Chemsafety
USING SCIENCE TO KEEP PEOPLE SAFE & HEALTHY

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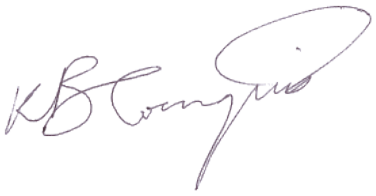
Environmental Microbial Monitoring December 2020

Living Earth

Prepared by



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Reference 72048
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Executive Summary

Living Earth operates an organic material composting plant at Metro Place, Bromley, Christchurch. Chemsafety have been requested to undertake environmental air monitoring for airborne microbes (bacteria and fungi) at the site and in the neighbouring suburbs. This monitoring was undertaken on 18 and 22 December 2020 by Bridgette Jennings and Kurt Blomquist.

Air monitoring was conducted over two days. Seven monitors were set up in the surrounding neighbourhoods, including one control upwind of the facility. The days were chosen when the forecasting was for north-east winds, which are prevailing, and also means the closest residential area is downwind of the facility.

In addition to the air sampling a bulk sample of the compost was analysed for microbial species and swab samples were collected from two neighbouring properties downwind of the prevailing wind of the facility to assess if microbes from dried compost are depositing on surfaces some distance from the facility.

The bulk compost sample was found to contain gram negative bacteria, actinomycetes, penicillium fungi, and aspergillus fumigatus fungi. Penicillium and gram negative bacteria are widespread in the environment. Aspergillus fumigatus is toxigenic and not typically found in the air.

Three locations (including the control) exceeded the suggested bacteria guidelines for outdoor air. Six locations exceeded the suggested fungi guidelines for outdoor air. This was due to elevated Cladosporium levels which are naturally high at this time of the year.

E.coli was not detected in any of the samples. Aspergillus fumigatus, a toxigenic species, was detected in the Woburn sample; however, the levels measured were low and unlikely to generate health symptoms.

All air samples, except Woburn Place Air sample , had small amounts of Actinomycetes present. These are not common in outdoor air and are unlikely to present a health hazard at the levels measured.

In summary, gram negative bacteria, actinomycetes, penicillium fungi, and aspergillus fumigatus fungi were present in the bulk compost sample. The predominant species found in the air samples were gram positive bacteria and Cladosporium fungi which were not identified in the bulk compost sample.

Small amounts of gram negative bacteria, penicillium, actinomycetes, and aspergillus fumigatus were detected in some samples but not at levels of significant health concern. In addition, these species were not present at high enough concentrations to say, with any certainty, that they are from the compost facility.

Contents

Introduction

Living Earth operates an organic material composting plant at Metro Place, Bromley, Christchurch. Chemsafety have been requested to undertake environmental air monitoring for airborne microbes (bacteria and fungi) at the site and in the neighbouring suburbs.

This monitoring was undertaken on 18 and 22 December 2020 by Bridgette Jennings and Kurt Blomquist.

Objectives

The objectives of this assessment is to:

- Measure and identify airborne microbial species in the suburbs surrounding the Living Earth processing plant.

Assessment Limitations

This report has been prepared based on visual inspections conducted by Chemsafety Ltd and discussions with Living Earth, Christchurch branch. The site conditions as described in this report have been interpreted from, and are subject to, this information and its limitations and accordingly Chemsafety does not represent that its interpretation accurately represents the full site conditions.

Representative air and surface samples are collected, and reasonable assumptions are made from those samples. These samples may not be a true representation of every element, part or component of the area concerned.

The information contained in this report applies to the time at which the inspections were carried out. With time, the site conditions could change, so that the reported assessment may be no longer valid. Thus, in the future, the report should not be used without confirming the validity of the report information at that time.

All work is undertaken subject to our General Terms and Conditions of Trade. The report has been prepared by Chemsafety for the purpose described in the report. Chemsafety accepts no liability to any other person if the report is used for any other purpose. Any such use or reliance will be solely at their own risk. The presence or absence of other chemicals or hazards at the site is not considered in this report.

Background Information

Geographical Location

Present in Figure 1 is the aerial site view of the composting facility. The wider Bromley suburb is shown in Figure 2. Immediately adjacent to the facility there is the Bromley industrial area to the east, the waste water treatment plant settling ponds to the north and west, and Charlesworth reserve to the south. The residential area of Bromley starts approximately 1.2km from the entrance to the facility.

Figure 1. Living Earth composting facility (outlined in yellow).

Figure 2. Aerial view of wider Bromley.

Assessment Procedure

To measure airborne microbe air samples were collected from eight locations over two days. The air samples were collected at points determined in conjunction with Living Earth with a view to collect data at the facility, downwind of the facility, and one sample upwind of the facility as a control.

The days were chosen when the forecasting was for north-east winds, which are prevailing, and also means the closest residential area is downwind of the facility.

In addition to the air sampling a bulk sample of the compost was analysed for microbial species and swab samples were collected from two neighbouring properties downwind of the prevailing wind of the facility to assess if microbes from dried compost are depositing on surfaces some distance from the facility.

A summary of the results is presented in Tables 3 and 5. Copies of the laboratory analysis reports are presented in Appendix 2.

Methodology

Airborne Microbes

Culturable airborne microbes monitoring is undertaken by drawing air through a gelatine filter using a calibrated air sampling pump. The filter is then diluted with growth media and cultured at 25 C. Colony forming species are identified and counted. Analysis is undertaken by Biodet Services Ltd, a specialist microbiological laboratory.

Bulk Sample

The compost was collected into a sterile container. A sample of the compost was cultured onto selective agar for bacteria, fungi, actinomycetes counts. Analysis is undertaken by Biodet Services Ltd, a specialist microbiological laboratory.

Swab Samples

Swab samples were collected by using a sterile swab to wipe an approximate 10cm x 10cm area. The samples were cultured onto agar and the fungi, bacteria, and actinomycetes species were counted. Analysis is undertaken by Biodet Services Ltd, a specialist microbiological laboratory.

Monitoring Information

Table 1. Monitoring Equipment Data 18 December 2020

Job Reference No:	72048-3261 v1
Sampling Date:	18 December 2020
Sampling By:	Kurt Blomquist

Sample No	Sample Name	Pump No	Initial Flow Rate (L/min)	Final Flow Rate (L/min)	Total Minutes (min)
3261.01	Pine Hill Avenue	110804	2.0361	1.9764	458
3261.02	Living Earth north carpark	112806	2.0234	1.7212	424
3261.03	Charlesworth Reserve, paddock SW of living Earth	114658	2.0487	2.0547	459
3261.04	Corner Cuthberts and Taurus place	108809	2.0678	2.1307	420
3261.05	St Johns Street	109742	2.0363	1.9289	382
3261.06	St Florian Place, north end of cul-de-sac	34390	2.0238	2.0686	402

Table 2. Monitoring Equipment Data 22 December 2020

Job Reference No:	72048-3268 v1
Sampling Date:	22 December 2020
Sampling By:	Kurt Blomquist

Sample No	Sample Name	Pump No	Initial Flow Rate (L/min)	Final Flow Rate (L/min)	Total Minutes (min)
3268.01	Living earth north car park	110804	2.0248	1.9022	396
3268.02	Butterfield Ave front yard	34390	2.0299	1.9684	392
3268.03	Woburn street side yard	110804	2.0369	1.9470	397

Monitoring Locations

Figure 3: Monitoring locations and dates of monitoring

Observations

Airborne Microbes

Figure 4. Pine Avenue, 18 December 2020.

Area type	Residential (Control)
Sampling location	Sampling outside car window
Distance from Living Earth	2.6km
Direction from Living Earth	East
Odour observation	None detectable
Microbial observation	No obvious areas of localised microbial growth. Grass verges, trees, and gardens present on house sections.

Figure 5. Living Earth Carpark, 18 December 2020.

Area type	Compost facility, north side
Sampling location	Sampling on a tripod
Distance from Living Earth	0km
Direction from Living Earth	-
Odour observation	Composting odour detectable
Microbial observation	Car park was surrounded by large birch and poplar trees.

Figure 6. Farm paddock, 18 December 2020.

Area type	Open farmland
Sampling location	Sampling on a wire fence
Distance from Living Earth	500m
Direction from Living Earth	South
Odour observation	None detectable
Microbial observation	Area is pasture farmland with animal waste present on the ground.

Figure 7. Corner Cuthberts and Taurus roads, 18 December 2020.

Area type	Industrial
Sampling location	Sampling outside car window
Distance from Living Earth	1.2km
Direction from Living Earth	North west
Odour observation	None detectable
Microbial observation	No obvious areas of localised microbial growth. Trees, grass, and leaf litter in the area.

Figure 8.St Johns Street, 18 December 2020.

Area type	Residential
Sampling location	Sampling outside car window
Distance from Living Earth	1.3km
Direction from Living Earth	South west
Odour observation	Mild odour present
Microbial observation	No obvious areas of localised microbial growth. Grass verges, trees, and gardens present on house sections.

Figure 9. St Florian Place north end of cul-de-sac, 18 December 2020.

Area type	Residential
Sampling location	Sampling outside car window
Distance from Living Earth	1.1km
Direction from Living Earth	South west
Odour observation	None detectable
Microbial observation	No obvious areas of localised microbial growth. Grass verges, trees, and gardens present on house sections.

Figure 10. Living Earth carpark, 22 December 2020.

Area type	Compost facility, north side
Sampling location	Sampling on a tripod
Distance from Living Earth	0km
Direction from Living Earth	-
Odour observation	Composting odour detectable
Microbial observation	Car park was surrounded by large birch and poplar trees.

Figure 11. Butterfield Avenue, 22 December 2020.

Area type	Residential
Sampling location	Sampling in front yard
Distance from Living Earth	2.5km
Direction from Living Earth	West north west
Odour observation	Slight musty odour, different to that near the composting facility.
Microbial observation	No obvious areas of localised microbial growth. Grass verges, trees, and gardens present in the sampling area.

Figure 12. Woburn street monitoring location 22 December 2020.

Area type	Residential
Sampling location	Sampling in front yard
Distance from Living Earth	1.1km
Direction from Living Earth	South west
Odour observation	Strong odour detectable
Microbial observation	No obvious areas of localised microbial growth. Grass verges, trees, and gardens present on house sections.

Swab Samples

Two properties at Woburn street were selected for swab sampling. These two properties are a joined pair of flats with garages separating the living areas.

The southern flat and had not been occupied for 3 months prior to testing on the site. There was a strong musty odour in the flat. The building had not been aired out or cleaned for a significant period of time which may have led to the creation of an environment likely to amplify microbial growth.

One unit was occupied and was regularly cleaned. There was no significant layers of dust observed within the property. The property did have an abundance of plants in the garden.

Samples were collected from the following locations:

- Woburn – vehicle rear windscreen, Figure 13
- Woburn un-occupied unit– master bedroom interior window ledge, Figure 14
- Woburn un-occupied unit – garage shelving. Figure 15
- Woburn occupied – master bedroom interior window ledge, Figure 16
- Woburn occupied – top of kitchen cabinetry, Figure 17

Figure 13. This vehicle had been parked outside for approximately 3 months. There was a fine layer of dust present on the surface of the car.

Figure 14 - Master bedroom swab location un-occupied Woburn street unit.

Figure 15 - Shelving units inside garage. Sample collected on the top of the shelving unit.

Figure 16 - Windowsill swab location from occupied Woburn street unit. No observable dust layer.

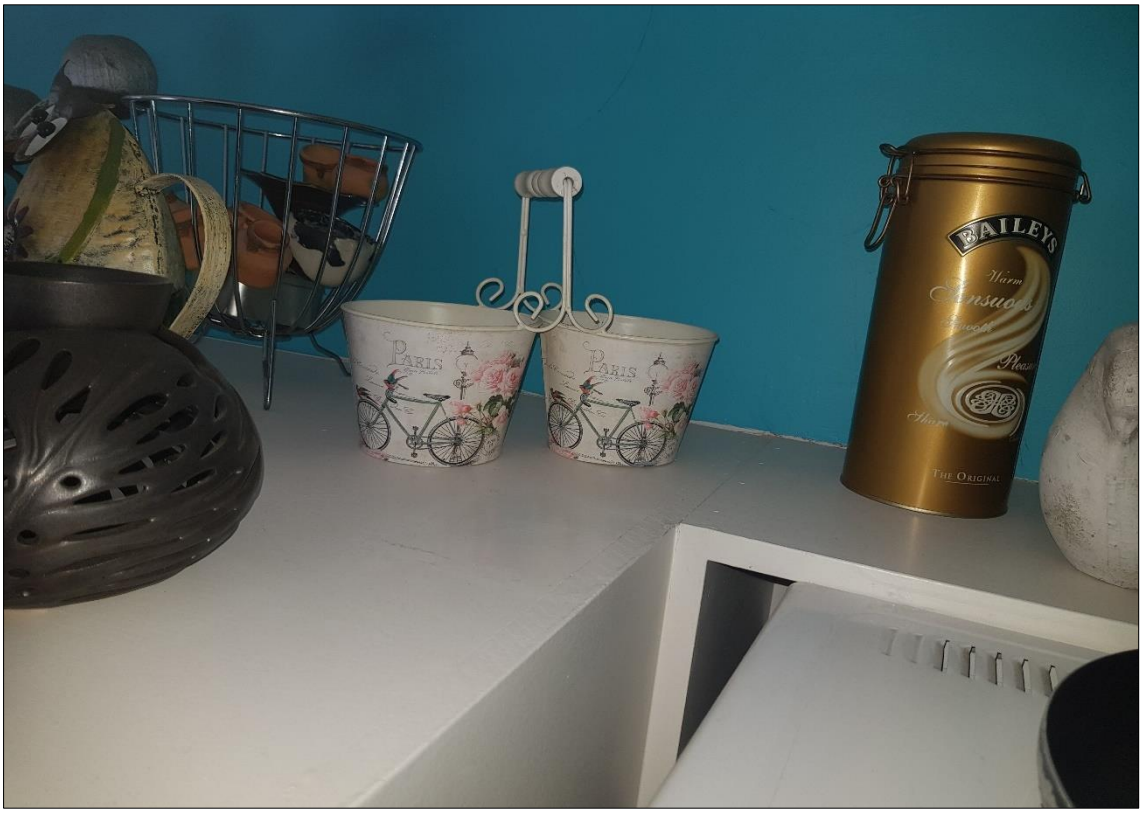


Figure 17 – Occupied Woburn street unit kitchen cupboard swab location. Light dust layer.

Weather Information

Living Earth has a weather station on site. Wind speed and direction from the weather station was provided and is presented in Figures 18 and 19 below. The wind direction data is shown in degrees which indicates the wind direction, a diagram showing how the degrees corresponds to the wind direction is shown in Figure 20.

On 18 December 2020 the wind starts as ENE and moves to a more easterly direction by midday. Towards the end of the day the wind turns SE for a time.

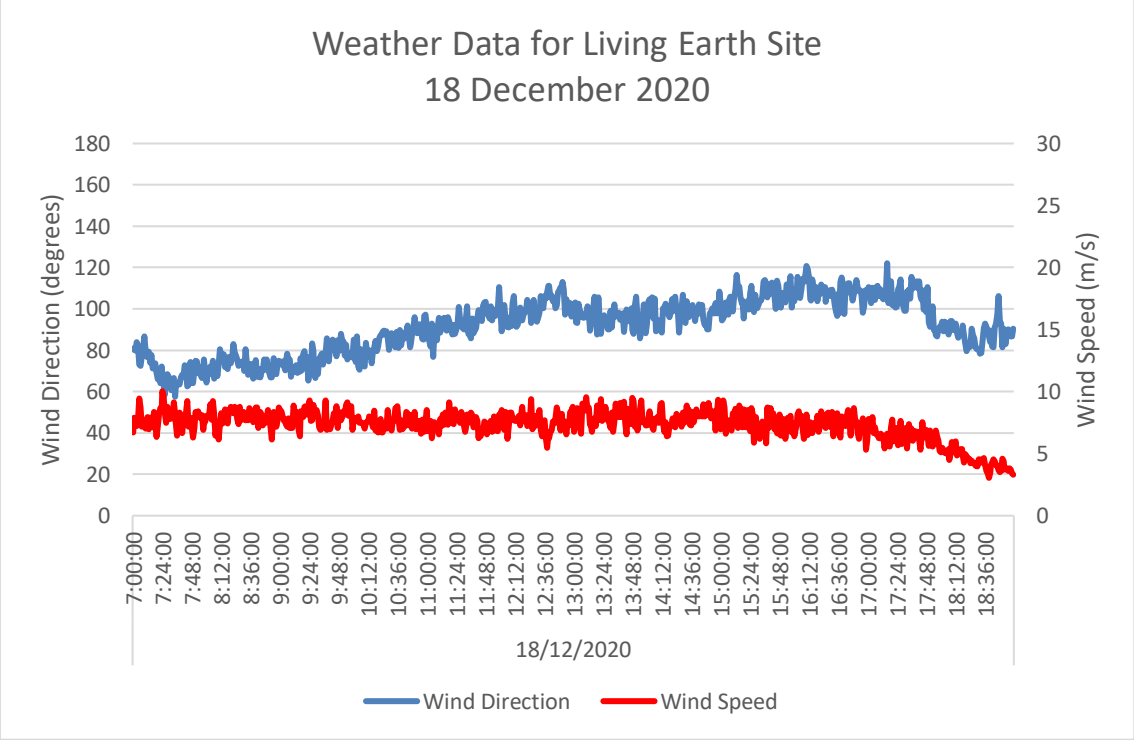


Figure 18 - Wind Speed and Direction 18 December 2020
57º (NE) – 120º (ESE) range. Average 90⁰ (East).

On 19 December 2020 the wind moved between NE and E in the early part of the morning. The wind then moved to ESE direction for the middle part of the day before returning to more NE direction later in the day.

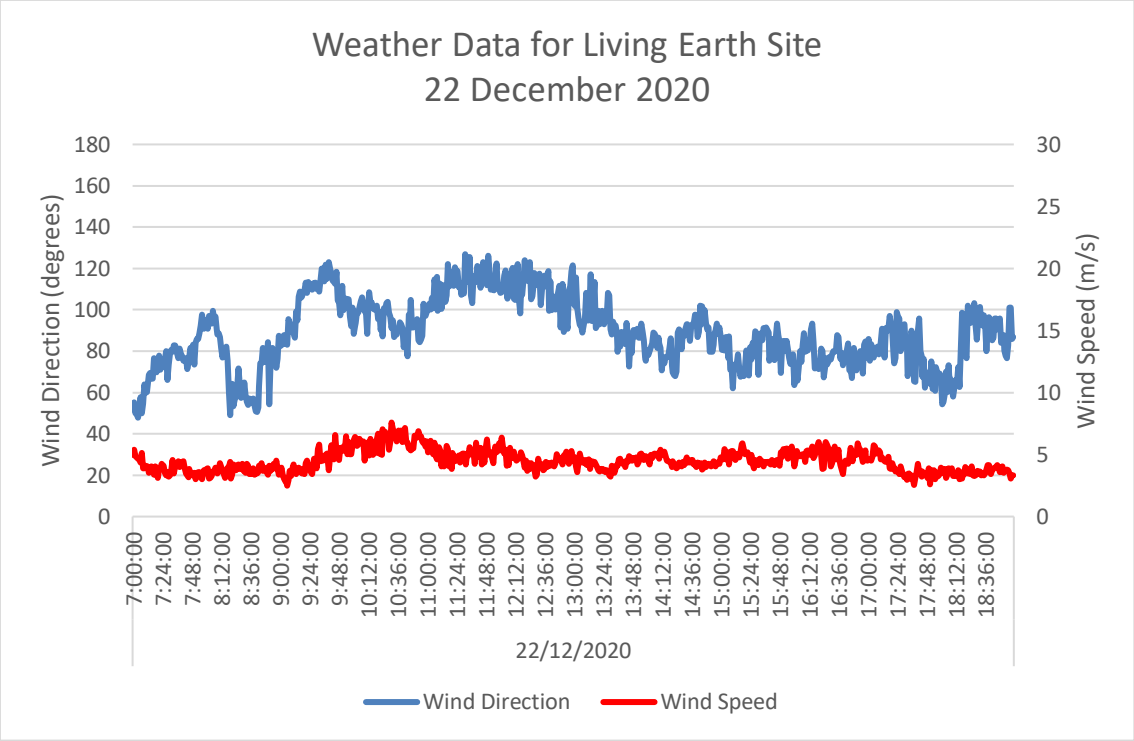
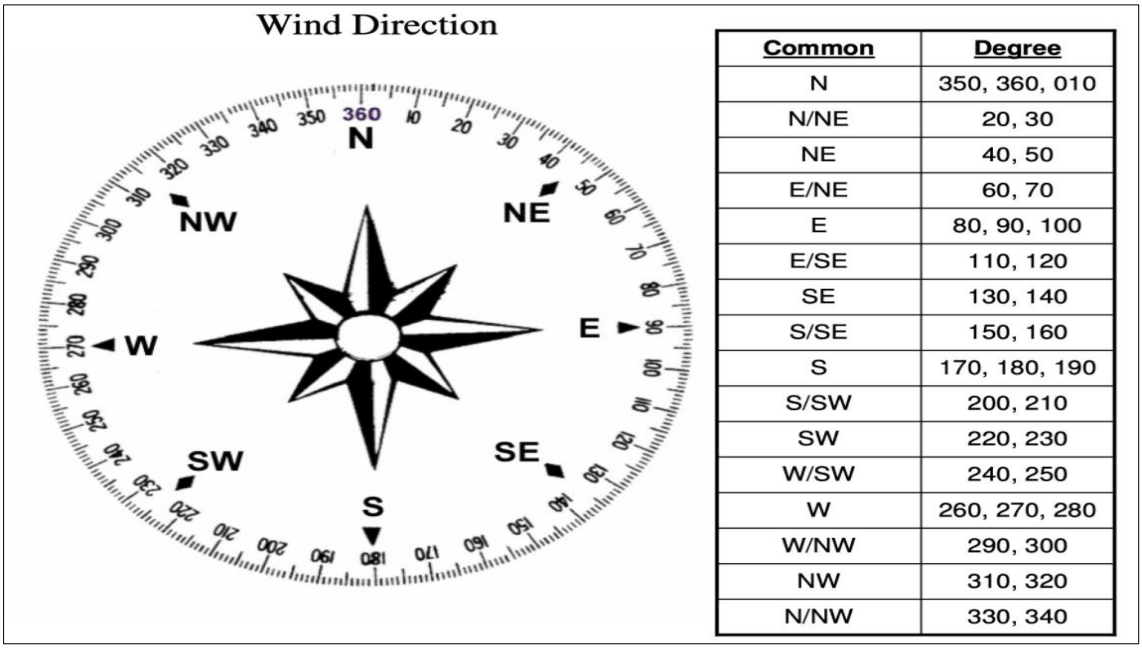


Figure 19 - Wind Speed and Direction 22 December 47° (NE) to 126° (ESE) range. Average 91° (East).



Common	Degree
N	350, 360, 010
N/NE	20, 30
NE	40, 50
E/NE	60, 70
E	80, 90, 100
E/SE	110, 120
SE	130, 140
S/SE	150, 160
S	170, 180, 190
S/SW	200, 210
SW	220, 230
W/SW	240, 250
W	260, 270, 280
W/NW	290, 300
NW	310, 320
N/NW	330, 340

Figure 20 - Compass illustrating generated wind direction relative to degrees

Odour Reporting

Environment Canterbury have developed an app for Canterbury residents to send in reports of unpleasant odours. The app is called 'Smelt-It'. The screenshots of the dashboard below show the approximate location of the reports, the darker the colour the more reports from the highlighted area.

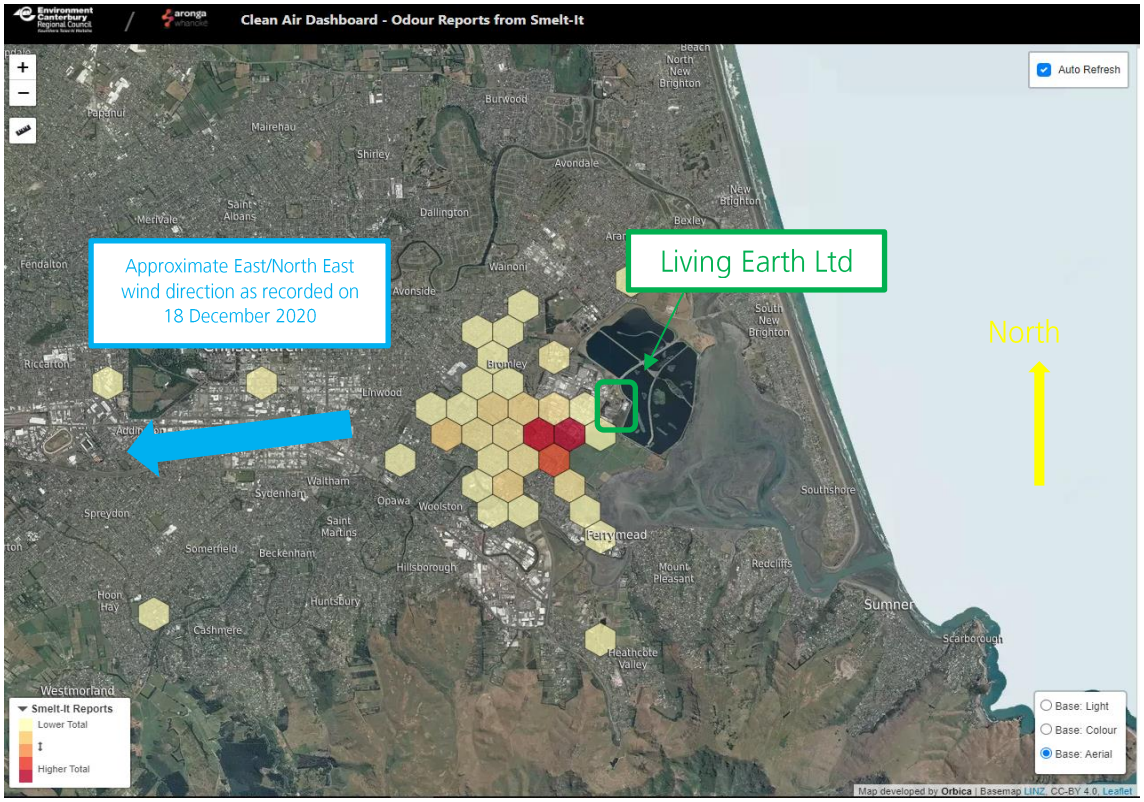


Figure 21 - Registration of odour reports 18 December 2020

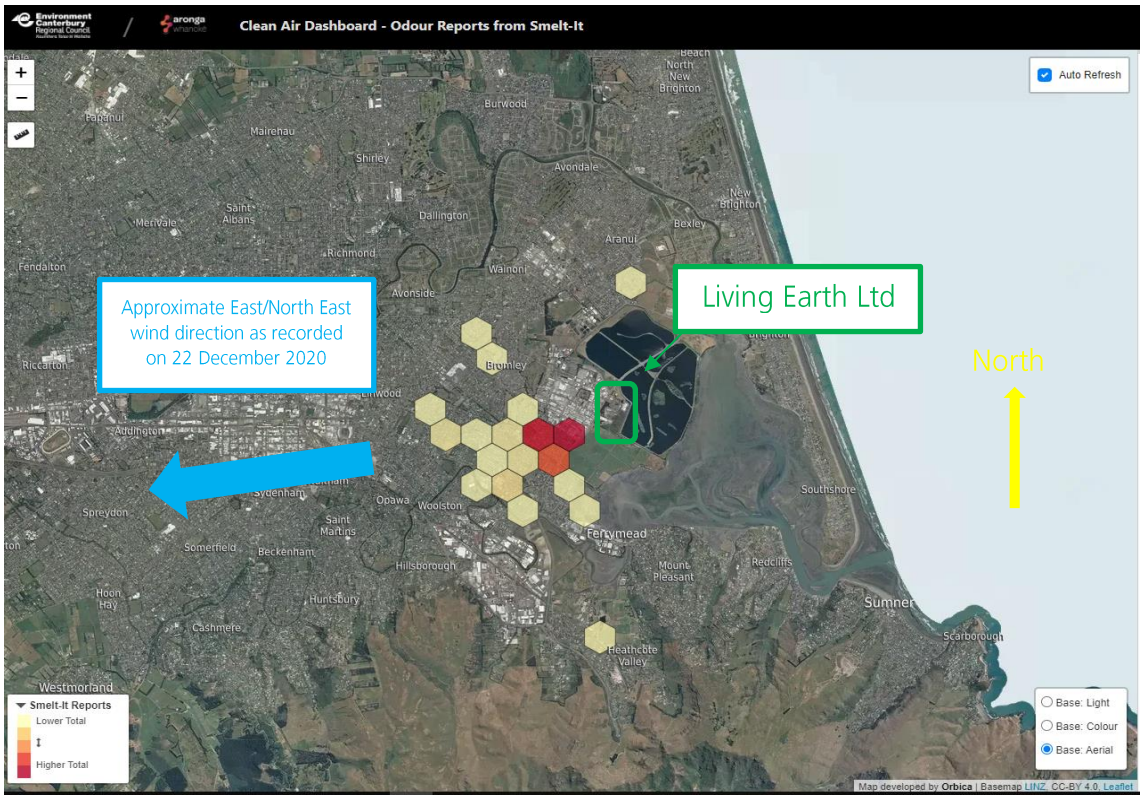


Figure 22 - registration of odour reports 22 December 2020

Monitoring Results

Table 3. Bulk Material Analysis Result

Sample Details	Bacteria Count Cfu/g	Actinomycetes Count Cfu/g	Escherichia coli Count Cfu/g	Yeast and Fungal Count @ 25° C Cfu/g	Yeast and Fungal Count @ 37° C Cfu/g
Sample #: 42588	6,100,000	20,0000	<10	<10	30
Sample Type: Bulk compost					
Location: Final product	Bacillus sp. 0% Staph/Micrococci 0% Other gram (+) 0% Pseudomonas sp. 0% Other gram (-) 100%				Penicillium 67% Asp.fumigatus 33%

Table 4. Swab Sample Results.

Sample Details	Total Bacteria (cfu/swab)	Total Actinomycetes (cfu/swab)	Total Yeast (cfu/swab)	Total Fungi (cfu/swab)
Sample #: 42591/1	**660,000**	**2000**	**250,000**	**10,000**
Location: Car parked at Woburn Street				
	Bacillus sp. <1% Other gram (+) 100%			Aureobasidium 90% Cladosporium 10%

Sample Details	Total Bacteria (cfu/swab)	Total Actinomycetes (cfu/swab)	Total Yeast (cfu/swab)	Total Fungi (cfu/swab)
Sample #: 42591/2 Location: Master bedroom interior windowsill un-occupied Woburn Street	**22,000,000** Other Gram (+) 100%	**20**	**420,000**	**27,000** Cladosporium 74% Aureobasidium 22% Penicillium 4%
Sample #: 42591/3 Location: Shelving inside garage un-occupied Woburn Street	**22,000** Bacillus sp. 68% Other Gram (+) 32%	**<10**	**160,000**	**110,000** Aureobasidium 82% Cladosporium 9% Unidentified other 9%
Sample #: 42591/4 Location: Interior windowsill master bedroom occupied Woburn street	**370,000** Other Gram (+) 97% Other Gram (-) 3%	**<10**	**110,000**	**50,000** Cladosporium 80% Aureobasidium 20% Unidentified other <1%
Sample #: 42591/5 Location: top of kitchen cupboards occupied Woburn Street	**12,000** Bacillus sp. 29% Staph/Micrococci 6% Other Gram (+) 65%	**1000**	**36,000**	**1,800** Cladosporium 55% Unidentified other 33% Rhizopus 6% Aspergillus 6%

<1000 = Low, 1000 – 10,000 = Moderate, 10,000 – 100,000 = High, >1,000,000 = Excessive

< = Less than > = More than

Table 5. Airborne microbial monitoring Results

Sample Details	Total Bacteria (cfu/m^3)	Total Actinomycetes (cfu/m^3)	Total Fungi (cfu/swab)
Sample #: 42590/1 Location: **Pine Avenue, South New Brighton** Date : 18 December 2020	**190** Bacillus sp. 14% Other Gram (+) 86%	41	350 Cladosporium 71% Unidentified other 14% Penicillium 14% Yeast 1%
Sample #: 42590/2 Location: **Living earth north side carpark, Bromley** Date : 18 December 2020	91 Bacillus sp. 44% Other Gram (+) 50% Other Gram (-) 6%	10	160 Cladosporium 68% Unidentified other 21% Penicillium 6% Mucor/ Rhizopus 3% Yeast 2%
Sample #: 42590/3 Location: **Farm paddock South west of Living Earth** Date : 18 December 2020	81 Bacillus sp. 3% Staph/Micrococci 11% Other Gram (+) 86%	15	**990** Cladosporium 93% Unidentified other 6% Penicillium 1%
Sample #: 42590/4 Location: **Corner Cuthberts and Taurus Roads, Bromley** Date : 18 December 2020	**210** Bacillus sp. 7% Staph/Micrococci 13% Other Gram (+) 80%	27	170 Cladosporium 81% Unidentified other 10% Penicillium 8% Mucor/ Rhizopus 1%

Sample Details	Total Bacteria (cfu/m^3)	Total Actinomycetes (cfu/m^3)	Total Fungi (cfu/swab)
Sample #: 42590/5 Sample Type: Gelatine Filter Location: **St Johns Street Bromley** Date : 18 December 2020	**190** Bacillus sp. 24% Staph/Micrococci 8% Other Gram (+) 68%	13	**580** Cladosporium 87% Unidentified other 12% Penicillium 1%
Sample #: 42590/6 Sample Type: Gelatine filter Location: **St Florian Place, north end of cul-de-sac, Woolston** Date : 18 December 2020	49 Bacillus sp. 5% Staph/Micrococci 5% Other Gram (+) 90%	12	**1,500** Cladosporium 92% Unidentified other 4% Yeast 3% Penicillium 1%
Sample #: 42589/1 Sample Type: Gelatine filter Location: **Living Earth north carpark, Bromley** Date : 22 December 2020	28 Bacillus sp. 29% Staph/Micrococci 18% Other Gram (+) 53%	5	**460** Unidentified other 54% Cladosporium 45% Yeast 1%
Sample #: 42589/2 Sample Type: Gelatine filter Location: **Butterfield Avenue, Linwood** Date : 22 December 2020	13 Other Gram (+) 77% Other Gram (-) 23%	20	**1,200** Cladosporium 78% Unidentified other 20% Yeast 1% Penicillium 1%

Sample Details	Total Bacteria (cfu/m^3)	Total Actinomycetes (cfu/m^3)	Total Fungi (cfu/swab)
Sample #: 42589/3	35	<3	**750**
Sample Type: Gelatine filter			
Location: **Woburn Street, Bromley**	Staph/Micrococci 7% Other Gram (+) 93%		Cladosporium 76% Unidentified other 22% Aspergillus fumigatus 2%
Date : 22 December 2020			
GUIDELINES: (based on Biodet database)			
Outdoor Air	50-100	-	50-350
Vicinity of waste-water treatment plant	50-500		500-5000

Results exceeded the upper level for the outdoor air guideline.

Microbe Information

Airborne microbe species which were found in the sample collected are shown below.

Key Terms

Deteriogenic – Species that can cause decay and rot in cellulose rich materials such as timber, wallpaper, plaster board, and cotton.

Allergenic – Species which can cause allergic-type reactions with hayfever-type symptoms in sensitive people.

Pathogenic – Species which can cause disease and infection in people.

Actinomycetes

These are filamentous bacteria which are soil borne and are commonly found on damp building materials and are often associated with a distinctive earthy smell. It is now recognised that some sub-groups within the Actinomycetes group can be both allergenic and toxigenic and are of significance in air quality.

Fungi

Aureobasdium: Aureobasdium is a common dematiaceous fungus commonly isolated from plant debris, soil, wood, textiles, and indoor air environment.

Cladosporium: Cladosporium is a mould that is common in the environment. Outdoors, it can be found on plants and other organic matter. Indoors, Cladosporium is common in the air and on surfaces such as wallpaper or carpet, particularly where moisture is present. Cladosporium is an allergenic fungus.

Superficial fungi: Aspergillus and Penicillium species are common environmental isolates and are often found on damp building materials. These fungi may contribute to high spore levels in the air resulting in allergenic reactions in sensitive people.

Yeast: Yeast are a common air spore which originate from water, humans, and plant material.

Mucur/Rhizopus: This could indicate dampness and the generation of aerosols from a shower or humidifier. This fungi is common in air.

Aspergillus fumigatus: This fungi is indicative of decomposing plant material and undesirable in indoor air. This fungus has been implicated in respiratory infections.

Bacteria

Staphylococcus / micrococcus: These bacterial are indicative of a large number of people or animals frequenting the area. They exist in the air, dust, sewage, and in the general environment.

Bacillus: Bacillus are typically found in dry, dusty areas and are ubiquitous in the environment.

Other gram positive bacteria: These are typically associated with people and animals or of decomposing organic vegetation. They are common in outdoor air.

Other gram negative bacteria: These are typically associated with very damp conditions.

Discussion

The bulk compost sample was found to contain gram negative bacteria, actinomycetes, penicillium fungi, and aspergillus fumigatus fungi. Penicillium and gram-negative bacteria are widespread in the environment. Aspergillus fumigatus is toxigenic and not typically found in the air.

The locations which exceeded the suggested bacteria guidelines for outdoor air and the predominant species are shown below:

- Pine Ave (control) – gram positive bacteria
- Corner Cuthberts and Taurus Roads (downwind) – gram positive bacteria
- St Johns St (downwind) – gram positive bacteria

Gram positive bacteria are common in outdoor air. E.coli was not detected in any of the samples. Aspergillus fumigatus, a toxigenic species, was detected in the Woburn Ave sample; however, the levels measured were low and unlikely to generate health effect symptoms.

The locations which exceeded the suggested fungi guidelines for outdoor air and the predominant species are shown below:

- Farm paddock SW of plant (downwind) – Cladosporium
- St Johns Street (downwind) – Cladosporium
- St Florian Place (downwind) – Cladosporium
- Living Earth carpark (on site) – Unidentified species
- Butterfield Avenue (downwind) – Cladosporium
- Woburn Place (downwind) - Cladosporium

Cladosporium was detected at elevated levels in the air monitoring samples above. The levels measured, while elevated, were at expected levels for the time of year the monitoring took place. Cladosporium is a common fungi species on vegetation and can produce hay fever like symptoms if there is significant exposure. The levels which were detected would be unlikely to cause such an exposure in most people.

All air samples, except Woburn Place, had small amounts of Actinomycetes present. These are not common in outdoor air and are unlikely to present a health hazard at the levels measured.

The swab samples taken from the un-occupied Woburn Street unit had high levels of bacteria, fungi, and yeast. This building had not been occupied for 3 months prior to testing. Swab samples taken from the interior of Woburn Street unit, which is currently occupied and regularly cleaned, had elevated levels of bacteria, fungi and yeast, however not at the same level detected in samples taken from the un-occupied building.

The type of fungi detected in the swab samples inside and outside the dwellings at Woburn street were predominantly species not identified in the bulk compost sample.

In summary, gram negative bacteria, actinomycetes, penicillium fungi, and aspergillus fumigatus fungi were present in the bulk compost sample. The predominant species found in the air samples were gram positive bacteria and Cladosporium fungi which were not identified in the bulk compost sample.

Small amounts of gram negative bacteria, penicillium, actinomycetes, and aspergillus fumigatus were detected in some samples but not at levels of significant health concern. In addition, these species were not present at high enough concentrations to say, with any certainty, that they are from the compost facility.

Appendix 1 – Calibration Certificates

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CERTIFICATE OF CALIBRATION

Issued by: TechRentals NZ

Certificate Number:	CH5094/280120/CA67	Page 1 of 2 Pages
Workorder Number:	2020000067	
Date of Calibration:	28th January 2020	
Client Name:	Chemsafety Limited	
Address:	2B 303 Blenheim Rd, Christchurch	
Unit Under Test (UUT)	**Description:** Flow Meter	
	Manufacturer: Mesa Labs	
	Model Number: Defender 530	
	Serial Number: 142269	
	Asset Number: BC002902	
Working Standards Used:	388248 388170	
TechRentals Procedure/s:	11.1.13 FLOW	
Environmental Conditions:	Temperature 24 °C ± 2	RH% 54 ± 5% Barometric 1016 mbar.

Comments, opinions & interpretations:

UUT meets manufacturers specifications at all points tested.

Calibration information:

1. *A Certificate of Calibration does not imply compliance to a specification. Please assess measured values against permissible limits and read the Comments, Opinions & Interpretations, when provided, to determine suitability of the UUT for its intended use.*
2. *Measurements taken under environmental conditions other than those stated in this report may produce values which differ from those quoted herein.*
3. *U = Measurement Uncertainty ± (Includes combined uncertainty of the reference and the UUT)*
4. *The expanded uncertainty limits quoted in the UUT results includes estimated drift and repeatability of the UUT and the reference standard observed during calibration as well as estimated UUT drift over the calibration interval. The estimated UUT drift may be determined from the manufacturers specifications, historical calibration data or a combination of both.*
5. *The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2.0, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with M3003 GUM Edition 3 Nov 2012.*

Calibrated by: _____ Checked by: _____

NAME:	*Bob Zhang*	NAME	*Mauray Ganter*
POSITION:	*Metrologist*	POSITION:	*Approved Signatory*

TechRentals NZ 101A Station Road, Penrose, Auckland. Ph(09) 5892030 Fax(09) 5892031

Revision 1.0 Issue Date: 28/10/15 Issued by: Mauray Ganter

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CERTIFICATE OF CALIBRATION

Certificate Number: CH5094/280120/CA67 cont'd

Units	UUT Range	UUT Indicated	Reference Value	UUT Correction	Measurement Uncertainty ±
Flow Rate					
mL/min	50 to 5000	589.70	586.7	-3.0	2
		1548.6	1551.5	+2.9	7
		4024.3	4063.4	+39.1	12

TechRentals NZ 101A Station Road, Penrose, Auckland. Ph(09) 5892030 Fax(09) 5892031

Revision 1.0 Issue Date: 28/10/15 Issued by: Mauray Ganter
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Appendix 2 – Laboratory Analysis Reports

Biodet Services Ltd
Consulting Industrial Microbiologists

Unit K, 383 Khyber Pass Road, PO Box 99010, Newmarket, Auckland 1149. Phone: 09-529-1563, E-mail: office@biodet.co.nz, www.biodet.co.nz

5 January 2021

Biodet Ref: 20/42590
Client Ref: 72048-3261

Chemsafety Ltd
2B, 303 Blenheim Road
Upper Riccarton
CHRISTCHURCH 8041

ATTN: Kurt Blomquist

Dear Kurt

Re: **VIABLE AIR SAMPLE ANALYSES**

The following samples were received 23 December 2020 for bacterial, yeast and fungal and *Escherichia coli* (*E.coli*) analysis. The samples were identified as follows:

Laboratory Number	Client Identification	Location	Date Sampled	Air Volume Sampled (L)
42590/1	3261.01	[redacted] Pine Hill Avenue #1	18 December 2020	918
42590/2	3261.02	Living Earth north side carpark #2	18 December 2020	793
42590/3	3261.03	Farm paddock SW of Living Earth #3	18 December 2020	941
42590/4	3261.04	Corner Cuthberts and Taurus Place #4	18 December 2020	881
42590/5	3261.05	[redacted] St Johns St #5	18 December 2020	757
42590/6	3261.06	St Florian Place, north end of culdesac #6	18 December 2020	822

METHOD:

The viable air samples were analysed by Gelatin Filter In-House Methods (available on request).

Analysis commenced 24 December 2020.

Biodet Services Ltd
Consulting Industrial Microbiologists

RESULTS:

Laboratory Number	Bacteria cfu/m³ Limit of detection is 2-3 cfu per cubic metre	Actinomycetes cfu/m³ Limit of detection is 2-3 cfu per cubic metre	Fungi cfu/m³ Limit of detection is 2-3 cfu per cubic metre
42590/1 3261.01	190 *Bacillus* sp. 14% Staph/Micrococci 0% Other Gram (+) 86% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	41	350 *Cladosporium* 71% Unidentified other 14% *Penicillium* 14% Yeast 1%
42590/2 3261.02	91 *Bacillus* sp. 44% Staph/Micrococci 0% Other Gram (+) 50% *Pseudomonas* 0% Other Gram (-) 6% *Escherichia coli* 0%	10	160 *Cladosporium* 68% Unidentified other 21% *Penicillium* 6% *Mucor/ Rhizopus* 3% Yeast 2%
42590/3 3261.03	81 *Bacillus* sp. 3% Staph/Micrococci 11% Other Gram (+) 86% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	15	990 *Cladosporium* 93% Unidentified other 6% *Penicillium* 1%
42590/4 3261.04	210 *Bacillus* sp. 7% Staph/Micrococci 13% Other Gram (+) 80% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	27	170 *Cladosporium* 81% Unidentified other 10% *Penicillium* 8% *Mucor/ Rhizopus* 1%
42590/5 3261.05	190 *Bacillus* sp. 24% Staph/Micrococci 8% Other Gram (+) 68% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	13	580 *Cladosporium* 87% Unidentified other 12% *Penicillium* 1% Yeast <1%

< = Less than

Biodet Services Ltd
Consulting Industrial Microbiologists

Laboratory Number	Bacteria cfu/m³ Limit of detection is 2-3 cfu per cubic metre	Actinomycetes cfu/m³ Limit of detection is 2-3 cfu per cubic metre	Fungi cfu/m³ Limit of detection is 2-3 cfu per cubic metre
42590/6 3261.06	49 *Bacillus* sp. 5% Staph/Micrococci 5% Other Gram (+) 90% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	12	1,500 *Cladosporium* 92% Unidentified other 4% Yeast 3% *Penicillium* 1%

BACTERIAL INTERPRETATION:
Gram-Negative Bacteria: *(Pseudomonas, Flavobacterium)* associated with very damp environments.
Escherichia coli: Indicates probable faecal contamination, either human or animal.
Gram-Positive Bacteria: *(Staphylococcus, Micrococcus, Streptococcus)* Indicative of large number of people or animals frequenting area. These bacteria exist in the air, dust, sewage and on environmental surfaces.
Gram-Positive Sporing Bacteria: *(Bacillus)* Ubiquitous, Dry dusty area
Other Gram-Positive Bacteria (Non-sporing): A large group of bacteria commonly associated with normal skin flora of people and animals, or decomposing organic material such as vegetation
Actinomycetes: Common in air in summer. Thermophilic Actinomycetes have been implicated in Hypersensitivity Pneumonitis. Presence is usually associated with recent soil/ dust contamination.

FUNGAL INTERPRETATION:
Fungi: *(Cladosporium)* Plant material, indicative of outdoor air or severe fungal amplification indoors
Fungi: *(Aspergillus, Penicillium)* Common indoor fungi
Aspergillus fumigatus is indicative of decomposing plant material and is undesirable in indoor air. This fungus has been implicated in respiratory infections.
Fungi: (yeast) Common air spores, origins: water, human tissues, plant material
Fungi: *(Mucor, Aureobasidium, Phoma, Acremonium)* Common air spora, could indicate dampness, or creation of aerosols from a shower or humidifiers.

GUIDELINES: (based on Biodet database)	COLONY-FORMING UNITS PER CUBIC METER AIR	
	BACTERIA	FUNGI
Non-Air-conditioned building	50-100	100-400
Outdoor air	50-100	50-350
Vicinity of waste-water treatment plant	50-500	500-5000

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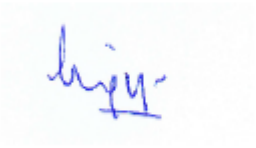
Biodet Services Ltd
Consulting Industrial Microbiologists

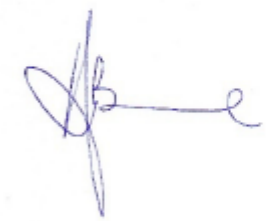
CONCLUSIONS:

- The bacteria levels were slightly elevated in Samples 1, 4 and 5 when compared to the Biodet guidelines for outdoor air, but not excessively so. The predominant type was non-sporing other gram-positive bacteria, which are commonly found in outdoor air. The other areas exhibited bacterial levels that were within the range for an outdoor air.
- The Actinomycete levels were low.
- *Aspergillus fumigatus* and *Escherichia coli* were not detected in any of the samples.
- The fungal levels were slightly elevated in Samples 3 and 6 for an outdoor air when compared to the Biodet guidelines, but again were not excessive. The fungal levels in the other areas were within the range for an outdoor air.
- *Cladosporium* species predominated in all samples. These fungi are typically found growing outside as saprophytes on vegetation, with levels significantly fluctuating seasonally and geographically. The fungal counts observed at the sampling points were likely typical for this time of year and would be very unlikely to result in any health issues.

I hope this information is of help to you. If you have any queries, please do not hesitate to contact us.

Yours faithfully





Elaine Khor
B.Sc.

Adrienne Burnie
B.Sc., NZCMT

The samples were tested as received.
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Biodet Services Ltd
Consulting Industrial Microbiologists

Unit K, 383 Khyber Pass Road, PO Box 99010, Newmarket, Auckland 1149. Phone: 09-529-1563, E-mail: office@biodet.co.nz, www.biodet.co.nz

5 January 2021

Biodet Ref: 20/42591
Client Ref: 72048-3262

Chemsafety Ltd
2B, 303 Blenheim Road
Upper Riccarton
CHRISTCHURCH 8041

ATTN: Kurt Blomquist

Dear Kurt

Re: **SURFACE SWAB SAMPLE ANALYSES**

The following surface swab samples were received 23 December 2020 for bacterial, yeast and fungal and *Escherichia coli* (*E.coli*) analysis. The samples were identified as follows:

Laboratory Number	Client Identification	Location
42591/1	3262.01	Car, [redacted] Woburn
42591/2	3262.02	Master bedroom interior windowsill, [redacted] Woburn
42591/3	3262.03	Shelving in garage, [redacted] Woburn
42591/4	3262.04	Master bedroom interior windowsill, [redacted] Woburn
42591/5	3262.05	Top of kitchen cupboards, [redacted] Woburn

METHOD:

The swab-heads were emulsified in 10ml of 0.1% Buffered peptone water with Tween, serially diluted, and plated on selective agar for bacteria, yeast and mould counts.

A breakdown of the types of microorganisms observed was performed.

Analysis commenced 23 December 2020.

Biodet Services Ltd
Consulting Industrial Microbiologists

CULTURE RESULTS

Limit of detection for the bacterial count is 10 colony forming units (cfu) per swab.

Laboratory Number	Bacteria Count cfu/swab	Actinomycetes Count cfu/swab	Yeast Count cfu/swab	Fungi Count cfu/swab
42591/1 3262.01 [redacted]car	660,000 *Bacillus* sp. <1% Staph/Micrococci 0% Other Gram (+) 100% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	2,000	250,000	10,000 *Aureobasidium* 90% *Cladosporium* 10% Unidentified other <1% *Penicillium* <1% *Mucor/ Rhizopus* <1%
42591/2 3262.02 [redacted]Master bedroom windowsill	22,000,000 *Bacillus* sp. <1% Staph/Micrococci 0% Other Gram (+) 100% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	20	420,000	27,000 *Cladosporium* 74% *Aureobasidium* 22% *Penicillium* 4% Unidentified other <1%
42591/3 3262.03 [redacted]Garage shelves	22,000 *Bacillus* sp. 68% Staph/Micrococci 0% Other Gram (+) 32% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	<10	160,000	110,000 *Aureobasidium* 82% *Cladosporium* 9% Unidentified other 9% *Penicillium* <1% *Aspergillus* <1%
42591/4 3262.04 [redacted]Master bedroom windowsill	370,000 *Bacillus* sp. 0% Staph/Micrococci 0% Other Gram (+) 97% *Pseudomonas* 0% Other Gram (-) 3% *Escherichia coli* 0%	<10	110,000	50,000 *Cladosporium* 80% *Aureobasidium* 20% Unidentified other <1%
42591/5 3262.05 [redacted]Kitchen cupboard top	12,000 *Bacillus* sp. 29% Staph/Micrococci 6% Other Gram (+) 65% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	1,000	36,000	1,800 *Cladosporium* 55% Unidentified other 33% *Rhizopus* 6% *Aspergillus* 6% *Penicillium* <1%

< = less than

There are no standards or guidelines for bacterial and fungal levels on surfaces but our experience at Biodet indicate the following guidelines:

Count	Total Colony-forming units per 10x10cm area. (Bacteria, fungi and Actinomycetes)
Low	<1,000
Moderate	1,000 - 10,000
High	10,000 - 100,000
Excessive	>1,000,000 (10^6)

< = Less than > = More than

(A 10x10cm area is equivalent to an area of 100 square centimetres)

CONCLUSIONS

- All of the surfaces sampled exhibited high to excessive levels of bacteria, yeast and filamentous fungi.
- The predominant bacterial type in all areas except for the [redacted] garage shelves were non-sporing other gram-positive bacteria, which are ubiquitous in the normal environment. The levels suggest that the swabbed areas were likely damp with accumulated dust/ debris.
- The [redacted] garage shelves exhibited a predominance of *Bacillus* species, suggesting that the swabbed area was likely dusty.
- Elevated Actinomycetes levels noted from the [redacted] car and the [redacted] kitchen cupboard top, suggest either an accumulation of dust/ debris over time, or a recent soil disturbance in these vicinities.
- Significantly high levels of yeast and varying levels of *Aureobasidium* were noted in most of the swabbed locations. The presence of *Aureobasidium* and yeast are usually indicative of raised moisture and/ or poor hygiene. As the overall microbial levels were high, it was likely an accumulation of household dust including a variety of microorganisms had occurred over time.
- *Cladosporium* was also predominant in three out of the five swabs. This fungus is commonly associated with outdoor vegetation, and the levels can vary seasonally. It can also amplify indoors in response to raised moisture such as condensation.

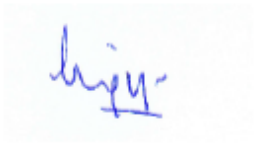
RECOMMENDATIONS

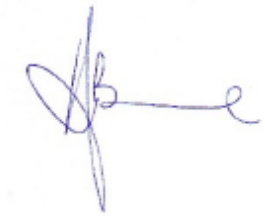
- Regular cleaning will prevent the accumulation of dust/ debris and its associated microorganisms.
- Increasing ventilation can lessen indoor moisture levels, which would reduce proliferation of any accumulated microorganisms.

Biodet Services Ltd
Consulting Industrial Microbiologists

I hope this information is of help to you. If you have any queries, please do not hesitate to contact us.

Yours faithfully





Elaine Khor
B.Sc.

Adrienne Burnie
B.Sc., NZCMT

The samples were tested as received.
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Biodet Services Ltd
Consulting Industrial Microbiologists

Unit K, 383 Khyber Pass Road, PO Box 99010, Newmarket, Auckland 1149. Phone: 09-529-1563, E-mail: office@biodet.co.nz, www.biodet.co.nz

5 January 2021

Biodet Ref: 20/42589
Client Ref: 72048-3268

Chemsafety Ltd
2B, 303 Blenheim Road
Upper Riccarton
CHRISTCHURCH 8041

ATTN: Kurt Blomquist

Dear Kurt

Re: **VIABLE AIR SAMPLE ANALYSES**

The following samples were received 23 December 2020 for bacterial, yeast and fungal and *Escherichia coli* (*E.coli*) analysis. The samples were identified as follows:

Laboratory Number	Client Identification	Location	Date Sampled	Air Volume Sampled (L)
42589/1	3268.01	Living Earth north carpark #7	21 December 2020	776
42589/2	3268.02	[redacted] Butterfield Ave front yard #8	21 December 2020	784
42589/3	3268.03	[redacted] Woburn Street side yard #9	21 December 2020	790

METHOD:

The viable air samples were analysed by Gelatin Filter In-House Methods (available on request).

Analysis commenced 24 December 2020.

Biodet Services Ltd
Consulting Industrial Microbiologists

RESULTS:

Laboratory Number	Bacteria cfu/m³ Limit of detection is 3 cfu per cubic metre	Actinomycetes cfu/m³ Limit of detection is 3 cfu per cubic metre	Fungi cfu/m³ Limit of detection is 3 cfu per cubic metre.
42589/1 3268.01	28 *Bacillus* sp. 29% Staph/Micrococci 18% Other Gram (+) 53% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	5	460 Unidentified other 54% *Cladosporium* 45% Yeast 1% *Penicillium* <1%
42589/2 3268.02	13 *Bacillus* sp. 0% Staph/Micrococci 0% Other Gram (+) 77% *Pseudomonas* 0% Other Gram (-) 23% *Escherichia coli* 0%	20	1200 *Cladosporium* 78% Unidentified other 20% Yeast 1% *Penicillium* 1%
42589/3 3268.03	35 *Bacillus* sp. 0% Staph/Micrococci 7% Other Gram (+) 93% *Pseudomonas* 0% Other Gram (-) 0% *Escherichia coli* 0%	<3	750 *Cladosporium* 76% Unidentified other 22% *Aspergillus fumigatus* 2% *Aspergillus* <1%

< = Less than

BACTERIAL INTERPRETATION:
Gram-Negative Bacteria: *(Pseudomonas, Flavobacterium)* associated with very damp environments.
Escherichia coli: Indicates probable faecal contamination, either human or animal.
Gram-Positive Bacteria: *(Staphylococcus, Micrococcus, Streptococcus)* Indicative of large number of people or animals frequenting area. These bacteria exist in the air, dust, sewage and on environmental surfaces.
Gram-Positive Sporing Bacteria: *(Bacillus)* Ubiquitous, Dry dusty area
Other Gram-Positive Bacteria (Non-sporing): A large group of bacteria commonly associated with normal skin flora of people and animals, or decomposing organic material such as vegetation
Actinomycetes: Common in air in summer. Thermophilic Actinomycetes have been implicated in Hypersensitivity Pneumonitis. Presence is usually associated with recent soil/ dust contamination.

FUNGAL INTERPRETATION:
Fungi: *(Cladosporium)* Plant material, indicative of outdoor air or severe fungal amplification indoors
Fungi: *(Aspergillus, Penicillium)* Common indoor fungi
Aspergillus fumigatus is indicative of decomposing plant material and is undesirable in indoor air. This fungus has been implicated in respiratory infections.
Fungi: (yeast) Common air spores, origins: water, human tissues, plant material
Fungi: *(Mucor, Aureobasidium, Phoma, Acremonium)* Common air spora, could indicate dampness, or creation of aerosols from a shower or humidifiers.

Biodet Services Ltd
Consulting Industrial Microbiologists

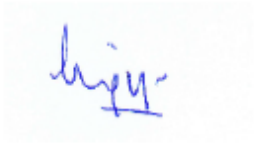
GUIDELINES: (based on Biodet database)	COLONY-FORMING UNITS PER CUBIC METER AIR	
	BACTERIA	FUNGI
Non-Air-conditioned building	50-100	100-400
Outdoor air	50-100	50-350
Vicinity of waste-water treatment plant	50-500	500-5000

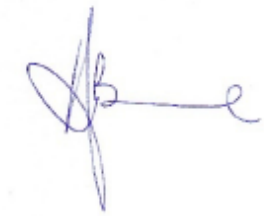
CONCLUSIONS:

- The bacteria and Actinomycete levels at all sampling points were well within the guidelines for outdoor air.
- *Escherichia coli* was not detected in any of the samples.
- The fungal levels were slightly elevated for an outdoor air when compared to the Biodet guidelines, with *Cladosporium* species predominating. These fungi are typically found growing outside as saprophytes on vegetation, with levels significantly fluctuating seasonally and geographically. The fungal counts observed at the sampling points were likely typical for this time of year.
- *Aspergillus fumigatus* was present in a very low level in the [redacted] Woburn St side yard air sample. This fungus has been implicated in respiratory infections, but the level observed would be very unlikely to result in any health issues.

I hope this information is of help to you. If you have any queries, please do not hesitate to contact us.

Yours faithfully





Elaine Khor
B.Sc.

Adrienne Burnie
B.Sc., NZCMT

The samples were tested as received.
This report must not be reproduced except in full.

Biodet Services Ltd
Consulting Industrial Microbiologists

Unit K, 383 Khyber Pass Road, PO Box 99010, Newmarket, Auckland 1149. Phone: 09-529-1563, E-mail: office@biodet.co.nz, www.biodet.co.nz

5 January 2021

Biodet Ref: 20/42588
Client Ref: 72048-3267

Chemsafety Ltd
2B, 303 Blenheim Road
Upper Riccarton
CHRISTCHURCH 8041

ATTN: Kurt Blomquist

Dear Kurt

Re: **COMPOST SAMPLE ANALYSES**

A compost sample was received 23 December 2020 for bacterial, yeast and fungal and *Escherichia coli* (*E.coli*) analysis. The sample was identified as follows:

Laboratory Number	Client Identification	Sample Name	Sample Appearance
42588	3267.01	Final product, compost	Free-flowing with some bark-like material. No visible fungal growth or unusual odour noted.

METHOD:

The compost was cultured onto selective agar for bacteria, *Escherichia coli*, yeast and mould counts.

A breakdown of the types of microorganisms observed was performed where required.

Analysis commenced 24 December 2020.

CULTURE RESULTS

Limit of detection for the bacterial count is 10 colony forming units (cfu) per gram (g).

Laboratory Number	Bacteria Count cfu/g	Actinomycetes Count cfu/g	*Escherichia coli* Count cfu/g	Yeast and Fungal Count @ 25°C cfu/g	Yeast and Fungi @ 37°C Count cfu/g
42588 3267.01 Compost	6,100,000 *Bacillus* sp. 36% Staph/Micrococci 0% Other Gram (+) 62% *Pseudomonas* 0% Other Gram (-) 2%	200,000	<10	<10	30 *Penicillium* 67% *Asp. fumigatus* 33%

< = less than

Biodet Services Ltd
Consulting Industrial Microbiologists

BACTERIAL INTERPRETATION:
Gram-Negative Bacteria: *(Pseudomonas, Flavobacterium)* associated with very damp environments.
Escherichia coli: Indicates probable faecal contamination, either human or animal.
Gram-Positive Bacteria: *(Staphylococcus, Micrococcus, Streptococcus)* Indicative of large number of people or animals frequenting area. These bacteria exist in the air, dust, sewage and on environmental surfaces.
Gram-Positive Sporing Bacteria: *(Bacillus)* Ubiquitous, Dry dusty area
Other Gram-Positive Bacteria (Non-sporing): A large group of bacteria commonly associated with normal skin flora of people and animals, or decomposing organic material such as vegetation
Actinomycetes: Common in air in summer. Thermophilic Actinomycetes have been implicated in Hypersensitivity Pneumonitis. Presence can also be associated with recent soil/ dust contamination.

FUNGAL INTERPRETATION:
Fungi: *(Cladosporium)* Plant material, indicative of outdoor air or severe fungal amplification indoors
Fungi: *(Aspergillus, Penicillium)* Common indoor fungi
Aspergillus fumigatus is indicative of decomposing plant material and is undesirable in indoor air. This fungus has been implicated in respiratory infections.
Fungi: (yeast) Common air spores, origins: water, human tissues, plant material
Fungi: *(Mucor, Aureobasidium, Phoma, Acremonium)* Common air spora, could indicate dampness, or creation of aerosols from a shower or humidifiers.

CONCLUSIONS

- The compost sample exhibited high levels of non-sporing other gram-positive bacteria, *Bacillus* and Actinomycetes. This would be considered typical microbial flora for a soil/ compost sample.
- The fungal level at 25°C was absent and at 37°C was very low, suggesting the composting process renders vegetative fungal growth non-viable. Low-level thermophiles such as *Aspergillus fumigatus* and some *Penicillium* species can survive the composting process.
- It is recommended that anyone handling the compost wear personal protective clothing, masks and gloves.
- Odours associated with a composting plant would likely be due to microbial processes, but do not necessarily correspond to high airborne microbial levels. Microbial volatile organic compounds (mVOCs) are detected as odours and may be unpleasant, but are not in themselves, a health risk.

I hope this information is of help to you. If you have any queries, please do not hesitate to contact us.

Yours faithfully

Elaine Khor
B.Sc.

Adrienne Burnie
B.Sc., NZCMT

The sample was tested as received.
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Report 42588 2