples.

#### September 19, 2019

CVWPCC expressed concern that collected OU analysis conducted on samples taken during the day may not be representative of OU values during the evening period, as the majority of residential



complaints are received in the evening hours. RWDI visited the facility to replicate the sample locations taken on September 4<sup>th</sup> during evening operations.

Sampling was conducted at the same 3 points along each bioreactor pond, for a total of 6 samples.

### **Flux Chamber Sampling**

Sampling at the bioreactor was conducted using a flux chamber.

Odour emissions from the waste water surface were measured using a floating flux chamber. The flux chamber is 40.6 cm in diameter; and approximately 35 cm high, and constructed of 14-gauge stainless steel, as per the designer's specifications outlined in Ontario Stack Testing Code Method ON-6. All interior and exterior fittings are constructed from odour neutral material being stainless steel and all lines were made from Teflon tubing with some variance at connections. The flux chamber is equipped with ports: one for sweep gas line and one for sample line. The chamber is fitted with a floatation device to hold it on top of the surface.

Ultra high purity nitrogen gas was used as the sweep gas, which was metered into the chamber at a constant rate of 5 litres per minute. The sweep gas was allowed to run through the chamber for 30 minutes prior to sample collection.

The odour samples were collected through a sample port on the flux chamber into a Tedlar bag using a lung sampler. The sample bag was filled at a rate of less 5 L/min in order to not significantly affect the equilibrium of the chamber.

### **Scrubber Outlet Sampling**

The odour samples were collected through a pre-existing sample port, located at the outlet of the odour control unit using a lung sampler. The lung sampler utilizes a large container with an airtight lid and two air line fittings. A Tedlar bag is inserted into the container and a sample line is connected to the Tedlar bag. A vacuum is then applied to the cavity in the container which, through pressure differential, draws the sample air into the Tedlar sample bag; the sample bag was filled at a rate of 5 L/min.

### **Odour Sample Analysis**

The samples collected on September 4<sup>th</sup> were air shipped to Pinchin Ltd. Environmental Consulting, in Mississauga Ontario, for analysis by an eight-member odour panel within 24-hours of testing (September 5, 2019). Details about the odour panel methodology are contained in Appendix A: Odour Evaluation Report Pinchin Ltd.



Pinchin Ltd. Environmental Consulting was unable to conduct any odour sampling during the week of September 16, so an alternate accredited laboratory was used.

The samples collected on September 19<sup>th</sup> were air shipped to Environmental Odour Consulting Corporation, in Oakville Ontario, for analysis by an eight-member odour panel within 24-hours of testing (September 20, 2019). Details about the odour panel methodology are contained in Appendix B: Odour Evaluation Report Environmental Odour Consulting Corporation.

Once the odour concentration of the samples has been determined, the odour flux rate is calculated. The sweep gas rate is used to calculate the odour flux rate based on the total air movement into the chamber. The formula that was used to calculate the odour flux rate is as follows:

$$\text{Odour Flux Rate} \left( \frac{\text{ou}}{\text{s} \cdot \text{m}^2} \right) = \frac{\text{Odour Concentration} \left( \frac{\text{ou}}{\text{m}^3} \right) \cdot \text{Sweep Rate} \left( \frac{\text{m}^3}{\text{s}} \right)}{\text{Area of flux chamber} (\text{m}^2)}$$

The odour flux rates from the bioreactor were simply averaged and the flux rate was applied to the total surface area of the bioreactor clarifiers.

## Total Reduced Sulfur Sampling Methodology

TRS sampling was conducted, in triplicate, at the inlet to the scrubber and at the exit of the scrubber. Sampling values were used to calculate the scrubber and polisher efficiency in reducing TRS.

Sulfur compounds collection was conducted using ALS laboratory supplied vacuum canister media. Air was drawn from the flux chamber into the vacuum canister media to collect the sample.

## Chemical Analysis

Total reduced sulfur collection media was sent to ALS Environmental in Burnaby BC for analysis. Details about the analysis methodology are contained in Appendix C: Certificate of Analysis, ALS Environmental.

## Odour Results

The testing programs were completed on September 4<sup>th</sup> and 19<sup>th</sup>, 2019, using the techniques described in the methodology section. The odour lab results are summarized in Table 1 and 2; the complete laboratory analysis reports can be found in Appendix A and B. Field notes from the sampling program can be found in Appendix D.



**Table 1: Odour Laboratory Analysis Sample Results – September 4, 2019**

| Location                | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Sample Time (24hr) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/m <sup>2</sup> /s) |
|-------------------------|-----------------|-----------------|--------------------------------|--------------------|---|--------------------------------|
| Bioreactor Test 1 - out | 108             | 1 : 1           | 108                            | 08:14              | 0.07  | 0.47                           |
| Bioreactor Test 2 - mid | 198             | 1 : 1           | 198                            | 08:35              | 0.13  |                                |
| Bioreactor Test 3 - in  | 1892            | 1 : 1           | 1892                           | 09:00              | 1.22  |                                |
| Bioreactor Test 4 - out | 181             | 1 : 1           | 181                            | 09:25              | 0.12  | 0.71                           |
| Bioreactor Test 5 - mid | 236             | 1 : 1           | 236                            | 09:50              | 0.15  |                                |
| Bioreactor Test 6 - in  | 2918            | 1 : 1           | 2918                           | 10:14              | 1.87  |                                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.

**Table 2: Odour Laboratory Analysis Sample Results – September 19, 2019**

| Location           | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Sample Time (24hr) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/m <sup>2</sup> /s) | Odour Emission Rate (OU/s) | Average (OU/s) |
|--------------------|-----------------|-----------------|--------------------------------|--------------------|---|--------------------------------|----------------------------|----------------|
| Bioreactor 1 - out | 282             | 1 : 1           | 282                            | 21:15              | 0.18  | 1.26                           | N/A                        | N/A            |
| Bioreactor 1 - mid | 475             | 1 : 1           | 475                            | 21:35              | 0.31  |                                | N/A                        | N/A            |
| Bioreactor 1 - in  | 5061            | 1 : 1           | 5061                           | 21:52              | 3.25  |                                | N/A                        | N/A            |
| Bioreactor 2 - out | 318             | 1 : 1           | 318                            | 22:10              | 0.20  |                                | N/A                        | N/A            |
| Bioreactor 2 - mid | 492             | 1 : 1           | 492                            | 22:25              | 0.32  |                                | N/A                        | N/A            |
| Bioreactor 2 - in  | 5142            | 1 : 1           | 5142                           | 22:43              | 3.30  |                                | N/A                        | N/A            |
| Scrubber out 1     | 145             | 1 : 1           | 145                            | 20:20              | N/A   | N/A                            | 2654.03                    | 3050.61        |
| Scrubber out 2     | 172             | 1 : 1           | 172                            | 20:28              | N/A   | N/A                            | 3148.23                    |                |
| Scrubber out 3     | 183             | 1 : 1           | 183                            | 20:40              | N/A   | N/A                            | 3349.57                    |                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.



## Total Reduced Sulfur Results

The testing program for total sulfur compounds was completed on September 4<sup>th</sup>, 2019, using the techniques described in the methodology section. The lab results are summarized in Table 3; the complete laboratory analysis report can be found in Appendix C. Field notes from the sampling program can be found in Appendix D.

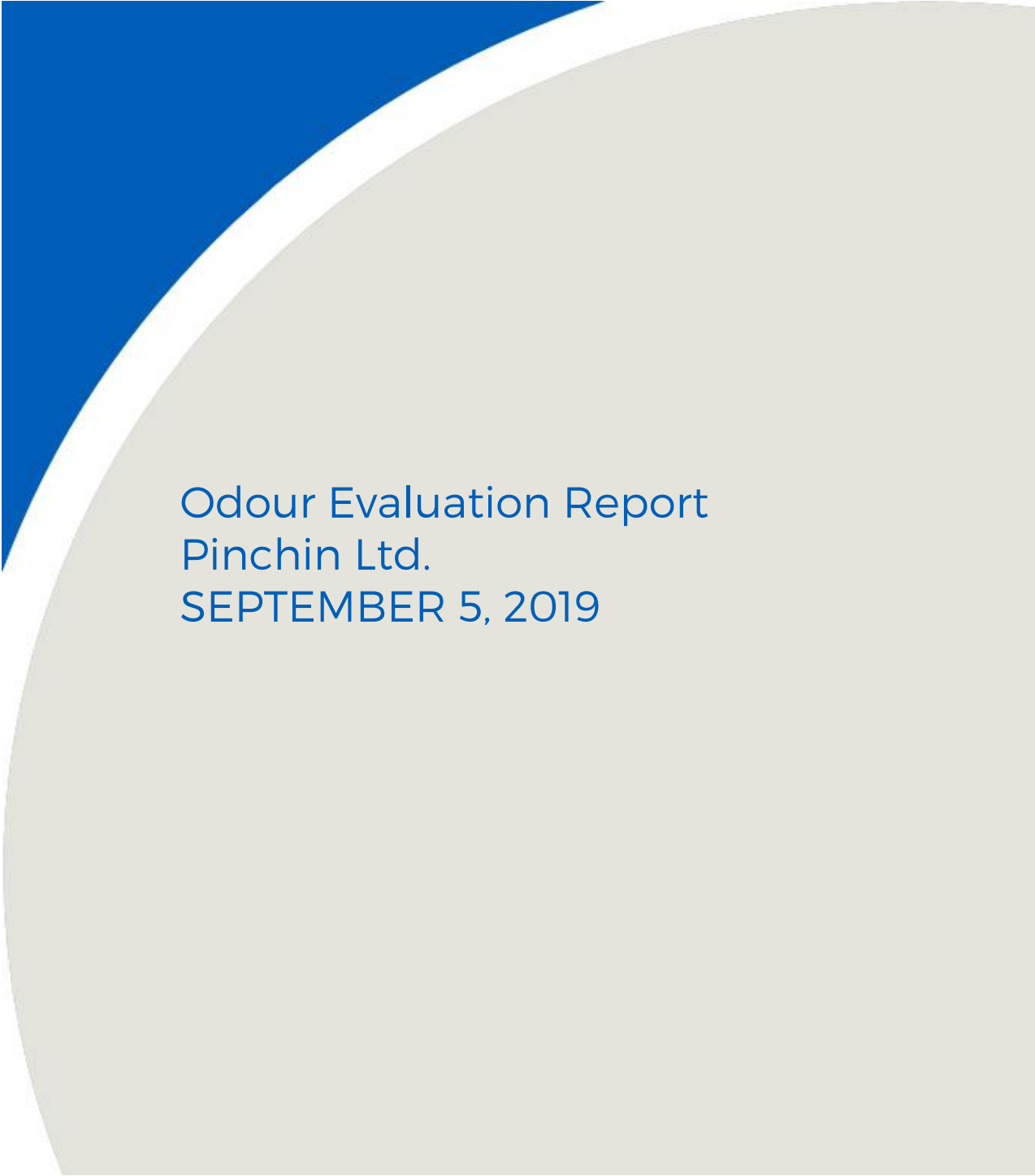
**Table 3: Total Reduced Sulfur Analysis Sample Results**

| Location          | H <sub>2</sub> S (ppb(V)) | H <sub>2</sub> S (ppb(V))<br>Average | H <sub>2</sub> S (ug/m <sup>3</sup> ) | H <sub>2</sub> S (ug/m <sup>3</sup> ) |
|-------------------|---------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| Scrubber Inlet 1  | 2570                      | 2956.7                               | 3590                                  | 4126.7                                |
| Scrubber Inlet 2  | 3490                      |                                      | 4870                                  |                                       |
| Scrubber Inlet 3  | 2810                      |                                      | 3920                                  |                                       |
| Scrubber Outlet 1 | 19                        | 19.7                                 | 26                                    | 26.3                                  |
| Scrubber Outlet 2 | 19                        |                                      | 27                                    |                                       |
| Scrubber Outlet 3 | 18                        |                                      | 26                                    |                                       |
| <b>Efficiency</b> | <b>99.4%</b>              |                                      |                                       |                                       |

If you have any questions regarding these results, we would be happy to discuss them with you at any time in the future.

Matthew Sawycky, B.Sc.  
Senior Project Manager

## APPENDIX A

The background features a large, light grey circular shape on the right side, partially overlapping a blue triangular shape on the left. The text is centered within the grey area.

Odour Evaluation Report  
Pinchin Ltd.  
SEPTEMBER 5, 2019



FINAL

# Odour Evaluation Report

2470 Milltower Court  
Mississauga, ON  
L5N 7W5

Prepared for:

**John DeYoe**  
RWDI  
600 Southgate Drive  
Guelph, Ontario N1G 4P6

September 27, 2019

Pinchin File: 202859-090519



**Issued to:** RWDI  
**Contact:** John DeYoe

**Issued on:** September 27, 2019  
**Pinchin file:** 202859-090519  
**Issuing Office:** 2470 Milltower Court,  
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## APPENDICES

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## 1.0 EVALUATION SAMPLE & TIMING SUMMARY

Pinchin Ltd. (Pinchin) was contracted to determine the detection threshold (DT) of air samples submitted to Pinchin's Odour Laboratory located in Mississauga, Ontario. The particulars of the odour panel were as follows:

|   |                                   |
|---|-----------------------------------|
| <b>Client Name:</b>                             | RWDI                              |
| <b>No. of Samples Delivered:</b>                | Six (6)                           |
| <b>Date Samples Received:</b>                   | September 5, 2019                 |
| <b>Condition of the Sample Bags on Arrival:</b> | No leaks or condensation detected |
| <b>No. of Samples Analyzed:</b>                 | Six (6)                           |
| <b>Date of Odour Panel Analysis:</b>            | September 5, 2019                 |
| <b>Time of Odour Panel Analysis:</b>            | 9:21 – 10:50 AM                   |

## 2.0 METHODOLOGY

### 2.1 Laboratory Methodology

All samples were evaluated in accordance with the Ministry of the Environment, Conservation and Parks "Ontario Source Testing Code" (OSTC), Version #3, June 2010 (Part G, Method ON-6), using an AC'SCENT International triangular forced-choice, ascending concentration, dynamic dilution Olfactometer. A listing of Standard Practices to which the evaluations conform is provided in Appendix II.

The AC'SCENT Olfactometer was calibrated according to the manufacturer's guidelines on the day of sample evaluation. The CHEMFLUOR® PTFE tubing through which the odour sample is presented to the panellists was replaced prior to the assessment session. All sample delivery lines were purged continuously with odour free air between sample presentations.

A panel of eight trained assessors was employed in the evaluation of the odour samples. Each panel is screened for accuracy and repeatability following the procedures outlined in British Standard, BS EN 13725:2003, "Air quality – Determination of odour concentration by dynamic olfactometry", utilizing 50 ppm n-butanol calibration gas prior to sample evaluation. The geometric mean of the individual threshold estimates for 50 ppm n-butanol was determined to be between 20 and 80 ppb/v.

The odour samples were presented to the panellists using the “triangular forced-choice” method, described by ASTM E679-04, “Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits”. Each panellist evaluated the odour by “sniffing” the diluted odour samples presented by the Olfactometer. At each dilution level, the panellist “sniffed” three sample presentations, two of which were blank, odour free samples and one that contained the odorous air. The panellist was then asked to identify which of the three presentations was different from the other two by recording a “guess”, “detect” or “recognize” response as defined by ASTM E679-04.

A “guess” response was recorded when the assessor could not distinguish between any of the presentations. A “detect” response was recorded when the assessor could differentiate the odorous sample from the two blanks, and “recognize” was recorded when the assessor could identify and describe the odorous sample.

As per BS EN 13725:2003, each sample assessment began with the Olfactometer diluting the odorous sample to sub-detection levels. The odour sample and two blanks were then presented to one panellist, who “sniffed” the three presentations and recorded their response. The concentration of odorous gas was then doubled and re-presented to the same assessor with two blanks. Again, the assessor “sniffed” the three presentations and recorded their response. The process continued with the concentration of odorous gas increasing until the panellist had correctly detected the odour in at least two consecutive presentations as described by BS EN 13725:2003. The process was repeated for each panellist until all samples were evaluated.

Sample analysis was conducted “blind”; neither the panellist nor the test administrator knew which port would deliver the odour sample. Panellist’s results were recorded and analyzed using AC’SCENT DataSense Olfactometry software integrated with the Olfactometer. The software incorporates an Access database program designed specifically for olfactometry laboratories and is compatible with international olfactometry standards including BS EN 13725:2003 and ASTM E679-04.

As part of laboratory Quality Assurance and Quality Control (QAQC), test results were retrospectively screened in accordance with BS EN 13725:2003. As the standard requires, each assessor’s individual threshold estimate ( $Z_{ITE}$ ) was compared to the panel’s average threshold, with the ratio between the individual threshold estimate and the panel average threshold represented as  $\Delta Z$ . Assessors having a  $\Delta Z$  greater than 5.0 or lower than -5.0, were eliminated from the results. The purpose was to exclude panel members that showed deviant responses due to health factors or specific hyperosmia or anosmia for the odour of the analyzed sample. Where screening was required, both the screened and unscreened results were provided.

## 2.2 Odour Evaluation Parameters

### 2.2.1 Odour Threshold Values – Detection Threshold (DT)

The detection threshold (DT) is the dilution ratio at which 50% of the panellists correctly detected the odour. DT, as defined by ASTM E679-04, is synonymous with the MECP Draft definition of an odour threshold value ( $ED_{50}$ ) and the BS EN 13725:2003 definition of odour concentration ( $C_{OD}$ ). That is, the DT represents the amount of dilution required for the odour to be just detectable. Since DT values are dimensionless, pseudo-dimensions of odour units per unit volume (i.e. odour units per cubic metre ( $ou/m^3$ )) are often used for reporting purposes.

In accordance with BS EN 13725:2003, individual threshold estimates ( $Z_{ITE}$ ) were calculated as the geometric mean of the lowest dilution ratio where the odour could not be detected and the dilution ratio at which the panellist correctly detected the odour. Where a detection response could not be established at the Olfactometer's dilution limit, it was assumed that the panellist would have detected the odour at a dilution ratio half that of the limit, and the  $Z_{ITE}$  was calculated. The sample odour concentration ( $C_{OD}$ ) was then calculated as the geometric mean of the  $Z_{ITE}$  values.

## 3.0 RESULTS

The odour threshold value results for detection threshold (DT) are presented in Table 1. Where appropriate, the DT values have been adjusted for field pre-dilution reported by the client. The adjusted DT values are recorded as  $DT_{NET}$ . Datasheets are provided in Appendix I.



Table 1 – Odour Threshold Value Results

Client: RWDI

Test Reference No.: 202859-090519

Pinchin Project No.: 202859

Evaluation Date: 5-Sep-19

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1933 | Comox 1                      | 1 :1               | 9:21 - 9:36 AM     | 108       | 108               |          |
| PO19-202859-S1934 | Comox 2                      | 1 :1               | 9:37 - 9:49 AM     | 198       | 198               |          |
| PO19-202859-S1935 | Comox 4                      | 1 :1               | 9:50 - 10:03 AM    | 181       | 181               |          |
| PO19-202859-S1936 | Comox 5                      | 1 :1               | 10:04 - 10:14 AM   | 236       | 236               |          |
| PO19-202859-S1937 | Comox 3A/3B                  | 1 :1               | 10:16 - 10:36 AM   | 1892      | 1892              |          |
| PO19-202859-S1938 | Comox 6A/6B                  | 1 :1               | 10:37 - 10:50 AM   | 2918      | 2918              |          |

**Odour Evaluation Report Nomenclature**

DT Detection Threshold

DT<sub>NET</sub> Detection Threshold adjusted for field dilution

\* This report may not be reproduced except in full, without written authorization from the laboratory.

J:\202000s\0202859.000 RWDI,650Woodlawn,ENVNS,ODPNL\Odour Lab\2019\Sept 5, 2019\202859-090519 - RWDI Odour Report for Detection Threshold.docx

Template: 14852 – Report Template for Detection Threshold Determination - September 19, 2014

**APPENDIX I**  
**Odour Evaluation Data Sheets**  
**Pinchin File: 202859-090519**  
**(6 Pages)**

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019  
 Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                                |                                 |
|------------------------------------|--------------------------------|---------------------------------|
| <b>Sample Information</b>          |                                | Sampling Date : <u>9/4/2019</u> |
| Lab No. : <u>PO19-202859-S1933</u> | Field No. : <u>Comox 1</u>     | Sampling Time : _____           |
| Description : <u>1:1</u>           | Sample Collector : <u>RWDI</u> | Sample Source : <u>unknown</u>  |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |  |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|--|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |  |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |  |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |  |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |  |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |  |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |  |
| 14853-665 1     |        |        |        |        |        |        |        | 2      | 1      | 1      | 1      | 6      | 6      |        |   | 1.96  | 1.96  |  |
| 2018-1 1        |        |        |        |        |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |   | 2.26  | 1.96  |  |
| 14853-917 1     |        |        |        |        |        |        |        |        | 1      | 1      | 1      | 1      | 6      | 6      |   | 1.66  | 1.66  |  |
| 14853-671 1     |        |        |        |        |        |        |        |        | 2      | 1      | 1      | 6      | 6      |        |   | 1.96  | 1.96  |  |
| 14853-719 1     |        |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |   | 2.26  | 2.26  |  |
| 14853-1232 1    |        |        |        |        |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |   | 2.26  | 1.96  |  |
| 14853-946 1     |        |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |   | 2.26  | 2.26  |  |
| 14853-1903 1    |        |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |   | 2.56  | 2.26  |  |

**Sample Comments :**

|   |            |
|---|------------|
| <b>Specific Chemical Concentration Data</b> |            |
| Chemical :                                  | <u>N/A</u> |
| Concentration (ppm) :                       | _____      |

**Response Key:**  
 1 = Incorrect Guess  
 2 = Correct Guess  
 5 = Incorrect Detection  
 6 = Correct Detection  
 7 = Incorrect Recognition  
 8 = Correct Recognition

|                      |             |             |             |
|----------------------|-------------|-------------|-------------|
| <b>Final Results</b> |             |             |             |
|                      | <b>G</b>    | <b>D</b>    | <b>R</b>    |
| Avg. Log Value       | <u>2.15</u> | <u>2.03</u> | <u>0.00</u> |
| Std. Dev.            | <u>0.28</u> | <u>0.21</u> | <u>0.00</u> |
| Threshold            | <u>140</u>  | <u>108</u>  | <u>1</u>    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1934 Field No. : Comox 2 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |

| Assessor/Round |   |  |  |  |  |  |  |   |   |   |   |   |  |  | Log G | Log D | Log R |
|----------------|---|--|--|--|--|--|--|---|---|---|---|---|--|--|-------|-------|-------|
| 14853-665      | 1 |  |  |  |  |  |  | 2 | 2 | 6 | 6 |   |  |  | 2.86  | 2.26  |       |
| 2018-1         | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-917      | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-671      | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-719      | 1 |  |  |  |  |  |  | 1 | 2 | 1 | 6 | 6 |  |  | 1.96  | 1.96  |       |
| 14853-1232     | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-946      | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.56  | 2.56  |       |
| 14853-1903     | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.56  | 2.56  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.37 | 2.30 | 0.00 |
| Std. Dev.      | 0.28 | 0.19 | 0.00 |
| Threshold      | 236  | 198  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019  
 Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                            |                                 |
|------------------------------------|----------------------------|---------------------------------|
| <b>Sample Information</b>          |                            | Sampling Date : <u>9/4/2019</u> |
| Lab No. : <u>PO19-202859-S1935</u> | Field No. : <u>Comox 4</u> | Sampling Time : _____           |
| Description : <u>1:1</u>           |                            | Sample Collector : <u>RWDI</u>  |
|                                    |                            | Sample Source : <u>unknown</u>  |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60.782 | 32.882 | 16.577 | 8.254  | 4.127  | 2.064  | 1.031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        | 2.86  | 2.26  |       |
| 2018-1 1        |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-917 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-671 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-719 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-1232 1    |        |        |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        | 2.86  | 2.26  |       |
| 14853-946 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-1903 1    |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.41 | 2.26 | 0.00 |
| Std. Dev.      | 0.28 | 0.00 | 0.00 |
| Threshold      | 257  | 181  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1936 Field No. : Comox 5 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 2018-1 1        |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        | 2.56  | 2.26  |       |
| 14853-917 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-671 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-719 1     |        |        |        |        |        |        |        | 1      | 2      | 1      | 6      | 6      |        |        | 2.26  | 2.26  |       |
| 14853-1232 1    |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.56  | 2.56  |       |
| 14853-946 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.56  | 2.56  |       |
| 14853-1903 1    |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        | 2.86  | 2.56  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.45 | 2.37 | 0.00 |
| Std. Dev.      | 0.23 | 0.16 | 0.00 |
| Threshold      | 281  | 236  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1937 Field No. : Comox 3A/3B

Sampling Date : 9/4/2019

Description : 1:1

Sampling Time : \_\_\_\_\_

Sample Collector : RWDI

Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |
| 2018-1 1        |        |        |        | 1      | 1      | 5      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-917 1     |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        | 3.47  | 2.86  |       |
| 14853-671 1     |        |        |        |        | 1      | 2      | 5      | 6      | 6      |        |        |        |        |        | 2.86  | 2.86  |       |
| 14853-719 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-946 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47  | 3.16  |       |
| 14853-1903 1    |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.47  | 3.28  | 0.00 |
| Std. Dev.      | 0.32  | 0.32  | 0.00 |
| Threshold      | 2,918 | 1,892 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1938 Field No. : Comox 6A/6B Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60.782 | 32.882 | 16.577 | 8.254  | 4.127  | 2.064  | 1.031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 2018-1 1        |        |        |        | 2      | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-917 1     |        |        |        | 1      | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-671 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-719 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-946 1     |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |
| 14853-1903 1    |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.50  | 3.47  | 0.00 |
| Std. Dev.      | 0.25  | 0.23  | 0.00 |
| Threshold      | 3,182 | 2,918 | 1    |

**APPENDIX II**  
**Odour Evaluation Quality Assurance**  
**Pinchin File: 202859-090519**  
**(1 Page)**

## ODOUR EVALUATION QUALITY ASSURANCE

- Odour evaluations conducted at the Pinchin Odour Laboratory conform to the procedures outlined in the Ministry of the Environment, Conservation and Parks “Ontario Source Testing Code” (OSTC), Version #3, June 2010 (Part G, Method ON-6) and are in accordance with ASTM (American Society for Testing and Materials) Standard Practice E679-04, Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series of Limits.
- The AC’SCENT® Dynamic Dilution Forced-Choice Triangle Olfactometer complies with all aspects of the ASTM E679-04 standard as well as the operational requirements of the British Standard, BS EN 13725:2003, “Air quality – Determination of odour concentration by dynamic olfactometry”.
- The detection threshold values are reported as defined by ASTM E679-04 and BS EN 13725:2003.
- Assessors are selected and trained in accordance with BS EN 13725:2003.
- The Pinchin Odour Laboratory is managed based on the requirements of the International Organization for Standardization (ISO) International Standard ISO 17025:2005, “General requirements for the competence of testing and calibration laboratories”.
- Samples are consumed during the evaluation and all sample bags are destroyed 48 hours after transmittal of the Preliminary Odour Evaluation Results, unless otherwise specified.



## APPENDIX B

Odour Evaluation Report  
Environmental Odour  
Consulting Corporation  
SEPTEMBER 20, 2019

# Report

## Odour Panel Evaluation

### **Report to:**

RWDI Air Inc.  
650 Woodlawn Road West  
Guelph, Ontario  
N1K 1B8  
Mr. Matthew Sawycky  
E-mail: Matthew.Sawycky@RWDI.com  
Phone: 519 823 1311

### **Prepared by:**

#### ***EOC Environmental Odour Consulting Corporation***

Anna H. Bokowa, M.Sc.  
*President*  
Tel: (647) 988-5814  
Bokowa.anna@environmentalodourconsulting.com

**Date of the Report**  
October 1, 2019  
12 pages, 2 Appendices

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## 1. INTRODUCTION

EOC Environmental Odour Consulting Corporation (EOC) was contracted by RWDI Air Inc. (RWDI) to perform an odour evaluation on samples delivered to EOC.

One batch of nine (9) samples was shipped from Vancouver via Air Canada FedEx. On September 20, 2019, samples were picked up from the Air Canada Cargo Centre located at 2580 Britannia Rd E, Mississauga, ON. All samples were evaluated on September 20, 2019.

All evaluations for odour detection threshold value (ODTV) were performed according to the European standard EN13725: 2003 (with exceptions) and Ontario Ministry of the Environment Method ON-6 using dynamic olfactometry with eight screened panelists.

All samples were in good condition upon delivery.

## 2. METHODOLOGY

The evaluations were based on the European Standard EN 13725:2003 with the exception that each sample was introduced once to the panel members and eight panel members were used for all evaluations. Odour evaluations were also completed in accordance to the Ontario Ministry of the Environment's Method ON-6 "Determination of Odour Emission from Stationary Sources."

The EOC olfactometer is capable to perform evaluations using either the Triangular Forced Choice Method, or the Binary Forced Choice Method. For the Forced Choice Method; the panelist is presented with two or three ports (Triangular, Binary), of which one panelist presents the diluted sample and the other(s) neutral gas. The sample is presented randomly over the two or three ports. The panelist is asked to indicate the port with the sample. The panelist is also asked if his/her choice was a guess, inkling or if they were certain. By combining the chosen results and the indicated level of certainty, the response is classified as false or true. The odour evaluation procedure requires the first sample to be presented to the panelist at the dilution that will be below the detection threshold. Therefore, the several initial presentations to the panelists require the panelist to select one port by guessing. Each panelist observes an odour sample in the ascending concentration series (increasing concentration). For this program, a Binary Forced Choice Mode was chosen for odour evaluations. Each sample bag was evaluated by eight panelists with the option that for each dilution, each of the 8 panelists were asked to indicate their responses. Therefore, each panelist was introduced to the same dilution steps. Also, the same step between dilutions was used (1.51) for evaluation of all the samples.

The panelists' responses were recorded by computer software and were processed to determine the odour detection threshold value (ODTV) for each sample. The ODTV is a dilution factor and therefore has no units. For convenience, however, the ODTV may be expressed in odour units (ou).

A screened odour panel was used for all evaluations. They were tested for odour sensitivity using n-butanol as a reference gas. All panelists were within the normal range according to the European Standard EN 13725:2003 (20-80 ppb n-butanol). All panelists were included in the evaluations.

All screening data for the day of evaluation are presented in Appendix 1.

### **3. QUALITY CONTROL MEASURES AND CALIBRATION DATA**

EOC provided extensive quality control measures for the evaluations. These included, but were not limited to:

- Keeping constant dilution steps between analysis of the samples from the same source.
- Each sample bag was evaluated by eight panelists with the option that for each dilution each of the 8 panelists were asked to indicate their responses (each panelist was exposed to the same dilution).
- The EOC olfactometer is calibrated by the manufacturer against carbon monoxide at all used ports. The calibrations are within the limits of EN13725 standard.
- The EOC olfactometer is checked before each use for consistent volumetric flow rates at each “sniff port.”
- EOC panelists are screened using European Method EN; 13725 with n-butanol and they are within the range of that standard- all screening data are provided in the report.
- EOC panelists are trained to avoid any odorous products such as perfumes and scented lotions.
- EOC panelists are advised and trained to avoid coffee or spicy food one hour before a session.
- EOC makes sure that the sessions for the odour panel evaluations are not too long.
- EOC provides frequent breaks to avoid any panelist’s fatigue.
- All panelists’ data are computer recorded.

### **4. RESULTS**

Table 1 shows the results for odour detection threshold values for samples evaluated on September 20, 2019.

Appendix 1 shows the screening data for the panel used during the program.

All calibration data for the olfactometer are presented in Appendix 2.

Prepared by:



Anna H. Bokowa, M.Sc.  
President, Environmental Odour Consulting

**Table 1: Odour Detection Threshold Values- September 20, 2019**

| <b>Client<br/>Description</b> | <b>EOC<br/>Sample<br/>Identification</b> | <b>ODTV<br/><br/>ou</b> |
|-------------------------------|--|-------------------------|
| Scrubber Out 1                | A001                                     | 145                     |
| Scrubber Out 2                | A002                                     | 172                     |
| Scrubber Out 3                | A003                                     | 183                     |
| Bioreactor 1 Outlet           | A004                                     | 282                     |
| Bioreactor 2 Outlet           | A005                                     | 318                     |
| Bioreactor 1 Mid              | A006                                     | 475                     |
| Bioreactot 2 Mid              | A007                                     | 492                     |
| Bioreactor 1 Inlet            | A008                                     | 5061                    |
| Bioreactor 2 Inlet            | A009                                     | 5142                    |

## **APPENDIX 1**

### **Panelist's Screening Data**

**(1 page)**

| Panelist No | Panelist ID | n- butanol ppb Test 1 | n- butanol ppb Test 2 | n- butanol ppb Test 3 | n- butanol ppb Test 4 | n- butanol ppb Test 5 | n- butanol ppb Test 6 | n- butanol ppb Test 7 | n- butanol ppb Test 8 | n- butanol ppb Test 9 | n- butanol ppb Test 10 | n- butanol ppb Test 11 | n- butanol ppb Test 12 | n- butanol ppb Average |
|-------------|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|
| Panelist 1  | P201        | 55                    | 47                    | 48                    | 55                    | 57                    | 48                    | 47                    | 56                    | 51                    | 43                     | 56                     | 58                     | 52                     |
| Panelist 2  | P202        | 32                    | 47                    | 48                    | 42                    | 43                    | 32                    | 36                    | 32                    | 38                    | 33                     | 42                     | 44                     | 39                     |
| Panelist 3  | P205        | 24                    | 27                    | 24                    | 24                    | 25                    | 32                    | 27                    | 24                    | 38                    | 25                     | 32                     | 25                     | 27                     |
| Panelist 4  | P208        | 42                    | 47                    | 48                    | 42                    | 43                    | 48                    | 47                    | 42                    | 38                    | 43                     | 42                     | 44                     | 44                     |
| Panelist 5  | P210        | 24                    | 27                    | 24                    | 24                    | 25                    | 24                    | 27                    | 24                    | 29                    | 25                     | 24                     | 25                     | 25                     |
| Panelist 6  | P212        | 42                    | 47                    | 48                    | 42                    | 43                    | 32                    | 47                    | 42                    | 38                    | 43                     | 42                     | 44                     | 43                     |
| Panelist 7  | P213        | 32                    | 36                    | 32                    | 32                    | 33                    | 32                    | 36                    | 32                    | 38                    | 33                     | 32                     | 33                     | 33                     |
| Panelist 8  | P216        | 55                    | 47                    | 56                    | 55                    | 57                    | 56                    | 47                    | 42                    | 51                    | 57                     | 56                     | 58                     | 53                     |

### Panelists Screening Data- September 20, 2019

| Panelist No | Panelist ID | n- butanol ppb 20-Sep-19 |
|-------------|-------------|--------------------------|
| Panelist 1  | P201        | 56                       |
| Panelist 2  | P202        | 32                       |
| Panelist 3  | P205        | 32                       |
| Panelist 4  | P208        | 42                       |
| Panelist 5  | P210        | 24                       |
| Panelist 6  | P212        | 42                       |
| Panelist 7  | P213        | 32                       |
| Panelist 8  | P216        | 56                       |

## **APPENDIX 2**

### **Calibration Data**

**(3 pages)**

## Certificate of Calibration- Olfactometer SC300

Date of Calibration: September 18, 2019

Device Description: Olfactometer SC300

Calibration Conditions: T: 22.5°C ± 2°C P: 750 psi ± 1 psi

Diluting Air Flow:

| Set Point<br>(ml/min) | Measured<br>(ml/min) | Difference % | MFC<br>used |
|-----------------------|----------------------|--------------|-------------|
| 10000                 | 10040                | 0.4          | MFC 3       |
| 12000                 | 12095                | 0.8          | MFC 3       |
| 15000                 | 14925                | 0.5          | MFC 3       |
| 18000                 | 18160                | 0.9          | MFC 3       |
| 20000                 | 20010                | 0.1          | MFC 3       |

Acceptable limit is within 2%. Acceptable error limit in accordance to EN13725 is 10%.

Measured using Gas collection method

Uncertainty of Measurement: ±0.5% based on a confidence of probability of greater than 95%.

Dilutions:

| <i>Settings</i> | <i>Measured</i> | <i>Difference %</i> | <i>MFC</i> |
|-----------------|-----------------|---------------------|------------|
| 12              | 12.4            | 3.3                 | MFC 2      |
| 16              | 16.3            | 1.9                 | MFC 2      |
| 32              | 32.5            | 1.6                 | MFC 2      |
| 64              | 67.3            | 5.1                 | MFC 2      |
| 128             | 121             | 5.5                 | MFC 2      |
| 256             | 264             | 3.1                 | MFC 1      |
| 512             | 502             | 1.9                 | MFC 1      |
| 1024            | 1029            | 0.5                 | MFC 1      |
| 2048            | 2071            | 1.1                 | MFC 1      |
| 4096            | 4344            | 6.1                 | MFC 1      |
| 8192            | 8746            | 6.8                 | MFC1       |
| 16384           | 16078           | 1.9                 | MFC1       |
| 32768           | 35684           | 8.9                 | MFC1       |

Acceptable error limit in accordance to EN13725 is 20%.

Measured using Tracer gas calibration method with certified CO calibration gas cylinders and Carbon Monoxide analyzer.

## Velocity Readings: September 20, 2019

| <b>Test No</b> | <b>Port A<br/>Velocity<br/>m/s</b> | <b>Port B<br/>Velocity<br/>m/s</b> |
|----------------|------------------------------------|------------------------------------|
| Test 1         | 0.314                              | 0.315                              |
| Test 2         | 0.312                              | 0.313                              |
| Test 3         | 0.310                              | 0.316                              |
| Test 4         | 0.314                              | 0.314                              |
| Test 5         | 0.310                              | 0.312                              |
| Test 6         | 0.312                              | 0.310                              |

## APPENDIX C

A large decorative graphic on the page, featuring a blue triangle in the top-left corner and a large, light gray semi-circle that overlaps the triangle and extends across the bottom and right sides of the page.

Certificate of Analysis  
Total Reduced Sulfur  
ALS Environmental



RWDI AIR INC.  
ATTN: Matthew Sawycky  
#280 - 1385 West 8th Avenue  
Vancouver BC V6H 3V9

Date Received: 05-SEP-19  
Report Date: 17-SEP-19 18:29 (MT)  
Version: FINAL

Client Phone: 604-730-5688

## Certificate of Analysis

Lab Work Order #: L2341651  
Project P.O. #: NOT SUBMITTED  
Job Reference: 1904012  
C of C Numbers: 17-762085  
Legal Site Desc:

Rojina Ghavami  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company



# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                            | <b>Sample ID</b><br><b>Description</b><br><b>Sampled Date</b><br><b>Sampled Time</b><br><b>Client ID</b> | L2341651-6<br>SUMP<br>04-SEP-19<br>13:30<br>COMOX OUT #3 |  |  |  |
|----------------------------|--|--|--|--|--|
| Grouping                   | Analyte  |  |  |  |  |
| <b>CANISTER</b>            |  |  |  |  |  |
| <b>Sulfur Compounds</b>    | n-Butyl mercaptan (ppb(V))   | <4.0   |  |  |  |
|                            | n-Butyl mercaptan (ug/m3)  | <15  |  |  |  |
|                            | Butyl(t) mercaptan (ppb(V))  | <4.0   |  |  |  |
|                            | Butyl(t) mercaptan (ug/m3)   | <15  |  |  |  |
|                            | Carbon Disulfide (ppb(V))  | 2.2  |  |  |  |
|                            | Carbon Disulfide (ug/m3)   | 6.9  |  |  |  |
|                            | Carbonyl sulfide (ppb(V))  | 14.2   |  |  |  |
|                            | Carbonyl sulfide (ug/m3)   | 34.8   |  |  |  |
|                            | Diethyl disulfide (ppb(V))   | <2.0   |  |  |  |
|                            | Diethyl disulfide (ug/m3)  | <10  |  |  |  |
|                            | Diethyl Sulfide (ppb(V))   | <4.0   |  |  |  |
|                            | Diethyl Sulfide (ug/m3)  | <15  |  |  |  |
|                            | Dimethyl disulfide (ppb(V))  | <2.0   |  |  |  |
|                            | Dimethyl disulfide (ug/m3)   | <7.7   |  |  |  |
|                            | Dimethyl sulfide (ppb(V))  | <4.0   |  |  |  |
|                            | Dimethyl sulfide (ug/m3)   | <10  |  |  |  |
|                            | 2,5-Dimethylthiophene (ppb(V))   | <4.0   |  |  |  |
|                            | 2,5-Dimethylthiophene (ug/m3)  | <18  |  |  |  |
|                            | Ethyl mercaptan (ppb(V))   | <4.0   |  |  |  |
|                            | Ethyl mercaptan (ug/m3)  | <10  |  |  |  |
|                            | Ethyl Methyl Sulfide (ppb(V))  | <4.0   |  |  |  |
|                            | Ethyl Methyl Sulfide (ug/m3)   | <12  |  |  |  |
|                            | 2-Ethylthiophene (ppb(V))  | <4.0   |  |  |  |
|                            | 2-Ethylthiophene (ug/m3)   | <18  |  |  |  |
|                            | Hydrogen Sulfide (ppb(V))  | <4.0   |  |  |  |
|                            | Hydrogen Sulfide (ug/m3)   | <5.6   |  |  |  |
|                            | Isobutyl Mercaptan (ppb(V))  | <4.0   |  |  |  |
|                            | Isobutyl Mercaptan (ug/m3)   | <15  |  |  |  |
|                            | Isopropyl Mercaptan (ppb(V))   | <4.0   |  |  |  |
|                            | Isopropyl Mercaptan (ug/m3)  | <12  |  |  |  |
|                            | Methyl mercaptan (ppb(V))  | <4.0   |  |  |  |
|                            | Methyl mercaptan (ug/m3)   | <7.9   |  |  |  |
|                            | 2-Methylthiophene (ppb(V))   | <4.0   |  |  |  |
|                            | 2-Methylthiophene (ug/m3)  | <16  |  |  |  |
| 3-Methylthiophene (ppb(V)) | <4.0   |  |  |  |  |
| 3-Methylthiophene (ug/m3)  | <16  |  |  |  |  |
| Propyl mercaptan (ppb(V))  | <4.0   |  |  |  |  |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                         |   | Sample ID    | L2341651-1           | L2341651-2  | L2341651-3  | L2341651-4   | L2341651-5   |
|-------------------------|---|--------------|----------------------|-------------|-------------|--------------|--------------|
|                         |   | Description  | SUMP                 | SUMP        | SUMP        | SUMP         | SUMP         |
|                         |   | Sampled Date | 04-SEP-19            | 04-SEP-19   | 04-SEP-19   | 04-SEP-19    | 04-SEP-19    |
|                         |   | Sampled Time | 13:30                | 13:30       | 13:30       | 13:30        | 13:30        |
|                         |   | Client ID    | COMOX IN #1          | COMOX IN #2 | COMOX IN #3 | COMOX OUT #1 | COMOX OUT #2 |
| Grouping                | Analyte                                   |              |                      |             |             |              |              |
| <b>CANISTER</b>         |   |              |                      |             |             |              |              |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  | <12          | <12                  | <12         | <12         | <12          | <12          |
|                         | Tetrahydrothiophene (ppb(V))              | <4.0         | <4.0                 | <4.0        | <4.0        | <4.0         | <4.0         |
|                         | Tetrahydrothiophene (ug/m3)               | <14          | <14                  | <14         | <14         | <14          | <14          |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  | <6.0         | <6.0                 | <6.0        | <6.0        | <6.0         | <6.0         |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   | <21          | <21                  | <21         | <21         | <21          | <21          |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) | 2570         | 3490                 | 2810        | 19          | 19           | 19           |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  | 3590         | 4870                 | 3920        | 26          | 27           | 27           |
| <b>Miscellaneous</b>    | Batch Proof ID                            | 181212.301   | 181105.13100<br>0001 | 190610.109  | 181121.231  | 181121.202   | 181121.202   |
|                         | Canister ID                               | 01400-0008   | 01400-0384           | 01400-0121  | 01400-0412  | 01400-0051   | 01400-0051   |
|                         | Pressure on Receipt (in Hg)               | 0.8          | 0.8                  | -11.4       | 1.0         | 0.8          | 0.8          |
|                         | Regulator ID                              | N/A          | N/A                  | N/A         | N/A         | N/A          | N/A          |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping                | Analyte                                   | Sample ID  | Description | Sampled Date | Sampled Time | Client ID    |
|-------------------------|---|------------|-------------|--------------|--------------|--------------|
|                         |   | L2341651-6 | SUMP        | 04-SEP-19    | 13:30        | COMOX OUT #3 |
| <b>CANISTER</b>         |   |            |             |              |              |              |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  |            |             |              |              | <12          |
|                         | Tetrahydrothiophene (ppb(V))              |            |             |              |              | <4.0         |
|                         | Tetrahydrothiophene (ug/m3)               |            |             |              |              | <14          |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  |            |             |              |              | <6.0         |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   |            |             |              |              | <21          |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) |            |             |              |              | 18           |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  |            |             |              |              | 26           |
| <b>Miscellaneous</b>    | Batch Proof ID                            |            |             |              |              | 181105.104   |
|                         | Canister ID                               |            |             |              |              | 01400-0037   |
|                         | Pressure on Receipt (in Hg)               |            |             |              |              | 0.2          |
|                         | Regulator ID                              |            |             |              |              | N/A          |

## Reference Information

**Test Method References:**

| ALS Test Code   | Matrix   | Test Description  | Method Reference** |
|---|----------|---|--------------------|
| <b>CAN-DATA-WT</b>  | Canister | Canister Information<br>Batch Proof ID, Canister ID, Pressure on Receipt, Regulator ID. | EPA TO-15          |
| <b>REDUC-SULF-22-SCD-WT</b>   | Canister | 22 Reduced Sulfur Compounds by GC-SCD   | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.</p> <p>Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p> |          |   |                    |
| <b>TRS-22-SCD-WT</b>  | Canister | Total Reduced Sulfur as H2S   | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.</p> <p>Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p> |          |   |                    |
| <b>TRS22-SUM-CALC-WT</b>  | Canister | Total Reduced Sulfur as H2S (22 Comp'ds)  | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. A volume of air sample is transferred from the canister to a preconcentrator system where the analytes are trapped &amp; focused. The analytes are then thermally desorbed into a GC-SCD for analysis. Test results are not blank corrected unless indicated by a qualifier. Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p>  |          |   |                    |

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location                           |
|----------------------------|---|
| WT                         | ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA |

**Chain of Custody Numbers:**

17-762085

**GLOSSARY OF REPORT TERMS**

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com



L2341651-COFC

COC Number: 17 - 762085

Page of

|  |   |  |              |   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| <b>Report To</b><br>Contact and company name below will appear on the final report                                   |   | <b>Report Format / Distribution</b>  |              | <b>Select Service Level Below - Contact your AM to confirm all E&amp;P TATs (surcharges may apply)</b>  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company: <b>RWDI</b>   |   | Select Report Format: <input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input type="checkbox"/> EDD (DIGITAL) |              | Regular [R] <input checked="" type="checkbox"/> Standard TAT if received by 3 pm - business days - no surcharges apply  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Contact: <b>Math Sawycky</b>   |   | Quality Control (QC) Report with Report <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO                                    |              | PRIORITY (Business days)  |       | EMERGENCY   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Phone: <b>519-823-1311 x 2639</b>  |   | <input type="checkbox"/> Compare Results to Criteria on Report - provide details below if box checked  |              | 4 day [P4-20%] <input type="checkbox"/>   |       | 1 Business day [E - 100%] <input type="checkbox"/>  |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company address below will appear on the final report  |   | Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX                      |              | 3 day [P3-25%] <input type="checkbox"/>   |       | Same Day, Weekend or Statutory holiday [E2 - 200% (Laboratory opening fees may apply)] <input type="checkbox"/> |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Street: <b>280-1385 West 8th Ave</b>   |   | Email 1 or Fax: <b>Matthew.Sawycky@RWDI.com</b>  |              | Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| City/Province: <b>Vancouver BC</b>   |   | Email 2  |              | For tests that can not be performed according to the service level selected, you will be contacted.   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Postal Code:   |   | Email 3  |              | <b>Analysis Request</b>   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Invoice To</b>  |   | <b>Invoice Distribution</b>  |              | <table border="1"> <tr> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">NUMBER OF CONTAINERS</td> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">Total Reduced Substans</td> <td colspan="12">Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below</td> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">SAMPLES ON HOLD</td> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">SUSPECTED HAZARD (see Special Instructions)</td> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table> |       |   |                          | NUMBER OF CONTAINERS | Total Reduced Substans | Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below |  |  |  |                 |   |  |  |  |  |  |  | SAMPLES ON HOLD | SUSPECTED HAZARD (see Special Instructions) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NUMBER OF CONTAINERS   | Total Reduced Substans  | Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below   |              |   |       |   |                          |                      |                        |  |  |  |  | SAMPLES ON HOLD | SUSPECTED HAZARD (see Special Instructions) |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Same as Report To <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO                                |   | Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX              |              |   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Copy of Invoice with Report <input type="checkbox"/> YES <input type="checkbox"/> NO                                 |   | Email 1 or Fax   |              |   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company:   |   | Email 2  |              |   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Contact:   |   | Email 3  |              |   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Project Information</b>   |   | <b>Oil and Gas Required Fields (client use)</b>  |              |   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Account # / Quote #:   |   | AFE/Cost Center:   |              | PO#   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Job #: <b>1904012</b>  |   | Major/Minor Code:  |              | Routing Code:   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PO / AFE:  |   | Requisitioner:   |              |   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| LSD:   |   | Location:  |              |   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Lab Work Order # (lab use only):   |   | ALS Contact: <b>Rogina</b>   |              | Sampler: <b>M. Sawycky</b>  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Sample # (lab use only)  | Sample Identification and/or Coordinates (This description will appear on the report) | Date (dd-mmm-yy)   | Time (hh:mm) | Sample Type   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX IN #1   | 4-9-19   | 1:30         | SUMA  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX IN #2   | ↓  | ↓            | ↓   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX IN #3   | ↓  | ↓            | ↓   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX OUT #1  | ↓  | ↓            | ↓   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX OUT #2  | ↓  | ↓            | ↓   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX OUT #3  | ↓  | ↓            | ↓   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Drinking Water (DW) Samples<sup>1</sup> (client use)</b>  |   | <b>Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)</b>                  |              | <b>SAMPLE CONDITION AS RECEIVED (lab use only)</b>  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Are samples taken from a Regulated DW System?<br><input type="checkbox"/> YES <input checked="" type="checkbox"/> NO |   |  |              | Frozen <input type="checkbox"/> SIF Observations Yes <input type="checkbox"/> No <input type="checkbox"/>   |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Are samples for human consumption/ use?<br><input type="checkbox"/> YES <input checked="" type="checkbox"/> NO       |   |  |              | Ice Packs <input type="checkbox"/> Ice Cubes <input type="checkbox"/> Custody seal intact Yes <input type="checkbox"/> No <input type="checkbox"/>  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   |  |              | Cooling Initiated <input type="checkbox"/>  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   |  |              | INITIAL COOLER TEMPERATURES °C  |       | FINAL COOLER TEMPERATURES °C  |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   |  |              |   |       | 21  |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>SHIPMENT RELEASE (client use)</b>   |   | <b>INITIAL SHIPMENT RECEPTION (lab use only)</b>   |              | <b>FINAL SHIPMENT RECEPTION (lab use only)</b>  |       |   |                          |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Released by: <b>[Signature]</b>  | Date: <b>5-9-19</b>   | Time:  | Received by: | Date:   | Time: | Received by: <b>SC</b>  | Date: <b>SEP 05 2019</b> |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   |  |              |   |       |   | Time: <b>8:56AM</b>      |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

# AIR SAMPLING MEDIA REQUEST FORM



Grey sections are for INTERNAL USE ONLY

BR# 253764 - Pls ship EXPRESS tomorrow -confirm delivery date pls

|                       |                                   |                     |            |
|-----------------------|-----------------------------------|---------------------|------------|
| CLIENT:               | Comox Valley Regional District    | CLIENT EXPECT DATE: | 09/03/2019 |
| CLIENT CONTACT:       | Zoe Berkey                        | ORDER TAKEN BY:     | J. Pearson |
| CLIENT PROJECT:       |                                   | ORDER DATE:         | 08/27/2019 |
| DELIVERY TO:          | 445 Brent Road, Comox, BC V9M 3V9 | QUOTE #:            |            |
| TELEPHONE NUMBER:     |                                   | ORDER FILLED BY:    | LB1        |
| SHIP TO/ATTENTION OF: |                                   | DATE COMPLETED:     | 08/28/2019 |

Shipping Method:  Ground: (4 business days to Western Canada, 2 business day to Winnipeg)  Express: (2 business days to Western Canada, 1 business day to WP)  External Courier

Tracking Number: 7760 9894 4739

ALS Drivers:   
Pickup at ALS Waterloo:

TAT Information:  Regular TAT 10 Business Days No surcharge  
(select one)  5-day 5 Business Days 50% surcharge  
ALL TAT except Regular  3-day 3 Business Days 100% surcharge  
requires Prior Confirmation  2-day 2 Business Days 200% surcharge  
 1-day 1 Business Day 300% surcharge

**Completion of all Sections is Mandatory**

1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawspace; **OH&S** - Industrial, Commercial, Residential comment: ADAPTOR BAG TO CAN

2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**

3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**

This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:               | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-----------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                       | 24 hr           |          |                           |                                |  |                             |
|                                   | 12 hr           |          |                           |                                |  |                             |
|                                   | 8 hr            |          |                           |                                |  |                             |
|                                   | 4 hr            |          |                           |                                |  |                             |
|                                   | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters _____         | 30 mins         |          |                           |                                |  |                             |
| 1.4L Canister                     | 1 hr            |          |                           |                                |  |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters _____         |                 |          |                           |                                |  |                             |
| Bottle Vacs                       | 1 hr            |          |                           |                                |  |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters _____         |                 |          |                           |                                |  |                             |
| Passive CarboPak X Tubes          |                 |          |                           |                                |  |                             |
| Diffusive Caps                    |                 |          |                           |                                |  |                             |
| Active SVI Tubes                  |                 |          |                           |                                |  |                             |
| Calibration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |

| Other Sampling Supplies   | ID #                                  | Quantity | Additional Information & Special Instructions or Requests |
|---|---------------------------------------|----------|---|
| Pressure Gauge  |                                       |          | 6XTedlar to canister adapters for reduced sulphur .       |
| Caplok Tool   |                                       |          |   |
| Canister Stands   |                                       |          |   |
| Valve Adaptor for Soil Vapour   |                                       |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS | <input type="checkbox"/>              |          |   |
| Chargeable Supplies   |                                       |          |   |
| Duplicate Sampler - \$40 can/\$25 tube                                  |                                       |          |   |
| Teflon Tubing   |                                       |          |   |
| -Total length _____ft   | without nuts and ferrules             |          |   |
| -Length per section _____ft - \$3 per foot / \$6 per N+F set            | with nuts and ferrules (single end)   |          |   |
|   | with nuts and ferrules (double ended) |          |   |
| Siloxane Kit - \$45 each  |                                       |          |   |



L2341651-COFC

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client.)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$350.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00

# AIR SAMPLING MEDIA REQUEST FORM



Grey sections are for INTERNAL USE ONLY

BR# 253757

|                       |   |                     |            |
|-----------------------|---|---------------------|------------|
| CLIENT:               | RWDI - c/o Comox Valley Regional District | CLIENT EXPECT DATE: | 08/30/2019 |
| CLIENT CONTACT:       | Matthew Sawycky                           | ORDER TAKEN BY:     |            |
| CLIENT PROJECT:       |   | ORDER DATE:         | 08/27/2019 |
| DELIVERY TO:          | 445 Brent Rd, Comox, BC V9M 3V9           | QUOTE #:            |            |
| TELEPHONE NUMBER:     |   | ORDER FILLED BY:    | JW Lopez   |
| SHIP TO/ATTENTION OF: | Zoe Berkey                                | DATE COMPLETED:     |            |

Shipping Method:  Ground: (4 business days to Western Canada, 2 business days to Winnipeg)  Express: (2 business days to Western Canada, 1 business day to WP)  External Courier

Tracking Number:

ALS Drivers:   
 Pickup at ALS Westport:

TAT Information: (select one)  
 ALL TAT except Regular requires Prior Confirmation

|                                   |                  |                |
|-----------------------------------|------------------|----------------|
| <input type="radio"/> Regular TAT | 10 Business Days | No surcharge   |
| <input type="radio"/> 5-day       | 5 Business Days  | 50% surcharge  |
| <input type="radio"/> 3-day       | 3 Business Days  | 100% surcharge |
| <input type="radio"/> 2-day       | 2 Business Days  | 200% surcharge |
| <input type="radio"/> 1-day       | 1 Business Day   | 300% surcharge |

QC'd JR  
 Sep 03/19

**Completion of all Sections is Mandatory**


1. What type of air is being sampled? *check all appropriate* eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawlspace; **O&HS** - Industrial, Commercial, Residential comment: Commercial Indoor Air

2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**

3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**

This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:               | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-----------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                       | 24 hr           |          |                           |                                |  |                             |
|                                   | 12 hr           |          |                           |                                |  |                             |
|                                   | 8 hr            |          |                           |                                |  |                             |
|                                   | 4 hr            |          |                           |                                |  |                             |
|                                   | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters               | 30 mins         |          |                           |                                |  |                             |
| 1.4L Canister                     | 1 hr            |          | reduced sulfur            | 01400-0384                     | -30                                      |                             |
|                                   | 20 mins         |          |                           | 01400-0121                     | -30                                      |                             |
|                                   | 10 mins         |          |                           | 01400-0008                     | -30                                      |                             |
|                                   | 4 mins          |          |                           | 01400-0051                     | -30                                      |                             |
| Bottle Vacs                       | 1 hr            |          |                           | 01400-0421                     | -30                                      |                             |
|                                   | 20 mins         |          |                           | 01400-0037                     | -24                                      |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
| Number of Canisters               | 4 mins          |          |                           |                                |  |                             |
| Passive CarboPak X Tubes          |                 |          |                           |                                |  |                             |
| Diffusive Caps                    |                 |          |                           |                                |  |                             |
| Active SVI Tubes                  |                 |          |                           |                                |  |                             |
| Calibration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |

| Other Sampling Supplies   | ID #                                  | Quantity | Additional Information & Special Instructions or Requests   |
|---|---------------------------------------|----------|---|
| Pressure Gauge  |                                       |          | <br>L2341651-COFC |
| Caplok Tool   |                                       |          |   |
| Canister Stands   |                                       |          |   |
| Valve Adaptor for Soil Vapour   |                                       |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS | <input type="checkbox"/>              |          |   |
| Chargeable Supplies   |                                       |          |   |
| Duplicate Sampler - \$40 each/\$25 tube                                 |                                       |          |   |
| Teflon Tubing   |                                       |          |   |
| Total length _____  | without nuts and ferrules             |          |   |
| Length per section _____  | with nuts and ferrules (single end)   |          |   |
| \$3 per foot / \$6 per N+F set  | with nuts and ferrules (double ended) |          |   |
| Siloxane Kit - \$45 each  |                                       |          |   |

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
 6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$850.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00

## APPENDIX D

A decorative graphic on the left side of the page. It features a blue triangular shape in the top-left corner, a white curved line separating it from a large grey curved shape that fills the rest of the left side of the page.

Field Notes

Sept 4 2019  
Comox WWTP  
Start Purge 5 lpm  
@ 8:04  
Sample 1  
"COMOX 1"  
at outlet of Bioreactor  
5 lpm Dwyer 10 psi del  
Sampling 8:14 to 8:20

COMOX 2  
purging start at 8:25  
Mid Point of Bioreactor  
A  
Sampling 8:35 - 8:45

Comox 3  
purging start @ 8:50  
taken at the inlet of  
Bioreactor A

Sept 4 2019  
COMOX 4  
outlet of bioreactor C  
purging starts @ 9:15  
Sampling 9:25-35

COMOX 5  
mid section of  
Bioreactor C purge  
at 9:39  
sampling 9:50-10:00

COMOX 6  
inlet of Bioreactor C  
purging @ 10:02  
sampling 10:14-10:24

MATT 5  
WILL C

SEPTEMBER 19 Comox

|              |   |         |
|--------------|---|---------|
| SCRUBBER OUT | 1 | 820 pm  |
| SCRUBBER OUT | 2 | 828 pm  |
| SCRUBBER OUT | 3 | 840 pm. |

|            |   |     |         |
|------------|---|-----|---------|
| BIOREACTOR | 1 | IN  | 915 pm  |
| BIOREACTOR | 1 | MID | 938 pm  |
| BIOREACTOR | 1 | OUT | 952 pm  |
| BIOREACTOR | 2 | OUT | 1010 pm |
| BIOREACTOR | 2 | MID | 1025 pm |
| BIOREACTOR | 2 | IN  | 1043 pm |

POSSIBLE  
MIXED LABELS  
~~\*SOME~~ TIMES CORRECT  
POSSIBLE ORDER CHANGE



RWDI AIR Inc.  
280 – 1385 West 8<sup>th</sup> Avenue  
Vancouver, BC V6H 3V9  
Canada

Tel: +1.604.730.5688  
E-mail: [solutions@rwdi.com](mailto:solutions@rwdi.com)

## Appendix B

# MEMORANDUM

|              |   |  |
|--------------|---|--|
| <b>DATE:</b> | 2019-08-09  | <b>RWDI #:</b> 1904012   |
| <b>TO:</b>   | Zoe Berkey  | <b>EMAIL:</b> <a href="mailto:zberkey@comoxvalleyrd.ca">zberkey@comoxvalleyrd.ca</a> |
| <b>FROM:</b> | Matthew Sawycky   | <b>EMAIL:</b> <a href="mailto:matthew.sawycky@rwdi.com">matthew.sawycky@rwdi.com</a> |
| <b>CC:</b>   | John DeYoe  | <b>EMAIL:</b> <a href="mailto:john.deyoe@rwdi.com">john.deyoe@rwdi.com</a>           |
| <b>RE:</b>   | <b>Existing Odour Framework in Canada<br/>Comox, BC</b> |  |

Zoe,

RWDI, in 2015, had conducted a thorough review to summarize Canada's existing odour framework; below is a summary of those findings. We review criteria on an on-going basis and to the best of our knowledge these are all still current guidelines.

## BRITISH COLUMBIA

British Columbia does not have any province-wide regulation regarding odour, but government of Metro Vancouver is currently undertaking the development of an odour regulation for that area. A proposed regulation was circulated in 2012, but has since been withdrawn, and it is expected that a new, and significantly altered proposed regulation, was to be posted for review in 2014. As of early 2015 the proposed regulation has yet to be posted and therefore, at this time the only regulation of odour is done through application of nuisance law.

The British Columbia Environmental Management Act (BCEMA) does not explicitly define odour but does define "air contaminants" in such a manner that odour could be construed as an air contaminant. Additional pertinent definitions are "waste" and the phrase "introduced into the environment".

*"air contaminant" means a substance that is introduced into the air and that*

- a) injures or is capable of injuring the health or safety of a person,*
- b) injures or is capable of injuring property or any life form,*
- c) interferes with or is capable of interfering with visibility,*



- d) *interferes with or is capable of interfering with the normal conduct of business,*
- e) *causes or is capable of causing material physical discomfort to a person, or*
- f) *damages or is capable of damaging the environment;*

"waste" includes:

- a) *air contaminants,*

*"introduce into the environment", in relation to waste, includes discharge, emit, dump, abandon, spill, release and allow to escape into the environment;*

*SBC 2003 c53 s1 (1);*

Based on these definitions, if odour could be considered to cause or be capable of causing "material physical discomfort to a person", it would be considered an air contaminant, and therefore a waste. Under s. 14 of the BCEMA, the introduction of waste into the environment requires a permit; therefore, the BCEMA could be interpreted to require that a facility obtain a permit for odorous discharges.

Specific to the oil and gas industry, the British Columbia Flaring and Venting Reduction Guideline, set out by the BC Oil & Gas Commission, does provide specific wording on odours from flares, incinerators and other gas combustion systems. Section 7.1 specifically states that:

- i. *Flares, incinerators and other gas combustion systems, including those using sour gas as a fuel for production or process equipment, must be designed, maintained, and operated so that emissions do not:*
  - i. *result in off-lease odours, or*
  - ii. *result in adverse impacts to public health and safety or injury to vegetation*
- ii. *Permit holders must modify or replace existing flares or incinerators if operations result in off-lease odours, odour complaints, or visible emissions (e.g. black smoke).*

*British Columbia Flaring and Venting Reduction Guideline, v. 4.3*

Section 7.1.1 further states that a minimum combined flare gas heating value of not less than 20 MJ/m<sup>3</sup> when flare stacks have a history of odour complaints.

Section 8 deals with venting and fugitive emissions management requirements, and Section 8.1 sets out as a general requirement that "venting must not result in off-site odours". Section 8.4 further states that:



*Non-combustible gas mixtures containing odorous compounds including H<sub>2</sub>S must not be vented to the atmosphere if off-lease odours may result. Alternatives to venting such gas include flaring or incinerating with sufficient fuel gas to ensure destruction of odorous compounds or underground disposal.*

*British Columbia Flaring and Venting Reduction Guideline, v. 4.3*

The British Columbia Ambient Air Quality Objectives lists two 1-hour average objectives for Total Reduced Sulphur (TRS) measured as H<sub>2</sub>S. The “acceptable” objective of 28 µg/m<sup>3</sup> (Level B) is higher than in any other province except Nova Scotia. The “desirable” level objective of 7 µg/m<sup>3</sup> (Level A) would not be a value used for permitting purposes but is very stringent. No other contaminant among the Ambient Air quality Objectives is related to odour thresholds.

## ALBERTA

Releases of odorant emissions in Alberta are generally regulated under the Environmental Protection and Enhancement Act (EPEA), but the EPEA is also not entirely clear with respect to potential impacts due to odours. In fact, the EPEA does not define the term odour, nor is “odour” included explicitly under the definition of “substance”. The EPEA does define “adverse effect”, as follows:

*“adverse effect” means impairment of or damage to the environment, human health or safety or property.*

*RSA 2000 cE-12 s1;*

While this does not specifically mention impacts due to odour, “impairment” of the environment or property due to odour emissions could be construed as an adverse effect.

The EPEA does specifically refer to odour in Section 116, which deals with environmental protection orders regarding offensive odours:

### *Environmental Protection Orders Regarding Odour*

#### *Section 116*

- (1) Where the Director is of the opinion that a substance or thing is causing or has caused an offensive odour, the Director may issue an environmental protection order to the person responsible for the substance or thing.*
- (2) Subsection (1) does not apply in respect of an offensive odour that results from an agricultural operation that is carried out in accordance with generally accepted practices for such an operation or in respect of which recommendations under Part 1 of the Agricultural Operation Practices Act indicate that the agricultural operation follows a generally accepted agricultural practice.*



- (3) *An environmental protection order under this section may order the person to whom it is directed to take any or all of the following measures:*
- i. investigate the situation;*
  - ii. take any action specified by the Director to prevent the offensive odour;*
  - iii. minimize or remedy the effects of the offensive odour;*
  - iv. monitor, measure, contain, remove, store, destroy or otherwise dispose of the substance or thing causing the offensive odour or lessen or prevent the offensive odour;*
  - v. install, replace or alter any equipment or thing in order to control or eliminate the offensive odour;*
  - vi. construct, improve, extend or enlarge a plant, structure or thing if that is necessary to control or eliminate the offensive odour;*
  - vii. take any other action the Director considers to be necessary;*
  - viii. report on any matter ordered to be done in accordance with directions set out in the order.*

*RSA 2000 cE-12 s116;2001 c16 s6*

Neither Section 116, nor the EPEA in general provides a definition of the term “offensive”, nor a test as to what constitutes an “offensive” odour. Section 116 does however appear to treat odorous emissions more stringently than other releases into the environment. This can be gleaned from a review of Sections 108, 109 and 113 of the EPEA, and how “approved” releases are handled.

Under EPEA, releases to the environment are either approved or not approved. Under the EPEA:

- f) “approval” means an approval issued under this Act in respect of an activity, and includes the renewal of an approval;*

*RSA 2000 cE-12 s1;*

Section 108 of EPEA prohibits releases to the environment above the amount specified in the approval. Section 109 explicitly prohibits discharges that may cause an adverse effect when those discharges are not approved. Section 113 further emphasizes this issue by indicating that if a release may potentially cause an adverse effect, an Environmental Protection Order may not be issued if that release was approved. Only an Emergency Environmental Protection Order may be issued, as indicated by Section 114. Section 116, in contrast, does not refer to approvals, and therefore, an Environmental Protection Order Regarding Odour can be issued regardless of whether a source is approved or not under the EPEA.



With respect to H<sub>2</sub>S, the Alberta Air Quality Objective is 14 µg/m<sup>3</sup> on a 1-hour basis. The 1-hour value is the shortest averaging period for which Alberta has an objective, and is therefore, the most relevant with respect to discussing potential odour impacts. In addition to H<sub>2</sub>S, Alberta has 1-hour objectives for ammonia (1400 µg/m<sup>3</sup>) and carbon disulphide (30 µg/m<sup>3</sup>) based on odour perception and odour threshold.

## SASKATCHEWAN

The Saskatchewan Environmental Management and Protection Act (SEMPA) does not explicitly define odour, but does define adverse effect, discharge and substance (2002).

*“adverse effect” means impairment of or damage to the environment, or harm to human health, caused by one or any combination of any chemical, physical or biological alteration;*

*“discharge” means a discharge into the environment and includes any drainage, deposit, release or emission into the environment;*

*“substance” means any solid, liquid, particulate or gas that:*

- i. is capable of becoming dispersed in or discharged into the environment; or*
- ii. is capable of becoming transformed in the environment into matter defined in subclause (i);*

2002, c.E-10.21, s.2

The Saskatchewan Clean Air Act (SCAA) does provide clear definitions with respect to odour however, as follows:

*“air contaminant” means a solid, liquid, gas or combination of any of them in the ambient air that contributes to air pollution;*

*“air pollution” means the presence in the ambient air of any air contaminant:*

- i. in a concentration greater than the permissible concentration specified in a permit or prescribed in the regulations;*
- ii. in quantities that are or are likely to:*
  - a) be injurious to the health, safety, comfort or well-being of the public;*
  - b) be injurious or damaging to property or plant or animal life; or*
  - c) interfere with normal business; or*
- iii. that has an offensive or obnoxious odour, regardless of its concentration;*

1986-87-88, c.C-12.1, s.2



The SCAA also sets out the permitting requirement for any facility, which indicates that a facility that discharges an odorant requires a permit in order to do so.

*5 - Subject to sections 6 and 7, no person shall:*

- a) operate an industrial source, an incinerator or fuel-burning equipment; or*
- b) alter, add to or change an industrial source, an incinerator or fuel-burning equipment in a manner that affects the emission of air contaminants;*

*unless he holds a valid subsisting permit authorizing him to do so.*

*1986-87-88, c.C-12.1, s.5*

The Saskatchewan Clean Air Regulation sets out the detailed requirements for obtaining a permit, which includes reference to the following:

- ix. the expected mass rate of release into the ambient air of all air contaminants on a daily basis as well as an annual basis, under normal and maximum production conditions;*
- x. information about the possible variations in the composition of any atmospheric emission or the release rate of any air contaminant under different production rates, during start-up, shut-down or upset conditions;*
- xi. the calculated ground level concentrations of all air contaminants that may be released under normal and maximum production conditions; calculated ground level concentrations of all air contaminants*

*27 Oct 89 cC-12.1 Reg 1 s3.*

In support of this requirement, Saskatchewan released the Saskatchewan Air Quality Modelling Guideline (SAQMG) in 2012. The SAQMG proposes a tiered approach to modelling, with screening level dispersion models (the U.S. EPA SCREEN3 or AERSCREEN models) acting as the basis for the first tier. If compliance cannot be demonstrated using the screening level dispersion models, a refined tier is available using the AERMOD dispersion model, which is the current regulatory model in the United States. The “specialized” modelling is available only for situations in which the first two tiers are not appropriate, such as where complex terrain or land-water interfaces are a concern or areas where a large frequency of very low wind speeds can be expected. Road and rail traffic infrastructure projects can also be modelled using the approaches in this tier.

Section 11.3 of the SAQMG provides a detailed procedure for conducting an assessment of odour impacts. Section 11.3 also provides draft recommended ambient odour criteria for odour dispersion modelling in Saskatchewan. At this time, Saskatchewan is the only province to have such detailed requirements with respect to odour published in an official guideline. It does share many similarities with the Ontario approach, discussed later in this report.



Aside from odour, the criterion for H<sub>2</sub>S provides a useful comparison to other provinces. Saskatchewan Ambient Air Quality Standard (AAQS) for H<sub>2</sub>S is 14 µg/m<sup>3</sup>. No other compound usually considered odourous is reported in the AAQS since odour itself is considered in the Saskatchewan Clean Air Regulation and SAQMG.

## MANITOBA

Releases of odour emissions in Manitoba are covered under the Environment Act (MEA). The MEA also contains a definition of adverse effect that is similar to that provided under the EPEA:

*"adverse effect" means impairment of or damage to the environment, including a negative effect on human health or safety*

C.C.S.M. c. E125 s. 1 (2).

Unlike the EPEA, the MEA defines a pollutant more broadly:

*"pollutant" means any solid, liquid, gas, smoke, waste, odour, heat, sound, vibration, radiation, or a combination of any of them that is foreign to or in excess of the natural constituents of the environment, and*

- a) *affects the natural, physical, chemical, or biological quality of the environment, or*
- b) *is or is likely to be injurious to the health or safety of persons, or injurious or damaging to property or to plant or animal life, or*
- c) *interferes with or is likely to interfere with the comfort, well being, livelihood or enjoyment of life by a person; (« pollutant »)*

C.C.S.M. c. E125 s. 1 (2).

The MEA controls the release of pollutants through a licensing process for developments.

*"development" means any project, industry, operation or activity, or any alteration or expansion of any project, industry, operation or activity which causes or is likely to cause*

- a) *the release of any pollutant into the environment, or*
- b) *an effect on any unique, rare, or endangered feature of the environment, or*
- c) *the creation of by-products, residual or waste products not regulated by The Dangerous Goods Handling and Transportation Act, or*
- d) *a substantial utilization or alteration of any natural resource in such a way as to pre-empt or interfere with the use or potential use of that resource for any other purpose, or*

- e) *a substantial utilization or alteration of any natural resource in such a way as to have an adverse impact on another resource, or*
- f) *the utilization of a technology that is concerned with resource utilization and that may induce environmental damage, or*
- g) *a significant effect on the environment or will likely lead to a further development which is likely to have a significant effect on the environment, or*
- h) *a significant effect on the social, economic, environmental health and cultural conditions that influence the lives of people or a community in so far as they are caused by environmental effects;*

Under the MEA, there is also an odour nuisance management strategy, which includes for the provision of the following clause on licenses for developments, where appropriate:

*The Licensee shall not cause or permit an odour nuisance to be created as a result of the construction, operation or alteration of the Development, and shall take such steps as the Director may require to eliminate or mitigate an odour nuisance.*

#### *Summary of the Odour Nuisance Management Strategy (2008)*

The intent of this clause is to place the responsibility for odour nuisance complaints solely on the development in question, and allows for enforcement through the licensing process. Manitoba Conservation provides a protocol that details how odour nuisance complaints from the public will be handled and the responsibilities of all parties involved.

The Manitoba Ambient Air Quality Criteria, published by Manitoba Conservation, sets out air quality criteria for 25 compounds in addition to odour. These criteria are divided between guidelines and objectives, as well as the Canada Wide Standards for ozone and fine particulate. Manitoba sets two guidelines for odour, 2 OU at residential locations, and 7 OU at industrial locations. These values are used for the assessment of potential impacts from new facilities only and are not an enforcement tool to be used once the facility is in operation, or for existing facilities.

Aside from odour, the guideline for H<sub>2</sub>S provides a useful comparison to other provinces. The Manitoba 1-hour “acceptable” guideline is 15 µg/m<sup>3</sup>, while the Ontario 10-minute odour-based standard is only 13 µg/m<sup>3</sup> and the Alberta odour-based 1-hour ambient objective is 14 µg/m<sup>3</sup>.



Converting the Ontario 10-minute standard to a 1 hour averaging time would result in an even greater discrepancy between the two values (using Ontario's recommended approach to converting from 10-minute values to 1-hour values<sup>1</sup> would give a 1-hour H<sub>2</sub>S value of approximately 8 µg/m<sup>3</sup>). This suggests that a facility that can show compliance with the guideline or standard may still pose a significant odour impact, based on this example of H<sub>2</sub>S. It should be noted that Manitoba's "desirable" 1-hour H<sub>2</sub>S guideline of 1 µg/m<sup>3</sup> is the lowest in Canada, however.

In addition to H<sub>2</sub>S, Manitoba has a guideline for maximum acceptable 1-hour level concentrations for two other odourous compounds; phenol (63 µg/m<sup>3</sup>) and ammonia (1.4 mg/m<sup>3</sup>).

## ONTARIO

The Ontario Environmental Protection Act (OEPA) defines "adverse effect" much more broadly:

*"adverse effect" means one or more of,*

- a) *impairment of the quality of the natural environment for any use that can be made of it,*
- b) *injury or damage to property or to plant or animal life,*
- c) *harm or material discomfort to any person,*
- d) *an adverse effect on the health of any person,*
- e) *impairment of the safety of any person,*
- f) *rendering any property or plant or animal life unfit for human use,*
- g) *loss of enjoyment of normal use of property, and*
- h) *interference with the normal conduct of business;*

*R.S.O. 1990 c. E.19, s. 1 (1)*

The OEPA also defines "contaminant" more broadly:

*"contaminant" means any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination of any of them resulting directly or indirectly from human activities that causes or may cause an adverse effect; ("contaminant")*

*R.S.O. 1990 c. E.19, s. 1 (1)*

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<sup>1</sup> When estimating contaminant concentrations at shorter averaging periods than an hour, 1-hour dispersion modelling results are quite often considered and a conversion factor to estimate a maximum concentration at the averaging period in question is applied (See Section 5.2). Using this conversion factor, the equivalent 1-hour concentration can be calculated.



In addition, the OEPA is more explicit with respect to prohibiting discharges of a contaminant, which includes odours, into the environment:

*No person shall discharge into the natural environment any contaminant, and no person responsible for a source of contaminant shall permit the discharge into the natural environment of any contaminant from the source of contaminant, in an amount, concentration or level in excess of that prescribed by the regulations.*

*R.S.O. 1990, c. E.19, s. 6 (1).*

It is also more explicit with respect to prohibiting the causing of an adverse effect:

*Subject to subsection (2) but despite any other provision of this Act or the regulations, a person shall not discharge a contaminant or cause or permit the discharge of a contaminant into the natural environment, if the discharge causes or may cause an adverse effect.*

*R.S.O. 1990, c. E.19, s. 14 (1).*

The subsection referred to in Section 14 of the OEPA refer to water treatment and agricultural operations.

Ontario has a comprehensive set of effects-based air quality standards and guidelines, and many of these are odour-based. Under Section 9 of the OEPA, discharges of contaminants into the natural environment that are below these standards and guidelines must be approved under a permitting process:

*No person shall, except under and in accordance with an environmental compliance approval,*

- a) use, operate, construct, alter, extend or replace any plant, structure, equipment, apparatus, mechanism or thing that may discharge or from which may be discharged a contaminant into any part of the natural environment other than water; or*
- b) alter a process or rate of production with the result that a contaminant may be discharged into any part of the natural environment other than water or the rate or manner of discharge of a contaminant into any part of the natural environment other than water may be altered.*

*R.S.O. 1990, c. E.19, s. 9 (1).*



If the facility is deemed to cause or is likely to cause an adverse effect, the Ontario Ministry of the Environment and Climate Change (MOECC) should be notified of this by the industry and/or their environmental consultant. Alternately, the MOECC may require a facility to include odour as part of the application for an Environmental Certificate of Approval (ECA), if the MOECC has reason to believe that odour may be a concern. Where facilities are emitting odours from a mixture of compounds, the MOECC can and will include specific terms, performance conditions and Schedules within the ECA. The restrictions applicable to each ECA are separately negotiated with the MOECC and can have different approaches to dealing with OEPA Section 14 “adverse effect” odours. Typically, however, the performance condition will set a specific target in terms of allowable odorant concentration that must be met at sensitive receptors (e.g., residences, nursing homes, health care facilities, day cares, schools). This target may also allow for some frequency of excursions above the target, but not always. As such, there is a significant inconsistency from one facility to another when it comes to how odour is handled.

In April 2008 the MOECC’s Standards Development Branch published a Technical Bulletin which presents how to undertake dispersion modelling in order to assess compliance with 10-minute odour based Guidelines and Standards; however, the Bulletin does not provide the framework for determining impacts for odours composed of a mix of compounds. At the end of Section 1 of the Technical Bulletin, it is clearly stated that:

*“Ministry standards and guidelines are contaminant-specific under the context of O. Reg. 419, and are used to assess emissions from a single facility. Odour impacts are typically addressed in relation to adverse effects as defined in Section 14 of the Environmental Protection Act. As such, odour impacts due to aggregate exposure to a mixture of odorous compounds (usually expressed in odour units (OU)) are not addressed in this technical bulletin. In addition, this technical bulletin does not address odourous emissions from multiple facilities. This technical bulletin only deals with a suggested technical method for modelling assessments of contaminant specific standards and guidelines with 10-minute averages concentrations as they apply to individual facilities.” [emphasis added]*

## QUEBEC

The Quebec Environment Quality Act (EQA) does not explicitly define adverse impact, but does define odour as a contaminant:

*(5) “contaminant”: a solid, liquid or gaseous matter, a microorganism, a sound, a vibration, rays, heat, an odour, a radiation or a combination of any of them likely to alter the quality of the environment in any way;*

*R.S.Q., 1981, c. Q-2, s. 1.(5)*



Under the Quebec Regulation Respecting the Quality of the Atmosphere (QRRQA), promulgated under the Environment Quality Act (EQA), odour is further defined through the definition of “odour level”. The regulation also provides the relevant measurement method.

*1. (8) “odor level”: the volume in cubic metres occupied by a cubic metre of contaminated air when diluted at the threshold of perception;*

*R.R.Q., 1981, c. Q-2, r. 38, s. 1*

*96. (i). Odors are determined according to the method entitled Standard Method for Measurement of Odor in Atmospheres (Dilution Method) published by the American Society for Testing Materials (ASTM) under No. D 1391-57 (1967) in the 1974 Book of ASTM Standards*

*R.R.Q., 1981, c. Q-2, r. 38, s. 96*

Under this regulation, odour is regulated using a quantitative emission criterion. This applies only to specific industries, but the criterion for an “asphalt saturation plant” would provide some sense of comparison to a heavy oil site.

*16. Standard: All odors discharged by a fried food plant or coffee roasting plant, by a smoke house with a capacity greater than 250 kg of meat per week, by a brewery, a distillery, a rubber recycling plant and an asphalt saturation plant shall be ducted and treated so that the concentration of odours discharged into the atmosphere does not exceed 120 degrees of odour per cubic metre.*

*Odours emitted by the processes and general ventilation of a dismembering plant must be ducted and treated by equipment for the treatment of gas. The concentration of the odours emitted by that equipment must be less than 100 degrees of odour per cubic metre.*

*The operating areas for the processes and the stocking areas must be located within closed premises and must be maintained under negative pressure.*

*R.R.Q., 1981, c. Q-2, r. 38, s. 16<sup>[2]</sup>*

Quebec appears to be singular amongst the provincial legislation in this approach. The benefit of this method is that enforcement can be done through mandatory source testing, which can then provide a specific pass / fail determination. In this respect, it is more effective from a regulatory point of view, and provides a clear set of requirements for facility operators.

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<sup>2</sup> This is taken from the English translation of the Quebec Legislation. 100 degrees of odour per cubic metre is assumed to actually translate to units of odour per cubic metre.



The Quebec Clean Air Regulation (QCAR) also has a set of over 116 air quality standards, many of which could be considered to be odorants. Of particular interest are the large number of 4-minute standards, most of which apply to the range of contaminants that would be expected to be odorants.

Although the QCAR does not specifically mention odour, the relationship of the 4-minute standard to odour is suggested by the Quebec Guide De La Modélisation De La Dispersion Atmosphérique, April 2005 (GMDA). Section 9 of the GMDA deals with emissions of odorants and refers to the need to assess odorants on a 4-minute basis.

Using this rationale, the Quebec 4-minute standard for H<sub>2</sub>S is 6 µg/m<sup>3</sup>. Using the formula provided in the QCAR, converting this standard to a 1-hour basis gives a value of approximately 3.1 µg/m<sup>3</sup>, which is lower than the Alberta 1-hour objective<sup>3</sup>. Converting the Quebec standard to a 10-minute average using the same formula provides a value of 5.4 µg/m<sup>3</sup>, which is lower than the Ontario 10-minute standard. In fact, Quebec has the strictest H<sub>2</sub>S standard in the country unless considering Manitoba's maximum desirable level. Thirty-six additional compounds are listed for 4-minute standards including ammonia (350µg/m<sup>3</sup>) and carbon disulphide (25µg/m<sup>3</sup>).

## NEW BRUNSWICK

The New Brunswick Clean Air Act (NBCAA) defines odour as a potential contaminant. The definition also incorporates the possible effects caused by contaminants. The NBCAA also defines the release of a contaminant.

*"contaminant" means*

- (a) any solid, liquid, gas, micro-organism, odour, heat, cold, sound, vibration, radiation or combination of any of them, present in the environment,*
- (i) that is foreign to or in excess of the natural constituents of the environment,*
- (ii) that affects the natural, physical, chemical or biological quality or constitution of the environment, or*

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<sup>3</sup> When estimating contaminant concentrations at shorter averaging periods than an hour, 1-hour dispersion modelling results are quite often considered and a conversion factor to estimate a maximum concentration at the averaging period in question is applied. Using this conversion factor, the equivalent concentration for additional averaging periods can be calculated.



(iii) *that endangers the health of human, plant or animal life or the safety or comfort of a human, that causes damage to property or plant or animal life or renders them unfit for use by persons or that interferes with visibility, the normal conduct of transport or business or the normal enjoyment of life or use or enjoyment of property,*

(b) *any pesticide or waste, or*

(c) *anything that is designated by the Minister as a contaminant under s. 7;*

*S.N.B. 1997, c. C-5.2, s. 1.*

*“release”, when used with reference to a contaminant or other matter regardless of form, includes the discharging, emitting, leaving, depositing or throwing of the contaminant or other matter and the doing of or the omission to do any other activity in respect of the contaminant or other matter, with the direct or indirect result that the contaminant or other matter enters the air, whether or not the contaminant or other matter previously existed in the air;*

*S.N.B. 1997, c. C-5.2, s. 1.*

The New Brunswick Air Quality Regulation, promulgated under the NBCAA, sets out air quality standards for 6 compounds, but does not explicitly regulate odorant emissions. Furthermore, it is not clear that the air quality standards for the compounds listed include odour as an effect. Using H<sub>2</sub>S as an example of a compound that is typically considered an odorant, the New Brunswick 1-hour objective is 15 µg/m<sup>3</sup>, while the Ontario 10-minute odour-based criteria is only 13 µg/m<sup>3</sup> and the Alberta odour-based 1-hour ambient objective is 14 µg/m<sup>3</sup>. Converting the Ontario criteria to a 1-hour averaging time would result in an even greater discrepancy between the two values<sup>4</sup>. This suggests that a facility that can show compliance with the objective may still pose a significant odour impact, based on this example of H<sub>2</sub>S. No additional compounds that are usually associated with odour are listed in the New Brunswick Air Quality Regulation.

## NOVA SCOTIA

The Nova Scotia Environment Act (NSEA) does not explicitly mention odour, but does contain definitions for “adverse effect”, “contaminant”, “release” and “substance”.

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<sup>4</sup> When estimating contaminant concentrations at shorter averaging periods than an hour, 1-hour dispersion modelling results are quite often considered and a conversion factor to estimate a maximum concentration at the averaging period in question is applied (See Section 5.2). Using this conversion factor, the equivalent 1-hour concentration can be calculated.



*"adverse effect" means an effect that impairs or damages the environment or changes the environment in a manner that negatively affects aspects of human health;*

*"contaminant" means, unless otherwise defined in the regulations, a substance that causes or may cause an adverse effect;*

*"release" means to spill, discharge, dispose of, spray, inject, inoculate, abandon, deposit, leak, seep, pour, emit, empty, throw, dump, place, drain, pump or exhaust;*

*"substance" means*

- i. any solid, liquid or gas,*
- ii. any sound, vibration, heat, radiation or another form of energy, or*
- iii. any combination of any of the things referred to in subclauses (i) and (ii);*

*S.N.S. 1994-95, c. 1*

Similar to New Brunswick, the Nova Scotia Air Quality Regulation, promulgated under the NSEA, sets out air quality criteria for 6 compounds, but does not explicitly regulate odour emissions. Also, it is once again unclear that the air quality criteria for the compounds listed include odour as an effect. Once again using H<sub>2</sub>S as an example, the Nova Scotia 1-hour criteria is 42 µg/m<sup>3</sup>, which is nearly 3 times the New Brunswick value. To an even greater extent than in New Brunswick, this suggests that a facility that can show compliance with the criteria may still pose a significant odour impact, based on this example of H<sub>2</sub>S. No additional compounds that are usually associated with odour are listed in the Nova Scotia Environment Act.

## PRINCE EDWARD ISLAND

The Prince Edward Island Environmental Protection Act (PEIEPA) explicitly mentions odour under the definition of a contaminant and contains definitions for "contaminant" and "discharge" (2012).

*"contaminant" includes any solid, liquid, gas, waste, odour, vibration, radiation, sound, or a combination of them*

- i. which is foreign to or in excess of the natural constituents of the environment into which it is being introduced,*
- ii. which will or may adversely affect, either directly or indirectly, the natural, physical, chemical, or biological quality of the environment,*
- iii. which is or may be injurious to the health or safety of a person or be damaging to property or to plant or animal life,*



- iv. *which interferes with or is likely to interfere with the comfort, well-being, livelihood, or enjoyment of life of a person, or*
- v. *which is declared by regulation to be a contaminant;*

*"discharge" includes any drainage, deposit, release, spill, leak or emission;*

*R.S.P.E.I. 1988, Cap. E-9. s.1.*

The Prince Edward Island Air Quality Regulation (PEIAQR), promulgated under the NLEPA, sets out air quality standards for 5 compounds, but similar to New Brunswick and Nova Scotia, does not explicitly regulate odorant emissions (2004). Also, it is once again unclear that the air quality standards for the compounds listed include odour as an effect. Once again using H<sub>2</sub>S as an example, the Prince Edward Island 1-hour standard is identical to the New Brunswick standard, which again suggests that a facility that can show compliance with the standard may still pose a significant odour impact, based on this example of H<sub>2</sub>S. No additional compounds that are usually associated with odour are listed under the PEIAQR.

The PEIAQR is also similar to the Saskatchewan regulation in that it provides a detailed list of requirements under the permitting process for sources of air emissions. Although it does not seem to have an accompanying air dispersion modelling guideline, it is more detailed than in many jurisdictions.

## NEWFOUNDLAND AND LABRADOR

The Newfoundland and Labrador Environmental Protection Act (NLEPA) explicitly mentions odour under the definition of a "substance". Other relevant definitions provided are "adverse effect", "contaminant", "release" and "substance":

*"adverse effect" means an effect that impairs or damages the environment and includes an adverse effect to the health of humans;*

*"contaminant" means, unless otherwise defined in the regulations, a substance that causes or may cause an adverse effect;*

*"release", except in Part X, means to spill, discharge, dispose of, spray, inject, inoculate, abandon, deposit, leak, seep, pour, emit, empty, throw, dump, place, drain, pump or exhaust;*

*"substance" means*

- i. *matter that may become dispersed in the environment,*
- ii. *matter that is capable of becoming transformed in the environment into matter referred to in subparagraph (i),*
- iii. *heat, radiation or another form of energy,*



- iv. *an odour or a thing that causes an odour or which may be transformed to produce or cause an odour,*
- v. *an organism, whether or not it is living, and*
- vi. *a combination of things referred to in subparagraphs (i) to (v);*

*SNL2002 CHAPTER E-14.2. s.1.*

The Newfoundland and Labrador Air Quality Regulation (NLAQR), promulgated under the NLEPA, sets out air quality standards for 22 compounds, but similar to New Brunswick, Nova Scotia and Prince Edward Island, does not explicitly regulate odour emissions. Also, it is once again unclear that the air quality standards for the compounds listed include odour as an effect. Using H<sub>2</sub>S as an example, the Newfoundland and Labrador 1-hour standard is identical to the New Brunswick standard, which again suggests that a facility that can show compliance with the standard may still pose a significant odour impact, on H<sub>2</sub>S alone. Besides H<sub>2</sub>S, 1-hour ambient air quality standards for mercaptans expressed as methyl mercaptan (20 µg/m<sup>3</sup>) and reduced sulphur compounds expressed as H<sub>2</sub>S (30 µg/m<sup>3</sup>) are also present in the NLAQR.

Of interest however is that the NLAQR does mandate that any new or modified facility implement the best available control technology (BACT). If a facility emits an odorant, it is therefore possible that the facility would have to implement BACT in order to minimize those emissions. This is not mentioned in any other provincial acts or regulations at this time.

## CLOSING

The various jurisdictions have protections in place which are based on greater or lesser degrees of subjectivity, The Ontario guideline does have a quantifiable evaluation process that the other jurisdictions do not have. This quantifiable guideline is probably the best practice approach for design evaluation from a due diligence standpoint, until British Columbia adopts a similar numeric approach. If you have any questions, we would be happy to discuss them with you at any time in the future.



# Summary of Odour Control at Select Wastewater Treatment Plants in BC

OCTOBER 9, 2019

ZOE BERKEY

Summarized within the report below is a sampling of odour control measures and standards for a number of wastewater treatment plants within British Columbia. This list is intended to provide a broad overview of what a select handful of wastewater treatment plants in BC do in terms of odour control but is by no means a comprehensive list of all wastewater treatment plants in BC.

The summary provided below only discusses a few of the wastewater treatment plants in BC. The areas contacted were selected primarily based on a list of population centers within BC, with the intent of contacting the City or Regional District in charge of wastewater treatment for the top ten largest population centers as determined by the 2016 census data. As defined by the Canadian census a population center is a populated place or a cluster of interrelated population places which meet the demographic characteristics of an urban area.

The data reported on within, was based on telephone conversations or email exchanges with each jurisdiction and information available on their website. Some regional districts operate more than one wastewater treatment plant, as such the information provided is intended to present a snapshot of what other jurisdictions are doing in terms of odour control. It is important to note as well that there are a number of variables within the analysis, such as wastewater treatment technology and size of the plant, so direct comparisons are challenging to make.

Provided below is a summary of the areas contacted, more information for each plant contact is available hereafter. For areas where there are more than one wastewater treatment plant the local government and name of wastewater treatment plant contacted are provided below. For MetroVancouver general information was provided by staff for all for wastewater treatment plants that are operated by MetroVancouver.

| <b>Population Centre as Defined by Census Canada*</b> | <b>Local Government Contacted</b>         | <b>Wastewater Treatment Plant (WWTP) Contacted</b> | <b>Voluntary Odour Control Standards in Place?</b> |
|---|---|--|--|
| Vancouver   | MetroVancouver                            | Operate 5 WWTP                                     | Yes for all  |
| Victoria  | Capital Regional District                 | Mcloughlin Point (under construction)              | Yes  |
| Kelowna   | City of Kelowna                           | WWTF   | No   |
|   | Regional District of Central Okanagan     | Westside Regional WWTP                             |  |
| Abbotsford  | City of Abbotsford                        | James WWTP   |  |
| White Rock  | MetroVancouver                            | -  | -  |
| Nanaimo   | Regional District of Nanaimo              | French Creek Water Pollution Control Center        | No   |
|   |   | Greater Nanaimo Pollution Control Centre           |  |
| Kamloops  | City of Kamloops                          | WWTP   | No   |
| Chilliwack  | City of Chilliwack                        | WWTP   | No   |
| Prince George   | City of Prince George                     | WWTP   |  |
| Vernon  | City of Vernon                            | Vernon Water Reclamation Center                    |  |
| Okanagan Falls  | Regional District of Okanagan-Similkameen | Okanagan Falls WWTP                                | No   |

| <b>Metro Vancouver's Wastewater Treatment Plants</b> |  |
|--|--|
| <b>Wastewater Treatment Plant Size:</b>              | 5 Wastewater Treatment Plants  |
| <b>Voluntary Odour Control Standards:</b>            | Existing facilities: Good neighbor policy of trying to stay within a range of 50U at property line or minimally detectable odour at nearest sensitive receptors<br><br>Northwest Langley Treatment Plant Upgrades and Northshore Treatment Plant (not yet constructed): No detectable odour at fenceline |
| <b>Odour Control in Place:</b>                       |  |
| <b>Annacis Island:</b>                               |  |
|  |  |
| <b>Lions Gate Wastewater Treatment Plant:</b>        |  |

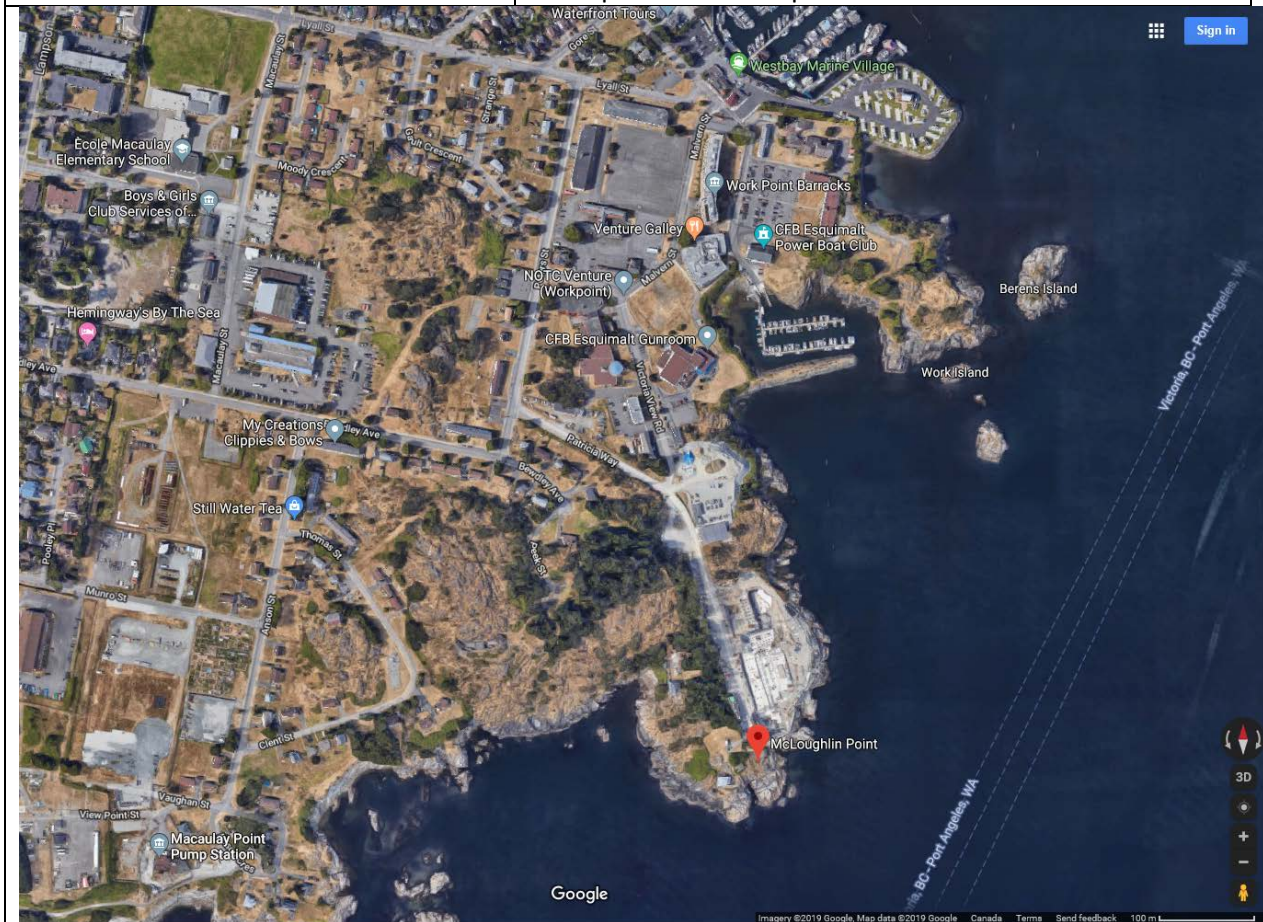


Northwest Langley Wastewater Treatment Plant:



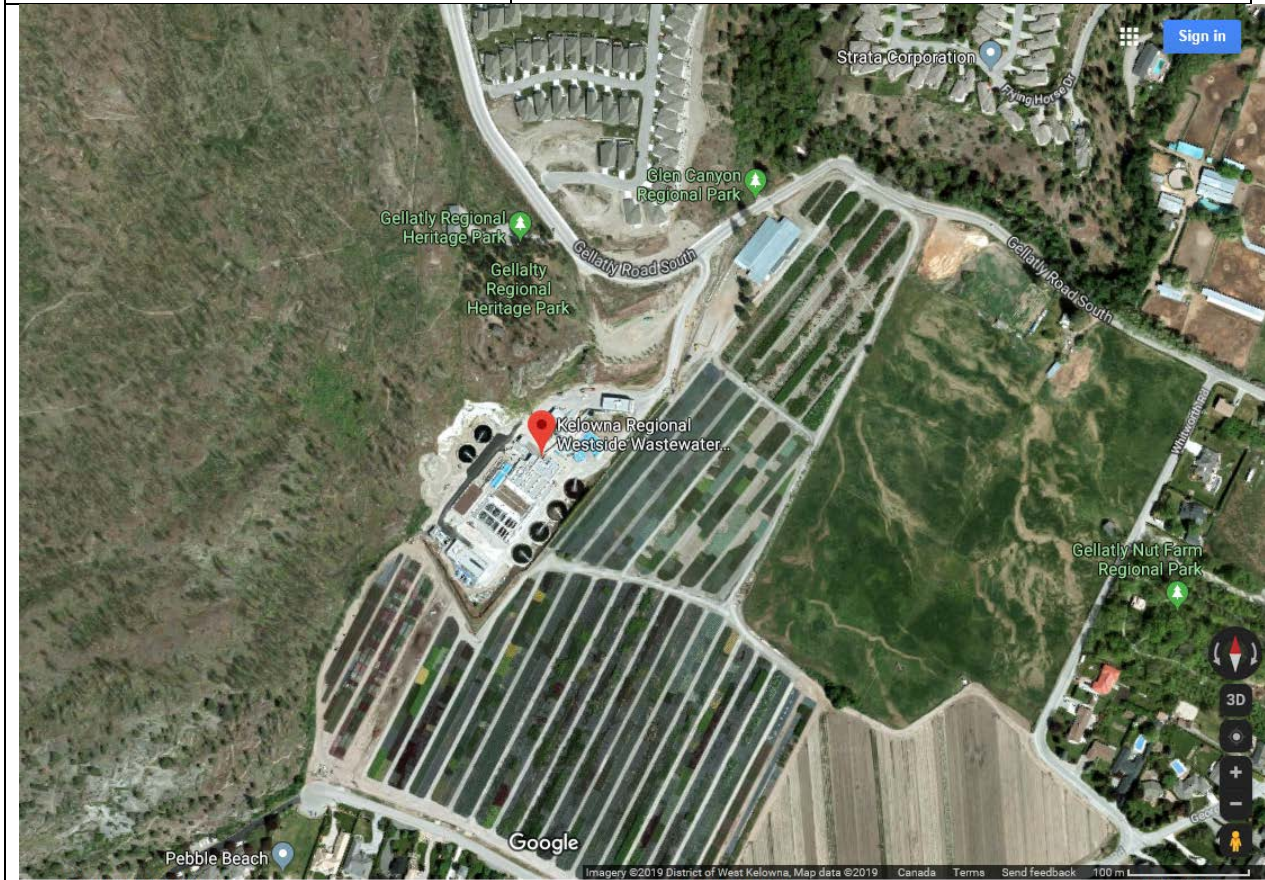
## Capital Regional District- McLoughlin Point WWTP (under construction)

|   |  |
|---|--|
| <b>Wastewater Treatment Plant Size:</b>   | 108,000m <sup>3</sup> /day   |
| <b>Voluntary Odour Control Standards:</b> | Yes, 5 odour units(OU)/ m <sup>3</sup> at property line  |
| <b>Odour Control in Place:</b>            | <ul style="list-style-type: none"><li>• All treatment tanks are covered</li><li>• State of the art odour control, including capturing and treating air</li><li>• 24hr control monitoring system for H<sub>2</sub>S</li><li>• Detailed procedure for responding to odour control complaints</li><li>• A phone line to report odours</li></ul> |



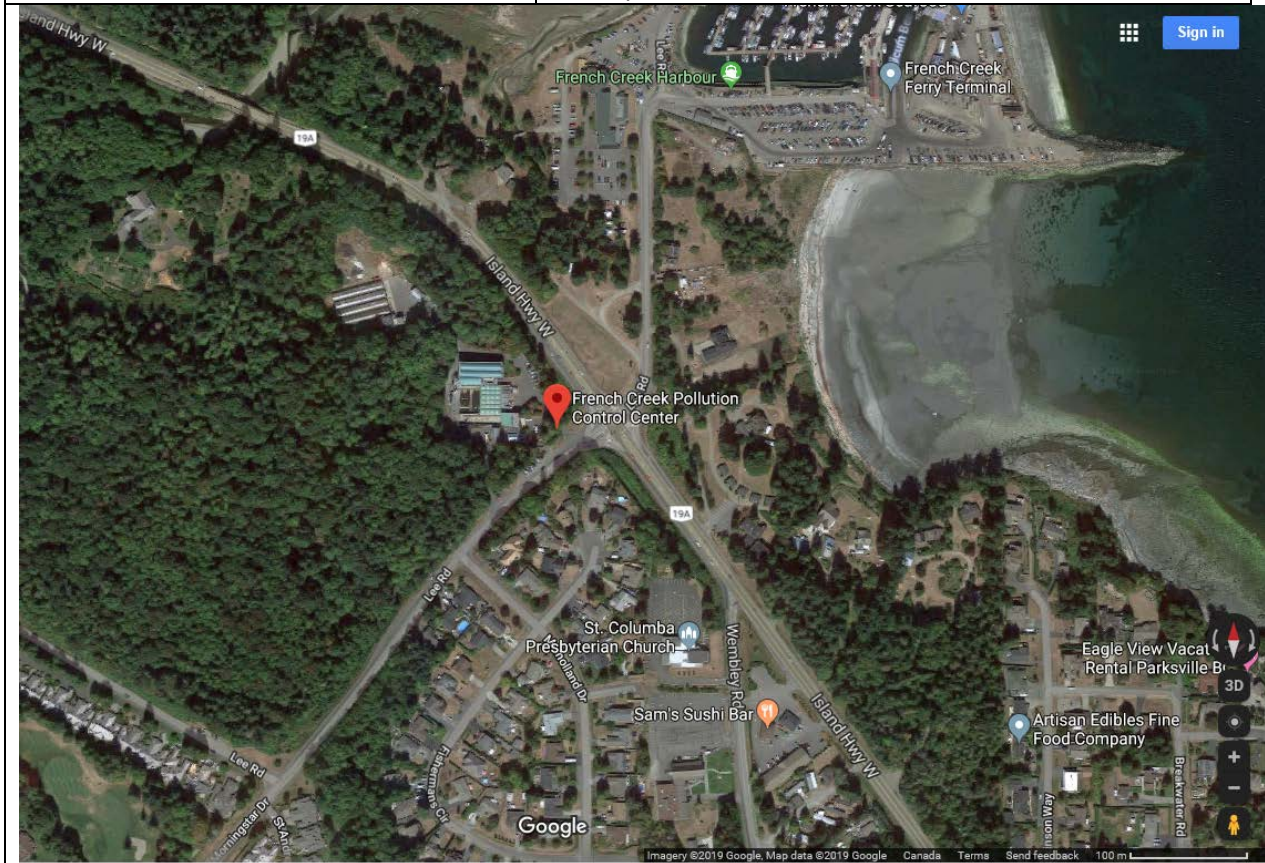
## Regional District of Central Okanagan- Westside Regional WWTP

|   |  |
|---|--|
| <b>Wastewater Treatment Plant Size:</b>   | 16,800m <sup>3</sup> / day   |
| <b>Voluntary Odour Control Standards:</b> | No   |
| <b>Odour Control in Place:</b>            | <ul style="list-style-type: none"><li>• Odourous air from grit room, headworks, sludge handling building, offline EQ basin (reconverted bioreactors) captured and air is treated through biofilter</li></ul> |



## Regional District of Nanaimo- French Creek Pollution Control Center

|   |  |
|---|--|
| <b>Wastewater Treatment Plant Size:</b>   | 27,000 people (approx. 10,800m <sup>3</sup> /day)  |
| <b>Voluntary Odour Control Standards:</b> | No but have program objectives for reducing complaints and have included an odour nuisance clause in new development occurring next door.  |
| <b>Odour Control in Place:</b>            | <ul style="list-style-type: none"><li>• UV light to purify trickling filter air</li><li>• Ferrous chloride for H<sub>2</sub>S</li><li>• Odorous air from grit tanks, solids contact tank, biosolids digestion and biosolids dewatering is captured and treated with a scrubber and biofilter</li></ul> |



## City of Kamloops- Kamloops Sewage Treatment Center

|   |   |
|---|---|
| <b>Wastewater Treatment Plant Size:</b>   | 30,000m <sup>3</sup> /day   |
| <b>Voluntary Odour Control Standards:</b> | No  |
| <b>Odour Control in Place:</b>            | <ul style="list-style-type: none"><li>• New headworks that includes odour bed</li><li>• Lagoon system, covered anaerobic lagoon that captures CO<sub>2</sub> and flares off</li></ul> |

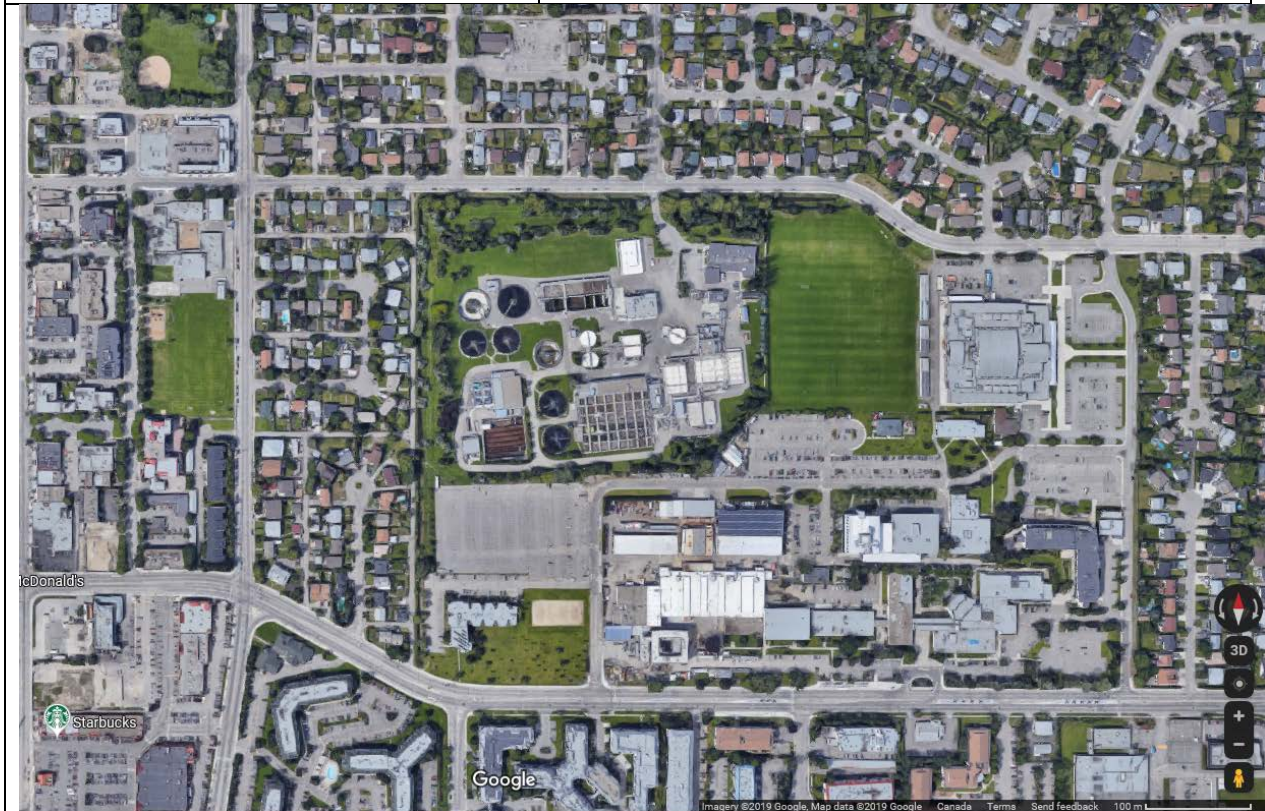


## Regional District of Okanagan-Similkameen- Okanagan Falls WWTP

|   |  |
|---|--|
| <b>Wastewater Treatment Plant Size:</b>   | 750 properties   |
| <b>Voluntary Odour Control Standards:</b> | No, plant was moved due to odour complaints and is now surrounded by agricultural properties.  |
| <b>Odour Control in Place:</b>            | <ul style="list-style-type: none"><li>• Screen, primary clarifiers/ fermenter, holding tanks is covered and air is collected and treated through a biofilter</li></ul> |



| City of Kelowna- Wastewater Treatment |   |
|---------------------------------------|---|
| Wastewater Treatment Plant Size:      | 70,000m <sup>3</sup> /day   |
| Voluntary Odour Control Standards:    | No, design limit for plant was 50U*   |
| Odour Control in Place:               | <ul style="list-style-type: none"> <li>• Air collected from majority of buildings and tanks throughout plant (not bioreactors)</li> <li>• Mechanical biofilter and 14 meter tall stack</li> </ul> |



\*from CRD website, "Wastewater Treatment Project Construction Information Presentation (April 2017)."

**City of Prince George- Prince George Wastewater Treatment Plant**

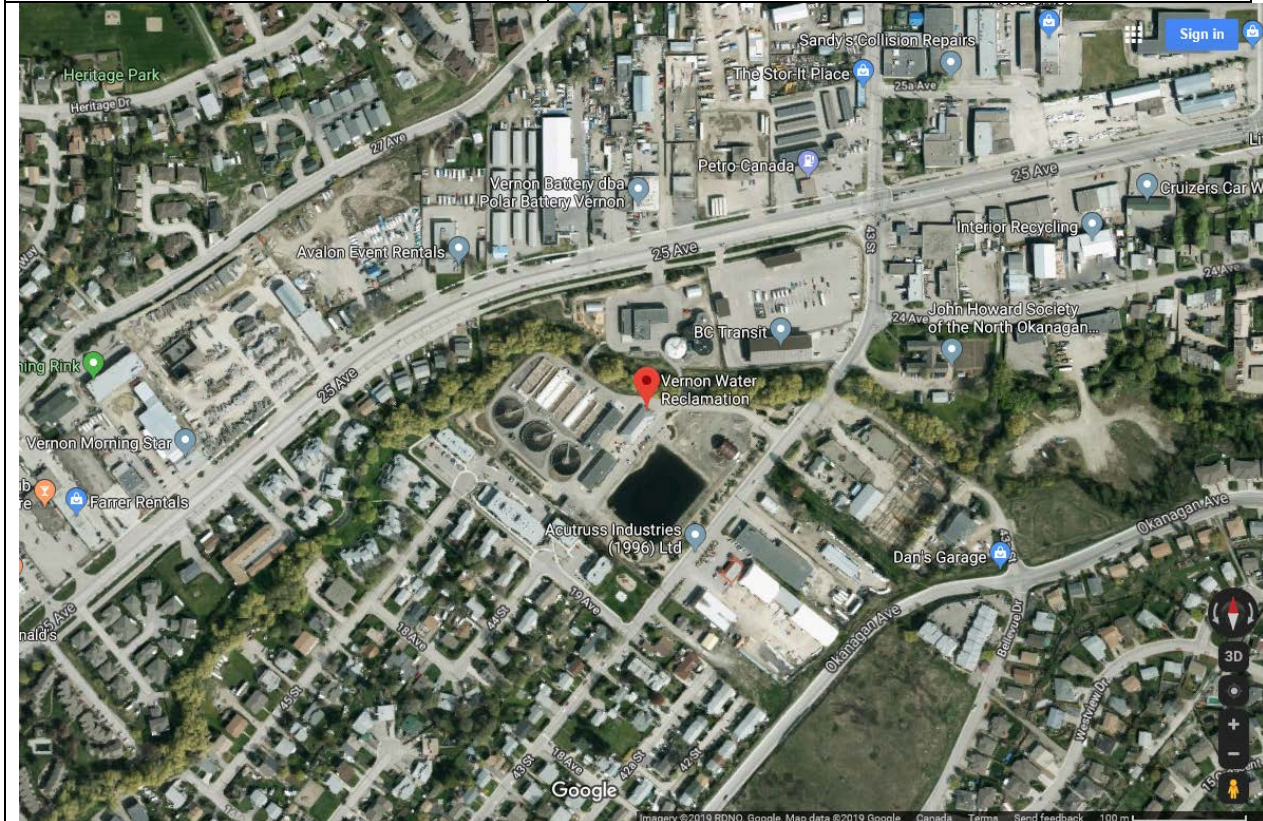
**Wastewater Treatment Plant Size:** -

**Voluntary Odour Control Standards:** No

**Odour Control in Place:** • None currently



| City of Vernon- Vernon Water Reclamation Center |   |
|---|---|
| Wastewater Treatment Plant Size:                | 13,000m <sup>3</sup> /day   |
| Voluntary Odour Control Standards:              | No, 50U was used for design limit*  |
| Odour Control in Place:                         | <ul style="list-style-type: none"> <li>Covered headworks, tanks and primary clarifiers in plant and all air treated through two activated carbon filters</li> </ul> |

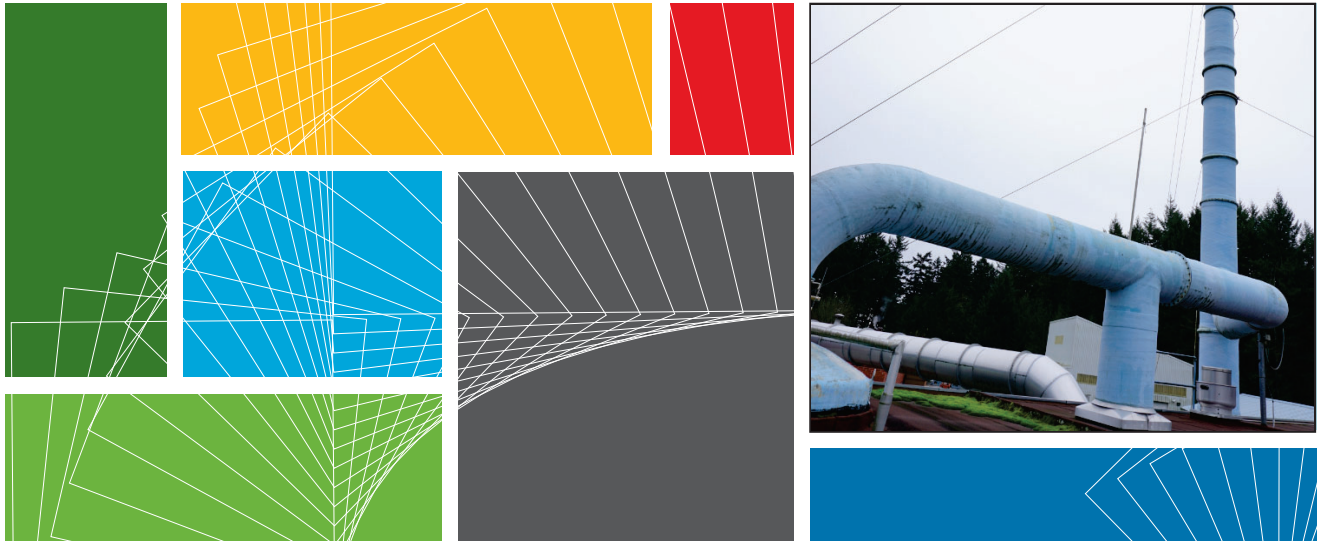


\*from CRD website, "Wastewater Treatment Project Construction Information Presentation (April 2017)."

| City of Abbotsford- JAMES WWTP            |   |
|---|---|
| <b>Wastewater Treatment Plant Size:</b>   | 48,000m <sup>3</sup>  |
| <b>Voluntary Odour Control Standards:</b> | No, plant is designed and meeting <0.005ppm H <sub>2</sub> S in a one-hour time weighted average as measured as total reduced sulfur at property line |
| <b>Odour Control in Place:</b>            | <ul style="list-style-type: none"> <li>• Odourous air is collected from various process areas and sent to biofilter for treatment</li> </ul>          |



| City of Chilliwack- Wastewater Treatment Plant |  |
|--|--|
| <b>Wastewater Treatment Plant Size:</b>        | 45,000m <sup>3</sup> /day  |
| <b>Voluntary Odour Control Standards:</b>      | No   |
| <b>Odour Control in Place:</b>                 | <ul style="list-style-type: none"> <li>• Odourous air collected through various buildings and tankage and treated through biofilter</li> </ul> |



## Comox Valley Regional District

Draft Report

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### Wastewater Treatment Plant Bioreactor Odour Control Study

October 2019





ISL Engineering and Land Services Ltd. is an award-winning full-service consulting firm dedicated to working with all levels of government and the private sector to deliver planning and design solutions for transportation, water, and land projects.



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## 1.0 Introduction

### 1.1 Authorization

ISL Engineering and Land Services Ltd. (ISL) was retained by the Comox Valley Regional District (CVRD) to provide engineering consulting services for the Comox Valley Water Pollution Control Centre (CVWPCC) Bioreactors Odour Control Study. The scope of the study included identifying the total air volume from the existing and future facilities that needs to be treated, and providing a cost estimate for the new odour control system.

### 1.2 Background

The CVWPCC is a secondary level wastewater treatment plant and is classified as a Level IV facility. The plant serves the City of Courtenay, the Town of Comox, K'omoks First Nation and CFB Comox. Currently, the facility is comprised of five main components:

- Preliminary treatment
- Primary treatment
- Biological secondary treatment
- Sludge processing and disposal
- Odour control system

Although the facility was constructed in 1984, its major odour treatment system (wet chemical scrubber) was added during the plant upgrade in 1997. At that time, due to frequent odour complaints from surrounding residents, the composting facilities were relocated away from the treatment plant to minimize odour impacts. In 2016, ISL provided a concept for covering the primary clarifiers and adding an activated carbon filter after the chemical scrubber. The CRVD completed the work in 2018/2019 and the work has resulted in lower odour emissions due to covering and treating air from the primary clarifiers. However, despite these efforts, there are still some odour complaints being received.

The existing odour control system serves the existing headwork, primary clarifiers, sludge storage and dewatering facility. The existing system is at its rated capacity limit and any future odour treatment will require a new odour control system. The CVRD would like to investigate adding a new odour control system for the existing bioreactors and future facilities. The system should have enough capacity to accommodate existing bioreactors and future facilities or to be easily expandable in the future.

### 1.3 Scope of Work

The scope of work of this project includes the following:

- Site visit
- Review of existing air flow rates from bioreactors and determine the number of future bioreactors that need to be included
- Develop more treatment options, if feasible
- Provide conceptual cost estimate (Class D)
- Provide layout for the selected option



## 1.4 References

- CVWPCC Record Drawings. Associated Engineering Services Ltd., 1982.
- Stage 1 Odour Control Design Drawings for the CVWPCC. Designed by Reid Crowther, October 1997.
- Odour Control System Evaluation Report for CVWPCC. Final Report by RWDI Air Inc., October 30, 2015.
- CVWPCC Wet Scrubber Efficiency Testing Memorandum for CVWPCC. Preliminary Draft by RWDI AIR Inc., September 21, 2016.
- Odour Dispersion Modelling Report for CVWPCC. Report by RWDI AIR Inc., September 21, 2016.
- CVRD Odour Control Options. ISL Engineering and Land Services Ltd., November 2016.
- CVWPCC Capacity Assessment Report. ISL Engineering and Land Services Ltd., 2016
- CVWPCC Odour Control Upgrade Drawings and Specifications. Associated Engineering Services Ltd., 2017.
- CVWPCC – Odour Assessment Draft Report. RWDI Air, October 2019.
- A Review of Odour Impact Criteria in Selected Countries around the World. Marlon and et all, 2017.
- NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities. National Fire Protection Association, 2008.
- Control of Odours and Emissions from Wastewater Treatment Plants, Water Environment Federation (WEF), MOP 25, 2004.

## 2.0 Odour Characterization

Domestic wastewater contains biosolids including proteins, amino acids and carbohydrates, which are an abundant source of food for microorganisms. These microorganisms degrade these energy sources, and odorous compounds are formed. Organic and inorganic forms of sulphur, mercaptans, ammonia, amines, and organic fatty acids are identified as the most offensive odour-causing compounds associated with wastewater treatment plants.

These compounds typically are released from the biosolids by heat, aeration and digestion. The odours vary by the type of solids processed and the method of processing. In general, most odours develop during pre-treatment, primary treatment and solid management processes. The most common odours, descriptions and thresholds are listed in Table 2.1.

Table 2.1: Sewage Odour Characteristics

| Malodour                             | Odour Description     | Odour Threshold    |
|--------------------------------------|-----------------------|--------------------|
| Hydrogen Sulphide (H <sub>2</sub> S) | Rotten eggs           | 3 ppb              |
| Mercaptans                           | Skunk, rotten cabbage | 20 to 300 ppt      |
| Carbon Disulphide                    | Rotten vegetables     | 200 to 800 ppb     |
| Dimethyl Sulphide                    | Decayed vegetables    | 1 ppb              |
| Indole, Skatole                      | Fecal, nauseating     | 100 ppt            |
| Amine                                | Putrid, fishy         | 400 ppt to 100 ppb |
| Ammonia                              | Pungent, irritating   | 17 to 50 ppm       |

Note:

ppm = parts per million; ppb = parts per billion; ppt = parts per trillion

Odour can be measured (detected) by sensory methods and specific odourant concentrations can be measured by instrumental methods. Direct measurement of certain chemical compound concentrations (such H<sub>2</sub>S and methyl mercaptan) is helpful. However, the aggregate effect of a mixture of chemical compounds on the odour cannot be measured by instrument. The presence of one chemical may mask the odour from another chemical, or the odorous effects from two or more chemicals may be additive.

Under a carefully controlled environment, measurement of odours by the human olfactory system provides meaningful and reliable information. Therefore, using the human olfactory system is still the most reliable method.

### 2.1 Odour Regulations

Odours are not regulated federally. On a provincial level, all provinces, with the exception of Ontario, Manitoba and Quebec, have no established specific odour impact criteria based on ambient air odour concentrations calculated by dispersion models. (Marlon and et al 2017). Table 2.2 summarizes the guidelines/limits for Ontario, Manitoba and Quebec.



Table 2.2: Ontario, Manitoba and Quebec Guidelines/Limits (K. David, 2016)

| Province | Guidelines/Limits   | Notes  |
|----------|---|--|
| Ontario  | <ul style="list-style-type: none"> <li>1 OU for sensitive land uses, should not exceed in 0.5% of the time (99.5<sup>th</sup> percentile) over 10-min averaging time</li> </ul> | This limit is not established in a regulation, however is used routinely in permitting approvals and abatement processes when public complaints from odour emissions are common. |
| Manitoba | <ul style="list-style-type: none"> <li>2 OU for residential areas</li> <li>7 OU for industrial zones</li> </ul>   | These limits are used only for evaluating potential impacts on a community.  |
| Quebec   | <ul style="list-style-type: none"> <li>1 OU at the 98<sup>th</sup> percentile</li> <li>5 OU at the 99.5<sup>th</sup> percentile</li> </ul>                                      | Objective exposure limits are not mentioned in the Environment Quality Act. These guidelines limits are for specific sectors including composting and biogas activities.         |

Note:

The guidelines/limits are calculated at the location of the first receptor

## 2.2 Instrumental Method

The CVRD retained RWDI Air Inc. for air sampling. RWDI collected three air samples from three locations: two from bioreactors 1 and 2, and one from the effluent chamber. RWDI sent the samples to ALS Environmental Laboratory for analysis. The analysis was conducted using gas chromatography (GC); each sample was analyzed for 24 odour compounds including ammonia and chlorine. Sample results are included in Appendix A - RWDI Odour Assessment & ALS Environmental Laboratory for analysis

The only measured compounds above the detection limits were ammonia and dimethyl disulphide. Ammonia was detected for one of the three samples (effluent chamber). The level registered for ammonia was low (400 ppb). The human detection threshold for ammonia is 17,000 ppb.

Dimethyl disulphide was detected for one of the three samples. The level registered for dimethyl disulphide on that sample was relatively low (6.2 ppb). The recognition threshold for dimethyl disulphide is 1.0 ppb. At this level, with any air dilution and dispersion, this level should not be a concern.

## 2.3 Olfactory Method

Odorous compounds responsible for producing psychological stress in humans are detected by the olfactory system. The odour evaluation is conducted under controlled laboratory conditions following standard industry practices using trained panelists. Odour panels consist of individuals that are selected and trained following certain guidelines. The most common odour parameters determined during odour testing is odour detection and recognition threshold. The determination of the odour detection and recognition is made using an instrument called an olfactometer and is expressed in OU.

The olfactometer simulates the dilution of odour in the ambient air. The panel members start sniffing with the most diluted sample (less smell), followed by more concentrated sample (less dilution ratio - higher smell). The dilution ratio is defined as the ratio between the diluted air sample divided by the undiluted odour sample. At each dilution ratio, the air is introduced to the panel members and each panelist is required to evaluate the odour and provide his response (guess, detection or recognition). The test administrator collects each panelist's response and applies a certain statistical procedure to determine the detection and recognition threshold.

When 50% of the panel members detect the odour at a specific dilution, this dilution level is called the detection threshold (D/T). When most of the panel provides a correct recognition response, this dilution ratio is called recognition threshold. Therefore, the detection threshold is always higher than the recognition threshold. The D/T is dimensionless ratio (dilution ratio) and is expressed in Odour Units (OU).

### 2.3.1 2016 – Olfactory Measurements

In August 16, 2016, RWDI collected air samples from the treatment plant from different locations including the entrance to bioreactor 3. The measured odour at the entrance of the bioreactor was 3,566 OU. Obviously, the high concentration will be recognized at the source location and less value will be recognized at the location of first odour receptor. Ideally, the odour concentration at the location of the first receptor should be less than 1 OU.

Odour dispersion models are used to estimate the odour concentrations at certain locations based on many factors such as temperature, wind direction, and area topography. In 2016, RWDI performed an air dispersion study based on the odour emitted from many sources: scrubber stack, primary clarifiers, bioreactors and secondary clarifiers.

Due to the dilution and dispersion of the odours' gases, the study indicated that the estimated odour concentration in the range of 4.57 to 11.1 OU at the locations of the receptors.

### 2.3.2 2019 – Olfactory Measurements

In September 20, 2019, RWDI analyzed 6 air samples. The samples were sent to Pinchin Ltd. in Ontario to determine the odour detection threshold (OU) by an odour panel.

Followed by the analysis, a dispersion study was conducted; the analysis and the dispersion report are included in Appendix A. The dispersion model results showed that the current configuration successfully reduced odour at the locations of receptors. Table 2.4 shows the 2016-dispersion model results and the 2019-dispersion model results after covering the primary clarifiers and installing the activated carbon filter.



Table 2.4: Odour Threshold 2016 Report vs 2019 Report

| Sensitive Receptor | 2016 Report              |                                  | 2019 Report              |                                  |
|--------------------|--------------------------|----------------------------------|--------------------------|----------------------------------|
|                    | Odour Concentration (OU) | Frequency of 1 OU Exceedance (%) | Odour Concentration (OU) | Frequency of 1 OU Exceedance (%) |
| SR1                | 5.45                     | 4.10%                            | 1.33                     | 0.15%                            |
| SR2                | 6.80                     | 13.70%                           | 5.01                     | 1.82%                            |
| SR3                | 5.90                     | 10.80%                           | 3.75                     | 0.82%                            |
| SR4                | 8.50                     | 16.30%                           | 6.12                     | 4.58%                            |
| SR5                | 11.10                    | 18.40%                           | 4.95                     | 9.08%                            |
| SR6                | 10.60                    | 17.30%                           | 4.74                     | 8.53%                            |
| SR7                | 10.00                    | 15.90%                           | 4.17                     | 7.39%                            |
| SR8                | 9.70                     | 11.70%                           | 2.94                     | 3.73%                            |
| SR9                | 4.57                     | 0.80%                            | 3.35                     | 0.46%                            |
| SR10               | 5.22                     | 2.60%                            | 3.28                     | 0.86%                            |
| SR11               | 6.54                     | 11.40%                           | 2.55                     | 3.07%                            |
| SR12               | 7.70                     | 15.60%                           | 6.27                     | 7.04%                            |

Notes:

- Frequency of exceedance (%) represents the exceedance of 1 OU at the receptor location
- The frequency of exceedance should not exceed 0.5% at all time.

RWDI modeled three scenarios:

- Scenario 1: which represents the existing system as of 2019 (stack 1000 mm diameter and 17.0 m height)
- Scenario 2: which represents the existing system with a lower stack height stack(i.e.1000 mm diameter and 6.6 m height)
- Scenario 3: which represents the existing system with covering the bioreactors and sending all the foul air through the chemical/activated carbon system and existing stack (1000 mm diameter and 17.0 m height).

Table 2.5 shows the expected Odour levels at the receptors locations. For RWDI dispersion model receptors locations, refer to Appendix A

|               | Scenario 1: 17 m stack            |                                  |                                  |                                  | Scenario 2: 6.6 m stack           |                                  |                                  |                                  | Scenario 3: Scenario 1 but covering bioreactors and sending through chemical/activated carbon |                                  |                                  |                                  |
|---------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|---|----------------------------------|----------------------------------|----------------------------------|
|               | Max 10 minutes concentration (OU) | Frequency of 1 OU exceedance (%) | Frequency of 2 OU exceedance (%) | Frequency of 5 OU exceedance (%) | Max 10 minutes concentration (OU) | Frequency of 1 OU exceedance (%) | Frequency of 2 OU exceedance (%) | Frequency of 5 OU exceedance (%) | Max 10 minutes concentration (OU)   | Frequency of 1 OU exceedance (%) | Frequency of 2 OU exceedance (%) | Frequency of 5 OU exceedance (%) |
| All receptors | 27.37                             | 32.45%                           | 28.79%                           | 14.13%                           | 27.37                             | 32.53%                           | 29.01%                           | 14.29%                           | 2.97  | 4.87%                            | 0.50%                            | 0.00%                            |
| SR1           | 1.33                              | 0.15%                            | 0.00%                            | 0.00%                            | 1.33                              | 0.16%                            | 0.00%                            | 0.00%                            | 0.32  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR2           | 5.01                              | 1.82%                            | 0.59%                            | 0.01%                            | 5.01                              | 2.04%                            | 0.61%                            | 0.01%                            | 0.37  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR3           | 3.75                              | 0.82%                            | 0.13%                            | 0.00%                            | 3.76                              | 0.88%                            | 0.14%                            | 0.00%                            | 0.35  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR4           | 6.12                              | 4.58%                            | 2.04%                            | 0.10%                            | 6.13                              | 5.19%                            | 2.13%                            | 0.10%                            | 0.38  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR5           | 4.95                              | 9.08%                            | 4.41%                            | 0.00%                            | 5.71                              | 9.52%                            | 4.90%                            | 0.07%                            | 0.40  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR6           | 4.74                              | 8.53%                            | 4.01%                            | 0.00%                            | 5.55                              | 8.84%                            | 4.65%                            | 0.06%                            | 0.41  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR7           | 4.17                              | 7.39%                            | 3.24%                            | 0.00%                            | 4.94                              | 7.69%                            | 3.88%                            | 0.00%                            | 0.48  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR8           | 2.94                              | 3.73%                            | 0.46%                            | 0.00%                            | 3.45                              | 4.27%                            | 0.90%                            | 0.00%                            | 0.59  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR9           | 3.35                              | 0.46%                            | 0.08%                            | 0.00%                            | 3.36                              | 0.46%                            | 0.08%                            | 0.00%                            | 0.38  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR10          | 3.28                              | 0.86%                            | 0.24%                            | 0.00%                            | 3.29                              | 0.89%                            | 0.24%                            | 0.00%                            | 0.40  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR11          | 2.55                              | 3.07%                            | 0.19%                            | 0.00%                            | 2.55                              | 3.20%                            | 0.19%                            | 0.00%                            | 0.45  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR12          | 6.27                              | 7.04%                            | 4.60%                            | 0.92%                            | 6.27                              | 7.18%                            | 4.60%                            | 0.92%                            | 0.47  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR13          | 3.71                              | 1.46%                            | 0.40%                            | 0.00%                            | 3.71                              | 1.46%                            | 0.40%                            | 0.00%                            | 0.51  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR14          | 7.18                              | 10.27%                           | 8.58%                            | 2.44%                            | 7.18                              | 10.79%                           | 8.60%                            | 2.45%                            | 0.50  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR15          | 2.91                              | 7.39%                            | 1.60%                            | 0.00%                            | 3.46                              | 7.84%                            | 2.00%                            | 0.00%                            | 0.59  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR16          | 4.40                              | 7.42%                            | 3.44%                            | 0.00%                            | 5.27                              | 7.76%                            | 3.93%                            | 0.03%                            | 0.57  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR17          | 6.41                              | 8.90%                            | 5.09%                            | 0.49%                            | 6.55                              | 9.35%                            | 5.61%                            | 0.51%                            | 0.42  | 0.00%                            | 0.00%                            | 0.00%                            |
| SR18          | 1.53                              | 0.21%                            | 0.00%                            | 0.00%                            | 1.53                              | 0.21%                            | 0.00%                            | 0.00%                            | 0.32  | 0.00%                            | 0.00%                            | 0.00%                            |

Based on Table 2.5 Scenario 3 represents the best scenario for odour emissions.



## 3.0 Design Criteria

### 3.1 CVWPCC – Planned Upgrades

In August 2016, ISL conducted an assessment of the wastewater treatment plant, with findings reported in “CVWPCC Capacity Assessment Report, 2016”. The report identified three options for plant upgrades. The report recommended Option 3 for implementation.

Table 3.1 provides the planned future facilities according to Option 3 of the report.

Table 3.1: Existing Bioreactors and Planned Future Facilities – Construction Year

|    | Treatment Process                                       | Year                | Average Plant Flow MLD | Population |
|----|---|---------------------|------------------------|------------|
| 1  | Bioreactors 1, 2 and 3                                  | Existing            | -                      | -          |
| 2  | Bioreactors 1, 2 and 3 (Influent and Effluent Channels) | Existing            | -                      | -          |
| 3  | Bioreactor 4  | 2024                | 17.5                   | 50,109     |
| 4  | Primary Clarifiers 4 and 5                              | 2033                | 19.8                   | 57,189     |
| 5  | Bioreactors 4, 5 and 6 (Influent and Effluent Channels) | 2024 to Beyond 2066 | -                      | -          |
| 6  | Primary Clarifier 6                                     | Beyond 2066         | -                      | -          |
| 7  | Bioreactor 5  | 2063                | 29.5                   | 85,140     |
| 8  | Bioreactor 6  | Beyond 2066         | -                      | -          |
| 9  | Headworks   | 2045                | 23.2                   | 66,786     |
| 10 | Grit Removal  | 2045                | 23.2                   | 66,786     |
| 11 | Grit Removal Room                                       | 2045                | 23.2                   | 66,786     |
| 12 | Gravity Thickener 3                                     | 2056                | 26.9                   | 76,169     |

### 3.2 Ventilation Rates

Placing covers above existing and new future structures identified in Table 3.1 is required to keep nuisance odours from escaping to the surrounding atmosphere. A negative pressure must be maintained in the airspace, under the cover, to prevent release of nuisance odours to the atmosphere. This negative pressure draws air through cracks, vents, or designed openings. The negative pressure is maintained using a fan that exhausts more air than the supply air. National Fire Protection Association (NFPA) Standard 820 states 0.1-inch water gauge pressure differential as the design standards for odour control systems (NFPA, 2008).



Ventilation of the enclosed air space is required to maintain a negative pressure at all times. The ventilation rate should be enough to control buildup of moisture over structural elements, such as concrete and metal surfaces. Hydrogen sulphate absorbed by the moisture can be readily converted to sulphuric acid, which can be corrosive to the concrete and metal surfaces. A minimum air change rate of 3-4 air changes per hour (AC/h) is the lowest design ventilation rate to control moisture buildup, according to WEF, MOP 25 “Control of Odours and Emissions from Wastewater Treatment Plants”. A 4-6 AC/h rate is widely used for Nonworker-accessible spaces. The 4-6 AC/h assumes that the liquid beneath the covers is not aerated.

For bioreactors, higher ventilation flow rates (i.e., more than the 4-6 AC/h) are required to account for the air diffused through the liquid and released at the surface. The CVWPCC plant is provided with five blowers (four duty and one standby) for aerating the bioreactors; normally the plant is running on three blowers during high air demand season (summer months).

The bioreactors’ ventilation flow rates are calculated based on the diffused air plus the minimum quantity of air required for 4 AC/h to control the moisture within the air space. The diffused air was calculated based on all blowers running at the same time (four blowers). In case the fourth blower is not running, the extra air will provide more AC/h to the containment air space. Table 3.2 provides the total airflow rate that needs to be treated by the new odour control system. A more detailed breakdown of the air ventilation rates and assumptions are included in Appendix B – Air Flow Ventilation Rates.

Table 3.2: Existing and Future Facilities - Air Ventilation Requirements

|   | Treatment Process                                       | Year               | Air Flow (m <sup>3</sup> /hr) |
|---|---|--------------------|-------------------------------|
| 1   | Bioreactors 1, 2 and 3                                  | Existing           | 19,061                        |
| 2   | Bioreactors 1, 2 and 3 (Influent and Effluent Channels) | Existing           | 1,558                         |
| <b>Required system capacity (2019)</b>            |   |                    | <b>20,619</b>                 |
| 3   | Bioreactor 4  | 2024               | 6,354                         |
| 4   | Primary Clarifiers 4 and 5                              | 2033               | 1,687                         |
| 5   | Bioreactors 4, 5 and 6 (Influent and Effluent Channels) | 2024 - Beyond 2066 | 1,558                         |
| <b>Required system capacity (25 years - 2044)</b> |   |                    | <b>30,218</b>                 |
| 6   | Primary Clarifier 6                                     | Beyond 2066        | 844                           |
| 7   | Bioreactor 5  | 2063               | 6,354                         |
| 8   | Bioreactor 6  | beyond 2066        | 6,354                         |
| 9   | Headworks   | 2045               | 752                           |

|                                 | Treatment Process   | Year | Air Flow (m <sup>3</sup> /hr) |
|---------------------------------|---------------------|------|-------------------------------|
| 10                              | Grit Removal        | 2045 | 330                           |
| 11                              | Grit Removal Room   | 2045 | 5,060                         |
| 12                              | Gravity Thickener 3 | 2056 | 0                             |
| Required system capacity (2066) |                     |      | 49,911                        |
| Rounded to                      |                     |      | 50,000                        |

Notes:

- Bioreactors, air void depth for existing and future bioreactors includes 1.0 m to compensate for the void air under the arch cover
- Bioreactors, air is based on four blowers, each with a capacity of 57 m<sup>3</sup>/min (3420 m<sup>3</sup>/hr)
- Gravity Thickener 3 (future) has small air requirements (300 m<sup>3</sup>/hr) and to be connected to the existing odour control system
- Air flow includes extra 10% safety factor to accommodate for unforeseen conditions

### 3.3 Bioreactor Covers – Area Classification

The NFPA developed a ventilation standard, NFPA 820, which is widely accepted as the industry standard of care for many municipalities. The NFPA 820 standard links the fire protection safety of the structure to its ventilation rate.

Review of the NFPA 820 indicates:

- the standard has no established ventilation rate for enclosed bioreactors preceded by primary treatment
- the area under the bioreactor covers is unclassified according to the NEC-Area Electrical classification
- the bioreactor covers can be constructed from materials that are non-combustible, limited-combustible, or low flame spread material. The low flame spread material is defined as a material with a flame spread rating of 25 or less.

The existing primary clarifiers are manufactured from fibre-reinforced plastic (FRP). From aesthetic prospective, the bioreactor covers should match the existing primary covers with the same material (FRP). The covers should be constructed from FRP with a flame spread rating of 25 or less, similar to the existing primary clarifier covers.

During the recent upgrade (covering primary clarifiers and adding an activated carbon system), the CVRD coated the primary clarifier's concrete surface with an epoxy coat for corrosion control. It is estimated that coating of the existing bioreactor will cost approximately \$800,000 (excluding engineering and construction contingencies).

### 3.4 Pipe Routing

Odorous gases will be transported to the new odour control system via FRP pipes similar to the existing odour collection system. Figure 3.1 shows the proposed routing of the FRP pipes.

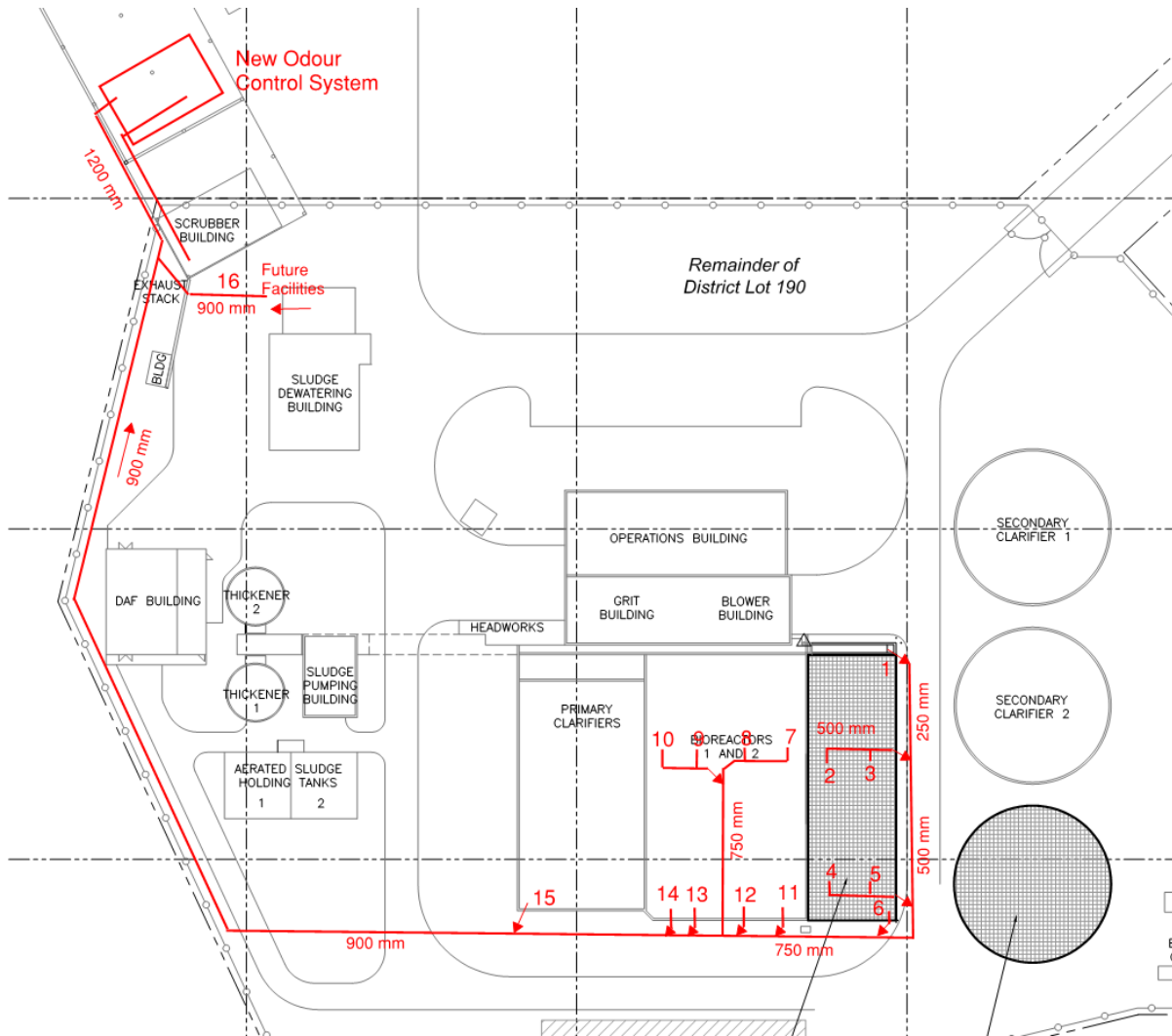


Figure 3.1: Proposed FRP Pipe Routing

Initial pipe sizing was carried out for cost estimating purposes. Table 3.3 summarizes the estimated air flowrate from each point of collection, complete with pipe diameter and air velocity within the pipe. More detailed information is included in Appendix B.



Table 3.3: Air Collection System – Pipe Diameters and Air Velocities

| Collection Point | Max. Air Flow        | Pipe Diameter | Velocity |
|------------------|----------------------|---------------|----------|
|                  | (m <sup>3</sup> /hr) | (mm)          | (m/s)    |
| 1                | 739                  | 250           | 4.2      |
| 2                | 1,588                | 400           | 3.5      |
| 3                | 1,588                | 400           | 3.5      |
| 4                | 1,588                | 400           | 3.5      |
| 5                | 1,588                | 400           | 3.5      |
| 6                | 409                  | 250           | 2.3      |
| 11               | 1,588                | 400           | 3.5      |
| 12               | 1,588                | 400           | 3.5      |
| 7                | 1,588                | 400           | 3.5      |
| 8                | 1,588                | 400           | 3.5      |
| 10               | 1,588                | 400           | 3.5      |
| 9                | 1,588                | 400           | 3.5      |
| 13               | 1,588                | 400           | 3.5      |
| 14               | 1,588                | 400           | 3.5      |
| 15               | 409                  | 250           | 2.3      |
| 16               | 29,292               | 900           | 12.8     |

Note:

Collection points are as shown on Figure 3.1



## 4.0 Odour Control Technologies

There are various technologies available to limit or control odours. The technologies considered for CVWPCC include:

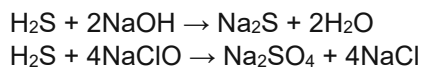
- Chemical scrubber followed by activated carbon (existing odour control system)
- Biological filters
- Ultraviolet (UV) radiation

### 4.1 Existing Chemical Wet Scrubber

The chemical wet scrubber is a proven technology which can remove up to 99% of H<sub>2</sub>S. Chemical scrubbing is a gas scrubbing method in which odorous gases are removed from the gas stream. During this process the gas stream passes through a packed structure with a large wet surface area. The wet area enables contact between the gas and the scrubbing chemicals and allows for removal of odorous gases from the gas stream.

Two chemicals are used for gas scrubbing: sodium hydroxide and sodium hypochlorite. There are sensors to monitor pH and oxidation reduction potential (ORP) levels. A pH probe and controller maintain the proper pH by regulating the rate of sodium hydroxide added to the solution. An ORP probe and controller maintain the proper chlorine residual by regulating the rate of sodium hypochlorite added to the solution. In terms of the current scrubber operation, the caustic dosing pump turns on or off based on the set level of pH 9.8, while the on and off setting of the hypochlorite dosing pump is driven by the set level of ORP 650 mV (millivolt). The set levels of pH and ORP are within the typical scrubber operational values.

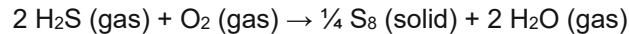
The first chemical is caustic soda (sodium hydroxide - NaOH) to target H<sub>2</sub>S removal. The second chemical used is sodium hypochlorite (NaOCl) to oxidize the remaining H<sub>2</sub>S and organic odours. The hypochlorite also neutralizes many other compounds and acts as a disinfectant, and serves as a masking agent for the stack odour. The mechanisms of the system are based on the two formulas below:



In 2017, the CVRD performed a scrubber inspection. It was found that the scrubber media was partially plugged. The plugged media was replaced with new media. Currently, the existing chemical scrubber is at its limited capacity and the bioreactor odorous gases can not be directed to the existing scrubber.

## 4.2 Activated Carbon

Activated carbon is an extremely porous media with very large surface area. As air passes through the carbon media, the odorous contaminants are trapped in the microscopic pores; this process is called adsorption. Odorous air is collected and passed through the adsorber. The activated carbon catalytically oxidizes the hydrogen sulphide to produce elemental sulphur and water by the following reaction:



The sulphur produced is adsorbed on the internal surface of the activated carbon while the water is mainly lost to the flowing air gas stream. The flowing air stream dissipates the heat. The adsorption process continues until the activated carbon pores are filled. In practice, it is estimated that about 25% of unused carbon will remain in the system when odours begin to break through (break through is the term used when detectable odours begin to be emitted from the system). The life expectancy of activated carbon is a function of the type and concentration of contaminants in the air stream. Some activated carbon has an H<sub>2</sub>S capacity on the order of 0.30 grams of H<sub>2</sub>S per cubic centimetre of carbon. Once the carbon is saturated, it must be replaced with clean media.

Normally, the activated carbon system consists of the following major components to achieve adsorption of 99.0% of H<sub>2</sub>S:

- Air exhaust fan
- Mist eliminator
- Vessel inlet volume control damper
- Fan outlet/adsorber inlet transition
- Carbon adsorber vessel
- Activated carbon media
- Control panel

## 4.3 Biofilters (Bio Trickling Filter)

Odour control systems using biofilters involve moving odorous gases through a packing filter in which two processes occur: sorption (adsorption/absorption) and bioconversion. Odorous gases are absorbed onto the surfaces where microorganisms oxidize the compounds to remove odour from the air. The indigenous bacteria and other microorganisms of the media acclimate to the compounds present and are enough to provide the "scrubbing" action; no bacterial inoculation or chemical addition is required.

A biofilter odour control system typically consists of the following major components to achieve 99.0% of H<sub>2</sub>S and the sum of odorous gases:

- Premium corrosion-resistant material tank with multi-stage odour control module; a typical material is FRP
- Expanded clay media for treatment of inorganic odours (H<sub>2</sub>S)
- Coal-based virgin media for treatment of inorganic and organic odours



- Irrigation system
- Air distribution system
- Nutrient addition system including the nutrient pump
- Air exhaust fan
- Control panel

#### 4.4 Ultraviolet

The ultraviolet (UV) technology is found to be effective and offers chemical-free odour treatment. A few full scale operations such as the Dockside Green plant in Victoria, BC, and some lift stations in Vernon, BC, adapted the system to reduce foul air. The wavelength frequency of the UV system's lamps is particularly tuned to affect the gas molecules of a wide range of compounds, including those of petrochemical origin and those containing sulphur, such as H<sub>2</sub>S and mercaptans. The UV light acts as a catalyst, breaking down the ambient oxygen and water vapour molecules into O- and OH- (hydroxyl) radicals. These free radicals oxidize the odorous contaminants in the air. This reaction results in a sequential and instantaneous gas breakdown of the contaminants with by-products of elemental sulphur, CO<sub>2</sub>, water vapour, molecular oxygen and trace ozone.

#### 4.5 Advantages and Disadvantages

The advantages and disadvantages of each technology are summarized in Table 4.1.

Table 4.1: Odour Control Technologies - Advantages and Disadvantages

| Technology                          | Advantages  | Disadvantages   | Target Application  |
|-------------------------------------|---|---|---|
| Chemical Scrubber (Existing System) | <ul style="list-style-type: none"> <li>• High efficiency for H<sub>2</sub>S and organics</li> <li>• High air flow capacity per unit footprint</li> <li>• Lower capital cost</li> <li>• Effective with odour spikes</li> </ul> | <ul style="list-style-type: none"> <li>• Chemical cost is proportional to odour concentration; however, at low odour concentrations, chemical consumption is mainly driven by the ambient CO<sub>2</sub> concentration more than by odorous gases concentrations</li> <li>• Complex chemical controls</li> <li>• Cost of maintenance</li> </ul> | <ul style="list-style-type: none"> <li>• High flow rates</li> <li>• Limited space areas</li> <li>• Moderate foul air concentration &lt;50 ppm</li> <li>• High concentration of organic odours</li> <li>• High removal efficiency</li> </ul> |

| Technology       | Advantages  | Disadvantages  | Target Application   |
|------------------|---|--|--|
| Activated Carbon | <ul style="list-style-type: none"> <li>• Low capital cost</li> <li>• Treat H<sub>2</sub>S and some organic odours</li> <li>• Moderate air flow capacity</li> <li>• Good response to odour spikes</li> </ul> | <ul style="list-style-type: none"> <li>• Limited H<sub>2</sub>S and organic odour capacities</li> <li>• High operating cost because of the activated carbon media replacement, especially if it is used as the only standalone treatment</li> <li>• Limited capacity for some organic odours</li> </ul>  | <ul style="list-style-type: none"> <li>• Low foul air levels (1 to 20 ppm)</li> <li>• Polishing stage after chemical scrubber or biofilter</li> </ul>  |
| Biofilter        | <ul style="list-style-type: none"> <li>• High efficiency for H<sub>2</sub>S removal</li> <li>• Moderate air flow capacity</li> <li>• Low operating cost</li> </ul>  | <ul style="list-style-type: none"> <li>• Requires long contact time (footage) compared with other technologies</li> <li>• High capital cost</li> <li>• Less responsive to sudden odour spikes</li> <li>• Treatment efficiency is reduced in cold months</li> <li>• Requires large footprint compared with other technologies</li> <li>• Efficiency depends on the health of microorganisms</li> <li>• The need to keep the biofilter moist at all times (100% humidity is typical)</li> <li>• Cost of operation is increased</li> <li>• 10 years of media life as compared to 20 years on chemical scrubber</li> </ul> | <ul style="list-style-type: none"> <li>• High H<sub>2</sub>S concentrations &gt;50 ppm</li> <li>• Pre-treatment of H<sub>2</sub>S prior to chemical scrubber or biofilter</li> <li>• More effective in hot climates</li> </ul> |



| Technology | Advantages   | Disadvantages   | Target Application   |
|------------|--|---|--|
| UV System  | <ul style="list-style-type: none"><li>• Smaller footprint</li><li>• Low capital cost</li></ul> | <ul style="list-style-type: none"><li>• Proprietary technology, literature and publications appears to be limited</li><li>• Limited installations for high capacity applications compared with other technologies</li><li>• Pilot testing is highly recommended if chosen</li></ul> | <ul style="list-style-type: none"><li>• Mainly target small air flows, small systems (pump stations)</li><li>• Area where internal air circulation is possible</li></ul> |

Based on the advantages and disadvantages, two technologies were considered: chemical scrubber and activated carbon. A biofilter was not considered due to the cold weather considerations and the low concentrations of H<sub>2</sub>S in the odorous air. At the same time, a UV system was not considered due to the limited installations of similar size systems within North America.

## 5.0 Upgrade Options

Upgrade options were developed based on the ventilation rates identified in Table 3.2 for Years 2044 and 2066, 30,218 m<sup>3</sup>/hr and 49,911 m<sup>3</sup>/hr, respectively. The upgrade options were also based on the considered treatment technologies (chemical scrubber and activated carbon).

Two main upgrade options for the odour control system were investigated:

- **Option 1:** new chemical scrubber with activated carbon filter with a capacity of 30,600 m<sup>3</sup>/hr to match the capacity of the existing activated carbon filter. This option will cover the plant requirements up to 2044.
- **Option 2:** new chemical scrubber with activated carbon filter with a capacity of 50,000 m<sup>3</sup>/hr to cover the plant requirements up to 2066.

Preliminary investigation (i.e., footprint) indicates that the new chemical scrubbers ancillary equipment such as recirculation pumps and chemical dosing pumps can fit into the existing building with some building/equipment modifications. The air fan, chemical scrubber and activated carbon filter will need to be installed outdoors at the current location of the garage. Table 5.1 summarizes upgrade options, design years, and rated capacities for each option.

ISL contacted Evoqua Ltd. for sizing of the chemical scrubber and activated carbon filter; the following table summarizes the equipment dimensions and weights. More detailed information is included in Appendix C – Manufacturer Literature.

Table 5.1: Upgrade Options, Design Years, Options and Rated Capacities

| Description                    | Units                   | Option 1      | Option 2      |
|--------------------------------|-------------------------|---------------|---------------|
| Design Year                    |                         | 2044          | 2066          |
| <b>Chemical Scrubber</b>       | <b>m<sup>3</sup>/hr</b> | <b>30,600</b> | <b>50,000</b> |
| Vessel diameter                | mm                      | 2,100         | 2,700         |
| Vessel height                  | mm                      | 6,450         | 7,050         |
| Operating weight               | kg                      | 5,455         | 8,180         |
| <b>Activated Carbon Filter</b> | <b>m<sup>3</sup>/hr</b> | <b>30,600</b> | <b>50,000</b> |
| Type                           |                         | V-Bank        | V-Bank        |
| Unit length                    | mm                      | 6,096         | 9,144         |
| Unit width                     | mm                      | 3,200         | 3,962         |
| Unit height                    | mm                      | 2,896         | 3,658         |



## 6.0 Capital Costs

The estimated capital costs in Table 6.1 are considered to be at a conceptual level (Class D). A contingency of 40% is included in the cost estimates for engineering and construction. The cost estimates do not include applicable taxes. A more detailed cost estimate is included in Appendix D – Capital Cost Estimates.

Table 6.1: Estimated Upgrade Options Costs

| Item | Description                         | Option 1           | Option 2           |
|------|-------------------------------------|--------------------|--------------------|
| 1.0  | General requirements                | \$1,260,000        | \$1,320,000        |
| 2.0  | Bioreactor and channels covers      | \$1,020,000        | \$1,020,000        |
| 3.0  | Pipes                               | \$967,000          | \$967,000          |
| 4.0  | Bioreactors epoxy coating           | \$800,000          | \$800,000          |
| 5.0  | Adding new chemical scrubber        | \$647,500          | \$745,000          |
| 6.0  | Adding new activated carbon filter  | \$862,500          | \$1,005,000        |
| 7.0  | Electrical                          | \$150,000          | \$180,000          |
|      | <b>Subtotal</b>                     | <b>\$5,707,000</b> | <b>\$6,037,000</b> |
|      | Engineering and contingencies (40%) | \$2,283,000        | \$2,415,000        |
|      | <b>Total (excluding GST)</b>        | <b>\$7,990,000</b> | <b>\$8,452,000</b> |

Note:  
GST is not included

## 7.0 Conclusions and Recommendations

### 7.1 Conclusions

The existing odour control system serves the existing headwork, primary clarifiers, sludge storage and dewatering facility. The existing system is at its rated capacity limit and any future odour treatment needs to be treated through a new odour control system.

Odorous gases were measured by gas chromatography (GC) for 24 odour compounds. The only measured compounds above the detection limits were ammonia and dimethyl disulphide. The levels registered for both compounds are low and with any air dilution and dispersion, these levels should not be a concern.

Under a carefully controlled environment, measurement of odours by the human olfactory system provides meaningful and reliable information. In 2019, RWDI conducted several olfactory tests and a dispersion model study. The study showed that the current configuration successfully reduced odour exceedances from the scrubber/stack system. However, the study predicted that the odour levels at the location of the odour receptors still high. The study also predicted that decreasing the stack height and/or removing the chemical scrubber system will increase the overall odour levels.

Odours are not regulated federally. On a provincial level, all provinces, with exception of Ontario, Manitoba and Quebec, have no established specific odour impact criteria based on ambient air odour concentrations calculated by dispersion models. Ontario limits are not established in a regulation, however they are used routinely in permitting approvals and abatement processes when public complaints from odour emissions are common. Ontario uses a limit of 1 OU for sensitive land uses, and should not exceed in 0.5% of the time (99.5<sup>th</sup> percentile) over 10-min averaging time.

The required new odour control system capacity is 20,619 m<sup>3</sup>/hr, 30,218 m<sup>3</sup>/hr and 49,911 m<sup>3</sup>/hr for years 2019, 2044 and 2066, respectively. The system should be sized with a minimum capacity to cover 25 years of operations (i.e., up to 2044).

Various odour treatment technologies were evaluated and the following options were considered:

- **Option 1:** new chemical scrubber with activated carbon filter with a capacity of 30,600 m<sup>3</sup>/hr to match the capacity of the existing activated carbon filter. This option will cover the plant requirements up to 2044.
- **Option 2:** new chemical scrubber with activated carbon filter with a capacity of 50,000 m<sup>3</sup>/hr to cover the plant requirements up to 2066.

Preliminary investigation (i.e., footprint) indicates that the new chemical scrubbers ancillary equipment such as recirculation pumps and chemical dosing pumps can fit into the existing building with some building/equipment modifications. The air fan, chemical scrubber and activated carbon filter will need to be installed outdoors at the current location of the garage.



The estimated capital costs for Option 1 and Option 2 are \$7.990 M and \$8.452M, respectively (including 40% engineering and construction contingencies). The differential cost between both options is not substantial and both options will provide significant odour reduction.

Both options will be provided with VFDs which means that both Options can be operated at a lower ventilation rates. As a result, Option 2 can have the same operating and chemical costs as Option 1 when the ventilation fan (50,000 m<sup>3</sup>/hr) is operated at 30,600 m<sup>3</sup>/hr. For both Options, the main components of the new system are manufactured from FRP material which is more resistant to corrosion and weather conditions compared with metals, and the system has an expected design life of over 50 years.

Option 2 provides more value when compared with Option 1. Adding only \$462 K (5.8% of project cost) will provide extra 20 years of system life and the system will have a sufficient capacity for all anticipated future facilities up to 2066.



**APPENDIX**  
RWDI Odour Assessment &  
ALS Environmental Laboratory for Analysis

**A**



## COMOX VALLEY WATER POLLUTION CONTROL CENTRE

COMOX, BC

ODOUR ASSESSMENT\_DRAFT

RWDI # 1904012

October 16, 2019

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## EXECUTIVE SUMMARY

RWDI was retained by the Comox Valley Regional District (CVRD) to conduct an odour assessment for the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC. The odour assessment included the measurement of odour sources at the CVWPCC which were then used to calculate emission rates input into a dispersion model to predict off-site odours due to the facility operations. The methodology and results of the odour sampling programs is discussed in separate memos (RWDI, 2019a & 2019b). This report discusses the results of the odour modelling.

The CVWPCC is a secondary level wastewater treatment plant that provides improved wastewater treatment to the City of Courtenay, the Town of Comox, the Department of National Defence and the K'omoks First Nation. The plant is located east of the Town of Comox in a rural area adjacent to the Salish Sea.

This study was a continuation of a series of studies performed by RWDI since 2015. The purpose of this assessment was to assess the impact of recent mitigation measures to reduce off-site odours which are negatively impacting the neighboring community. The mitigation strategies used by CVWPCC include adding an activated charcoal polisher downstream of the current wet scrubber system and, covering the Primary Clarifier (determined to be a major source of odour in a previous study) and routing its emissions to the current scrubbing system.

In addition to the current configuration, two additional scenarios were modelled: (a) current configuration with the stack removed (i.e., release at building height), and (b) a mitigation scenario, where it was assumed that the bioreactors are covered, and emissions are directed through the scrubber for removal. The removal efficiency for this scenario was based on the recently measured efficiency of the scrubber and polisher.

The results showed that the current configuration successfully reduced odour exceedances from the scrubber/stack system. Also, it was predicted that removing the stack and releasing at the building height will adversely affect the predicted off-site odour levels. The modelling results for the mitigation scenario (b), with the secondary bioreactors covered, showed that the applying this measure will successfully eliminate odour exceedances at the sensitive receptors.



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|--|--|
| Appendix A: Source Testing Memo - Comox Valley Water Pollution Control Centre - Summer 2019    |  |
| Appendix B: Source Testing Memo - Comox Valley Water Pollution Control Centre - September 2019 |  |



# 1 INTRODUCTION

RWDI was retained by the Comox Valley Regional District (CVRD) to conduct an odour assessment for the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC (the facility). The assessment consists of two parts: (a) an odour sampling program that includes the collection of samples at several emission points throughout the facility and analysis of those samples by an odour panel located in Mississauga, Ontario; and (b) odour modelling, to predict the impact of the facility operations on off-site odour levels using the results of the sampling program and advanced dispersion modelling.

The methodology and results of the odour sampling programs are provided in two separate memos (RWDI, 2019a & 2019b). This current report presents the assessment approach, and, provides a discussion of the results of the odour modelling assessment.

## 1.1 Project Description and Background

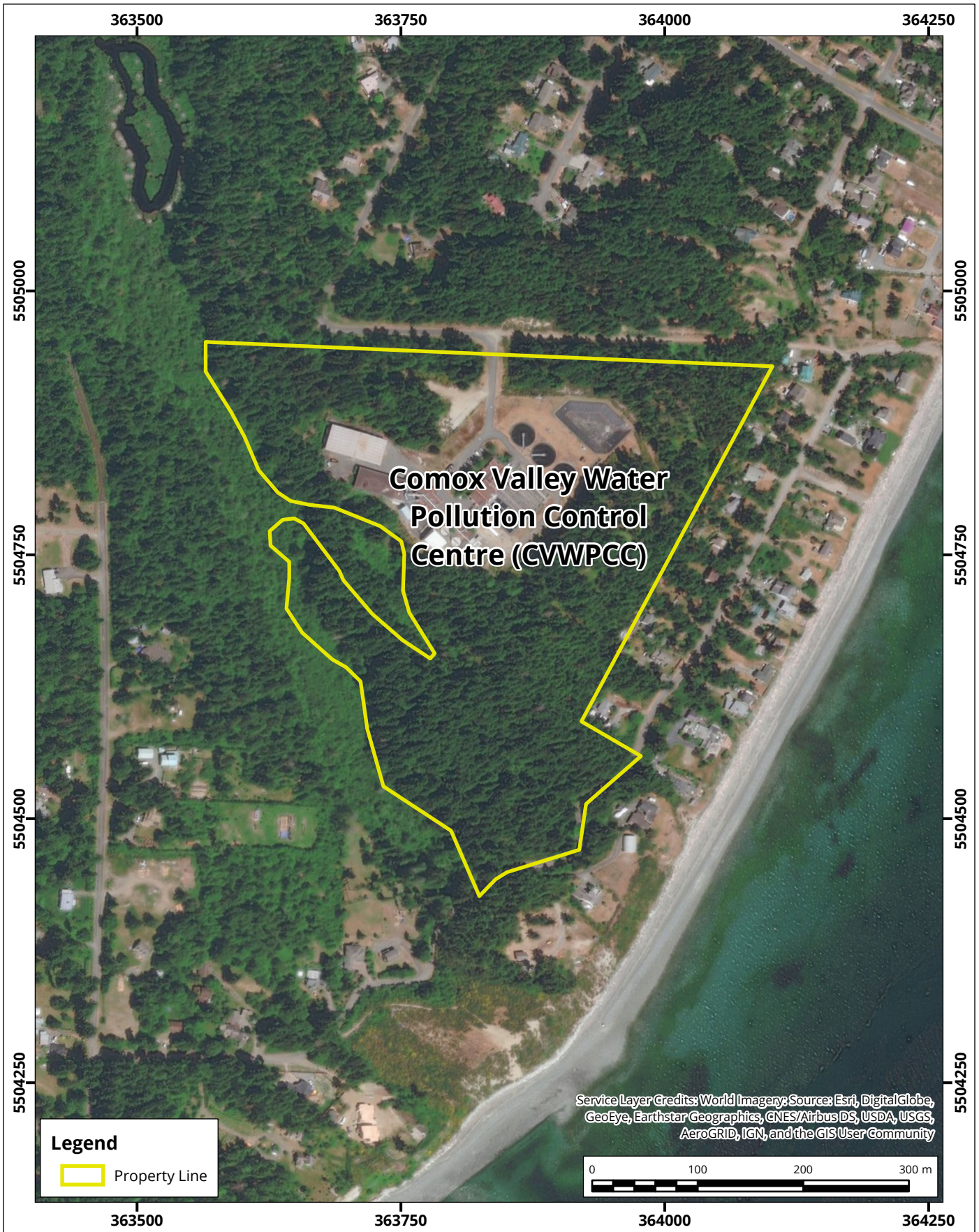
The CVWPCC is a secondary level wastewater treatment plant that provides improved wastewater treatment to the City of Courtenay, the Town of Comox, the Department of National Defence and the K'omoks First Nation. The plant is located east of the Town of Comox in a rural area adjacent to the Salish Sea (Figure 1 Figure 1).

Soon after start-up in 1984 the CVRD began to receive odour complaints related to plant operation. These complaints tended to be from residents along Curtis Road where odours are more frequent, especially on evenings in the late summer or early fall when certain weather conditions (off-shore wind) prevail.

RWDI has performed a number of assessments since 2015 including site observations in January 2015, additional assessments in the Spring of 2015, odour and hydrogen sulfide site measurements in August 2016 and numerical odour modelling with mitigation analysis in Fall of 2016. The results of all these assessments were compiled in a full odour assessment report in March 2017 (RWDI, 2017).

The mitigation study in 2016 suggested that the best mitigation strategy is to install a bio-filter type system on the scrubber stack, since the model predicted that it has the largest impact on odour. However, even with additional control on the stack, the site would still have significant odour impacts associated with the primary clarifiers and the bioreactors. RWDI further recommended that the bioreactor tanks be covered and vented through the scrubber stack with an improved control efficiency.

Since then, the CVWPCC has taken mitigation measures to reduce the odour impact of their operations. An activated carbon polisher on the stack downstream of the existing wet chemical scrubber has been installed. In addition, the primary clarifiers have been covered and has been tied into the existing odour control collection system. The bioreactors and secondary clarifiers remain uncovered.



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**Site Map**

Map Projection: NAD 1983 UTM Zone 10N  
 Comox Valley Water Pollution Control Centre - Comox, B.C.



Project #: 1904012

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| Date Revised: Jul 26, 2019 |           |





## 1.2 Objectives

The main objective of this assessment is to predict the off-site odour levels from the operations of the CVWPCC and to review the effectiveness of the applied mitigation measures on ambient odour levels.

This report provides modelled maximum ambient odour levels resulting from the current configuration of the facility at several sensitive receptors around the CVWPCC property, and, compares them with the values from the previous study. In addition, frequency of exceedances from odour unit (OU) thresholds of 1 OU, 2 OU and 5 OU are provided to better understand the overall effect on off-site odours.

Two additional scenarios were also modelled and compared: (a) current configuration with the stack removed (i.e., release at building height), and (b) a modified configuration to explore the mitigation strategy of covering the secondary bioreactor and directing its emissions through odour control infrastructure.

The parameters, meteorological data, and CALPUFF modelling used in this assessment were similar to the ones used in the previous dispersion model.

## 2 MODELLING APPROACH

A dispersion model study was conducted to determine the off-site areas that could be influenced by odour from the CVWPCC. The modelling was conducted using the CALPUFF regulatory dispersion model (version 7.2.1). CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal, and is the recommended model under the *British Columbia Air Quality Dispersion Modelling Guideline* (AQDMG, BC MOE, 2015).

As there is currently no odour standard in British Columbia, odour standards from Ontario's Ministry of the Environment, Conservation and Parks have been referenced (MECP, 2016). The MECP requires that a 10-minute odour-based standard is exceeded less than 0.5% of the time which corresponds to approximately 44 hours per year. The Ontario standard is similar to the methodology proposed by Metro Vancouver in *Odour Management Framework, A Guide to Odour Management in Metro Vancouver* (Metro Vancouver, 2017).

Similar to the previous study, the calendar year of 2014 was selected for the model year as it originally represented the most recent year for which the BC MOE meteorological data required for use in the model study were available from the nearest monitoring station. This allows for a direct comparison of the results of this study to the previous ones, and a better understanding of the effects of the applied mitigation measures.

The ISC-type meteorological data file (one year of hourly single point meteorology) was used as input to the CALPUFF dispersion model to predict the maximum odour levels resulting from estimated emissions. To understand the contribution of various sources, emissions sources were modelled separately. The total contribution from all sources was also modelled.

It should be noted that numerical modelling is a conservative approach. The emission factors input into the model are obtained using reasonably conservative assumptions were applicable. Model results represent the worst-case meteorological conditions that occurred during the modelling period.

## 2.1 Odour Source Characterization

Five (5) odour sources (Figure 2) were input to the model as follows:

- one point source to represent the scrubber/stack;
- one area source to represent the secondary bioreactor; and,
- three area sources to represent the secondary clarifiers.

Note that the primary clarifiers are now covered, tied into the existing odour control collection system and routed to the scrubber stack for removal. Therefore, the primary clarifiers are not included in the model. Any unremoved emissions are captured in the estimated emissions from the stack.

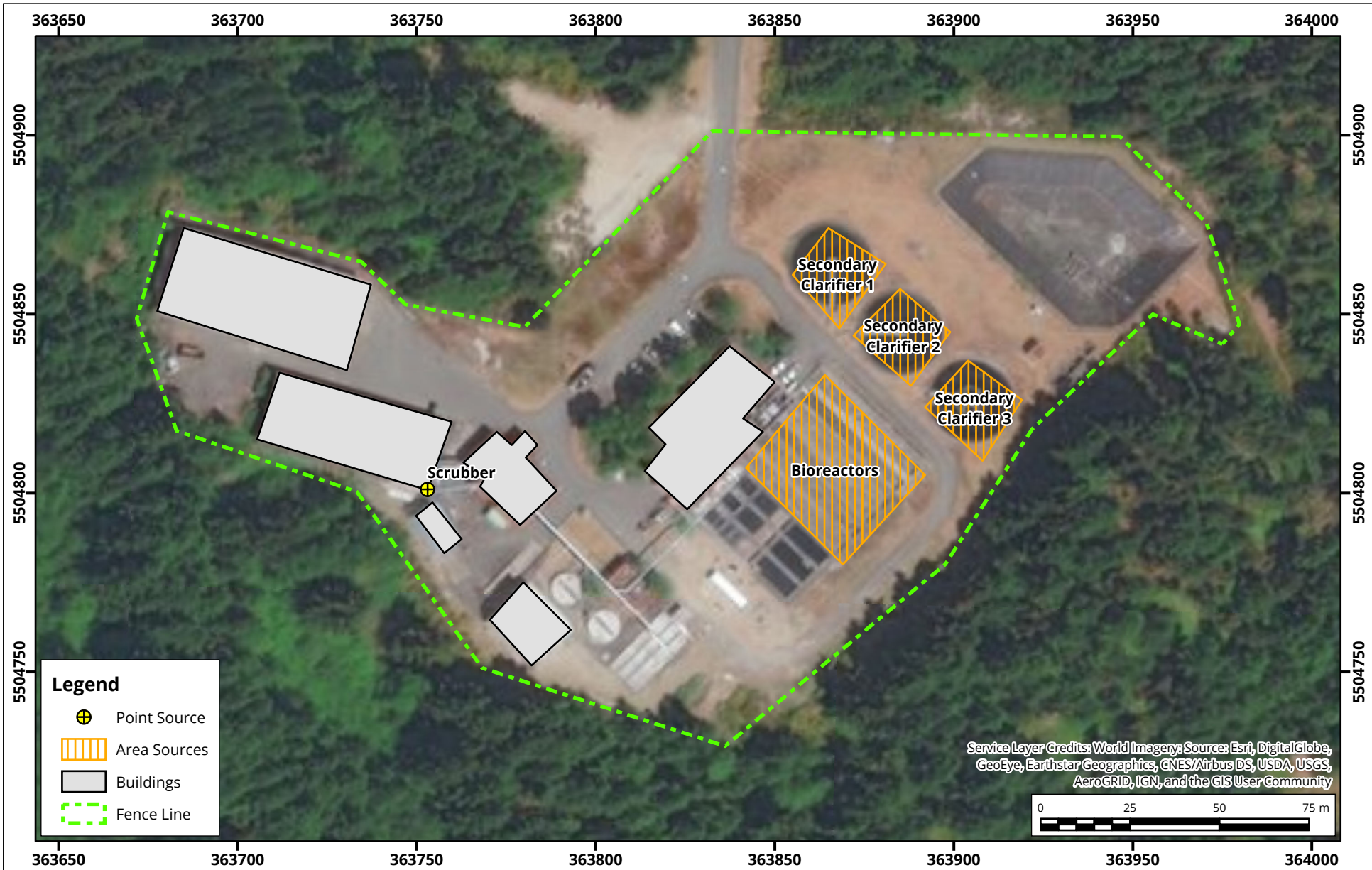
The scrubber stack height (17 m from the ground) and the stack inner diameter (1 m) were provided by CVWPCC. The exit velocity (23.30 m/s) and exit temperature (11°C) were estimated based on measurements during the sampling performed in June 2019. Clarifiers and bioreactors were modelled as area sources; the release height for all area sources was estimated to be 1 m from the ground, and surface areas were estimated from the exposed surface of each bioreactor and clarifier.

Emission rates are expressed in Odour Units per second (OU/s). An odour unit is defined as the amount of odorant that when dispersed in a cubic metre of clean air would be detectable to 50% of the population.

The emission rates for the scrubber stack and the secondary bioreactor are based on onsite odour sampling completed on September 19, 2019 by RWDI and analyzed by Environmental Odour Consulting Corporation, in Oakville Ontario. Details of the testing and analysis results are contained in Appendix A and Appendix B. The secondary clarifiers were not sampled this year, and emission rates from the previous study (RWDI, 2017) were used.

For scenario (b), it was considered that the secondary bioreactor is covered, and its emissions are routed to the scrubber stack for removal. Therefore, emission rate of the secondary bioreactor source was set to zero for this scenario. The removal efficiency of the scrubber system was calculated using an average of removal efficiencies based on odour sampling performed on June 20 (RWDI, 2019a), odour sampling performed on September 19 (RWDI, 2019b), and the total reduced sulphur sampling performed on September 4, 2019 (RWDI, 2019b). The unremoved portion of odours from the bioreactors were added to the odour emission rate of the scrubber in scenario (a).

Modelled emission rates are provided in Table 1.



## Modelled Sources and Buildings

Map Projection: NAD 1983 UTM Zone 10N

Comox Valley Water Pollution Control Centre - Comox, B.C.

True North



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Figure: 2

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**Table 1: Modelled Emission Rates**

| Emission Source       | Source Type    | Surface Area (m <sup>2</sup> ) | Emission Flux (OU/s/m <sup>2</sup> ) | Emission Rate (OU/s) |
|-----------------------|----------------|--------------------------------|--------------------------------------|----------------------|
| Scrubber/Stack        | Point          | -                              | -                                    | 3,051 <sup>1</sup>   |
|                       |                |                                |                                      | 3,287 <sup>2</sup>   |
| Secondary Bioreactors | Area           | 1320.0                         | 1,26 <sup>1</sup>                    | 1,663 <sup>1</sup>   |
|                       |                |                                | 0.0 <sup>2</sup>                     | 0.0 <sup>2</sup>     |
| Secondary Clarifier 1 | Area           | 368.5                          | 0.0888                               | 32.5                 |
| Secondary Clarifier 2 | Area           | 366.0                          | 0.0888                               | 32.5                 |
| Secondary Clarifier 3 | Area           | 382.0                          | 0.0888                               | 32.5                 |
| All Sources           | Point and Area | 2436.5                         | -                                    | 4,812 <sup>1</sup>   |
|                       |                |                                |                                      | 3,385 <sup>2</sup>   |

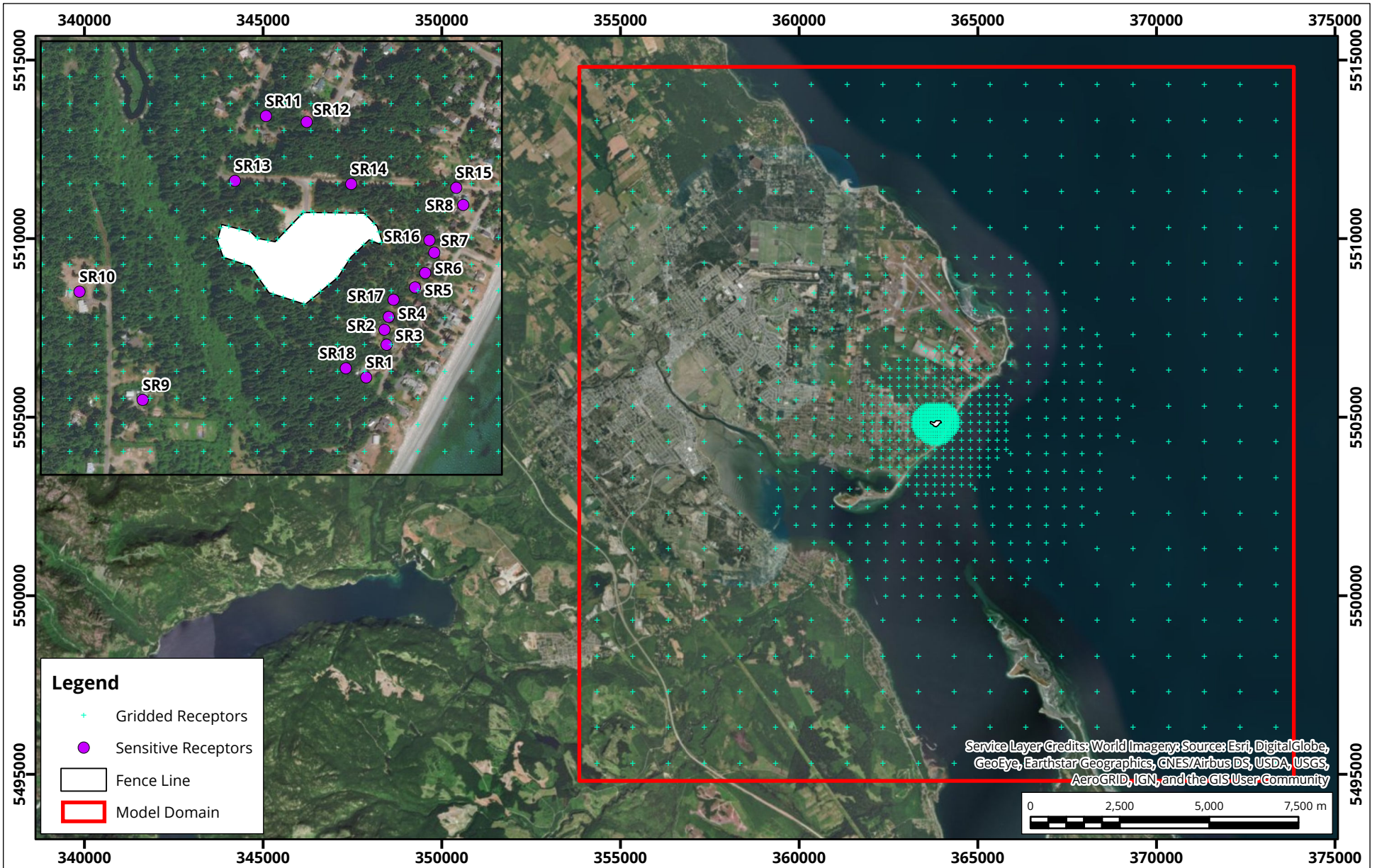
Notes: Primary clarifiers have been recently covered and emissions are routed to the scrubber emissions.  
 1. Presents emissions for current configuration; and scenario (a) = current configuration with a low (6.6 m) stack height  
 2. Presents emissions for mitigation scenario (b): current configuration with the secondary bioreactors covers and emissions routed to the scrubber stack

## 2.2 Meteorological Data

Meteorological data file from the previous study was used in this assessment. Meteorological information for CALPUFF was provided using a single station ISC-type meteorological data file. This was developed from measurements for the model period of 2014 from the Courtenay station that is part of the BC MOE network of stations. As per the BC AQDMG the mixing heights were derived using the ‘plume+1’ approximation and surface meteorological data.

## 2.3 Model Domain

In accordance with the BC AQDMG, a 20 km by 20 km CALPUFF model domain shown in Figure 3, was selected to capture the effects of facility operations on ambient odour levels. Model predictions are reported at discrete receptor locations within this domain.



## Receptors and Modelling Domain

Map Projection: NAD 1983 UTM Zone 10N

Comox Valley Water Pollution Control Centre - Comox, B.C.

True North



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Approx. Scale: 1:150,000

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## 2.4 Receptors

Receptor locations were chosen in accordance with BC AQDMG. Local elevation data were used to determine receptor elevations so that topography in the area of the facility is properly represented. Terrain elevations for all other receptors included as input to the CALPUFF model were extracted from 1:50,000 scale Canadian Digital Elevation Data obtained from GeoGratis.

Receptor spacing for the Cartesian grid is as follows:

- 20-m spacing along the terminal fence line;
- 50-m spacing within 500 m of the terminal;
- 250-m spacing within 2 km of the terminal;
- 500-m spacing within 5 km of the terminal; and
- 1,000-m spacing for the remainder of the study area.

Twelve special receptors were identified as the nearest residences in various directions from the CVWPCC property boundary and were used in the previous modelling. For this study, 6 additional receptors were added at the CVWPCC property boundary. Locations of all sensitive receptors are shown in Figure 3. Please note that the Ontario odour guideline does not apply at the property line. The guideline applies at sensitive odour receptors, in this case the residences.

## 2.5 Post-processing of Model Results

Post-processing of hourly model results was conducted to determine required results for comparison with odour standards. Model results are expressed as odour units (OU) and represent worst-case values over the 1 year of meteorological data.

The modelled concentrations were converted from 1-hour based averages to a 10-minute averaging time (typical for odour assessments) using a 1.65 conversion factor as per the Ministry of the Environment, Conservation and Parks (MECP), formerly Ontario Ministry of Environment and Climate Change, guidance document Methodology for Modelling Assessments of Contaminants with 10-Minute Average Standards and Guidelines (MECP, 2016). Frequencies of exceedances from the 1 OU, 2 OU and 5 OU thresholds are also calculated.

## 3 MODEL RESULTS

Numerical modelling is a conservative approach, it represents the worst-case scenario and is the preferred protocol in Ontario by the MECP and other jurisdictions. This is currently the only guideline value in any Canadian jurisdiction, so it has been used in this study, though strictly speaking it does not apply. It also is only meant to be applied at critical receptors such as residences and is not applied at the fence line.

### 3.1 Current Configuration

Isopleths showing the maximum predicted 10-minute average odour levels are presented in Figure 4. The maximum odour levels were predicted to occur at the property as expected. The area where maximum odour level was predicted to be greater than 1 OU extends ~1 km from the CVWPCC. The MECP odour guideline allows for the odour levels to exceed the 1OU threshold for 0.5% of times or 44 hours per year. Isopleths showing the frequency of exceedance from the 1 OU threshold are presented in Figure 5.

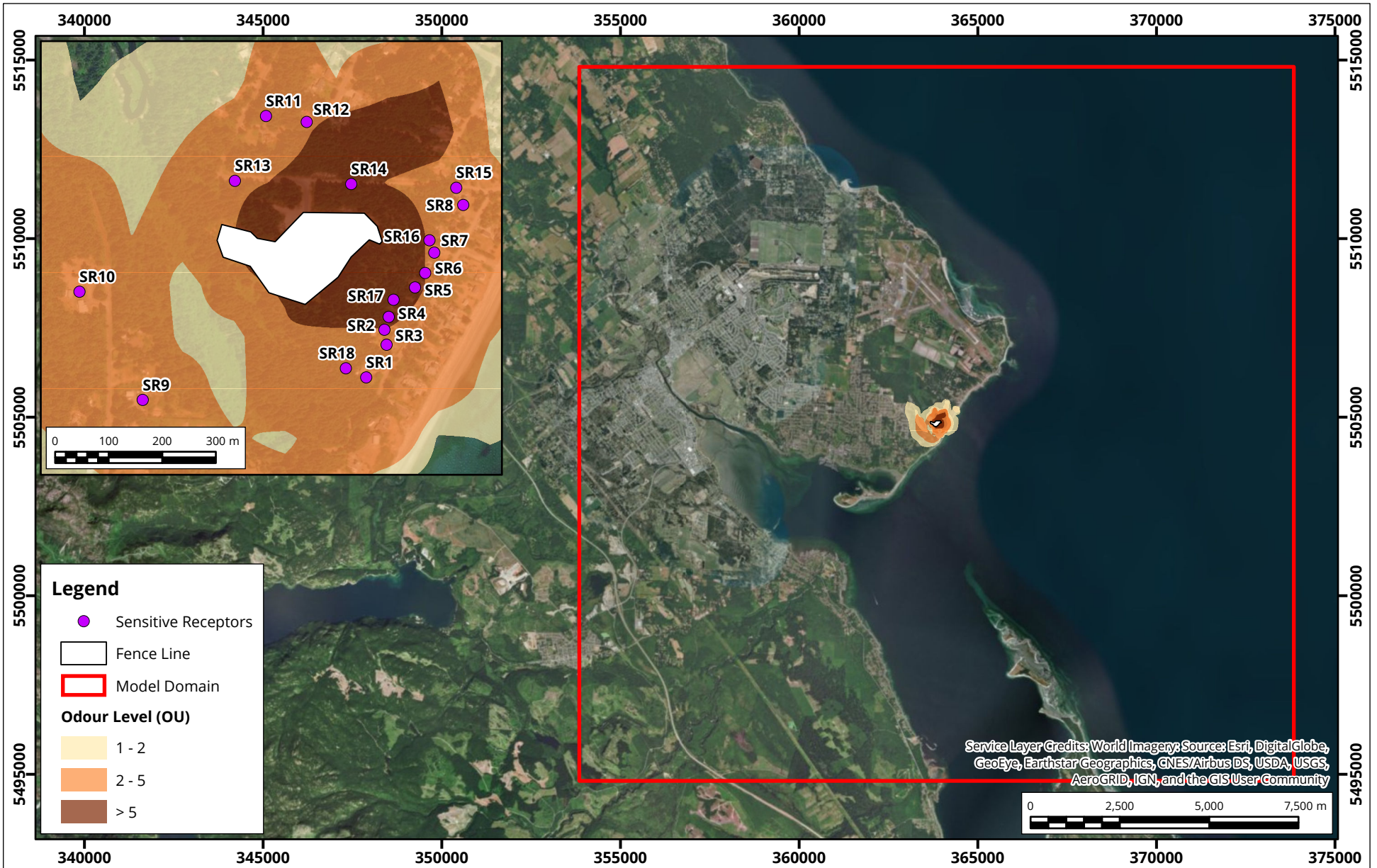
Maximum predicted 10-minute average odour levels and the frequency of exceeding the 1OU and 5 OU thresholds at all sensitive receptors are presented in Table 2. Results from the previous study are also presented for comparison. At all sensitive receptors except SR1, SR18 and SR9, the frequencies of exceedance from the 1 OU threshold were greater than the MECP guideline of 0.5% or 44 hours per year. At 2 OU, the exceedance percentage of 0.5% was exceeded for 10 sensitive receptors. At 5 OU the exceedance percentage of 0.5% was exceeded for only 2 sensitive receptors. The sensitive receptor with the greatest predicted odour level is SR14 to the north of the facility.

### 3.2 Additional Scenarios

In addition to the current configuration of the facility, 2 additional scenarios were modelled: (a) current configuration with the stack removed (i.e., release at building height), and (b) a modified configuration where it was assumed that the secondary bioreactor is covered, and its emissions are redirected to the scrubber/polisher and released through the stack. The modelling results for these additional scenarios are also shown in Table 2. Removal of the stack, resulted in an increase of the off-site odour levels, while covering the bioreactors and mitigating their emissions through the scrubber resulted in reduced off-site odour levels.

For the existing configuration, compared to the previous modelling results, maximum predicted odour levels were decreased for all sensitive receptors. This is mainly attributed to the mitigation measures applied by the CVWPCC; with the addition of the activated carbon polisher to the scrubber stack, the emission rates from the stack were reduced significantly. In addition, the primary clarifier was covered and therefore not present in this round of modelling.

To better understand the effect of each source on the off-site odour levels, and also to evaluate the effectiveness of the applied mitigation measures, maximum contribution of each source to odour levels are presented in Table 3. As can be seen in Table 3, the secondary bioreactor has the highest impact on the off-site odour levels. Also, removing the stack, or removing the scrubber, will adversely affect the odour levels.



## Maximum Predicted Odour Levels for the Current Facility Configuration

Map Projection: NAD 1983 UTM Zone 10N

Comox Valley Water Pollution Control Centre - Comox, B.C.

True North



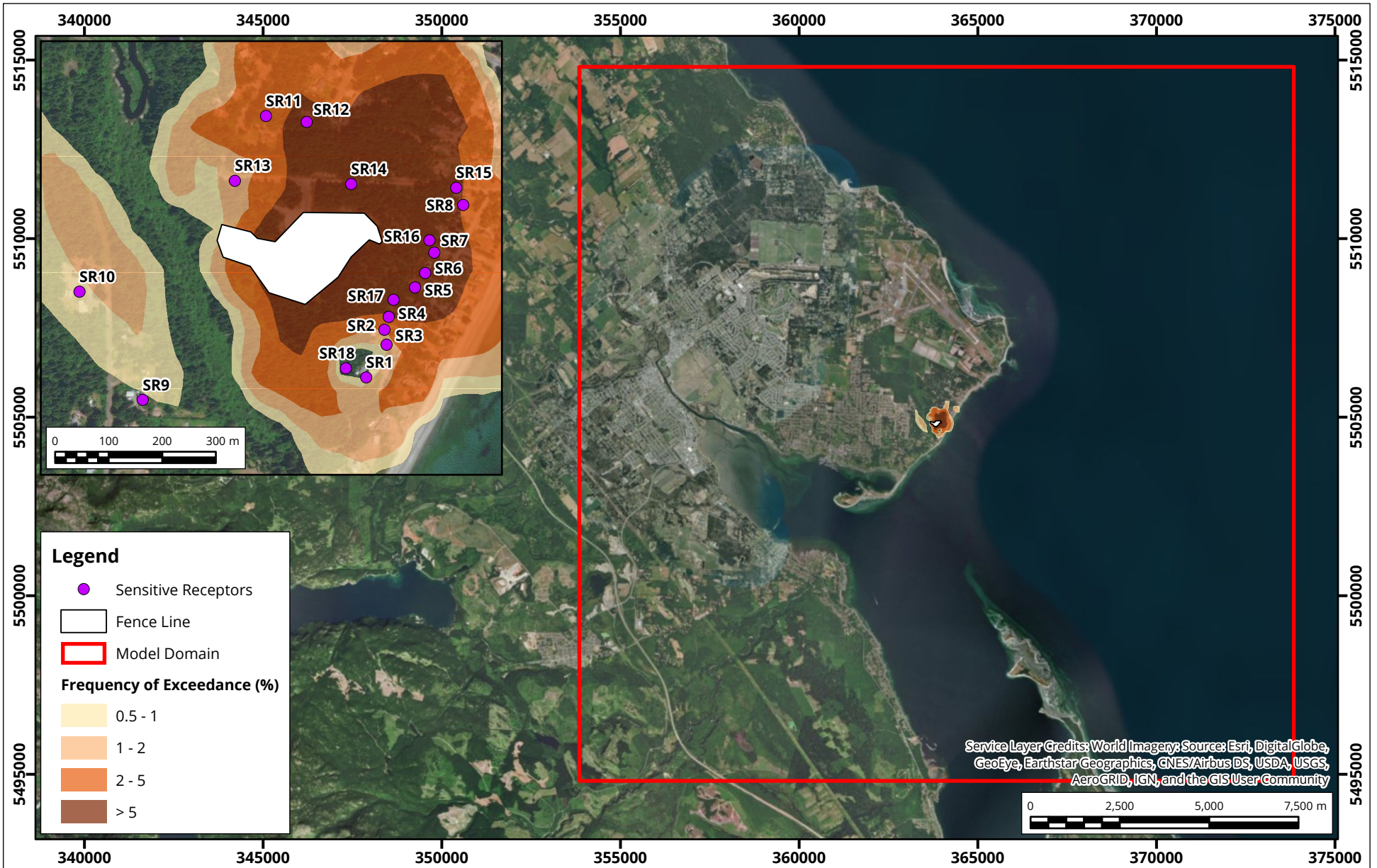
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Approx. Scale: 1:150,000

Date Revised: Oct 8, 2019

Project #: 1904012





## Frequency of Exceedances from 1 OU Threshold for the Current Facility Configuration



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| Approx. Scale: 1:150,000  |           |
| Date Revised: Oct 8, 2019 |           |



Map Projection: NAD 1983 UTM Zone 10N

Comox Valley Water Pollution Control Centre - Comox, B.C.

Project #: 1904012



**Table 2: Maximum Predicted Odour Levels at Sensitive Receptors based on 10-minute averaging period and Frequency of Exceedance from 1 OU, 2 OU and 5 OU Thresholds**

| Sensitive Receptor | Lat     | Lon      | Previous Model |                              | Odour Level (OU) |              |              | Frequency of 1 OU Exceedance (%) |              |              | Frequency of 2 OU Exceedance (%) |              |              | Frequency of 5 OU Exceedance (%) |              |              |
|--------------------|---------|----------|----------------|------------------------------|------------------|--------------|--------------|----------------------------------|--------------|--------------|----------------------------------|--------------|--------------|----------------------------------|--------------|--------------|
|                    |         |          | Odour Level    | Freq. of 1 OU Exceedance (%) | Current config.  | Scenario (a) | Scenario (b) | Current config.                  | Scenario (a) | Scenario (b) | Current config.                  | Scenario (a) | Scenario (b) | Current config.                  | Scenario (a) | Scenario (b) |
| SR1                | 363.95  | 5504.593 | 5.45           | 4.1                          | 1.33             | 1.33         | 0.32         | 0.15%                            | 0.16%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR2                | 363.984 | 5504.683 | 6.8            | 13.7                         | 5.01             | 5.01         | 0.37         | 1.82%                            | 2.04%        | 0.00%        | 0.59%                            | 0.61%        | 0.00%        | 0.01%                            | 0.01%        | 0.00%        |
| SR3                | 363.988 | 5504.654 | 5.9            | 10.8                         | 3.75             | 3.76         | 0.35         | 0.82%                            | 0.88%        | 0.00%        | 0.13%                            | 0.14%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR4                | 363.992 | 5504.707 | 8.5            | 16.3                         | 6.12             | 6.13         | 0.38         | 4.58%                            | 5.19%        | 0.00%        | 2.04%                            | 2.13%        | 0.00%        | 0.10%                            | 0.10%        | 0.00%        |
| SR5                | 364.041 | 5504.762 | 11.1           | 18.4                         | 4.95             | 5.71         | 0.40         | 9.08%                            | 9.52%        | 0.00%        | 4.41%                            | 4.90%        | 0.00%        | 0.00%                            | 0.07%        | 0.00%        |
| SR6                | 364.06  | 5504.789 | 10.6           | 17.3                         | 4.74             | 5.55         | 0.41         | 8.53%                            | 8.84%        | 0.00%        | 4.01%                            | 4.65%        | 0.00%        | 0.00%                            | 0.06%        | 0.00%        |
| SR7                | 364.077 | 5504.827 | 10.0           | 15.9                         | 4.17             | 4.94         | 0.48         | 7.39%                            | 7.69%        | 0.00%        | 3.24%                            | 3.88%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR8                | 364.131 | 5504.916 | 9.7            | 11.7                         | 2.94             | 3.45         | 0.59         | 3.73%                            | 4.27%        | 0.00%        | 0.46%                            | 0.90%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR9                | 363.533 | 5504.551 | 4.57           | 0.8                          | 3.35             | 3.36         | 0.38         | 0.46%                            | 0.46%        | 0.00%        | 0.08%                            | 0.08%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR10               | 363.415 | 5504.753 | 5.22           | 2.6                          | 3.28             | 3.29         | 0.40         | 0.86%                            | 0.89%        | 0.00%        | 0.24%                            | 0.24%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR11               | 363.763 | 5505.082 | 6.54           | 11.4                         | 2.55             | 2.55         | 0.45         | 3.07%                            | 3.20%        | 0.00%        | 0.19%                            | 0.19%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR12               | 363.839 | 5505.07  | 7.7            | 15.6                         | 6.27             | 6.27         | 0.47         | 7.04%                            | 7.18%        | 0.00%        | 4.60%                            | 4.60%        | 0.00%        | 0.92%                            | 0.92%        | 0.00%        |
| SR13               | 363.705 | 5504.96  | -              | -                            | 3.71             | 3.71         | 0.51         | 1.46%                            | 1.46%        | 0.00%        | 0.40%                            | 0.40%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR14               | 363.922 | 5504.955 | -              | -                            | 7.18             | 7.18         | 0.50         | 10.27%                           | 10.79%       | 0.00%        | 8.58%                            | 8.60%        | 0.00%        | 2.44%                            | 2.45%        | 0.00%        |
| SR15               | 364.118 | 5504.947 | -              | -                            | 2.91             | 3.46         | 0.59         | 7.39%                            | 7.84%        | 0.00%        | 1.60%                            | 2.00%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |
| SR16               | 364.068 | 5504.85  | -              | -                            | 4.40             | 5.27         | 0.57         | 7.42%                            | 7.76%        | 0.00%        | 3.44%                            | 3.93%        | 0.00%        | 0.00%                            | 0.03%        | 0.00%        |
| SR17               | 364.001 | 5504.738 | -              | -                            | 6.41             | 6.55         | 0.42         | 8.90%                            | 9.35%        | 0.00%        | 5.09%                            | 5.61%        | 0.00%        | 0.49%                            | 0.51%        | 0.00%        |
| SR18               | 363.912 | 5504.61  | -              | -                            | 1.53             | 1.53         | 0.32         | 0.21%                            | 0.21%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        | 0.00%                            | 0.00%        | 0.00%        |

Notes: Scenario (a) = current configuration with a low (6.6 m) stack height  
Scenario (b) = current configuration with the secondary bioreactors covers and emissions routed to the scrubber stack



Table 3: Odour Levels and Frequencies of Exceedance Resulting from each Individual Source

| Sensitive Receptor | Odour Levels (OU) |             |                       |                      | Frequency of Exceedances from 1 OU |             |                       |                      |
|--------------------|-------------------|-------------|-----------------------|----------------------|------------------------------------|-------------|-----------------------|----------------------|
|                    | 17 m Stack        | 6.6 m Stack | Secondary Bioreactors | Secondary Clarifiers | 17 m Stack                         | 6.6 m Stack | Secondary Bioreactors | Secondary Clarifiers |
| SR1                | 0.37              | 0.76        | 1.27                  | 0.07                 | 0.00%                              | 0.00%       | 0.11%                 | 0.00%                |
| SR2                | 0.40              | 1.21        | 4.94                  | 0.11                 | 0.00%                              | 0.02%       | 1.75%                 | 0.00%                |
| SR3                | 0.39              | 1.09        | 3.73                  | 0.08                 | 0.00%                              | 0.02%       | 0.79%                 | 0.00%                |
| SR4                | 0.40              | 1.10        | 6.06                  | 0.26                 | 0.00%                              | 0.01%       | 4.26%                 | 0.00%                |
| SR5                | 0.42              | 1.32        | 4.85                  | 0.35                 | 0.00%                              | 0.15%       | 8.31%                 | 0.00%                |
| SR6                | 0.43              | 1.26        | 4.27                  | 0.30                 | 0.00%                              | 0.13%       | 7.74%                 | 0.00%                |
| SR7                | 0.43              | 1.17        | 3.66                  | 0.25                 | 0.00%                              | 0.15%       | 6.70%                 | 0.00%                |
| SR8                | 0.53              | 1.25        | 2.54                  | 0.16                 | 0.00%                              | 0.07%       | 2.79%                 | 0.00%                |
| SR9                | 0.36              | 0.40        | 3.18                  | 0.17                 | 0.00%                              | 0.00%       | 0.42%                 | 0.00%                |
| SR10               | 0.37              | 0.68        | 3.10                  | 0.18                 | 0.00%                              | 0.00%       | 0.79%                 | 0.00%                |
| SR11               | 0.49              | 1.29        | 2.43                  | 0.18                 | 0.00%                              | 0.10%       | 2.83%                 | 0.00%                |
| SR12               | 0.48              | 1.42        | 5.91                  | 0.36                 | 0.00%                              | 0.11%       | 6.77%                 | 0.00%                |
| SR13               | 0.50              | 0.64        | 3.66                  | 0.25                 | 0.00%                              | 0.00%       | 1.36%                 | 0.00%                |
| SR14               | 0.45              | 1.61        | 6.80                  | 0.38                 | 0.00%                              | 0.33%       | 9.95%                 | 0.00%                |
| SR15               | 0.56              | 1.33        | 2.53                  | 0.16                 | 0.00%                              | 0.18%       | 6.40%                 | 0.00%                |
| SR16               | 0.45              | 1.33        | 3.91                  | 0.26                 | 0.00%                              | 0.19%       | 6.50%                 | 0.00%                |
| SR17               | 0.42              | 1.23        | 6.33                  | 0.42                 | 0.00%                              | 0.07%       | 8.16%                 | 0.00%                |
| SR18               | 0.37              | 0.68        | 1.46                  | 0.08                 | 0.00%                              | 0.00%       | 0.19%                 | 0.00%                |



## 4 CONCLUSIONS AND RECOMMENDATIONS

RWDI was retained by the Comox Valley Regional District (CVRD) to conduct an odour assessment for the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC. A dispersion model was used to assess the impact of recent mitigation measures used by CVWPCC which included adding an activated charcoal polisher downstream of the current wet scrubber system and covering the primary clarifiers which are tied in with the current scrubbing system.

The results of the odour sampling part of the assessment were presented in two separate memos (RWDI, 2019a & 2019b), and were used in the current dispersion modelling. The model results show that the mitigation measures successfully reduced the off-site odour impact from the scrubber/stack.

One additional scenario for the stack/scrubber was modelled to estimate the impacts of the scrubber and stack height on off-site odour predictions. The results showed that decreasing the stack height will adversely affect the off-site odour levels, and therefore, it is not recommended.

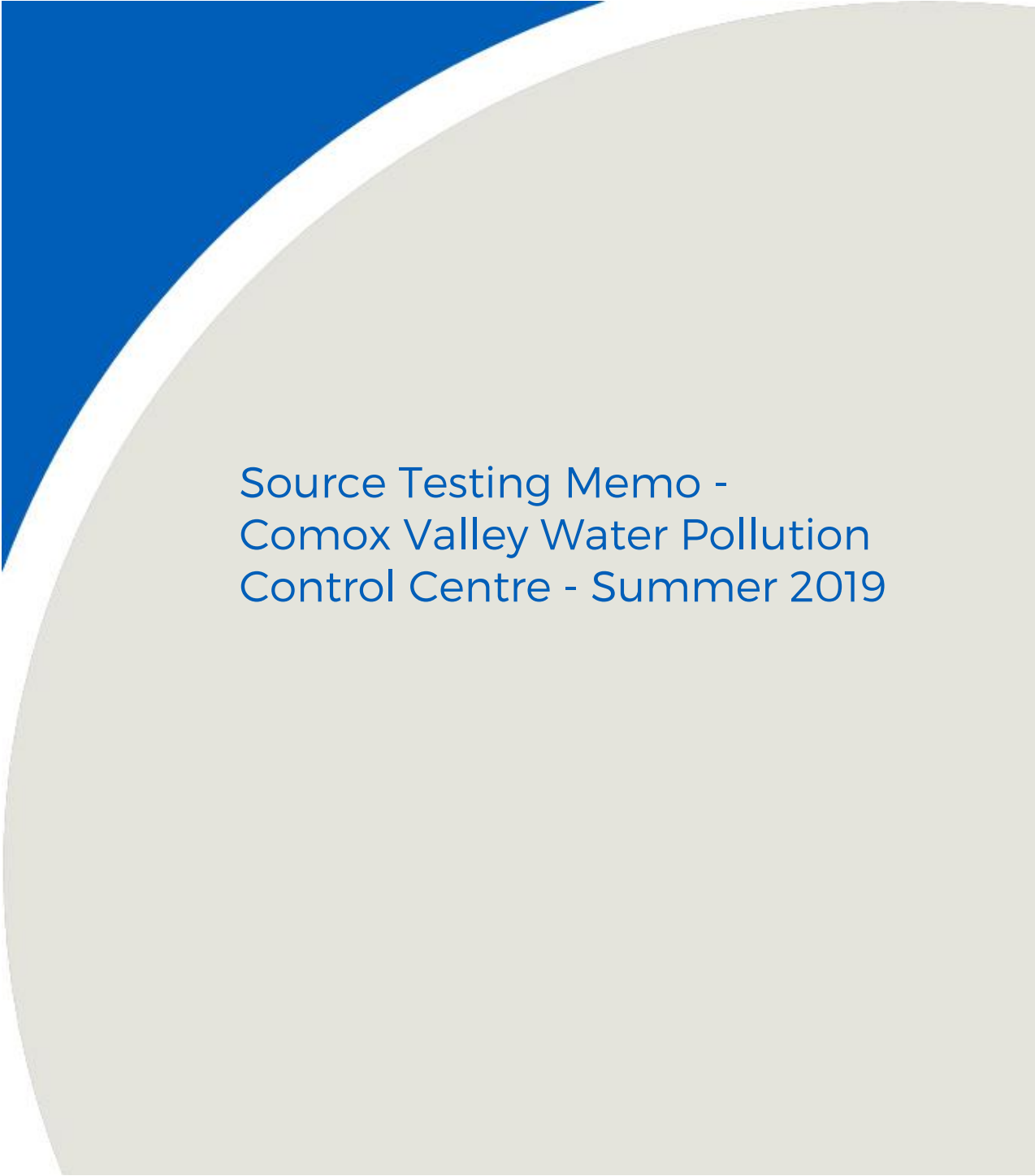
In addition, a mitigation scenario was modelled to investigate a mitigation measure where the secondary bioreactors are covered, and their emissions are rerouted to the scrubber stack for removal. Modelling results predicted that applying this measure will successfully eliminate odour exceedances at the sensitive receptors.



## 5 REFERENCES

- British Columbia Ministry of Environment (BC MOE), 2015. *Environment British Columbia Air Quality Dispersion Modelling Guideline*, Environmental Protection Division, Environmental Standards Branch, Clean Air Section. Victoria, British Columbia. November 2015.
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## APPENDIX A

A large decorative graphic on the left side of the page, featuring a blue triangle in the top-left corner and a large, light-grey semi-circle that overlaps the triangle and extends across the page.

Source Testing Memo -  
Comox Valley Water Pollution  
Control Centre - Summer 2019



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## MEMORANDUM

|              |  |                            |  |
|--------------|--|----------------------------|--|
| <b>DATE:</b> | 2019-07-31   | <b>RWDI Reference No.:</b> | 1904012  |
| <b>TO:</b>   | Zoe Berkey   | <b>EMAIL:</b>              | <a href="mailto:zberkey@comoxvalleyrd.ca">zberkey@comoxvalleyrd.ca</a> |
| <b>FROM:</b> | Matthew Sawycky  | <b>EMAIL:</b>              | <a href="mailto:matthew.sawycky@rwdi.com">matthew.sawycky@rwdi.com</a> |
| <b>CC:</b>   | John DeYoe   | <b>EMAIL:</b>              | <a href="mailto:john.deyoe@rwdi.com">john.deyoe@rwdi.com</a>           |
| <b>CC:</b>   | William Clarke   | <b>EMAIL:</b>              | <a href="mailto:william.clarke@rwdi.com">william.clarke@rwdi.com</a>   |
| <b>RE:</b>   | <b>Source Testing Memo - Comox Valley Water Pollution Control Centre - Summer 2019<br/>Comox, BC</b> |                            |  |

Zoe,

Please find this memorandum for methodology and results from testing at the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC (the facility).

RWDI conducted sampling at the facility on June 17<sup>th</sup> and 18<sup>th</sup>, 2019. Samples were collected for laboratory analysis of:

- odour,
- ammonia,
- chlorine and,
- sulfur compounds (list of sulfur compounds tested can be seen in Appendix A)

### **Odour Emissions Sampling Methodology**

As RWDI has the previous odour sampling results, August 2016, only sampling on the upgraded odour control system was completed. Engineering and design changes since August 2016 include the elimination of the prior open primary clarifiers, and an addition of an activated carbon polisher, after the wet chemical scrubber.

Sampling the upgraded odour control system was conducted to provide odour unit (OU) values for subsequent dispersion modelling to be conducted.



Sampling was conducted at:

1. odour control inlet (3 samples)
2. odour control outlet (3 samples)
3. odour control outlet, with scrubber turned off (3 samples)
4. bioreactor sampling (3 samples)

### **Inlet and Outlet Sampling**

The odour samples were collected through pre-existing sample ports, located at the inlet and outlet of the odour control unit using a lung sampler. The lung sampler utilizes a large container with an airtight lid and two air line fittings. A Tedlar bag is inserted into the container and a sample line is connected to the Tedlar bag. A vacuum is then applied to the cavity in the container which, through pressure differential, draws the sample air into the Tedlar sample bag; the sample bag was filled at a rate of less 5 L/min.

### **Flux Chamber Sampling**

Sampling at the bioreactor was conducted using a flux chamber.

Odour emissions from the waste water surface were measured using a floating flux chamber. The flux chamber is 40.6 cm in diameter; and approximately 35 cm high, and constructed of 14-gauge stainless steel, as per the designer's specifications outlined in Ontario Stack Testing Code Method ON-6. All interior and exterior fittings are constructed from odour neutral material being stainless steel and all lines were made from Teflon tubing with some variance at connections. The flux chamber is equipped with ports: one for sweep gas line and one for sample line. The chamber is fitted with a floatation device to hold it on top of the surface.

Ultra high purity nitrogen gas was used as the sweep gas, which was metered into the chamber at a constant rate of 5 litres per minute. The sweep gas was allowed to run through the chamber for 30 minutes prior to sample collection.

The odour samples were collected through a sample port on the flux chamber into a Tedlar bag using a lung sampler. The sample bag was filled at a rate of less 5 L/min in order to not significantly affect the equilibrium of the chamber.



## Odour Sample Analysis

Once collected, the samples were air shipped to Pinchin Ltd. Environmental Consulting, in Mississauga Ontario, for analysis by an eight-member odour panel within 24-hours of testing. The panel is tested prior to the odour analysis and the members are screened to have normal odour sensitivity. Details about the odour panel methodology are contained in Appendix B: Odour Evaluation Report from Pinchin Ltd.

Once the odour concentration of the samples has been determined, the odour flux rate is calculated. The sweep gas rate is used to calculate the odour flux rate based on the total air movement into the chamber. The formula that was used to calculate the odour flux rate is as follows:

$$\text{Odour Flux Rate} \left( \frac{\text{ou}}{\text{s} \cdot \text{m}^2} \right) = \frac{\text{Odour Concentration} \left( \frac{\text{ou}}{\text{m}^3} \right) \cdot \text{Sweep Rate} \left( \frac{\text{m}^3}{\text{s}} \right)}{\text{Area of flux chamber} (\text{m}^2)}$$

The odour flux rates from the bioreactor were simply averaged and the flux rate was applied to the total surface area of the bioreactor clarifiers.

## Chemical Compounds Sampling Methodology

At the request of CVWPCC, sampling was conducted for ammonia, chlorine and sulfur compounds. Sampling locations were requested by CVWPCC and included:

1. the inlet of bioreactor 1
2. the inlet of bioreactor 2 and,
3. the effluent outlet.

### Ammonia

Ammonia collection was conducted using ALS laboratory supplied silica tube media. Air was drawn from the flux chamber through the sample media at 200mL/min for 20 minutes, using a GilAir pump to collect the sample.

### Chlorine

Chlorine collection was conducted using ALS laboratory supplied cassette media. Air was drawn from the flux chamber through the sample media at 1L/min for 20 minutes, using a GilAir pump to collect the sample



## **Sulfur Compounds**

Sulfur compounds collection was conducted using ALS laboratory supplied vacuum canister media. Air was drawn from the flux chamber into the vacuum canister media at 300mL/min for 20 minutes to collect the sample

## **Chemical Analysis**

Ammonia, Chlorine and Sulfur media was sent to ALS Environmental in Burnaby BC for analysis. Details about the analysis methodology are contained in Appendix C: Certificate of Analysis, ALS Environmental.

## **Odour Results**

The testing program was completed on June 18<sup>th</sup>, 2019, using the techniques described in the methodology section. The odour lab results are summarized in Table 1; the complete laboratory analysis report can be found in Appendix B, a summary of results table provided by Pinchin Ltd. can be found in Appendix D. Field notes from the sampling program can be found in Appendix E.



**Table 1: Odour Laboratory Analysis Sample Results**

| Location                          | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Odour Emission Rate (OU/s) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/s) | Average (OU/m <sup>2</sup> /s) |
|-----------------------------------|-----------------|-----------------|--------------------------------|----------------------------|---|----------------|--------------------------------|
| <b>Odour Control Inlet Test 1</b> | 3514            | 1 : 1           | 3514                           | 37346.42                   | N/A   | 32570.95       | N/A                            |
| <b>Odour Control Inlet Test 2</b> | 3222            | 1 : 1           | 3222                           | 34243.07                   | N/A   |                |                                |
| <b>Odour Control Inlet Test 3</b> | 2485            | 1 : 1           | 2458                           | 26123.36                   | N/A   |                |                                |
| <b>Outlet Scrubber ON Test 1</b>  | 806             | 1 : 1           | 806                            | 8566.08                    | N/A   | 10649.15       | N/A                            |
| <b>Outlet Scrubber ON Test 2</b>  | 958             | 1 : 1           | 958                            | 10181.52                   | N/A   |                |                                |
| <b>Outlet Scrubber ON Test 3</b>  | 1242            | 1 : 1           | 1242                           | 13199.84                   | N/A   |                |                                |
| <b>Outlet Scrubber OFF Test 1</b> | 1611            | 1 : 1           | 1611                           | 17121.54                   | N/A   | 18202.04       | N/A                            |
| <b>Outlet Scrubber OFF Test 2</b> | 1611            | 1 : 1           | 1611                           | 17121.54                   | N/A   |                |                                |
| <b>Outlet Scrubber OFF Test 3</b> | 1916            | 1 : 1           | 1916                           | 20363.04                   | N/A   |                |                                |
| <b>Bioreactor Test 1</b>          | 1045            | 5 : 1           | 5225                           | N/A                        | 3.36  | N/A            | 7.54                           |
| <b>Bioreactor Test 2</b>          | 2485            | 5 : 1           | 12425                          | N/A                        | 7.98  |                |                                |
| <b>Bioreactor Test 3</b>          | 3514            | 5 : 1           | 17570                          | N/A                        | 11.29   |                |                                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.



## Chemical Results

The testing program for ammonia (NH<sub>3</sub>), chlorine (Cl) and sulfur compounds was completed on June 17<sup>th</sup>, 2019, using the techniques described in the methodology section. The lab results are summarized in Table 2 through 4; the complete laboratory analysis report can be found in Appendix C. Field notes from the sampling program can be found in Appendix E.

**Table 2: Ammonia Analysis Sample Results**

| Location           | Start Time | End Time | Ammonia (as NH <sub>3</sub> ) ppm | Ammonia (as NH <sub>3</sub> ) µg |
|--------------------|------------|----------|-----------------------------------|----------------------------------|
| Bioreactor 1 Inlet | 13:34      | 13:54    | < 0.36                            | < 1.0                            |
| Bioreactor 2 Inlet | 14:36      | 14:56    | < 0.36                            | < 1.0                            |
| Effluent Outlet    | 15:46      | 16:06    | 0.40                              | 1.1                              |
| Detection Limit    |            |          | <b>0.36</b>                       | <b>1.0</b>                       |

**Table 3: Chlorine Analysis Sample Results**

| Location           | Start Time | End Time | Chlorine ppm | Chlorine mg/m <sup>3</sup> |
|--------------------|------------|----------|--------------|----------------------------|
| Bioreactor 1 Inlet | 13:34      | 13:54    | < 0.086      | < 0.25                     |
| Bioreactor 2 Inlet | 14:36      | 14:56    | < 0.086      | < 0.25                     |
| Effluent Outlet    | 15:46      | 16:06    | < 0.086      | < 0.25                     |
| Detection Limit    |            |          | <b>0.086</b> | <b>0.25</b>                |



**Table 4: Sulfur Analysis Sample Results**

| Sulfur Compounds                 | Detection Limit | Units             | Bioreactor 1 Inlet | Bioreactor 2 Inlet | Effluent Outlet |
|----------------------------------|-----------------|-------------------|--------------------|--------------------|-----------------|
| n-Butyl mercaptan                | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| n-Butyl mercaptan                | 15              | ug/m <sup>3</sup> | <15                | <15                | <15             |
| Butyl(t) mercaptan               | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Butyl(t) mercaptan               | 15              | ug/m <sup>3</sup> | <15                | <15                | <15             |
| Carbon Disulfide                 | 2.0             | ppb(V)            | <2.0               | <2.0               | <2.0            |
| Carbon Disulfide                 | 6.2             | ug/m <sup>3</sup> | <6.2               | <6.2               | <6.2            |
| Carbonyl sulfide                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Carbonyl sulfide                 | 9.8             | ug/m <sup>3</sup> | <9.8               | <9.8               | <9.8            |
| Diethyl disulfide                | 2.0             | ppb(V)            | <2.0               | <2.0               | <2.0            |
| Diethyl disulfide                | 10              | ug/m <sup>3</sup> | <10                | <10                | <10             |
| Diethyl Sulfide                  | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Diethyl Sulfide                  | 15              | ug/m <sup>3</sup> | <15                | <15                | <15             |
| Dimethyl disulfide               | 2.0             | ppb(V)            | 6.2                | <2.0               | <2.0            |
| Dimethyl disulfide               | 7.7             | ug/m <sup>3</sup> | 23.8               | <7.7               | <7.7            |
| Dimethyl sulfide                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Dimethyl sulfide                 | 10              | ug/m <sup>3</sup> | <10                | <10                | <10             |
| 2,5-Dimethylthiophene            | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| 2,5-Dimethylthiophene            | 18              | ug/m <sup>3</sup> | <18                | <18                | <18             |
| Ethyl mercaptan                  | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Ethyl mercaptan                  | 10              | ug/m <sup>3</sup> | <10                | <10                | <10             |
| Ethyl Methyl Sulfide             | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Ethyl Methyl Sulfide             | 12              | ug/m <sup>3</sup> | <12                | <12                | <12             |
| 2-Ethylthiophene                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| 2-Ethylthiophene                 | 18              | ug/m <sup>3</sup> | <18                | <18                | <18             |
| Hydrogen Sulfide                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Hydrogen Sulfide                 | 5.6             | ug/m <sup>3</sup> | <5.6               | <5.6               | <5.6            |
| Isobutyl Mercaptan               | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Isobutyl Mercaptan               | 15              | ug/m <sup>3</sup> | <15                | <15                | <15             |
| Isopropyl Mercaptan              | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Isopropyl Mercaptan              | 12              | ug/m <sup>3</sup> | <12                | <12                | <12             |
| Methyl mercaptan                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Methyl mercaptan                 | 7.9             | ug/m <sup>3</sup> | <7.9               | <7.9               | <7.9            |
| 2-Methylthiophene                | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| 2-Methylthiophene                | 16              | ug/m <sup>3</sup> | <16                | <16                | <16             |
| 3-Methylthiophene                | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| 3-Methylthiophene                | 16              | ug/m <sup>3</sup> | <16                | <16                | <16             |
| Propyl mercaptan                 | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Propyl mercaptan                 | 12              | ug/m <sup>3</sup> | <12                | <12                | <12             |
| Tetrahydrothiophene              | 4.0             | ppb(V)            | <4.0               | <4.0               | <4.0            |
| Tetrahydrothiophene              | 14              | ug/m <sup>3</sup> | <14                | <14                | <14             |
| sec-Butyl Mercaptan + Thiophene  | 6.0             | ppb(V)            | <6.0               | <6.0               | <6.0            |
| sec-Butyl Mercaptan + Thiophene  | 21              | ug/m <sup>3</sup> | <21                | <21                | <21             |
| Total Reduced Sulfur (22) as H2S | 18              | ppb(V)            | <18                | <18                | <18             |
| Total Reduced Sulfur (22) as H2S | 25              | ug/m <sup>3</sup> | <25                | <25                | <25             |



Comox Valley Water Pollution Control Centre  
Comox Valley Regional District  
RWDI #1904012  
JULY 31, 2019

If you have any questions regarding these results, we would be happy to discuss them with you at any time in the future.

A handwritten signature in blue ink, appearing to read 'Matthew Sawycky', is positioned below the text. The signature is fluid and cursive.

Matthew Sawycky, B.Sc.  
Senior Project Manager

## APPENDIX A

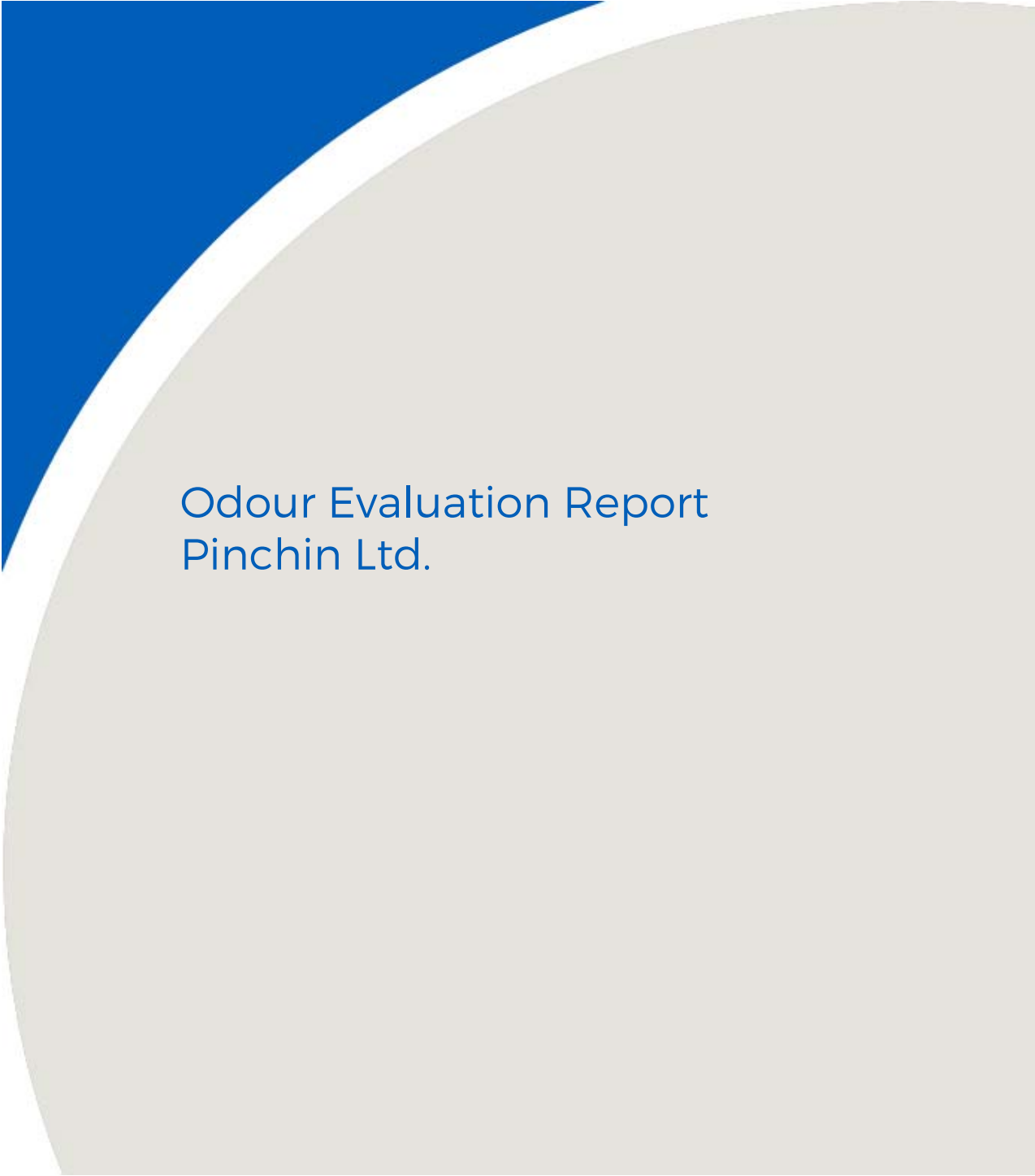
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### Sulfur Compound Test List

## ALS Environmental Sulfur Compound Analysis List

| Synonym                                       | RL Units | RL Units          |
|---|----------|-------------------|
|   | ppb(V)   | µg/m <sup>3</sup> |
| n-Butyl mercaptan                             | 4        | 14.8              |
| Butyl(t) mercaptan                            | 4        | 14.8              |
| Carbon Disulfide                              | 2        | 6.2               |
| Carbonyl sulfide                              | 4        | 9.8               |
| Diethyl disulfide                             | 2        | 10.0              |
| Diethyl Sulfide                               | 4        | 14.8              |
| Dimethyl disulfide                            | 2        | 7.7               |
| Dimethyl sulfide                              | 4        | 10.2              |
| 2,5-Dimethylthiophene                         | 4        | 18.4              |
| Ethyl mercaptan                               | 4        | 10.2              |
| Ethyl Methyl Sulfide                          | 4        | 18.4              |
| 2-Ethylthiophene                              | 4        | 18.4              |
| Hydrogen Sulfide                              | 4        | 5.6               |
| Isobutyl Mercaptan                            | 4        | 14.8              |
| Isopropyl Mercaptan                           | 4        | 12.5              |
| Methyl mercaptan                              | 4        | 7.9               |
| 2-Methylthiophene                             | 4        | 16.1              |
| 3-Methylthiophene                             | 4        | 16.1              |
| Propyl mercaptan                              | 4        | 12.5              |
| Tetrahydrothiophene                           | 4        | 14.4              |
| sec-Butyl Mercaptan + Thiophene               | 6        | 21.5              |
| Total Reduced Sulfur (22) as H <sub>2</sub> S | 4        | 5.6               |

## APPENDIX B

A large decorative graphic on the left side of the page, featuring a blue triangle in the top-left corner and a large, light-grey curved shape that overlaps the rest of the page.

# Odour Evaluation Report Pinchin Ltd.



FINAL

# Odour Evaluation Report

2470 Milltower Court  
Mississauga, ON  
L5N 7W5

Prepared for:

**Matthew Sawycky**  
RWDI  
60 Southgate Drive  
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June 19, 2019

Pinchin File: 202859-061919



**Issued to:** RWDI  
**Contact:** Matthew Sawycky

**Issued on:** June 19, 2019  
**Pinchin file:** 202859-061919  
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## APPENDICES

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| APPENDIX I  | Odour Evaluation Data Sheets       |
| APPENDIX II | Odour Evaluation Quality Assurance |



## 1.0 EVALUATION SAMPLE & TIMING SUMMARY

Pinchin Ltd. (Pinchin) was contracted to determine the detection threshold (DT) of air samples submitted to Pinchin's Odour Laboratory located in Mississauga, Ontario. The particulars of the odour panel were as follows:

|   |                                   |
|---|-----------------------------------|
| <b>Client Name:</b>                             | RWDI                              |
| <b>No. of Samples Delivered:</b>                | Twelve (12) samples               |
| <b>Date Samples Received:</b>                   | June 19, 2019                     |
| <b>Condition of the Sample Bags on Arrival:</b> | No leaks or condensation detected |
| <b>Session A</b>                                |                                   |
| <b>No. of Samples Analyzed:</b>                 | Eight (8)                         |
| <b>Date of Odour Panel Analysis:</b>            | June 19, 2019                     |
| <b>Time of Odour Panel Analysis:</b>            | 9:06 – 10:46 AM                   |
| <b>Session B</b>                                |                                   |
| <b>No. of Samples Analyzed:</b>                 | Four (4)                          |
| <b>Date of Odour Panel Analysis:</b>            | June 19, 2019                     |
| <b>Time of Odour Panel Analysis:</b>            | 10:47 – 11:38 AM                  |

## 2.0 METHODOLOGY

### 2.1 Laboratory Methodology

All samples were evaluated in accordance with the Ministry of the Environment, Conservation and Parks "Ontario Source Testing Code" (OSTC), Version #3, June 2010 (Part G, Method ON-6), using an AC'SCENT International triangular forced-choice, ascending concentration, dynamic dilution Olfactometer. A listing of Standard Practices to which the evaluations conform is provided in Appendix II.

The AC'SCENT Olfactometer was calibrated according to the manufacturer's guidelines on the day of sample evaluation. The CHEMFLUOR® PTFE tubing through which the odour sample is presented to the panellists was replaced prior to the assessment session. All sample delivery lines were purged continuously with odour free air between sample presentations.

A panel of eight trained assessors was employed in the evaluation of the odour samples. Each panel is screened for accuracy and repeatability following the procedures outlined in British Standard, BS EN 13725:2003, "Air quality – Determination of odour concentration by dynamic olfactometry", utilizing 50 ppm n-butanol calibration gas prior to sample evaluation. The geometric mean of the individual threshold estimates for 50 ppm n-butanol was determined to be between 20 and 80 ppb/v.

The odour samples were presented to the panellists using the "triangular forced-choice" method, described by ASTM E679-04, "Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits". Each panellist evaluated the odour by "sniffing" the diluted odour samples presented by the Olfactometer. At each dilution level, the panellist "sniffed" three sample presentations, two of which were blank, odour free samples and one that contained the odorous air. The panellist was then asked to identify which of the three presentations was different from the other two by recording a "guess", "detect" or "recognize" response as defined by ASTM E679-04.

A "guess" response was recorded when the assessor could not distinguish between any of the presentations. A "detect" response was recorded when the assessor could differentiate the odorous sample from the two blanks, and "recognize" was recorded when the assessor could identify and describe the odorous sample.

As per BS EN 13725:2003, each sample assessment began with the Olfactometer diluting the odorous sample to sub-detection levels. The odour sample and two blanks were then presented to one panellist, who "sniffed" the three presentations and recorded their response. The concentration of odorous gas was then doubled and re-presented to the same assessor with two blanks. Again, the assessor "sniffed" the three presentations and recorded their response. The process continued with the concentration of odorous gas increasing until the panellist had correctly detected the odour in at least two consecutive presentations as described by BS EN 13725:2003. The process was repeated for each panellist until all samples were evaluated.

Sample analysis was conducted "blind"; neither the panellist nor the test administrator knew which port would deliver the odour sample. Panellist's results were recorded and analyzed using AC'SCENT DataSense Olfactometry software integrated with the Olfactometer. The software incorporates an Access database program designed specifically for olfactometry laboratories and is compatible with international olfactometry standards including BS EN 13725:2003 and ASTM E679-04.

As part of laboratory Quality Assurance and Quality Control (QAQC), test results were retrospectively screened in accordance with BS EN 13725:2003. As the standard requires, each assessor's individual threshold estimate ( $Z_{ITE}$ ) was compared to the panel's average threshold, with the ratio between the individual threshold estimate and the panel average threshold represented as  $\Delta Z$ . Assessors having a  $\Delta Z$  greater than 5.0 or lower than -5.0, were eliminated from the results. The purpose was to exclude panel

members that showed deviant responses due to health factors or specific hypersomia or anosmia for the odour of the analyzed sample. Where screening was required, both the screened and unscreened results were provided.

## 2.2 Odour Evaluation Parameters

### 2.2.1 Odour Threshold Values – Detection Threshold (DT)

The detection threshold (DT) is the dilution ratio at which 50% of the panellists correctly detected the odour. DT, as defined by ASTM E679-04, is synonymous with the MOE Draft definition of an odour threshold value ( $ED_{50}$ ) and the BS EN 13725:2003 definition of odour concentration ( $C_{OD}$ ). That is, the DT represents the amount of dilution required for the odour to be just detectable. Since DT values are dimensionless, pseudo-dimensions of odour units per unit volume (i.e. odour units per cubic metre ( $ou/m^3$ )) are often used for reporting purposes.

In accordance with BS EN 13725:2003, individual threshold estimates ( $Z_{ITE}$ ) were calculated as the geometric mean of the lowest dilution ratio where the odour could not be detected and the dilution ratio at which the panellist correctly detected the odour. Where a detection response could not be established at the Olfactometer's dilution limit, it was assumed that the panellist would have detected the odour at a dilution ratio half that of the limit, and the  $Z_{ITE}$  was calculated. The sample odour concentration ( $C_{OD}$ ) was then calculated as the geometric mean of the  $Z_{ITE}$  values.

## 3.0 RESULTS

The odour threshold value results for detection threshold (DT) are presented in Table 1. Where appropriate, the DT values have been adjusted for field pre-dilution reported by the client. The adjusted DT values are recorded as  $DT_{NET}$ . Datasheets are provided in Appendix I.



Table 1 – Odour Threshold Value Results

Client: RWDI Test Reference No.: A202859-0619191  
 Pinchin Project No.: 202859 Evaluation Date: 19-Jun-19  
 Client Project No.: 1904012

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1563 | Bioreactor T1                | 5 :1               | 9:06 - 9:14 AM     | 1045      | 5225              |          |
| PO19-202859-S1564 | Bioreactor T2                | 5 :1               | 9:15 - 9:25 AM     | 2485      | 12425             |          |
| PO19-202859-S1565 | Bioreactor T3                | 5 :1               | 9:27 - 9:39 AM     | 3514      | 17570             |          |
| PO19-202859-S1566 | Outlet Scrub Off T1          | 1 :1               | 9:40 - 9:51 AM     | 1611      | 1611              |          |
| PO19-202859-S1567 | Outlet Scrub Off T2          | 1 :1               | 9:52 - 10:05 AM    | 1611      | 1611              |          |
| PO19-202859-S1568 | Outlet Scrub Off T3          | 1 :1               | 10:06 - 10:18 AM   | 1916      | 1916              |          |
| PO19-202859-S1569 | Outlet Scrub On T1           | 1 :1               | 10:19 - 10:32 AM   | 806       | 806               |          |
| PO19-202859-S1570 | Outlet Scrub On T2           | 1 :1               | 10:34 - 10:46 AM   | 958       | 958               |          |



Table 2 – Odour Threshold Value Results

Client: RWDI

Test Reference No.: B202859-0619191

Pinchin Project No.: 202859

Evaluation Date: 19-Jun-19

Client Project No.: 1904012

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1571 | Outlet Scrub On T3           | 1 :1               | 10:47 - 11:00 AM   | 1242      | 1242              |          |
| PO19-202859-S1572 | Inlet Scrub On T1            | 1 :1               | 11:01 - 11: 12 AM  | 3514      | 3514              |          |
| PO19-202859-S1573 | Inlet Scrub On T2            | 1 :1               | 11:13 - 11:25 AM   | 3222      | 3222              |          |
| PO19-202859-S1574 | Inlet Scrub On T3            | 1 :1               | 11:26 - 11:38 AM   | 2485      | 2485              |          |

**Odour Evaluation Report Nomenclature**

DT Detection Threshold

DT<sub>NET</sub> Detection Threshold adjusted for field dilution

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J:\202000s\0202859.000 RWDI,650Woodlawn,ENVNS,ODPNL\Odour Lab\2019\June 19, 2019\202859-061919 RWDI Odour Report.docx

Template: 14852 – Report Template for Detection Threshold Determination - September 19, 2014

**APPENDIX I**  
**Odour Evaluation Data Sheets**  
**Pinchin File: 202859-061919**  
**(12 Pages)**

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                                  |                                  |
|------------------------------------|----------------------------------|----------------------------------|
| <b>Sample Information</b>          |                                  | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1563</u> | Field No. : <u>Bioreactor T1</u> | Sampling Time : _____            |
| Description : <u>5:1</u>           | Sample Collector : <u>RWDI</u>   | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        | 2.57   | 2.57  |       |
| 14853-961 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 14853-1231 1    |        |        |        |        |        | 1      | 2      | 2      | 6      | 6      |        |        |        |        | 3.17   | 2.57  |       |
| 14853-956 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-946 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-954 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |

Sample Comments :

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

Response Key:

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

Final Results

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.17  | 3.02  | 0.00 |
| Std. Dev.      | 0.28  | 0.32  | 0.00 |
| Threshold      | 1,477 | 1,045 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                                  |                                  |
|------------------------------------|----------------------------------|----------------------------------|
| <b>Sample Information</b>          |                                  | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1564</u> | Field No. : <u>Bioreactor T2</u> | Sampling Time : _____            |
| Description : <u>5:1</u>           | Sample Collector : <u>RWDI</u>   | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66.846 | 33.423 | 16.712 | 8.356  | 4.178  | 2.089  | 1.045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-961 1     |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        |        | 4.07   | 3.47  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        | 3.77   | 3.17  |       |
| 14853-1231 1    |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77   | 3.47  |       |
| 14853-956 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        |        | 4.07   | 3.47  |       |
| 14853-954 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.66  | 3.40  | 0.00 |
| Std. Dev.      | 0.32  | 0.14  | 0.00 |
| Threshold      | 4,556 | 2,485 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1565 Field No. : Bioreactor T3 Sampling Date : 6/18/2019  
 Description : 5:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-961 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 2018-6 1        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-1232 1    |        |        |        | 1      | 2      | 2      | 6      | 6      |        |        |        |        |        |        | 3.77   | 3.17  |       |
| 14853-1231 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-956 1     |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        |        | 4.07   | 3.47  |       |
| 14853-946 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-954 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.70  | 3.55  | 0.00 |
| Std. Dev.      | 0.21  | 0.21  | 0.00 |
| Threshold      | 4,969 | 3,514 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1566 Field No. : Outlet Scrub. Off T1 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-961 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77   | 3.47  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1232 1    |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-1231 1    |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-956 1     |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-946 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77   | 3.47  |       |
| 14853-954 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.36  | 3.21  | 0.00 |
| Std. Dev.      | 0.32  | 0.19  | 0.00 |
| Threshold      | 2,278 | 1,611 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |   |                                  |
|------------------------------------|---|----------------------------------|
| <b>Sample Information</b>          |   | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1567</u> | Field No. : <u>Outlet Scrub. Off T2</u> | Sampling Time : _____            |
| Description : <u>1:1</u>           | Sample Collector : <u>RWDI</u>          | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66.846 | 33.423 | 16.712 | 8.356  | 4.178  | 2.089  | 1.045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-961 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1231 1    |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-956 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-954 1     |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.24  | 3.21  | 0.00 |
| Std. Dev.      | 0.14  | 0.11  | 0.00 |
| Threshold      | 1,757 | 1,611 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-203859-S1568 Field No. : Outlet Scrub. Off T3 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-961 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 2018-6 1        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-1232 1    |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 14853-1231 1    |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        | 3.77   | 3.17  |       |
| 14853-956 1     |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        | 3.77   | 3.17  |       |
| 14853-946 1     |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-954 1     |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.51  | 3.28  | 0.00 |
| Std. Dev.      | 0.25  | 0.28  | 0.00 |
| Threshold      | 3,222 | 1,916 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1569 Field No. : Outlet Scrub. On T1 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-961 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 2018-6 1        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1232 1    |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1231 1    |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 14853-956 1     |        |        |        |        |        | 1      | 1      | 2      | 6      | 6      |        |        |        |        | 2.87   | 2.57  |       |
| 14853-946 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-954 1     |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.98 | 2.91 | 0.00 |
| Std. Dev.      | 0.16 | 0.19 | 0.00 |
| Threshold      | 958  | 806  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1570 Field No. : Outlet Scrub. On T2 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66.846 | 33.423 | 16.712 | 8.356  | 4.178  | 2.089  | 1.045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        | 2.57   | 2.57  |       |
| 14853-961 1     |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 2018-6 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1231 1    |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-956 1     |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |
| 14853-946 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-954 1     |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D    | R    |
|----------------|-------|------|------|
| Avg. Log Value | 3.13  | 2.98 | 0.00 |
| Std. Dev.      | 0.30  | 0.28 | 0.00 |
| Threshold      | 1,355 | 958  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1571 Field No. : Outlet Scrub. On T3 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-961 1     |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 2018-6 1        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        | 2.87   | 2.87  |       |
| 14853-1232 1    |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1231 1    |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77   | 3.47  |       |
| 14853-956 1     |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        | 3.47   | 2.87  |       |
| 14853-946 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-954 1     |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        | 3.17   | 2.87  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n./a  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.28  | 3.09  | 0.00 |
| Std. Dev.      | 0.28  | 0.21  | 0.00 |
| Threshold      | 1,916 | 1,242 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1572 Field No. : Inlet Scrub ON T1 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-961 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 2018-6 1        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-1232 1    |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-1231 1    |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-956 1     |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-954 1     |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.55  | 3.55  | 0.00 |
| Std. Dev.      | 0.21  | 0.21  | 0.00 |
| Threshold      | 3,514 | 3,514 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019

Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1573 Field No. : Inlet Scrub ON T2 Sampling Date : 6/18/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66,846 | 33,423 | 16,712 | 8,356  | 4,178  | 2,089  | 1,045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-961 1     |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        |        | 4.07   | 3.77  |       |
| 2018-6 1        |        |        |        | 1      | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-1231 1    |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-956 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-954 1     |        |        |        | 2      | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.55  | 3.51  | 0.00 |
| Std. Dev.      | 0.31  | 0.25  | 0.00 |
| Threshold      | 3,514 | 3,222 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-061919 Test Date : 6/19/2019  
 Test Administrator : Rebecca Wakoli Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                                      |                                  |
|------------------------------------|--------------------------------------|----------------------------------|
| <b>Sample Information</b>          |                                      | Sampling Date : <u>6/18/2019</u> |
| Lab No. : <u>PO19-202859-S1574</u> | Field No. : <u>Inlet Scrub ON T3</u> | Sampling Time : _____            |
| Description : <u>1:1</u>           | Sample Collector : <u>RWDI</u>       | Sample Source : <u>unknown</u>   |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>6/19/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|-------|-------|
| Sample Volume   | 0.30   | 0.61   | 1.21   | 2.42   | 4.84   | 9.7    | 19.4   | 38.7   | 77.42  | 157.5  | 314.2  | 628.6  | 1257   | 2514   |  |       |       |
| Total Volume    | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 | 20,221 |  |       |       |
| Dilution Ratio  | 66.846 | 33.423 | 16.712 | 8.356  | 4.178  | 2.089  | 1.045  | 522    | 261    | 128    | 64.4   | 32.2   | 16.1   | 8.0    |  |       |       |
| Geometric Mean  | 94,535 | 47,267 | 23,634 | 11,817 | 5,908  | 2,955  | 1,477  | 739    | 369    | 183    | 91     | 45.5   | 22.7   | 11.4   |  |       |       |
| Log (Geo. Mean) | 4.98   | 4.67   | 4.37   | 4.07   | 3.77   | 3.47   | 3.17   | 2.87   | 2.57   | 2.26   | 1.96   | 1.66   | 1.36   | 1.06   |  |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G  | Log D | Log R |
| 2018-2 1        |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-961 1     |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        |        |        | 4.07   | 3.47  |       |
| 2018-6 1        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47   | 3.17  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-1231 1    |        |        |        | 1      | 1      | 5      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |
| 14853-956 1     |        |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47   | 3.47  |       |
| 14853-946 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77   | 3.77  |       |
| 14853-954 1     |        |        |        | 2      | 1      | 1      | 6      | 6      |        |        |        |        |        |        | 3.17   | 3.17  |       |

Sample Comments :

**Specific Chemical Concentration Data**

Chemical : n/a

Concentration (ppm) : \_\_\_\_\_

**Response Key:**  
 1 = Incorrect Guess  
 2 = Correct Guess  
 5 = Incorrect Detection  
 6 = Correct Detection  
 7 = Incorrect Recognition  
 8 = Correct Recognition

| Final Results  | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.51  | 3.40  | 0.00 |
| Std. Dev.      | 0.30  | 0.21  | 0.00 |
| Threshold      | 3,222 | 2,485 | 1    |

**APPENDIX II**  
**Odour Evaluation Quality Assurance**  
**Pinchin File: 202859-061919**  
**(1 Page)**

## ODOUR EVALUATION QUALITY ASSURANCE

- Odour evaluations conducted at the Pinchin Odour Laboratory conform to the procedures outlined in the Ministry of the Environment, Conservation and Parks “Ontario Source Testing Code” (OSTC), Version #3, June 2010 (Part G, Method ON-6) and are in accordance with ASTM (American Society for Testing and Materials) Standard Practice E679-04, Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series of Limits.
- The AC’SCENT® Dynamic Dilution Forced-Choice Triangle Olfactometer complies with all aspects of the ASTM E679-04 standard as well as the operational requirements of the British Standard, BS EN 13725:2003, “Air quality – Determination of odour concentration by dynamic olfactometry”.
- The detection threshold values are reported as defined by ASTM E679-04 and BS EN 13725:2003.
- Assessors are selected and trained in accordance with BS EN 13725:2003.
- The Pinchin Odour Laboratory is managed based on the requirements of the International Organization for Standardization (ISO) International Standard ISO 17025:2005, “General requirements for the competence of testing and calibration laboratories”.
- Samples are consumed during the evaluation and all sample bags are destroyed 48 hours after transmittal of the Preliminary Odour Evaluation Results, unless otherwise specified.

## APPENDIX C

A large decorative graphic on the page. It features a blue triangular shape in the top-left corner, a white curved line separating it from a large light-grey circular area, and a white curved line separating the grey area from the rest of the page.

Certificate of Analysis  
ALS Environmental



RWDI AIR INC.  
ATTN: Matthew Sawycky  
#280 - 1385 West 8th Avenue  
Vancouver BC V6H 3V9

Date Received: 19-JUN-19  
Report Date: 09-JUL-19 13:10 (MT)  
Version: FINAL

Client Phone: 604-730-5688

## Certificate of Analysis

Lab Work Order #: L2295084  
Project P.O. #: 1904012-1000-100  
Job Reference:  
C of C Numbers: 17-830387  
Legal Site Desc:

Joanne Lee  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                            |                                | Sample ID    | L2295084-7                      | L2295084-8                      | L2295084-9                          |  |  |
|----------------------------|--------------------------------|--------------|---------------------------------|---------------------------------|-------------------------------------|--|--|
|                            |                                | Description  | Air                             | Air                             | Air                                 |  |  |
|                            |                                | Sampled Date | 17-JUN-19                       | 17-JUN-19                       | 17-JUN-19                           |  |  |
|                            |                                | Sampled Time | 13:58                           | 15:00                           | 16:06                               |  |  |
|                            |                                | Client ID    | CANISTER 01400-0326-BIOREACT T1 | CANISTER 01400-0003-BIOREACT T2 | CANISTER 01400-0373-EFFLUENT CH. T3 |  |  |
| Grouping                   | Analyte                        |              |                                 |                                 |                                     |  |  |
| <b>CANISTER</b>            |                                |              |                                 |                                 |                                     |  |  |
| <b>Sulfur Compounds</b>    | n-Butyl mercaptan (ppb(V))     | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | n-Butyl mercaptan (ug/m3)      | <15          | <15                             | <15                             |                                     |  |  |
|                            | Butyl(t) mercaptan (ppb(V))    | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Butyl(t) mercaptan (ug/m3)     | <15          | <15                             | <15                             |                                     |  |  |
|                            | Carbon Disulfide (ppb(V))      | <2.0         | <2.0                            | <2.0                            |                                     |  |  |
|                            | Carbon Disulfide (ug/m3)       | <6.2         | <6.2                            | <6.2                            |                                     |  |  |
|                            | Carbonyl sulfide (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Carbonyl sulfide (ug/m3)       | <9.8         | <9.8                            | <9.8                            |                                     |  |  |
|                            | Diethyl disulfide (ppb(V))     | <2.0         | <2.0                            | <2.0                            |                                     |  |  |
|                            | Diethyl disulfide (ug/m3)      | <10          | <10                             | <10                             |                                     |  |  |
|                            | Diethyl Sulfide (ppb(V))       | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Diethyl Sulfide (ug/m3)        | <15          | <15                             | <15                             |                                     |  |  |
|                            | Dimethyl disulfide (ppb(V))    | 6.2          | <2.0                            | <2.0                            |                                     |  |  |
|                            | Dimethyl disulfide (ug/m3)     | 23.8         | <7.7                            | <7.7                            |                                     |  |  |
|                            | Dimethyl sulfide (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Dimethyl sulfide (ug/m3)       | <10          | <10                             | <10                             |                                     |  |  |
|                            | 2,5-Dimethylthiophene (ppb(V)) | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | 2,5-Dimethylthiophene (ug/m3)  | <18          | <18                             | <18                             |                                     |  |  |
|                            | Ethyl mercaptan (ppb(V))       | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Ethyl mercaptan (ug/m3)        | <10          | <10                             | <10                             |                                     |  |  |
|                            | Ethyl Methyl Sulfide (ppb(V))  | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Ethyl Methyl Sulfide (ug/m3)   | <12          | <12                             | <12                             |                                     |  |  |
|                            | 2-Ethylthiophene (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | 2-Ethylthiophene (ug/m3)       | <18          | <18                             | <18                             |                                     |  |  |
|                            | Hydrogen Sulfide (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Hydrogen Sulfide (ug/m3)       | <5.6         | <5.6                            | <5.6                            |                                     |  |  |
|                            | Isobutyl Mercaptan (ppb(V))    | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Isobutyl Mercaptan (ug/m3)     | <15          | <15                             | <15                             |                                     |  |  |
|                            | Isopropyl Mercaptan (ppb(V))   | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Isopropyl Mercaptan (ug/m3)    | <12          | <12                             | <12                             |                                     |  |  |
|                            | Methyl mercaptan (ppb(V))      | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | Methyl mercaptan (ug/m3)       | <7.9         | <7.9                            | <7.9                            |                                     |  |  |
|                            | 2-Methylthiophene (ppb(V))     | <4.0         | <4.0                            | <4.0                            |                                     |  |  |
|                            | 2-Methylthiophene (ug/m3)      | <16          | <16                             | <16                             |                                     |  |  |
| 3-Methylthiophene (ppb(V)) | <4.0                           | <4.0         | <4.0                            |                                 |                                     |  |  |
| 3-Methylthiophene (ug/m3)  | <16                            | <16          | <16                             |                                 |                                     |  |  |
| Propyl mercaptan (ppb(V))  | <4.0                           | <4.0         | <4.0                            |                                 |                                     |  |  |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                         |   | Sample ID    | L2295084-7                      | L2295084-8                      | L2295084-9                          |  |  |
|-------------------------|---|--------------|---------------------------------|---------------------------------|-------------------------------------|--|--|
|                         |   | Description  | Air                             | Air                             | Air                                 |  |  |
|                         |   | Sampled Date | 17-JUN-19                       | 17-JUN-19                       | 17-JUN-19                           |  |  |
|                         |   | Sampled Time | 13:58                           | 15:00                           | 16:06                               |  |  |
|                         |   | Client ID    | CANISTER 01400-0326-BIOREACT T1 | CANISTER 01400-0003-BIOREACT T2 | CANISTER 01400-0373-EFFLUENT CH. T3 |  |  |
| Grouping                | Analyte                                   |              |                                 |                                 |                                     |  |  |
| <b>CANISTER</b>         |   |              |                                 |                                 |                                     |  |  |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  |              | <12                             | <12                             | <12                                 |  |  |
|                         | Tetrahydrothiophene (ppb(V))              |              | <4.0                            | <4.0                            | <4.0                                |  |  |
|                         | Tetrahydrothiophene (ug/m3)               |              | <14                             | <14                             | <14                                 |  |  |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  |              | <6.0                            | <6.0                            | <6.0                                |  |  |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   |              | <21                             | <21                             | <21                                 |  |  |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) |              | <18                             | <18                             | <18                                 |  |  |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  |              | <25                             | <25                             | <25                                 |  |  |
| <b>Miscellaneous</b>    | Batch Proof ID                            |              | 181025.121                      | 181105.232                      | 181025.126                          |  |  |
|                         | Canister ID                               |              | 01400-0326                      | 01400-0003                      | 01400-0373                          |  |  |
|                         | Pressure on Receipt (in Hg)               |              | 0.4                             | -1.8                            | 0.4                                 |  |  |
|                         | Regulator ID                              |              | N/A                             | N/A                             | N/A                                 |  |  |

# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                    |                | Sample ID    | L2295084-1                          | L2295084-2                          | L2295084-3                              | L2295084-4                            | L2295084-5                            |
|--------------------|----------------|--------------|-------------------------------------|-------------------------------------|---|---------------------------------------|---------------------------------------|
|                    |                | Description  | Air                                 | Air                                 | Air                                     | Air                                   | Air                                   |
|                    |                | Sampled Date | 17-JUN-19                           | 17-JUN-19                           | 17-JUN-19                               | 17-JUN-19                             | 17-JUN-19                             |
|                    |                | Sampled Time | 13:34                               | 14:36                               | 15:49                                   | 13:34                                 | 14:36                                 |
|                    |                | Client ID    | TUBE<br>78654000032-<br>BIOREACT T1 | TUBE<br>78654000039-<br>BIOREACT T2 | TUBE<br>78654000036-<br>EFFLUENT CH. T3 | CASSETTE T1-<br>BIOREACTOR 1<br>INLET | CASSETTE T2-<br>BIOREACTOR 2<br>INLET |
| Grouping           | Analyte        |              |                                     |                                     |   |                                       |                                       |
| <b>MISC.</b>       |                |              |                                     |                                     |   |                                       |                                       |
| <b>Field Tests</b> | Air volume (L) | 3.98         | 3.98                                | 3.98                                | 20                                      | 20                                    |                                       |

# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                    | <b>Sample ID</b><br><b>Description</b><br><b>Sampled Date</b><br><b>Sampled Time</b><br><b>Client ID</b> |    |  |  |  |
|--------------------|--|----|--|--|--|
|                    | L2295084-6<br>Air<br>17-JUN-19<br>15:49<br>CASSETTE T3-<br>EFFLUENT<br>CHANNEL                           |    |  |  |  |
| Grouping           | Analyte  |    |  |  |  |
| <b>MISC.</b>       |  |    |  |  |  |
| <b>Field Tests</b> | Air volume (L)   | 20 |  |  |  |

# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                             | Sample ID<br>Description<br>Sampled Date<br>Sampled Time<br>Client ID | L2295084-1<br>Air<br>17-JUN-19<br>13:34<br>TUBE<br>78654000032-<br>BIOREACT T1 | L2295084-2<br>Air<br>17-JUN-19<br>14:36<br>TUBE<br>78654000039-<br>BIOREACT T2 | L2295084-3<br>Air<br>17-JUN-19<br>15:49<br>TUBE<br>78654000036-<br>EFFLUENT CH. T3 |  |  |
|-----------------------------|---|--|--|--|--|--|
| Grouping                    | Analyte   |  |  |  |  |  |
| <b>TUBE</b>                 |   |  |  |  |  |  |
| <b>Anions and Nutrients</b> | Ammonia (as NH3) (ppm)  | <0.36  | <0.36  | 0.40   |  |  |
|                             | Ammonia (as NH3) (ug)   | <1.0   | <1.0   | 1.1  |  |  |

## Reference Information

### Test Method References:

| ALS Test Code   | Matrix   | Test Description                         | Method Reference**       |
|---|----------|--|--------------------------|
| <b>AIR VOLUME-ED</b>  | Misc.    | Air volume (L)                           | HYGIENE METHOD           |
| NOTE: When air concentrations of analytes are reported, they are based on air sampling information (air volume, sampling time, sampling flow rate) supplied by the client.  |          |  |                          |
| <b>CAN-DATA-WT</b>  | Canister | Canister Information                     | EPA TO-15                |
| Batch Proof ID, Canister ID, Pressure on Receipt, Regulator ID.   |          |  |                          |
| <b>NH3-ED</b>   | Tube     | Ammonia                                  | NIOSH 6015md-Colorimetry |
| The silica gel from the tube is desorbed with 0.2% sulfuric acid in ultra high purity water. Ammonia is determined using the automated phenate colorimetric method. Samples are not field blank corrected.  |          |  |                          |
| <b>REDUC-SULF-22-SCD-WT</b>   | Canister | 22 Reduced Sulfur Compounds by GC-SCD    | ASTM D5504               |
| This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.   |          |  |                          |
| Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.   |          |  |                          |
| <b>TRS-22-SCD-WT</b>  | Canister | Total Reduced Sulfur as H2S              | ASTM D5504               |
| This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.   |          |  |                          |
| Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.   |          |  |                          |
| <b>TRS22-SUM-CALC-WT</b>  | Canister | Total Reduced Sulfur as H2S (22 Comp'ds) | ASTM D5504               |
| This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. A volume of air sample is transferred from the canister to a preconcentrator system where the analytes are trapped & focused. The analytes are then thermally desorbed into a GC-SCD for analysis. Test results are not blank corrected unless indicated by a qualifier. Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager. |          |  |                          |

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location                           |
|----------------------------|---|
| WT                         | ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA |
| ED                         | ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA |

### Chain of Custody Numbers:

17-830387

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



**ANALYTICAL REPORT**  
**Amended-20190709**

Report Date: July 09, 2019

Joanne Lee  
ALS Environmental  
8081 Lougheed Hwy  
Burnaby, BC V5A 1W9  
CANADA

Phone: 604-253-4188 x 3220

E-mail: Joanne.Lee@alsglobal.com

Workorder: **34-1918441**

Client Project ID: L2295084  
Purchase Order: NA  
Project Manager: Jessica Helland

**Analytical Results**

|                              |                           |   |                     |                                      |
|------------------------------|---------------------------|---|---------------------|--------------------------------------|
| Sample ID: <b>L2295084-4</b> |                           | Collected: 06/17/2019   |                     |                                      |
| Lab ID: 1918441001           |                           | Received: 06/25/2019  |                     |                                      |
| <b>Method: NIOSH 6011</b>    |                           | <b>Media:</b> SKC 225-9006, Cleaned silver membrane filter, black poly cassette |                     | <b>Instrument:</b> IC05              |
|                              |                           | <b>Sampling Info:</b> Air Volume 20 L   |                     | <b>Analyzed:</b> 07/02/2019 (242677) |
| <b>Analyte</b>               | <b>Result (ug/sample)</b> | <b>Result (mg/m³)</b>   | <b>Result (ppm)</b> | <b>RL (ug/sample)</b>                |
| Chlorine                     | <5.0                      | <0.25   | <0.086              | 5.0                                  |

|                              |                           |   |                     |                                      |
|------------------------------|---------------------------|---|---------------------|--------------------------------------|
| Sample ID: <b>L2295084-5</b> |                           | Collected: 06/17/2019   |                     |                                      |
| Lab ID: 1918441002           |                           | Received: 06/25/2019  |                     |                                      |
| <b>Method: NIOSH 6011</b>    |                           | <b>Media:</b> SKC 225-9006, Cleaned silver membrane filter, black poly cassette |                     | <b>Instrument:</b> IC05              |
|                              |                           | <b>Sampling Info:</b> Air Volume 20 L   |                     | <b>Analyzed:</b> 07/02/2019 (242677) |
| <b>Analyte</b>               | <b>Result (ug/sample)</b> | <b>Result (mg/m³)</b>   | <b>Result (ppm)</b> | <b>RL (ug/sample)</b>                |
| Chlorine                     | <5.0                      | <0.25   | <0.086              | 5.0                                  |

|                              |                           |   |                     |                                      |
|------------------------------|---------------------------|---|---------------------|--------------------------------------|
| Sample ID: <b>L2295084-6</b> |                           | Collected: 06/17/2019   |                     |                                      |
| Lab ID: 1918441003           |                           | Received: 06/25/2019  |                     |                                      |
| <b>Method: NIOSH 6011</b>    |                           | <b>Media:</b> SKC 225-9006, Cleaned silver membrane filter, black poly cassette |                     | <b>Instrument:</b> IC05              |
|                              |                           | <b>Sampling Info:</b> Air Volume 20 L   |                     | <b>Analyzed:</b> 07/02/2019 (242677) |
| <b>Analyte</b>               | <b>Result (ug/sample)</b> | <b>Result (mg/m³)</b>   | <b>Result (ppm)</b> | <b>RL (ug/sample)</b>                |
| Chlorine                     | <5.0                      | <0.25   | <0.086              | 5.0                                  |

**Comments**

**Workorder: 1918441**

Report amended to correct air volume per client request. No raw data was changed.



# ANALYTICAL REPORT

**Amended-20190709**

Workorder: **34-1918441**

Client Project ID: L2295084

Purchase Order: NA

Project Manager: Jessica Helland

## Comments

**Quality Control: NIOSH 6011 - (HBN: 242677)**

The LCS/LCSD and all field samples were media blank corrected with the LMB result.

## Report Authorization (/S/ is an electronic signature that complies with 21 CFR Part 11)

| Method     | Analyst                               | Peer Review                                |
|------------|---------------------------------------|--|
| NIOSH 6011 | /S/ Nadjla Borges<br>07/02/2019 15:49 | /S/ Christopher Winter<br>07/02/2019 16:15 |

## Laboratory Contact Information

ALS Environmental  
960 W Levoy Drive  
Salt Lake City, Utah 84123

Phone: (801) 266-7700  
Email: alsit.lab@ALSGlobal.com  
Web: www.alssl.com

## General Lab Comments

The results provided in this report relate only to the items tested.  
Samples were received in acceptable condition unless otherwise noted.  
Samples have not been blank corrected unless otherwise noted.  
This test report shall not be reproduced, except in full, without written approval of ALS.

ALS provides professional analytical services for all samples submitted. ALS is not in a position to interpret the data and assumes no responsibility for the quality of the samples submitted.

All quality control samples processed with the samples in this report yielded acceptable results unless otherwise noted.

ALS is accredited for specific fields of testing (scopes) in the following testing sectors. The quality system implemented at ALS conforms to accreditation requirements and is applied to all analytical testing performed by ALS. The following table lists testing sector, accreditation body, accreditation number and website. Please contact these accrediting bodies or your ALS project manager for the current scope of accreditation that applies to your analytical testing.

| Testing Sector      | Accreditation Body (Standard) | Certificate Number  | Website   |
|---------------------|-------------------------------|---|---|
| Environmental       | PJLA (DoD ELAP)               | L17-506   | <a href="http://www.pjlab.com">http://www.pjlab.com</a>   |
|                     | PJLA (ISO 17025)              | L17-507-R1  | <a href="http://www.pjlab.com">http://www.pjlab.com</a>   |
|                     | Utah (TNI)                    | UT00953   | <a href="http://lams.nelac-institute.org/search">http://lams.nelac-institute.org/search</a>   |
|                     | Nevada (TNI)                  | UT00953201-1  | <a href="https://ndep.nv.gov/water/lab-certification">https://ndep.nv.gov/water/lab-certification</a>   |
|                     | Iowa (TNI)                    | IA# 376   | <a href="http://www.shl.uiowa.edu/labcert/idnr/">http://www.shl.uiowa.edu/labcert/idnr/</a>   |
|                     | Kansas                        | E-10416   | <a href="http://www.kdheks.gov/envlab/disclaimer.html">http://www.kdheks.gov/envlab/disclaimer.html</a>   |
|                     | Oklahoma (TNI)                | IJ# 9980  | <a href="http://www.deq.state.ok.us/CSDnew/labcert.htm">http://www.deq.state.ok.us/CSDnew/labcert.htm</a>   |
| Texas (TNI)         | T104704456-18-9               | <a href="https://www.tceq.texas.gov/assets/public/compliance/compliance_support/qa/txnelap_lab_list.pdf">https://www.tceq.texas.gov/assets/public/compliance/compliance_support/qa/txnelap_lab_list.pdf</a> |   |
| Industrial Hygiene  | AIHA (ISO 17025 & AIHA IHLAP) | 101574  | <a href="http://www.aihaaccreditedlabs.org">http://www.aihaaccreditedlabs.org</a>   |
|                     | DOECAP-AP                     | L18-606   | <a href="http://www.pjlab.com">http://www.pjlab.com</a>   |
|                     | Washington                    | C596  | <a href="https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Laboratory-Accreditation">https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Laboratory-Accreditation</a> |
| Dietary Supplements | PJLA (ISO 17025)              | L17-507-R1  | <a href="http://www.pjlab.com">http://www.pjlab.com</a>   |



## ANALYTICAL REPORT

**Amended-20190709**

Workorder: **34-1918441**

Client Project ID: L2295084

Purchase Order: NA

Project Manager: Jessica Helland

### Definitions

LOD = Limit of Detection = MDL = Method Detection Limit, A statistical estimate of method/media/instrument sensitivity.

LOQ = Limit of Quantitation = RL = Reporting Limit, A verified value of method/media/instrument sensitivity.

ND = Not Detected, Testing result not detected above the LOD or LOQ.

NA = Not Applicable.

\*\* No result could be reported, see sample comments for details.

< Means this testing result is less than the numerical value.

() This testing result is between the LOD and LOQ and has higher analytical uncertainty than values at or above the LOQ.





# AIR SAMPLING MEDIA REQUEST FORM



BR# 246457

|                       |                                       |                     |               |
|-----------------------|---------------------------------------|---------------------|---------------|
| CLIENT:               | RWDI / Comox Valley Regional District | CLIENT EXPECT DATE: | 06/13/2019    |
| CLIENT CONTACT:       | Matthew Sawycky (RWDI)                | ORDER TAKEN BY:     |               |
| CLIENT PROJECT:       | 1904012-1000-100                      | ORDER DATE:         | 06/14/2019    |
| DELIVERY TO:          |                                       | QUOTE #:            |               |
| TELEPHONE NUMBER:     | 604-730-5688 ext. 2639                | ORDER FILLED BY:    | RS            |
| SHIP TO/ATTENTION OF: |                                       | DATE COMPLETED:     | June 13, 2019 |

Shipping Method:  Ground: (4 business days to Western Canada, 2 business days to Winnipeg)  Express: (2 business days to Western Canada, 1 business day to WP)

External Courier

ALS Drivers:

Pickup at ALS Warehouse:

TAT Information: (select one)

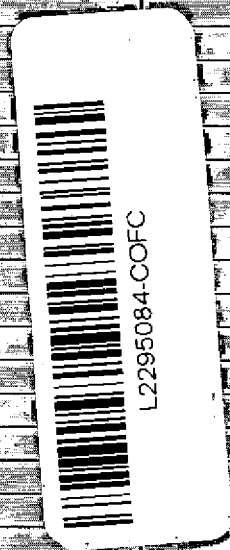
|  |                  |                |
|--|------------------|----------------|
| <input checked="" type="radio"/> Regular TAT | 10 Business Days | No surcharge   |
| <input type="radio"/> 5-day                  | 5 Business Days  | 50% surcharge  |
| <input type="radio"/> 3-day                  | 3 Business Days  | 100% surcharge |
| <input type="radio"/> 2-day                  | 2 Business Days  | 200% surcharge |
| <input type="radio"/> 1-day                  | 1 Business Day   | 300% surcharge |

ALL TAT except Regular requires Prior Confirmation

**Completion of all Sections is Mandatory**

1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawlspace; **OH&S** - Industrial, Commercial, Residential  comment: **Waste Water treatment Plant**
  2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**
  3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**
- This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:                 | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-------------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                         | 24 hr           |          |                           | 01400-0003 ✓                   |  |                             |
|                                     | 12 hr           |          |                           | 01400-0326 ✓                   |  |                             |
|                                     | 8 hr            |          |                           | 01400-0593 ✓                   |  |                             |
|                                     | 4 hr            |          |                           |                                |  |                             |
|                                     | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters                 |                 |          |                           |                                |  |                             |
| 1.4L Canister                       | 1 hr            |          |                           |                                |  |                             |
|                                     | 20 mins         |          |                           |                                |  |                             |
|                                     | 10 mins         |          |                           |                                |  |                             |
| Number of Canisters                 |                 | 3        |                           |                                |  |                             |
| Bottle Vacs                         | 1 hr            |          |                           |                                |  |                             |
|                                     | 20 mins         |          |                           |                                |  |                             |
|                                     | 10 mins         |          |                           |                                |  |                             |
| Number of Canisters                 |                 |          |                           |                                |  |                             |
| Passive CarboPak X Tubes            |                 |          |                           |                                |  |                             |
| Diffusive Caps                      |                 |          |                           |                                |  |                             |
| Active SVI Tubes                    |                 |          |                           |                                |  |                             |
| Concentration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |



| Other Sampling Supplies  | ID # | Quantity | Additional Information & Special Instructions or Requests   |
|--|------|----------|---|
| Pressure Gauge   |      |          | 3 canisters for reduced sulfur<br>3 adapters tedlar to canister<br><br>Note: No pressure gauges or MFC included w/ canisters. |
| Caplok Tool  |      |          |   |
| Canister Stands  |      |          |   |
| Valve Adaptor for Soil Vapour  |      |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS <input type="checkbox"/> |      |          |   |
| Chargeable Supplies  |      |          |   |
| Duplicate Sampler - \$40 ea / \$25 tube  |      |          |   |
| Teflon Tubing  |      |          |   |
| - Total length _____   |      |          |   |
| - Length per section _____   |      |          |   |
| \$3 per foot / \$6 per N+F set   |      |          |   |
| Siloxane Kit - \$45 each   |      |          |   |

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client.)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$850.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00



# THERMAL DESORPTION INFORMATION

HA  
6/19



L2295084-COFC

ALS File

1246457

|                |                        |
|----------------|------------------------|
| Date Returned: |                        |
| QC Check:      | <i>JK</i><br>Jun 13/19 |

(To be filled out by ALS upon return of samples to ALS)

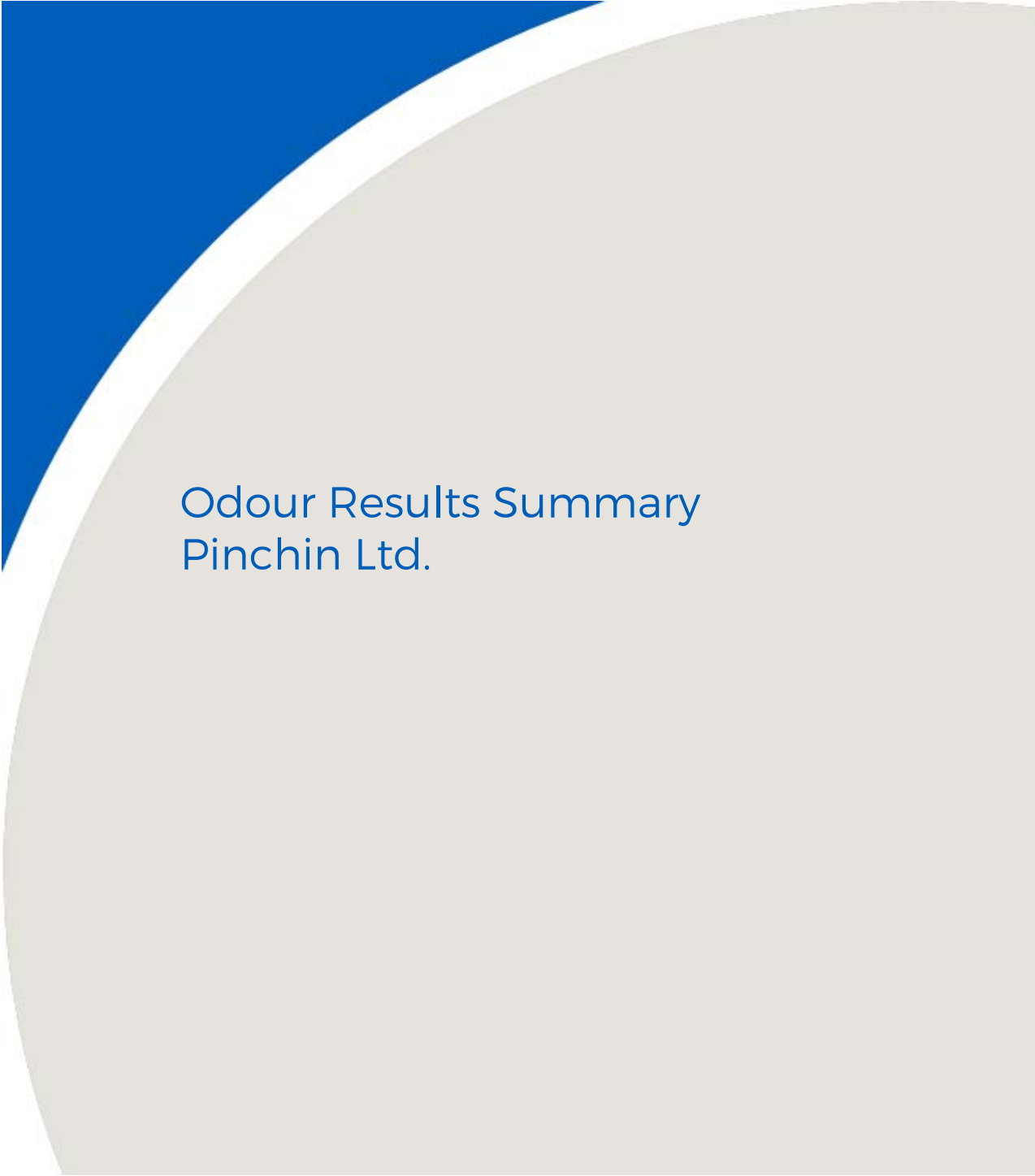
| 1. Sampling Supplies (To be filled out by ALS)                       |   |   |                 |
|--|---|---|-----------------|
| Company Name/Location:   | Comox Valley Regional District / RWDI   | Project/Job No:   | Not supplied    |
| Pump Requested By:   | Zoe Berkley   | Date of Request:  | June 13/19      |
| ALS Account Manager:   | Brent Mack  | Pump(s) Prepared By:  | <i>JK</i>       |
| # of Pumps (TD x 1 @ 1L/min):  | 1   | Date Required @ Shipping:   | June 14/19 noon |
| # of Pumps (TD x 1 @ 200mL/min):                                     | 1   | Flow Verification Tubes <u>1</u>                                      | Other           |
| Other Supplies Provided: 3 cassettes (chlorina) <u>1</u> tube cutter | Lithium-ion Battery Charger<br>Splitters & Tubing<br>Alkaline Battery Adapter | Pelican Case (Single)<br>Pelican Case (Multiple)<br>Additional Pumps: |                 |
| TD Tubes : 6 SG tubes for NH3  |   |   |                 |

| 2. Flow Rates (Flow rates before and after - ALS, flow rates in-situ - Client) |  |   |                                     |  |
|--|--|---|-------------------------------------|--|
| Pump ID  | Pump flow before sampling (mL/min) - ALS | Pump flow after sampling (mL/min) - ALS | Pump Flow in situ (mL/min) - CLIENT | Notes  |
| 1. 012473  | A 199<br>B                               | A<br>B                                  | A<br>B                              | ✓  |
| 2. 012471  | A 1006<br>B                              | A<br>B                                  | A<br>B                              | no moisture trap + low flow adaptor attached to achieve the 1L/min rate. |
| 3.   | A<br>B                                   | A<br>B                                  | A<br>B                              |  |
| 4.   | A<br>B                                   | A<br>B                                  | A<br>B                              |  |

If in-situ flow measurements have been provided, these will be used for all air concentrations calculations.

| 3. Sample Information (To be filled out by Client) |                  |        |                     |                 |                           |   |   |                          |
|--|------------------|--------|---------------------|-----------------|---------------------------|---|---|--------------------------|
| TD Tube Serial #                                   | Client Sample ID | Pump # | Sampling Time (min) | Date/Time       | Elevated Levels Expected? |   |   | Recvd @ Lab              |
|  |                  |        |                     |                 | Y                         | ? | N |                          |
| 1 7865400032                                       | Bio. React. T1   | 12473  | 20 min              | June 17 1:34 pm | X                         |   |   | ✓                        |
| 2 7865400039                                       | Bio React. T2    | 12473  | 20 min              | June 17 2:36 pm | X                         |   |   | ✓                        |
| 3 7865400036                                       | Effluent Ch. T3  | 12473  | 20 min              | June 17 3:49 pm |                           |   | X | ✓                        |
| 4 786500031  |                  |        |                     |                 |                           |   |   | ✓                        |
| 5 7865400038                                       |                  |        |                     |                 |                           |   |   | ✓                        |
| 6 7865400035                                       |                  |        |                     |                 |                           |   |   | ✓                        |
| 7  |                  |        |                     |                 |                           |   |   |                          |
| 8  |                  |        |                     |                 |                           |   |   |                          |
| 9  |                  |        |                     |                 |                           |   |   |                          |
| 10   |                  |        |                     |                 |                           |   |   |                          |
| 11   |                  |        |                     |                 |                           |   |   |                          |
| 12 7679700166                                      |                  |        |                     |                 |                           |   |   | Flow Verification tube ✓ |

## APPENDIX D

A decorative background featuring a large, light grey circle on the right side, partially overlapping a blue triangle on the left. The text is centered within the grey circle.

### Odour Results Summary Pinchin Ltd.

### Odour Evaluation Results

Client:                     RWDI                    

Test Reference No.:                     A202859-0619191                    

Pinchin Project No.:                     202859                    

Evaluation Date:                     19-Jun-19                    

Client Project No.:                     1904012                    

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1563 | Bioreactor T1                | 5 :1               | 9:06 - 9:14 AM     | 1045      | 5225              |          |
| PO19-202859-S1564 | Bioreactor T2                | 5 :1               | 9:15 - 9:25 AM     | 2485      | 12425             |          |
| PO19-202859-S1565 | Bioreactor T3                | 5 :1               | 9:27 - 9:39 AM     | 3514      | 17570             |          |
| PO19-202859-S1566 | Outlet Scrub Off T1          | 1 :1               | 9:40 - 9:51 AM     | 1611      | 1611              |          |
| PO19-202859-S1567 | Outlet Scrub Off T2          | 1 :1               | 9:52 - 10:05 AM    | 1611      | 1611              |          |
| PO19-202859-S1568 | Outlet Scrub Off T3          | 1 :1               | 10:06 - 10:18 AM   | 1916      | 1916              |          |
| PO19-202859-S1569 | Outlet Scrub On T1           | 1 :1               | 10:19 - 10:32 AM   | 806       | 806               |          |
| PO19-202859-S1570 | Outlet Scrub On T2           | 1 :1               | 10:34 - 10:46 AM   | 958       | 958               |          |

Client:                     RWDI                    

Test Reference No.:                     B202859-0619191                    

Pinchin Project No.:                     202859                    

Evaluation Date:                     19-Jun-19                    

Client Project No.:                     1904012                    

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1571 | Outlet Scrub On T3           | 1 :1               | 10:47 - 11:00 AM   | 1242      | 1242              |          |
| PO19-202859-S1572 | Inlet Scrub On T1            | 1 :1               | 11:01 - 11: 12 AM  | 3514      | 3514              |          |
| PO19-202859-S1573 | Inlet Scrub On T2            | 1 :1               | 11:13 - 11:25 AM   | 3222      | 3222              |          |
| PO19-202859-S1574 | Inlet Scrub On T3            | 1 :1               | 11:26 - 11:38 AM   | 2458      | 2458              |          |

<sup>\*</sup>DT<sub>net</sub> - Results have been adjusted for field dilution  
Presentation Flow Rate = 20 litres per minute

## APPENDIX E

A decorative graphic on the left side of the page. It features a blue triangular shape in the top-left corner, a white curved line separating it from a large grey curved shape that fills the rest of the left side of the page.

Field Notes

# — Odour Sampling Field Data —

Client: Comox Odour Survey  
 Project #: 1904012  
 Sample Locations: Bio Reactor  
 Date: June 18 2019  
 Dilution Gas: Nitrogen

| Dilution # | Sample I.D.   | Sample Pressure<br><del>100</del> | Motive Pressure<br>"H2O | Field Dilution | Flux in. Flux Scr. Pool |                  |                  | Time ON | OFF  | Tedlar Bag QA      |            |
|------------|---------------|-----------------------------------|-------------------------|----------------|-------------------------|------------------|------------------|---------|------|--------------------|------------|
|            |               |                                   |                         |                | Eductor Temp<br>°F      | Probe Temp<br>°F | Stack Temp<br>°F |         |      | Moisture?<br>(Y/N) | Leak Check |
| 1          | T1 Bioreactor | 1 LPM                             | 2.1                     | 5 LPM          | 73.6                    | 74.3             | 71.2             | 8:23    | 8:28 | N                  | ✓          |
|            | T2 Bioreactor | 1 LPM                             | 2.1                     | 5 LPM          | 73.6                    | 74.3             | 71.2             | 8:33    | 8:38 | N                  | ✓          |
|            | T3 Bioreactor | 1 LPM                             | 2.1                     | 5 LPM          | 73.6                    | 74.3             | 71.2             | 8:45    | 8:50 | N                  | ✓          |
| 2          |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
|            |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
| 3          |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
|            |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
| 4          |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
|            |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
| 5          |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |
|            |               |                                   |                         |                |                         |                  |                  |         |      |                    |            |

Comments

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# RWDI AIR Inc. Odour Sampling Datasheet

Date: June 18 2019  
 Wind Direction: ~~W~~ N  
 Wind Speed: 17 Km/h

Client: Comox  
 Location: Inlet/Outlet of Scrubber

PST

| Sample No.   | Sample Location    | Dilution | Sample Time | Tedlar Bag QA |            | Comments |
|--------------|--------------------|----------|-------------|---------------|------------|----------|
|              |                    |          |             | Moisture?     | Leak Check |          |
| T1 Outlet    | Outlet Scrub. off  | -        | 7:25        | NO            | ✓          |          |
| T2 Outlet    | Outlet Scrub. off  | -        | 7:35        | NO            | ✓          |          |
| T3 Outlet    | Outlet Scrub. off  | -        | 7:43        | NO            | ✓          |          |
| T1 Inlet     | Inlet Scrubber ON  | -        | 9:09        | NO            | ✓          |          |
| T2 Inlet     | Inlet Scrubber ON  | -        | 9:20        | NO            | ✓          |          |
| T3 Inlet     | Inlet Scrubber ON  | -        | 9:30        | NO            | ✓          |          |
| T1 Outlet ON | Outlet Scrubber ON | -        | 09:44       | NO            | ✓          |          |
| T2 Outlet ON | Outlet Scrubber ON | -        | 09:54       | NO            | ✓          |          |
| T3 Outlet ON | Outlet Scrubber ON | -        | 10:04       | NO            | ✓          |          |
|              |                    |          |             |               |            |          |
|              |                    |          |             |               |            |          |
|              |                    |          |             |               |            |          |
|              |                    |          |             |               |            |          |
|              |                    |          |             |               |            |          |

— NH<sub>3</sub>, Cl, and Canister Sampling Field Data —

Client: Comox WWTP  
 Project #: 1904012  
 Sample Locations: T1 (Inlet of Bioreactor 1)  
                           T2 (Inlet of Bioreactor 2)  
                           T3 (Effluent Outlet)  
 Date: 17-Jun-19  
 Dilution Gas: Nitrogen

T1  
T2  
T3

| Dilution # | Sample I.D. | LPM                               |                                   | Field Dilution | Eductor Temp °F | Probe Temp °F | Ambient       |         | Time ON | OFF   |
|------------|-------------|-----------------------------------|-----------------------------------|----------------|-----------------|---------------|---------------|---------|---------|-------|
|            |             | Sample Pressure #H <sub>2</sub> O | Motive Pressure "H <sub>2</sub> O |                |                 |               | Stack Temp °F | Temp °F |         |       |
| 1          | IAQ Tube #1 | .2 LPM                            | 2.4                               | 5 LPM          | 68.2            | 80.0          | 71.6          | 71.6    | 13:34   | 13:54 |
|            | Filter #1   | 1 LPM                             | 2.4                               | 5 LPM          | 68.2            | 80.0          | 71.6          | 71.6    | 13:34   | 13:54 |
|            | Can # 00955 | .3 LPM                            | 2.4                               | 5 LPM          | 68.2            | 80.0          | 71.6          | 71.6    | 13:35   | 14:00 |
| 2          | IAQ Tube #2 | .2                                | 2.0                               | 5 LPM          | 81.8            | 74.2          | 75.2          | 75.2    | 14:36   | 14:56 |
|            | Filter #2   | 1                                 | 2.0                               | 5 LPM          | 81.8            | 74.2          | 75.2          | 75.2    | 14:36   | 14:56 |
|            | Can # 103   | .3                                | 2.0                               | 5 LPM          | 81.8            | 74.2          | 75.2          | 75.2    | 15:00   | 15:05 |
| 3          | IAQ Tube #3 | .2                                | 2.2                               | 5 LPM          | 69.0            | 64.3          | 75.2          | 75.2    | 15:46   | 16:06 |
|            | Filter #3   | 1                                 | 2.2                               | 5 LPM          | 69.0            | 64.3          | 75.2          | 75.2    | 15:46   | 16:06 |
|            | Can # 6353  | .3                                | 2.2                               | 5 LPM          | 69.0            | 64.3          | 75.2          | 75.2    | 16:10   | 16:15 |
| 4          |             |                                   |                                   |                |                 |               |               |         |         |       |
| 5          |             |                                   |                                   |                |                 |               |               |         |         |       |

Comments

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## APPENDIX B

A large decorative graphic on the page, featuring a blue triangle in the top-left corner and a large, light-grey semi-circle that overlaps the triangle and extends across the middle and bottom of the page.

Source Testing Memo -  
Comox Valley Water Pollution  
Control Centre - September 2019



RWDI  
Suite 280, 1385 West 8th Avenue  
Vancouver BC Canada  
V6H 3V9

Tel: +1.604.730.5688  
E-mail: [solutions@rwdi.com](mailto:solutions@rwdi.com)

## MEMORANDUM

|              |   |                            |  |
|--------------|---|----------------------------|--|
| <b>DATE:</b> | 2019-10-04  | <b>RWDI Reference No.:</b> | 1904012  |
| <b>TO:</b>   | Zoe Berkey  | <b>EMAIL:</b>              | <a href="mailto:zberkey@comoxvalleyrd.ca">zberkey@comoxvalleyrd.ca</a> |
| <b>FROM:</b> | Matthew Sawycky   | <b>EMAIL:</b>              | <a href="mailto:matthew.sawycky@rwdi.com">matthew.sawycky@rwdi.com</a> |
| <b>CC:</b>   | John DeYoe  | <b>EMAIL:</b>              | <a href="mailto:john.deyoe@rwdi.com">john.deyoe@rwdi.com</a>           |
| <b>CC:</b>   | William Clarke  | <b>EMAIL:</b>              | <a href="mailto:william.clarke@rwdi.com">william.clarke@rwdi.com</a>   |
| <b>RE:</b>   | <b>Source Testing Memo - Comox Valley Water Pollution Control Centre - September 2019<br/>Comox, BC</b> |                            |  |

Zoe,

Please find this memorandum for methodology and results from testing at the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC (the facility).

RWDI conducted sampling at the facility on September 4<sup>th</sup>, 2019 for laboratory analysis of odour and total reduced sulfur (TRS), and September 19<sup>th</sup> for laboratory analysis of odour.

### Odour Emissions Sampling Methodology

#### September 4, 2019

Upon receipt of the odour value results collected in June, it was speculated that recent changes to the facilities operations prior to the sampling program may have resulted in higher than normal values. RWDI was commissioned to re-sample odour at the facility in early September.

Sampling was conducted to provide odour unit (OU) values as a comparison to June collected values and for subsequent dispersion modelling to be conducted.

Sampling was conducted at 3 points along each bioreactor pond, for a total of 6 samples.

#### September 19, 2019

CVWPCC expressed concern that collected OU analysis conducted on samples taken during the day may not be representative of OU values during the evening period, as the majority of residential



complaints are received in the evening hours. RWDI visited the facility to replicate the sample locations taken on September 4<sup>th</sup> during evening operations.

Sampling was conducted at the same 3 points along each bioreactor pond, for a total of 6 samples.

### **Flux Chamber Sampling**

Sampling at the bioreactor was conducted using a flux chamber.

Odour emissions from the waste water surface were measured using a floating flux chamber. The flux chamber is 40.6 cm in diameter; and approximately 35 cm high, and constructed of 14-gauge stainless steel, as per the designer's specifications outlined in Ontario Stack Testing Code Method ON-6. All interior and exterior fittings are constructed from odour neutral material being stainless steel and all lines were made from Teflon tubing with some variance at connections. The flux chamber is equipped with ports: one for sweep gas line and one for sample line. The chamber is fitted with a floatation device to hold it on top of the surface.

Ultra high purity nitrogen gas was used as the sweep gas, which was metered into the chamber at a constant rate of 5 litres per minute. The sweep gas was allowed to run through the chamber for 30 minutes prior to sample collection.

The odour samples were collected through a sample port on the flux chamber into a Tedlar bag using a lung sampler. The sample bag was filled at a rate of less 5 L/min in order to not significantly affect the equilibrium of the chamber.

### **Scrubber Outlet Sampling**

The odour samples were collected through a pre-existing sample port, located at the outlet of the odour control unit using a lung sampler. The lung sampler utilizes a large container with an airtight lid and two air line fittings. A Tedlar bag is inserted into the container and a sample line is connected to the Tedlar bag. A vacuum is then applied to the cavity in the container which, through pressure differential, draws the sample air into the Tedlar sample bag; the sample bag was filled at a rate of 5 L/min.

### **Odour Sample Analysis**

The samples collected on September 4<sup>th</sup> were air shipped to Pinchin Ltd. Environmental Consulting, in Mississauga Ontario, for analysis by an eight-member odour panel within 24-hours of testing (September 5, 2019). Details about the odour panel methodology are contained in Appendix A: Odour Evaluation Report Pinchin Ltd.



Pinchin Ltd. Environmental Consulting was unable to conduct any odour sampling during the week of September 16, so an alternate accredited laboratory was used.

The samples collected on September 19<sup>th</sup> were air shipped to Environmental Odour Consulting Corporation, in Oakville Ontario, for analysis by an eight-member odour panel within 24-hours of testing (September 20, 2019). Details about the odour panel methodology are contained in Appendix B: Odour Evaluation Report Environmental Odour Consulting Corporation.

Once the odour concentration of the samples has been determined, the odour flux rate is calculated. The sweep gas rate is used to calculate the odour flux rate based on the total air movement into the chamber. The formula that was used to calculate the odour flux rate is as follows:

$$\text{Odour Flux Rate} \left( \frac{\text{ou}}{\text{s} \cdot \text{m}^2} \right) = \frac{\text{Odour Concentration} \left( \frac{\text{ou}}{\text{m}^3} \right) \cdot \text{Sweep Rate} \left( \frac{\text{m}^3}{\text{s}} \right)}{\text{Area of flux chamber} (\text{m}^2)}$$

The odour flux rates from the bioreactor were simply averaged and the flux rate was applied to the total surface area of the bioreactor clarifiers.

## Total Reduced Sulfur Sampling Methodology

TRS sampling was conducted, in triplicate, at the inlet to the scrubber and at the exit of the scrubber. Sampling values were used to calculate the scrubber and polisher efficiency in reducing TRS.

Sulfur compounds collection was conducted using ALS laboratory supplied vacuum canister media. Air was drawn from the flux chamber into the vacuum canister media to collect the sample.

## Chemical Analysis

Total reduced sulfur collection media was sent to ALS Environmental in Burnaby BC for analysis. Details about the analysis methodology are contained in Appendix C: Certificate of Analysis, ALS Environmental.

## Odour Results

The testing programs were completed on September 4<sup>th</sup> and 19<sup>th</sup>, 2019, using the techniques described in the methodology section. The odour lab results are summarized in Table 1 and 2; the complete laboratory analysis reports can be found in Appendix A and B. Field notes from the sampling program can be found in Appendix D.



**Table 1: Odour Laboratory Analysis Sample Results – September 4, 2019**

| Location                | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Sample Time (24hr) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/m <sup>2</sup> /s) |
|-------------------------|-----------------|-----------------|--------------------------------|--------------------|---|--------------------------------|
| Bioreactor Test 1 - out | 108             | 1 : 1           | 108                            | 08:14              | 0.07  | 0.47                           |
| Bioreactor Test 2 - mid | 198             | 1 : 1           | 198                            | 08:35              | 0.13  |                                |
| Bioreactor Test 3 - in  | 1892            | 1 : 1           | 1892                           | 09:00              | 1.22  | 0.71                           |
| Bioreactor Test 4 - out | 181             | 1 : 1           | 181                            | 09:25              | 0.12  |                                |
| Bioreactor Test 5 - mid | 236             | 1 : 1           | 236                            | 09:50              | 0.15  |                                |
| Bioreactor Test 6 - in  | 2918            | 1 : 1           | 2918                           | 10:14              | 1.87  |                                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.

**Table 2: Odour Laboratory Analysis Sample Results – September 19, 2019**

| Location           | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Sample Time (24hr) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/m <sup>2</sup> /s) | Odour Emission Rate (OU/s) | Average (OU/s) |
|--------------------|-----------------|-----------------|--------------------------------|--------------------|---|--------------------------------|----------------------------|----------------|
| Bioreactor 1 - out | 282             | 1 : 1           | 282                            | 21:15              | 0.18  | 1.26                           | N/A                        | N/A            |
| Bioreactor 1 - mid | 475             | 1 : 1           | 475                            | 21:35              | 0.31  |                                | N/A                        | N/A            |
| Bioreactor 1 - in  | 5061            | 1 : 1           | 5061                           | 21:52              | 3.25  |                                | N/A                        | N/A            |
| Bioreactor 2 - out | 318             | 1 : 1           | 318                            | 22:10              | 0.20  |                                | N/A                        | N/A            |
| Bioreactor 2 - mid | 492             | 1 : 1           | 492                            | 22:25              | 0.32  |                                | N/A                        | N/A            |
| Bioreactor 2 - in  | 5142            | 1 : 1           | 5142                           | 22:43              | 3.30  |                                | N/A                        | N/A            |
| Scrubber out 1     | 145             | 1 : 1           | 145                            | 20:20              | N/A   | N/A                            | 2654.03                    | 3050.61        |
| Scrubber out 2     | 172             | 1 : 1           | 172                            | 20:28              | N/A   | N/A                            | 3148.23                    |                |
| Scrubber out 3     | 183             | 1 : 1           | 183                            | 20:40              | N/A   | N/A                            | 3349.57                    |                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.



## Total Reduced Sulfur Results

The testing program for total sulfur compounds was completed on September 4<sup>th</sup>, 2019, using the techniques described in the methodology section. The lab results are summarized in Table 3; the complete laboratory analysis report can be found in Appendix C. Field notes from the sampling program can be found in Appendix D.

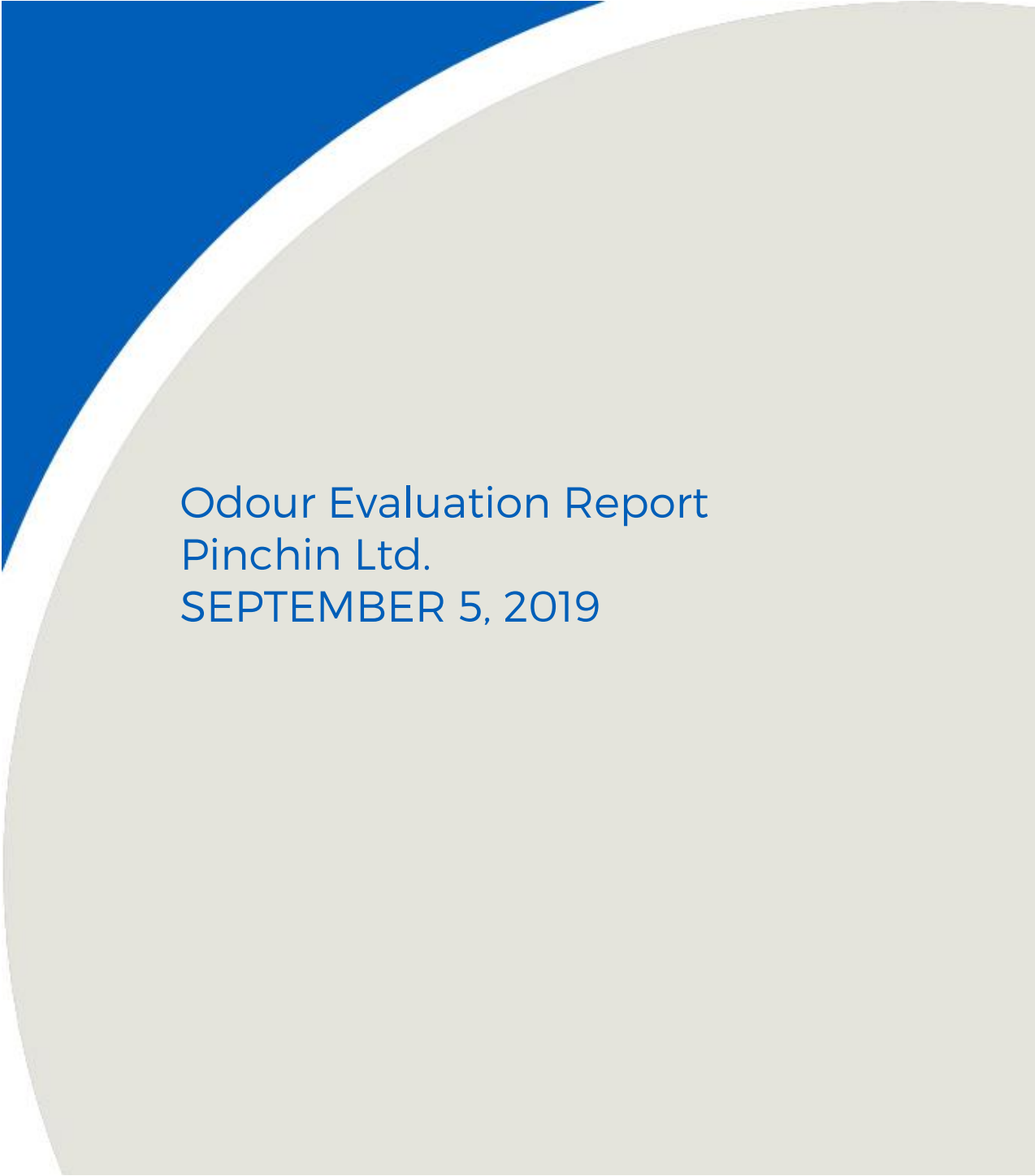
**Table 3: Total Reduced Sulfur Analysis Sample Results**

| Location          | H <sub>2</sub> S (ppb(V)) | H <sub>2</sub> S (ppb(V))<br>Average | H <sub>2</sub> S (ug/m <sup>3</sup> ) | H <sub>2</sub> S (ug/m <sup>3</sup> ) |
|-------------------|---------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| Scrubber Inlet 1  | 2570                      | 2956.7                               | 3590                                  | 4126.7                                |
| Scrubber Inlet 2  | 3490                      |                                      | 4870                                  |                                       |
| Scrubber Inlet 3  | 2810                      |                                      | 3920                                  |                                       |
| Scrubber Outlet 1 | 19                        | 19.7                                 | 26                                    | 26.3                                  |
| Scrubber Outlet 2 | 19                        |                                      | 27                                    |                                       |
| Scrubber Outlet 3 | 18                        |                                      | 26                                    |                                       |
| <b>Efficiency</b> | <b>99.4%</b>              |                                      |                                       |                                       |

If you have any questions regarding these results, we would be happy to discuss them with you at any time in the future.

Matthew Sawycky, B.Sc.  
Senior Project Manager

## APPENDIX A

A decorative background featuring a large, light grey circular shape on the right side, partially overlapping a blue triangular shape on the left. The text is centered within the grey area.

Odour Evaluation Report  
Pinchin Ltd.  
SEPTEMBER 5, 2019



FINAL

# Odour Evaluation Report

2470 Milltower Court  
Mississauga, ON  
L5N 7W5

Prepared for:

**John DeYoe**  
RWDI  
600 Southgate Drive  
Guelph, Ontario N1G 4P6

September 27, 2019

Pinchin File: 202859-090519



**Issued to:** RWDI  
**Contact:** John DeYoe

**Issued on:** September 27, 2019  
**Pinchin file:** 202859-090519  
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## APPENDICES

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## 1.0 EVALUATION SAMPLE & TIMING SUMMARY

Pinchin Ltd. (Pinchin) was contracted to determine the detection threshold (DT) of air samples submitted to Pinchin's Odour Laboratory located in Mississauga, Ontario. The particulars of the odour panel were as follows:

|   |                                   |
|---|-----------------------------------|
| <b>Client Name:</b>                             | RWDI                              |
| <b>No. of Samples Delivered:</b>                | Six (6)                           |
| <b>Date Samples Received:</b>                   | September 5, 2019                 |
| <b>Condition of the Sample Bags on Arrival:</b> | No leaks or condensation detected |
| <b>No. of Samples Analyzed:</b>                 | Six (6)                           |
| <b>Date of Odour Panel Analysis:</b>            | September 5, 2019                 |
| <b>Time of Odour Panel Analysis:</b>            | 9:21 – 10:50 AM                   |

## 2.0 METHODOLOGY

### 2.1 Laboratory Methodology

All samples were evaluated in accordance with the Ministry of the Environment, Conservation and Parks "Ontario Source Testing Code" (OSTC), Version #3, June 2010 (Part G, Method ON-6), using an AC'SCENT International triangular forced-choice, ascending concentration, dynamic dilution Olfactometer. A listing of Standard Practices to which the evaluations conform is provided in Appendix II.

The AC'SCENT Olfactometer was calibrated according to the manufacturer's guidelines on the day of sample evaluation. The CHEMFLUOR® PTFE tubing through which the odour sample is presented to the panellists was replaced prior to the assessment session. All sample delivery lines were purged continuously with odour free air between sample presentations.

A panel of eight trained assessors was employed in the evaluation of the odour samples. Each panel is screened for accuracy and repeatability following the procedures outlined in British Standard, BS EN 13725:2003, "Air quality – Determination of odour concentration by dynamic olfactometry", utilizing 50 ppm n-butanol calibration gas prior to sample evaluation. The geometric mean of the individual threshold estimates for 50 ppm n-butanol was determined to be between 20 and 80 ppb/v.

The odour samples were presented to the panellists using the “triangular forced-choice” method, described by ASTM E679-04, “Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits”. Each panellist evaluated the odour by “sniffing” the diluted odour samples presented by the Olfactometer. At each dilution level, the panellist “sniffed” three sample presentations, two of which were blank, odour free samples and one that contained the odorous air. The panellist was then asked to identify which of the three presentations was different from the other two by recording a “guess”, “detect” or “recognize” response as defined by ASTM E679-04.

A “guess” response was recorded when the assessor could not distinguish between any of the presentations. A “detect” response was recorded when the assessor could differentiate the odorous sample from the two blanks, and “recognize” was recorded when the assessor could identify and describe the odorous sample.

As per BS EN 13725:2003, each sample assessment began with the Olfactometer diluting the odorous sample to sub-detection levels. The odour sample and two blanks were then presented to one panellist, who “sniffed” the three presentations and recorded their response. The concentration of odorous gas was then doubled and re-presented to the same assessor with two blanks. Again, the assessor “sniffed” the three presentations and recorded their response. The process continued with the concentration of odorous gas increasing until the panellist had correctly detected the odour in at least two consecutive presentations as described by BS EN 13725:2003. The process was repeated for each panellist until all samples were evaluated.

Sample analysis was conducted “blind”; neither the panellist nor the test administrator knew which port would deliver the odour sample. Panellist’s results were recorded and analyzed using AC’SCENT DataSense Olfactometry software integrated with the Olfactometer. The software incorporates an Access database program designed specifically for olfactometry laboratories and is compatible with international olfactometry standards including BS EN 13725:2003 and ASTM E679-04.

As part of laboratory Quality Assurance and Quality Control (QAQC), test results were retrospectively screened in accordance with BS EN 13725:2003. As the standard requires, each assessor’s individual threshold estimate ( $Z_{ITE}$ ) was compared to the panel’s average threshold, with the ratio between the individual threshold estimate and the panel average threshold represented as  $\Delta Z$ . Assessors having a  $\Delta Z$  greater than 5.0 or lower than -5.0, were eliminated from the results. The purpose was to exclude panel members that showed deviant responses due to health factors or specific hyperosmia or anosmia for the odour of the analyzed sample. Where screening was required, both the screened and unscreened results were provided.

## 2.2 Odour Evaluation Parameters

### 2.2.1 Odour Threshold Values – Detection Threshold (DT)

The detection threshold (DT) is the dilution ratio at which 50% of the panellists correctly detected the odour. DT, as defined by ASTM E679-04, is synonymous with the MECP Draft definition of an odour threshold value ( $ED_{50}$ ) and the BS EN 13725:2003 definition of odour concentration ( $C_{OD}$ ). That is, the DT represents the amount of dilution required for the odour to be just detectable. Since DT values are dimensionless, pseudo-dimensions of odour units per unit volume (i.e. odour units per cubic metre ( $ou/m^3$ )) are often used for reporting purposes.

In accordance with BS EN 13725:2003, individual threshold estimates ( $Z_{ITE}$ ) were calculated as the geometric mean of the lowest dilution ratio where the odour could not be detected and the dilution ratio at which the panellist correctly detected the odour. Where a detection response could not be established at the Olfactometer's dilution limit, it was assumed that the panellist would have detected the odour at a dilution ratio half that of the limit, and the  $Z_{ITE}$  was calculated. The sample odour concentration ( $C_{OD}$ ) was then calculated as the geometric mean of the  $Z_{ITE}$  values.

## 3.0 RESULTS

The odour threshold value results for detection threshold (DT) are presented in Table 1. Where appropriate, the DT values have been adjusted for field pre-dilution reported by the client. The adjusted DT values are recorded as  $DT_{NET}$ . Datasheets are provided in Appendix I.



Table 1 – Odour Threshold Value Results

Client: RWDI

Test Reference No.: 202859-090519

Pinchin Project No.: 202859

Evaluation Date: 5-Sep-19

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1933 | Comox 1                      | 1 :1               | 9:21 - 9:36 AM     | 108       | 108               |          |
| PO19-202859-S1934 | Comox 2                      | 1 :1               | 9:37 - 9:49 AM     | 198       | 198               |          |
| PO19-202859-S1935 | Comox 4                      | 1 :1               | 9:50 - 10:03 AM    | 181       | 181               |          |
| PO19-202859-S1936 | Comox 5                      | 1 :1               | 10:04 - 10:14 AM   | 236       | 236               |          |
| PO19-202859-S1937 | Comox 3A/3B                  | 1 :1               | 10:16 - 10:36 AM   | 1892      | 1892              |          |
| PO19-202859-S1938 | Comox 6A/6B                  | 1 :1               | 10:37 - 10:50 AM   | 2918      | 2918              |          |

**Odour Evaluation Report Nomenclature**

DT Detection Threshold

DT<sub>NET</sub> Detection Threshold adjusted for field dilution

\* This report may not be reproduced except in full, without written authorization from the laboratory.

J:\202000s\0202859.000 RWDI,650Woodlawn,ENVNS,ODPNL\Odour Lab\2019\Sept 5, 2019\202859-090519 - RWDI Odour Report for Detection Threshold.docx

Template: 14852 – Report Template for Detection Threshold Determination - September 19, 2014

**APPENDIX I**  
**Odour Evaluation Data Sheets**  
**Pinchin File: 202859-090519**  
**(6 Pages)**

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019  
 Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                            |                                 |
|------------------------------------|----------------------------|---------------------------------|
| <b>Sample Information</b>          |                            | Sampling Date : <u>9/4/2019</u> |
| Lab No. : <u>PO19-202859-S1933</u> | Field No. : <u>Comox 1</u> | Sampling Time : _____           |
| Description : <u>1:1</u>           |                            | Sample Collector : <u>RWDI</u>  |
|                                    |                            | Sample Source : <u>unknown</u>  |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |  |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|--|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |  |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |  |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |  |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |  |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |  |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |  |
| 14853-665 1     |        |        |        |        |        |        |        | 2      | 1      | 1      | 1      | 6      | 6      |        |   | 1.96  | 1.96  |  |
| 2018-1 1        |        |        |        |        |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |   | 2.26  | 1.96  |  |
| 14853-917 1     |        |        |        |        |        |        |        |        | 1      | 1      | 1      | 1      | 6      | 6      |   | 1.66  | 1.66  |  |
| 14853-671 1     |        |        |        |        |        |        |        |        | 2      | 1      | 1      | 6      | 6      |        |   | 1.96  | 1.96  |  |
| 14853-719 1     |        |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |   | 2.26  | 2.26  |  |
| 14853-1232 1    |        |        |        |        |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |   | 2.26  | 1.96  |  |
| 14853-946 1     |        |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |   | 2.26  | 2.26  |  |
| 14853-1903 1    |        |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |   | 2.56  | 2.26  |  |

**Sample Comments :**

|   |            |
|---|------------|
| <b>Specific Chemical Concentration Data</b> |            |
| Chemical :                                  | <u>N/A</u> |
| Concentration (ppm) :                       | _____      |

**Response Key:**  
 1 = Incorrect Guess  
 2 = Correct Guess  
 5 = Incorrect Detection  
 6 = Correct Detection  
 7 = Incorrect Recognition  
 8 = Correct Recognition

|                      |             |             |             |
|----------------------|-------------|-------------|-------------|
| <b>Final Results</b> |             |             |             |
|                      | <b>G</b>    | <b>D</b>    | <b>R</b>    |
| Avg. Log Value       | <u>2.15</u> | <u>2.03</u> | <u>0.00</u> |
| Std. Dev.            | <u>0.28</u> | <u>0.21</u> | <u>0.00</u> |
| Threshold            | <u>140</u>  | <u>108</u>  | <u>1</u>    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1934 Field No. : Comox 2 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |

| Assessor/Round |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Log G | Log D | Log R |      |      |  |
|----------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|-------|-------|-------|------|------|--|
| 14853-665 1    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |       |       |       | 2.86 | 2.26 |  |
| 2018-1 1       |  |  |  |  |  |  |  |  |  |  |  |  |  |  |       |       |       | 2.26 | 2.26 |  |
| 14853-917 1    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |       |       |       | 2.26 | 2.26 |  |
| 14853-671 1    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |       |       |       | 2.26 | 2.26 |  |
| 14853-719 1    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |       |       |       | 1.96 | 1.96 |  |
| 14853-1232 1   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |       |       |       | 2.26 | 2.26 |  |
| 14853-946 1    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |       |       |       | 2.56 | 2.56 |  |
| 14853-1903 1   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |       |       |       | 2.56 | 2.56 |  |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.37 | 2.30 | 0.00 |
| Std. Dev.      | 0.28 | 0.19 | 0.00 |
| Threshold      | 236  | 198  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019  
 Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                            |                                 |
|------------------------------------|----------------------------|---------------------------------|
| <b>Sample Information</b>          |                            | Sampling Date : <u>9/4/2019</u> |
| Lab No. : <u>PO19-202859-S1935</u> | Field No. : <u>Comox 4</u> | Sampling Time : _____           |
| Description : <u>1:1</u>           |                            | Sample Collector : <u>RWDI</u>  |
|                                    |                            | Sample Source : <u>unknown</u>  |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60.782 | 32.882 | 16.577 | 8.254  | 4.127  | 2.064  | 1.031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        | 2.86  | 2.26  |       |
| 2018-1 1        |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-917 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-671 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-719 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-1232 1    |        |        |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        | 2.86  | 2.26  |       |
| 14853-946 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-1903 1    |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.41 | 2.26 | 0.00 |
| Std. Dev.      | 0.28 | 0.00 | 0.00 |
| Threshold      | 257  | 181  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1936 Field No. : Comox 5 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 2018-1 1        |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        | 2.56  | 2.26  |       |
| 14853-917 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-671 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-719 1     |        |        |        |        |        |        |        | 1      | 2      | 1      | 6      | 6      |        |        | 2.26  | 2.26  |       |
| 14853-1232 1    |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.56  | 2.56  |       |
| 14853-946 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.56  | 2.56  |       |
| 14853-1903 1    |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        | 2.86  | 2.56  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.45 | 2.37 | 0.00 |
| Std. Dev.      | 0.23 | 0.16 | 0.00 |
| Threshold      | 281  | 236  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1937 Field No. : Comox 3A/3B Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |
| 2018-1 1        |        |        |        | 1      | 1      | 5      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-917 1     |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        | 3.47  | 2.86  |       |
| 14853-671 1     |        |        |        |        | 1      | 2      | 5      | 6      | 6      |        |        |        |        |        | 2.86  | 2.86  |       |
| 14853-719 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-946 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47  | 3.16  |       |
| 14853-1903 1    |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.47  | 3.28  | 0.00 |
| Std. Dev.      | 0.32  | 0.32  | 0.00 |
| Threshold      | 2,918 | 1,892 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1938 Field No. : Comox 6A/6B Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60.782 | 32.882 | 16.577 | 8.254  | 4.127  | 2.064  | 1.031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 2018-1 1        |        |        |        | 2      | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-917 1     |        |        |        | 1      | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-671 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-719 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-946 1     |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |
| 14853-1903 1    |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

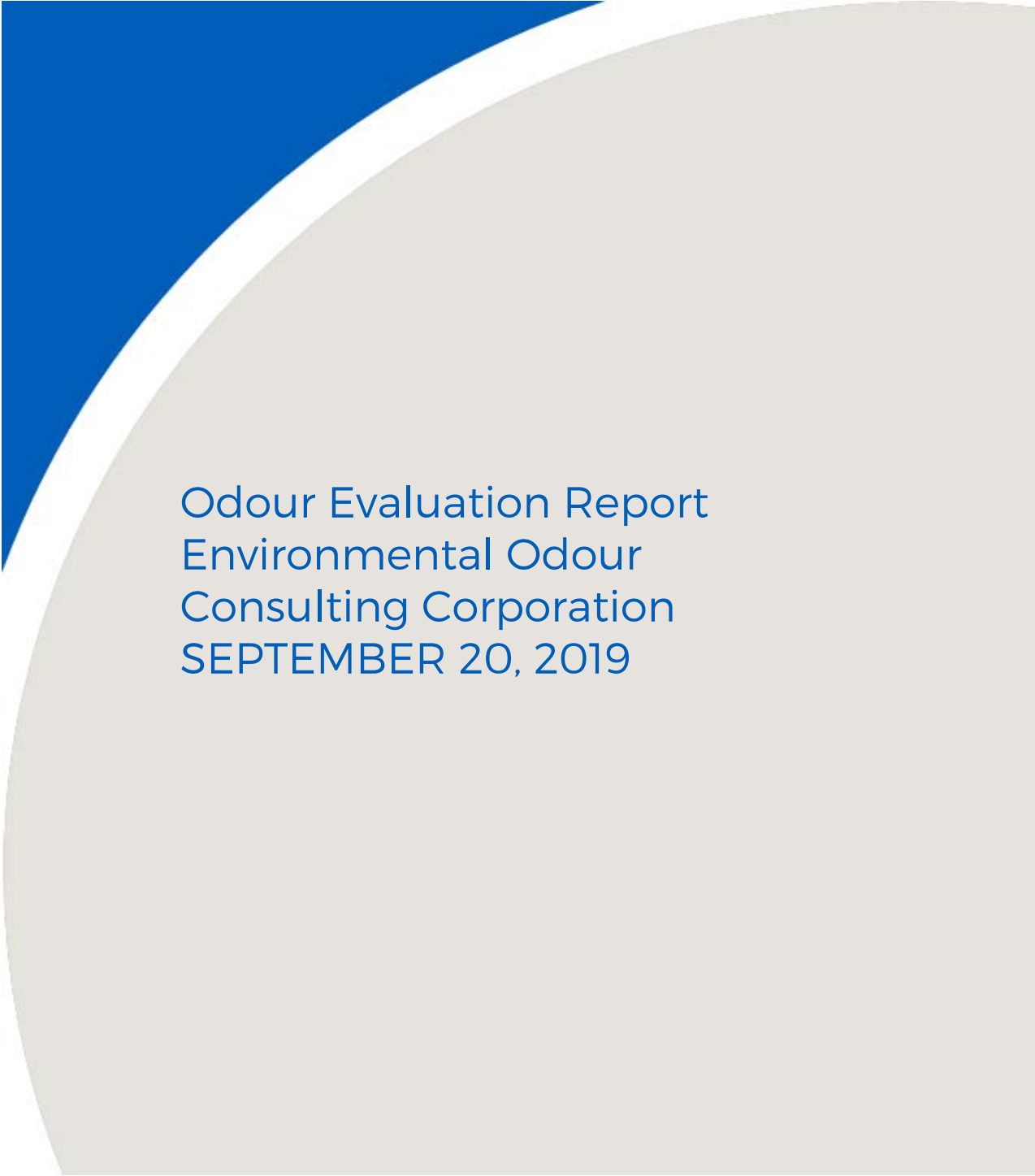
|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.50  | 3.47  | 0.00 |
| Std. Dev.      | 0.25  | 0.23  | 0.00 |
| Threshold      | 3,182 | 2,918 | 1    |

**APPENDIX II**  
**Odour Evaluation Quality Assurance**  
**Pinchin File: 202859-090519**  
**(1 Page)**

## ODOUR EVALUATION QUALITY ASSURANCE

- Odour evaluations conducted at the Pinchin Odour Laboratory conform to the procedures outlined in the Ministry of the Environment, Conservation and Parks “Ontario Source Testing Code” (OSTC), Version #3, June 2010 (Part G, Method ON-6) and are in accordance with ASTM (American Society for Testing and Materials) Standard Practice E679-04, Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series of Limits.
- The AC’SCENT® Dynamic Dilution Forced-Choice Triangle Olfactometer complies with all aspects of the ASTM E679-04 standard as well as the operational requirements of the British Standard, BS EN 13725:2003, “Air quality – Determination of odour concentration by dynamic olfactometry”.
- The detection threshold values are reported as defined by ASTM E679-04 and BS EN 13725:2003.
- Assessors are selected and trained in accordance with BS EN 13725:2003.
- The Pinchin Odour Laboratory is managed based on the requirements of the International Organization for Standardization (ISO) International Standard ISO 17025:2005, “General requirements for the competence of testing and calibration laboratories”.
- Samples are consumed during the evaluation and all sample bags are destroyed 48 hours after transmittal of the Preliminary Odour Evaluation Results, unless otherwise specified.

## APPENDIX B

A decorative background featuring a large, light grey circular shape on the right side, partially overlapping a blue triangular shape on the left. The text is centered within the grey area.

Odour Evaluation Report  
Environmental Odour  
Consulting Corporation  
SEPTEMBER 20, 2019

# Report

## Odour Panel Evaluation

### **Report to:**

RWDI Air Inc.  
650 Woodlawn Road West  
Guelph, Ontario  
N1K 1B8  
Mr. Matthew Sawycky  
E-mail: Matthew.Sawycky@RWDI.com  
Phone: 519 823 1311

### **Prepared by:**

***EOC Environmental Odour Consulting Corporation***

Anna H. Bokowa, M.Sc.  
*President*  
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**Date of the Report**  
October 1, 2019  
12 pages, 2 Appendices

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## 1. INTRODUCTION

EOC Environmental Odour Consulting Corporation (EOC) was contracted by RWDI Air Inc. (RWDI) to perform an odour evaluation on samples delivered to EOC.

One batch of nine (9) samples was shipped from Vancouver via Air Canada FedEx. On September 20, 2019, samples were picked up from the Air Canada Cargo Centre located at 2580 Britannia Rd E, Mississauga, ON. All samples were evaluated on September 20, 2019.

All evaluations for odour detection threshold value (ODTV) were performed according to the European standard EN13725: 2003 (with exceptions) and Ontario Ministry of the Environment Method ON-6 using dynamic olfactometry with eight screened panelists.

All samples were in good condition upon delivery.

## 2. METHODOLOGY

The evaluations were based on the European Standard EN 13725:2003 with the exception that each sample was introduced once to the panel members and eight panel members were used for all evaluations. Odour evaluations were also completed in accordance to the Ontario Ministry of the Environment's Method ON-6 "Determination of Odour Emission from Stationary Sources."

The EOC olfactometer is capable to perform evaluations using either the Triangular Forced Choice Method, or the Binary Forced Choice Method. For the Forced Choice Method; the panelist is presented with two or three ports (Triangular, Binary), of which one panelist presents the diluted sample and the other(s) neutral gas. The sample is presented randomly over the two or three ports. The panelist is asked to indicate the port with the sample. The panelist is also asked if his/her choice was a guess, inkling or if they were certain. By combining the chosen results and the indicated level of certainty, the response is classified as false or true. The odour evaluation procedure requires the first sample to be presented to the panelist at the dilution that will be below the detection threshold. Therefore, the several initial presentations to the panelists require the panelist to select one port by guessing. Each panelist observes an odour sample in the ascending concentration series (increasing concentration). For this program, a Binary Forced Choice Mode was chosen for odour evaluations. Each sample bag was evaluated by eight panelists with the option that for each dilution, each of the 8 panelists were asked to indicate their responses. Therefore, each panelist was introduced to the same dilution steps. Also, the same step between dilutions was used (1.51) for evaluation of all the samples.

The panelists' responses were recorded by computer software and were processed to determine the odour detection threshold value (ODTV) for each sample. The ODTV is a dilution factor and therefore has no units. For convenience, however, the ODTV may be expressed in odour units (ou).

A screened odour panel was used for all evaluations. They were tested for odour sensitivity using n-butanol as a reference gas. All panelists were within the normal range according to the European Standard EN 13725:2003 (20-80 ppb n-butanol). All panelists were included in the evaluations.

All screening data for the day of evaluation are presented in Appendix 1.

### **3. QUALITY CONTROL MEASURES AND CALIBRATION DATA**

EOC provided extensive quality control measures for the evaluations. These included, but were not limited to:

- Keeping constant dilution steps between analysis of the samples from the same source.
- Each sample bag was evaluated by eight panelists with the option that for each dilution each of the 8 panelists were asked to indicate their responses (each panelist was exposed to the same dilution).
- The EOC olfactometer is calibrated by the manufacturer against carbon monoxide at all used ports. The calibrations are within the limits of EN13725 standard.
- The EOC olfactometer is checked before each use for consistent volumetric flow rates at each “sniff port.”
- EOC panelists are screened using European Method EN; 13725 with n-butanol and they are within the range of that standard- all screening data are provided in the report.
- EOC panelists are trained to avoid any odorous products such as perfumes and scented lotions.
- EOC panelists are advised and trained to avoid coffee or spicy food one hour before a session.
- EOC makes sure that the sessions for the odour panel evaluations are not too long.
- EOC provides frequent breaks to avoid any panelist’s fatigue.
- All panelists’ data are computer recorded.

### **4. RESULTS**

Table 1 shows the results for odour detection threshold values for samples evaluated on September 20, 2019.

Appendix 1 shows the screening data for the panel used during the program.

All calibration data for the olfactometer are presented in Appendix 2.

Prepared by:



Anna H. Bokowa, M.Sc.  
President, Environmental Odour Consulting

**Table 1: Odour Detection Threshold Values- September 20, 2019**

| <b>Client<br/>Description</b> | <b>EOC<br/>Sample<br/>Identification</b> | <b>ODTV<br/><br/>ou</b> |
|-------------------------------|--|-------------------------|
| Scrubber Out 1                | A001                                     | 145                     |
| Scrubber Out 2                | A002                                     | 172                     |
| Scrubber Out 3                | A003                                     | 183                     |
| Bioreactor 1 Outlet           | A004                                     | 282                     |
| Bioreactor 2 Outlet           | A005                                     | 318                     |
| Bioreactor 1 Mid              | A006                                     | 475                     |
| Bioreactot 2 Mid              | A007                                     | 492                     |
| Bioreactor 1 Inlet            | A008                                     | 5061                    |
| Bioreactor 2 Inlet            | A009                                     | 5142                    |

## **APPENDIX 1**

### **Panelist's Screening Data**

**(1 page)**

| Panelist No | Panelist ID | n- butanol ppb Test 1 | n- butanol ppb Test 2 | n- butanol ppb Test 3 | n- butanol ppb Test 4 | n- butanol ppb Test 5 | n- butanol ppb Test 6 | n- butanol ppb Test 7 | n- butanol ppb Test 8 | n- butanol ppb Test 9 | n- butanol ppb Test 10 | n- butanol ppb Test 11 | n- butanol ppb Test 12 | n- butanol ppb Average |
|-------------|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|
| Panelist 1  | P201        | 55                    | 47                    | 48                    | 55                    | 57                    | 48                    | 47                    | 56                    | 51                    | 43                     | 56                     | 58                     | 52                     |
| Panelist 2  | P202        | 32                    | 47                    | 48                    | 42                    | 43                    | 32                    | 36                    | 32                    | 38                    | 33                     | 42                     | 44                     | 39                     |
| Panelist 3  | P205        | 24                    | 27                    | 24                    | 24                    | 25                    | 32                    | 27                    | 24                    | 38                    | 25                     | 32                     | 25                     | 27                     |
| Panelist 4  | P208        | 42                    | 47                    | 48                    | 42                    | 43                    | 48                    | 47                    | 42                    | 38                    | 43                     | 42                     | 44                     | 44                     |
| Panelist 5  | P210        | 24                    | 27                    | 24                    | 24                    | 25                    | 24                    | 27                    | 24                    | 29                    | 25                     | 24                     | 25                     | 25                     |
| Panelist 6  | P212        | 42                    | 47                    | 48                    | 42                    | 43                    | 32                    | 47                    | 42                    | 38                    | 43                     | 42                     | 44                     | 43                     |
| Panelist 7  | P213        | 32                    | 36                    | 32                    | 32                    | 33                    | 32                    | 36                    | 32                    | 38                    | 33                     | 32                     | 33                     | 33                     |
| Panelist 8  | P216        | 55                    | 47                    | 56                    | 55                    | 57                    | 56                    | 47                    | 42                    | 51                    | 57                     | 56                     | 58                     | 53                     |

### Panelists Screening Data- September 20, 2019

| Panelist No | Panelist ID | n- butanol ppb 20-Sep-19 |
|-------------|-------------|--------------------------|
| Panelist 1  | P201        | 56                       |
| Panelist 2  | P202        | 32                       |
| Panelist 3  | P205        | 32                       |
| Panelist 4  | P208        | 42                       |
| Panelist 5  | P210        | 24                       |
| Panelist 6  | P212        | 42                       |
| Panelist 7  | P213        | 32                       |
| Panelist 8  | P216        | 56                       |

## **APPENDIX 2**

### **Calibration Data**

**(3 pages)**

## Certificate of Calibration- Olfactometer SC300

Date of Calibration: September 18, 2019

Device Description: Olfactometer SC300

Calibration Conditions: T: 22.5°C ± 2°C P: 750 psi ± 1 psi

Diluting Air Flow:

| Set Point<br>(ml/min) | Measured<br>(ml/min) | Difference % | MFC<br>used |
|-----------------------|----------------------|--------------|-------------|
| 10000                 | 10040                | 0.4          | MFC 3       |
| 12000                 | 12095                | 0.8          | MFC 3       |
| 15000                 | 14925                | 0.5          | MFC 3       |
| 18000                 | 18160                | 0.9          | MFC 3       |
| 20000                 | 20010                | 0.1          | MFC 3       |

Acceptable limit is within 2%. Acceptable error limit in accordance to EN13725 is 10%.

Measured using Gas collection method

Uncertainty of Measurement: ±0.5% based on a confidence of probability of greater than 95%.

Dilutions:

| <i>Settings</i> | <i>Measured</i> | <i>Difference %</i> | <i>MFC</i> |
|-----------------|-----------------|---------------------|------------|
| 12              | 12.4            | 3.3                 | MFC 2      |
| 16              | 16.3            | 1.9                 | MFC 2      |
| 32              | 32.5            | 1.6                 | MFC 2      |
| 64              | 67.3            | 5.1                 | MFC 2      |
| 128             | 121             | 5.5                 | MFC 2      |
| 256             | 264             | 3.1                 | MFC 1      |
| 512             | 502             | 1.9                 | MFC 1      |
| 1024            | 1029            | 0.5                 | MFC 1      |
| 2048            | 2071            | 1.1                 | MFC 1      |
| 4096            | 4344            | 6.1                 | MFC 1      |
| 8192            | 8746            | 6.8                 | MFC1       |
| 16384           | 16078           | 1.9                 | MFC1       |
| 32768           | 35684           | 8.9                 | MFC1       |

Acceptable error limit in accordance to EN13725 is 20%.

Measured using Tracer gas calibration method with certified CO calibration gas cylinders and Carbon Monoxide analyzer.

### Velocity Readings: September 20, 2019

| <b>Test No</b> | <b>Port A<br/>Velocity<br/>m/s</b> | <b>Port B<br/>Velocity<br/>m/s</b> |
|----------------|------------------------------------|------------------------------------|
| Test 1         | 0.314                              | 0.315                              |
| Test 2         | 0.312                              | 0.313                              |
| Test 3         | 0.310                              | 0.316                              |
| Test 4         | 0.314                              | 0.314                              |
| Test 5         | 0.310                              | 0.312                              |
| Test 6         | 0.312                              | 0.310                              |

## APPENDIX C

A large decorative graphic on the left side of the page, featuring a blue triangle in the top-left corner and a large, light gray curved shape that overlaps the triangle and extends across the page.

Certificate of Analysis  
Total Reduced Sulfur  
ALS Environmental



RWDI AIR INC.  
ATTN: Matthew Sawycky  
#280 - 1385 West 8th Avenue  
Vancouver BC V6H 3V9

Date Received: 05-SEP-19  
Report Date: 17-SEP-19 18:29 (MT)  
Version: FINAL

Client Phone: 604-730-5688

## Certificate of Analysis

Lab Work Order #: L2341651  
Project P.O. #: NOT SUBMITTED  
Job Reference: 1904012  
C of C Numbers: 17-762085  
Legal Site Desc:

Rojina Ghavami  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company



# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                            |                                | Sample ID    | L2341651-6   |  |  |  |
|----------------------------|--------------------------------|--------------|--------------|--|--|--|
|                            |                                | Description  | SUMP         |  |  |  |
|                            |                                | Sampled Date | 04-SEP-19    |  |  |  |
|                            |                                | Sampled Time | 13:30        |  |  |  |
|                            |                                | Client ID    | COMOX OUT #3 |  |  |  |
| Grouping                   | Analyte                        |              |              |  |  |  |
| <b>CANISTER</b>            |                                |              |              |  |  |  |
| <b>Sulfur Compounds</b>    | n-Butyl mercaptan (ppb(V))     | <4.0         |              |  |  |  |
|                            | n-Butyl mercaptan (ug/m3)      | <15          |              |  |  |  |
|                            | Butyl(t) mercaptan (ppb(V))    | <4.0         |              |  |  |  |
|                            | Butyl(t) mercaptan (ug/m3)     | <15          |              |  |  |  |
|                            | Carbon Disulfide (ppb(V))      | 2.2          |              |  |  |  |
|                            | Carbon Disulfide (ug/m3)       | 6.9          |              |  |  |  |
|                            | Carbonyl sulfide (ppb(V))      | 14.2         |              |  |  |  |
|                            | Carbonyl sulfide (ug/m3)       | 34.8         |              |  |  |  |
|                            | Diethyl disulfide (ppb(V))     | <2.0         |              |  |  |  |
|                            | Diethyl disulfide (ug/m3)      | <10          |              |  |  |  |
|                            | Diethyl Sulfide (ppb(V))       | <4.0         |              |  |  |  |
|                            | Diethyl Sulfide (ug/m3)        | <15          |              |  |  |  |
|                            | Dimethyl disulfide (ppb(V))    | <2.0         |              |  |  |  |
|                            | Dimethyl disulfide (ug/m3)     | <7.7         |              |  |  |  |
|                            | Dimethyl sulfide (ppb(V))      | <4.0         |              |  |  |  |
|                            | Dimethyl sulfide (ug/m3)       | <10          |              |  |  |  |
|                            | 2,5-Dimethylthiophene (ppb(V)) | <4.0         |              |  |  |  |
|                            | 2,5-Dimethylthiophene (ug/m3)  | <18          |              |  |  |  |
|                            | Ethyl mercaptan (ppb(V))       | <4.0         |              |  |  |  |
|                            | Ethyl mercaptan (ug/m3)        | <10          |              |  |  |  |
|                            | Ethyl Methyl Sulfide (ppb(V))  | <4.0         |              |  |  |  |
|                            | Ethyl Methyl Sulfide (ug/m3)   | <12          |              |  |  |  |
|                            | 2-Ethylthiophene (ppb(V))      | <4.0         |              |  |  |  |
|                            | 2-Ethylthiophene (ug/m3)       | <18          |              |  |  |  |
|                            | Hydrogen Sulfide (ppb(V))      | <4.0         |              |  |  |  |
|                            | Hydrogen Sulfide (ug/m3)       | <5.6         |              |  |  |  |
|                            | Isobutyl Mercaptan (ppb(V))    | <4.0         |              |  |  |  |
|                            | Isobutyl Mercaptan (ug/m3)     | <15          |              |  |  |  |
|                            | Isopropyl Mercaptan (ppb(V))   | <4.0         |              |  |  |  |
|                            | Isopropyl Mercaptan (ug/m3)    | <12          |              |  |  |  |
|                            | Methyl mercaptan (ppb(V))      | <4.0         |              |  |  |  |
|                            | Methyl mercaptan (ug/m3)       | <7.9         |              |  |  |  |
|                            | 2-Methylthiophene (ppb(V))     | <4.0         |              |  |  |  |
| 2-Methylthiophene (ug/m3)  | <16                            |              |              |  |  |  |
| 3-Methylthiophene (ppb(V)) | <4.0                           |              |              |  |  |  |
| 3-Methylthiophene (ug/m3)  | <16                            |              |              |  |  |  |
| Propyl mercaptan (ppb(V))  | <4.0                           |              |              |  |  |  |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                         |   | Sample ID    | L2341651-1           | L2341651-2  | L2341651-3  | L2341651-4   | L2341651-5   |
|-------------------------|---|--------------|----------------------|-------------|-------------|--------------|--------------|
|                         |   | Description  | SUMP                 | SUMP        | SUMP        | SUMP         | SUMP         |
|                         |   | Sampled Date | 04-SEP-19            | 04-SEP-19   | 04-SEP-19   | 04-SEP-19    | 04-SEP-19    |
|                         |   | Sampled Time | 13:30                | 13:30       | 13:30       | 13:30        | 13:30        |
|                         |   | Client ID    | COMOX IN #1          | COMOX IN #2 | COMOX IN #3 | COMOX OUT #1 | COMOX OUT #2 |
| Grouping                | Analyte                                   |              |                      |             |             |              |              |
| <b>CANISTER</b>         |   |              |                      |             |             |              |              |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  | <12          | <12                  | <12         | <12         | <12          | <12          |
|                         | Tetrahydrothiophene (ppb(V))              | <4.0         | <4.0                 | <4.0        | <4.0        | <4.0         | <4.0         |
|                         | Tetrahydrothiophene (ug/m3)               | <14          | <14                  | <14         | <14         | <14          | <14          |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  | <6.0         | <6.0                 | <6.0        | <6.0        | <6.0         | <6.0         |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   | <21          | <21                  | <21         | <21         | <21          | <21          |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) | 2570         | 3490                 | 2810        | 19          | 19           | 19           |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  | 3590         | 4870                 | 3920        | 26          | 27           | 27           |
| <b>Miscellaneous</b>    | Batch Proof ID                            | 181212.301   | 181105.13100<br>0001 | 190610.109  | 181121.231  | 181121.202   | 181121.202   |
|                         | Canister ID                               | 01400-0008   | 01400-0384           | 01400-0121  | 01400-0412  | 01400-0051   | 01400-0051   |
|                         | Pressure on Receipt (in Hg)               | 0.8          | 0.8                  | -11.4       | 1.0         | 0.8          | 0.8          |
|                         | Regulator ID                              | N/A          | N/A                  | N/A         | N/A         | N/A          | N/A          |

# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                         | <b>Sample ID</b><br><b>Description</b><br><b>Sampled Date</b><br><b>Sampled Time</b><br><b>Client ID</b> | L2341651-6 | SUMP | 04-SEP-19 | 13:30 | COMOX OUT #3 |
|-------------------------|--|------------|------|-----------|-------|--------------|
| Grouping                | Analyte  |            |      |           |       |              |
| <b>CANISTER</b>         |  |            |      |           |       |              |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)   | <12        |      |           |       |              |
|                         | Tetrahydrothiophene (ppb(V))   | <4.0       |      |           |       |              |
|                         | Tetrahydrothiophene (ug/m3)  | <14        |      |           |       |              |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))   | <6.0       |      |           |       |              |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)  | <21        |      |           |       |              |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V))  | 18         |      |           |       |              |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)   | 26         |      |           |       |              |
| <b>Miscellaneous</b>    | Batch Proof ID   | 181105.104 |      |           |       |              |
|                         | Canister ID  | 01400-0037 |      |           |       |              |
|                         | Pressure on Receipt (in Hg)  | 0.2        |      |           |       |              |
|                         | Regulator ID   | N/A        |      |           |       |              |

## Reference Information

**Test Method References:**

| ALS Test Code   | Matrix   | Test Description  | Method Reference** |
|---|----------|---|--------------------|
| <b>CAN-DATA-WT</b>  | Canister | Canister Information<br>Batch Proof ID, Canister ID, Pressure on Receipt, Regulator ID. | EPA TO-15          |
| <b>REDUC-SULF-22-SCD-WT</b>   | Canister | 22 Reduced Sulfur Compounds by GC-SCD   | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.</p> <p>Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p> |          |   |                    |
| <b>TRS-22-SCD-WT</b>  | Canister | Total Reduced Sulfur as H2S   | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.</p> <p>Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p> |          |   |                    |
| <b>TRS22-SUM-CALC-WT</b>  | Canister | Total Reduced Sulfur as H2S (22 Comp'ds)  | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. A volume of air sample is transferred from the canister to a preconcentrator system where the analytes are trapped &amp; focused. The analytes are then thermally desorbed into a GC-SCD for analysis. Test results are not blank corrected unless indicated by a qualifier. Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p>  |          |   |                    |

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location                           |
|----------------------------|---|
| WT                         | ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA |

**Chain of Custody Numbers:**

17-762085

**GLOSSARY OF REPORT TERMS**

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878



L2341651-COFC

COC Number: 17 - 762085

Page of

www.alsglobal.com

|   |   |  |                            |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|--|----------------------------|-------------|---|--|--|--|--|----------------------|------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| <b>Report To</b><br>Contact and company name below will appear on the final report    |   | <b>Report Format / Distribution</b>  |                            |             | <b>Select Service Level Below - Contact your AM to confirm all E&amp;P TATs (surcharges may apply)</b>  |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company: <b>RWDI</b>  |   | Select Report Format: <input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input type="checkbox"/> EDD (DIGITAL) |                            |             | Regular [R] <input checked="" type="checkbox"/> Standard TAT if received by 3 pm - business days - no surcharges apply  |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Contact: <b>Math Sawycky</b>  |   | Quality Control (QC) Report with Report <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO                                    |                            |             | PRIORITY (Business days)  |  | EMERGENCY  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Phone: <b>519-823-1311 x 2639</b>   |   | <input type="checkbox"/> Compare Results to Criteria on Report - provide details below if box checked  |                            |             | 4 day [P4-20%] <input type="checkbox"/>   |  | 1 Business day [E - 100%] <input type="checkbox"/>   |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company address below will appear on the final report                                 |   | Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX                      |                            |             | 3 day [P3-25%] <input type="checkbox"/>   |  | Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] <input type="checkbox"/> |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Street: <b>280-1385 West 8th Ave</b>  |   | Email 1 or Fax: <b>Matthew.Sawycky@RWDI.com</b>  |                            |             | Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm  |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| City/Province: <b>Vancouver BC</b>  |   | Email 2  |                            |             | For tests that can not be performed according to the service level selected, you will be contacted.   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Postal Code:  |   | Email 3  |                            |             | <b>Analysis Request</b>   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Invoice To</b>   |   | <b>Invoice Distribution</b>  |                            |             | <table border="1"> <tr> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">NUMBER OF CONTAINERS</td> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">Total Reduced Substans</td> <td colspan="10">Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below</td> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table> |  |  |  |  | NUMBER OF CONTAINERS | Total Reduced Substans | Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Same as Report To <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO |   | Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX              |                            |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Copy of Invoice with Report <input type="checkbox"/> YES <input type="checkbox"/> NO  |   | Email 1 or Fax   |                            |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company:  |   | Email 2  |                            |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Contact:  |   | Email 3  |                            |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Project Information</b>  |   | <b>Oil and Gas Required Fields (client use)</b>  |                            |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Account # / Quote #:  |   | AFE/Cost Center:   | PO#                        |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Job #: <b>1904012</b>   |   | Major/Minor Code:  | Routing Code:              |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| LSD:  |   | Location:  |                            |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Lab Work Order # (lab use only):  |   | ALS Contact: <b>Rogina</b>   | Sampler: <b>M. Sawycky</b> |             |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Sample # (lab use only)   | Sample Identification and/or Coordinates (This description will appear on the report) | Date (dd-mmm-yy)   | Time (hh:mm)               | Sample Type | <table border="1"> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table>   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|   | COMOX IN #1   | 4-9-19   | 1:30                       | SUMA        |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|   | COMOX IN #2   | ↓  | ↓                          | ↓           |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|   | COMOX IN #3   | ↓  | ↓                          | ↓           |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|   | COMOX OUT #1  | ↓  | ↓                          | ↓           |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|   | COMOX OUT #2  | ↓  | ↓                          | ↓           |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|   | COMOX OUT #3  | ↓  | ↓                          | ↓           |   |  |  |  |  |                      |                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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SAMPLES ON HOLD

SUSPECTED HAZARD (see Special Instructions)

|  |                     |   |              |       |  |                        |                          |                     |  |  |
|--|---------------------|---|--------------|-------|--|------------------------|--------------------------|---------------------|--|--|
| <b>Drinking Water (DW) Samples<sup>1</sup> (client use)</b>  |                     | <b>Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)</b> |              |       | <b>SAMPLE CONDITION AS RECEIVED (lab use only)</b>   |                        |                          |                     |  |  |
| Are samples taken from a Regulated DW System?<br><input type="checkbox"/> YES <input checked="" type="checkbox"/> NO |                     |   |              |       | Frozen <input type="checkbox"/> SIF Observations Yes <input type="checkbox"/> No <input type="checkbox"/>  |                        |                          |                     |  |  |
| Are samples for human consumption/ use?<br><input type="checkbox"/> YES <input checked="" type="checkbox"/> NO       |                     |   |              |       | Ice Packs <input type="checkbox"/> Ice Cubes <input type="checkbox"/> Custody seal intact Yes <input type="checkbox"/> No <input type="checkbox"/> |                        |                          |                     |  |  |
|  |                     |   |              |       | Cooling Initiated <input type="checkbox"/>   |                        |                          |                     |  |  |
|  |                     |   |              |       | INITIAL COOLER TEMPERATURES °C   |                        |                          |                     |  |  |
|  |                     |   |              |       | FINAL COOLER TEMPERATURES °C   |                        |                          |                     |  |  |
|  |                     |   |              |       | 21   |                        |                          |                     |  |  |
| <b>SHIPMENT RELEASE (client use)</b>   |                     | <b>INITIAL SHIPMENT RECEPTION (lab use only)</b>  |              |       | <b>FINAL SHIPMENT RECEPTION (lab use only)</b>   |                        |                          |                     |  |  |
| Released by: <b>[Signature]</b>  | Date: <b>5-9-19</b> | Time:   | Received by: | Date: | Time:  | Received by: <b>SC</b> | Date: <b>SEP 05 2019</b> | Time: <b>8:56AM</b> |  |  |

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

# AIR SAMPLING MEDIA REQUEST FORM



Grey sections are for INTERNAL USE ONLY

BR# 253764 - Pls ship EXPRESS tomorrow -confirm delivery date pls

|                               |   |                     |                |
|-------------------------------|---|---------------------|----------------|
| CLIENT:                       | Comox Valley Regional District  | CLIENT EXPECT DATE: | 09/03/2019     |
| CLIENT CONTACT:               | Zoe Berkey  | ORDER TAKEN BY:     | J. Pearson     |
| CLIENT PROJECT:               |   | ORDER DATE:         | 08/27/2019     |
| DELIVERY TO:                  | 445 Brent Road, Comox, BC V9M 3V9   | QUOTE #:            |                |
| TELEPHONE NUMBER:             |   | ORDER FILLED BY:    | LB1            |
| SHIP TO/ATTENTION OF:         |   | DATE COMPLETED:     | 08/28/2019     |
| Shipping Method: (Select one) | <input checked="" type="radio"/> Ground: (4 business days to Western Canada, 2 business day to Winnipeg)<br><input type="radio"/> Express: (2 business days to Western Canada, 1 business day to WP)<br><input checked="" type="radio"/> External Courier | Tracking Number:    | 7760 9894 4739 |

ALS Drivers:

Pickup at ALS Waterloo:

TAT Information: (select one)

|  |                  |                |
|--|------------------|----------------|
| <input type="radio"/> Regular TAT      | 10 Business Days | No surcharge   |
| <input checked="" type="radio"/> 5-day | 5 Business Days  | 50% surcharge  |
| <input type="radio"/> 3-day            | 3 Business Days  | 100% surcharge |
| <input type="radio"/> 2-day            | 2 Business Days  | 200% surcharge |
| <input type="radio"/> 1-day            | 1 Business Day   | 300% surcharge |

ALL TAT except Regular requires Prior Confirmation

**Completion of all Sections is Mandatory**

1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawspace; **OH&S** - Industrial, Commercial, Residential comment: ADAPTOR BAG TO CAN

2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**

3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**

This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:               | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-----------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                       | 24 hr           |          |                           |                                |  |                             |
|                                   | 12 hr           |          |                           |                                |  |                             |
|                                   | 8 hr            |          |                           |                                |  |                             |
|                                   | 4 hr            |          |                           |                                |  |                             |
|                                   | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters _____         | 30 mins         |          |                           |                                |  |                             |
| 1.4L Canister                     | 1 hr            |          |                           |                                |  |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters _____         |                 |          |                           |                                |  |                             |
| Bottle Vacs                       | 1 hr            |          |                           |                                |  |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters _____         |                 |          |                           |                                |  |                             |
| Passive CarboPak X Tubes          |                 |          |                           |                                |  |                             |
| Diffusive Caps                    |                 |          |                           |                                |  |                             |
| Active SVI Tubes                  |                 |          |                           |                                |  |                             |
| Calibration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |

| Other Sampling Supplies   | ID #                                  | Quantity | Additional Information & Special Instructions or Requests |
|---|---------------------------------------|----------|---|
| Pressure Gauge  |                                       |          | 6XTedlar to canister adapters for reduced sulphur .       |
| Caplok Tool   |                                       |          |   |
| Canister Stands   |                                       |          |   |
| Valve Adaptor for Soil Vapour   |                                       |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS | <input type="checkbox"/>              |          |   |
| Chargeable Supplies   |                                       |          |   |
| Duplicate Sampler - \$40 can/\$25 tube                                  |                                       |          |   |
| Teflon Tubing   |                                       |          |   |
| -Total length _____ ft  | without nuts and ferrules             |          |   |
| -Length per section _____ ft - \$3 per foot / \$6 per N+F set           | with nuts and ferrules (single end)   |          |   |
|   | with nuts and ferrules (double ended) |          |   |
| Siloxane Kit - \$45 each  |                                       |          |   |



L2341651-COFC

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client.)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$350.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00

# AIR SAMPLING MEDIA REQUEST FORM



Grey sections are for INTERNAL USE ONLY

BR# 253757

|                       |   |                     |            |
|-----------------------|---|---------------------|------------|
| CLIENT:               | RWDI - c/o Comox Valley Regional District | CLIENT EXPECT DATE: | 08/30/2019 |
| CLIENT CONTACT:       | Matthew Sawycky                           | ORDER TAKEN BY:     |            |
| CLIENT PROJECT:       |   | ORDER DATE:         | 08/27/2019 |
| DELIVERY TO:          | 445 Brent Rd, Comox, BC V9M 3V9           | QUOTE #:            |            |
| TELEPHONE NUMBER:     |   | ORDER FILLED BY:    | JW Lopez   |
| SHIP TO/ATTENTION OF: | Zoe Berkey                                | DATE COMPLETED:     |            |

Shipping Method:  Ground: (4 business days to Western Canada, 2 business days to Winnipeg)  Express: (2 business days to Western Canada, 1 business day to WP)  External Courier

Tracking Number

ALS Drivers:   
 Pickup at ALS Westport:

TAT Information (select one):  
 Regular TAT 10 Business Days No surcharge  
 5-day 5 Business Days 50% surcharge  
 3-day 3 Business Days 100% surcharge  
 2-day 2 Business Days 200% surcharge  
 1-day 1 Business Day 300% surcharge  
 ALL TAT except Regular requires Prior Confirmation

QC'd JR  
 Sep 03/19

**Completion of all Sections is Mandatory**


1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawlspace; **O&HS** - Industrial, Commercial, Residential comment: Commercial Indoor Air

2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**

3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**

This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:               | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-----------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                       | 24 hr           |          |                           |                                |  |                             |
|                                   | 12 hr           |          |                           |                                |  |                             |
|                                   | 8 hr            |          |                           |                                |  |                             |
|                                   | 4 hr            |          |                           |                                |  |                             |
|                                   | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters               |                 | 30 mins  |                           |                                |  |                             |
| 1.4L Canister                     | 1 hr            |          | reduced sulfur            | 01400-0384                     | -30                                      |                             |
|                                   | 20 mins         |          |                           | 01400-0121                     | -30                                      |                             |
|                                   | 10 mins         |          |                           | 01400-0008                     | -30                                      |                             |
|                                   | 4 mins          |          |                           | 01400-0051                     | -30                                      |                             |
| Number of Canisters               |                 | 6        |                           | 01400-0121                     | -30                                      |                             |
| Bottle Vacs                       | 1 hr            |          |                           | 01400-0037                     | -24                                      |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
| Number of Canisters               |                 | 4 mins   |                           |                                |  |                             |
| Passive CarboPak X Tubes          |                 |          |                           |                                |  |                             |
| Diffusive Caps                    |                 |          |                           |                                |  |                             |
| Active SVI Tubes                  |                 |          |                           |                                |  |                             |
| Calibration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |

| Other Sampling Supplies  | ID # | Quantity | Additional Information & Special Instructions or Requests   |
|--|------|----------|---|
| Pressure Gauge   |      |          | <br>L2341651-COFC |
| Caplok Tool  |      |          |   |
| Canister Stands  |      |          |   |
| Valve Adaptor for Soil Vapour  |      |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS <input type="checkbox"/> |      |          |   |
| Chargeable Supplies  |      |          |   |
| Duplicate Sampler - \$40 each/\$25 tube  |      |          |   |
| Teflon Tubing  |      |          |   |
| - Total length _____   |      |          |   |
| - Length per section _____   |      |          |   |
| \$3 per foot / \$6 per N+F set   |      |          |   |
| Siloxane Kit - \$45 each   |      |          |   |

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
 6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$850.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00

## APPENDIX D

A large decorative graphic on the page. It features a blue triangular shape in the top-left corner, separated from a large, light-grey curved shape by a white border. The text 'Field Notes' is centered within the grey area.

Field Notes

Sept 4 2019  
Comox WWTP  
Start Purge 5 lpm  
@ 8:04  
Sample 1  
"COMOX 1"  
at outlet of Bioreactor  
5 lpm Dwyer 10 psi del  
Sampling 8:14 to 8:20

COMOX 2  
purging start at 8:25  
Mid Point of Bioreactor  
A  
Sampling 8:35 - 8:45

Comox 3  
purging start @ 8:50  
taken at the inlet of  
Bioreactor A

Sept 4 2019  
COMOX 4  
outlet of bioreactor C  
purging starts @ 9:15  
Sampling 9:25-35

COMOX 5  
mid section of  
Bioreactor C purge  
at 9:39  
sampling 9:50-10:00

COMOX 6  
inlet of Bioreactor C  
purging @ 10:02  
sampling 10:14-10:24

MATT S  
WILL C

SEPTEMBER 19 Comox

|              |   |         |
|--------------|---|---------|
| SCRUBBER OUT | 1 | 820 pm  |
| SCRUBBER OUT | 2 | 828 pm  |
| SCRUBBER OUT | 3 | 840 pm. |

|            |   |     |         |
|------------|---|-----|---------|
| BIOREACTOR | 1 | IN  | 915 pm  |
| BIOREACTOR | 1 | MID | 938 pm  |
| BIOREACTOR | 1 | OUT | 952 pm  |
| BIOREACTOR | 2 | OUT | 1010 pm |
| BIOREACTOR | 2 | MID | 1025 pm |
| BIOREACTOR | 2 | IN  | 1043 pm |

POSSIBLE  
MIXED LABELS  
~~\*SOME~~ TIMES CORRECT  
POSSIBLE ORDER CHANGE



RWDI  
Suite 280, 1385 West 8th Avenue  
Vancouver BC Canada  
V6H 3V9

Tel: +1.604.730.5688  
E-mail: [solutions@rwdi.com](mailto:solutions@rwdi.com)

## MEMORANDUM

|              |   |                            |  |
|--------------|---|----------------------------|--|
| <b>DATE:</b> | 2019-10-04  | <b>RWDI Reference No.:</b> | 1904012  |
| <b>TO:</b>   | Zoe Berkey  | <b>EMAIL:</b>              | <a href="mailto:zberkey@comoxvalleyrd.ca">zberkey@comoxvalleyrd.ca</a> |
| <b>FROM:</b> | Matthew Sawycky   | <b>EMAIL:</b>              | <a href="mailto:matthew.sawycky@rwdi.com">matthew.sawycky@rwdi.com</a> |
| <b>CC:</b>   | John DeYoe  | <b>EMAIL:</b>              | <a href="mailto:john.deyoe@rwdi.com">john.deyoe@rwdi.com</a>           |
| <b>CC:</b>   | William Clarke  | <b>EMAIL:</b>              | <a href="mailto:william.clarke@rwdi.com">william.clarke@rwdi.com</a>   |
| <b>RE:</b>   | <b>Source Testing Memo - Comox Valley Water Pollution Control Centre - September 2019 Comox, BC</b> |                            |  |

Zoe,

Please find this memorandum for methodology and results from testing at the Comox Valley Water Pollution Control Centre (CVWPCC) in Comox, BC (the facility).

RWDI conducted sampling at the facility on September 4<sup>th</sup>, 2019 for laboratory analysis of odour and total reduced sulfur (TRS), and September 19<sup>th</sup> for laboratory analysis of odour.

### Odour Emissions Sampling Methodology

#### September 4, 2019

Upon receipt of the odour value results collected in June, it was speculated that recent changes to the facilities operations prior to the sampling program may have resulted in higher than normal values. RWDI was commissioned to re-sample odour at the facility in early September.

Sampling was conducted to provide odour unit (OU) values as a comparison to June collected values and for subsequent dispersion modelling to be conducted.

Sampling was conducted at 3 points along each bioreactor pond, for a total of 6 samples.

#### September 19, 2019

CVWPCC expressed concern that collected OU analysis conducted on samples taken during the day may not be representative of OU values during the evening period, as the majority of residential



complaints are received in the evening hours. RWDI visited the facility to replicate the sample locations taken on September 4<sup>th</sup> during evening operations.

Sampling was conducted at the same 3 points along each bioreactor pond, for a total of 6 samples.

### **Flux Chamber Sampling**

Sampling at the bioreactor was conducted using a flux chamber.

Odour emissions from the waste water surface were measured using a floating flux chamber. The flux chamber is 40.6 cm in diameter; and approximately 35 cm high, and constructed of 14-gauge stainless steel, as per the designer's specifications outlined in Ontario Stack Testing Code Method ON-6. All interior and exterior fittings are constructed from odour neutral material being stainless steel and all lines were made from Teflon tubing with some variance at connections. The flux chamber is equipped with ports: one for sweep gas line and one for sample line. The chamber is fitted with a floatation device to hold it on top of the surface.

Ultra high purity nitrogen gas was used as the sweep gas, which was metered into the chamber at a constant rate of 5 litres per minute. The sweep gas was allowed to run through the chamber for 30 minutes prior to sample collection.

The odour samples were collected through a sample port on the flux chamber into a Tedlar bag using a lung sampler. The sample bag was filled at a rate of less 5 L/min in order to not significantly affect the equilibrium of the chamber.

### **Scrubber Outlet Sampling**

The odour samples were collected through a pre-existing sample port, located at the outlet of the odour control unit using a lung sampler. The lung sampler utilizes a large container with an airtight lid and two air line fittings. A Tedlar bag is inserted into the container and a sample line is connected to the Tedlar bag. A vacuum is then applied to the cavity in the container which, through pressure differential, draws the sample air into the Tedlar sample bag; the sample bag was filled at a rate of 5 L/min.

### **Odour Sample Analysis**

The samples collected on September 4<sup>th</sup> were air shipped to Pinchin Ltd. Environmental Consulting, in Mississauga Ontario, for analysis by an eight-member odour panel within 24-hours of testing (September 5, 2019). Details about the odour panel methodology are contained in Appendix A: Odour Evaluation Report Pinchin Ltd.



Pinchin Ltd. Environmental Consulting was unable to conduct any odour sampling during the week of September 16, so an alternate accredited laboratory was used.

The samples collected on September 19<sup>th</sup> were air shipped to Environmental Odour Consulting Corporation, in Oakville Ontario, for analysis by an eight-member odour panel within 24-hours of testing (September 20, 2019). Details about the odour panel methodology are contained in Appendix B: Odour Evaluation Report Environmental Odour Consulting Corporation.

Once the odour concentration of the samples has been determined, the odour flux rate is calculated. The sweep gas rate is used to calculate the odour flux rate based on the total air movement into the chamber. The formula that was used to calculate the odour flux rate is as follows:

$$\text{Odour Flux Rate} \left( \frac{\text{ou}}{\text{s} \cdot \text{m}^2} \right) = \frac{\text{Odour Concentration} \left( \frac{\text{ou}}{\text{m}^3} \right) \cdot \text{Sweep Rate} \left( \frac{\text{m}^3}{\text{s}} \right)}{\text{Area of flux chamber} (\text{m}^2)}$$

The odour flux rates from the bioreactor were simply averaged and the flux rate was applied to the total surface area of the bioreactor clarifiers.

## Total Reduced Sulfur Sampling Methodology

TRS sampling was conducted, in triplicate, at the inlet to the scrubber and at the exit of the scrubber. Sampling values were used to calculate the scrubber and polisher efficiency in reducing TRS.

Sulfur compounds collection was conducted using ALS laboratory supplied vacuum canister media. Air was drawn from the flux chamber into the vacuum canister media to collect the sample.

## Chemical Analysis

Total reduced sulfur collection media was sent to ALS Environmental in Burnaby BC for analysis. Details about the analysis methodology are contained in Appendix C: Certificate of Analysis, ALS Environmental.

## Odour Results

The testing programs were completed on September 4<sup>th</sup> and 19<sup>th</sup>, 2019, using the techniques described in the methodology section. The odour lab results are summarized in Table 1 and 2; the complete laboratory analysis reports can be found in Appendix A and B. Field notes from the sampling program can be found in Appendix D.



**Table 1: Odour Laboratory Analysis Sample Results – September 4, 2019**

| Location                | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Sample Time (24hr) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/m <sup>2</sup> /s) |
|-------------------------|-----------------|-----------------|--------------------------------|--------------------|---|--------------------------------|
| Bioreactor Test 1 - out | 108             | 1 : 1           | 108                            | 08:14              | 0.07  | 0.47                           |
| Bioreactor Test 2 - mid | 198             | 1 : 1           | 198                            | 08:35              | 0.13  |                                |
| Bioreactor Test 3 - in  | 1892            | 1 : 1           | 1892                           | 09:00              | 1.22  |                                |
| Bioreactor Test 4 - out | 181             | 1 : 1           | 181                            | 09:25              | 0.12  | 0.71                           |
| Bioreactor Test 5 - mid | 236             | 1 : 1           | 236                            | 09:50              | 0.15  |                                |
| Bioreactor Test 6 - in  | 2918            | 1 : 1           | 2918                           | 10:14              | 1.87  |                                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.

**Table 2: Odour Laboratory Analysis Sample Results – September 19, 2019**

| Location           | Odour Threshold | Sample Dilution | Net Odour (OU/m <sup>3</sup> ) | Sample Time (24hr) | Odour Emission Flux Rate (OU/m <sup>2</sup> /s) | Average (OU/m <sup>2</sup> /s) | Odour Emission Rate (OU/s) | Average (OU/s) |
|--------------------|-----------------|-----------------|--------------------------------|--------------------|---|--------------------------------|----------------------------|----------------|
| Bioreactor 1 - out | 282             | 1 : 1           | 282                            | 21:15              | 0.18  | 1.26                           | N/A                        | N/A            |
| Bioreactor 1 - mid | 475             | 1 : 1           | 475                            | 21:35              | 0.31  |                                | N/A                        | N/A            |
| Bioreactor 1 - in  | 5061            | 1 : 1           | 5061                           | 21:52              | 3.25  |                                | N/A                        | N/A            |
| Bioreactor 2 - out | 318             | 1 : 1           | 318                            | 22:10              | 0.20  |                                | N/A                        | N/A            |
| Bioreactor 2 - mid | 492             | 1 : 1           | 492                            | 22:25              | 0.32  |                                | N/A                        | N/A            |
| Bioreactor 2 - in  | 5142            | 1 : 1           | 5142                           | 22:43              | 3.30  |                                | N/A                        | N/A            |
| Scrubber out 1     | 145             | 1 : 1           | 145                            | 20:20              | N/A   | N/A                            | 2654.03                    | 3050.61        |
| Scrubber out 2     | 172             | 1 : 1           | 172                            | 20:28              | N/A   | N/A                            | 3148.23                    |                |
| Scrubber out 3     | 183             | 1 : 1           | 183                            | 20:40              | N/A   | N/A                            | 3349.57                    |                |

Note: \*Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.



## Total Reduced Sulfur Results

The testing program for total sulfur compounds was completed on September 4<sup>th</sup>, 2019, using the techniques described in the methodology section. The lab results are summarized in Table 3; the complete laboratory analysis report can be found in Appendix C. Field notes from the sampling program can be found in Appendix D.

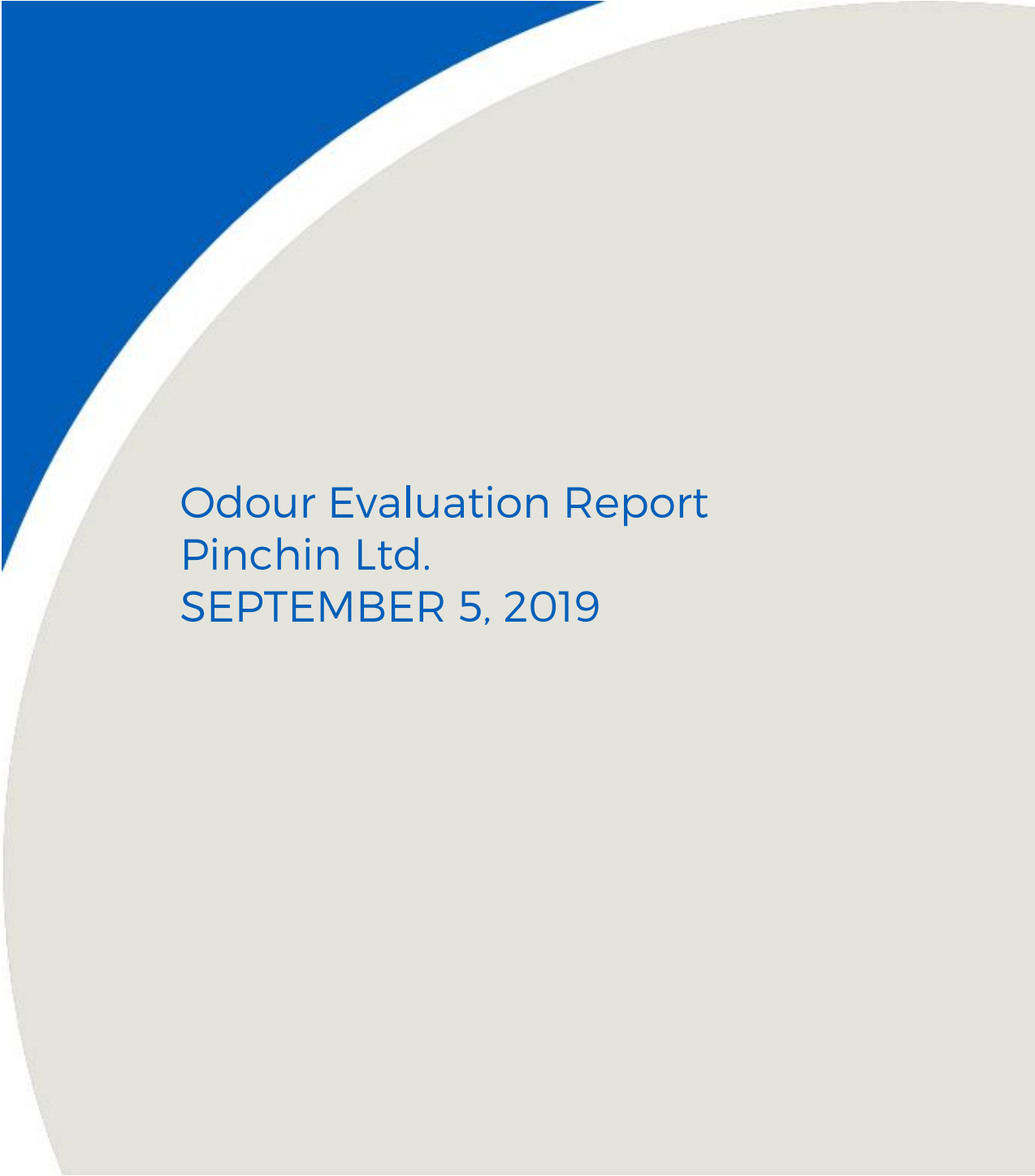
**Table 3: Total Reduced Sulfur Analysis Sample Results**

| Location          | H <sub>2</sub> S (ppb(V)) | H <sub>2</sub> S (ppb(V))<br>Average | H <sub>2</sub> S (ug/m <sup>3</sup> ) | H <sub>2</sub> S (ug/m <sup>3</sup> ) |
|-------------------|---------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| Scrubber Inlet 1  | 2570                      | 2956.7                               | 3590                                  | 4126.7                                |
| Scrubber Inlet 2  | 3490                      |                                      | 4870                                  |                                       |
| Scrubber Inlet 3  | 2810                      |                                      | 3920                                  |                                       |
| Scrubber Outlet 1 | 19                        | 19.7                                 | 26                                    | 26.3                                  |
| Scrubber Outlet 2 | 19                        |                                      | 27                                    |                                       |
| Scrubber Outlet 3 | 18                        |                                      | 26                                    |                                       |
| <b>Efficiency</b> | <b>99.4%</b>              |                                      |                                       |                                       |

If you have any questions regarding these results, we would be happy to discuss them with you at any time in the future.

Matthew Sawycky, B.Sc.  
Senior Project Manager

## APPENDIX A

The background features a large, light grey circular shape on the right side, partially overlapping a blue triangular shape on the left. The text is centered within the grey area.

Odour Evaluation Report  
Pinchin Ltd.  
SEPTEMBER 5, 2019



FINAL

# Odour Evaluation Report

2470 Milltower Court  
Mississauga, ON  
L5N 7W5

Prepared for:

**John DeYoe**  
RWDI  
600 Southgate Drive  
Guelph, Ontario N1G 4P6

September 27, 2019

Pinchin File: 202859-090519



**Issued to:** RWDI  
**Contact:** John DeYoe

**Issued on:** September 27, 2019  
**Pinchin file:** 202859-090519  
**Issuing Office:** 2470 Milltower Court,  
Mississauga, ON L5N 7W5

---

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Reviewer: \_\_\_\_\_  
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| 2.2.1 | Odour Threshold Values – Detection Threshold (DT) ..... | 3 |
| 3.0   | RESULTS.....  | 3 |

## APPENDICES

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| APPENDIX I  | Odour Evaluation Data Sheets       |
| APPENDIX II | Odour Evaluation Quality Assurance |



## 1.0 EVALUATION SAMPLE & TIMING SUMMARY

Pinchin Ltd. (Pinchin) was contracted to determine the detection threshold (DT) of air samples submitted to Pinchin's Odour Laboratory located in Mississauga, Ontario. The particulars of the odour panel were as follows:

|   |                                   |
|---|-----------------------------------|
| <b>Client Name:</b>                             | RWDI                              |
| <b>No. of Samples Delivered:</b>                | Six (6)                           |
| <b>Date Samples Received:</b>                   | September 5, 2019                 |
| <b>Condition of the Sample Bags on Arrival:</b> | No leaks or condensation detected |
| <b>No. of Samples Analyzed:</b>                 | Six (6)                           |
| <b>Date of Odour Panel Analysis:</b>            | September 5, 2019                 |
| <b>Time of Odour Panel Analysis:</b>            | 9:21 – 10:50 AM                   |

## 2.0 METHODOLOGY

### 2.1 Laboratory Methodology

All samples were evaluated in accordance with the Ministry of the Environment, Conservation and Parks "Ontario Source Testing Code" (OSTC), Version #3, June 2010 (Part G, Method ON-6), using an AC'SCENT International triangular forced-choice, ascending concentration, dynamic dilution Olfactometer. A listing of Standard Practices to which the evaluations conform is provided in Appendix II.

The AC'SCENT Olfactometer was calibrated according to the manufacturer's guidelines on the day of sample evaluation. The CHEMFLUOR® PTFE tubing through which the odour sample is presented to the panellists was replaced prior to the assessment session. All sample delivery lines were purged continuously with odour free air between sample presentations.

A panel of eight trained assessors was employed in the evaluation of the odour samples. Each panel is screened for accuracy and repeatability following the procedures outlined in British Standard, BS EN 13725:2003, "Air quality – Determination of odour concentration by dynamic olfactometry", utilizing 50 ppm n-butanol calibration gas prior to sample evaluation. The geometric mean of the individual threshold estimates for 50 ppm n-butanol was determined to be between 20 and 80 ppb/v.

The odour samples were presented to the panellists using the “triangular forced-choice” method, described by ASTM E679-04, “Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits”. Each panellist evaluated the odour by “sniffing” the diluted odour samples presented by the Olfactometer. At each dilution level, the panellist “sniffed” three sample presentations, two of which were blank, odour free samples and one that contained the odorous air. The panellist was then asked to identify which of the three presentations was different from the other two by recording a “guess”, “detect” or “recognize” response as defined by ASTM E679-04.

A “guess” response was recorded when the assessor could not distinguish between any of the presentations. A “detect” response was recorded when the assessor could differentiate the odorous sample from the two blanks, and “recognize” was recorded when the assessor could identify and describe the odorous sample.

As per BS EN 13725:2003, each sample assessment began with the Olfactometer diluting the odorous sample to sub-detection levels. The odour sample and two blanks were then presented to one panellist, who “sniffed” the three presentations and recorded their response. The concentration of odorous gas was then doubled and re-presented to the same assessor with two blanks. Again, the assessor “sniffed” the three presentations and recorded their response. The process continued with the concentration of odorous gas increasing until the panellist had correctly detected the odour in at least two consecutive presentations as described by BS EN 13725:2003. The process was repeated for each panellist until all samples were evaluated.

Sample analysis was conducted “blind”; neither the panellist nor the test administrator knew which port would deliver the odour sample. Panellist’s results were recorded and analyzed using AC’SCENT DataSense Olfactometry software integrated with the Olfactometer. The software incorporates an Access database program designed specifically for olfactometry laboratories and is compatible with international olfactometry standards including BS EN 13725:2003 and ASTM E679-04.

As part of laboratory Quality Assurance and Quality Control (QAQC), test results were retrospectively screened in accordance with BS EN 13725:2003. As the standard requires, each assessor’s individual threshold estimate ( $Z_{ITE}$ ) was compared to the panel’s average threshold, with the ratio between the individual threshold estimate and the panel average threshold represented as  $\Delta Z$ . Assessors having a  $\Delta Z$  greater than 5.0 or lower than -5.0, were eliminated from the results. The purpose was to exclude panel members that showed deviant responses due to health factors or specific hyperosmia or anosmia for the odour of the analyzed sample. Where screening was required, both the screened and unscreened results were provided.

## 2.2 Odour Evaluation Parameters

### 2.2.1 Odour Threshold Values – Detection Threshold (DT)

The detection threshold (DT) is the dilution ratio at which 50% of the panellists correctly detected the odour. DT, as defined by ASTM E679-04, is synonymous with the MECP Draft definition of an odour threshold value ( $ED_{50}$ ) and the BS EN 13725:2003 definition of odour concentration ( $C_{OD}$ ). That is, the DT represents the amount of dilution required for the odour to be just detectable. Since DT values are dimensionless, pseudo-dimensions of odour units per unit volume (i.e. odour units per cubic metre ( $ou/m^3$ )) are often used for reporting purposes.

In accordance with BS EN 13725:2003, individual threshold estimates ( $Z_{ITE}$ ) were calculated as the geometric mean of the lowest dilution ratio where the odour could not be detected and the dilution ratio at which the panellist correctly detected the odour. Where a detection response could not be established at the Olfactometer's dilution limit, it was assumed that the panellist would have detected the odour at a dilution ratio half that of the limit, and the  $Z_{ITE}$  was calculated. The sample odour concentration ( $C_{OD}$ ) was then calculated as the geometric mean of the  $Z_{ITE}$  values.

## 3.0 RESULTS

The odour threshold value results for detection threshold (DT) are presented in Table 1. Where appropriate, the DT values have been adjusted for field pre-dilution reported by the client. The adjusted DT values are recorded as  $DT_{NET}$ . Datasheets are provided in Appendix I.



Table 1 – Odour Threshold Value Results

Client: RWDI

Test Reference No.: 202859-090519

Pinchin Project No.: 202859

Evaluation Date: 5-Sep-19

| Lab No.           | Field Number/<br>Description | Dilution<br>Factor | Evaluation<br>Time | Detection |                   | Comments |
|-------------------|------------------------------|--------------------|--------------------|-----------|-------------------|----------|
|                   |                              |                    |                    | DT        | DT <sub>net</sub> |          |
| PO19-202859-S1933 | Comox 1                      | 1 :1               | 9:21 - 9:36 AM     | 108       | 108               |          |
| PO19-202859-S1934 | Comox 2                      | 1 :1               | 9:37 - 9:49 AM     | 198       | 198               |          |
| PO19-202859-S1935 | Comox 4                      | 1 :1               | 9:50 - 10:03 AM    | 181       | 181               |          |
| PO19-202859-S1936 | Comox 5                      | 1 :1               | 10:04 - 10:14 AM   | 236       | 236               |          |
| PO19-202859-S1937 | Comox 3A/3B                  | 1 :1               | 10:16 - 10:36 AM   | 1892      | 1892              |          |
| PO19-202859-S1938 | Comox 6A/6B                  | 1 :1               | 10:37 - 10:50 AM   | 2918      | 2918              |          |

**Odour Evaluation Report Nomenclature**

DT Detection Threshold

DT<sub>NET</sub> Detection Threshold adjusted for field dilution

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J:\202000s\0202859.000 RWDI,650Woodlawn,ENVNS,ODPNL\Odour Lab\2019\Sept 5, 2019\202859-090519 - RWDI Odour Report for Detection Threshold.docx

Template: 14852 – Report Template for Detection Threshold Determination - September 19, 2014

**APPENDIX I**  
**Odour Evaluation Data Sheets**  
**Pinchin File: 202859-090519**  
**(6 Pages)**

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019  
 Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice  
 Flow Rate (lpm) : 20 Sniff Time (sec) : 3

|                                    |                            |                                 |
|------------------------------------|----------------------------|---------------------------------|
| <b>Sample Information</b>          |                            | Sampling Date : <u>9/4/2019</u> |
| Lab No. : <u>PO19-202859-S1933</u> | Field No. : <u>Comox 1</u> | Sampling Time : _____           |
| Description : <u>1:1</u>           |                            | Sample Collector : <u>RWDI</u>  |
|                                    |                            | Sample Source : <u>unknown</u>  |

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |  |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|--|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |  |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |  |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |  |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |  |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |  |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |  |
| 14853-665 1     |        |        |        |        |        |        |        | 2      | 1      | 1      | 1      | 6      | 6      |        |   | 1.96  | 1.96  |  |
| 2018-1 1        |        |        |        |        |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |   | 2.26  | 1.96  |  |
| 14853-917 1     |        |        |        |        |        |        |        |        | 1      | 1      | 1      | 1      | 6      | 6      |   | 1.66  | 1.66  |  |
| 14853-671 1     |        |        |        |        |        |        |        |        | 2      | 1      | 1      | 6      | 6      |        |   | 1.96  | 1.96  |  |
| 14853-719 1     |        |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |   | 2.26  | 2.26  |  |
| 14853-1232 1    |        |        |        |        |        |        |        |        | 2      | 1      | 2      | 6      | 6      |        |   | 2.26  | 1.96  |  |
| 14853-946 1     |        |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |   | 2.26  | 2.26  |  |
| 14853-1903 1    |        |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |   | 2.56  | 2.26  |  |

**Sample Comments :**

|   |            |
|---|------------|
| <b>Specific Chemical Concentration Data</b> |            |
| Chemical :                                  | <u>N/A</u> |
| Concentration (ppm) :                       | _____      |

**Response Key:**  
 1 = Incorrect Guess  
 2 = Correct Guess  
 5 = Incorrect Detection  
 6 = Correct Detection  
 7 = Incorrect Recognition  
 8 = Correct Recognition

|                      |             |             |             |
|----------------------|-------------|-------------|-------------|
| <b>Final Results</b> |             |             |             |
|                      | <b>G</b>    | <b>D</b>    | <b>R</b>    |
| Avg. Log Value       | <u>2.15</u> | <u>2.03</u> | <u>0.00</u> |
| Std. Dev.            | <u>0.28</u> | <u>0.21</u> | <u>0.00</u> |
| Threshold            | <u>140</u>  | <u>108</u>  | <u>1</u>    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1934 Field No. : Comox 2 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |

| Assessor/Round |   |  |  |  |  |  |  |   |   |   |   |   |  |  | Log G | Log D | Log R |
|----------------|---|--|--|--|--|--|--|---|---|---|---|---|--|--|-------|-------|-------|
| 14853-665      | 1 |  |  |  |  |  |  | 2 | 2 | 6 | 6 |   |  |  | 2.86  | 2.26  |       |
| 2018-1         | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-917      | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-671      | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-719      | 1 |  |  |  |  |  |  | 1 | 2 | 1 | 6 | 6 |  |  | 1.96  | 1.96  |       |
| 14853-1232     | 1 |  |  |  |  |  |  | 1 | 1 | 6 | 6 |   |  |  | 2.26  | 2.26  |       |
| 14853-946      | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.56  | 2.56  |       |
| 14853-1903     | 1 |  |  |  |  |  |  | 2 | 1 | 6 | 6 |   |  |  | 2.56  | 2.56  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A

Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.37 | 2.30 | 0.00 |
| Std. Dev.      | 0.28 | 0.19 | 0.00 |
| Threshold      | 236  | 198  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1935 Field No. : Comox 4 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60.782 | 32.882 | 16.577 | 8.254  | 4.127  | 2.064  | 1.031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        | 2.86  | 2.26  |       |
| 2018-1 1        |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-917 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-671 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-719 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-1232 1    |        |        |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        | 2.86  | 2.26  |       |
| 14853-946 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-1903 1    |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.41 | 2.26 | 0.00 |
| Std. Dev.      | 0.28 | 0.00 | 0.00 |
| Threshold      | 257  | 181  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1936 Field No. : Comox 5 Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 2018-1 1        |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        | 2.56  | 2.26  |       |
| 14853-917 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-671 1     |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.26  | 2.26  |       |
| 14853-719 1     |        |        |        |        |        |        |        | 1      | 2      | 1      | 6      | 6      |        |        | 2.26  | 2.26  |       |
| 14853-1232 1    |        |        |        |        |        |        |        | 1      | 1      | 6      | 6      |        |        |        | 2.56  | 2.56  |       |
| 14853-946 1     |        |        |        |        |        |        |        | 2      | 1      | 6      | 6      |        |        |        | 2.56  | 2.56  |       |
| 14853-1903 1    |        |        |        |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        | 2.86  | 2.56  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G    | D    | R    |
|----------------|------|------|------|
| Avg. Log Value | 2.45 | 2.37 | 0.00 |
| Std. Dev.      | 0.23 | 0.16 | 0.00 |
| Threshold      | 281  | 236  | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1937 Field No. : Comox 3A/3B Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60,782 | 32,882 | 16,577 | 8,254  | 4,127  | 2,064  | 1,031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |
| 2018-1 1        |        |        |        | 1      | 1      | 5      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-917 1     |        |        |        |        |        | 2      | 2      | 6      | 6      |        |        |        |        |        | 3.47  | 2.86  |       |
| 14853-671 1     |        |        |        |        | 1      | 2      | 5      | 6      | 6      |        |        |        |        |        | 2.86  | 2.86  |       |
| 14853-719 1     |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-946 1     |        |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        | 3.47  | 3.16  |       |
| 14853-1903 1    |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.47  | 3.28  | 0.00 |
| Std. Dev.      | 0.32  | 0.32  | 0.00 |
| Threshold      | 2,918 | 1,892 | 1    |

**Olfactometer Evaluation Results**  
**AC'SCENT International Olfactometer**

Test Name : RWDI Test No. : 202859-090519 Test Date : 9/5/2019

Test Administrator : Mary Mekhail Test Method : Triangular Forced Choice

Flow Rate (lpm) : 20 Sniff Time (sec) : 3

**Sample Information**

Lab No. : PO19-202859-S1938 Field No. : Comox 6A/6B Sampling Date : 9/4/2019  
 Description : 1:1 Sampling Time : \_\_\_\_\_  
 Sample Collector : RWDI  
 Sample Source : unknown

| Dilution Level  | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | Calibration Date :<br>9/5/2019<br><br>THRESHOLDS<br>G = Guess<br>D = Detection<br>R = Recognition |       |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|-------|-------|
| Sample Volume   | 0.33   | 0.61   | 1.21   | 2.43   | 4.86   | 9.7    | 19.5   | 38.9   | 77.74  | 157.3  | 313.5  | 626.8  | 1250   | 2500   |   |       |       |
| Total Volume    | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 | 20,058 |   |       |       |
| Dilution Ratio  | 60.782 | 32.882 | 16.577 | 8.254  | 4.127  | 2.064  | 1.031  | 516    | 258    | 128    | 64.0   | 32.0   | 16.0   | 8.0    |   |       |       |
| Geometric Mean  | 85,958 | 44,706 | 23,347 | 11,697 | 5,837  | 2,918  | 1,459  | 729    | 365    | 181    | 90     | 45.2   | 22.7   | 11.3   |   |       |       |
| Log (Geo. Mean) | 4.93   | 4.65   | 4.37   | 4.07   | 3.77   | 3.47   | 3.16   | 2.86   | 2.56   | 2.26   | 1.96   | 1.66   | 1.36   | 1.05   |   |       |       |
| Assessor/Round  |        |        |        |        |        |        |        |        |        |        |        |        |        |        | Log G   | Log D | Log R |
| 14853-665 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 2018-1 1        |        |        |        | 2      | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-917 1     |        |        |        | 1      | 2      | 1      | 6      | 6      |        |        |        |        |        |        | 3.16  | 3.16  |       |
| 14853-671 1     |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-719 1     |        |        |        | 1      | 2      | 6      | 6      |        |        |        |        |        |        |        | 3.77  | 3.47  |       |
| 14853-1232 1    |        |        |        | 1      | 1      | 6      | 6      |        |        |        |        |        |        |        | 3.47  | 3.47  |       |
| 14853-946 1     |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |
| 14853-1903 1    |        |        | 2      | 1      | 6      | 6      |        |        |        |        |        |        |        |        | 3.77  | 3.77  |       |

**Sample Comments :**

**Specific Chemical Concentration Data**

Chemical : N/A  
 Concentration (ppm) : \_\_\_\_\_

**Response Key:**

- 1 = Incorrect Guess
- 2 = Correct Guess
- 5 = Incorrect Detection
- 6 = Correct Detection
- 7 = Incorrect Recognition
- 8 = Correct Recognition

**Final Results**

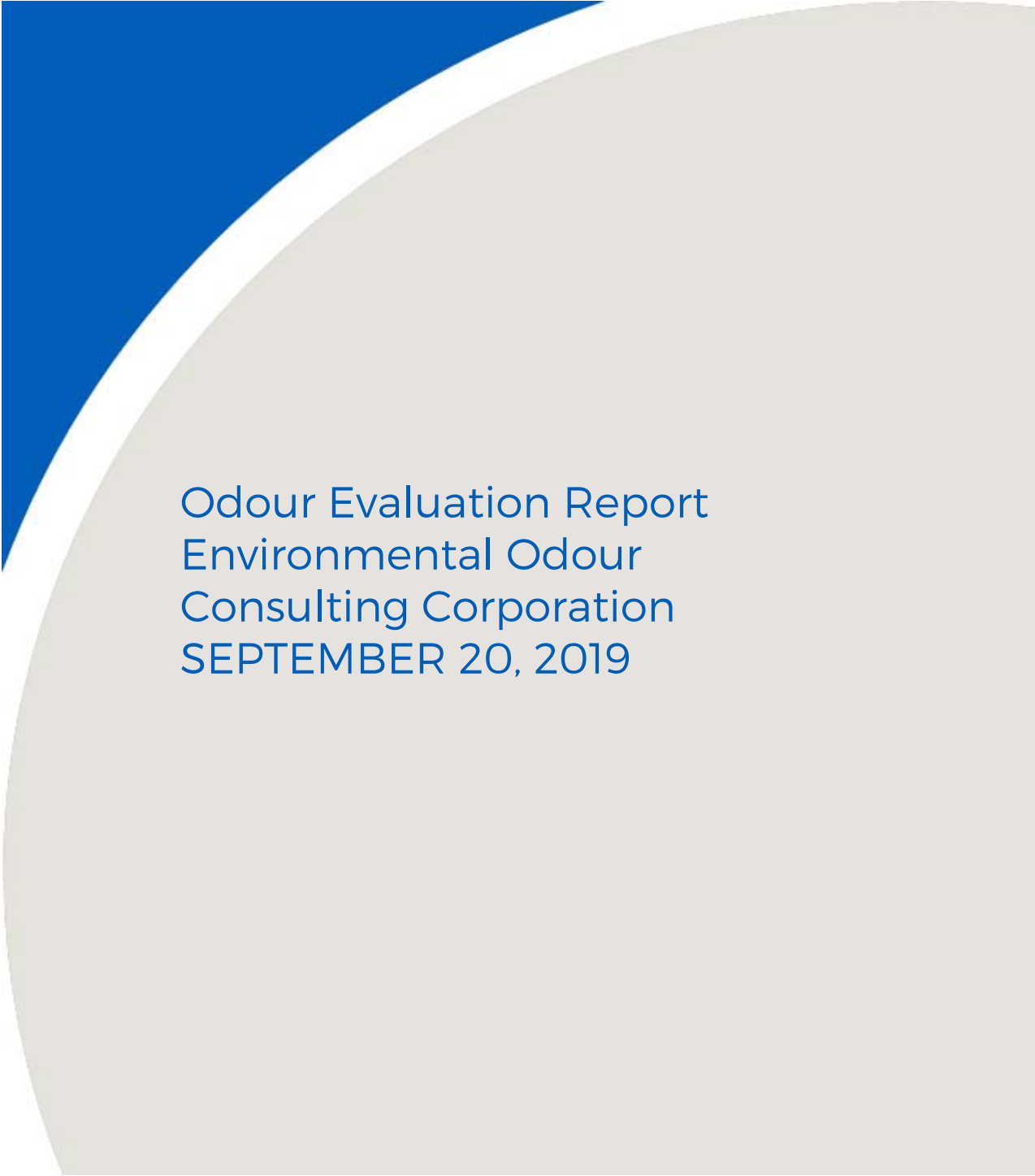
|                | G     | D     | R    |
|----------------|-------|-------|------|
| Avg. Log Value | 3.50  | 3.47  | 0.00 |
| Std. Dev.      | 0.25  | 0.23  | 0.00 |
| Threshold      | 3,182 | 2,918 | 1    |

**APPENDIX II**  
**Odour Evaluation Quality Assurance**  
**Pinchin File: 202859-090519**  
**(1 Page)**

## ODOUR EVALUATION QUALITY ASSURANCE

- Odour evaluations conducted at the Pinchin Odour Laboratory conform to the procedures outlined in the Ministry of the Environment, Conservation and Parks “Ontario Source Testing Code” (OSTC), Version #3, June 2010 (Part G, Method ON-6) and are in accordance with ASTM (American Society for Testing and Materials) Standard Practice E679-04, Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series of Limits.
- The AC’SCENT® Dynamic Dilution Forced-Choice Triangle Olfactometer complies with all aspects of the ASTM E679-04 standard as well as the operational requirements of the British Standard, BS EN 13725:2003, “Air quality – Determination of odour concentration by dynamic olfactometry”.
- The detection threshold values are reported as defined by ASTM E679-04 and BS EN 13725:2003.
- Assessors are selected and trained in accordance with BS EN 13725:2003.
- The Pinchin Odour Laboratory is managed based on the requirements of the International Organization for Standardization (ISO) International Standard ISO 17025:2005, “General requirements for the competence of testing and calibration laboratories”.
- Samples are consumed during the evaluation and all sample bags are destroyed 48 hours after transmittal of the Preliminary Odour Evaluation Results, unless otherwise specified.

## APPENDIX B

A large decorative graphic on the left side of the page, featuring a blue triangle at the top left corner and a large, light grey semi-circle that curves from the bottom left towards the right side of the page.

Odour Evaluation Report  
Environmental Odour  
Consulting Corporation  
SEPTEMBER 20, 2019

# Report

## Odour Panel Evaluation

### **Report to:**

RWDI Air Inc.  
650 Woodlawn Road West  
Guelph, Ontario  
N1K 1B8  
Mr. Matthew Sawycky  
E-mail: Matthew.Sawycky@RWDI.com  
Phone: 519 823 1311

### **Prepared by:**

#### ***EOC Environmental Odour Consulting Corporation***

Anna H. Bokowa, M.Sc.  
*President*  
Tel: (647) 988-5814  
Bokowa.anna@environmentalodourconsulting.com

**Date of the Report**  
October 1, 2019  
12 pages, 2 Appendices

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## 1. INTRODUCTION

EOC Environmental Odour Consulting Corporation (EOC) was contracted by RWDI Air Inc. (RWDI) to perform an odour evaluation on samples delivered to EOC.

One batch of nine (9) samples was shipped from Vancouver via Air Canada FedEx. On September 20, 2019, samples were picked up from the Air Canada Cargo Centre located at 2580 Britannia Rd E, Mississauga, ON. All samples were evaluated on September 20, 2019.

All evaluations for odour detection threshold value (ODTV) were performed according to the European standard EN13725: 2003 (with exceptions) and Ontario Ministry of the Environment Method ON-6 using dynamic olfactometry with eight screened panelists.

All samples were in good condition upon delivery.

## 2. METHODOLOGY

The evaluations were based on the European Standard EN 13725:2003 with the exception that each sample was introduced once to the panel members and eight panel members were used for all evaluations. Odour evaluations were also completed in accordance to the Ontario Ministry of the Environment's Method ON-6 "Determination of Odour Emission from Stationary Sources."

The EOC olfactometer is capable to perform evaluations using either the Triangular Forced Choice Method, or the Binary Forced Choice Method. For the Forced Choice Method; the panelist is presented with two or three ports (Triangular, Binary), of which one panelist presents the diluted sample and the other(s) neutral gas. The sample is presented randomly over the two or three ports. The panelist is asked to indicate the port with the sample. The panelist is also asked if his/her choice was a guess, inkling or if they were certain. By combining the chosen results and the indicated level of certainty, the response is classified as false or true. The odour evaluation procedure requires the first sample to be presented to the panelist at the dilution that will be below the detection threshold. Therefore, the several initial presentations to the panelists require the panelist to select one port by guessing. Each panelist observes an odour sample in the ascending concentration series (increasing concentration). For this program, a Binary Forced Choice Mode was chosen for odour evaluations. Each sample bag was evaluated by eight panelists with the option that for each dilution, each of the 8 panelists were asked to indicate their responses. Therefore, each panelist was introduced to the same dilution steps. Also, the same step between dilutions was used (1.51) for evaluation of all the samples.

The panelists' responses were recorded by computer software and were processed to determine the odour detection threshold value (ODTV) for each sample. The ODTV is a dilution factor and therefore has no units. For convenience, however, the ODTV may be expressed in odour units (ou).

A screened odour panel was used for all evaluations. They were tested for odour sensitivity using n-butanol as a reference gas. All panelists were within the normal range according to the European Standard EN 13725:2003 (20-80 ppb n-butanol). All panelists were included in the evaluations.

All screening data for the day of evaluation are presented in Appendix 1.

### **3. QUALITY CONTROL MEASURES AND CALIBRATION DATA**

EOC provided extensive quality control measures for the evaluations. These included, but were not limited to:

- Keeping constant dilution steps between analysis of the samples from the same source.
- Each sample bag was evaluated by eight panelists with the option that for each dilution each of the 8 panelists were asked to indicate their responses (each panelist was exposed to the same dilution).
- The EOC olfactometer is calibrated by the manufacturer against carbon monoxide at all used ports. The calibrations are within the limits of EN13725 standard.
- The EOC olfactometer is checked before each use for consistent volumetric flow rates at each “sniff port.”
- EOC panelists are screened using European Method EN; 13725 with n-butanol and they are within the range of that standard- all screening data are provided in the report.
- EOC panelists are trained to avoid any odorous products such as perfumes and scented lotions.
- EOC panelists are advised and trained to avoid coffee or spicy food one hour before a session.
- EOC makes sure that the sessions for the odour panel evaluations are not too long.
- EOC provides frequent breaks to avoid any panelist’s fatigue.
- All panelists’ data are computer recorded.

### **4. RESULTS**

Table 1 shows the results for odour detection threshold values for samples evaluated on September 20, 2019.

Appendix 1 shows the screening data for the panel used during the program.

All calibration data for the olfactometer are presented in Appendix 2.

Prepared by:



Anna H. Bokowa, M.Sc.  
President, Environmental Odour Consulting

**Table 1: Odour Detection Threshold Values- September 20, 2019**

| <b>Client<br/>Description</b> | <b>EOC<br/>Sample<br/>Identification</b> | <b>ODTV<br/><br/>ou</b> |
|-------------------------------|--|-------------------------|
| Scrubber Out 1                | A001                                     | 145                     |
| Scrubber Out 2                | A002                                     | 172                     |
| Scrubber Out 3                | A003                                     | 183                     |
| Bioreactor 1 Outlet           | A004                                     | 282                     |
| Bioreactor 2 Outlet           | A005                                     | 318                     |
| Bioreactor 1 Mid              | A006                                     | 475                     |
| Bioreactot 2 Mid              | A007                                     | 492                     |
| Bioreactor 1 Inlet            | A008                                     | 5061                    |
| Bioreactor 2 Inlet            | A009                                     | 5142                    |

## **APPENDIX 1**

### **Panelist's Screening Data**

**(1 page)**

| Panelist No | Panelist ID | n- butanol ppb Test 1 | n- butanol ppb Test 2 | n- butanol ppb Test 3 | n- butanol ppb Test 4 | n- butanol ppb Test 5 | n- butanol ppb Test 6 | n- butanol ppb Test 7 | n- butanol ppb Test 8 | n- butanol ppb Test 9 | n- butanol ppb Test 10 | n- butanol ppb Test 11 | n- butanol ppb Test 12 | n- butanol ppb Average |
|-------------|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|
| Panelist 1  | P201        | 55                    | 47                    | 48                    | 55                    | 57                    | 48                    | 47                    | 56                    | 51                    | 43                     | 56                     | 58                     | 52                     |
| Panelist 2  | P202        | 32                    | 47                    | 48                    | 42                    | 43                    | 32                    | 36                    | 32                    | 38                    | 33                     | 42                     | 44                     | 39                     |
| Panelist 3  | P205        | 24                    | 27                    | 24                    | 24                    | 25                    | 32                    | 27                    | 24                    | 38                    | 25                     | 32                     | 25                     | 27                     |
| Panelist 4  | P208        | 42                    | 47                    | 48                    | 42                    | 43                    | 48                    | 47                    | 42                    | 38                    | 43                     | 42                     | 44                     | 44                     |
| Panelist 5  | P210        | 24                    | 27                    | 24                    | 24                    | 25                    | 24                    | 27                    | 24                    | 29                    | 25                     | 24                     | 25                     | 25                     |
| Panelist 6  | P212        | 42                    | 47                    | 48                    | 42                    | 43                    | 32                    | 47                    | 42                    | 38                    | 43                     | 42                     | 44                     | 43                     |
| Panelist 7  | P213        | 32                    | 36                    | 32                    | 32                    | 33                    | 32                    | 36                    | 32                    | 38                    | 33                     | 32                     | 33                     | 33                     |
| Panelist 8  | P216        | 55                    | 47                    | 56                    | 55                    | 57                    | 56                    | 47                    | 42                    | 51                    | 57                     | 56                     | 58                     | 53                     |

### Panelists Screening Data- September 20, 2019

| Panelist No | Panelist ID | n- butanol ppb 20-Sep-19 |
|-------------|-------------|--------------------------|
| Panelist 1  | P201        | 56                       |
| Panelist 2  | P202        | 32                       |
| Panelist 3  | P205        | 32                       |
| Panelist 4  | P208        | 42                       |
| Panelist 5  | P210        | 24                       |
| Panelist 6  | P212        | 42                       |
| Panelist 7  | P213        | 32                       |
| Panelist 8  | P216        | 56                       |

## **APPENDIX 2**

### **Calibration Data**

**(3 pages)**

## Certificate of Calibration- Olfactometer SC300

Date of Calibration: September 18, 2019

Device Description: Olfactometer SC300

Calibration Conditions: T: 22.5°C ± 2°C P: 750 psi ± 1 psi

Diluting Air Flow:

| Set Point<br>(ml/min) | Measured<br>(ml/min) | Difference % | MFC<br>used |
|-----------------------|----------------------|--------------|-------------|
| 10000                 | 10040                | 0.4          | MFC 3       |
| 12000                 | 12095                | 0.8          | MFC 3       |
| 15000                 | 14925                | 0.5          | MFC 3       |
| 18000                 | 18160                | 0.9          | MFC 3       |
| 20000                 | 20010                | 0.1          | MFC 3       |

Acceptable limit is within 2%. Acceptable error limit in accordance to EN13725 is 10%.

Measured using Gas collection method

Uncertainty of Measurement: ±0.5% based on a confidence of probability of greater than 95%.

Dilutions:

| <i>Settings</i> | <i>Measured</i> | <i>Difference %</i> | <i>MFC</i> |
|-----------------|-----------------|---------------------|------------|
| 12              | 12.4            | 3.3                 | MFC 2      |
| 16              | 16.3            | 1.9                 | MFC 2      |
| 32              | 32.5            | 1.6                 | MFC 2      |
| 64              | 67.3            | 5.1                 | MFC 2      |
| 128             | 121             | 5.5                 | MFC 2      |
| 256             | 264             | 3.1                 | MFC 1      |
| 512             | 502             | 1.9                 | MFC 1      |
| 1024            | 1029            | 0.5                 | MFC 1      |
| 2048            | 2071            | 1.1                 | MFC 1      |
| 4096            | 4344            | 6.1                 | MFC 1      |
| 8192            | 8746            | 6.8                 | MFC1       |
| 16384           | 16078           | 1.9                 | MFC1       |
| 32768           | 35684           | 8.9                 | MFC1       |

Acceptable error limit in accordance to EN13725 is 20%.

Measured using Tracer gas calibration method with certified CO calibration gas cylinders and Carbon Monoxide analyzer.

## Velocity Readings: September 20, 2019

| <b>Test No</b> | <b>Port A<br/>Velocity<br/>m/s</b> | <b>Port B<br/>Velocity<br/>m/s</b> |
|----------------|------------------------------------|------------------------------------|
| Test 1         | 0.314                              | 0.315                              |
| Test 2         | 0.312                              | 0.313                              |
| Test 3         | 0.310                              | 0.316                              |
| Test 4         | 0.314                              | 0.314                              |
| Test 5         | 0.310                              | 0.312                              |
| Test 6         | 0.312                              | 0.310                              |

## APPENDIX C

A large decorative graphic on the page, featuring a blue triangle in the top-left corner and a large, light-grey, rounded shape that covers most of the lower half of the page. The text is centered within this grey shape.

Certificate of Analysis  
Total Reduced Sulfur  
ALS Environmental



RWDI AIR INC.  
ATTN: Matthew Sawycky  
#280 - 1385 West 8th Avenue  
Vancouver BC V6H 3V9

Date Received: 05-SEP-19  
Report Date: 17-SEP-19 18:29 (MT)  
Version: FINAL

Client Phone: 604-730-5688

## Certificate of Analysis

Lab Work Order #: L2341651  
Project P.O. #: NOT SUBMITTED  
Job Reference: 1904012  
C of C Numbers: 17-762085  
Legal Site Desc:

Rojina Ghavami  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company



# ALS ENVIRONMENTAL ANALYTICAL REPORT

|                         | Sample ID<br>Description<br>Sampled Date<br>Sampled Time<br>Client ID |      |  |  |  |
|-------------------------|---|------|--|--|--|
|                         | L2341651-6<br>SUMP<br>04-SEP-19<br>13:30<br>COMOX OUT #3              |      |  |  |  |
| Grouping                | Analyte   |      |  |  |  |
| <b>CANISTER</b>         |   |      |  |  |  |
| <b>Sulfur Compounds</b> | n-Butyl mercaptan (ppb(V))  | <4.0 |  |  |  |
|                         | n-Butyl mercaptan (ug/m3)   | <15  |  |  |  |
|                         | Butyl(t) mercaptan (ppb(V))   | <4.0 |  |  |  |
|                         | Butyl(t) mercaptan (ug/m3)  | <15  |  |  |  |
|                         | Carbon Disulfide (ppb(V))   | 2.2  |  |  |  |
|                         | Carbon Disulfide (ug/m3)  | 6.9  |  |  |  |
|                         | Carbonyl sulfide (ppb(V))   | 14.2 |  |  |  |
|                         | Carbonyl sulfide (ug/m3)  | 34.8 |  |  |  |
|                         | Diethyl disulfide (ppb(V))  | <2.0 |  |  |  |
|                         | Diethyl disulfide (ug/m3)   | <10  |  |  |  |
|                         | Diethyl Sulfide (ppb(V))  | <4.0 |  |  |  |
|                         | Diethyl Sulfide (ug/m3)   | <15  |  |  |  |
|                         | Dimethyl disulfide (ppb(V))   | <2.0 |  |  |  |
|                         | Dimethyl disulfide (ug/m3)  | <7.7 |  |  |  |
|                         | Dimethyl sulfide (ppb(V))   | <4.0 |  |  |  |
|                         | Dimethyl sulfide (ug/m3)  | <10  |  |  |  |
|                         | 2,5-Dimethylthiophene (ppb(V))  | <4.0 |  |  |  |
|                         | 2,5-Dimethylthiophene (ug/m3)   | <18  |  |  |  |
|                         | Ethyl mercaptan (ppb(V))  | <4.0 |  |  |  |
|                         | Ethyl mercaptan (ug/m3)   | <10  |  |  |  |
|                         | Ethyl Methyl Sulfide (ppb(V))   | <4.0 |  |  |  |
|                         | Ethyl Methyl Sulfide (ug/m3)  | <12  |  |  |  |
|                         | 2-Ethylthiophene (ppb(V))   | <4.0 |  |  |  |
|                         | 2-Ethylthiophene (ug/m3)  | <18  |  |  |  |
|                         | Hydrogen Sulfide (ppb(V))   | <4.0 |  |  |  |
|                         | Hydrogen Sulfide (ug/m3)  | <5.6 |  |  |  |
|                         | Isobutyl Mercaptan (ppb(V))   | <4.0 |  |  |  |
|                         | Isobutyl Mercaptan (ug/m3)  | <15  |  |  |  |
|                         | Isopropyl Mercaptan (ppb(V))  | <4.0 |  |  |  |
|                         | Isopropyl Mercaptan (ug/m3)   | <12  |  |  |  |
|                         | Methyl mercaptan (ppb(V))   | <4.0 |  |  |  |
|                         | Methyl mercaptan (ug/m3)  | <7.9 |  |  |  |
|                         | 2-Methylthiophene (ppb(V))  | <4.0 |  |  |  |
|                         | 2-Methylthiophene (ug/m3)   | <16  |  |  |  |
|                         | 3-Methylthiophene (ppb(V))  | <4.0 |  |  |  |
|                         | 3-Methylthiophene (ug/m3)   | <16  |  |  |  |
|                         | Propyl mercaptan (ppb(V))   | <4.0 |  |  |  |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

|                         |   | Sample ID    | L2341651-1           | L2341651-2  | L2341651-3  | L2341651-4   | L2341651-5   |
|-------------------------|---|--------------|----------------------|-------------|-------------|--------------|--------------|
|                         |   | Description  | SUMP                 | SUMP        | SUMP        | SUMP         | SUMP         |
|                         |   | Sampled Date | 04-SEP-19            | 04-SEP-19   | 04-SEP-19   | 04-SEP-19    | 04-SEP-19    |
|                         |   | Sampled Time | 13:30                | 13:30       | 13:30       | 13:30        | 13:30        |
|                         |   | Client ID    | COMOX IN #1          | COMOX IN #2 | COMOX IN #3 | COMOX OUT #1 | COMOX OUT #2 |
| Grouping                | Analyte                                   |              |                      |             |             |              |              |
| <b>CANISTER</b>         |   |              |                      |             |             |              |              |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  | <12          | <12                  | <12         | <12         | <12          | <12          |
|                         | Tetrahydrothiophene (ppb(V))              | <4.0         | <4.0                 | <4.0        | <4.0        | <4.0         | <4.0         |
|                         | Tetrahydrothiophene (ug/m3)               | <14          | <14                  | <14         | <14         | <14          | <14          |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  | <6.0         | <6.0                 | <6.0        | <6.0        | <6.0         | <6.0         |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   | <21          | <21                  | <21         | <21         | <21          | <21          |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) | 2570         | 3490                 | 2810        | 19          | 19           | 19           |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  | 3590         | 4870                 | 3920        | 26          | 27           | 27           |
| <b>Miscellaneous</b>    | Batch Proof ID                            | 181212.301   | 181105.13100<br>0001 | 190610.109  | 181121.231  | 181121.202   | 181121.202   |
|                         | Canister ID                               | 01400-0008   | 01400-0384           | 01400-0121  | 01400-0412  | 01400-0051   | 01400-0051   |
|                         | Pressure on Receipt (in Hg)               | 0.8          | 0.8                  | -11.4       | 1.0         | 0.8          | 0.8          |
|                         | Regulator ID                              | N/A          | N/A                  | N/A         | N/A         | N/A          | N/A          |

## ALS ENVIRONMENTAL ANALYTICAL REPORT

| Grouping                | Analyte                                   | Sample ID  | Description | Sampled Date | Sampled Time | Client ID    |
|-------------------------|---|------------|-------------|--------------|--------------|--------------|
|                         |   | L2341651-6 | SUMP        | 04-SEP-19    | 13:30        | COMOX OUT #3 |
| <b>CANISTER</b>         |   |            |             |              |              |              |
| <b>Sulfur Compounds</b> | Propyl mercaptan (ug/m3)                  |            |             |              |              | <12          |
|                         | Tetrahydrothiophene (ppb(V))              |            |             |              |              | <4.0         |
|                         | Tetrahydrothiophene (ug/m3)               |            |             |              |              | <14          |
|                         | sec-Butyl Mercaptan + Thiophene (ppb(V))  |            |             |              |              | <6.0         |
|                         | sec-Butyl Mercaptan + Thiophene (ug/m3)   |            |             |              |              | <21          |
|                         | Total Reduced Sulfur (22) as H2S (ppb(V)) |            |             |              |              | 18           |
|                         | Total Reduced Sulfur (22) as H2S (ug/m3)  |            |             |              |              | 26           |
| <b>Miscellaneous</b>    | Batch Proof ID                            |            |             |              |              | 181105.104   |
|                         | Canister ID                               |            |             |              |              | 01400-0037   |
|                         | Pressure on Receipt (in Hg)               |            |             |              |              | 0.2          |
|                         | Regulator ID                              |            |             |              |              | N/A          |

## Reference Information

**Test Method References:**

| ALS Test Code   | Matrix   | Test Description  | Method Reference** |
|---|----------|---|--------------------|
| <b>CAN-DATA-WT</b>  | Canister | Canister Information<br>Batch Proof ID, Canister ID, Pressure on Receipt, Regulator ID. | EPA TO-15          |
| <b>REDUC-SULF-22-SCD-WT</b>   | Canister | 22 Reduced Sulfur Compounds by GC-SCD   | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.</p> <p>Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p> |          |   |                    |
| <b>TRS-22-SCD-WT</b>  | Canister | Total Reduced Sulfur as H2S   | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. By means of a loop system, a volume of air is transferred from the canister and cryofocused before determining the sulfur compounds by GC-SCD. Silica coated passivated canisters may allow for reliable sample analysis after 24 hours. In such cases, analysis is recommended within 7 days of collection.</p> <p>Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p> |          |   |                    |
| <b>TRS22-SUM-CALC-WT</b>  | Canister | Total Reduced Sulfur as H2S (22 Comp'ds)  | ASTM D5504         |
| <p>This analysis is performed using procedures adapted from ASTM D5504. Air samples are collected into cleaned evacuated silica-coated canisters. A volume of air sample is transferred from the canister to a preconcentrator system where the analytes are trapped &amp; focused. The analytes are then thermally desorbed into a GC-SCD for analysis. Test results are not blank corrected unless indicated by a qualifier. Canister samples will be retained for 7 calendar days after final report. If you require a longer canister storage time, please contact your account manager.</p>  |          |   |                    |

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location                           |
|----------------------------|---|
| WT                         | ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA |

**Chain of Custody Numbers:**

17-762085

**GLOSSARY OF REPORT TERMS**

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878



L2341651-COFC

COC Number: 17 - 762085

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| <b>Report To</b><br>Contact and company name below will appear on the final report                                   |   | <b>Report Format / Distribution</b>  |              | <b>Select Service Level Below - Contact your AM to confirm all E&amp;P TATs (surcharges may apply)</b>  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company: <b>RWDI</b>   |   | Select Report Format: <input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input type="checkbox"/> EDD (DIGITAL) |              | Regular [R] <input checked="" type="checkbox"/> Standard TAT if received by 3 pm - business days - no surcharges apply  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Contact: <b>Math Sawycky</b>   |   | Quality Control (QC) Report with Report <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO                                    |              | PRIORITY (Business days)  |  | EMERGENCY   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Phone: <b>519-823-1311 x 2639</b>  |   | <input type="checkbox"/> Compare Results to Criteria on Report - provide details below if box checked  |              | 4 day [P4-20%] <input type="checkbox"/>   |  | 1 Business day [E - 100%] <input type="checkbox"/>  |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company address below will appear on the final report  |   | Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX                      |              | 3 day [P3-25%] <input type="checkbox"/>   |  | Same Day, Weekend or Statutory holiday [E2 - 200% (Laboratory opening fees may apply)] <input type="checkbox"/> |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Street: <b>280-1385 West 8th Ave</b>   |   | Email 1 or Fax: <b>Matthew.Sawycky@RWDI.com</b>  |              | Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| City/Province: <b>Vancouver BC</b>   |   | Email 2  |              | For tests that can not be performed according to the service level selected, you will be contacted.   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Postal Code:   |   | Email 3  |              | <b>Analysis Request</b>   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Invoice To</b>  |   | <b>Invoice Distribution</b>  |              | <table border="1"> <tr> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">NUMBER OF CONTAINERS</td> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">Total Reduced Substans</td> <td colspan="12">Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below</td> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">SAMPLES ON HOLD</td> <td rowspan="10" style="writing-mode: vertical-rl; transform: rotate(180deg);">SUSPECTED HAZARD (see Special Instructions)</td> </tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table> |  |   |  | NUMBER OF CONTAINERS | Total Reduced Substans | Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below |  |  |  |                 |   |  |  |  |  |  |  | SAMPLES ON HOLD | SUSPECTED HAZARD (see Special Instructions) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Same as Report To <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO                                |   | Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX              |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Copy of Invoice with Report <input type="checkbox"/> YES <input type="checkbox"/> NO                                 |   | Email 1 or Fax   |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Company:   |   | Email 2  |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Contact:   |   | Email 3  |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Project Information</b>   |   | <b>Oil and Gas Required Fields (client use)</b>  |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Account # / Quote #: <b>1904012</b>  |   | AFE/Cost Center: PO#   |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Job #: <b>1904012</b>  |   | Major/Minor Code: Routing Code:  |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PO / AFE:  |   | Requisitioner:   |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| LSD:   |   | Location:  |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Lab Work Order # (lab use only):   |   | ALS Contact: <b>Rogina</b>   |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   | Sampler: <b>M. Sawycky</b>   |              |   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALS Sample # (lab use only)  | Sample Identification and/or Coordinates (This description will appear on the report) | Date (dd-mmm-yy)   | Time (hh:mm) | Sample Type   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX IN #1   | 4-9-19   | 1:30         | SUMA  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX IN #2   | ↓  | ↓            | ↓   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX IN #3   | ↓  | ↓            | ↓   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX OUT #1  | ↓  | ↓            | ↓   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX OUT #2  | ↓  | ↓            | ↓   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | COMOX OUT #3  | ↓  | ↓            | ↓   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>Drinking Water (DW) Samples<sup>1</sup> (client use)</b>  |   | <b>Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)</b>                  |              | <b>SAMPLE CONDITION AS RECEIVED (lab use only)</b>  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Are samples taken from a Regulated DW System?<br><input type="checkbox"/> YES <input checked="" type="checkbox"/> NO |   |  |              | Frozen <input type="checkbox"/> SIF Observations Yes <input type="checkbox"/> No <input type="checkbox"/>   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Are samples for human consumption/ use?<br><input type="checkbox"/> YES <input checked="" type="checkbox"/> NO       |   |  |              | Ice Packs <input type="checkbox"/> Ice Cubes <input type="checkbox"/> Custody seal intact Yes <input type="checkbox"/> No <input type="checkbox"/>  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   |  |              | Cooling Initiated <input type="checkbox"/>  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   |  |              | INITIAL COOLER TEMPERATURES °C  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   |  |              | FINAL COOLER TEMPERATURES °C  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |   |  |              | 21  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>SHIPMENT RELEASE (client use)</b>   |   | <b>INITIAL SHIPMENT RECEPTION (lab use only)</b>   |              | <b>FINAL SHIPMENT RECEPTION (lab use only)</b>  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Released by: <b>[Signature]</b>  |   | Received by: <b>[Signature]</b>  |              | Received by: <b>SC</b>  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Date: <b>5-9-19</b>  |   | Date:  |              | Date: <b>SEP 05 2019</b>  |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Time:  |   | Time:  |              | Time: <b>8:56AM</b>   |  |   |  |                      |                        |  |  |  |  |                 |   |  |  |  |  |  |  |                 |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

# AIR SAMPLING MEDIA REQUEST FORM



Grey sections are for INTERNAL USE ONLY

BR# 253764 - Pls ship EXPRESS tomorrow -confirm delivery date pls

|                               |   |                     |                |
|-------------------------------|---|---------------------|----------------|
| CLIENT:                       | Comox Valley Regional District  | CLIENT EXPECT DATE: | 09/03/2019     |
| CLIENT CONTACT:               | Zoe Berkey  | ORDER TAKEN BY:     | J. Pearson     |
| CLIENT PROJECT:               |   | ORDER DATE:         | 08/27/2019     |
| DELIVERY TO:                  | 445 Brent Road, Comox, BC V9M 3V9   | QUOTE #:            |                |
| TELEPHONE NUMBER:             |   | ORDER FILLED BY:    | LB1            |
| SHIP TO/ATTENTION OF:         |   | DATE COMPLETED:     | 08/28/2019     |
| Shipping Method: (Select one) | <input checked="" type="radio"/> Ground: (4 business days to Western Canada, 2 business day to Winnipeg)<br><input type="radio"/> Express: (2 business days to Western Canada, 1 business day to WP)<br><input checked="" type="radio"/> External Courier | Tracking Number:    | 7760 9894 4739 |

ALS Drivers:   
Pickup at ALS Waterloo:

TAT Information: (select one)

|                                   |                  |                |
|-----------------------------------|------------------|----------------|
| <input type="radio"/> Regular TAT | 10 Business Days | No surcharge   |
| <input type="radio"/> 5-day       | 5 Business Days  | 50% surcharge  |
| <input type="radio"/> 3-day       | 3 Business Days  | 100% surcharge |
| <input type="radio"/> 2-day       | 2 Business Days  | 200% surcharge |
| <input type="radio"/> 1-day       | 1 Business Day   | 300% surcharge |

ALL TAT except Regular requires Prior Confirmation

**Completion of all Sections is Mandatory**

1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawspace; **OH&S** - Industrial, Commercial, Residential comment: ADAPTOR BAG TO CAN

2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**

3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**

This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:               | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-----------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                       | 24 hr           |          |                           |                                |  |                             |
|                                   | 12 hr           |          |                           |                                |  |                             |
|                                   | 8 hr            |          |                           |                                |  |                             |
|                                   | 4 hr            |          |                           |                                |  |                             |
|                                   | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters _____         | 30 mins         |          |                           |                                |  |                             |
| 1.4L Canister                     | 1 hr            |          |                           |                                |  |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters _____         |                 |          |                           |                                |  |                             |
| Bottle Vacs                       | 1 hr            |          |                           |                                |  |                             |
|                                   | 20 mins         |          |                           |                                |  |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
|                                   | 4 mins          |          |                           |                                |  |                             |
| Number of Canisters _____         |                 |          |                           |                                |  |                             |
| Passive CarboPak X Tubes          |                 |          |                           |                                |  |                             |
| Diffusive Caps                    |                 |          |                           |                                |  |                             |
| Active SVI Tubes                  |                 |          |                           |                                |  |                             |
| Calibration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |

| Other Sampling Supplies   | ID #                                  | Quantity | Additional Information & Special Instructions or Requests |
|---|---------------------------------------|----------|---|
| Pressure Gauge  |                                       |          | 6XTedlar to canister adapters for reduced sulphur .       |
| Caplok Tool   |                                       |          |   |
| Canister Stands   |                                       |          |   |
| Valve Adaptor for Soil Vapour   |                                       |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS | <input type="checkbox"/>              |          |   |
| Chargeable Supplies   |                                       |          |   |
| Duplicate Sampler - \$40 can/\$25 tube                                  |                                       |          |   |
| Teflon Tubing   |                                       |          |   |
| -Total length _____ft   | without nuts and ferrules             |          |   |
| -Length per section _____ft - \$3 per foot / \$6 per N+F set            | with nuts and ferrules (single end)   |          |   |
|   | with nuts and ferrules (double ended) |          |   |
| Siloxane Kit - \$45 each  |                                       |          |   |



L2341651-COFC

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client.)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$350.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00

# AIR SAMPLING MEDIA REQUEST FORM



Grey sections are for INTERNAL USE ONLY

BR# 253757

|                       |   |                     |            |
|-----------------------|---|---------------------|------------|
| CLIENT:               | RWDI - c/o Comox Valley Regional District | CLIENT EXPECT DATE: | 08/30/2019 |
| CLIENT CONTACT:       | Matthew Sawycky                           | ORDER TAKEN BY:     |            |
| CLIENT PROJECT:       |   | ORDER DATE:         | 08/27/2019 |
| DELIVERY TO:          | 445 Brent Rd, Comox, BC V9M 3V9           | QUOTE #:            |            |
| TELEPHONE NUMBER:     |   | ORDER FILLED BY:    | JW Lopez   |
| SHIP TO/ATTENTION OF: | Zoe Berkey                                | DATE COMPLETED:     |            |

Shipping Method:  Ground: (4 business days to Western Canada, 2 business days to Winnipeg)  Express: (2 business days to Western Canada, 1 business day to WP)  External Courier

Tracking Number:

ALS Drivers:   
 Pickup at ALS Westport:

TAT Information (select one):  
 Regular TAT 10 Business Days No surcharge  
 5-day 5 Business Days 50% surcharge  
 3-day 3 Business Days 100% surcharge  
 2-day 2 Business Days 200% surcharge  
 1-day 1 Business Day 300% surcharge  
 ALL TAT except Regular requires Prior Confirmation

QC'd JW Lopez

**Completion of all Sections is Mandatory**


1. What type of air is being sampled? check all appropriate eg. **Soil Vapour** - Indoor Air, Ambient Air; **Soil Gas** - Subsurface probe/well, Sub-slab, Landfill, Crawlspace; **O&HS** - Industrial, Commercial, Residential comment: Commercial Indoor Air

2. Please provide a list of compounds and reporting limits that are required. **Please include regulation & target list (attach to email)**

3. What is the duration of the sampling event? Short-term grab or time-weighted average sampling required? **Please specify**

This form must be reviewed by an ALS account manager prior to submission to the ALS Air Quality Department

| Canister Size/Tube:               | Regulator Times | Quantity | Parameters/ Product Codes | Canister/Tube Identification # | Initial Pressure/Flow (mm Hg/mL per min) | Controller Identification # |
|-----------------------------------|-----------------|----------|---------------------------|--------------------------------|--|-----------------------------|
| 6L Canister                       | 24 hr           |          |                           |                                |  |                             |
|                                   | 12 hr           |          |                           |                                |  |                             |
|                                   | 8 hr            |          |                           |                                |  |                             |
|                                   | 4 hr            |          |                           |                                |  |                             |
|                                   | 1 hr            |          |                           |                                |  |                             |
| Number of Canisters               | 30 mins         |          |                           |                                |  |                             |
| 1.4L Canister                     | 1 hr            |          | reduced sulfur            | 01400-0384                     | -30                                      |                             |
|                                   | 20 mins         |          |                           | 01400-0121                     | -30                                      |                             |
|                                   | 10 mins         |          |                           | 01400-0008                     | -30                                      |                             |
|                                   | 4 mins          |          |                           | 01400-0051                     | -30                                      |                             |
| Bottle Vacs                       | 1 hr            |          |                           | 01400-0421                     | -30                                      |                             |
|                                   | 20 mins         |          |                           | 01400-0037                     | -24                                      |                             |
|                                   | 10 mins         |          |                           |                                |  |                             |
| Number of Canisters               | 4 mins          |          |                           |                                |  |                             |
| Passive CarboPak X Tubes          |                 |          |                           |                                |  |                             |
| Diffusive Caps                    |                 |          |                           |                                |  |                             |
| Active SVI Tubes                  |                 |          |                           |                                |  |                             |
| Calibration Tube for SVI (yes/no) |                 |          |                           |                                |  |                             |

| Other Sampling Supplies   | ID #                                  | Quantity | Additional Information & Special Instructions or Requests   |
|---|---------------------------------------|----------|---|
| Pressure Gauge  |                                       |          | <br>L2341651-COFC |
| Caplok Tool   |                                       |          |   |
| Canister Stands   |                                       |          |   |
| Valve Adaptor for Soil Vapour   |                                       |          |   |
| Please include sampling supplies from other ALS location - SEE COMMENTS | <input type="checkbox"/>              |          |   |
| Chargeable Supplies   |                                       |          |   |
| Duplicate Sampler - \$40 each/\$25 tube                                 |                                       |          |   |
| Teflon Tubing   |                                       |          |   |
| Total length _____  | without nuts and ferrules             |          |   |
| Length per section _____  | with nuts and ferrules (single end)   |          |   |
| \$3 per foot / \$6 per N+F set  | with nuts and ferrules (double ended) |          |   |
| Siloxane Kit - \$45 each  |                                       |          |   |

**MEDIA REPLACEMENT COSTS:** (Media lost or damaged will be charged to the client)

- 1) TD SORBENT TUBE & CAPS - \$190.00 2) TD DIFFUSION CAP - \$30.00 3) CAPLOK TOOL SET - \$95.00 4) VACUUM GAUGE - \$240.00 5) BOTTLEVAC CANISTER - \$135.00  
 6) PROTECTIVE CAP - \$20.00 7) CANISTER - 6L: \$650.00; 1.4L: \$450.00 8) CONTROLLER - TWA: \$950.00; GRAB: \$850.00 9) CANISTER STAND - \$75.00 10) DUPLICATE SAMPLER - \$550.00

## APPENDIX D

A decorative graphic consisting of a large grey semi-circle on the right and a blue triangular shape on the left, separated by a white curved line.

Field Notes

Sept 4 2019  
Comox WWTP  
Start Purge 5 lpm  
@ 8:04  
Sample 1  
"COMOX 1"  
at outlet of Bioreactor  
5 lpm Dwyer 10 psi del  
Sampling 8:14 to 8:20

COMOX 2  
purging start at 8:25  
Mid Point of Bioreactor  
A  
Sampling 8:35 - 8:45

Comox 3  
purging start @ 8:50  
taken at the inlet of  
Bioreactor A

Sept 4 2019  
COMOX 4  
outlet of bioreactor C  
purging starts @ 9:15  
Sampling 9:25-35

COMOX 5  
mid section of  
Bioreactor C purge  
at 9:39  
sampling 9:50-10:00

COMOX 6  
inlet of Bioreactor C  
purging @ 10:02  
sampling 10:14-10:24

MATT 5  
WILL C

SEPTEMBER 19 Comox

|              |   |         |
|--------------|---|---------|
| SCRUBBER OUT | 1 | 820 pm  |
| SCRUBBER OUT | 2 | 828 pm  |
| SCRUBBER OUT | 3 | 840 pm. |

|            |   |     |         |
|------------|---|-----|---------|
| BIOREACTOR | 1 | IN  | 915 pm  |
| BIOREACTOR | 1 | MID | 938 pm  |
| BIOREACTOR | 1 | OUT | 952 pm  |
| BIOREACTOR | 2 | OUT | 1010 pm |
| BIOREACTOR | 2 | MID | 1025 pm |
| BIOREACTOR | 2 | IN  | 1043 pm |

POSSIBLE  
MIXED LABELS  
~~\*SOME~~ \*TIMES CORRECT  
POSSIBLE ORDER CHANGE



**APPENDIX**  
Air Flow Ventilation Rates

**B**



Table B.1 – Existing Bioreactors & Planned Future Facilities – Construction Year

| #  | Treatment Process                                 | Year               | Population |
|----|---|--------------------|------------|
| 1  | Bioreactor # 1-3                                  | Existing           | -          |
| 2  | Bioreactor # 1-3 (Influent and Effluent Channels) | Existing           | -          |
| 3  | Bioreactor # 4                                    | 2024               | 50,109     |
| 4  | Primary Clarifiers # 4 & 5                        | 2033               | 57,189     |
| 5  | Bioreactor # 4-6 (Influent and Effluent Channels) | 2024 - Beyond 2066 | -          |
| 6  | Primary Clarifier # 6                             | Beyond 2066        | -          |
| 7  | Bioreactor # 5                                    | 2063               | 85,140     |
| 8  | Bioreactor # 6                                    | beyond 2066        | -          |
| 9  | Headworks   | 2045               | 66,786     |
| 10 | Grit Removal                                      | 2045               | 66,786     |
| 11 | Grit Removal Room                                 | 2045               | 66,786     |
| 12 | Gravity Thickener # 3                             | 2056               | 76,169     |

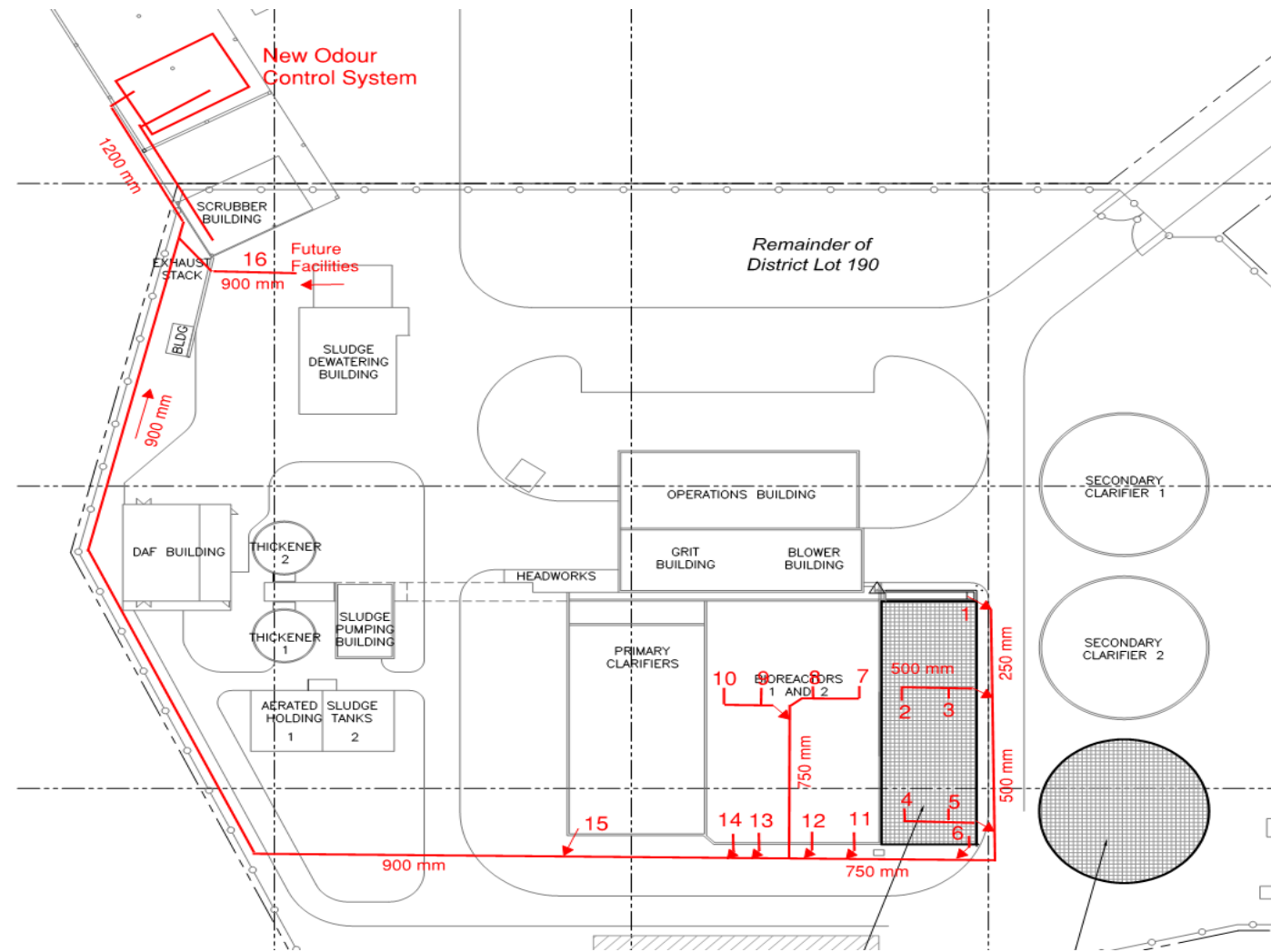




Table B.2 – Existing and Future Ventilation Flow Rates

| #  | Treatment Process                                    | Year               | Dimensions, each (m) |                    |                                 | Void Air Volume (m <sup>3</sup> ) | # AC/h       | Air flow (m <sup>3</sup> /hr) | Air Flow including 10% Safety Factor (m <sup>3</sup> /hr) | Notes   |
|----|--|--------------------|----------------------|--------------------|---------------------------------|-----------------------------------|--------------|-------------------------------|---|---|
|    |  |                    | Length (m)           | Air Void Width (m) | Air Void Depth <sup>1</sup> (m) |                                   |              |                               |   |   |
| 1  | Bioreactor # 1-3                                     | Existing           |                      |                    |                                 |                                   |              |                               |   |   |
|    | 1.1 Required air for corrosion control               |                    | 76.2                 | 3.99               | 1                               | 912.114                           | 4            | 3,648                         | 4,013   |   |
|    | 1.2 Required air to compensate for diffused aeration |                    |                      |                    |                                 | 13680                             |              | 13,680                        | 15,048  |   |
| 2  | Bioreactor # 1-3 (Influent and Effluent Channels)    | Existing           |                      |                    |                                 |                                   |              |                               |   |   |
|    | 2.1 Primary tanks effluent channels                  |                    | 19                   | 1.5                | 1                               | 29                                | 4            | 114                           | 125   |   |
|    | 2.2 Bioreactors influent channels                    |                    | 140                  | 1.5                | 0.75                            | 158                               | 4            | 630                           | 693   |   |
|    | 2.3 Bioreactors effluent channel                     |                    | 35                   | 1.5                | 3.2                             | 168                               | 4            | 672                           | 739   |   |
| 3  | Bioreactor # 4                                       | 2024               |                      |                    |                                 |                                   |              | 5,776                         | 6,354   |   |
| 4  | Primary Clarifiers # 4 & 5                           | 2033               |                      |                    |                                 |                                   |              | 1,534                         | 1,687   | 767 m <sup>3</sup> /hr per clarifier as per the latest primary clarifier odour control upgrade drawings, 2018 |
| 5  | Bioreactor # 4-6 (Influent and Effluent Channels)    | 2024 - Beyond 2066 |                      |                    |                                 |                                   |              | 1,416                         | 1,558   |   |
| 6  | Primary Clarifier # 6                                | Beyond 2066        |                      |                    |                                 |                                   |              | 767                           | 844   | 767 m <sup>3</sup> /hr as per the latest primary clarifier odour control upgrade drawings, 2018               |
| 7  | Bioreactor # 5                                       | 2063               |                      |                    |                                 |                                   |              | 5,776                         | 6,354   |   |
| 8  | Bioreactor # 6                                       | beyond 2066        |                      |                    |                                 |                                   |              | 5,776                         | 6,354   |   |
| 9  | Headworks  | 2045               |                      |                    |                                 |                                   |              | 684                           | 752   | as per the record drawings, Stage 1 Odour Control, 1997   |
| 10 | Grit Removal   | 2045               |                      |                    |                                 |                                   |              | 300                           | 330   | as per the record drawings, Stage 1 Odour Control, 1997   |
| 11 | Grit Removal Room                                    | 2045               |                      |                    |                                 |                                   |              | 4,600                         | 5,060   | as per the record drawings, Stage 1 Odour Control, 1997   |
| 12 | Gravity Thickener # 3                                | 2056               |                      |                    |                                 |                                   |              | 0                             | 0   | To be connected to existing odour control system  |
|    |  |                    |                      |                    |                                 |                                   | <b>Total</b> | <b>45,374</b>                 | <b>49,911</b>   |   |

Table B.3 – Existing and Future Ventilation Flow Rates

| #   | Treatment Process                                 | Year               | Max. air flow (m <sup>3</sup> /hr) |
|---|---|--------------------|------------------------------------|
| 1   | Bioreactor # 1-3                                  | Existing           | 19,061                             |
| 2   | Bioreactor # 1-3 (Influent and Effluent Channels) | Existing           | 1,558                              |
| <b>Required system capacity (2019)</b>            |   |                    | <b>20,619</b>                      |
| 4   | Bioreactor # 4                                    | 2024               | 6,354                              |
| 5   | Primary Clarifiers # 4 & 5                        | 2033               | 1,687                              |
| 6   | Bioreactor # 4-6 (Influent and Effluent Channels) | 2024 - Beyond 2066 | 1,558                              |
| <b>Required system capacity (25 years - 2044)</b> |   |                    | <b>30,218</b>                      |
| 7   | Primary Clarifier # 6                             | Beyond 2066        | 844                                |
| 8   | Bioreactor # 5                                    | 2063               | 6,354                              |
| 9   | Bioreactor # 6                                    | beyond 2066        | 6,354                              |
| 10  | Headworks   | 2045               | 752                                |
| 11  | Grit Removal                                      | 2045               | 330                                |
| 12  | Grit Removal Room                                 | 2045               | 5,060                              |
| 13  | Gravity Thickener # 3                             | 2056               | 0                                  |
| <b>Required system capacity (2066)</b>            |   |                    | <b>49,911</b>                      |



Table B-4: Estimated Pipes Diameters and Lengths

| #  | Treatment Process  | Year     | No of Units | Max. air flow        |        | Pipe diameter |      | Velocity |       | Pipe length |       |
|----|--|----------|-------------|----------------------|--------|---------------|------|----------|-------|-------------|-------|
|    |  |          |             | (m <sup>3</sup> /hr) | cfm    | (mm)          | (in) | (m/s)    | (fpm) | m           | ft.   |
| 1  | Bioreactor effluent channel  | Existing | 1           | 739                  | 435    | 250           | 10   | 4.2      | 823   | 25          | 82    |
| 2  | Bioreactor #3 -A   | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 12          | 39    |
| 3  | Bioreactor # 3 -B  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 5           | 16    |
|    | Cumulative air flow  |          | 1           | 3,177                | 1,870  | 500           | 20   | 4.5      | 885   | 6           | 20    |
|    | Cumulative air flow  |          | 1           | 3,916                | 2,305  | 500           | 20   | 5.5      | 1,091 | 25          | 82    |
| 4  | Bioreactor # 3 -C  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 12          | 39    |
| 5  | Bioreactor # 3 -D  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 5           | 16    |
|    | Cumulative air flow  |          | 1           | 3,177                | 1,870  | 500           | 20   | 4.5      | 885   | 6           | 20    |
|    | Cumulative air flow  |          | 1           | 7,093                | 4,175  | 750           | 30   | 4.5      | 878   | 15          | 49    |
| 6  | Primary tanks effluent channel & Bioreactor influent channels        | Existing | 1           | 409                  | 241    | 250           | 10   | 2.3      | 456   | 8           | 26    |
|    | Cumulative air flow  |          | 1           | 7,502                | 4,416  | 750           | 30   | 4.7      | 929   | 13          | 43    |
| 11 | Bioreactor # 2 -D  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 12          | 39    |
|    | Cumulative air flow  |          | 1           | 9,091                | 5,351  | 900           | 36   | 4.0      | 781   | 6           | 20    |
| 12 | Bioreactor # 2 -C  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 12          | 39    |
|    | Cumulative air flow  |          | 1           | 10,679               | 6,285  | 900           | 36   | 4.7      | 918   | 3           | 10    |
| 7  | Bioreactor # 2 -B  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 12          | 39    |
| 8  | Bioreactor # 2 -A  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 5           | 16    |
|    | Cumulative air flow  |          | 1           | 3,177                | 1,870  | 500           | 20   | 4.5      | 885   | 8           | 26    |
| 10 | Bioreactor # 1 -A  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 12          | 39    |
| 9  | Bioreactor # 2 -B  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 5           | 16    |
|    | Cumulative air flow  |          | 1           | 3,177                | 1,870  | 500           | 20   | 4.5      | 885   | 8           | 26    |
|    | Cumulative air flow  |          | 1           | 6,354                | 3,740  | 750           | 30   | 4.0      | 786   | 30          | 98    |
|    | Cumulative air flow  |          | 1           | 17,033               | 10,025 | 900           | 36   | 7.4      | 1,464 | 5           | 16    |
| 13 | Bioreactor # 1 -D  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 12          | 39    |
|    | Cumulative air flow  |          | 1           | 18,621               | 10,960 | 900           | 36   | 8.1      | 1,601 | 5           | 16    |
| 14 | Bioreactor # 1 -C  | Existing | 1           | 1,588                | 935    | 400           | 16   | 3.5      | 691   | 12          | 39    |
|    | Cumulative air flow  |          | 1           | 20,210               | 11,895 | 900           | 36   | 8.8      | 1,737 | 24          | 79    |
| 15 | Primary tanks effluent channel & Bioreactor influent channels        | Existing | 1           | 409                  | 241    | 250           | 10   | 2.3      | 456   | 12          | 39    |
|    | Cumulative air flow from existing bioreactors, channels and effluent |          | 1           | 20,619               | 12,136 | 900           | 36   | 9.0      | 1,772 | 180         | 591   |
| 16 | Cumulative air flow from future facilities                           |          | 1           | 29,292               | 17,241 | 900           | 36   | 12.8     | 2,518 | 0           | 0     |
|    |  |          |             |                      |        |               |      |          |       | 555         | 1,821 |

Table B-5: Pipes Diameters and Lengths Summary

| Pipe Diameter | Pipe Length |
|---------------|-------------|
| mm            | m           |
| 250           | 45          |
| 400           | 116         |
| 500           | 53          |
| 750           | 58          |
| 900           | 223         |
| 1200          | 60          |
| <b>Total</b>  | <b>555</b>  |





**APPENDIX**  
Manufacturer Literatures

C





**eVOQUA**  
WATER TECHNOLOGIES



## PACKED TOWER ODOR CONTROL SYSTEM

Evoqua Water Technologies offers a full range of chemical scrubber odor control systems for municipal and industrial odor control.

### Packed Tower Scrubbers

The packed tower scrubber has been used successfully for odor control for many years. It offers the advantage of being able to treat large air volumes, up to 56,500 cfm (96,000 m<sup>3</sup>/h) in a single tower. Multiple towers may be placed in series to target ammonia, H<sub>2</sub>S and other odorous compounds.

The packed tower may use a variety of chemical processes to remove odors. Most typical are:

- NaOH for up to 95% of the H<sub>2</sub>S only
- NaOH/NaOCl for > 99% of H<sub>2</sub>S and organic odors
- H<sub>2</sub>SO<sub>4</sub> for > 99% of ammonia and amines

Other scrubber systems using hydrogen peroxide, chlorine dioxide, potassium permanganate, or other oxidants are also available upon request.

### Special Configuration

Evoqua offers a unique packed tower design incorporating an extended sump deck. This enables the use of vertical sealless recirculation pumps, and reduces the required footprint. It also facilitates removal of pH and ORP probes for maintenance and calibration.

Towers are fabricated from premium vinyl ester FRP for optimum strength and corrosion resistance.

### Standard Features

- High Airflow Volume
- Multiple towers can remove H<sub>2</sub>S, Mercaptans, Organic Sulfides, Ammonia and amines in one system train
- FRP Construction
- Evoqua Service and Support

## PACKED TOWER DESIGN INFORMATION

| Model     | Air Flow Rate                 | Diameter        | Height          | Shipping Weight | Operating Weight | Fan Motor Power | Pump Motor Power |
|-----------|-------------------------------|-----------------|-----------------|-----------------|------------------|-----------------|------------------|
|           | CFM<br><i>m<sup>3</sup>/h</i> | ft<br><i>mm</i> | ft<br><i>mm</i> | lb<br><i>kg</i> | lb<br><i>kg</i>  | HP<br><i>kw</i> | HP<br><i>kw</i>  |
| RJP-600   | 13,500                        | 6.0             | 21.25           | 2,000           | 9,000            | 30.0            | 10.0             |
|           | 22950                         | 1800            | 6375            | 900             | 4090             | 22              | 7.5              |
| RJP-700   | 18,500                        | 7.0             | 21.5            | 3,500           | 12,000           | 40.0            | 15.0             |
|           | 31450                         | 2100            | 6450            | 1590            | 5455             | 30              | 11               |
| RJP-800   | 24,000                        | 8.0             | 22.25           | 4,500           | 15,000           | 50.0            | 15.0             |
|           | 40800                         | 2400            | 6675            | 2045            | 6810             | 37.30           | 11.19            |
| RJP-900   | 30,000                        | 9.0             | 23.5            | 5,500           | 18,000           | 75.0            | 25.0             |
|           | 51000                         | 2700            | 7050            | 2500            | 8180             | 55              | 18.5             |
| RJP-1000  | 37,000                        | 10.0            | 24.25           | 6,500           | 22,000           | 100.0           | 30.0             |
|           | 62900                         | 3000            | 7275            | 2955            | 10000            | 75              | 22               |
| RJP-1100  | 45,000                        | 11.0            | 24.5            | 7,500           | 26,000           | 100.0           | 40.0             |
|           | 76500                         | 3300            | 7350            | 3400            | 11800            | 75              | 30               |
| RJP-1200* | 56,500                        | 12.0            | 25.5            | 8,500           | 32,000           | 150.0           | 50.0             |
|           | 96050                         | 3600            | 7650            | 3850            | 14545            | 110             | 37               |



Ulu Pandan STW  
Singapore

Thirty-eight PT-700 Packed Tower Scrubbers in seventeen multiple tower odor control trains.

Email [odorcontrol@evoqua.com](mailto:odorcontrol@evoqua.com) or visit  
[www.evoqua.com/packed-tower](http://www.evoqua.com/packed-tower) to connect with an expert.



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## V-BANK HORIZONTAL CARBON ADSORBER SYSTEM

### V-BANK CARBON ADSORBER

The V-Bank Carbon Adsorber is a horizontal flow, vertical bed carbon adsorber with two carbon media beds arranged in vertical V-pattern.

Air enters between the two beds at the wide end of the V, then flows horizontally through the media beds. The V-pattern is designed to provide even air flow through the carbon media beds. A vertical rectangular inlet is used to help distribute the air vertically.

Air exits either from each side, or from a common exit at the opposite end from the inlet.

Carbon media is loaded and removed through access ports on the top of the vessel.

### HIGH CAPACITY

The V-Bank arrangement enables treatment of very high air flow rates with a single carbon adsorber and compact footprint. The photograph above shows a large V-Bank designed to treat 65,000 cfm (110,000 m<sup>3</sup>/hr), and two smaller V-Banks treating 10,000 cfm (17,000 m<sup>3</sup>/hr) each.

### CARBON MEDIA

The V-Bank system may use a variety of carbon media, depending on the specific project requirements. Typical options are:

- Midas media for primary odor control up to about 20 ppm H<sub>2</sub>S concentration
- VOCarb P60 for secondary odor control following a bioscrubber or chemical scrubber

## CUSTOM DESIGN

Each V-Bank system is custom designed for the specific air flow rate, odor removal requirements, pressure drop, footprint and height limitations.

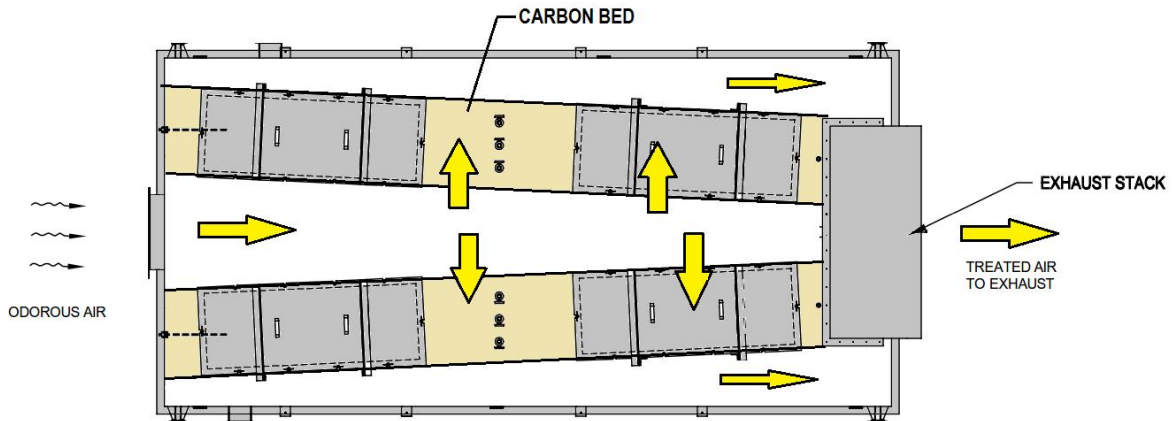


Some typical sizes are shown below.

| Model           | Airflow Rate            | Footprint      | Height      | Bed Depth  | Carbon Weight  | Operating Weight | Fan Motor  |
|-----------------|-------------------------|----------------|-------------|------------|----------------|------------------|------------|
|                 | cfm (m <sup>3</sup> /h) | ft (m)         | ft (m)      | ft (m)     | lbs (kg)       | lbs (kg)         | hp (kW)    |
| <b>RJV-1510</b> | <b>15,000</b>           | <b>15 x 10</b> | <b>12.5</b> | <b>3.0</b> | <b>30,500</b>  | <b>40,000</b>    | <b>30</b>  |
|                 | 25500                   | 4.6 x 3.1      | 3.8         | 0.9        | 13800          | 18300            | 22         |
| <b>RJV-2912</b> | <b>30,000</b>           | <b>29 x 12</b> | <b>12.5</b> | <b>3.0</b> | <b>60,300</b>  | <b>78,000</b>    | <b>60</b>  |
|                 | 51000                   | 8.9 x 3.7      | 3.8         | 0.9        | 27400          | 35400            | 45         |
| <b>RJV-4413</b> | <b>45,000</b>           | <b>43 x 13</b> | <b>12.5</b> | <b>3.0</b> | <b>90,800</b>  | <b>116,000</b>   | <b>100</b> |
|                 | 76500                   | 13.1 x 4.0     | 3.8         | 0.9        | 41200          | 52800            | 67         |
| <b>RJV-5814</b> | <b>60,000</b>           | <b>58 x 14</b> | <b>12.5</b> | <b>3.0</b> | <b>121,300</b> | <b>156,000</b>   | <b>150</b> |
|                 | 102000                  | 17.4 x 4.3     | 3.8         | 0.9        | 55000          | 70600            | 112        |

\*Carbon weight is based on assumed bulk density of 31 lbs/cf (0.5 g/cc). Will vary with type of carbon used.

## PROCESS FLOW DIAGRAM





**eVOQUA**  
WATER TECHNOLOGIES



## **WESTATES® COAL BASED PELLETIZED ACTIVATED CARBON - VOCARB® P60 AND P70 CARBONS (FORMERLY AP-640 AND AP-620)**

### **IDEALLY SUITED FOR GAS PHASE ADSORPTION APPLICATIONS**

#### **Description**

VOCarb® P60 and VOCarb® P70 pelletized activated carbons are manufactured from a high grade metallurgical coal (anthracite). They possess both a high surface area and a large internal pore volume. These properties give the VOCarb P60 and P70 activated carbons not only high VOC adsorption capacities but also high retentivities for retaining and preventing the desorption of previously adsorbed organic compounds. Their 4 mm diameter and pellet shape allow for a low bed pressure drop even at high gas flow rates. The superior hardness of these carbons result in minimal attrition and offer excellent resistance to dust and fines formation.

VOCarb P70 is more highly activated than P60, resulting in a higher surface area and more macroporous pore structure, which allows VoCarb P70 an increased VOC working capacity in solvent recovery applications.

#### **Applications**

Cost effective VOCarb activated carbons developed by Evoqua have been demonstrated to provide superior performance in an extensive array of gas phase treatment applications. VOCarb activated carbons are available for:

- Solvent recovery operations
- Chemical process applications
- VOC control from air strippers, soil vapor extraction and air sparge systems
- Control of tank vent emissions
- HVAC
- Odor control
- As a substrate for odor control carbon manufacture and as a catalyst support

### Features and Benefits:

- Exceptionally high VOC adsorption capacity
- Excellent VOC retentivity characteristics
- Cost effective
- Suitable for multiple cycles of regeneration and high temperature reactivation
- High ignition temperature
- Easily reactivated for recycle and reuse
- Low-pressure drop characteristics
- Backed by technical support and a strong QA/QC program

### Quality Control

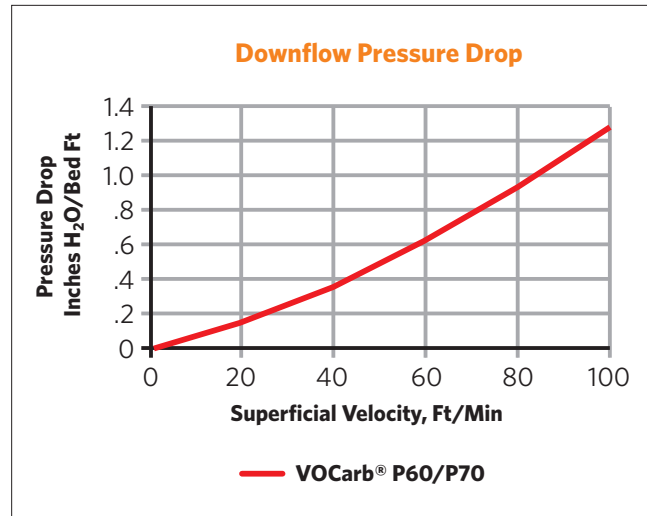
All VOCarb® activated carbons are extensively quality checked at our State of California certified environmental and carbon testing laboratory located in Los Angeles, CA. Evoqua’s laboratory is fully equipped to provide complete quality control analyses using ASTM standard test methods in order to assure the consistent quality of all Westates® carbons.

Our technical staff offers hands-on guidance in selecting the most appropriate system, operating conditions and carbon to meet your needs. For more information, contact your nearest Evoqua representative.

### TYPICAL PROPERTIES

| Parameter                 | VOCarb® P60     | VOCarb® P70     |
|---------------------------|-----------------|-----------------|
| Carbon Type               | Anthracite Coal | Anthracite Coal |
| Mesh Size, U.S. Sieve     | 4 x 6           | 4 x 6           |
| Butane Activity 1         | 23.5            | 27.5            |
| Hardness No., Wt.%        | 95              | 95              |
| Moisture Content, Wt.%    | 2               | 2               |
| Apparent Density, g/cc    | 0.47 - 0.53     | 0.47 - 0.53     |
| Mean Pellet Diameter, mm  | 4.0             | 4.0             |
| CTC Activity <sup>1</sup> | 60              | 70              |

<sup>1</sup> Butane activity (D5742) has been adopted by ASTM as a replacement for CTC activity (D3467) as a test method for estimating the micropore volume of an activated carbon.



### Warning

The adsorption of organic compounds onto activated carbon generates heat. In rare instances, adsorbed compounds may also react on the carbon surface to generate additional heat. If these heat sources are not properly dissipated, the carbon bed temperature may rise to the point where the carbon can ignite, leading to a fire or other hazardous condition. A description of industry-accepted engineering practices to assure the dissipation of heat and safe operation of the carbon bed can be provided upon request. In certain applications where the risk of ignition is significant, activated carbon may not be a recommended treatment technology. Please contact your Technical Sales Representative for more details.

Wet activated carbon readily adsorbs atmospheric oxygen. Dangerously low oxygen levels may exist in closed vessels or poorly ventilated storage areas. Workers should follow all applicable state and federal safety guidelines for entering oxygen depleted areas.



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WS-VO67-DS-0814



**APPENDIX**  
Capital Costs Estimates

**D**





## Appendix D Capital Costs Estimate

Table D.1 – Capital Cost Estimates

| Item | Description   | Option 1           | Option 2           |
|------|---|--------------------|--------------------|
| 1.0  | General requirement includes (overhead, indirect cost, contractor profit, mobilization and demobilization and temporary work at 25% of project value) | \$1,260,000        | \$1,320,000        |
| 2.0  | Design and supply of bioreactor covers  | \$700,000          | \$700,000          |
| 3.0  | Install of bioreactor covers  | \$200,000          | \$200,000          |
| 4.0  | Design, supply, and install of odour control ducting  |                    |                    |
|      | Diameter 250 mm (45 m)  | \$12,000           | \$12,000           |
|      | Diameter 400 mm (116 m)   | \$67,000           | \$67,000           |
|      | Diameter 500 mm (53 m)  | \$44,000           | \$44,000           |
|      | Diameter 750 mm (58 m)  | \$97,000           | \$97,000           |
|      | Diameter 900 mm (223 m)   | \$520,000          | \$520,000          |
|      | Diameter 1200 mm (60 m)   | \$227,000          | \$227,000          |
| 5.0  | Modifications and installation of bioreactors influent and effluent channels covers   | \$120,000          | \$120,000          |
| 6.0  | Bioreactors epoxy coating   | \$800,000          | \$800,000          |
| 7.0  | Design, supply and install of chemical scrubber   | \$547,500          | \$645,000          |
| 8.0  | Pipes/equipment modifications to accommodate new chemical scrubber  | \$100,000          | \$100,000          |
| 9.0  | Design, supply and install of AC  | \$862,500          | \$1,005,000        |
| 10.0 | Electrical  | \$150,000          | \$180,000          |
|      | <b>Subtotal</b>   | <b>\$5,707,000</b> | <b>\$6,037,000</b> |
|      | Engineering and contingencies (40%)   | \$2,283,000        | \$2,415,000        |
|      | <b>Total (excluding GST)</b>  | <b>\$7,990,000</b> | <b>\$8,452,000</b> |



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