Veolia Australia & New Zealand

Woodlawn Bioreactor Expansion Project

Independent Odour Audit #8

September 2020

Final Report

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LIST OF ABBREVIATIONS & DEFINITION

AS/NZS 4323.3	Australian/New Zealand Standard 4323.3: 2001: *Determination of odour concentration by dynamic olfactometry*
AS/NZS 4323.4	Australian/New Zealand Standard 4323.4:2009. *Stationary source emissions - Area source sampling - Flux chamber technique.*
ATF	Alterative Treatment Facility
BOD	Biochemical oxygen demand
BOM	Bureau of Meteorology
BWMS	Bioreactor Waste Management System
C & D	construction & demolition
DEM-S	Derived Smoothed Digital Elevation Model
DPIE	Department of Planning, Industry and Environment
EA 2010	Environmental Assessment Woodlawn Expansion Report (August 2010)
ED1	Evaporation Dam 1
ED3N	Evaporation Dam 3 North
ED3S	Evaporation Dam 3 South
EPL	Environment Protection License
FAOA	field ambient odour assessment
HRT	hydraulic retention time
IAC	impact assessment criterion
IFH	Isolation Flux Hood
IMF	Crisps Creek Intermodal Facility
IOA	Independent Odour Audit
KOPs	knock-out pots
LMS	Leachate Management System
LOM	Liquid Odour Method

LTD	Leachate Treatment Dam
LTP	Leachate Treatment Plant
MBR	Membrane Bioreactor
MBT	Mechanical Biological Treatment
mm	millimetres
MLP	Measurement Location Point
MSW	municipal solid waste
MW	megawatts
NATA	National Association of Testing Authorities
NSW EPA	New South Wales Environment Protection Authority
OER	odour emission rate
PTFE	polytetrafluoroethylene
RH	relative humidity
RL	reduced level
SCADA	supervisory control and data acquisition
SOER	specific odour emission rate
Solid Waste Guidelines 2016	NSW EPA Environmental Guidelines: Solid Waste Landfills (2016)
SRTM	Shuttle Radar Topography Mission
the 2019 Emissions Testing Report	Emission Testing Report Veolia Environmental Services (Australia) Pty Ltd Woodlawn Biogas Power Station, Tarago: September 2019
the Audit	2019 Independent Odour Audit
the Biofilter Manual	*The Biofilter System Operating & Maintenance Manual – Revision 0* dated November 2016
the Biofilter Trial Report	Report for the biofiltration trial at Woodlawn Bioreactor dated March 2017

the LMS May 2016 Report	*Woodlawn Bioreactor Facility Odour Modelling Study - Proposed Addition of ED3S to Leachate Management System* dated May 2016 Report
the Previous Model	The original EA 2010 odour dispersion modelling study used in the *Odour and Dust Impact Assessment (Rev 5)* Report dated 2 August 2010
the Site	Woodlawn Bioreactor Facility, Collector Road, Tarago, NSW
TOU	The Odour Unit Pty Ltd
tpa	tonnes per annum
TWL	Top Water Level
US EPA	United States Environment Protection Agency
USGS	United States Geological Survey
VENM	Virgin Excavated Natural Material
Veolia	Veolia Australia & New Zealand
WALTER	Woodlawn Aerated Leachate Treated Effluent Refiner
WIP 2020	Woodlawn Infrastructure Plan – Phase: May 2020

CHEMICAL NOMENCLATURE

CH_4	methane
CO_2	carbon dioxide
$Fe_2(SO_4)_3$	ferric sulphate
GIS	Geographic Information System
H_2S	hydrogen sulphide
H_2SO_4	sulphuric acid
N_2	nitrogen gas
NOx	nitrogen oxides
SO_3	sulphur trioxide

UNITS OF MEASUREMENTS

ha	hectare
km	kilometres
kW	kilowatts
L	litres
L/day	litres per day
L/min	litres per minute
L/s	litres per second
m	metres
m/s	metres per second
m^2	square metres
m^3	cubic metres
ou	odour concentration
$ou.m^3/m^2.s$	specific odour emission rate
$ou.m^3/s$	odour emission rate
ppm	parts per million, by volume

1 INTRODUCTION

In January 2020, Veolia Australia & New Zealand (**Veolia**) engaged The Odour Unit Pty Ltd (**TOU**) to carry out the eighth Independent Odour Audit (**the Audit**) of the Woodlawn Bioreactor Facility located at Collector Road, Tarago, NSW (**the Site**).

The specific scope of works for the Audit is detailed in *Condition 7* of *Schedule 4* in the *Specific Environmental Conditions - Landfill site* and enforced by *Section 75J* of the *Environmental Planning and Assessment Act 1979* as part of the project approval for the Woodlawn Waste Expansion Project.

1.1 WOODLAWN WASTE EXPANSION PROJECT BACKGROUND AND CONTEXT

In March 2010, Veolia issued an application to the Department of Planning & Infrastructure (**DPI**) seeking approval to increase the maximum throughput rate of the Woodlawn Bioreactor from 500,000 to 1.13 million tonnes per annum (**tpa**). Simultaneously, Veolia was also seeking to increase the maximum throughput rate of the nearby Crisps Creek Intermodal Facility (**IMF**) to 1.18 million tpa. In addition to these items, the proposal application entailed:

- Installing additional lighting at the Site;
- Extending the approved hours of operation at the Bioreactor and the IMF;
- Increasing the number of truck movements transporting waste to the Bioreactor from the IMF; and
- Increasing the amount of waste transported to the Site by road from regional councils from 50,000 to 130,000 tpa.

Veolia received approval for the Woodlawn Waste Expansion Project on 16 March 2012.

1.2 AUDIT OBJECTIVES

In accordance with the project approval requirements of *Condition 7* of *Schedule 4* in the *Specific Environmental Conditions - Landfill sites* (DA 10_0012), Veolia is required to carry out an independent odour audit three months from the date of project approval and annually thereafter, unless otherwise agreed by the Director-General. The Audit must:

a. *Consult with the Environment Protection Authority and the Department of Planning, Industry and Environment;*

b. *Audit the effectiveness of the odour controls on-site in regard to protecting receivers against offensive odour;*

c. *Review the Proponent's production data (that are relevant to the odour audit) and complaint records;*

d. *Review the relevant odour sections of the Air Quality and Greenhouse Gas Management Plan for the project and assess the effectiveness of the odour controls;*

e. *Measure all key odour sources on-site including:*

   i. *consideration of wet weather conditions providing all raw data used in this analysis;*

   ii. *consideration of (but not limited to) all liquid storage area, active tipping faces, waste cover area, aged waste areas and recirculation of leachate into waste in the void; and*

   iii. *a comparison of the results of these measurements against the predictions in the Environment Assessment.*

f. *Determine whether the project is complying with the requirements in this approval to protect receivers against offensive odour;*

g. *Outline all reasonable and feasible measures (including cost/benefit analysis, if required) that may be required to improve odour control at the site;*

h. *Recommend and prioritise (mandatory and non-mandatory) recommendations for their implementation; and*

i. *Consider and comment on Crisps Creek Intermodal Facility as part of any Independent Odour Audit undertaken at the site.*

This is the <u>eighth</u> Independent Odour Audit (**IOA**) commissioned since the Woodlawn Waste Expansion project approval was granted.

1.3 COMPLIANCE WITH AUDIT OBJECTIVES

The Audit consists of the following key items, as required by the project approval for the Site:

- **Fieldwork***:* collection of odour samples from key sources (as per *Condition 7 (e)),* recording of relevant field observations, measurements, and discussions with Veolia Woodlawn staff regarding the operations of the Bioreactor and IMF. The odour emissions inventory developed in the previous IOAs was used by the audit team as a basis for the sampling program in the Audit;

- **Reviewing***:* a comprehensive review of all new relevant assessments undertaken and documentation since the 2018 IOA. In the Audit, this included a review of:

  - Landfill gas capture and trend since the previous audit;

  - The status of the long-term leachate management solution via the construction and commissioning of a Leachate Treatment Plant (**LTP**);

  - Leachate quality data;
  - Record of received waste tonnage per month;
  - Odour complaints register and responses by Veolia;
  - Emission Testing Report Veolia Environmental Services (Australia) Pty Ltd Woodlawn Biogas Power Station, Tarago: September 2019 (**the 2019 Emissions Testing Report**);
  - *The MBT Facility Biofilter System Operating & Maintenance Manual – Revision 0* dated November 2016 (**the Biofilter Manual**); and
  - Waste Infrastructure Plan –May 2020 (**WIP 2020**).

- **Modelling**: the undertaking of an update and re-run of the site-specific odour dispersion model study used as part of the project approval process; and
- **Reporting***:* a comprehensive summary of all aspects of the Audit, complying with the Audit objectives specified in **Section 1.2**.

The WIP 2020 and the Biofilter Manual are commercial-in-confidence documents that have been utilised by TOU under privilege to assist with the thorough undertaking of the Audit. All relevant information has been extracted and reproduced as required in the Audit report.

1.3.1 Consultation with DPIE and NSW EPA

As required in *Condition 7 (A)* of the project approval, TOU initiated a consultation process with both the New South Wales Environment Protection Authority (**NSW EPA**) and Department of Planning, Industry and Environment (**DPIE**) on 7 February 2020 via email correspondence. A copy of the letter issued to the NSW EPA & DPIE and responses are appended as **Appendix A**.

1.3.2 Additional Work to Audit requirements

In addition to the approval requirements, the following work components were included in the Audit:

- Consideration and commentary on the Woodlawn Mechanical Biological Treatment (**MBT**) Facility, including biofilters and maturation pad stockpiles, as part of any Independent Odour Audit undertaken at the Site;
- Completion of a field ambient odour assessment (**FAOA**) survey during the Odour Audit. The FAOA surveys were conducted before 0730 hrs, midday and after 2100 hrs;
- The undertaking of an assessment of the odour potential for all the leachate evaporation dams, i.e. ED3N-1 (empty), ED3N-2, ED3N-3, ED3N-4 and ED3S-S (also known as Lagoon 1 - 5);
- Consideration and review of the long-term LTP and ED1 coffer dam;

- Collection of liquid samples of treated leachate stored in the evaporation lagoons for odour laboratory analysis, prepared using the Liquid Odour Method (**LOM**) as described in **Section 4.3**; and

- Re-run of the site-specific odour dispersion model (as completed in the previous IOA) with the current factors and data. This will include the Woodlawn Bioreactor and MBT Facility.

The following report summarises the Audit carried out by the auditors at the Site.

2 THE SITE

2.1 WOODLAWN BIOREACTOR FACILITY BACKGROUND

The Site is located 250 km south of Sydney, within the 6,000 hectares (**ha**) Woodlawn Eco-Precinct, in the Southern Tablelands near Goulburn in New South Wales. An aerial view of the Site, highlighting the key areas as they currently stand, is shown in **Figure 2.1**.

Prior to waste operations, the Site operated as a base metals open-cut mine site during the 1970s and 1990s, processing copper, lead and zinc. Since September 2004, the mine void has been operated as an in-situ Bioreactor, historically receiving putrescible waste solely from the Sydney metropolitan area via the Clyde Transfer Terminal Facility. Since early 2012, receival of waste from local regional areas had commenced.

Waste received and contained within the Bioreactor undergoes anaerobic decomposition resulting in the production of landfill gas. The landfill gas, predominately rich in methane (**CH_4**) and carbon dioxide (**CO_2**), is continuously extracted from the Bioreactor and directly consumed via purpose-built landfill gas-fired engines that form the Site's power plant. Each landfill gas-fired engine can generate up to 1.065 Megawatts (**MW**) of 'green' electricity. All electricity generated is exported to the main grid. The Bioreactor process is described in further detail in **Section 2.2**.

Aside from generating electricity from waste at the Site, Veolia is also undertaking mine rehabilitation works and has established an innovative wind farm, aquaculture and horticulture projects within the Eco-Precinct. In early-October 2018, Veolia had also commenced operation of its long-term leachate management solution via the commissioning and optimisation of the LTP at the Site, which falls under a separate development consent and environment protection licence (**EPL**), but at the time of the Audit was in the process-proving stage. The Audit has provided commentary on the implication of the LTP in the context of leachate management and odour emissions (see **Section 2.4.6** & **Section 8.2.1.1**). The existing leachate treatment dam (**LTD**) is still operating at capacity and servicing the Bioreactor operations at the Site.

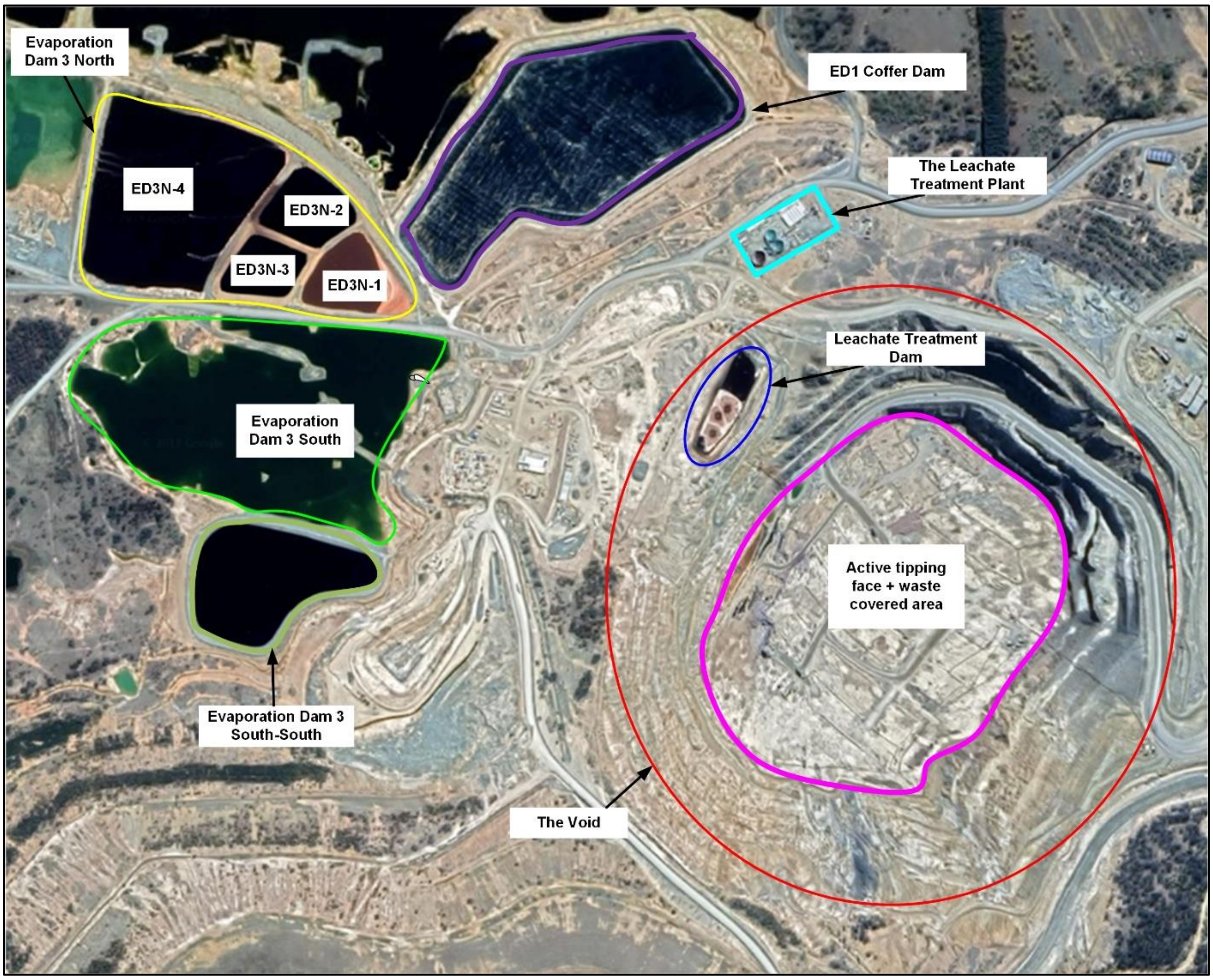


Figure 2.1 – An aerial view illustrating the layout of the Site as of the Audit (**Map source:** Google Earth ®)

2.2 PROCESS OVERVIEW

The Site has the approval to operate between 0600 hrs to 2200 hrs on Mondays to Saturdays, with no activities on Sundays, Good Friday or Christmas Day. For the Audit, the operational processes at the Site have been categorised under two primary management systems, namely:

1. The Bioreactor Waste Management System (**BWMS**); and
2. The Leachate Management System (**LMS**).

The above management systems are described in concise detail in **Section 2.3** & **Section 2.4**, respectively. Further details regarding these systems are contained in the *Environmental Assessment Woodlawn Expansion Report* dated August 2010 (**EA 2010**).

2.3 BIOREACTOR WASTE MANAGEMENT SYSTEM

At first glance, the Bioreactor surface layout appears to be a simple landfilling operation, consisting of the following:

- An active tipping face;
- Waste covered areas, including daily cover and intermediate cover;
- A mobile tipping platform;
- Leachate extraction, transfer and re-injection via the LMS. The re-injection feature of the LMS is very rarely used but the extraction and transfer are actively utilised (see **Section 2.3.2**); and
- A gas extraction system.

On closer inspection, however, there are complex procedures for the effective operation of the Bioreactor. A consequence of these procedures is a constantly evolving and dynamic site layout that varies temporally, spatially, and operationally. The key operations of the Bioreactor comprise of, but are not limited to:

- the requirement of covering areas of waste;
- the timing and necessary provisions for a given waste lift;
- the landfill gas collection system, including:
    - the strategic placement and maintenance of the vertical landfill gas extraction wells gridded system;
    - landfill gas collection pipe network;
    - condensate management and the leachate removal system; and
    - individual gas wells in the waste to manage high-risk areas prone to the release of fugitive landfill gas emissions from the surface of the Void;
- setup of the leachate extraction and recirculation system; and
- stormwater management in the Void, including catchment management and stormwater captured within the Void perimeter.

The Void layout and operations prevalent at the time of the Audit are shown in **Figure 2.2**.

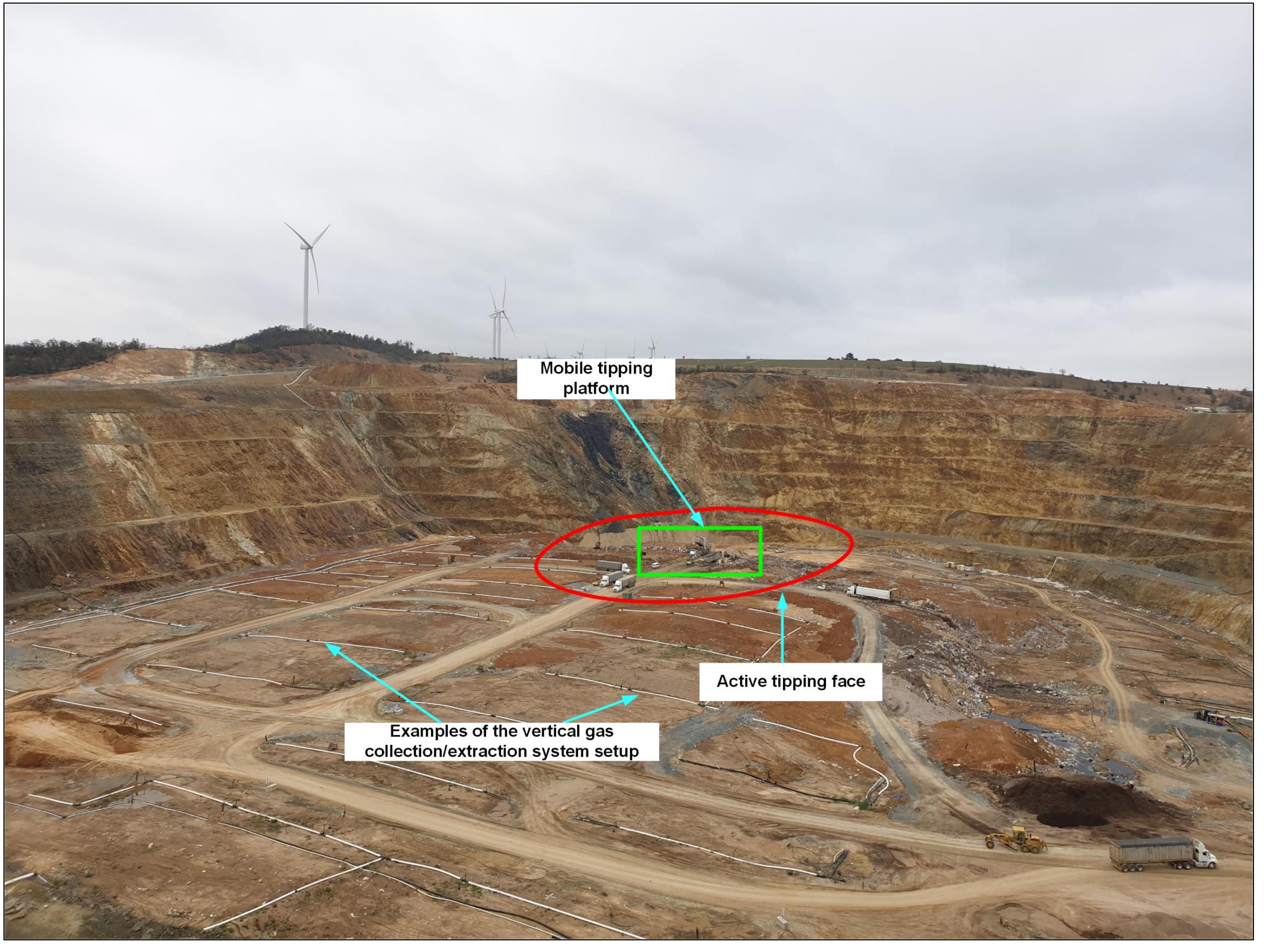


Figure 2.2 – Void layout and operations: 18 February 2020

2.3.1 Current procedure for operating the Bioreactor

The current procedure for operating the Bioreactor consists of the receival of putrescible waste transported to Woodlawn by rail from Sydney, after being containerised at one of the Veolia-operated transfer terminal facilities located at Clyde and Banksmeadow. The fully sealed containerised waste is received at the IMF and transported by a series of trucks to the Bioreactor, where waste is unloaded via a mobile tipping platform and subsequently transported by a dozer prior to compaction at the active tipping face area (as highlighted in **Figure 2.2**). The active tipping face area is progressively covered daily. As advised by Veolia in previous audits, covering the active tipping face is an on-going operational process, although the daily active tipping area will vary depending on positioning in the Void, gas infrastructure and weather conditions. It was evident in the Audit that the size of the active tipping face is still well below the area size specified in the EA 2010 (further discussed in **Section 8.2.1.6**).

When required, it is understood by the Audit that the tipping process is supplemented by a hydrogen sulphide (**H_2S**) emission control measure which involves the periodic in-situ addition of metal oxide (haematite and/or magnetite) to the waste as placed, as specified in the WIP 2020. The current procedure for operating the Bioreactor significantly restricts leachate recirculation due to its previously documented impact on landfill gas extraction through leachate pooling effects - as indicated in the WIP 2020.

2.3.2 Leachate extraction and transfer via the LMS

In the context of the Bioreactor operations, the LMS comprises of three major aspects:

1. Leachate extraction and transfer, including extraction pumps, ring main and tank transfer system, all of which are located within the Void. Leachate re-injection (or recirculation) is a back-up option for leachate transfer within the Void;

2. Leachate treatment via the LTD and LTP (see **Section 2.4.5** and **Section 2.4.6**, respectively); and

3. Treated leachate management via evaporation, which is discussed in **Section 2.4.1** to **Section 2.4.4**.

The Audit notes that if and when leachate recirculation is utilised within the Void, this is completed via a direct method into dedicated reinjection wells. This has the effect of minimising the exposure of leachate partitioning from the liquid phase to the gas phase through aerosol generation and/or evaporation pathways and subsequently leading to the generation of odorous emissions. As the leachate percolates through the upper layers of waste, a proportion of the liquid is retained in the upper layers of waste. Veolia had previously utilised covered reinjection trenches as part of the leachate recirculation process; however, this is understood to have been discontinued as part of the normal operations of the Bioreactor.

As of the Audit, and based on the WIP 2020, the leachate recirculation has been stopped due to leachate problems and the restriction of the landfill gas extraction caused by the leachate. As such, there is only one reinjection infrastructure being kept as contingency leachate management method when the leachate transfer system experiences any failure. The re-injection point is currently located in the eastern wall of the void, with a 110 mm high-density polyethylene pipe placed into the waste during the previous two lifts. The re-injection point is connected to the ring main and normally in the closed position. In the circumstance of leachate transfer system failure, e.g. pump failure or pipe damage, the valve between the re-injection point and the ring main will be opened to allow the extracted leachate to be re-injected to the waste. The re-injection will be stopped once the leachate transfer system is back to normal operation.

2.3.3 Landfill gas extraction

The landfill gas collection system is constantly expanded to promote better gas capture as waste filling progresses around the Void. The operational management and instalment of landfill gas extraction infrastructure in the Void are extensively described in the WIP 2020, as well as previous waste infrastructure plans reviewed by the audit team. The configuration during placement of waste on the surface of the Void and a waste lift is designed to ensure streamlined gas (and leachate) extraction. All extracted landfill gas is directed to the on-site power station, with moisture removal undertaken via a series of single or double knock-out pots (referred to as **KOPs** in the WIP 2020) along the landfill gas flow lines and the main header line.

2.4 LEACHATE MANAGEMENT SYSTEM

The key features of the LMS include:

- Evaporation Dam 3 North (**ED3N**), also known as evaporation lagoon 1-4;
- Evaporation Dam 3 South-South (**ED3S-S**), also known as evaporation lagoon 5;
- LTD; and
- The LTP.

Each of these listed features is described in **Section 2.4.2** to **Section 2.4.5**, respectively. Further details regarding the LMS have been previously documented and can be found in *Chapter 8* of the *EA 2010*, with updated features documented in the WIP 2020.

2.4.1 Volume reduction of treated leachate

It is a condition of the Site's EPL that no leachate (treated or untreated) can be directly discharged from the Site. The only means of volume reduction is through mechanical and/or natural evaporation processes. The details about the mechanical evaporation process of treated leachate are discussed in **Section 2.4.2.1.**

2.4.2 Evaporation Dam 3 North (ED3N)

ED3N pond system covers a total surface area of 6.1 hectares (**ha**), at top water level (**TWL**), and is divided into four (4) discrete lagoons, namely:

1. **ED3N–1:** receives treated leachate from the leachate treatment dam. The pond was empty at the time of the Audit;
2. **ED3N–2***:* receives treated leachate from the LTD. The pond surface area, as of the Audit, is approximately 0.81 ha;

3. **ED3N–3**: receives treated leachate from the LTD. The pond surface area, as of the Audit, is approximately 0.62 ha; and

4. **ED3N–4**: receives treated leachate overflow from ED3N–2, ED3N-3, or treated leachate direct from the LTD. The pond surface area, as of the Audit, is approximately 4.02 ha. There are up to five mechanical evaporators available which draw treated leachate from ED3N-4 to promote evaporation as a means of volume reduction. Further details on the mechanical evaporation process at the Site are described in **Section 2.4.2.1.**

Note: The surface areas and volumes of ED3N were as of 30 April 2019 and completed by an independent surveying company. At least 0.5 metres (**m**) freeboard is maintained at all times in the ED3N pond system.

2.4.2.1 ED3N - Mechanical evaporation system

2.4.2.1.1 System A

A mechanical evaporation system at the Site is currently active to manage the growing need for volume reduction in the ponds to retrieve storage capacity. The mechanical evaporation system is described and operated as per the WIP 2020. For ED3N-4, the mechanical evaporation system at the Site consists of five Turbomist ® evaporation units, each designed to spray 350 litres per minute (**L/min**) of liquid into the air driven by a common pump system. It is understood that the actual operating performance of the evaporation units is approximately 840-900 L/min. This evaporation mechanism is known as System A, as shown in **Figure 2.3**.

2.4.2.1.2 System B

System B, which is a surface spray evaporator system, is composed of six (6) sprays (one in each of ED3N2 and ED3N3, and four in ED3N4) floating in the middle of the dams and controlled by a weather station on the western bank of ED3N4. At the time of the Audit, ED3N-1 was empty and therefore did not have an active surface spray evaporation system. The operation of System B is in accordance with the feedback provided from the weather station, including temperature, humidity, wind direction and wind speed. Each of the sprayers is controlled independently, with setpoints based on weather conditions. As shown in **Figure 2.3**, the nominal location of each surface spray evaporator and the operating wind direction range is presented as arrows, with the span range visually illustrated. As documented in the WIP 2020, System B is under an active trial period, and the setpoints are being tested to ensure the spray mist will not drift out of the dam area. As the humidity and temperature conditions vary across the seasonal cycles, the setpoint for wind speed is modified accordingly. The operation and effectiveness of System B is regularly reviewed by the Site and setpoints optimised as required. A photo showing the operation of the surface spray evaporator system is shown in **Figure 2.4**.

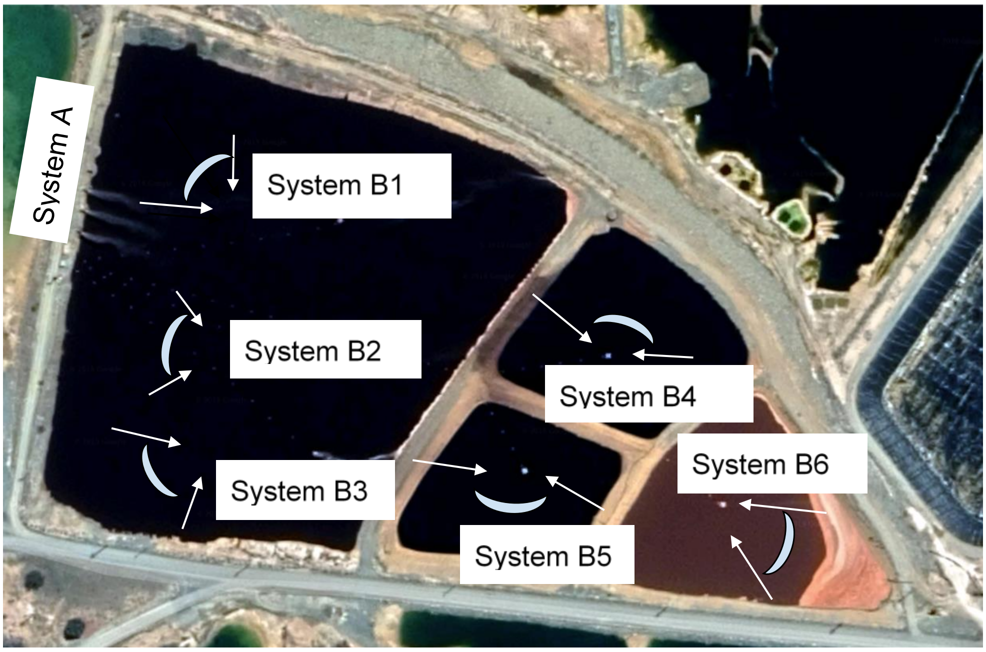


Figure 2.3 – The mechanical evaporation system layout for ED3N (**Source:** WIP 2020)

Figure 2.4 – Operation of System A and System B at the Site (**Source:** WIP 2020)

2.4.3 Evaporation Dam 3 South-South (ED3S-S)

ED3S-S receives treated leachate from the LTD. The pond surface area at TWL is 2.2 ha. At the time of the Audit, ED3S-S was at approximately 87% volume storage capacity, equivalent to a water surface area of approximately 1.9 ha. A photo of ED3S-S, as occurred during the Audit is shown in **Photo 2.1**.

Note: The surface area and volume of ED3S-S were as of 28 April 2020 and completed by an independent surveying company.

2.4.3.1 Mechanical Evaporation System

A ring main evaporation system is installed away from the bank of ED3S-S. A total of four spray bars, each bar with 5-6 nozzles, are installed at the north, west, south and east of ED3S-S, respectively, approximately 2 m away from the bank. The spray nozzles are controlled by an in-situ weather station and operate only when the wind is blowing from a certain direction, i.e. behind the bank into the dam. In addition to the ring main evaporation system, ED3S-S has three surface spray evaporators, similar to that described in **Section 2.4.2.1.2**. The operation of the surface spray evaporators occurs only during the daytime on weekdays and based on weather conditions.

Photo 2.1 – ED3S-S: 18 February 2020

2.4.4 Evaporation Dam 1 Coffer Dam

The Evaporation Dam 1 (**ED1**) coffer dam stores treated effluent from the LTP. The TWL of the ED1 coffer dam is approximately 6.4 ha.

2.4.5 Leachate Treatment Dam

The LTD is in the upper north-western edge of the Void and is an integral part of the LMS at the Site. Leachate from the Void is pumped directly to the LTD as required. Since the 2012 IOA, the LTD was upgraded from a batch-based wastewater treatment system to a continuous configuration. The upgraded system was commissioned in April 2013. Following this upgrade, the LTD process was modified since the previous audit to consist of anoxic and aeration zones to increase the efficiency of the leachate treatment process. **Photo 2.2** shows the LTD as occurred during the Audit, and **Figure 2.5** illustrates the current continuous treatment configuration for the LTD.

The LTD has a hydraulic retention time (**HRT**) of 33 days (dependent on treatment flow) and is capable of the continuous treatment of approximately 259,000 – 346,000 litres per day (**L/day**) of untreated leachate, equivalent to a current maximum treatment capacity of 3-4 L/s. The raw leachate is pumped from the Void and discharged into the anoxic zone of the LTD for denitrification. Following treatment in the anoxic zone, the leachate migrates to the aeration zone to promote mixing, oxygen transfer and nitrification. The effluent from the aeration zone of the LTD is dosed in-situ with ferric sulphate (**$Fe_2(SO_4)_3$**) and a polymer to facilitate with coagulation and flocculation processes before passing through a settling tank known as the Woodlawn Aerated Leachate Treated Effluent Refiner (**WALTER**). Under this treatment configuration, the LTD requires desludging at a frequency that is determined by Veolia experts. The sludge from the settling tank is returned to the LTD as required. Any sludge from the desludging process (and any excess sludge that may be generated) is transported and returned to the waste in the Void where it is buried and covered. A process flow schematic is shown in **Figure 2.5**.

Photo 2.2 – A view of the LTD: 18 February 2020

2.4.6 Leachate Treatment Plant

As previously mentioned in **Section 2.1**, the Site has constructed and commissioned the LTP as the long-term leachate management strategy, which is currently undergoing process-proving. As indicated in the WIP 2020, the LTP is in the process proving stage which includes, but is not limited to, biomass growth, biological process tuning and process optimisation. The LTP is located on the northern side of the Void, between the Bioreactor and Evaporation Dam 1 (as shown in **Figure 2.1**), and consists of a membrane bioreactor (**MBR**) treatment system with a design capacity of approximately 4 L/s. The MBR system has been designed as a modified activated sludge biological process to treat the main parameters found in the raw leachate extracted from bioreactor to a higher quality effluent. The LTD and LTP are currently operated simultaneously at the Site, providing an improvement in leachate management and treatment capacities from the Void.

A process flow schematic of the LTP is provided in **Figure 2.6,** with a flow schematic of the upgraded leachate management system at the Site shown in **Figure 2.7**. The key treatment process stages of the LTP includes:

1. A primary treatment stage, including screening to remove gross solids, large materials and other pollutants;

2. A balance tank to regulate treatment flow;

3. Anoxic Tanks;
4. Aeration Tanks; and
5. An ultrafiltration membrane system.

The product of the process stages above is a high-quality effluent that will be stored in the ED1 coffer dam. Given that the LTP is in the process proving stage, the preliminary critical control points and critical limits are continuously monitored with alarms and automatic shutdown using a dedicated Supervisory Control and Data Acquisition (**SCADA**) controls system if critical limits are reached. A view of the LTP is shown in **Photo 2.3**. A process flow schematic and diagram of the LTP is shown in **Figure 2.6** and **Figure 2.7**.

Overall, from odour emissions viewpoint, the Audit has obtained leachate treatment data of the effluent from the LTP and can comment that it is of a quality that will contribute negligible levels of odour. At the time of the Audit visit, ED1 coffer dam contained a very low level of treated leachate, as shown in **Photo 2.4**. This made area source sampling not possible during the Audit, but a liquid sample of the effluent and ED1 coffer dam was possible (see **Table 9.3** for further details). An overview of the LTP flow concept is shown in **Figure 2.8**.

Photo 2.3 – A view of the LTP: 19 February 2020

Photo 2.4 – ED1 Coffer Dam: 18 February 2020

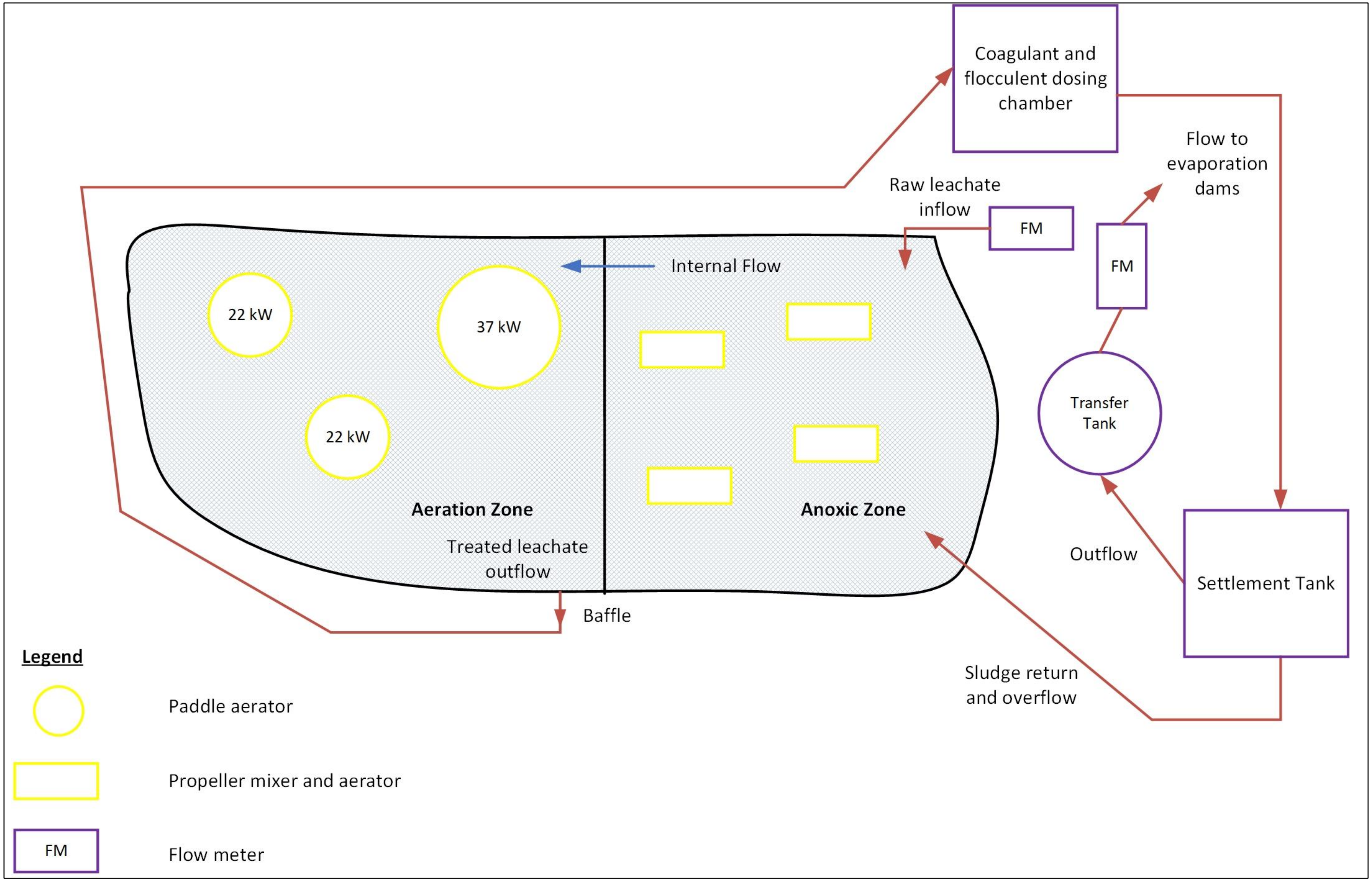


Figure 2.5 – A flow schematic of the current continuous treatment configuration for the LTD at the Site

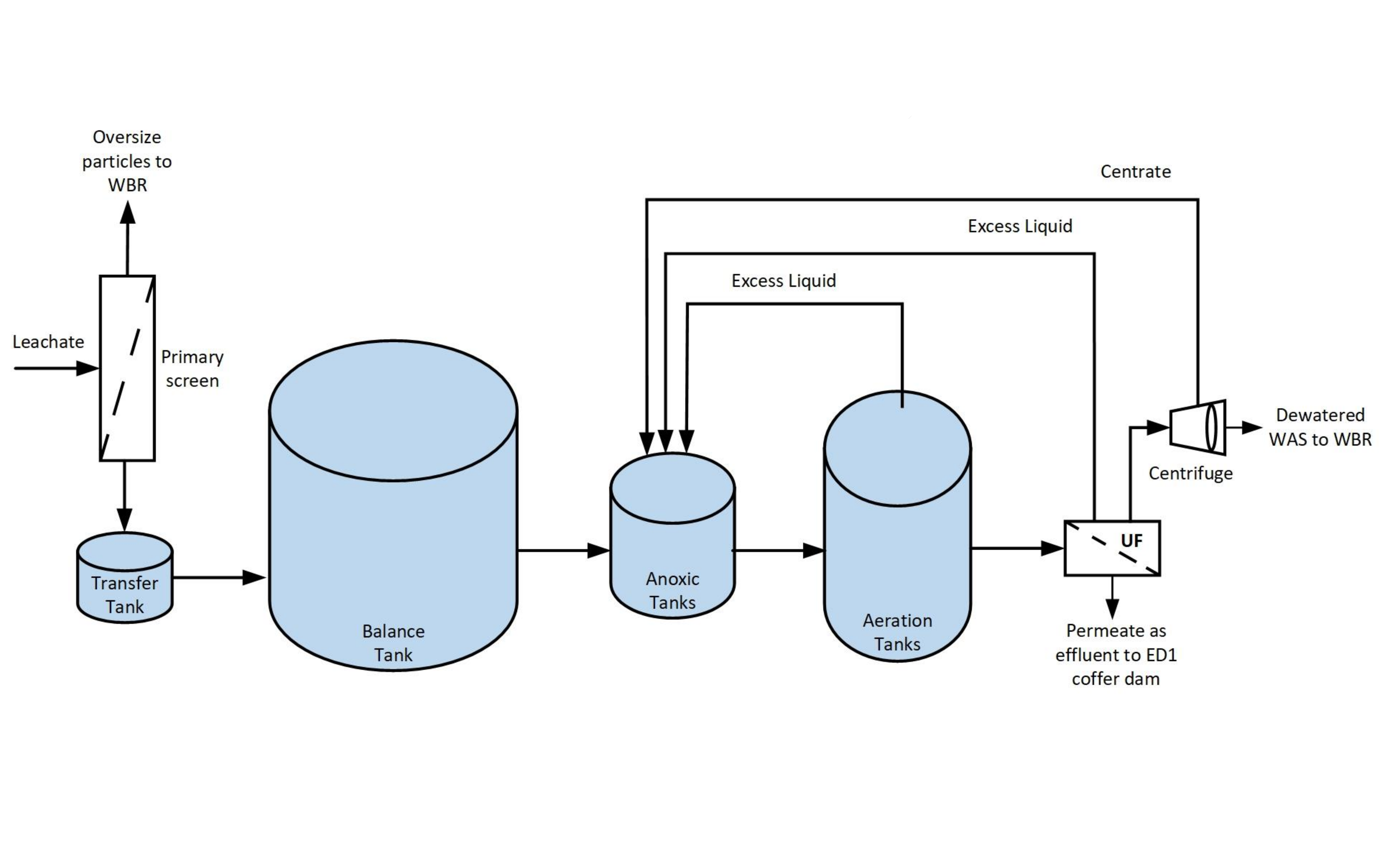


Figure 2.6 – LTP process flow diagram

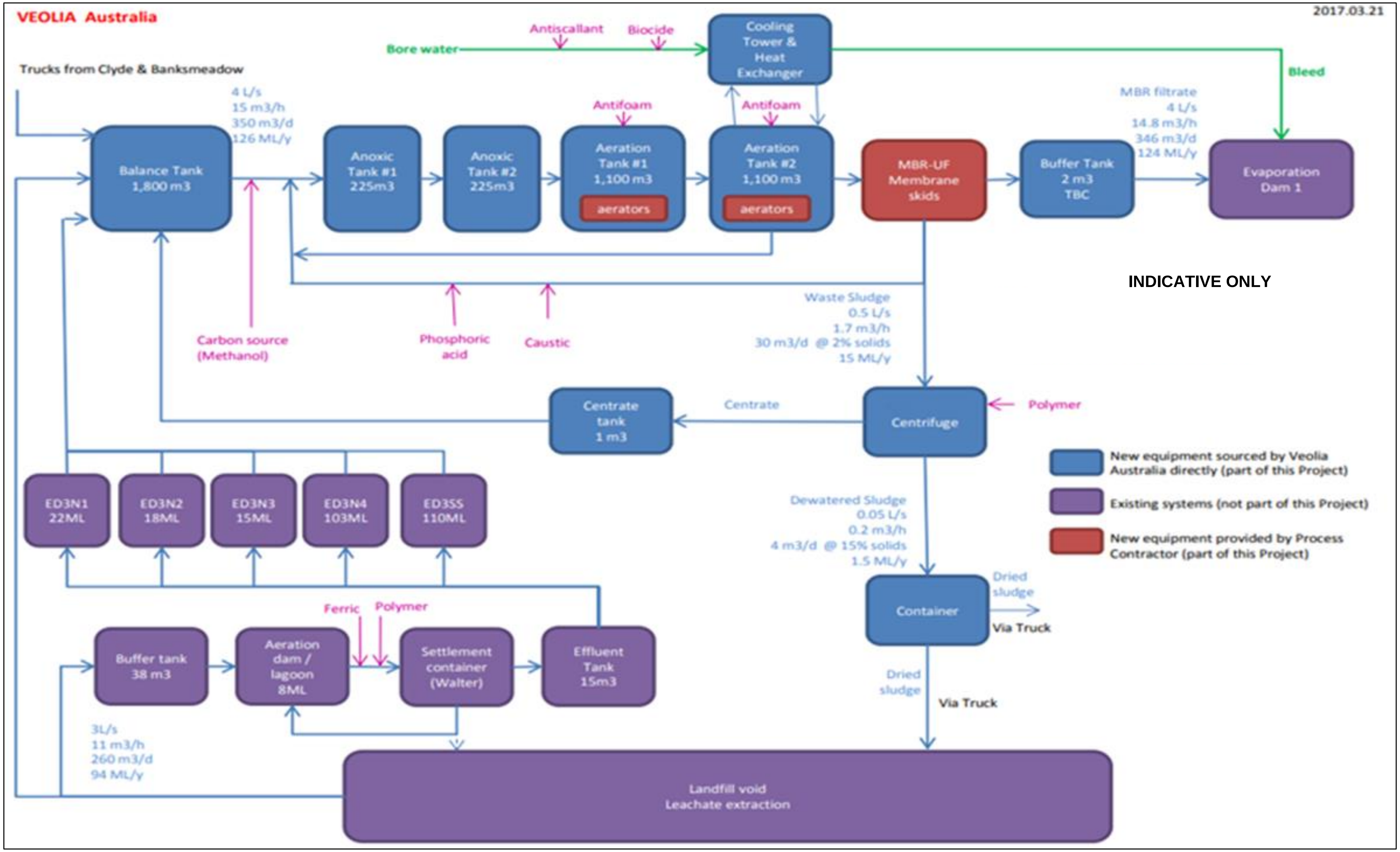


Figure 2.7 – A flow schematic of the upgraded leachate management system at the Site (**Source:** Previous IOA)

Figure 2.8 - Concept layout of the LMS for the Bioreactor (**Source**: WIP 2020)

2.5 STORMWATER MANAGEMENT

2.5.1 ED3S Stormwater

ED3S continues to receive stormwater runoff which is managed as acid mine drainage. At TWL, the pond surface area is 89.4 ha.

2.5.2 Stormwater Infrastructure in the Void

During stormwater events, all stormwater pumps operate to ensure stormwater water is pumped to Pond 5 and transferred to ED3S. According to the WIP 2020, the Void has been divided into multiple sub-catchment area, as shown in **Figure 2.9**. Each sub-catchment has either natural or engineered drainage and flow control infrastructure, such as concrete dish drains, clay berms, pumps and pipes to manage stormwater captured in the area. These systems minimise the amount of stormwater flow from the Bioreactor walls onto the waste surface of the Void and, in turn, the potential generation of excess leachate from stormwater flows. At the current stage, the stormwater management system is composed of two on-duty pumps, four backup pumps, four buffer ponds, as well as the related water drain, diversion and delivery pipework system.

2.5.2.1 Management of contaminated surface water

Surface water collected on the covered landfill surface is drained to temporary storage ponds and is transferred to Pond 5. Where it is suspected that leachate may have contaminated surface water, a sample is collected for testing of ammonia (a key indicator for contamination) to demonstrate that the water quality is suitable for discharge to ED3S. If it is found that the surface water has encountered waste or leachate, the water will be managed as leachate through the established treatment pathways of the LMS.

2.5.2.2 Management of high rainfall events

Any stormwater into the Void, especially the portion that directly falls on the waste surface of the Void and the runoff from the upper benches, is one major source of excess leachate generation. As documented in the WIP 2020, it is indicated that leachate generation is very sensitive to high rainfall events due to the large, increasing catchment area and partial stormwater interception.

During high rainfall events, large volumes of rainwater fall onto the waste surface. Currently, stormwater is not 100% intercepted from the surface of the waste before becoming contaminated. Following high rainfall events, the leachate extraction system prioritises the extraction of surface water over leachate collected from the sub-surface (i.e. within the Bioreactor). As leachate extraction rate is limited to approximately 2 - 4 L/s at the LTD, owing to the leachate treatment system capacity, these rainfall events result in further accumulation of leachate in the Bioreactor, potential reducing the efficiency of the landfill gas capture infrastructure and management of fugitive landfill gas emissions from the Void. Given the importance of the management of high rainfall events in the Void, the WIP 2020 indicates that an upgrade to the stormwater management system is currently being undertaken, which started from the 2019 calendar year and expected to finish before the end of 2020. Following the completion of this upgrade, optimisation of the infrastructure will be undertaken at the Site to minimise excess leachate generation so that stormwater can be diverted to ED3S.

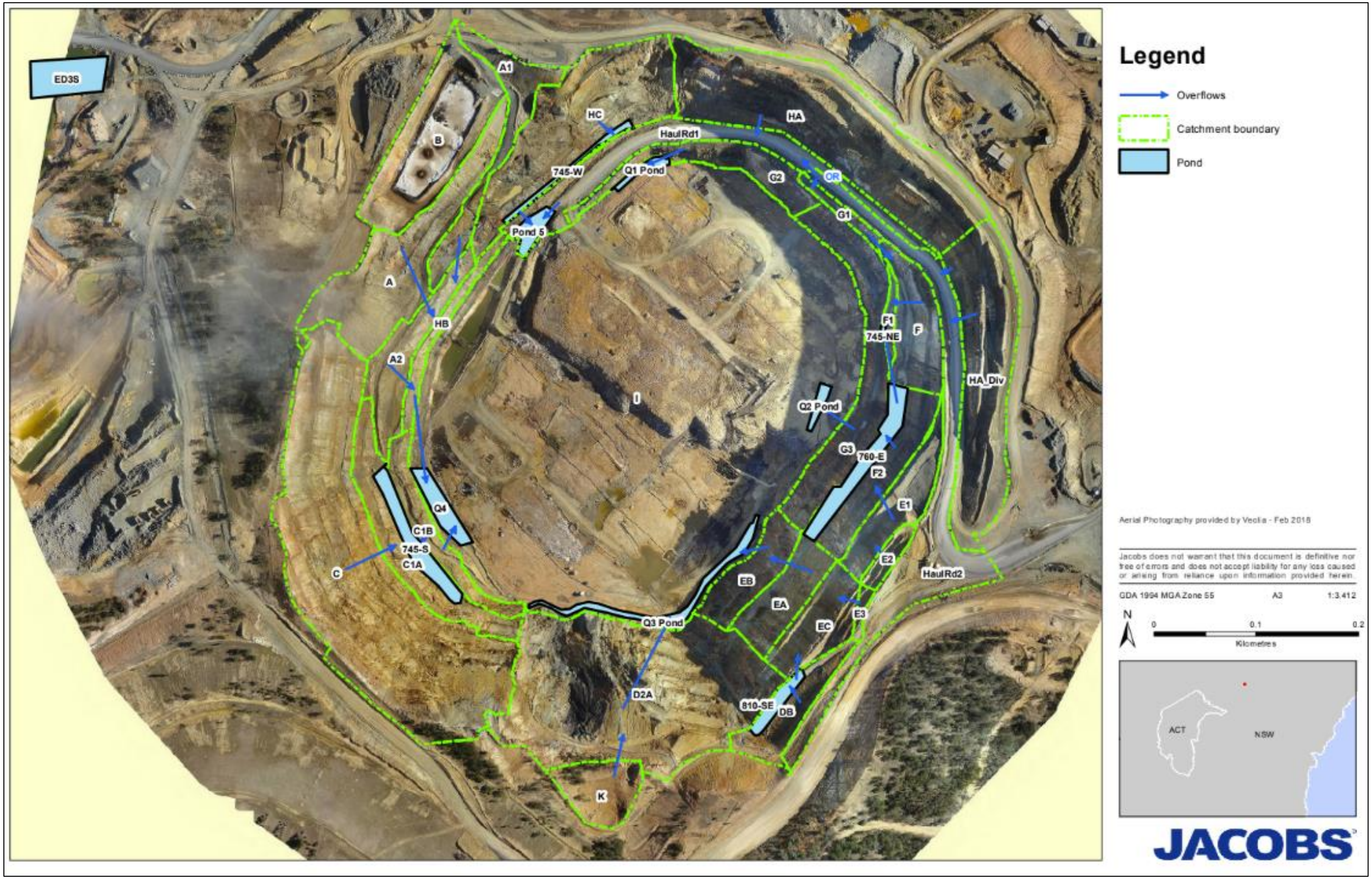


Figure 2.9 – Surface water management strategy in the Void as outlined in the WIP 2020

2.6 MBT FACILITY OPERATIONS

The MBT Facility at the Site operates under a separate EPL to the Bioreactor operations and is capable of processing up to 144,000 tonnes of putrescible waste per annum. The operation of the MBT Facility includes receipt of solid waste from municipal, commercial and industrial sources within the Sydney Metropolitan Area. The waste is transported in a similar manner to the Bioreactor, which is via the IMF. Upon receipt at the MBT Facility, the waste is processed in the following manner:

- Waste is accepted, weighed and unloaded on the Reception Building pit of the waste processing building, where it is screened for conforming waste;
- Waste is then loaded to the BRS drums in batches to ensure maximum residence time of 3-4 days;
- The waste from BRS drums is transferred to Refining Building for mechanical sorting with equipment, such as trommels, to separate waste into different sized fractions, magnets to remove ferrous material and ballistic separators to segregate light, organic material from inorganic material for composting. The refined and screened organic material is provisionally stored in the Organic Buffer Storage Building;
- The refined and screened organic material is transferred from the Organic Buffer Storage Building to the Fermentation Building for composting. Aerated stockpiles of the organic material are formed in specially designed cells through an automated delivery system. Oxygen, temperature and moisture levels are regulated through a dedicated SCADA system to ensure optimum and controlled conditions for composting to occur. The process of fermentation will effectively create a biologically stable product, at the end of which the compost produced will be moved into the Maturation Storage Pad Area, located adjacent to the fermentation buildings, until required for use; and
- Recovered ferrous metals is captured in the bin located outside the Refining Building and stored inside of the Organic Buffer Storage Building prior to transport off-site. Any residual material is sent to the Bioreactor for disposal.

2.6.1 Odour Control System

To facilitate the operations from an odour management perspective, the MBT Facility has been designed with a purpose-built biofilter-based odour control system. There are two biofilter systems at the MBT Facility, namely:

- **Biofilter System 1**, which is responsible for treating process and building airflow from the Reception Building and BRS Drum System; and
- **Biofilter System 2**, which is responsible for treating process and building airflow from the Organic Buffer Storage, Fermentation Building and Refining Building.

The Audit understands that the design philosophy for both odour control systems was identical in that consideration was given to the type of processes that will be occurring in the MBT Facility, the potential for each of these processing areas to generate odours, the layout of the MBT Facility site, the proximity of the site to potential odour receptors, and experience base from several other large in-vessel composting facilities across Australia. The product of this process resulted in a design that achieves the following objectives:

- Capture and/or containment of all odours generated at key processing areas including the Reception Building, BRS Drum System, Refining Building, and Organic Buffer Storage Building;
- The maintenance of negative pressure conditions in the above areas, under normal operating conditions;
- Capture of the bulk of the odours generated in the Fermentation Building, without necessarily achieving negative pressure conditions; and
- Treatment of all odour captured by the two independent collection systems in a pair of up-flow, open-bed biofilters, each equipped with a foul air humidification system.

2.6.2 MBT Odour Emissions Identification and Characterisation

An operational odour analysis was undertaken to identify and characterise all key emission points at the MBT Facility to facilitate the sampling program conducted in the Audit. This analysis resulted in the following key sources of interest:

- The biofilter system performance outlet discharge cells; and
- The maturation storage pad area.

All other locations are considered negligible, provided the odour control system infrastructure, operating setpoints, and design practices are followed.

3 SAMPLING PROGRAM

As per *Condition 7 (e)* of *Schedule 4* in the *Specific Environmental Conditions - Landfill site,* this Audit measured all current and key sources at the Site. As previously highlighted in **Section 1.3**, the odour emissions inventory developed in previous IOAs was used as a basis for the sampling program in the Audit and updated where required.

3.1 SAMPLING SCOPE

The Audit involved the collection of a total of fifty-one (51) gas samples, namely:

- Thirty-seven (37) gas samples for odour concentration measurement; and
- Fourteen (14) liquid samples for odour concentration measurement testing using an in-house NATA-accredited Liquid Odour Concentration Determination Method (see **Section 4.3** & **Appendix B** for details). The liquid samples, whilst not being a requirement for the Audit, were collected from the pond sources containing treated leachate, including ED3N-2, ED3N-3, ED3N-4, ED3S-S, ED1 Coffer Dam and the LTP to quantify the odour emissions caused by the natural or mechanical evaporation of the lagoons liquid contents (see **Section 8.2.1.4** for further details and results).

3.2 SAMPLING SCHEDULE

The sampling program schedule for the Audit is summarised in **Table 3.1.** As shown in **Table 3.1**, there are several key sampling locations at the Site. This includes:

- The Bioreactor;
- ED3N System;
- ED3S System;
- The Landfill Gas System;
- The LTP; and
- The MBT Facility.

The sampling program schedule includes all key sources requested in *Condition 7 (e) of Schedule 4 in the Specific Environmental Conditions - Landfill site* with the following exceptions:

- **Leachate recirculation***:* Since the 2012 IOA, the Audit has been unable to observe and thus collect representative samples for this scenario. Since the completion of EA 2010, Veolia has developed a leachate recirculation system that involves direct injection of leachate into the waste which eliminates the need for spraying over the surface (see **Section 8.2.1.1.1**). The audit team understands this will continue to remain normal practice, both for the Audit and future IOAs. Therefore, no suitable access points for the collection of odour samples from this source is – and will continue to be – possible. Notwithstanding this, as previously mentioned in **Section 2.3.2**, there is only one reinjection infrastructure being maintained in the Bioreactor as a contingency/back-up option for leachate management when the leachate transfer system experiences any failure. Therefore, the use of leachate recirculation technique is not used extensively as part of the normal operation for the Bioreactor. On this basis, it is not considered to be a significant source of odour. Subsequent IOAs will continue to assess the circumstances relating to leachate recirculation within the Void and document any variation in leachate recirculation practices as required.

3.2.1 Wet Weather Conditions

The Site encountered intermittent and very light wet weather conditions in the days leading up to and during the Audit visit period. As a result, the Audit was able to collect odour samples under wet weather conditions and observed the effects of wet weather regarding the need to handle increased levels of leachate and stormwater catchment in the Void.

3.2.2 Crisps Creek Intermodal Facility

No samples were collected from the IMF as all waste transportation is a fully contained process until the displacement of the contents into the Void via the mobile tipping platform.

3.2.2.1 Waste container management

The Audit notes that it is a requirement that all waste containers are to be designed, constructed, and maintained to prevent the emission of odour and be watertight to prevent the leakage of leachate from waste containers during transport and handling activities. This is a condition of consent for the Clyde Transfer Terminal Facility and Banksmeadow Transfer Terminal Facility, which is where the waste containerisation process occurs. As such, and as per previous audits, the Audit team classifies the IMF as a very low-risk source regarding odour. Moreover, as per previous audits, there are virtually no active pathways for odour emission release from this operation that can be practically measured under normal operations. Therefore, and as will be discussed in **Section 8.2.1.8** and noted in previous audits, the IMF continues to be a negligible contributor to the Site's overall odour emissions profile.

Table 3.1 – The Audit sampling program schedule as conducted between 17 February 2020 and 20 February 2020		
Location	**Source Type^**	**No. of samples collected**
The Bioreactor		
Active Tipping Face	Area source	3
Waste Covered Area	Area source	6
Leachate Treatment Dam		
LTD	Area source	2
ED3N Pond System		
ED3N - 1	Area source + Liquid odour measurement	0
ED3N - 2	Area source (3) + Liquid odour measurement (3)	6
ED3N - 3	Area source (3) + Liquid odour measurement (3)	6
ED3N - 4	Area source (3) + Liquid odour measurement (3)	6
ED3S Pond System		
ED3S	Area Source	2
ED3S-S	Area source (3) + Liquid odour measurement (3)	6
ED1 Coffer Dam		
ED1 Coffer Dam	Liquid odour measurement	1
LTP		
Leachate Treatment Plant Effluent	Liquid odour measurement	1
MBT Facility		
MBT Biofilter 1 System	Point source	4
MBT Biofilter 2 System	Point source	4
MBT Maturation Pad	Area source	4
TOTAL		**51**

^ see **Section 4** for details

4 SAMPLING METHODOLOGY

The sampling methodologies described in this section are associated with the 'Source Type' descriptions presented in **Section 3.2** - **Table 3.1**. Given the nature and characteristics of the emission sources sampled, the following sampling techniques are adopted in the Audit:

- Point source sampling, as detailed in **Section 4.1**;
- Area source sampling, as detailed in **Section 4.2**; and
- The liquid odour measurement method, as detailed in **Section 4.3**.

4.1 POINT SOURCE SAMPLING METHOD

The method used for the collection of gas samples from the inlet and outlet locations of the biofilter systems at the MBT Facility involved the use of a point source sampling, consisting of the drum and pump method. This method involves the drawing of the sample air through a polytetrafluoroethylene (**PTFE**) sampling tube into a single-use, Nalophan sample bag. The bag was housed within a container (sampling drum) that was evacuated with a vacuum pump, and the sample collected by induced flow. The "lung method", by which this sampling procedure is known, allowed the sample air to be collected without encountering any potentially odorous material. **Figure 4.1** illustrates a schematic of the point source sampling method.

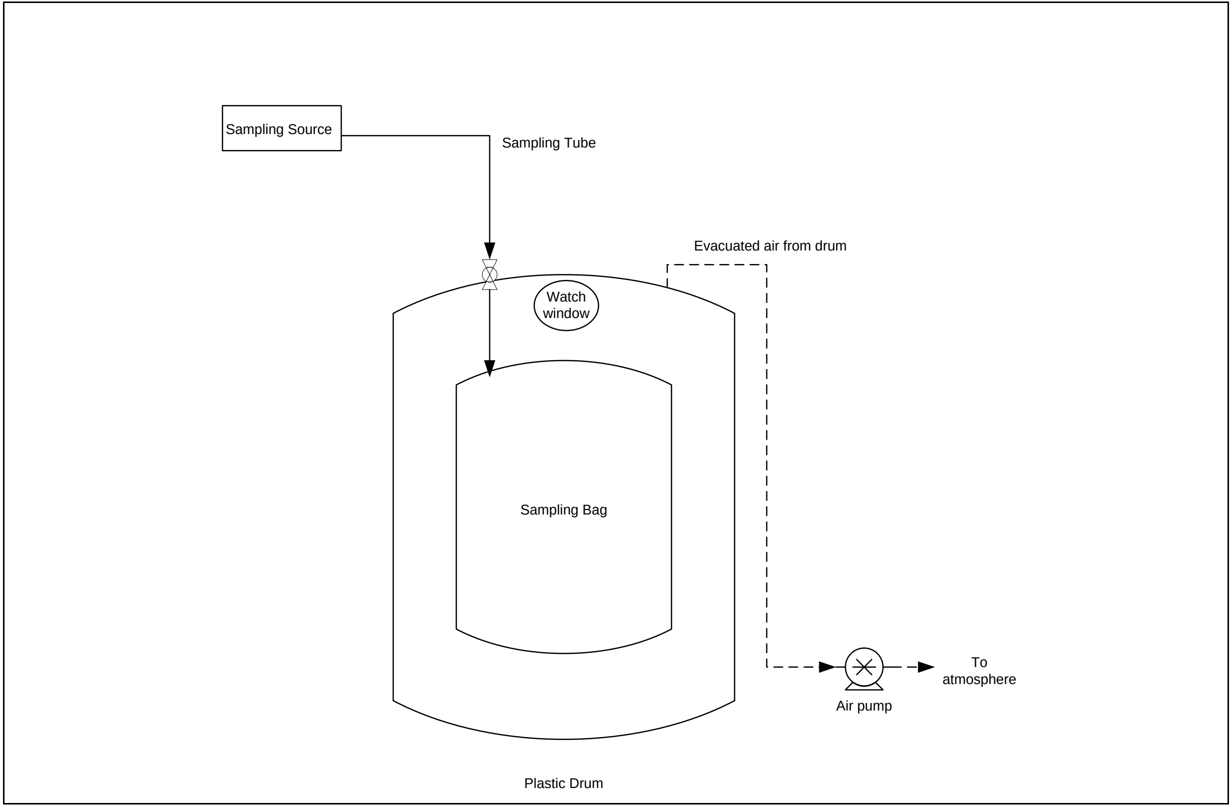


Figure 4.1 - Schematic of point source sampling

4.2 AREA SOURCE SAMPLING METHOD

The objective of the area source sampling was to collect representative odour samples from both solid and liquid surface areas at the Site. This was undertaken using an isolation flux hood (**IFH**). All sampling using the IFH was carried out according to the method described in the United States Environment Protection Agency (**US EPA**) technical report '*EPA/600/8-86/008*', from which Australian Standard 4323.4:2009 (**AS4323.4:2009**) is based upon and is considered an '*Other Approved Method (OM-8)' by EPA (DEC, 2007)*. TOU's IFH adheres to the design specifications, materials of construction and supporting equipment that the US EPA report '*EPA/600/8-86/008*' defines. The IFH has a diameter of 0.406 m, a chamber surface area of 0.126 square metres (**m²**) and a chamber volume of 30 litres (**L**), equivalent to 0.03 cubic metres (**m³**), when the skirt of the hood is inserted into the liquid or solid surface by the specified 25 millimetres (**mm**). Dry nitrogen is then introduced to the IFH at a sweep rate of 5 L/min.

As these area sources are open to the atmosphere, wind is a major factor in the release of odorous pollutants from the surface and conveying the pollutant from the source to areas beyond the boundary. The IFH system is designed to simulate the transfer of odorous pollutants by the wind, resulting in a controlled and consistent sampling environment. This is achieved by the flux of near pure nitrogen gas into the IFH that is positioned on the liquid or solid surface. On a liquid surface, this is achieved by floating the IFH within an inflated tyre inner tube. The nitrogen gas then transports the odour from the surface in the same way the wind does, albeit at a very low sweep velocity. This odorous air is then collected for odour and/or chemical analysis. As the IFH has a constant 5 L/min inflow of nitrogen gas to it, the sampling chamber remains under positive pressure and produces a net outflow through the vent on top of the IFH, therefore eliminating any chance of contamination of external air from the atmosphere. The IFH's volume of 30 L and the 5 L/min nitrogen sweep rate results in a gas residence time of six minutes. The US EPA method prescribes a minimum of four air changes as to achieve optimum purging and equilibrium in the hood, and therefore a total of 24 minutes is allowed before sampling commences. The sample is then collected over a 10-minute period to obtain a 20 L sample for odour and/or chemical analysis.

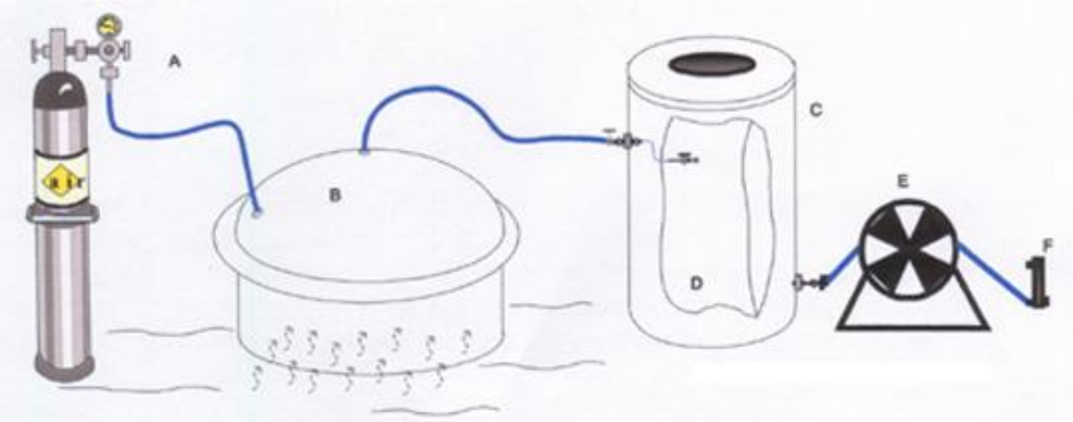
The US EPA method followed by TOU may be summarised as follows (and as described in the schematic of the sampling equipment shown in **Figure 4.2**):

- Dry nitrogen is directed into the IFH via odour free PTFE tubing until it has reached equilibrium. The nitrogen is channelled to a manifold fitted with small outlets above the surface, which direct the air towards the centre of the surface;

- The nitrogen flow (5 L/min) purges the flux hood with a residence time of four times the chamber volume occurring before sampling begins; and

- The odorous sample is drawn through a Teflon tube, into a single-use, odour-free Nalophan sample bag secured inside a drum that is under vacuum. The balance of the gas flow is vented to the atmosphere.

The IFH is manufactured from acrylic resin to ensure it does not contribute to the odour sample. All other surfaces in contact with the sample are made from PTFE or stainless steel. An example of IFH sampling on a solid surface and a liquid surface is shown in **Photo 4.1** & **Photo 4.2**, respectively.

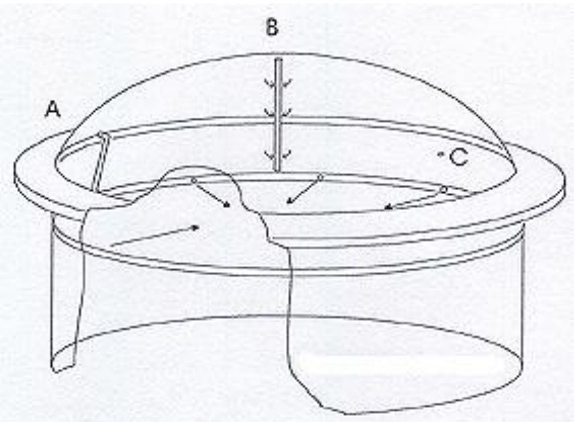


Source: Odotech - Odoflux Isolation Flux Hood Manual

Key

A	Cylinder of medical air, nitrogen or any neutral gas.
B	Isolation Flux Hood (a detailed diagram is shown in **Figure 4.3**)
C	Lung chamber (sampling drum)
D	Nalophan sampling bag
E	Sampling pump
F	Air flow meter

Figure 4.2 - Schematic of the isolation flux hood setup



Source: Odotech - Odoflux Isolation Flux Hood Manual

Key

A	Inlet gas from the gas cylinder.

B	Outlet to sample bag.

C	Additional gas outlet points for other sampling, or temperature and moisture monitoring.

Figure 4.3 – Details of the isolation flux hood chamber

.

Photo 4.1 – An example of IFH sampling on a solid surface at the MBT Facility as occurred on 18 February 2020

Photo 4.2 – An example of IFH sampling on a liquid surface (ED3N-2) as occurred on 17 February 2020

4.3 LIQUID ODOUR METHOD

4.3.1 Overview

The Liquid Odour Method (**LOM**) was developed by TOU for measurement of the odour release potential from process liquors, which is universally applicable to aqueous solutions containing odorous substances. In simple terms, it measures the odour released when an odorous liquid evaporates. It is directly relevant to the mechanical evaporation units in use at the Site and natural evaporation processes for volume reduction of treated leachate (see **Appendix D** for details on methodology).

4.4 AIR FLOW MEASUREMENTS

Air flow measurements from the biofilter inlet were recorded by inserting a hot-wire anemometer into a pre-drilled hole in ductwork for Biofilter System 1 and Biofilter System 2 at the MBT Facility. The collection of these airflows was necessary to enable an OER to be calculated (see **Table 6.3**).

5 ODOUR MEASUREMENT METHODS

5.1 ODOUR MEASUREMENT LABORATORY

All samples collected for the Audit were tested at TOU's NATA Accredited Odour Laboratory.

5.1.1 Odour Concentration Measurement

TOU's odour laboratory operates to the Australian Standard for odour measurement '*Determination of odour concentration by dynamic olfactometry'* (**AS/NZS 4323.3**) which prescribes a method for sample analysis that provides quality assurance/quality control and ensures a high degree of confidence in the accuracy, repeatability and reproducibility of results.

The concentration of the gaseous odour samples was measured using a technique known as dynamic olfactometry. Dynamic olfactometry involves the repeated presentation of both a diluted gaseous odour sample and an odour-free air stream to a panel of qualified assessors through two adjacent ports on the olfactometer (known as the Odormat™). TOU utilises four to six trained assessors (or panellists) for sample analysis, with the results from four qualified panellists being the minimum allowed under the AS/NZS 4323.3. For the Audit, four panelists were used.

The method for odour concentration analysis involves the odorous gas sample initially being diluted to the point where it cannot be detected by any member of the panel. The assessor's step- up to the olfactometer, in turn, takes a sniff from each port, then choose which port contains the odour and enter their response. At each stage of the testing process, the concentration of the odorous gas is systematically increased (doubled) and re-presented to the panellists. A round is completed when all assessors have correctly detected the presence of the odour with certainty. The odour is presented to the panel for three rounds and results taken from the latter two rounds, as stated in AS/NZS 4323.3.

The results obtained give an odour measurement measured regarding odour units (**ou**). One (1) ou is the concentration of odorous air that can be detected by 50% of members of an odour panel (persons chosen as representative of the average population sensitivity to odour). It is effectively the concentration of an odour at detection threshold level. The odour concentration of a sample expressed in odour units is the number of times the sample must be diluted to elicit a physiological response (the detection threshold level) from a panel. For example, twenty (20) odour units would mean that the odour sample will need to be diluted 20 times for the concentration to be at detection threshold level. This process is defined within AS/NZS 4323.3. The odour units can be subsequently multiplied by an emission rate or volumetric flow to obtain an Odour Emission Rate (**OER**) or a specific odour emission rate (**SOER**) for area source samples collected using the IFH method (see **Section 4.1** & **Section 5.1.2**).

5.1.2 Specific Odour Emission Rate

For area source samples collected using the IFH method, the results from odour concentration testing, derived in odour units (see **Section 4.1** for details), is multiplied by an emission rate to obtain a SOER. SOER is a measure of odour released from a representative point at a source. The SOER is multiplied by the area of the source to obtain the OER or the total odour released from each source, that is:

- SOER (ou.m^3 m^{-2} s^{-1}) = OC $\times$ Q / A; and
- OER (ou.m^3 s^{-1}) = SOER $\times$ area of source (m^2)

where:

- OC = odour concentration of compound from air in the chamber (ou)
- Q = sweep gas volumetric flow rate into chamber (m^3 s^{-1})
- A = sample source total surface area (m^2)

The SOER is presented in the units ou.m^3/m^2.s as per convention, and as referred to in the document – Klenbusch, M.R., 1986. USEPA Report No. EPA/600/8-86/008 '*Measurement of gaseous emission rates from land surfaces using an emission isolation flux chamber, - Users Guide'*. The OER is presented in the units' ou.m^3/s as referenced in the AS/NZS 4323.3.

5.1.3 Odour Measurement Accuracy

The repeatability and odour measurement accuracy of the Odormat™ is determined by its deviation from statistically reference values specified in AS/NZS 4323.3. This includes calculation of instrumental repeatability (r), where r must be less than 0.477 to comply with the standard criterion for repeatability. Its accuracy (A) is also tested against the 95th percentile confidence interval, where A must be less than 0.217 to comply with the accuracy criterion as mentioned in the Standard. The Odormat™ V04 complied with all requirements set out in the AS/NZS 4323.3 (see **Appendix B** – Result sheets: *Repeatability and Accuracy*). The calibration gas used was 51.4 parts per million (**ppm**), by volume, n-butanol in nitrogen gas (**N_2**).

6 ODOUR TESTING RESULTS

This chapter is dedicated to addressing the following audit requirement as outlined in **Section 1.2**, namely:

e. Measure all key odour sources on-site including:

i. consideration of wet weather conditions providing all raw data used in this analysis;
ii. consideration of (but not limited to) all liquid storage area, active tipping faces, waste cover area, aged waste areas and recirculation of leachate onto waste in the Void;
iii. a comparison of the results of these measurements against the predictions in the EA.

All key odour sources at the Site were measured in the Audit, with the results presented in several tables, as follows:

- **Table 6.1** summarises the odour emission results obtained from the Audit and compares the results against the EA 2010 predictions. As there are no EA 2010 predictions for the ED3S Pond System, the results are compared with the emissions data used in the odour modelling study titled *Proposed Addition of ED3S to Leachate Management System* and dated 30 May 2016 (**the LMS May 2016 Report**) as well as the results obtained for the ED3N Pond System in the Audit;

- **Table 6.2** summaries the global mean SOER results derived in the Audit and compares these results to those derived in the previous IOAs conducted between 2012 and 2017;

- **Table 6.3** summarises the MBT Facility biofilter system results;

- **Table 6.4** summarises the MBT Facility Maturation Storage Pad Area results; and

- **Table 6.5** summarises the liquid odour measurement results.

In **Section 8.5**, **Table 8.4** summarises the odour emission rates from emission sources amenable to quantitative measurements. These sources have been ranked in descending order. The results in **Table 8.4** do not include potential gas pathways and other fugitive emission sources from the waste surface, due to the difficulty in assigning an appropriate emission area for these sources to calculate an OER derived from the SOER and the area. This was a similar constraint in the previous IOAs.

Table 6.1 - The Audit odour emission testings results obtained between 17 February 2020 and 20 February 2020 compared with that adopted in EA 2010						
Source	**The Audit**				**EA**	
Sample Location	**TOU Sample Number**	**Odour Concentration (ou)**	**SOER ($ou.m^3/m^2.s$)**	**Odour Character**	**SOER Range ($ou.m^3/m^2.s$)**	**SOER Model Input ($ou.m^3/m^2.s$)**
Bioreactor (The Void)						
Active Tipping Area						
Active tipping face (less than one day old)	BC20080	5,790	3.4	vegetation	1.0 – 7.3*	7.3 (wet fresh waste emission adopted)
	BC20081	9,740	5.6	earthy, vegetation, undergrowth		
	BC20082	11,600	6.7	vegetation, leafy		
Aged Waste	n/m**				0.5	
Waste Covered Area (Virgin Excavated Natural Material (VENM) Cover)						
Waste Covered Area: 150 mm	BC20083	664	0.4	musty, rotten sweet	0.1 - 0.2* (covered) 7.5 – 23.9*** (fugitive emissions)	0.2 (covered) 23.9*** (fugitive emissions)
	BC20084	431	0.24	sweet fruit		
Waste Covered Area: 300 mm	BC20085	558	0.31	vomit, rancid		
	BC20086	430	0.22	dirty clothes		
	BC20087	362	0.19	rotten sweet fruit, vomit		
	BC20088	304	0.17	dirty clothes, wet shoes		

***** includes dry and wet covered waste
** unable to be sampled in the Audit due to access and safety concerns prevailing at the time
*** represents potential gas pathways
n/m = not measured

Table 6.1 (continued) - The Audit odour emission testings results obtained between 17 February 2020 and 20 February 2020 compared with that adopted in EA 2010						
Source	**The Audit**				**EA**	
Sample Location	**TOU Sample Number**	**Odour Concentration (ou)**	**SOER ($ou.m^3/m^2.s$)**	**Odour Character**	**SOER Range ($ou.m^3/m^2.s$)**	**SOER Model Input ($ou.m^3/m^2.s$)**
Bioreactor (The Void)						
Leachate Treatment Dam						
Leachate Treatment Dam (Aerated Zone)	BC20075	19,500	5.8	sewage, ammoniacal	0.1 - 7.4*	3.6
Leachate Treatment Dam (Anoxic Zone)	BC20074	8,930	12.6	sewage, ammoniacal		
Leachate recirculation system						
Leachate recirculation system	n/m				1.6 – 2.5	2.5
Landfill Gas Extraction System						
Landfill gas inlet	n/m				n/a	
Catchment Pond (leachate)^^						
Storage Pond 7	n/m				2.1 – 8.8	8.8
Catchment Pond (stormwater)^^						
Storage Pond 3 (Stormwater)	n/m				n/a	

* includes partially / fully treated leachate (dependent on the treatment stage of the process at the time samples were collected)
n/m = not measured
n/a = not applicable
^^ no longer in use

Table 6.1 (continued) - The Audit odour emission testings results obtained between 17 February 2020 and 20 February 2020 compared with that adopted in EA 2010						
Source	**The Audit**				**EA**	
Sample Location	**TOU Sample Number**	**Odour Concentration (ou)**	**SOER ($ou.m^3/m^2.s$)**	**Odour character**	**SOER Range ($ou.m^3/m^2.s$)**	**SOER Model Input ($ou.m^3/m^2.s$)**
Evaporation Dams						
ED3N Pond System						
ED3N-1	Empty at the time of the Audit				2.1 – 8.8	8.8
ED3N-2	BC20062	140	0.083	oily, nutty, roast pan scrapings	0.1 – 7.4	0.2*
	BC20063	139	0.082	oily, nutty, roast pan scrapings		
	BC20064	166	0.099	cooking oil, roast pan scrapings		
ED3N-3	BC20059	108	0.063	oily, gravel		
	BC20060	76	0.045	nutty, bitumen		
	BC20061	128	0.075	nutty		
ED3N-4	BC20068	128	0.083	earthy	0.1 – 0.7	0.7**
	BC20069	128	0.083	earthy		
	BC20070	139	0.090	fatty		
ED3S-S Pond System						
ED3S-S	BC20071	664	0.42	fatty	0.159***	
	BC20072	1,024	0.65	sewage, septic		
	BC20073	1,024	0.60	sewage		
ED3S Pond System						
ED3S	BC20057	181	0.11	rubber tyres	0.0 - 0.5	0.5
	BC20058	140	0.082	rubber tyres		

* partially / fully treated leachate
** includes groundwater and fully treated leachate
*** Not obtained from the EA. Source of emission data is the LMS May 2016 Report: Table 2.1
n/a = not applicable
n/m = not measured

Table 6.2 – Global mean SOER results: Comparison between the Audit and previous IOAs

Source	The Audit	2018 IOA	2017 IOA	2016 IOA	2015 IOA	2014 IOA	2013 IOA	2012 IOA
Location		TOU SOER ($ou.m^3/m^2.s$)						
ED3N-1	n/a (empty)	0.356	0.132	0.130	0.132	0.017	0.30	394
ED3N-2 & 3^	0.0745	0.102	0.129	0.175	0.118	0.049	11.6 ^^^^	0.29
ED3N-2	0.0881	0.169	0.120	0.148	0.145	0.066	20.1 ^^^	0.21
ED3N-3	0.0609	0.035	0.139	0.20	0.091	0.032	0.2	0.37
ED3N-4	0.0856	0.095	0.163	0.248	0.269	0.023	0.0604	0.41
Active Tipping Face	5.26	7.59	9.52	8.16	7.51^^^^^	4.28	3.04	8.36
Leachate Treatment Dam	9.19	0.186	0.243	0.27	0.276	0.026	0.323	0.46
Construction and Demolition Tip Face	n/a	n/a	n/a	n/m	0.326	n/a	0.293	n/a
ED3S	0.094	0.058	0.116	0.277	No previous measurements available as ED3S, ED3S-S, and Stormwater Pond 3 are new sources			
ED3S-S	0.554	0.13	1.97	0.437				
Stormwater Pond 3	n/a	n/a	n/a	n/a				
Storage Pond 7	n/a	n/a	n/a	n/a	n/m^^	n/a#		85

^ as specified in the EA 2010
^^ no longer exists
^^^ represents the sub-optimal pond contents that have now been treated (see **IOA 2013 Report** for details)
^^^^ bulk of emissions originating from ED3N-2 (see **IOA 2013 Report** for details)
^^^^^ includes testing results reflecting sampled areas with the polymer slurry applied
# There was no designated area for this location (see **IOA 2014 Report** for details)
n/a = not applicable
n/m = not measured

Table 6.3 – MBT Facility: Biofilter System Results

Sample Location		TOU Sample Number	Odour Concentration (ou)	Odour Emission Rate ($ou.m^3/s$)	Odour character	Inlet Airflow (m^3/hr, actual)
MBT Biofilter 1						
MBT Biofilter 1	Cell 1 Composite (Closet to fan)	BC20089	395	1,630	earthy	--
	Cell 2 (Middle)	BC20090	470	1,940	earthy, soil	
	Cell 3 Composite (Furthest from fan)	BC20091	4,470	18,400	silage, wet cereal	
	Common Inlet	BC20092	6,890	85,300	bin juice, compost, vegetation	53,100
MBT Biofilter 2						
MBT Biofilter 2	Western Cell Outlet Composite (Closet to inlet)	BC20097	2,900	25,600	nutty, compost	--
	Western Cell Outlet Composite (Furthest from inlet)	BC20098	5,790	51,200	nutty, compost	
	Eastern Cell Outlet Composite (Furthest from inlet)	BC20099	5,310	46,900	nutty, compost	
	Eastern Cell Outlet Composite (Closet to inlet)	BC20100	2,660	23,500	nutty, compost, soil, pickles	
	Common Inlet	BC20101	5,310	188,000	nutty, compost, soil	152,000

Table 6.4 – MBT Facility: Maturation Storage Pad Area Results

Sample Location		TOU Sample Number	Odour Concentration (ou)	Specific Odour Emission Rate ($ou.m^3/m^2.s$)	Odour character
MBT Maturation Storage Area					
MBT Maturation Pad	Unscreened 4 - 6 months	BC20076	5,790	2.8	cooked, burnt fat, rancid
	Screened 3 months	BC20077	861	0.391	light leafy, herbaceous, earthy, soil
	Screened 1 month	BC20078	11,600	5.82	pickles, vinegar, sour
	Screened 2 months	BC20079	2,440	1.19	roasted fat, woolstore

Table 6.5 – LOM derived odour emission rates for mechanical and natural evaporation methods: As collected on 20 February 2020^^^^

Sample Location	TOU Sample Number	Odour Concentration (ou)	Calculated Liquid Odour Potential (ou/mL)	Mechanical Evaporation Rate (L/min) per evaporator^ η = 20% / 30%	Mechanical Evaporation Mean Odour Emission Rate (ou.m³/s) per evaporator η = 20% / 30%	Mechanical Evaporation Mean Odour Emission Rate (ou.m³/s) ALL evaporators^^^ η = 20% / 30%
Evaporation method: Mechanical						
ED3N-2	SC20199	91	5.51	70 / 105	System A is not used for ED3N-1, ED3N-2 and ED3N-3, see **Section 2.4.2.1.1**. The OER for the surface spray evaporators has not been quantified in the Audit, as their contribution are considered negligible in the context of other on-site emission sources.	
	SC20200	118	7.14			
	SC20201	99	5.99			
ED3N-3	SC20196	166	10			
	SC20197	118	7.14			
	SC20198	108	6.54			
ED3N-4	SC20202	64	3.87		3,940 / 5,900	19,700 / 29,500
	SC20203	49	2.97			
	SC20204	54	3.27			
Evaporation method: Natural						
Sample Location	**TOU Sample Number**	**Odour Concentration (ou)**	**Calculated Liquid Odour Potential (ou/mL)**	**Current Surface Area (m^2)**	**Natural Evaporation rate (mm/month) ^^**	**Natural Evaporation – Mean Odour Emission Rate (ou.m³/s)**
ED3S-S	SC20222	470	28.5	19,100	92.67	9,400
	SC20223	181	11			
	SC20224	39	2.36			
ED1 Coffer Dam	SC20205	45	2.72	140,000		13,400
LTP Effluent	SC20225	56	3.39	--		--
ED3N-2	SC20199	91	5.51	8,060		1,770
	SC20200	118	7.14			
	SC20201	99	5.99			
ED3N-3	SC20196	166	10	6,220		1,730
	SC20197	118	7.14			
	SC20198	108	6.54			
ED3N-4	SC20202	64	3.87	40,200		4,780
	SC20203	49	2.97			
	SC20204	54	3.27			

^ Mechanical evaporation rate is based on 20% / 30% evaporation efficiency per evaporator.
^^ The natural evaporation rate is based on the mean evaporation rate recorded between May 2007 to June 2012, see **Appendix C**.
^^^ Based on five active and identical evaporators as is the current mode of operation.
^^^^Surface spray & ring main evaporation systems not included in calculation.

6.1 COMMENTS ON RESULTS

The following sections comment on the results presented in **Table 6.1**, **Table 6.2**, **Table 6.3**, **Table 6.4** and **Table 6.5**. Please note that a discussion relating to the

6.1.1 The Void Samples

The following comments are made based on the Void samples collected in the Audit:

- The sampling locations inside the Void have been nominally shown in **Figure 6.1**. The sample numbers presented in **Figure 6.1** correspond with those in the sampling location column in **Table 6.1**. The conditions prevailing in the Void at the time of the Audit is presented in **Photo 6.1**;

- As presented in **Table 6.2**, the mean SOER results for the Active Tipping Area (BC20080 – BC20082) in the Audit is 5.2 ou.m^3/m^2.s, representing a moderate decrease since the previous 2018 IOA (7.6 ou.m^3/m^2.s). The odour character of the active tipping face samples collected in the Audit reported as 'vegetation, earthy, undergrowth, leafy', representing a similar finding from previous IOAs. Based on previous IOA results for this source, this variation is considered to reflect normal variation from the active tipping face activity inside the Void; and

- The Waste Covered Area samples (BC20083 – BC20088) were collected from covered areas within the Void, including 150 mm and 300 mm VENM cover, at strategic locations designed to quantify the general emissions emanating from the Void. The SOER results are low and suggest fugitive emission release and cover condition at the sampled locations is effective.

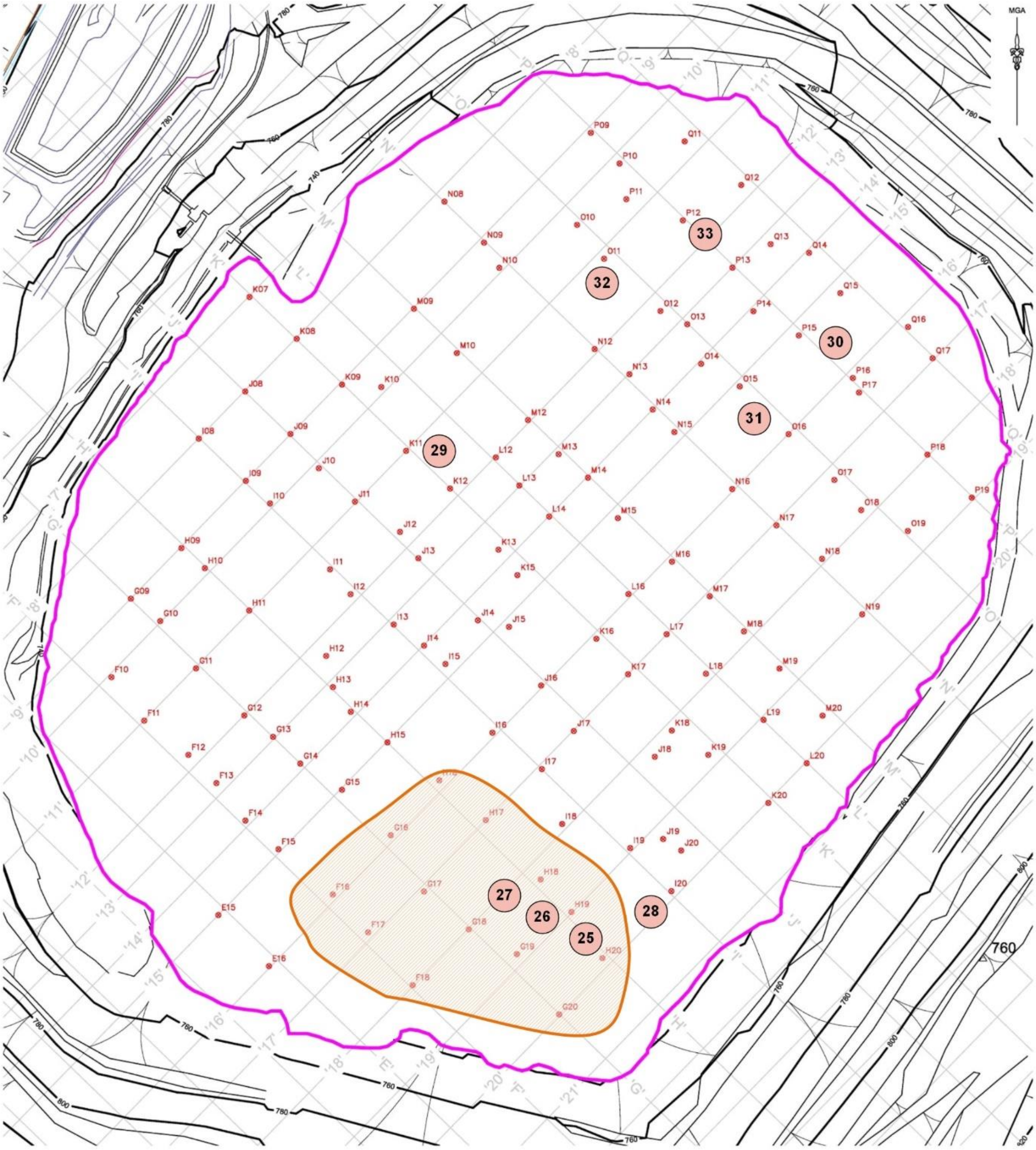


Image reproduced from the Woodlawn Bioreactor Landfill Monitoring Bore Locations (**Drawing 16700-241**) which was supplied by Veolia

Legend

Sample location and number

Active tipping face as found during the Audt

Figure 6.1 - Nominal sampling locations within the Void: 19 February 2020

Photo 6.1 – Conditions prevailing in the Void during the Audit on 18 February 2020

6.1.2 Pond Source Samples – ED3N Pond System

The following comments are made based on the ED3N Pond System samples collected in the Audit:

- ED3N-1 was empty, and therefore no samples were collected;
- All samples from the ED3N system were collected from the bank of the dams. The nominal sampling locations are shown in **Figure 6.2**; and
- All samples collected and tested from the ED3N Pond system (i.e. BC20059 – BC20064 & BC20068 – BC20070) were found to be below the EA 2010 SOER model inputs for each dam. The very low SOER values for all ponds (0.0632 – 0.0989 ou.m^3/m^2.s) are consistent with the previous IOA results. These consistent results indicate that the leachate treatment quality continues to be optimum and that the LMS at the Site is performing very well from an odour emissions viewpoint.

6.1.3 Pond Source Samples – ED3S Pond System

The following comments are made based on the ED3S Pond System samples collected in the Audit:

- The SOER results for ED3S were found to below the EA 2010 SOER model input of 0.5 ou.m^3/m^2.s, with the mean results (i.e. 0.058 ou.m^3/m^2.s) below this value. This is a good result; and
- The above result is consistent with a pond system storing stormwater.

6.1.4 Pond Source Samples – ED3S-S Pond System

The following comments are made based on the ED3S-S Pond System samples collected in the Audit:

- The SOER results for ED3S-S were found to be low and relatively consistent with results obtained from ED3N. This indicates that the treated leachate quality flowing to ED3S-S is of a quality that is conducive with low odour; and
- The SOER input from the LMS May 2016 Report used a SOER of 0.159 ou.m^3/m^2.s for the modelling of ED3S-S. The mean result derived from the Audit is 0.554 ou/m^3/m^2.s (see **Table 6.2**). This result is above the modelled value; however, as will be demonstrated in **Section 9.5**, this is unlikely to cause any adverse impact beyond the boundary of the Site.

Figure 6.2 – Pond sources nominal liquid & gas sampling locations: 17 & 18 February 2020

6.1.5 Leachate Treatment Dam Samples

The following comments are made based on the LTD samples collected in the Audit:

- The LTD was found to be operating under normal operating conditions at the time of the Audit. There are clearly now two treatment zones in the LTD, including an anoxic zone and an aerobic zone. Both zones were sampled as part of the Audit;

- The SOER results suggest that the LTD is not a significant odour emission source. This implies that the LTD was operating in optimum conditions at the time of the Audit from an odour viewpoint;

- The mean SOER result derived in the Audit for the LTD is 9.2 ou.m^3/m^2.s. This value is well above the EA 2010 SOER value of 3.6 ou.m^3/m^2.s for the LTD and is inconsistent with previous IOA results. The reason for this was immediately clear to the Audit as will be described below; and

- A single surface aerator was in active operation at the time of the Audit, with one of the aerators malfunctioning and sinking. This very likely explains the higher than normal SOER performance result from the LTD. The Site advised that, at the time of writing, the surface aerator was subsequently repaired and normal operational capacity has been restored in the LTD. **Photo 6.2** shows the LTD as found during the Audit.

Photo 6.2 – The LTD on 18 February 2020 (highlighted area indicates location of aerator malfunction)

6.1.6 Landfill Gas Samples

The following comments are made based on the landfill gas samples collected in the Audit:

- The Audit determined that it was not necessary to collect an inlet landfill gas sample to the Void based on the testing carried out during the 2019 Emissions Testing Report (see **Appendix C**).

6.1.7 Liquid Odour Measurement Samples

The following comments are made based on the liquid samples collected in the Audit:

- The liquid odour measurement results represent the odour that would be released if the sample were evaporated, either by natural or mechanical means. For this Audit the mechanical and natural evaporation has been used in calculations;

- The natural evaporation rate shown is based on the mean rate at the Site between May 2007 to June 2012;

- An extensive number of liquid samples were collected from ED3N-2, ED3N-3, ED3N-4, ED3S-S and ED1 coffer dam in the Audit. As such, the dataset obtained in the Audit provides a good level of confidence in relation to the leachate quality and odour potential when evaporated;

- The natural evaporation mean OER for ED3N-2, ED3N-3 and ED3N-4 were relatively similar, supporting the SOER data in **Table 6.1** which infers that the quality of effluent stored is consistent across these three dams;

- All collected liquid samples analysed via the LOM method were found to be low in odour, with only a 'musty' odour recorded. A 'musty, muddy water' odour is typically a reliable indicator of optimum pond health and minimal odour release conditions from a treated leachate dam, even at high OERs (i.e. the odour emission is of a treated quality odour). As such, despite the apparent high OERs as shown in **Table 6.5**, the quality of treated leachate in ED3N and ED3S-S continue to pose a minimal odour risk at the Site;

- The liquid sample results are consistent with previous IOAs and very unlikely to be problematical with respect to off-site impacts. This outcome is consistent with the results from the collected gas samples from the area source sampling (see **Section 6.1.2**). The implication of this result is discussed in **Section 8.2.1.4;** and

- The liquid sample of the LTP effluent indicated a similar result to the storage dam samples, suggesting that it is of treated quality. This was also consistent with the result obtained for the ED1 coffer dam, validating that the LTP was performing in an optimum condition at the time of the Audit, despite being in the process-proving phase.

6.1.8 MBT Facility

The following comments are made based on the MBT Facility samples collected in the Audit:

- The results for Samples BC20101 and BC20098 in **Table 6.3** represent virtually the same value (i.e. 5,790 ou versus 5,310 ou), and the difference is statistically insignificant for olfactometry laboratory analysis; and

- The biofilter outlet results indicate that at the time of sampling the biofilter bed moisture was low and requires optimisation. This applies to both Biofilter 1 and Biofilter 2 at the MBT Facility. The effect of this operating circumstances has meant that the biofilter outlet emissions are higher than desirable.

7 FIELD AMBIENT ODOUR ASSESSMENT SURVEY

A series of FAOA surveys were conducted as part of the Audit. It is understood that the completion of these FAOA surveys was required at specific times over the course of the Audit, as requested by NSW EPA. Specifically, the FAOA surveys were required to be undertaken during the following time periods:

- Before 0730 hrs;
- Midday; and
- After 2100 hrs.

The FAOA were conducted over the period between 17 February 2020 and 20 February 2020. All surveys were carried out by two calibrated and experienced TOU field assessors. The following section summarises the methodology and results from the FAOA surveys conducted as part of the Audit. The FAOA survey logsheets are provided in **Appendix E**.

7.1 FAOA SURVEY SCHEDULE

The FAOA survey schedule undertaken for the Audit is summarised in **Table 7.1.**

Table 7.1 – FAOA survey schedule: 17 February 2020 - 20 February 2020

FAOA Survey Session No.	Survey Date	Survey Time
1	17 February 2020	Evening, 2140 hrs – 2240 hrs
2	18 February 2020	Morning, 0630 hrs – 0730 hrs
3	20 February 2020	Midday, 1220 hrs – 1320 hrs

7.2 PREAMBLE

At present, no Australian Standard exists for FAOA surveys. Consequently, TOU utilises a method for assessing the ground-level impacts of odour emissions using a modified version of the German Standard VDI 3940 (1993) – '*Determination of Odorants in Ambient Air by Field Inspections*'. This standard prescribes the methods by which field technicians (or assessors) determine, define and document observed ground level odours and the manner in which the determination of these odours is defined in relation to odour character, the frequency of odours observed and the odour intensity of those individual observations as a quantitative scale of measure.

FAOA surveys are considered a valuable odour impact assessment tool as previous experience with ambient odour sampling and subsequent olfactometry testing suggests that accurate and useful ambient odour concentration data is difficult to obtain. Therefore, TOU has adopted a more practical approach based on the field measurement of odour intensity. With this method, calibrated and experienced odour assessor/s traverse the general area and downwind surrounds of odour sources in a strategically mapped pattern, assessing the presence, character and intensity of any odours encountered and recording these observations along with wind speed and direction (when applicable). For the FAOA surveys conducted at the Site, all accessible downwind areas were assessed. The assessed areas were based on the wind conditions prevailing at the time of the FAOA Survey.

7.3 FAOA SURVEY MEASUREMENTS METHODOLOGY

The techniques employed in the FAOA surveys conducted during the Audit were able to quantify and/or qualify the following:

- Odour intensity:
- Odour character;
- Frequency;
- Extent of odour plume; and
- Likely source of odours detected near and far-field from the Site.

For the surveys undertaken at the Site, each TOU assessor spent five- to ten-minutes at each Measurement Location Point (**MLP**) in order to gauge the effects of any odour impact. Each measurement cycle comprised of 30 individual 'grab' assessments of odour, one every ten seconds for a single measurement cycle of five minutes. When plotted each grab measurement resulted in a single data point.

Overall, each survey utilised two assessors, with each assessor undertaking measurements over the assessment area at different MLPs over the duration of each survey session. The derived results of the surveys were then illustrated visually on odour impact maps.

At each MLP, wind velocity and direction was checked using a vane anemometer. In the event of a positive detection of odour at an MLP, the TOU assessor attempted to evaluate the odour intensity, odour character and likely source (whenever possible). In this way, the FAOA method enables the determination and extent of the impact of odour around the area of interest, rank their intensity and likely source.

7.3.1 Odour Intensity Categories

The ranking scale for the observed off-site odours detected beyond the facility boundary was quantified according to the *German Standard VDI 3940 'Determination of Odorants in Ambient Air by Field Inspections'.* The standard's ranking system is based on the following 7-point intensity scale as shown in **Table 7.2**.

The MLP assigned an odour intensity score of '0' (not detectable) were still be recorded in order to outline the presence and extent of the odour present at the MLP. The 'distinct' level is that at which the odour character (e.g. landfill gas, garbage) is clearly definable.

Table 7.2 - VDI 3882 (Part 1) odour intensity categories		
Odour Strength	**Intensity Rank (code)**	**TOU Interpretation (meaning)**
Not detectable	0	No odour detected
Very Weak	1	Odour recognised and where possible assigned to the odour source
Weak	2	Odour is weak but not yet distinct
Distinct	3	Odour is clearly distinct
Strong	4	Strong odour detectable
Very Strong	5	Very strong odour detectable
Extremely Strong	6	Extremely strong odour detectable

7.3.2 Odour intensity and frequency criterion.

Although outside the scope of work for the Audit, and referring to the Odour Intensity Categories listed and described in **Table 7.2** above, a particular odour intensity level can often be linked to a possible odour impact from an assessed facility. This criterion, whether it is Category 2 (Weak) or Category 3 (Distinct), will be dependent upon the sensitivity of the receptor areas, the nature/offensiveness of the odours present, and the frequency of exposure. Odour Intensity Category 1 (very weak) would rarely, if ever, correspond to adverse odour impacts.

As previously mentioned in **Section 7.3**, the FAOA surveys conducted downwind of the Site resulting in two assessors generating 30 sniffs per measurement cycle per MLP. From this, the data was benchmarked against a suitable frequency impact criterion of 10%, i.e. a positive detection of an odour is measured for more than or equal to 10% of the time (equivalent to 3 sniffs over 5 minutes) during the measurement cycle at an odour intensity of 1 or greater. This criterion was selected based on previous FAOA studies conducted by TOU and considered to be the event in which adverse odour impact is likely.

7.3.3 FAOA Key Odour Descriptors

The odour sources at the Site have their origins from the processes occurring in each key area such as the Void, LMS and MBT Facility. Based on TOU's extensive experience at the Site, key odour descriptors were allocated and subsequently standardised to represent the quality of odours detected within the assessed area (as shown in **Figure 7.1**. The odour descriptors used in the surveys enabled for the characterisation of the detected odour/s and determination of likely source, by strategically undertaking the surveys upwind, downwind and closer to the Site boundary, when required.

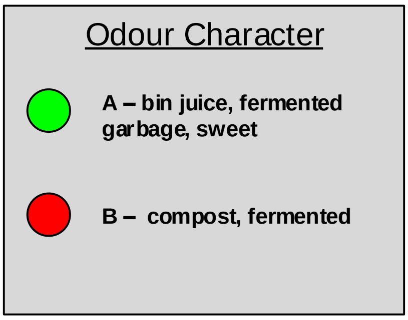


Figure 7.1 - Key odour characters/descriptors used for the FAOA assessment

The definition for each odour character/descriptor used in the FAOA surveys are as follows:

- **A – bin juice, fermented garbage, sweet**: based on the observations and findings made in the Audit, the likely source for this odour descriptor is the Void, specifically fugitive gas emissions;

- **B – compost, fermented**: based on the observations and findings made in the Audit, the likely source for this odour descriptor is the MBT Facility, specifically the untreated emission discharge to atmosphere from the biofilter system at the MBT Facility.

7.3.4 Survey Meteorological Conditions

Ideally, FAOA surveys should be carried out over a range of meteorological conditions, from near-calm to moderate to strong wind speeds, and under differing wind directions. The result of each FAOA survey would then determine the impact range within that assessment area for that survey, and the overall findings representing a broader picture of possible adverse odour impacts. For the FAOA Surveys conducted as part of the Audit, the focus was on the times of the day when calm to light winds are prevalent, i.e. early mornings and late evenings and cooler temperatures. These meteorological conditions are suspected to be the most problematical, based on logged odour complaints.

The general prevailing local wind conditions at the time of conducting the FAOA surveys were broadly calm to light wind speeds with westerly, north-westerly, east-north easterly, and easterly wind directions encountered. There was some rainfall encountered infrequently during the day, prior to the surveys being conducted.

7.3.5 Recording of Meteorological Conditions

Local meteorological conditions prevailing over the duration of the FAOA surveys were recorded using a Kestrel 4500 Pocket Weather Tracker Anemometer (see **Photo 7.1** for an illustrated setup). At each MLP assessed, the assessors would set up the anemometer apparatus enabling for a grab measurement of wind speed and direction at an MLP. This was undertaken during every survey at each MLP.

Photo 7.1 - Illustrated setup of the Kestrel Anemometer apparatus in operation (**Source**: The Odour Unit Pty Ltd)

7.3.6 Interpretation of Survey Findings

Each map plot result consists of several features. These are generally depicted on a pie chart and wind vane indicator on each map plot. The features include:

- **A measurement location point (MLP)**: these are strategic points on the map were designed to enable assessors to pursue upwind and downwind effects from the Site;

- **Location wind conditions**: the local wind direction and speed at each MLP has been indicated by a yellow arrow. In the event a wind direction has not been indicated, the conditions at the time were calm (i.e. < 0.5 m/s) and wind direction was unable to be accurately determined. The recorded wind conditions at each MLP may have varied at the time of the assessment from the prevailing wind conditions that existed in the general Tarago precinct recorded by local meteorological stations. Given the complex meteorological dynamics that can occur arising (such as local terrain, topography, katabatic channelling and effects from natural and built environments) affecting wind direction and speed, the local wind conditions experienced at some MLP varied from the prevailing wind condition; and

- **Odour descriptors:** at each MLP where a measurement cycle is undertaken, key parameters are recorded where an odour is detected. The key descriptors shown on the maps include the intensity of odour (how strong the smell is) based on the VDI 3882 German Odour Intensity Scale. In addition, the odour character is also recorded based on an odour character inventory developed by TOU to describe the range of odours encountered throughout the course of the surveys.

7.4 FAOA SURVEY RESULTS

The FAOA survey results are presented on odour impact map plots, as follows:

- **FAOA Survey Map Plot 1** – Session 1 (Evening): 17 February 2020 between 2140 hrs and 2240 hrs;
- **FAOA Survey Map Plot 2** – Session 2 (Morning): 18 February 2020 between 0630 hrs and 0730 hrs; and
- **FAOA Survey Map Plot 3** – Session 3 (Midday): 20 February 2020 between 1220 hrs and 1320 hrs.

7.4.1 Commentary on FAOA Results

Based on the FAOA survey map plot results, the following comments are made:

- **FAOA Survey Map Plot 1:** A 'bin juice, fermented garbage, sweet' odour was intermittently detectable at MLPs 4, 5 and 6 at an odour intensity of very weak (1) to distinct (3). The likely source was determined to be the Site, specifically the Void;
- **FAOA Survey Map Plot 2**: A 'bin juice, fermented garbage, sweet' odour was intermittently detectable at MLPs 3, 5 and 6 at an odour intensity of very weak (1) to distinct (3). The likely source was determined to be the Site, specifically the Void;
- **FAOA Survey Map Plot 3**: A 'bin juice, fermented garbage, sweet' odour was intermittently detectable at MLPs 5, 6, 7 and 8 at an odour intensity of very weak (1) to distinct (3). The likely sources were determined to be the Site, specifically the Void and MBT Facility;
- The FAOA survey findings are broadly consistent with the odour modelling predictions documented in **Section 9**. In view of the FAOA surveys and modelling plots (see **Section 9.5**), it is unlikely that the operating conditions as found during the Audit had the potential to adversely impact the nearest sensitive receptor to the Void and the Tarago Community; and
- No pond related sources including ED3N Pond System, ED3S-S Pond System, LTD, LTP and were detectable over the course of the FAOA surveys conducted in the Audit. This supports the derived odour emissions results found in the Audit, which show that all pond sources at the Site are very unlikely to lead to off-site impacts under the current treatment and storage conditions;

Overall, odour that can be traced back to the Site were detectable downwind at moderate distances during the FAOA Surveys conducted in the Audit. The major odour that was intermittently detectable was garbage-based at odour intensities that varied between very weak (1) and distinct (3). Based on the derived odour measurements, extensive experienced gained by the Audit team of the Site, and at other landfill operations, this odour is likely related to two sources at the Site, including:

- Fugitive gas emissions from the Void; and
- The untreated emission discharge to atmosphere from the biofilter system at the MBT Facility.

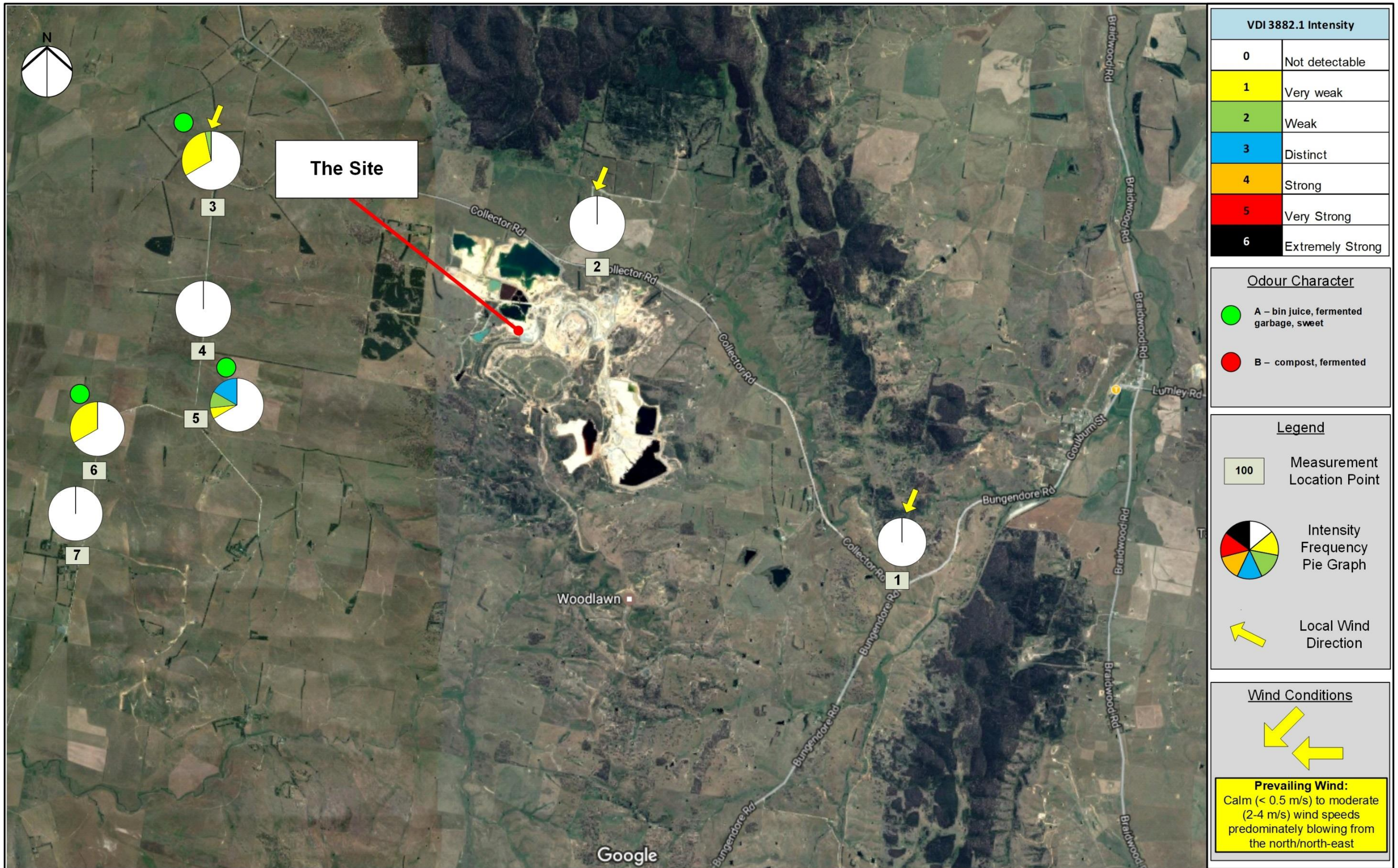
As discussed in **Section 8.2.1.2**, the fugitive landfill gas emissions from the Vid are judged to be the major contributor to the risk of odour emission release from the Void, supporting Veolia continued strategies as documented in the WIP 2020 (see **Section 10.2.1**). The operating condition of the biofilter systems at the MBT Facility as found during the Audit is considered to be a matter that can be readily managed via optimisation of existing infrastructure designed to maintain adequate biofilter bed moisture for sustainable and effective treatment performance (see **Section 10.3.3**).

THE ODOUR UNIT

Veolia Woodlawn – Odour Audit #8
Field Ambient Odour Assessment
Survey Session #1 - Evening
Odour Impact Map

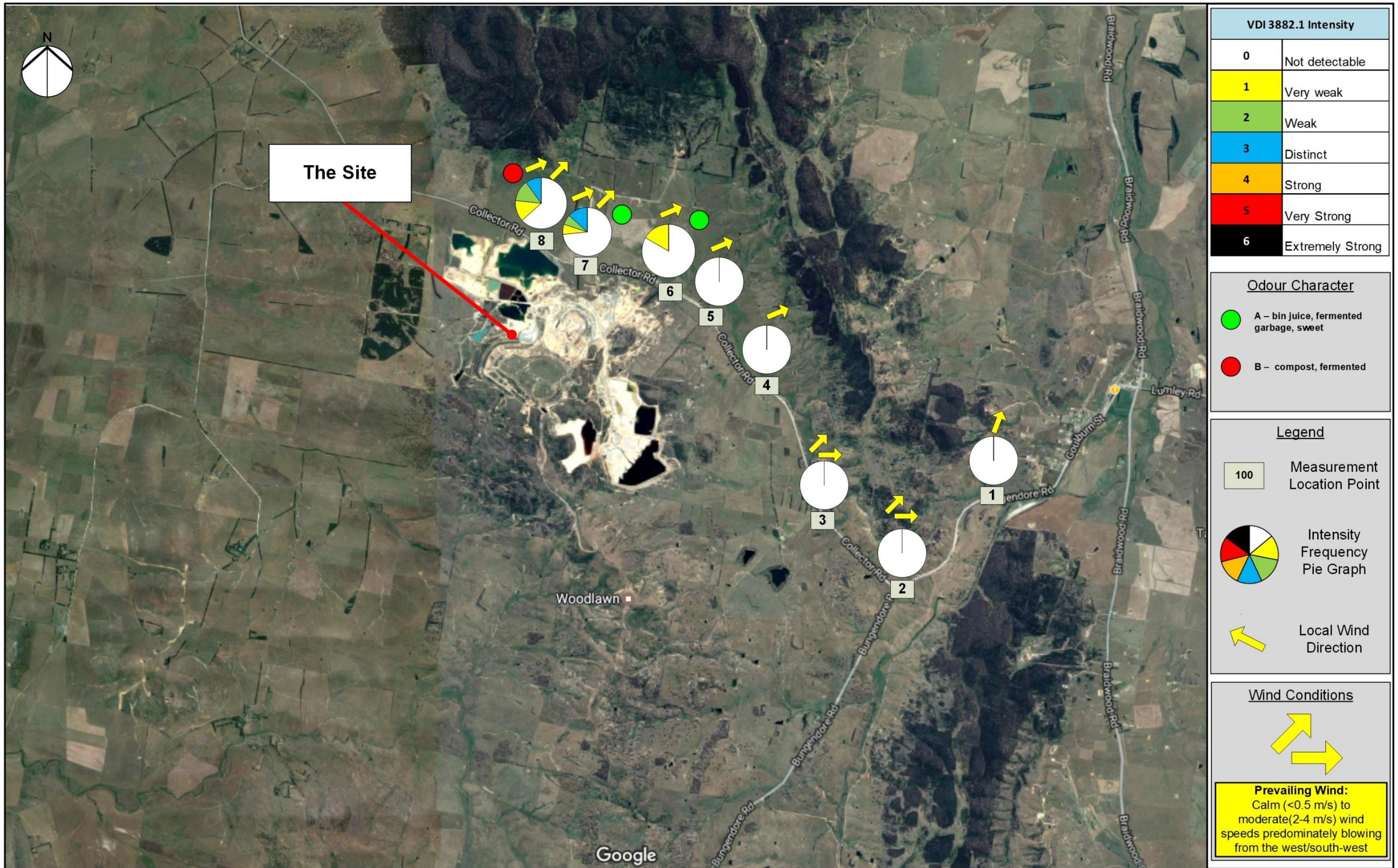
Field Ambient Odour Assessment Survey
Session Date: 17/02/2020 Session Time: 2140 hrs – 2240 hrs
Area: 1 Odour Impact Criterion: Intensity ≥ 1 Frequency ≥ 10%
Drawn By: S. Munro Revision: 1 Drawn Date: 22/07/2020

FAOA Survey Map Plot 1 – Session 1 (Evening): 17 February 2020 between 2140 hrs and 2240 hrs



THE ODOUR UNIT	Veolia Woodlawn – Odour Audit #8 Field Ambient Odour Assessment Survey Session #2 - Morning Odour Impact Map	**Field Ambient Odour Assessment Survey** Session Date: 18/02/2020 Session Time: 0630 hrs – 0730 hrs Area: 1 Odour Impact Criterion: Intensity ≥ 1 Frequency ≥ 10% Drawn By: S. Munro Revision: 1 Drawn Date: 22/07/2020

FAOA Survey Map Plot 2 – Session 2 (Morning): 18 February 2020 between 0630 hrs and 0730 hrs



THE ODOUR UNIT	Veolia Woodlawn – Odour Audit #8 Field Ambient Odour Assessment Survey Session #3 - Midday Odour Impact Map	**Field Ambient Odour Assessment Survey** Session Date: 20/02/2020 Session Time: 1220 hrs – 1320 hrs Area: 1 Odour Impact Criterion: Intensity ≥ 1 Frequency ≥ 10% Drawn By: S. Munro Revision: 1 Drawn Date: 22/07/2020

FAOA Survey Map Plot 3 – Session 3 (Midday): 20 February 2020 between 1220 hrs and 1320 hrs

8 AUDIT DISCUSSION

8.1 PREVIOUS AUDIT RECOMMENDATIONS

Table 8.1 & **Table 8.2** outline the mandatory and non-mandatory recommendations documented in the previous IOA, respectively, and Veolia's response to those recommendations since that time.

It is important to note that some of these recommendations are, and will continue to remain, an integral part of the on-going process operations and plans at the Site. The WIP 2020 is a comprehensive and technically focused document aimed at educating management, operators and relevant stakeholders on the operational philosophy, and continuous improvement and infrastructure development plans for the BWMS. These on-going process operations and plans are part of the WIP 2020 and include, but are not limited to:

- Planned infrastructure instalments within each waste lift.
- Landfill gas collection system including:
  - The design philosophy for the system of wells beneath the waste profile in the Void;
  - Well extensions; and
  - Horizontal infrastructure and condensate management.
- Continuous monitoring of leachate and gas extraction.
- Remediation actions in the event of equipment failure and process upset in the Void. It also documents the contingency measures in implemented to ensure the sustained operation of the Void in the event of equipment failure and process upset.
- The implementation of operational management programs, including:
  - Leachate management;
  - Pumps and pumping solutions; and
  - The expansion of wells in the Void to optimise and improve landfill gas extraction and minimise leachate generation.
- Specific management techniques for:
  - H_2S management;
  - Covering of waste;
  - The design, location and implementation of the biofiltration cover material along the perimeter of the Void, where required;

- Managing stormwater events as to minimise the generation of leachate; and
- Management of leachate eruptions, power failures.

- Details on current issues and long-term plan for the Site.

The above on-going process operations (and others) are comprehensively documented in previous Woodlawn Infrastructure Plan (**WIP**), with the latest details provided in the WIP 2020. The Audit notes that the WIP is a 'live' document that is constantly updated as the volume of waste into the Void increases over time.

Veolia made the full document of the WIP 2020 available for review in the Audit. As previously mentioned in **Section 1.3**, the relevant components of the WIP 2020 are incorporated into the Audit report, where required, as this is a commercial-in-confidence document.

8.1.1 Mandatory Recommendations

The mandatory recommendations from the previous IOA are summarised in **Table 8.1** and include Veolia's response since that time.

8.1.2 Non-Mandatory Recommendations

The non-mandatory recommendations from the previous IOA are summarised in **Table 8.2** and include Veolia's response since that time.

Table 8.1 – The 2018 IOA Mandatory Recommendations and Veolia's Response

No.	The 2018 IOA Mandatory Recommendations	Veolia's Response
1	<u>*Fugitive landfill gas emissions*</u> *Veolia should continue to improve landfill gas capture from the Bioreactor. This continuation is underway with Veolia completing its WIP 2019, which outlines a comprehensive plan that is being implemented to increase gas capture. It also seeks to address current areas of concern and the potential solution outcomes that can be implemented. This is an active (and effective) management approach that will result in a continual improvement in gas capture efficiency and ultimately reduce odour/landfill gas emissions from the Void. The Audit endorses this strategy as the primary measure to reduce odour emissions from the Void and recommends that Veolia continues the implementation of the gas systems detailed in the WIP 2019, including:* ▪ *the planned infrastructure instalments within each waste lift;* ▪ *the continuous improvement to leachate extraction, treatment performance, capacity and efficiency. This supported by the implementation of the long-term leachate solution in the form of the LTP that is the process-proving phase of operation;* ▪ *the continuous improvement in the waste tipping profile, covering and expansion and optimisation of the landfill gas infrastructure;* ▪ *the continuous monitoring of leachate and gas extraction;* ▪ *Remediation actions in the event of equipment failure and process upset in the Void;* ▪ *The implementation of operational management programs including:* ○ *Leachate management;* ○ *Pumps and pumping solutions; and* ○ *The expansion of wells in the Void for improved/minimisation of leachate recirculation and landfill gas extraction.*	The improvement in gas capture from within the Void is an on-going planning and operational exercise that Veolia will continue to be implemented. This is evident from the WIP 2020, an updated plan for the current and future operations at the Site. Similar to previous versions of the WIP, the WIP 2020 outlines the operational issues and plans to: ▪ improve and optimise leachate flow, treatment and recirculation; ▪ the process-proving of the long-term leachate strategy in the form of the LTP; ▪ improve gas capture through leachate management and infrastructure setup and configuration, ▪ reduce fugitive gas emission to minimise odour; ▪ optimise tipping strategy; and ▪ The connection of more wells/trenches. The WIP 2020 document is 'live' and designed around both a proactive and reactive approach in addressing infrastructure and operational issues. The WIP 2020 also has clear defined goals on targets with respect to gas performance and leachate management.

Table 7.1 continued – The 2018 IOA Mandatory Recommendations and Veolia's Response		
No.	**The 2018 IOA Mandatory Recommendations**	**Veolia's Response**
2	*Continue to adequately maintain and manage the upgraded LMS to ensure it is operating in an optimum state and meeting the leachate quality monitoring targets as outlined in the Leachate Treatment Operation Manual and recommended by Veolia Water. Moreover, continue the implementations planned in the WIP 2019. Both the manual and WIP 2019 should be considered as a 'live' document to reflect any variation in quality and operational demands and identifications of new constraints and/or issues. This should continue to attenuate the potential for significant odour generation from the leachate stored in ED3N & ED3S Pond Systems both now and in the future.* *The Audit finds that the LTP will provide additional leachate treatment capacity at the Site. It is also understood that treated leachate flowing to ED1 coffer dam from the LTP is of a very high quality. The inclusive of additional leachate treatment capacity will have a significant effect on the minimisation of odour from the Void and LMS. At the time of the Audit visit, ED1 coffer dam was empty. ED1 coffer dam will be included in the sampling and testing monitoring program in the next IOA*	It is clear from the on-site observations, odour emissions data collected during the Audit, and the WIP 2020 that Veolia continues to actively manage and improve the LMS. This is also evident in Veolia's implementation of long-term leachate management solution where an LTP is in the process proving phase of operation, resulting in high-quality effluent stored in ED1 coffer dam, which is supported by the LOM results (see **Section 6.1.7**).
3	*Veolia should continue to develop strategies for the minimising of the exposed active tipping face surface area. It should also proceed and continue with the details in the WIP 2019*	Based on the WIP 2020, disposed waste is covered daily and at intermediate stages of operation to minimise dust, litter, the presence of scavengers and vermin, fire risk, rainwater infiltration into the waste (and therefore the amount of leachate generated) and the emission of landfill gas at the Site. The active tipping face activities are regularly reviewed and configured to minimise the working surface area.

Table 8.2 - The 2018 IOA Non-mandatory recommendations

No.	The 2018 IOA Non-Mandatory Recommendations	Veolia's Response
1	<u>*Fugitive gas emissions*</u> *It is understood from the previous IOA that Veolia had engaged a university body to undertake a study on fugitive gas emissions/odour and its behaviour to further improve gas collection at the Site – the Audit was not made aware of the outcome from this study. If this study did not proceed, it is recommended that a landfill gas survey is undertaken to enhance understanding of the potential fugitive emission release from the Void. The landfill gas survey can include the isolation flux hood and the measurement of CH_4/H_2S as indicators of fugitive gas emission. If this is performed across a large area of the Void, it is possible that more accurate quantification of potential fugitive emission gas release can be obtained.*	There has been a significant improvement in landfill gas extraction in the Void (see **Section 8.2.1.2.1**) due to a number of factors including an expansion and improvement in the leachate management system through optimisation of surface water catchments, landfill gas infrastructure design, active tipping practices and increased leachate treatment capacity via the commissioning of the LTP. No further studies will be undertaken at this point in time, given Veolia's intent to invest in infrastructure and continued improvement of operational capability of the Void and LMS.
2	<u>*Refine investigation of odour issues in the community*</u> *From a qualitative viewpoint, the increase in odour complaint is unclear to the Audit given the significant improvement in landfill gas extraction in the Void and expansion and improvement in the leachate management system through optimisation of surface water catchments, landfill gas infrastructure design, active tipping practices and increased leachate treatment capacity via the commissioning of the LTP.* *Given this outcome, the Audit recommends that Veolia continue its active engagement with the community through its existing odour complaints and response management strategy. The handling and management of odour complaints will be reassessed in the next IOA to evaluate the need for additional forms of community engagement, given that the number of complaints remains historically low. As such, the refinement in community engagement remains as a non-mandatory recommendation in the Audit to ensure this matter is provided with the opportunity of continuous improvement. Specifically, Veolia should consider refining its investigation of odour issues in the community, particularly surrounding the most common complainants, as to assess the extent to which odour is present in the community. Such an investigation could include: potential odour transport pathways; undertaking of field odour surveys; assess the topography of surrounding land; analysis of climatic data; and a detailed review of odour complaint data.*	Odour complaints have increased since the previous IOA (see **Section 8.4.1**). From a qualitative viewpoint, this increase is unclear given the significant improvement in landfill gas extraction in the Void and expansion and improvement in the leachate management system through optimisation of surface water catchments, landfill gas infrastructure design, active tipping practices and increased leachate treatment capacity via the commissioning of the LTP. Given this outcome, the Audit recommends that Veolia continue its active engagement with the community through its existing odour complaints and response management strategy. The handling and management of odour complaints will be reassessed in the next IOA to evaluate the need for additional forms of community engagement, given that the number of complaints remain historically low (see **Section 8.4.1**).
3	<u>***IMF and Waste Transport Activities***</u> *Based on TOU observations, the Audit suggests that Veolia review the following aspects relating to the use of the IMF and waste transport activities to further improve its odour performance from minor and transient odour sources:* ▪ *The coverage of sprays at the wash bay and its ability to thoroughly clean a recently emptied truck. This will minimise transient levels of odour that may be detectable and associated with truck movement in the community;* ▪ *The washing practice associated with the sealed containers; and* ▪ *The maintenance of the sealed containers.*	Veolia has improved the coverage of the spray at the wash bay and its ability to thoroughly clean emptied trucks. Moreover, Veolia has a container management program implemented that seek to maintain the overall integrity, cleanliness and carbon filter pads.

8.2 DISCUSSION OF AUDIT FINDINGS

The following discussion examines the results of the Audit against each of the conditions of consent relating to the Woodlawn Waste Expansion Project.

8.2.1 Condition 7 (B & D)

Condition 7 (B & D) of the Audit requirements stipulate that the following will be carried out in the IOA:

- Audit the effectiveness of the odour controls on-site in regard to protecting receivers against offensive odour; and
- Review the relevant odour sections of the Air Quality and Greenhouse Gas Management Plan for the project and assess the effectiveness of odour control.

As mentioned in the previous IOAs and complemented by the Audit's on-site experience and discussions with Veolia personnel, there continues to be a range of current and on-going odour controls implemented at the Site designed to mitigate off-site impacts arising from its waste management operations. These revolve around:

1. The leachate recirculation method (see **Section 8.2.1.1**);
2. Optimisation and continuous treatment of excess leachate from the Void (see **Section 8.2.1.1**);
3. Improvement of landfill gas extraction from the Bioreactor (see **Section 8.2.1.2**);
4. Adequate combustion of landfill gas (see **Section 8.2.1.3**);
5. Improve evaporation capability (see **Section 8.2.1.4**);
6. The continued implementation of biofilter cover material, particularly in know high-risk areas such as the Void perimeter where shrinkage effects are pronounced (see **Section 8.2.1.5**);
7. Using the minimal active tipping face as practically possible (see **Section 8.2.1.6**);
8. Water cart to control dust (see **Section 8.2.1.7**);
9. Transportation of waste in sealed containers until unloading at the Bioreactor (see **Section 8.2.1.8**);
10. The minimisation of leachate generation during stormwater events through improved surface catchment management (see **Section 8.2.1.10**);
11. The effectiveness of the current odour control infrastructure at the MBT Facility (see **Section 8.2.1.11**); and

12. Quality of compost product stored in the Maturation Storage Pad Area (see **Section 8.2.1.12**).

8.2.1.1 Leachate Management Method

8.2.1.1.1 Operational status of leachate recirculation

To increase the landfill gas capture through the covered waste surfaces, leachate generated within the Bioreactor is removed when it becomes excess to the field capacity or interferes with gas extraction infrastructure. Any excess leachate that is extracted from the Void flows directly to the LTD for primary leachate treatment (see **Section 2.4** for further details).

The leachate recirculation method currently practised within the Void continues to be via direct injection techniques when required (see **Section 2.3.2**). As explained in previous IOAs, this has the effect of minimising the potential exposure of leachate partitioning from the liquid phase to the gas phase, through aerosol generation and/or evaporation pathways, and subsequently leading to the generation of odorous emissions. The 2012 IOA indicated that Veolia's adoption of this recirculation technique is more effective at minimising odours than previously utilised techniques (such as spray sprinklers). The previous 2013 IOA concurred with this finding.

As previously mentioned in **Section 2.3.2** and based on the WIP 2020, the leachate recirculation has been stopped due to leachate problems and the restriction of the landfill gas extraction caused by the leachate. As such, there is only one reinjection infrastructure being kept as a contingency leachate management method when the leachate transfer system experiences any failure. The re-injection point is currently located in the eastern wall of the void, with a 110 mm high-density polyethylene pipe placed into the waste during the previous two lifts. The re-injection point is connected to the ring main and normally in the close position. In the circumstance of leachate transfer system failure, e.g. pump failure or pipe damage, the valve between the re-injection point and the ring main will be opened to allow the extracted leachate to be re-injected to the waste.

8.2.1.1.2 Optimisation and continuous treatment of excess leachate from the Void

<u>The LTD</u>

The Audit understands that there is no longer a need to store untreated leachate in the evaporation dams following the upgrade improvements made to the LTD system since April 2013 (see **Section 2.4.5** for background details) and the growing waste volumes in the Bioreactor. Moreover, since the 2014 IOA, Veolia has further modified the leachate treatment process by dividing the LTD into two treatment zones, namely (in order of process flow):

- an anoxic zone; and
- an aerobic zone.

The splitting into these zones appears to suggest that the Site has converted the LTD into an activated sludge treatment process, which is aimed at optimising BOD reduction and/or nitrification/denitrification processes. This modification reflects Veolia's on-going efforts in optimising the treatment process. From an odour emissions viewpoint, the optimisation of leachate treatment has significantly improved the Site's odour emissions profile from pond-related source (see **Section 8.5.1**).

Based on the details above, the Audit continues to support this modification from a leachate treatment perspective, provided that optimum conditions in the LTD are sustained and continue to result in good quality treated leachate that contains none of the original odour characteristics of untreated leachate. It is understood that Veolia continues to regularly monitor the treated leachate quality and performance.

<u>The LTP</u>

The Site has constructed and commissioned an MBR-based facility (i.e. the LTP) as the long-term leachate management strategy. As indicated in the WIP 2020, the LTP is in the process proving stage which includes, but is not limited to, biomass growth, biological process tuning, and process optimisation. The LTP MBR-based system has been designed as a modified activated sludge biological process to treat the main parameters found in the raw leachate extracted from bioreactor to a higher quality effluent. The LTD and LTP are currently operated simultaneously at the Site, providing an improved capability in leachate management and treatment capacities from the Void.

Based on the above analysis, no further action is required by Veolia on this matter. If, however, there are future operational issues with the LMS, Veolia should take the precautionary measures of notifying the NSW EPA (and any other relevant stakeholders) until the issue is rectified.

8.2.1.2 Improvement of landfill gas extraction from the Bioreactor

Landfill gas extraction at this Site is an on-going operational process. The WIP 2020 indicates that there is a comprehensive plan by Veolia to increase gas capture by undertaking the following key items:

1. The continuous expansion of the new capture system to promote gas collection; and

2. Management of leachate via minimising surface water flow, leachate recirculation, improvement in landfill gas infrastructure design and condensate management, and improvement in continuous treatment capacity and efficiency (achieved via the installation of the LTP).

Further information regarding the design and operation of the landfill gas extraction system has been previously documented in extensive detail in the 2012 IOA Report. As such, it has not been documented in the Audit.

8.2.1.2.1 Landfill gas extraction and fugitive emissions

As outlined in the previous IOAs, it is difficult to calculate a representative odour emission rate from the Void given the dynamic virtue of the surface layout. Therefore, as per previous IOA, an alternative approach has been taken where improvement in landfill gas capture efficiency is used as an indicator of reduced potential for fugitive gas emissions from the Void surface.

Table 8.3 summarises the average monthly landfill gas extraction results over the period between January 2019 and February 2020 compares this result to that obtained in the 2018 IOA. As can be derived from the results in **Table 8.3**, the monthly averaged landfill gas extraction over the period between January 2019 and February 2020 was approximately 2,948,953 m^3 (gas to generators plus flared). In comparison to the gas extraction result obtained from the previous period in the 2018 IOA (i.e. 2,407,512 m^3), this represents an increase of approximately 22% in total gas extraction volume (equivalent to 541,441 m^3). This result reflects Veolia's on-going efforts to improvement landfill gas extraction from the Bioreactor.

Table 8.3 – Monthly landfill gas extraction between 2018 IOA & the Audit	
Summary table	**Values**
2018 IOA landfill gas extraction (m^3/month)	2,407,512
The Audit landfill gas extraction (m^3/month)	2,948,953
Improvement performance	**+22%**

The landfill gas trend between January 2019 and February 2020 is illustrated in **Figure 8.1**.

8.2.1.2.1.1 Fugitive landfill gas emissions

As noted in the previous 2017 IOA, the Audit understands that gas capture is measured against a calculated emissions model issued by the *Australian Government – Clean Energy Regulator*. This aspect is outside the scope of the Audit and is therefore not discussed further. Nevertheless, as demonstrated in previous IOAs, it remains clear that fugitive landfill gas emissions emitted from the Void surface can have a very high odour emission potential if gas capture efficiency were to decline. Therefore, the Audit continues to endorse Veolia's plan to actively improve gas extraction capability from the Bioreactor and the items addressed in the WIP 2020 to achieve this, including:

- Gas field balancing, where individual gas extraction wells in the gas extraction network are monitored routinely for gas composition and pressure. This monitoring aims to achieve the following operational objectives:
  - Adjust wells to optimise landfill gas extraction;
  - Determine if any wells are damaged or malfunctioning;
  - Determine average and highest H_2S exposure;
  - Occupational, health and safety concerns regarding H_2S exposure; and
  - Odour management.
- Monitoring of leachate extraction and treatment, as this improves gas extraction capacities;
- Biofilter cover material on high-risk areas prone to fugitive emissions, particularly in around the Void perimeter (see **Section 8.2.1.5** for further details);

- Optimise tipping strategy, as this ultimately affects the efficiency of landfill gas and leachate;
- The connection of more wells/trenches;
- The implementation of the long-term leachate strategy via the commissioning of the LTP; and
- Consider the undertaking of a trial for an alternative daily cover to identify potential operational benefits compared with current practices.

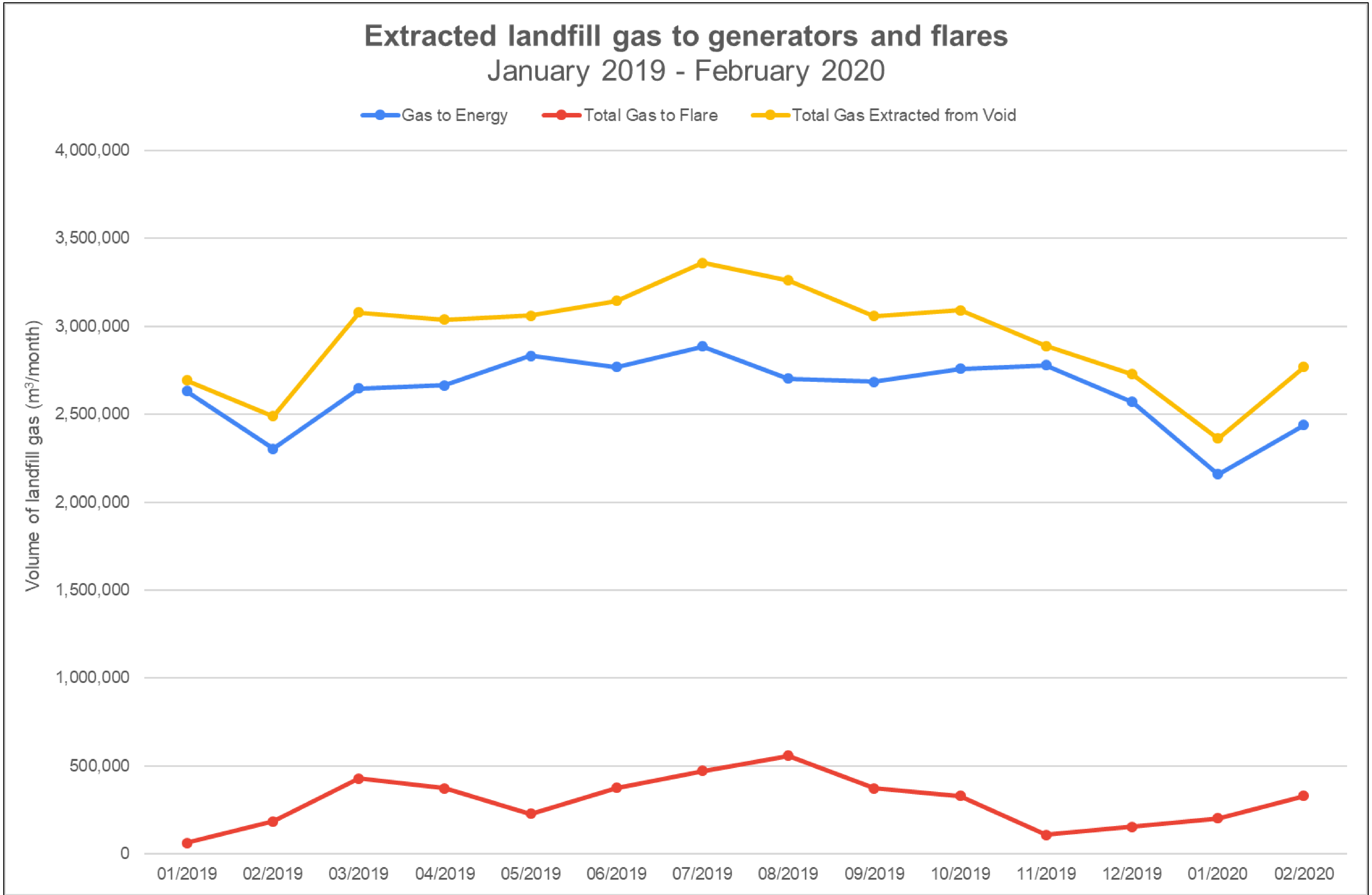


Figure 8.1 – Landfill gas trend between January 2019 and February 2020

8.2.1.3 Landfill gas combustion exhaust quality

According to the 2019 Emissions Testing Report (see **Appendix C**), all combusted gas emissions analysed on NSW EPA Point 8 - Generator No. 2 Exhaust Stack complied with the EPL Limits for NO_x, SO_3/H_2SO_4 and H_2S. The engine load at the time was reported to be 1,065 kilowatts (**kW**). The total hydrocarbon destruction efficiency was found to be 98%, indicating efficient combustion of the landfill gas supply to the generators.

Given the outcomes reported in the 2019 Emissions Testing Report and provided the landfill gas engines continue to operate under optimal conditions, and there is no significant deterioration in combustion performance and operating temperature, the landfill gas engine exhaust stacks are not considered to be significant odour emission sources at the Site. These results are consistent with the judgements made in the previous IOAs in that the engine stacks are a minor source of odour (given the operating combustion temperatures) and highly unlikely to result in adverse odour impact beyond the Site boundary. This finding continues to remain valid in the Audit.

8.2.1.4 Improve evaporation capability

Veolia could recommence mechanical evaporation since this activity ceased following the 2012 IOA finding of the odorous quality of the leachate previously stored in ED3N lagoons. The background for this is well documented in the previous IOAs. The Audit observed that the mechanical evaporators are now active and automated to operate under specific ambient and wind conditions (see **Section 2.4.2.1**).

8.2.1.4.1 ED3N Pond System evaporation and odour potential

The Audit finds that the quality of the treated leachate currently stored in ED3N pond system is relatively comparable to that observed in the previous 2018 IOA, where it was found to contain minimal odour emission potential and no evidence of untreated leachate character present in any of the samples collected (see **Section 6.1.2**). This outcome indicates that the leachate treatment quality continues to be optimum and that the LMS at the Site is performing very well from an odour emissions viewpoint. This finding is also consistent with the liquid test results that indicate the liquid odour potential if the liquid was to partition to gas phase either by natural or mechanical evaporation processes. This is further discussed in **Section 8.2.1.4.2** and **Section 8.2.1.4.3**.

8.2.1.4.2 ED3S Pond System evaporation and odour potential

The SOER input from the LMS May 2016 Report used a SOER of 0.159 ou.m^3/m^2.s for the modelling of ED3S-S. The mean result derived from the Audit is 0.554 ou/m^3/m^2.s (see **Table 6.2**). This result is marginally above the modelled value, but unlikely to cause any adverse impact beyond the boundary of the Site, as demonstrated in the modelling documented in **Section 9**.

8.2.1.4.3 Status of evaporation capability from an odour viewpoint

The results derived using the LOM testing is summarised in **Table 6.5** The odour testing results found in the Audit, through conventional area source sampling and the liquid odour measurement potential techniques, indicate very low SOERs and odour concentration values, respectively. Also, the evaporation liquid odour character as determined by the panellists during laboratory testing indicated an 'earthy, musty' character across all samples, suggesting that there is no original, untreated leachate character and favourable treatment of the stored effluent in the ED3N, ED3S-S and ED1 Coffer Dam.

Overall, the Audit deduces that the pond sources at the Site continue to be a minor source of odour at the Site and unlikely to cause adverse odour impacts beyond the boundary. Moreover, the stored contents in ED3N Pond System continues to be suitable for mechanical evaporation and is unlikely to result in adverse odour impact, provided the effluent quality continues to remain of high quality as found in the Audit. The adequate management of the LMS continues to be in the Audit as a mandatory recommendation (see **Section 10.2.2**).

8.2.1.5 The implementation of improved capping material in the form of a biofilter trial program

The Audit found that the biofilter trial program has been extended and continues to be used as a means of managing odour emissions from the Void surface. The biofilter medium cover has shown that it can be effective at attenuating odour from fugitive emission pathways. However, proper management of the biofilter medium is necessary. This includes the regular watering and topping-up of biofilter medium as required. To achieve this, Veolia has developed an action strategy to streamline the management of this material. This is detailed in the Biofilter Trial Report and WIP 2020. The Audit endorses its continued use around high-risk areas prone to fugitive gas emission leaks, where required.

8.2.1.6 Using the minimal active tipping face as practically possible

As identified in the previous IOAs, the active tipping face can vary depending on the tonnage input and how the waste is managed. Since the 2015 IOA, the exposed active tipping face was revised to reflect more realistic conditions that are prevalent in the Void (discussed further below). In addition to this, minimising the active tipping face continues to be one of the key performance indicators at the Site for the following reasons (as outlined in previous IOAs):

1. Reduces surface area of potential odour source;
2. Minimises temporary decommissioning of gas extraction infrastructure;
3. Minimises fuel usage, particularly in dozer and compactor; and
4. To meet EPA benchmark techniques.

Photo 8.1 provides a visual indication of the active tipping face area size at the time of the Audit field visit. The original value adopted in the EA 2010 for the active tipping face was 40,000 m^2. This value was later revised to between 4,000 m^2 and 6,000 m^2 in the 2013 IOA to reflect realistic and previous operating conditions occurring at the time. As of the Audit, the current active tipping area is now approximately between 1,000 m^2 and 2,000 m^2, reflecting Veolia's continued efforts at minimising the active tipping face in the Void.

Photo 8.1 - A distant view of the active tipping face area size as found on 18 February 2020

The SOER value determined during this Audit was approximately 5.2 ou.m^3/m^2.s. This is lower than the SOER value used in the EA 2010 modelling of 7.6 ou.m^3/m^2.s. Based on these results and the outcome of the modelling study (see **Section 9**), there is a very low risk that the active tipping face will result in downwind odour impact on the nearest sensitive receptor. Moreover, this variation is considered to reflect normal variation from the active tipping face activity inside the Void. Notwithstanding this, it should be noted that:

- Fugitive landfill gas emissions are still judged to be the major contributor to odour emissions from the Void, as previously highlighted in **Section 8.2.1.2**; and

- Veolia has optimised operational practices such as the active tipping surface area is being kept to a minimum. This practice has a significant effect on the rate of emission from this source. That is, any reduction in the exposed waste surface area will result in a proportional decrease in emissions from the active tipping face, and vice versa.

The Audit finds that current practices at the Site relating to the active tipping face are conducive to the minimisation of odour from this source

8.2.1.7 Water cart to control dust

Use of the water cart is an ongoing operational activity, which is effective at minimising dust generation. This was visually evident during the fieldwork component of the Audit. The Audit observed that the operating practice of using a water cart to control dust continues to be an on-going practice at the Site. On the above basis, no further action is required by Veolia for this component of the Site's operations.

8.2.1.8 The use of the truck wash bay

The use of the truck wash bay at the Site was observed to be consistently used by trucks upon exiting the Void. The consistent use of the truck wash bay is good practice at minimising potential odour emissions off-site that may be related to truck vehicle movement. Since the previous IOA, the truck wash bay has been optimised as follows:

- Wheel wash is continuously used for the clean the trucks coming out of the void and the performance of the wheel wash was monitored during operation; and
- Several of the spray nozzles have been modified and changed the spray angle to achieve better coverage (especially the tail of the truck) and washing performance, as shown in **Photo 8.2.** This optimisation will minimise transient levels of odour that may be detectable and associated with truck movement in the community.

Photo 8.2 – Truck wash bay nozzle optimisation (**Source:** Veolia)

8.2.1.9 Transportation of waste in sealed containers until unloading at the Bioreactor

Similar to the previous IOAs, the Audit has found that the current measures used for waste transport operations are very effective at mitigating any odour emissions. The Audit team inspected the IMF and conducted a brief downwind olfactometry assessment to determine any presence of waste-based odour. The inspection did not find any evidence of any waste-based odour being emitted at the IMF. On this basis, the Audit determines that there is still no need to sample the IMF as it is very unlikely to generate problematical odour emissions. This is provided that the waste containers used in the process continue to be adequately maintained and remain fully sealed during waste transportation. As such, current practices should be continued and monitored. A photo of the IMF as found during the Audit on 20 February 2020 is shown in **Photo 8.3** and **Photo 8.4.**

Based on TOU observations, the Audit suggests that Veolia continue to review the following aspects relating to the transportation of waste in sealed containers to facilitate in the minimisation of odour from this area/activity:

- The washing practice associated with the sealed containers; and
- The maintenance of the sealed containers.

Photo 8.3 - The IMF facing south-west as observed during the Audit inspection visit on 20 February 2020

Photo 8.4 - The IMF facing south-east as observed during the Audit inspection visit on 20 February 2020

8.2.1.10 The minimisation of leachate generation during stormwater events

As indicated in **Section 2.5.2,** the WIP 2020, the surface water in the Void is managed in sub-catchments, as shown in **Figure 2.9.** Each sub-catchment has either a natural or engineered drainage and flow control infrastructure, such as concrete dish drains, clay berms, pumps and pipes, to manage surface water. These sub-catchment areas are intended to minimise the amount of surface water flow from the Bioreactor walls onto the waste. This aims to minimise the potential generation of excess leachate from surface water flows.

8.2.1.10.1 Management of high rainfall events

As previously mentioned in **Section 2.5.2.2**, any stormwater into the Void, especially the portion that directly falls on the waste surface of the Void and the runoff from the upper benches, is one major source of excess leachate generation. As documented in the WIP 2020, it is indicated that leachate generation is very sensitive to high rainfall events due to the large, influencing catchment area and partial stormwater interception.

During high rainfall events, large volumes of rainwater fall onto the waste surface. Currently, stormwater is not 100% intercepted from the surface of the waste before becoming contaminated. Following high rainfall events, the leachate extraction system prioritises the extraction of surface water over leachate collected from the sub-surface (i.e. within the Bioreactor). As leachate extraction rate is approximately 2 - 4 L/s, owing to the leachate treatment system capacity, these rainfall events result in further accumulation of leachate in the Bioreactor, potentially reducing the efficiency of the landfill gas capture infrastructure and management of fugitive landfill gas emissions from the Void. It should be noted, however, that the leachate extraction rate represents normal operation but not the peak treatment capacity that can be managed by the LTD. Under normal operating conditions, the Site can maintain a certain freeboard in the LTD to be able to handle a peak flow event from the Void. Nevertheless, given the importance of the management of high rainfall events in the Void, the WIP 2020 indicates that an upgrade to the stormwater management system has been undertaken at the Site to minimise excess leachate generation so that stormwater can be diverted to ED3S.

This feature will continue to be examined as part of the IOA.

8.2.1.11 Effectiveness of odour controls at the MBT Facility

The MBT Facility consists of an extensive odour collection and control system to manage odour emissions throughout the composting process cycle. It was found that the biofilter performance was effective in substantially reducing odour prior to atmospheric discharge. However, it is known that biofiltration of this modern design can achieve further reduction if optimised. As such, the Audit notes that Veolia should operate and maintain the biofilter-based odour control system to the Biofilter Manual as part of best practice. As such, the Audit recommends the following performance metrics be reviewed as part of the next IOA:

- Biofilter airflow;
- Inlet humidity levels and performance of the inlet air humidification system;
- Biofilter outlet performance; and
- Biofilter back-pressure.

Given the outcomes of the odour modelling study (see **Section 9**), the effectiveness of the odour controls at the MBT Facility will continue to reviewed as part of the IOA at the Site.

8.2.1.12 Quality of compost product in the Maturation Storage Pad Area

The quality of compost product stored in the maturation storage pad area appeared to vary, with aged and screened material relatively lower in odour compared with aged and unscreened material. This suggests that compost product in the maturation storage pad area should be screened to minimise odour emission release from this area, or as a trigger response strategy under atypical scenarios as may be noticed by the operators. The requirement to further optimise and improve the storage practices at the Maturation Storage Pad Area of the MBT Facility will be reviewed in the context of the active alternative daily cover trial program being implemented at the MBT Facility and the Void. Notwithstanding this, the odour modelling predictions (see **Section 9**) indicates that the odour outcome is satisfactory under the conditions found in the Audit.

8.3 CONDITION 7 (C)

Condition 7 (C) of the Audit requirements stipulates that the following will be carried out in the IOA:

- *Review the proponents' production data (that are relevant to the odour audit) and complaint records*

The production data that is relevant to the Audit include:

- Waste throughput to the Bioreactor;
- On-site evaporation data (from the 2012 IOA); and
- Landfill gas consumption in the generators and flare system.

This Audit obtained updated data relating to waste throughput to the Bioreactor, complaint records, and evaporation data from Veolia for the Site since the previous 2016 IOA. These were reviewed as part of the Audit and are appended as **Appendix C.** Complaint log records indicate that the necessary fields required by the *EPL Condition M4 Recording of pollution complaints* are being documented by Veolia.

On the above basis, the Audit is satisfied that all relevant record-keeping duties continue to be adequately maintained.

8.4 CONDITION 7 (F)

Condition 7 *(F)* of the Audit requirements stipulates that the following will be carried out in the IOA:

- *Determine whether the project is complying with the requirements in this approval to protect receivers against offensive odour.*

This Audit has examined compliance or otherwise with *Condition 7(F)* from three perspectives, namely:

- Odour complaints data review and analysis and associated response from Veolia (discussed in **Section 8.4.1**); and
- Compliance with the modelling-based, project-specific odour performance goal of 6 ou (discussed in **Section 9**).

The above points have been discussed in **Section 8.4.1** and **Section 9,** respectively.

8.4.1 Odour Complaints Analysis and Response from Veolia

The odour complaints data logged by Veolia and associated response letters were reviewed and analysed in the Audit. **Figure 8.2** illustrates the seasonal distribution of logged odour complaints between 1 April 2019 and 31 March 2020.

The odour complaints analysis indicated the following:

- Since the previous 2018 IOA, over the period of 1 April 2019 and 31 March 2020, there were ten (10) logged odour complaints, equivalent to an 81% decrease in logged complaints;

- There were no complaints in summer or spring, with the logged complaints occurring in the winter and autumn periods;

- The logged odour complaints data continue to not assist in identifying the nature or likely source of the problematic odours. This appears to be an on-going challenge in the community liaison process; and

- Veolia responded to each logged complaint over the period between 1 April 2019 and 31 March 2020. All responses can be found in **Appendix C**.

Given the significant improvement in landfill gas extraction in the Void and expansion and improvement in the leachate management system through optimisation of surface water catchments, landfill gas infrastructure design, active tipping practices and increased leachate treatment capacity via the commissioning of the LTP, the odour complaints trend appears to have materialised the benefits of the continuous improvement plans implemented at the Site - this is an excellent outcome and expected to be observed in future IOAs.

Notwithstanding the substantial reduction in odour complaints, the Audit recommends that Veolia continue its active engagement with the community through its existing odour complaints and response management strategy. The handling and management of odour complaints will be reassessed in the next IOA to evaluate the need for additional forms of community engagement. As such, the refinement in community engagement remains as a non-mandatory recommendation in the Audit to ensure this matter is provided with the opportunity of continuous improvement (see **Section 10.3.1** for more details).

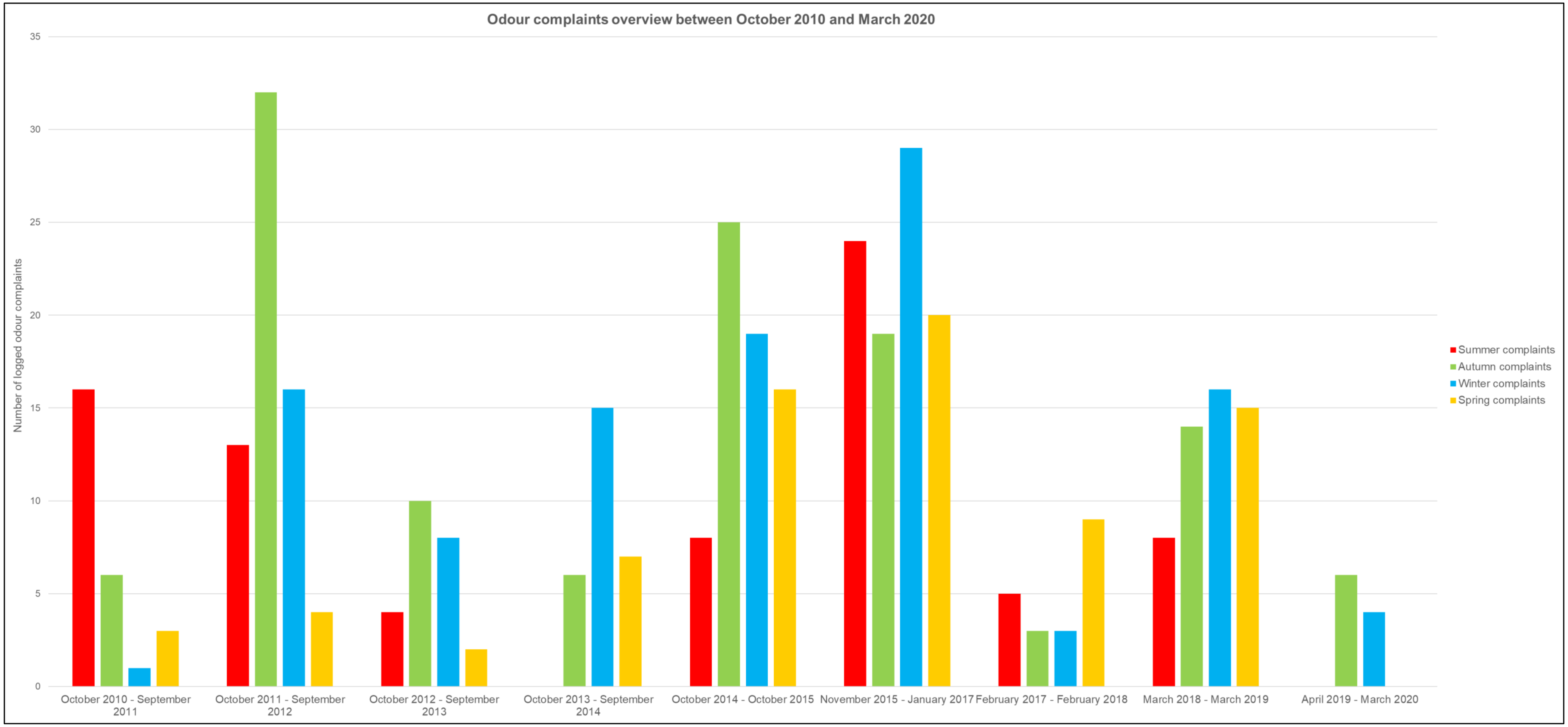


Figure 8.2 - Number of logged odour complaints between October 2010 and March 2020

8.5 ODOUR EMISSIONS INVENTORY DISCUSSION

As per the recommendation of the previous IOAs, the Audit recommends using an overall odour emissions inventory for the Site and examined it as to place into context the emissions from any single source.

Table 8.4 details the odour emission inventory for the Site as determined by the testing carried out in the Audit and compares these results with predictions of emissions contained in the EA. It also makes a comparison with the impact of the revised areas (where applicable) for each odour emission source as found in the Audit.

It is acknowledged that there are odour emissions not listed in this inventory, emanating mostly from sources where quantitative measurement or even estimates are difficult. These include the fugitive odour releases from the Void, previously described as potential gas pathways, arising from gas leakages from the covered areas and around the walls of the Void and leachate recirculation air pressure relief vent. Despite these omissions, it is considered that the incomplete inventory remains to have real value and is discussed later (see **Section 8.5.2**).

Table 8.4 - Measurable odour emission rates for the Site ^

Parameters						The Audit		2018 Audit		2017 IOA		2016 IOA		2015 IOA		2014 IOA		2013 IOA			2012 IOA		EA		
Location	Current Area (m^2)	2018 Area (m^2)	2016 Area (m^2)	2014 Area (m^2) ^^	2012 Area (m^2)	SOER ($ou.m^3/m^2.s$)	OER - Current Area ($ou.m^3/s$)	SOER ($ou.m^3/m^2.s$)	OER - Current Area ($ou.m^3/s$)	SOER ($ou.m^3/m^2.s$)	OER - Current Area ($ou.m^3/s$)	SOER ($ou.m^3/m^2.s$)	OER - Current Area ($ou.m^3/s$)	SOER ($ou.m^3/m^2.s$)	OER - Current Area ($ou.m^3/s$)	SOER ($ou.m^3/m^2.s$)	OER - Current Area ($ou.m^3/s$)	SOER ($ou.m^3/m^2.s$)	OER 2012 Area ($ou.m^3/s$)	OER - Current Area ($ou.m^3/s$)	SOER ($ou.m^3/m^2.s$)	OER ($ou.m^3/s$)	SOER ($ou.m^3/m^2.s$)	OER ($ou.m^3/s$)	OER - Current ($ou.m^3/s$)
ED3N-1	7,500	7,500	6,000	6,000	7,000	n/a	n/a	0.356	2,670	0.132	792	0.130	780	0.132	794	0.017	104	0.30	2,100	1,800	394	2,760,000	8.8	61,600	52,800
ED3N-2 & 3 ^^^	14,280	12,400	11,000	11,000	13,000	0.0745	1,060	0.102	1,260	0.129	1,420	0.175	1,930	0.118	1,300	0.049	543	11.6	150,000	127,000	0.29	3,800	7.4	96,200	81,400
ED3N-2	8,060	7,000	5,500	5,500	6,500	0.0881	710	0.169	1,180	0.120	660	0.148	811	0.145	797	0.066	365	20.1	131,000	111,000	0.21	1,350	n/a^^^		
ED3N-3	6,220	5,400	5,500	5,500	6,500	0.0609	379	0.035	190	0.139	765	0.20	1,110	0.091	500	0.032	178	0.2	1,010	852	0.37	2,430			
ED3N-4	40,200	39,000	25,000	25,000	16,000	0.0856	3,440	0.095	3,710	0.163	4,080	0.248	6,200	0.269	6,720	0.023	575	0.0604	966	1,510	0.41	6,600	0.7	11,200	17,500
ED3S	77,100	89,400	89,435	n/a		0.094	7,250	0.058	5,190	0.116	10,400	0.277	24,700	No previous measurements available as ED3S & ED3S-S are new sources									0.5	44,700	24,700
ED3S-S**	19,100	19,000	1,420			0.554	10,600	0.134	2,550	1.97	44,700	0.437	621										0.159	4,510	226
Active Tipping Face	2,000	2,000	6,000	6,000	40,000 *	5.26	10,500	7.59	15,200	9.52	14,300	8.16	49,000	7.51	45,100	4.28	25,700	3.04	122,000	18,200	8.36	334,000	7.3	292,000	43,800
Leachate Treatment Dam	4,170	5,000	5,000	5,000	2,000	9.19	38,300	0.186	930	0.243	1,220	0.27	1,350	0.276	1,380	0.026	129	0.323	647	1,620	0.46	920	3.6	7,200 #	18,000
Construction and Demolition Tip Face	900	900	900	500	900	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.326	294	n/a^	n/a	0.293	264	147	n/a	n/a	n/a	n/a	n/a
Storage Pond 7	n/a	n/a	n/a	n/a	1,200	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/m^^	n/a	n/m	n/m	n/m	85	102,000	n/m	n/m	n/m

n/a = not applicable, ED3N-1 empty
n/m = not measured
^ All odour emission rates represent the derived mean SOER values for each location
^^ As advised by Veolia
^^^ reported in the EA 2010 as a single emission source i.e. ED3N-2 & ED3N-3 as a single area
# represents mean result for different batches of leachate between 2007 and 2011
* as per AAQMP estimate
** Target SOER not obtained from the EA. Source of emission data is the LMS May 2016 Report: Table 2.1

Based on the result in **Table 8.4**, the following comments are made (excluding the MBT Facility and LTP):

- The total measurable odour emission rate from the Site found in the Audit was 72,200, ou.m^3/s, representing a substantial increase since the 2018 IOA. The dominant contributor to this result appears to be the increase in OER for the LTD, which was impacted by a failure in one of the surface aerators. This matter has now been rectified (see **Section 6.1.5** for details);

- The active tipping face is within normal trends for total measurable odour emissions, without consideration of fugitive landfill gas emissions (see **Section 8.2.1.2**);

- The LMS continues to operate under very low odour emission conditions and is unlikely to be contributing to any significant odour impact beyond the Site boundary;

- From a comparative viewpoint, the SOER results show fairly close agreement between the Audit results and the EA 2010 value for all emission sources (see **Table 6.1**), with the exception to the LTD anomaly due to an unfortunate equipment failure. This is a significant result as it shows that the SOER predictions in the EA 2010 are suitable for current and future operations at the Site. This is supported by the odour modelling study conducted in the Audit (see **Section 9**); and

- Like the previous IOAs, ED3N-2 & ED3N-3 have been reported both as separate emission sources and a single source (as per the EA 2010) as to determine the relative contribution of odour emission from each pond separately.

The following sections discuss the results from the odour emissions inventory and Audit in the context of the pond and non-pond sources (see **Sections 8.5.1 & 8.5.2** respectively).

8.5.1 Pond sources

All pond sources at the Site sampled in the Audit are considered area sources, including:

- ED3N Pond System: this includes ED3N-1, 2, 3 and 4;

- ED3S Pond System: this includes ED3S & ED3S-S; and

- LTD.

The following sections discuss each of the above pond sources.

8.5.1.1 ED3N Pond System

In the context of the odour emissions inventory for the Site, the Audit finds that at the current and above performance targets for leachate quality, leachate effluent stored in ED3N represents very low odour emissions since the IOAs began in 2011. The derived mean SOER's for ED3N-2, 3 & 4 in the Audit is 0.0881 ou.m^3/m^2.s, 0.0609 ou.m^3/m^2.s, and 0.0856 ou.m^3/m^2.s, respectively. At these values, the stored contents of ED3N continue to be a minor odour emission source at the Site.

On the above basis, the Audit finds that the leachate performance targets set by Veolia are appropriate in attenuating odour emissions from pond-related sources. It can be considered that any significant deviation of the leachate quality monitoring targets would be a reasonable indicator that there will be an increase in risk potential for odour emission generation from the ED3N Pond System. This risk potential is considered to be significantly mitigated with the commissioning of the LTP.

8.5.1.2 ED3S Pond System

8.5.1.2.1 ED3S

In the context of the odour emissions inventory for the Site, the Audit finds that at the current and above performance targets for stormwater quality stored in ED3S represents very low odour emissions since the IOAs began in 2011. The derived mean SOER for ED3S in the Audit is 0.094 ou.m^3/m^2.s. At this value, the stormwater stored in ED3S is of a quality that is conducive with low odour.

8.5.1.3 ED3S-S

The SOER input from the LMS May 2016 Report used a SOER of 0.159 ou.m^3/m^2.s for the modelling of ED3S-S. The mean result derived from the Audit is 0.554 ou.m^3/m^2.s (see **Table 6.2**). This result is higher than the modelled value but unlikely to cause any adverse impact beyond the boundary of the Site given the odour modelling analysis and logged number of odour complaints as found in the Audit.

8.5.1.4 Leachate Treatment Dam

The LTD was found to be operating in an atypical performance due to the faulty aerator. As such, the SOER derived in the Audit from this source is 9.2 ou.m^3/m^2.s, which is well above the EA 2010 value of 3.6 ou.m^3/m^2.s. Given that the aerator has now been rectified, the historical performance from previous IOAs are expected to be restored. Notwithstanding this, given the odour modelling results and nature of the source, it is unlikely to lead to adverse impacts downwind of the Site at nearby sensitive receptors to the Site.

8.5.2 Non-pond sources

The activities within the Void were judged to be similar regarding process operations to that found in the 2016 IOA, except for the landform adopted for the active tipping face within the Void (see **Section 8.2.1.5** for details) . The Audit endorses the continued use of biofiltration cover material around high-risk areas prone to fugitive gas emission leaks, where required.

The Audit odour testing results indicate that the Void continues to remain the major contributor to odour emissions at the Site, through fugitive gas emissions, if gas extraction is not effectively maintained. The fugitive landfill gas emissions that arise due to wall effects and cracks in the capping of waste, particularly near landfill gas extraction wells and Void perimeter, are an on-going operational issue at the Site. A reduction in leachate extraction can also impact the effectiveness of landfill gas extraction. Based on the significant in landfill gas capture, it appears that the Void was operating in a state with minimal fugitive gas emissions at the time of the Audit (see **Section 8.2.1.2.1**).

8.5.3 Active Tipping Face

For reasons discussed in **Section 8.2.1.6**, the mean SOER result of 5.26 $ou.m^3/m^2.s$) from the active tipping face as found in the Audit is not considered significant from an odour impact viewpoint, but demonstrates the importance of continued efforts to minimise the active tipping face as much as practically possible. Overall, the Audit finds that current practices at the Site in relation to the active tipping face are conducive to the minimisation of odour from this source.

9 ODOUR MODELLING STUDY

9.1 PREFACE

As part of the Audit's scope of work, TOU was requested to deliver a re-run of the site-specific odour dispersion model initially done in the EA 2010 with the current operational factors and odour audit emissions data. As previously mentioned in **Section 8.4**, the purpose of the re-run is to demonstrate compliance with the modelling-based, project-specific odour performance goal of 6 ou and *Condition 7 (F)* of the Audit requirements.

9.1.1 Relevant Modelling Background Information

To enable the undertaking of the modelling re-run, TOU was supplied the original odour dispersion model used in the EA 2010 developed by the former Heggies Pty Ltd, now operating under SLR Consulting. TOU updated the original CALMET meteorology for its initial assessment of the addition of the ED3S dam to the leachate management system (refer to the LMS May 2016 Report). The preparation methodology for the meteorology has been reproduced in **Section 9.3**. For the CALPUFF odour dispersion modelling and under strict instructions, the ED3S study and subsequent studies involved the addition of new sources without modification to existing sources within the original EA odour model (**the Previous Model**). The original configuration and odour emission rates can be found in *Section 5* of the EA 2010 titled *Odour and Dust Impact Assessment (Rev 5) Report* dated 2 August 2010.

9.1.2 Scope of Works

The scope of the Audit required the update of the previous odour dispersion model with current operational factors and odour audit emissions data measured as part of the current IOA. This involved the modification and removal of existing odour sources from the original CALPUFF dispersion model to best represent the present operations during the Audit period.

For the previous IOA, the Previous Model was updated with operational factors and emissions data measured in February 2019. This involved the modification and removal of existing odour sources from the previous iteration of the CALPUFF dispersion model to best represent the present operations during the previous IOA.

The scope of the Audit requires the adjustment to the previous model with current operational factors and current emissions data measurements. This involved the addition, modification and removal of existing odour sources to represent the present operations during the Audit.

The following report details the methodology and findings of the odour modelling study.

9.2 ODOUR DISPERSION MODELLING METHODOLOGY

9.2.1 Odour Emissions Testing Results Summary

The results of the odour emissions testing carried out for the Audit containing the source areas, SOERs and OERs are summarised in **Table 9.1.** The tabulated odour emission inventories for the EA and each of the annual odour audits, along with the individual sample results for the current and previous odour audits, can be provided upon request.

Location	Area (m^2)	SOER ($ou.m^3/m^2.s$)	OER ($ou.m^3/s$)	Comments
Table 9.1 – A summary of odour emissions data used in the modelling study				
ED3N1	7,500	0	0	Empty at the time from the Audit
ED3N2 & 3	14,280	0.0745	1,060	Mean value of 6 samples from the Audit
ED3N4	8,060	0.0856	3,440	Mean value of 3 samples from the Audit
ED3S	77,100	0.058	5,190	Mean value of 2 samples from the Audit
ED3SS	19,100	0.134	3,040	Mean value of 3 samples from the Audit
Active Tipping Face	2,000	5.26	10,500	Mean value of 3 samples from the Audit
Leachate Treatment Dam	4,170	9.19	38,300	Mean value of anoxic and aeration zone samples from the Audit
Waste Covered Area	154,000	0.407	62,700	75th percentile of 12 samples from previous IOA and the Audit
MBT Maturation Pad (Screened 1 month)	900	5.82	5,240	Measured SOERs multiplied by the stockpile surface areas as provided in **Figure 9.3**.
MBT Maturation Pad (screened 2 months)	1,530	1.19	1,820	
MBT Maturation Pad (screened 3 months)	5,360	0.391	2,100	
MBT Maturation Pad (unscreened 4 – 6 months)	3,800	2.8	10,600	
MBT Biofilter 1	--	--	22,000	Sum of measured OER from 3 samples from the Audit
MBT Biofilter 2	--	--	147,000	Sum of measured OER from 4 samples from the Audit

The exclusion for the modelling exercise is as follows:

- The contribution of the spray evaporation system (as described in **Section 2.4.2.1**) and reported in **Table 6.5**. There is no evidence to suggest that the mechanical spray evaporation is a problematical activity from an odour viewpoint given the outcome of the LOM analysis undertaken in the Audit (see **Section 6.1.7**); and

- The MBT leachate pond was not measured in the Audit and will be assessed in the next IOA when safe access is possible. It is not expected to be a significant contributor to the overall OER for the MBT Facility and the Site. Notwithstanding this, the Audit has assumed the LTD SOER for this source, which is considered to be conservative given the higher than normal SOER due to the faulty aerator (refer to **Section 8.5.1.4**).

9.2.2 Odour Source and Emission Rate Configurations

Sources from the previous IOA model had their location and dimensions corrected, defunct sources were removed, and new sources were added to best represent the present operations reflected in the latest iteration of odour emissions testing for the Audit. The result is illustrated in **Figure 9.1**. It should be noted that odour sources from the MBT Facility and the LTP have been added to the Audit model, shown in **Figure 9.2** and **Figure 9.4**, respectively.

A comparison of the sources from previous IOA model to the Audit model are facilitated through odour emissions inventories provided in **Table 9.2** and **Table 9.3**, respectively.

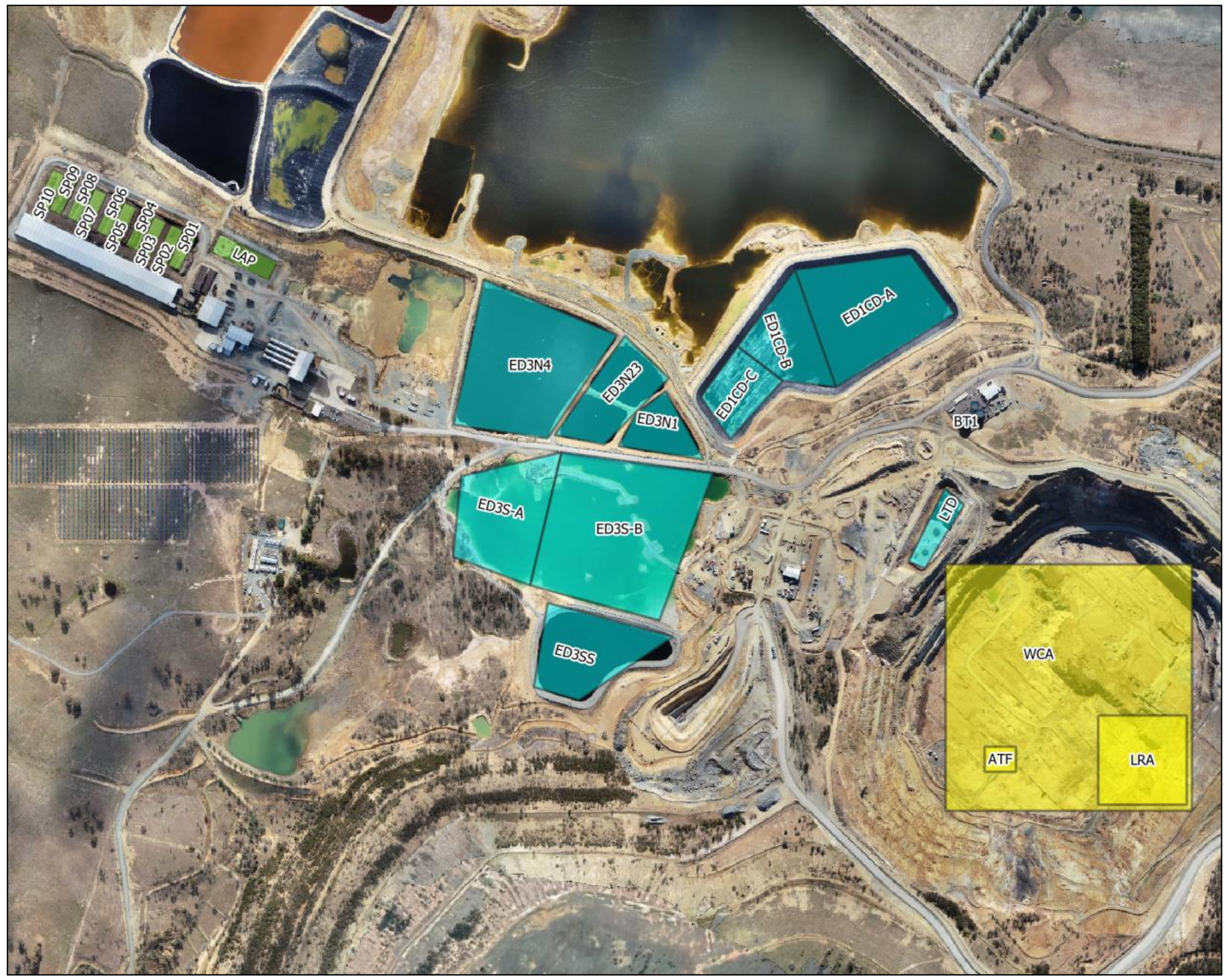


Figure 9.1 – Layout of sources in the Audit

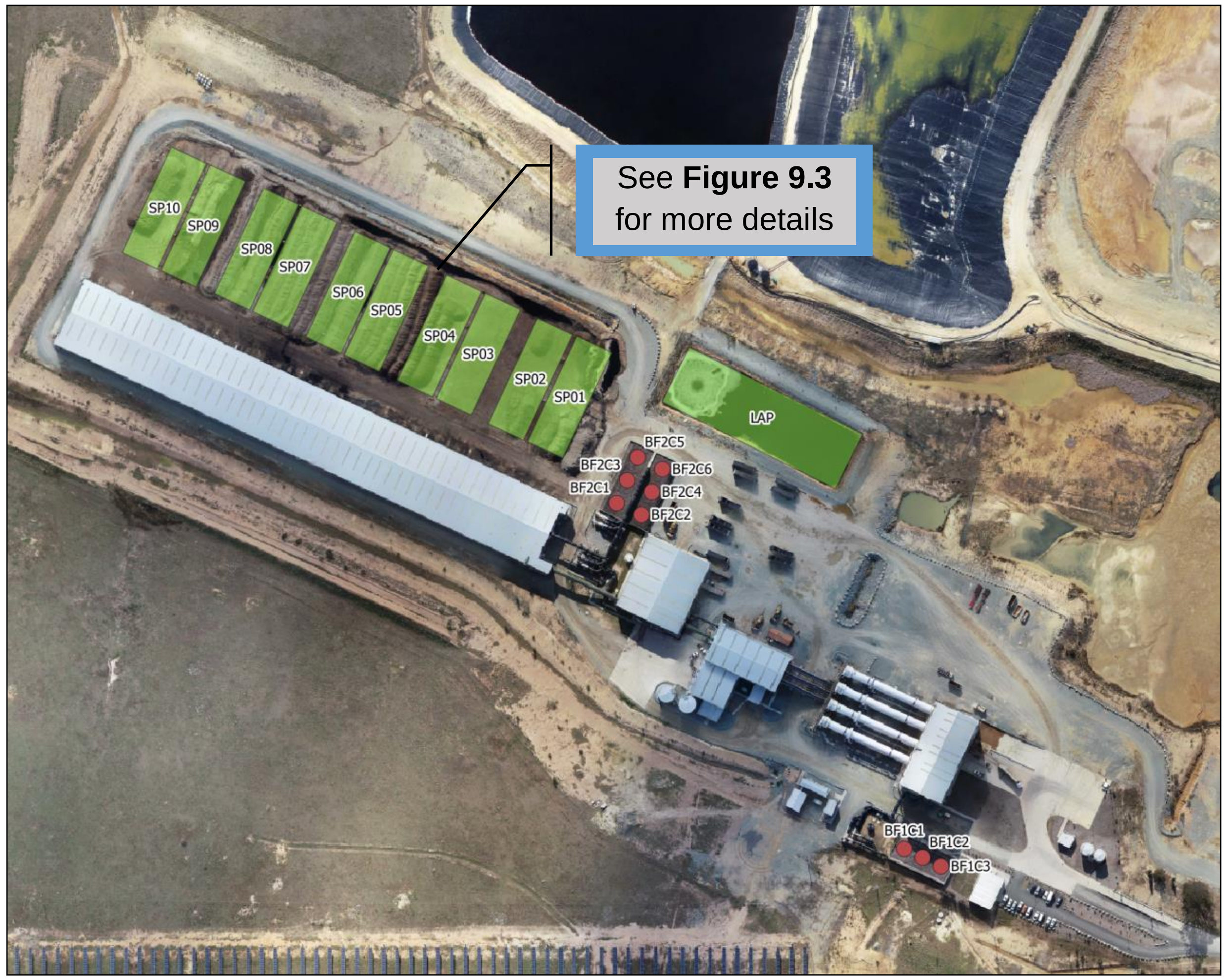


Figure 9.2 – Layout of MBT sources for the Audit

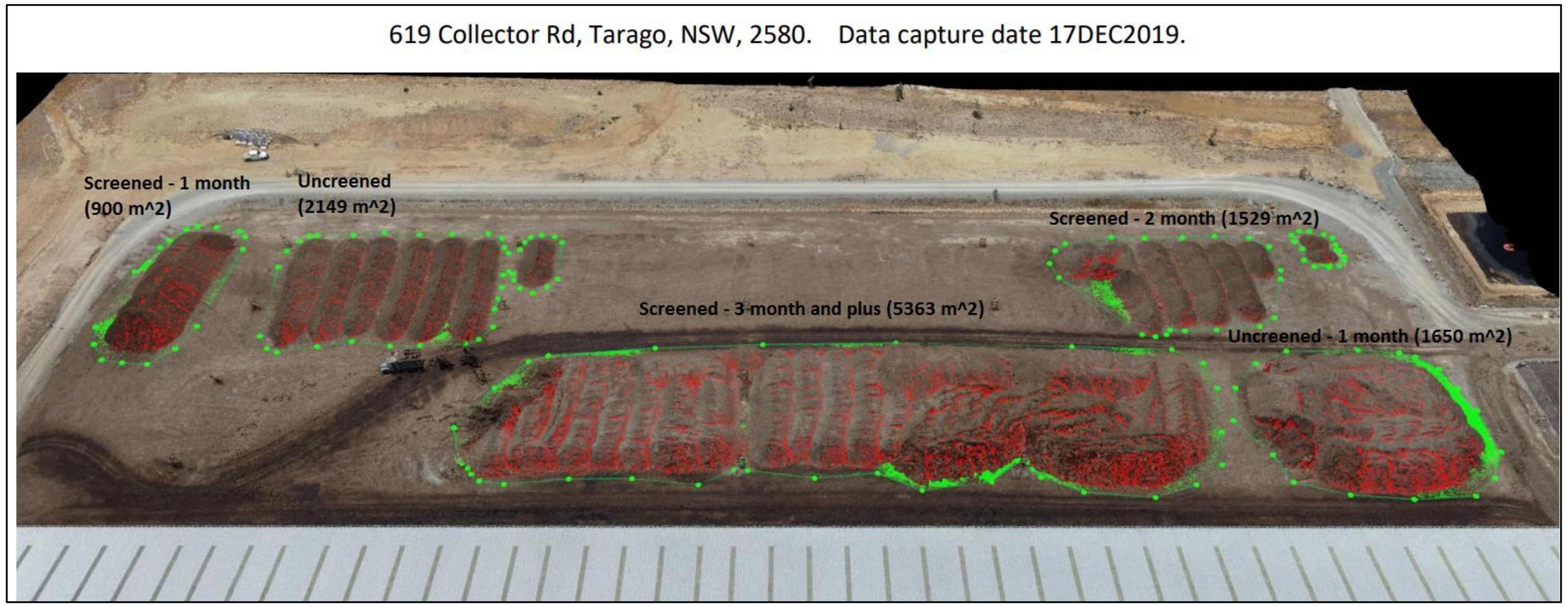


Figure 9.3 – A representation of the maturation pad stockpile as measured on 17 December 2019

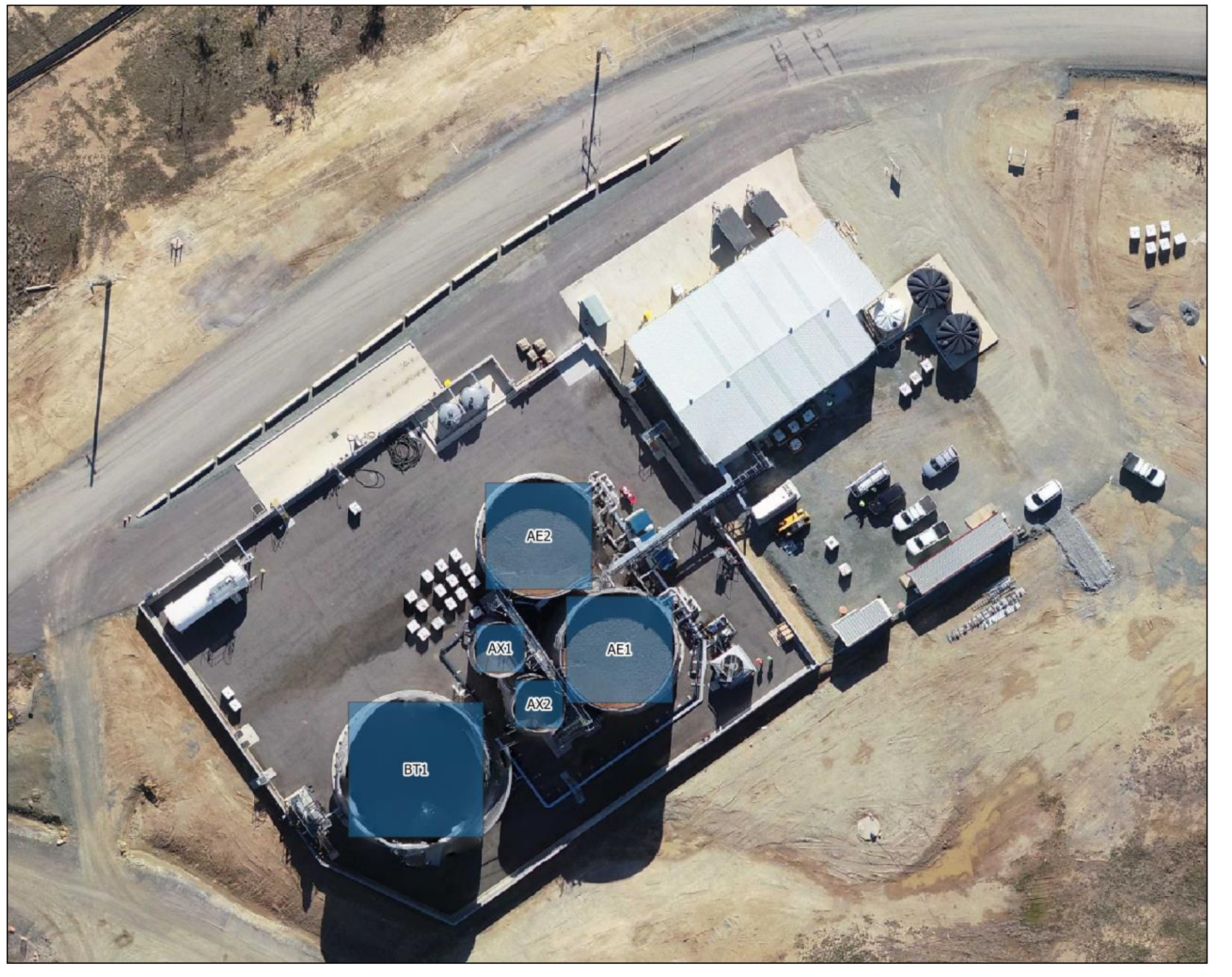


Figure 9.4 - Layout of LTP sources for the Audit

Table 9.2 – The previous IOA model source areas and emission rates

Source ID	Description	Area (m^2)	SOER ($ou.m^3/m^2.s$)	OER ($ou.m^3/s$)	Comment
ATF	Active Tipping Face	1,500	7.59	11,400	Elevation RL740.
LRA	Leachate Recirculation Area (ceased)	20,000	0	0	Leachate recirculation ceased (WIP 2020). Elevation RL740.
WCA	Waste Covered Area (fugitives)	122,000	2.59	317,000	Elevation RL740.
ED2-A	Heron Mine Dewatering	54,400	0.078	4,240	Removed from IOA #8 Model.
ED2-B	Heron Mine Dewatering	161,000	0.078	12,500	Removed from IOA #8 Model.
ED3N-1	Leachate Evaporation Dam 3 North System	6,000	0.356	2,140	None.
ED3N-2-3	Leachate Evaporation Dam 3 North System	11,000	0.102	1,120	None.
ED3N-4	Leachate Evaporation Dam 3 North System	25,000	0.095	2,380	None.
ED3S1	Leachate Evaporation Dam 3 South System	24,200	0.058	1,400	None.
ED3S2	Leachate Evaporation Dam 3 South System	65,300	0.058	3,800	None.
ED3S-S	Leachate Evaporation Dam 3 South-South System	22,700	0.134	3,040	None.
LTD	Leachate Treatment Dam	5,000	0.186	930	None.
			The previous IOA model total OER	**360,000**	To three significant figures

Table 9.3 – The Audit model source areas and emission rates					
Source ID	**Description**	**Area (m^2)**	**SOER ($ou.m^3/m^2.s$)**	**OER ($ou.m^3/s$)**	**Comment**
Bioreactor and Leachate Evaporation System					
ATF	Active Tipping Face	2,000	5.26	10,500	None.
LRA	Leachate Recirculation Area (ceased)	20,000	0.000	0	Leachate recirculation ceased (WIP 2020).
WCA	Waste Covered Area (fugitives)	154,000	0.407	62,700	None.
ED1CD	ED1 Coffer Dam (Sections A, B & C)	55,100	0.182	10,000	Not measured. Mean of ED3 system SOERs assumed.
ED3N1	Leachate Evaporation Dam 3 North 1	6,000	0.000	0	Empty at time of audit.
ED3N23	Leachate Evaporation Dam 3 North 2 & 3	14,300	0.0745	1,060	Embankment separating sections 2 & 3 included in area.
ED3N4	Leachate Evaporation Dam 3 North 4	40,200	0.0856	3,440	None.
ED3S	Leachate Evaporation Dam 3 South System (Sections A & B)	77,100	0.0940	2,280	None.
ED3SS	Leachate Evaporation Dam 3 South-South System	19,200	0.554	10,600	None.
LTD	Leachate Treatment Dam	4,170	9.19	38,400	None.
Sub-total OER				**144,000**	To three significant figures.
MBT Maturation Pad, Leachate and Biofilters					
LAP	Leachate Aeration Pond	3,140	9.19	28,900	Not measured. LAP SOER assumed due to safety access constraint during IOA. This will be resolved and validated as part of the next audit.
SP01	MBT Maturation Pad Stockpiles	12,000	1.65	19,800	The derived SOER is based on the total measured OER from the MBT maturation pad in the Audit and a nominal stockpile surface area of 12,000 m^2. The advised surface area at the time of measurement was approximately 12,000 m^2 (see **Figure 9.3**). However, the modelled OER is identical to the measured OER.
SP02					
SP03					
SP04					
SP05					
SP06					
SP07					
SP08					
SP09					
SP10					
BF1	Biofilter 1 (Cells 1, 2 & 3)	--	--	22,000	None.
BF2	Biofilter 2 (Cells 1, 2, 3, 4, 5 & 6)	--	--	147,000	None.
SUB-TOTAL OER				**218,000**	To three significant figures.
Leachate Treatment Plant					
BT1	Balance Tank 1	227	4.16	944	77 h residence time (Note 1)
AX1	Anoxic Tank 1	28	1.71	48	163 h residence time (Note 1)
AX2	Anoxic Tank 2	28	1.40	39	182 h residence time (Note 1)
AE1	Aeration Tank 1	141	0.781	110	238 h residence time (Note 1)
AE2	Aeration Tank 2	141	0.296	42	332 h residence time (Note 1)
SUB-TOTAL OER				**1,180**	To three significant figures.
IOA #8 MODEL TOTAL OER				**368,000**	To three significant figures.

Note 1 - SOER of LTP process units in series estimated by exponential decay of measured SOER from LTD to mean of ED3 system as a function of residence time based on flowrate of 282 m3/d through the LTP as advised at time of audit.

9.3 ODOUR DISPERSION MODELLING METHODOLOGY

9.3.1 NSW Odour Criteria and Dispersion Model Guidelines

Regulatory authority guidelines for odorous impacts of gaseous process emissions are not designed to satisfy a 'zero odour impact criteria', but rather to minimise the nuisance effect to acceptable levels of these emissions to a large range of odour sensitive receptors within the local community.

The odour impact assessment for this project has been carried out in accordance with the methods outlined by the documents:

- Environment Protection Authority, 2017, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*;
- Environment Protection Authority, 2006, *Technical Framework (and Notes): Assessment and Management of Odour from Stationary Sources in NSW*; and
- Barclay & Scire, 2011. *Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'*.

The documents specify that the odour modelling for Level 3 impact assessments, upon which this study has been conducted, be based on the use of:

- The 99.0th percentile dispersion model predictions;
- 1-hour averaging times with built–in peak-to-mean ratios to adjust the averaging time to a 1-second nose-response-time;
- Odour emission rates multiplied by the peak-to-mean ratios as outlined in **Table 9.4**;
- The far-field distance typically defined as greater than 10 times the largest source dimension, either height or width; and
- The appropriate odour impact assessment criterion (**IAC**), based on the population of the affected community near the development.

Table 9.4 – NSW EPA peak-to-mean factors

Source type	Pasquill-Gifford stability class	Near-field P/M60*	Far-field P/M60*
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A-F	6	6
Surface wake-free point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3

* Ratio of peak 1-second average concentrations to mean 1-hour average concentrations
Source: Environment Protection Authority, 2005 – Table 6.1

The IAC for complex mixtures of odours are designed to include receptors with a range of sensitivities. Therefore, a statistical approach is used to determine the acceptable ground level concentration of odour at the nearest sensitive receptor. This criterion is determined by the following equation:

$$IAC = \frac{\log_{10}(p) - 4.5}{-0.6}$$

Equation 9.1

where,
IAC = Impact Assessment Criteria (ou)
***p* =** population

Source: NSW EPA, 2017, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales – Equation 7.2*

Based on **Equation 9.1**, **Table 9.5** outlines the odour performance criteria for six different affected population density categories. It states that higher odour concentrations are permitted in lower population density applications.

Table 9.5 – Odour IAC under various population densities

Population of affected community	Odour performance criterion (ou)
Urban Area (≥ ~2000)	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤ ~2)	7.0

Source: NSW EPA, 2017, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales – Table 7.5*

The original odour impact assessment contained in the EA 2010 had adopted the IAC of **6 ou** "*given the low number of sensitive receptor locations in the vicinity of the*

Woodlawn site". TOU has maintained consistency with this approach as conditions have not significantly changed.

9.3.2 Odour Dispersion Model Selection

The odour dispersion modelling assessment was carried out using the CALPUFF System (Version 6.42). CALPUFF is a puff dispersion model that can simulate the effects of time- and space-varying meteorological conditions on pollutant transport. CALMET is a meteorological model that produces three-dimensional gridded wind and temperature fields to be fed into CALPUFF. The primary output from CALPUFF is hourly pollutant concentrations evaluated at gridded and/or discrete receptor locations. CALPOST/CALRANK processes the hourly pollutant concentration output to produce tables at each receptor and contour plots across the modelling domain. For further technical information about the CALPUFF modelling system refer to the document *CALPUFF Modeling System Version 6 User Instructions*.

The CALPUFF system can account for a variety of effects such as non-steady-state meteorological conditions, complex terrain, varying land uses, plume fumigation and low wind speed dispersion. CALPUFF is considered an appropriate dispersion model for impact assessment by NSW EPA in their document - *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales* in one or more of the following applications:

- complex terrain, non-steady-state conditions;
- buoyant line plumes;
- coastal effects such as fumigation;
- high frequency of stable calm night-time conditions;
- high frequency of calm conditions; and
- inversion break-up fumigation conditions.

In the case of this odour modelling study in the Audit, CALPUFF was required to handle the complexity of surrounding terrain features. Under calm and very light winds, non-steady-state conditions such as accumulation of odour and/or downslope movement with drainage airflow would almost certainly occur.

For the odour modelling study in the Audit, the air contaminant was odour and ground-level concentrations in odour units (**ou**) have been projected.

9.3.3 Geophysical and Meteorological Configuration

A CALMET hybrid three-dimensional meteorological data file for Woodlawn was produced that incorporated of gridded numerical meteorological data supplemented by surface observation data, topography and land use over the domain area.

9.3.4 Terrain configuration

Terrain elevations were sourced from 1 Second Shuttle Radar Topography Mission (**SRTM**) Derived Smoothed Digital Elevation Model (**DEM-S**). The SRTM data was treated with several processes including but not limited to removal of stripes, void filling, tree offset removal and adaptive smoothing. The DEM-S was used as input into TERREL processor to produce 20 kilometres (**km**) by 20 km grid at 0.15 km resolution. A map of the terrain is illustrated in **Figure 9.5.**

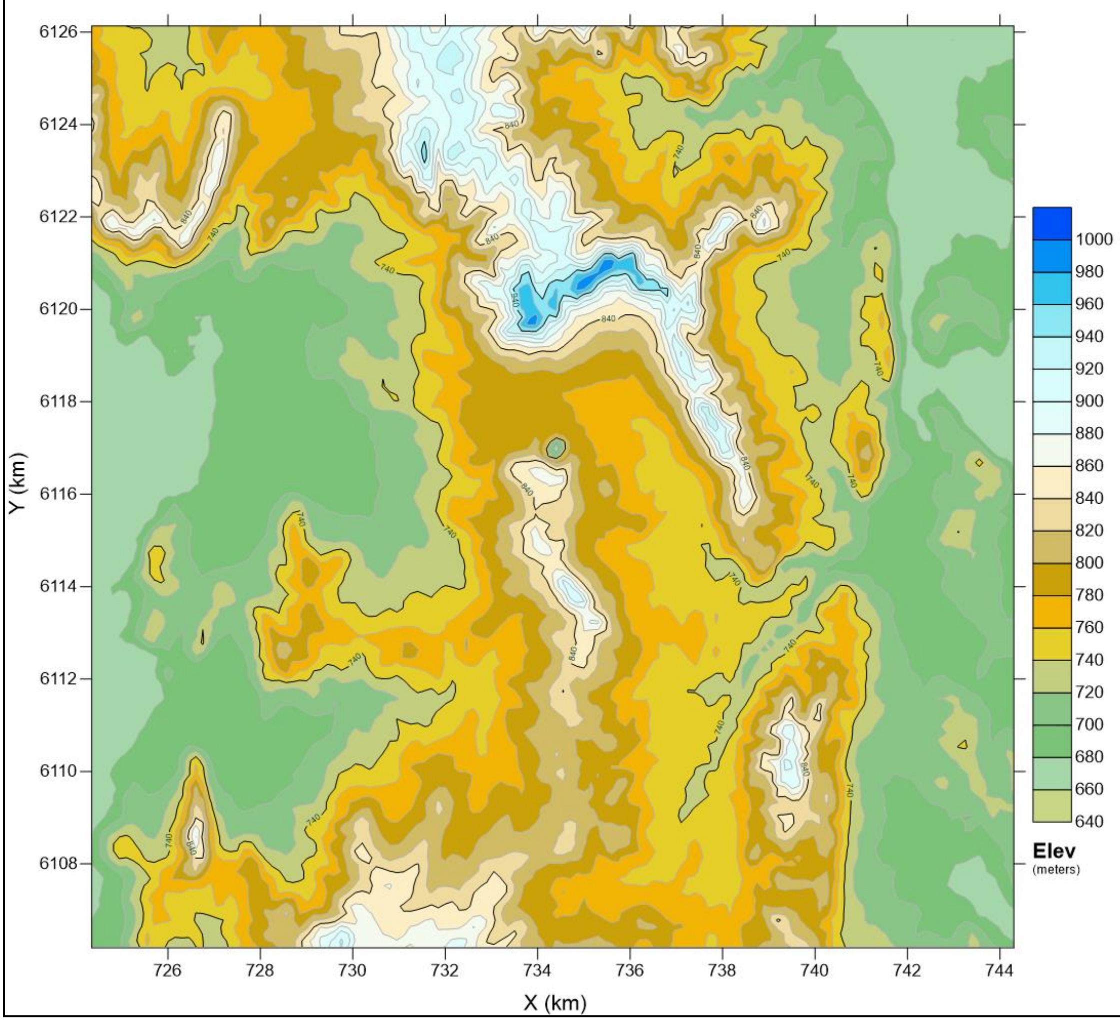


Figure 9.5 – Terrain map of Woodlawn and surrounds

9.3.5 Land use configuration

Land use was sourced from the United States Geological Survey (**USGS**) Global Land Cover Characteristics Data Base for the Australia-Pacific region. The data was used as input into CTGPROC processor to produce a 20 km by 20 km grid at 0.15 km resolution. A map of the land use is illustrated in **Figure 9.6**.

9.3.6 Geophysical configuration

The geophysical data file was created using the MAKEGEO processor. Land use data from CTGPROC and terrain data from TERREL was used as input to produce a 20 km by 20 km geophysical grid at 0.15 km resolution.

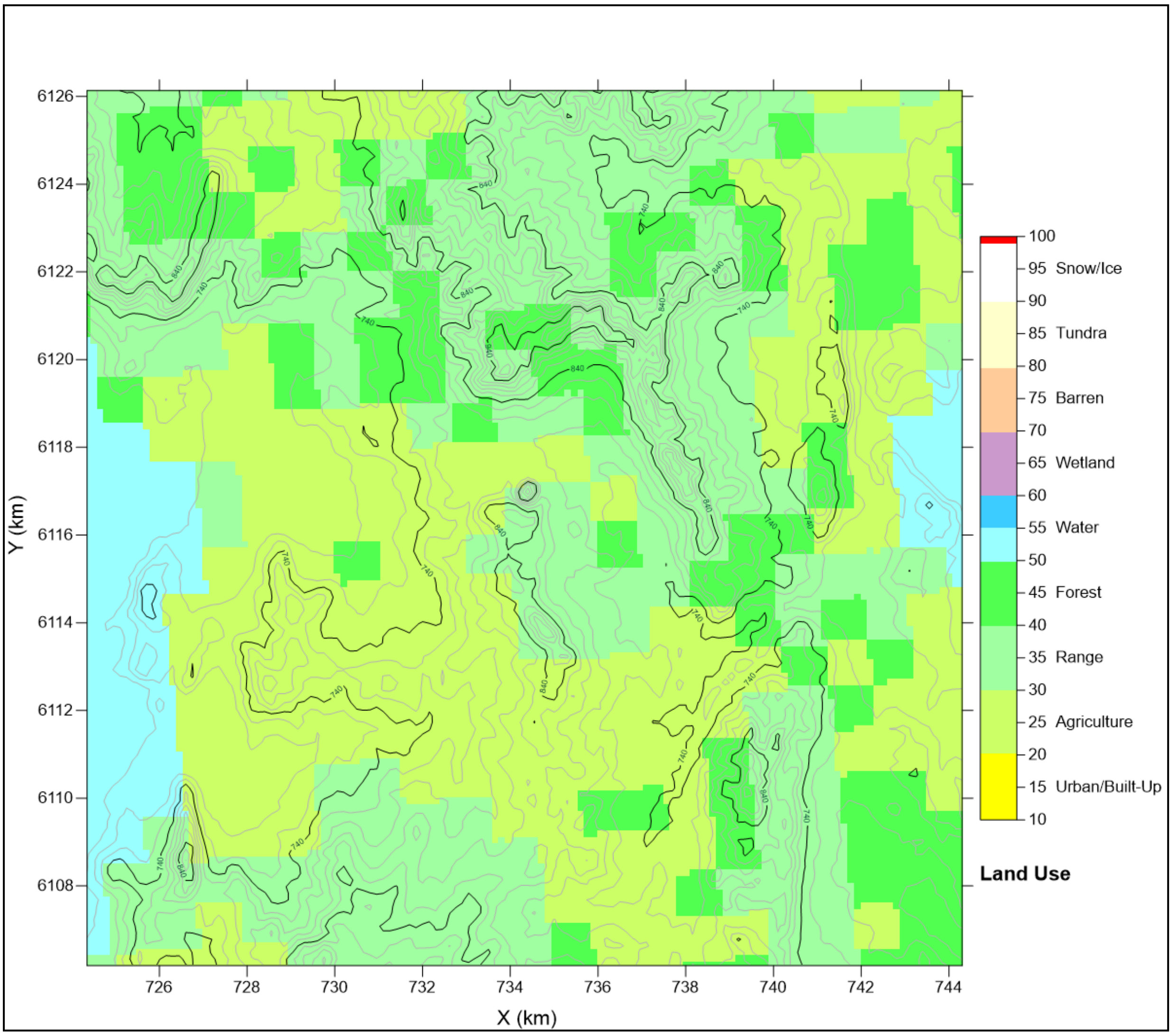


Figure 9.6 – Land use map of Woodlawn and surrounds

9.3.7 Meteorological configuration

9.3.7.1 Input data

One-hour average observed meteorological surface data for a representative year (2015) was sourced from Goulburn Airport that is maintained by the Bureau of Meteorology (**BOM**). The BOM data was formatted into a generic format and was processed with SMERGE to produce a surface meteorological data file.

Numerical meteorological data was produced as a 3D data tile from The Air Pollution Model (v4.0.5) and processed it with CALTAPM (v7.0.0) into a suitable format. TAPM was run using multiple nested grids, at least three nests and 35 vertical levels centred over the Woodlawn site. TAPM innermost nest was 33 km by 33 km at 1 km resolution. The nested grid resolutions were close to a ratio of three as possible.

9.3.7.2 CALMET meteorological model configuration

CALMET was run using the hybrid option that uses geophysical data, surface station data from Bundaberg Airport and upper-air data from the TAPM 3D data tile. The data was used to initialise the diagnostic functions of the CALMET module to produce a full 3D meteorology data for input into CALPUFF. **Table 9.6** shows the key variable fields selected.

9.3.7.3 Meteorological data analysis

Observed 2015 BOM surface data was compared with longer-term climate (2011 – 2015) from Goulburn Airport to gauge how representative and suitable the year is for air quality dispersion modelling. For reference, meteorological data were also extracted from the CALMET model for the location directly near the Woodlawn site office. The annual windroses for Goulburn Airport show very good agreement with west to northwest winds dominating (**Figure 9.7**)**.** The Woodlawn windroses (**Figure 9.8**) show bias to lighter winds and greater frequency of east to south-easterly winds, perhaps due influences from the nearby valley and ridgelines. A more conservative bias is expected relative to the observations at Goulburn Airport.

Both monthly average (**Figure 9.9**) and diurnal temperature (**Figure 9.10**) profiles for the long term and 2015 are in very good agreement. Diurnal mixing heights and stability class frequencies over the Woodlawn site are shown in **Figure 9.11** and **Figure 9.12**, respectively.

Table 9.6 – CALMET key variable fields

Grid Configuration (WGS-84 UTM Zone 55S)		
134		**NX Cells**
134		**NY Cells**
0.15		**Cell Size (km)**
724.277	6106.107	**SW Corner (km)**
11		**Vertical Layers**

ZFACE (m)	0	20	40	80	160	320	640	1000	1500	2000	2500	3000
LAYER	1	2	3	4	5	6	7	8	9	10	11	
MID-PT (m)	10	30	60	120	240	480	820	1250	1750	2250	2750	

Critical Wind Field Settings

Value	Found	Typical	Values
TERRAD	4	None	Terrain scale (km) for terrain effects
IEXTRP	-4	4,-4	Similarity extrap. of wind (-4 ignore upper stn sfc)
ICALM	0	0	Do Not extrapolate calm winds
RMAX1	6	None	MAX radius of influence over land in layer 1 (km)
RMAX2	8	None	MAX radius of influence over land aloft (km)
R1	3	None	Distance (km) where OBS wt = IGF wt in layer 1
R2	4	None	Distance (km) where OBS wt = IGF wt aloft

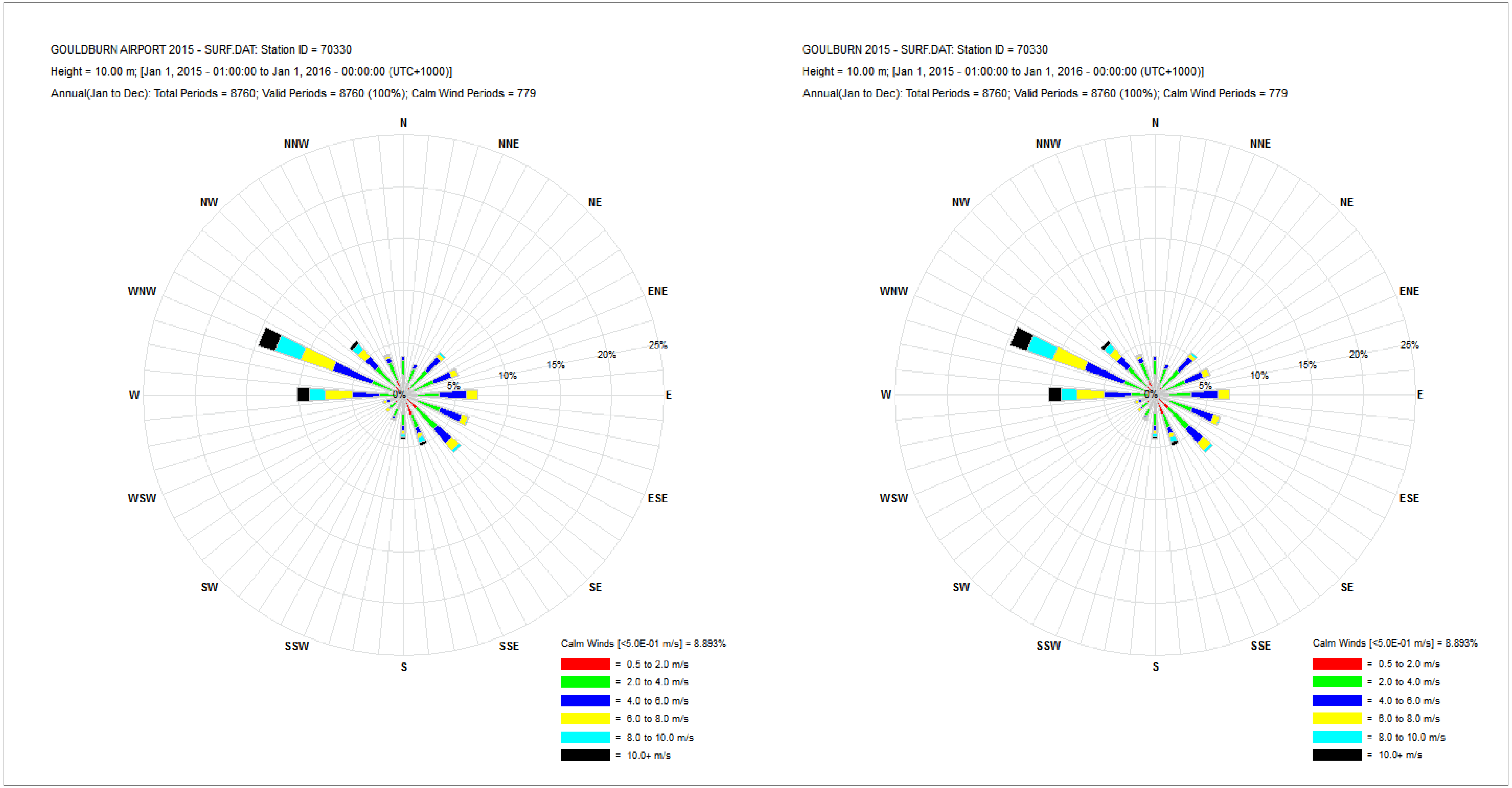


Figure 9.7 – Annual windroses for Goulburn Airport 5 years and 2015 only

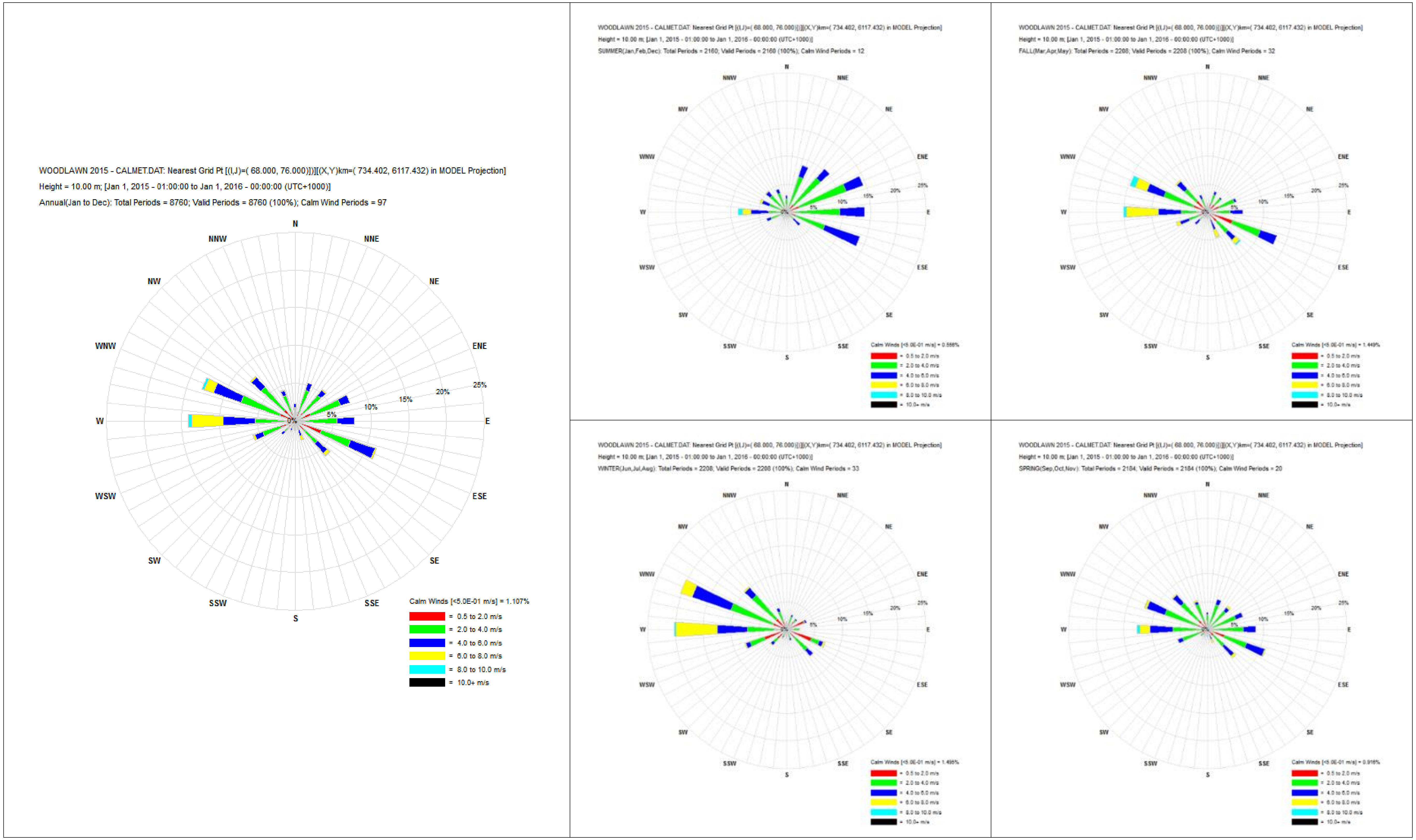


Figure 9.8 – Annual and seasonal windroses for Woodlawn 2015 (modelled)

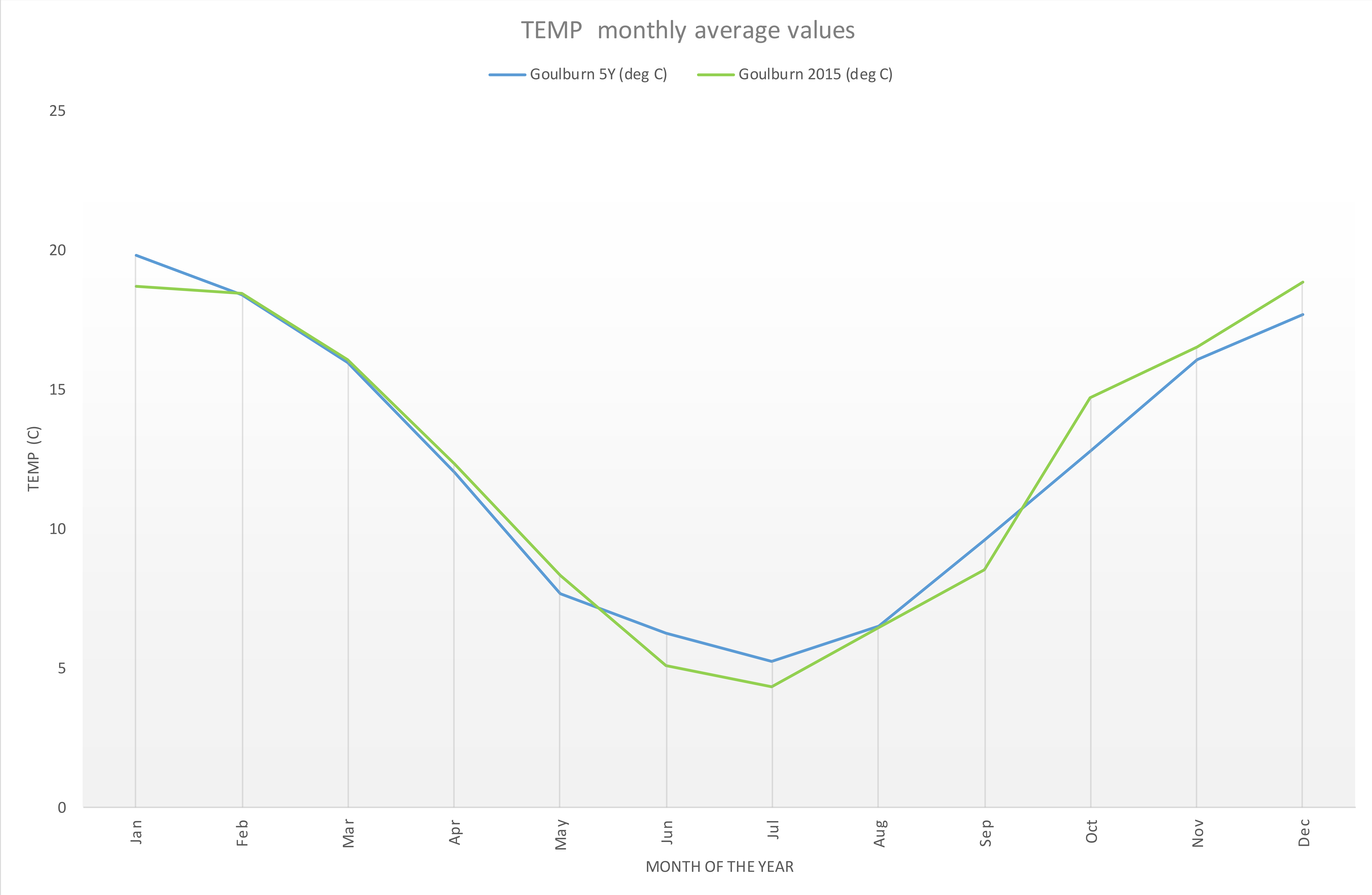


Figure 9.9 – Monthly average temperatures for Goulburn Airport 5 years and 2015 only

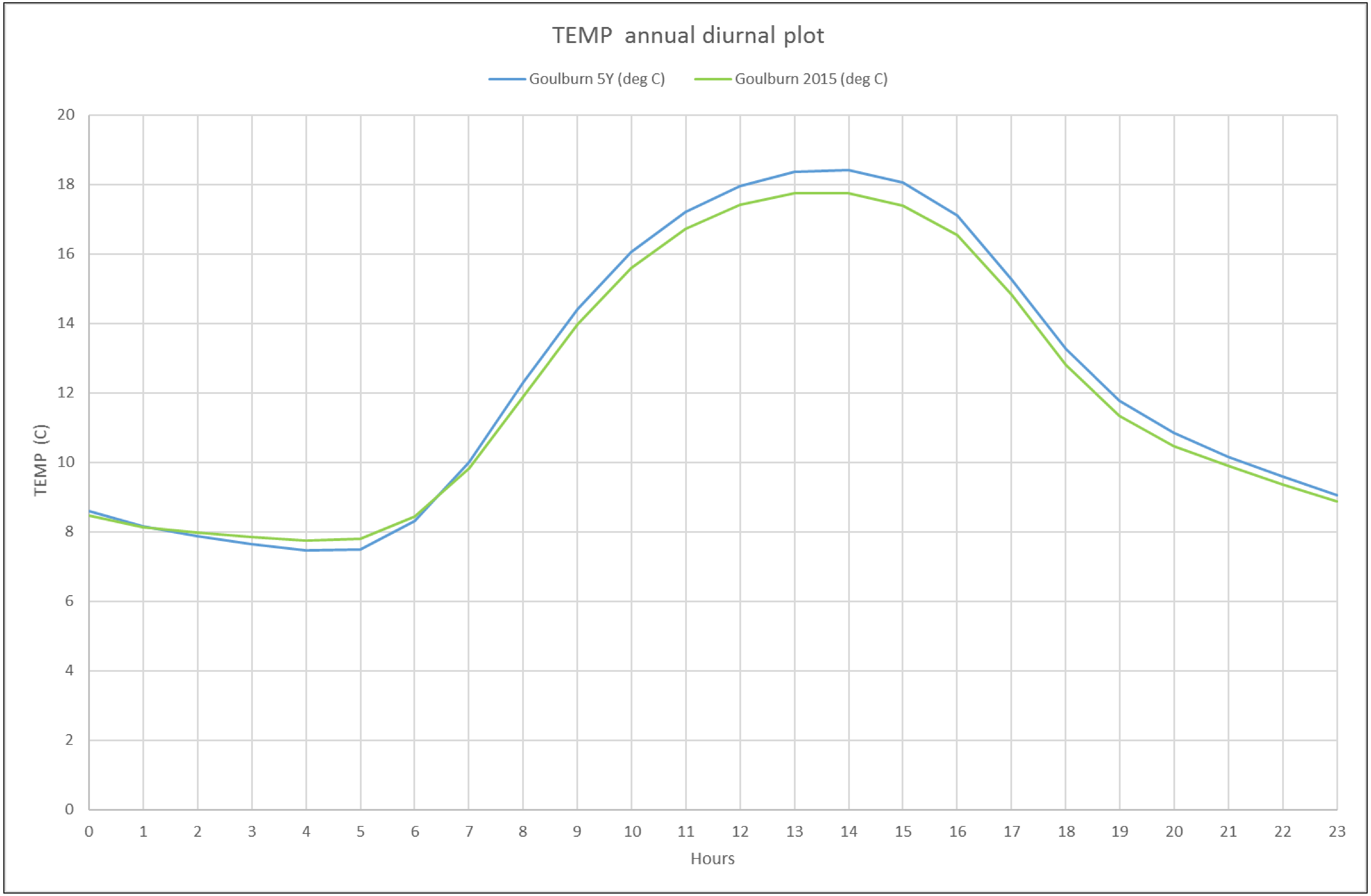


Figure 9.10 – Annual diurnal temperature for Goulburn Airport 5 years and 2015 only

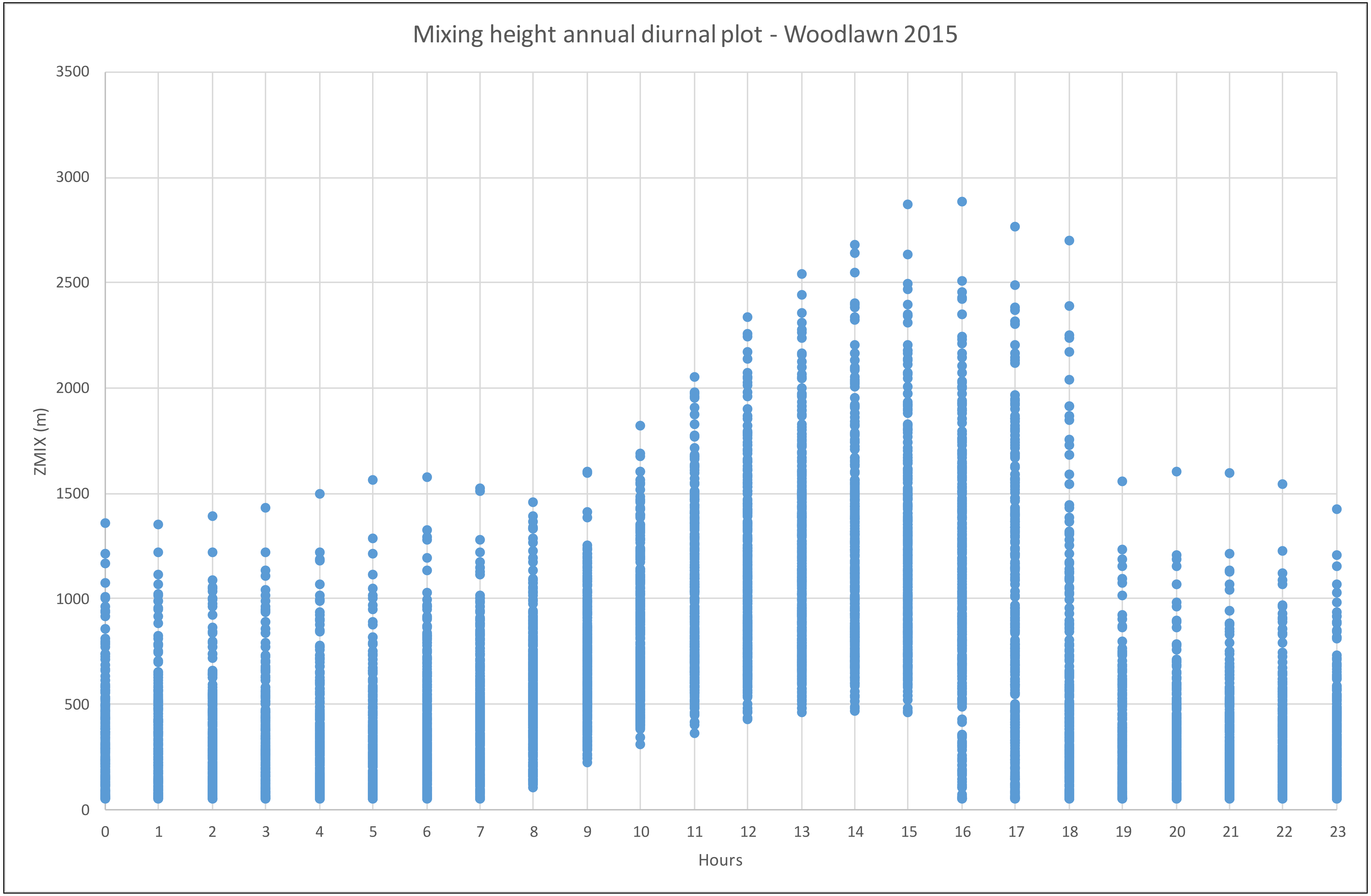


Figure 9.11 – Annual X-Y scatter plot diurnal mixing height for Woodlawn 2015 (modelled)

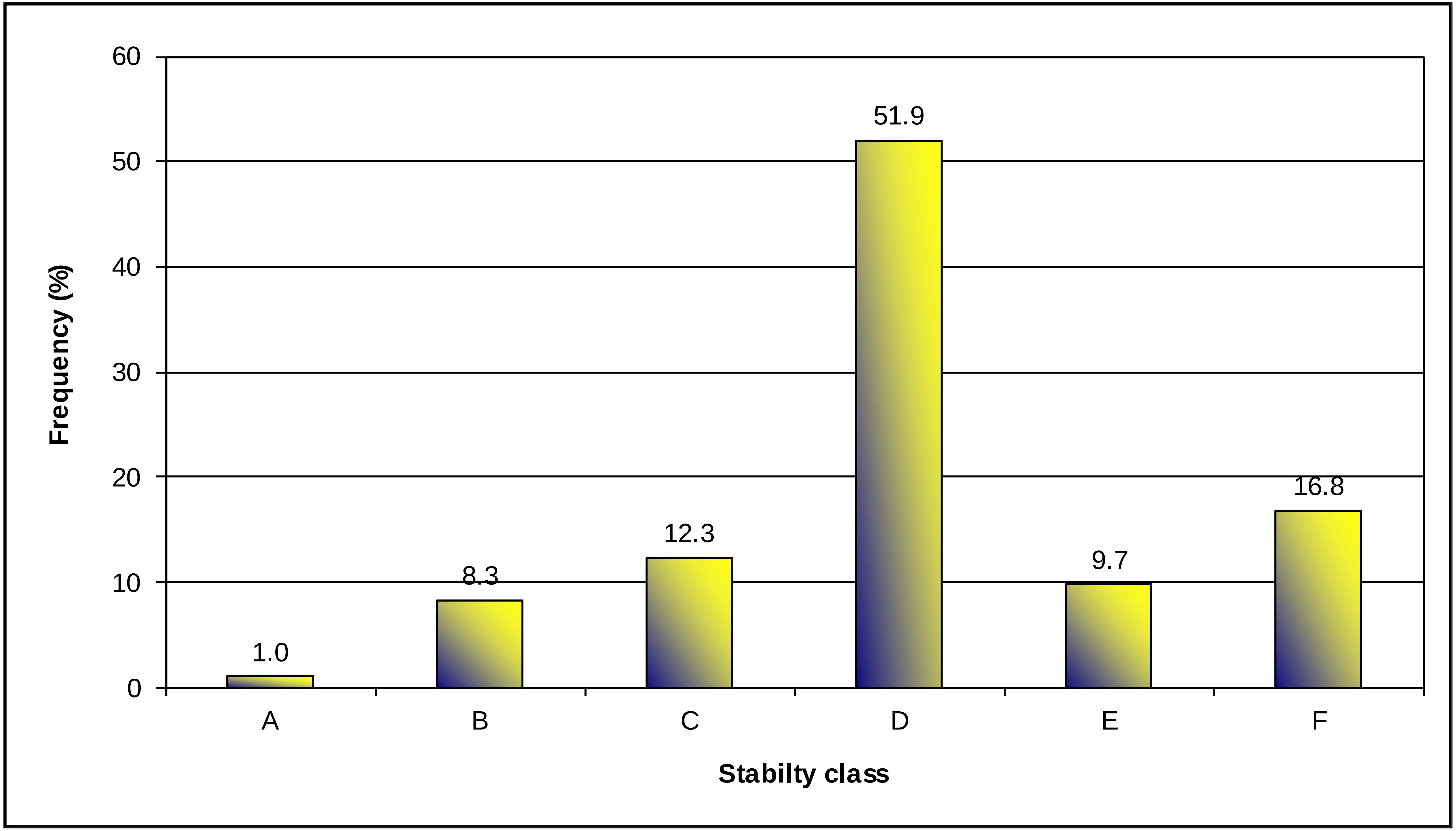


Figure 9.12 – Annual stability class frequency for Woodlawn 2015 (modelled)

9.3.8 CALPUFF Dispersion Model Configuration

9.3.8.1 Computational domain

The computational domain was set to the same parameters as the meteorological domain.

9.3.9 Receptor configuration

Three groups of arbitrary discrete receptors were configured over the modelling domain. A receptor grid was created with a fine resolution inner nest of 9.6 km by 9.6 km by 0.15 km spacing; and an outer nest of 19.35 km by 19.35 km by 0.45 km spacing. A sensitive receptor was placed over the location of the main dwelling at the Torokina property to the southwest of the Site operations. The discrete receptors over properties to the north and east of the Site have been removed from the updated model as they are project-related residences and not considered relevant to the Audit.

9.3.10 Source Configuration and Emission Rates

Full odour source and emission rate configurations are available upon request.

9.3.11 CALPUFF Model Options

CALPUFF default model options were set except for the following as recommended in *Table A*-4 contained and explained within *Barclay and Scire (2011)*:

- Dispersion coefficients (MDISP) = dispersion coefficients from internally calculated sigma v, sigma w using micrometeorological variables (2);
- Probability Density Function used for dispersion under convective conditions (MPDF) = Yes (1); and
- Minimum turbulence velocities sigma v for each stability class over land and water (SVMIN) = 0.2 m/s for A, B, C, D, E, F (0.200, 0.200, … , 0.200).

9.4 ODOUR EMISSIONS SCENARIO

The odour emissions scenario used for the modelling was for what was observed during the Audit, except for the Waste Covered Area that used a dataset from the previous IOA and the Audit. This scenario represents TOU's best estimate of total odour emissions from normal operations during 2019. This scenario does not consider abnormal conditions or upset events.

9.5 ODOUR DISPERSION MODELLING RESULTS

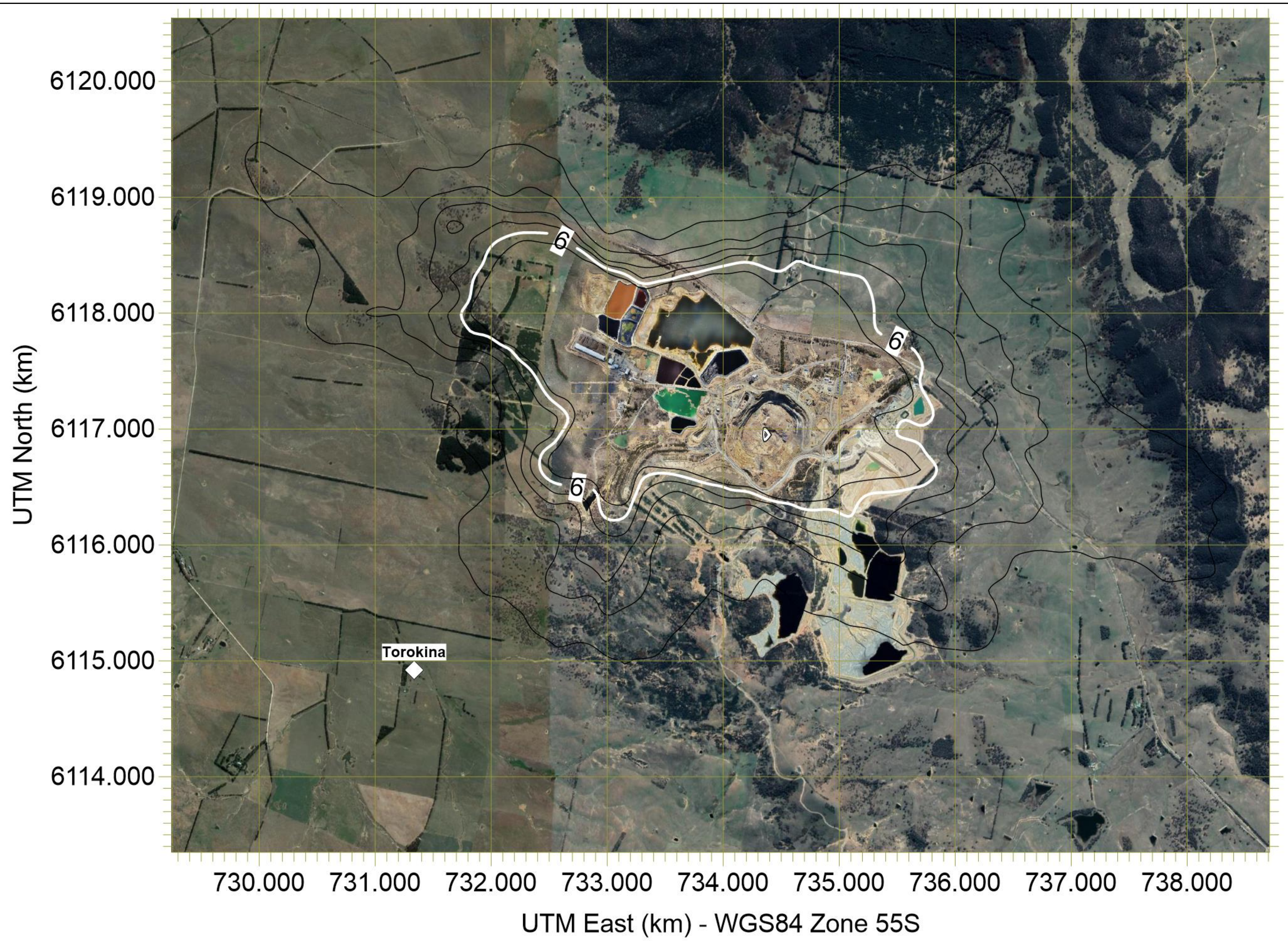
The odour dispersion modelling results are visually shown as contour plots that illustrate the contour plot of the ground level odour IAC of 6.0 ou (99%, P/M60) for the following source groups:

- **Figure 9.13** - Predicted odour impact from all odour sources of Woodlawn operations;
- **Figure 9.14** - Predicted odour impact from Bioreactor/Leachate and MBT source groups;
- **Figure 9.15** - Predicted odour impact from Leachate and Void source groups; and
- **Figure 9.16** - Predicted odour impact from Maturation Pad/LAP and Biofilter source groups

The predicted odour concentration at the Torokina property is provided in **Table 9.7** below, which indicates that the ground level odour concentration has not significantly changed since the previous model.

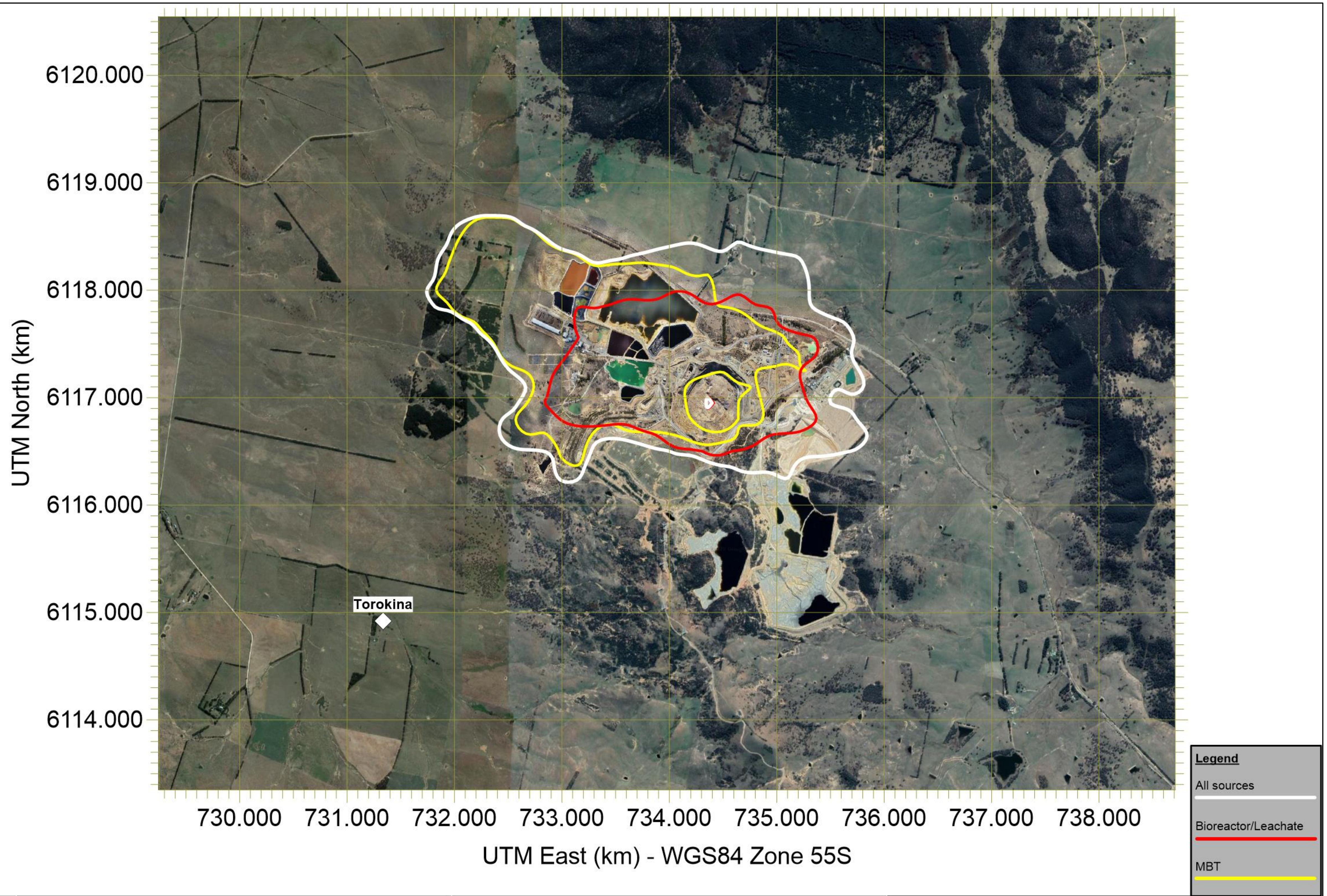
Table 9.7 – Sensitive receptor location and predicted odour impact result

Receptor	UTM East (km)	UTM North (km)	Elevation (m)	Ground level odour concentration (ou)
Torokina	731.336	6114.923	717	1.2



CALPUFF modelling for Veolia **Woodlawn Odour Audit #8** **Modelled by: S. Hayes 25/09/20** **Checked by: M. Assal**	**Predicted odour impact from Woodlawn operations**	**Ground level odour concentration (ou, 99%, P/M60)** **1 ou contour interval** **CALMET (Hybrid) 2015 meteorology** **Odour Audit #8 (2019) meas/est emissions included**

Figure 9.13 - Predicted odour impact from all odour sources of Woodlawn operations



CALPUFF modelling for Veolia Woodlawn Odour Audit #8 Modelled by: S. Hayes 25/09/20 Checked by: M. Assal	**Predicted odour impact from Woodlawn operations**	Ground level odour concentration (ou, 99%, P/M60) 6 ou contour CALMET (Hybrid) 2015 meteorology Odour Audit #8 (2019) meas/est emissions included

Figure 9.14 - Predicted odour impact from Bioreactor/Leachate and MBT source groups

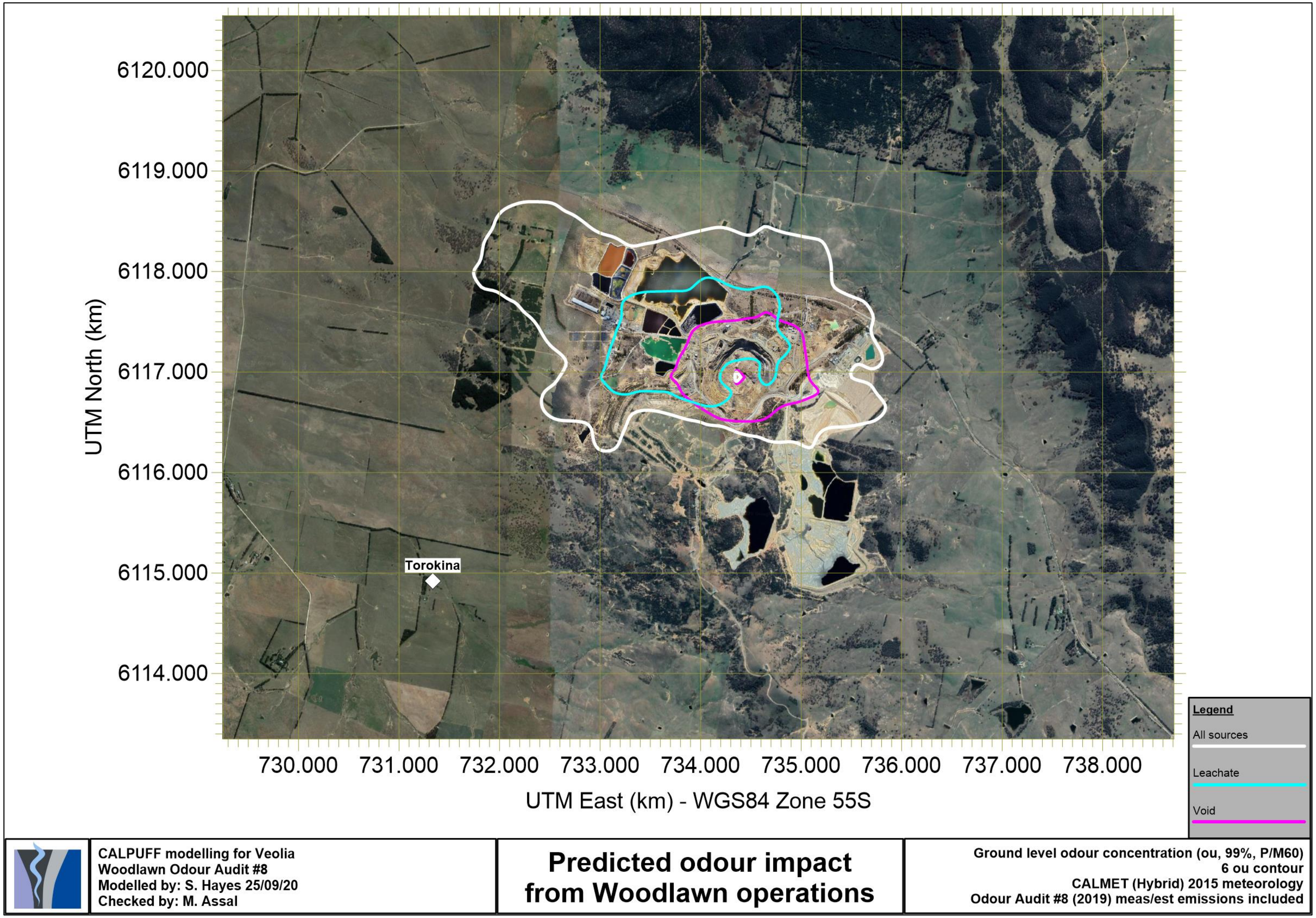
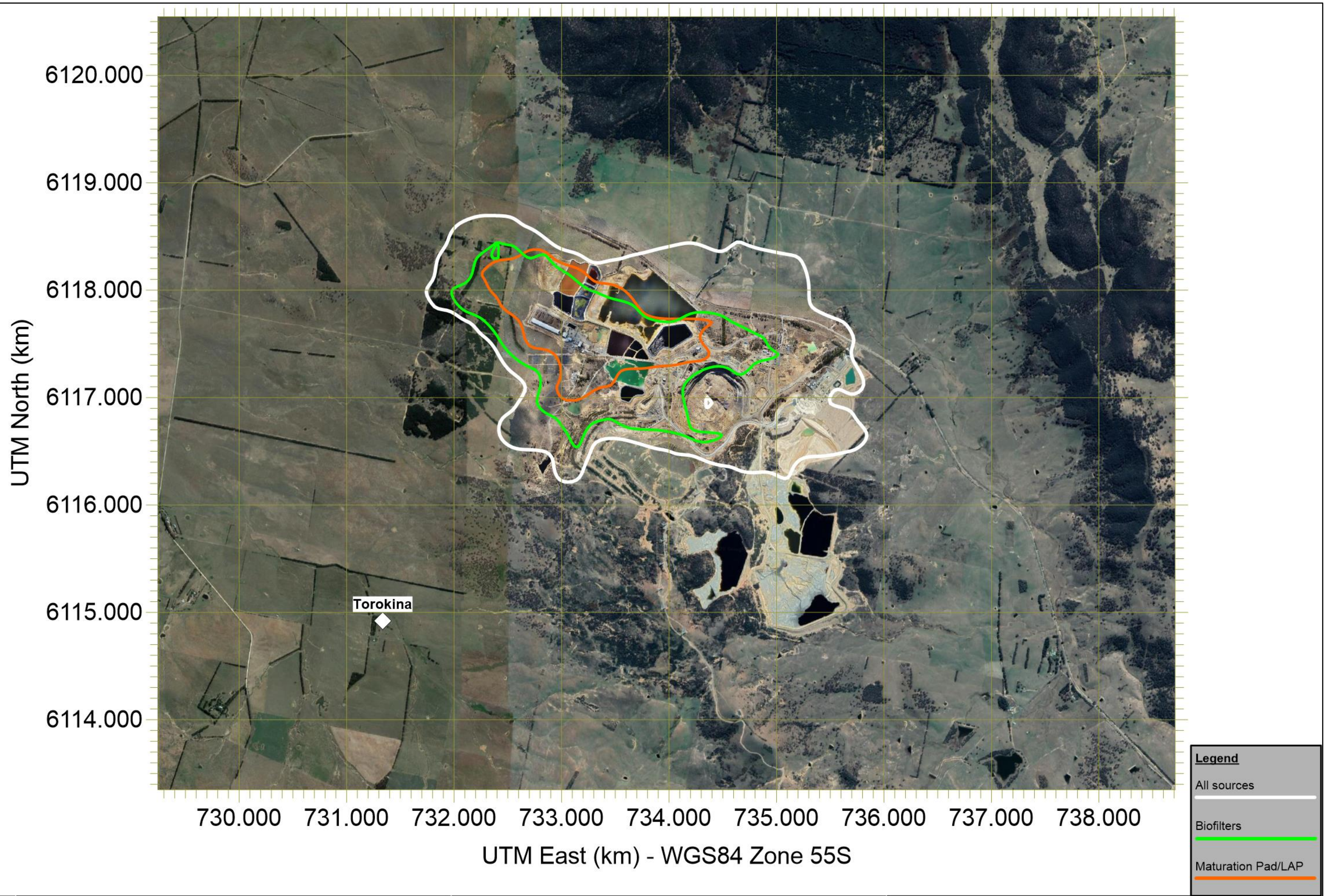


Figure 9.15 - Predicted odour impact from Leachate and Void source groups



CALPUFF modelling for Veolia **Woodlawn Odour Audit #8** **Modelled by: S. Hayes 25/09/20** **Checked by: M. Assal**	**Predicted odour impact from Woodlawn operations**	**Ground level odour concentration (ou, 99%, P/M60)** **6 ou contour** **CALMET (Hybrid) 2015 meteorology** **Odour Audit #8 (2019) meas/est emissions included**

Figure 9.16 - Predicted odour impact from Maturation Pad/LAP and Biofilter source groups

9.6 MODELLING STUDY FINDINGS

An odour dispersion modelling study of the Site using the previous IOA with current operational factors and emissions data determined for the Audit in February 2020 was completed as part of the Audit. This involved the modification of the previous IOA model to best represent the present operations during the Audit period, i.e. calendar year 2019.

The odour emissions scenario used for the modelling was that observed during the Audit. This scenario represents TOU's best estimate of total odour emissions from normal operational conditions for the Woodlawn Bioreactor during 2019. This scenario does not consider abnormal conditions or upset events.

It has been found that the MBT Facility source group is a notable contributor to the overall odour profile of the Site, primarily due to the condition of the biofilters and the maturation pad odour sources at the time of the Audit. The Bioreactor and LMS operations are the second largest contributor from the Void operations. The LTD operation provided an almost negligible contribution to the overall impact, primarily due to the relatively small-scale footprint of the operation. The Audit has made commentary regarding on-going management and monitoring of fugitive gas emissions in **Section 10.2.1**.

Notwithstanding the above observations, the modelling has found that the ground level concentration at the nearest sensitive receptor (i.e. the Torokina property dwelling) is predicted to be well below the NSW EPA odour IAC of 6.0 ou (99%, P/M60). Therefore, it can be concluded that adverse odour impacts are unlikely to be caused by the Site operations under normal operational conditions.

9.6.1 Modelling Study Concluding Remark

The modelling outcome outlined in the Audit is consistent with the previous IOA findings, where compliance was deemed likely given that the majority of the SOER and corresponding OER results were within the ranges used in the EA 2010 (see **Table 8.4**). Moreover, the Audit finds that Veolia continues to actively undertake measures to minimise odour emissions from the Site, including participation in a community consultation process designed to provide the necessary odour impact feedback. This feedback will continue to be important in the management of odour complaints/issues, particularly as a means of managing the increased number of complaints as observed in **Section 8.4.1**. The Audit recommends that this continue in the future as a means of determining compliance or otherwise with the project-specific goal.

10 AUDIT RECOMMENDATIONS

10.1 CONDITION 7 (G & H)

The following section is designed to address the following Audit requirement:

- *Outline all reasonable and feasible measures (including cost/benefit analysis, if required) that may be required to improve odour control at the site; and*
- *Recommend and prioritise (mandatory and non-mandatory) recommendations for their implementations.*

Based on the findings from this Audit, the following mandatory and non-mandatory measures have been recommended. In addition to these measures, Veolia should continue the current community liaison program (including the Woodlawn Community Liaison Committee and the Tarago and District Progress Association Inc.) to notify affected/nearby residents of works and address concerns. Veolia should also continue to log and monitor odour complaints in the current odour complaints register.

The Audit team understands that the odour diary project is currently suspended given the active engagement between Veolia and the affected community as well as the significant reduction in odour complaints noted in the Audit since the previous IOA (refer to **Section 8.4.1**).

10.2 MANDATORY RECOMMENDATIONS

The mandatory recommendations in this Audit revolve around the leachate management system, the continuation of odour mitigation from the Void and optimisation of the odour control infrastructure servicing the MBT Facility. These have been discussed in the following sections.

10.2.1 Odour Mitigation from the Void

Fugitive landfill gas emissions

Veolia should continue to improve landfill gas capture from the Bioreactor. This continuation is underway with Veolia completing its WIP 2020, which outlines a comprehensive plan that is being implemented to increase gas capture. It also seeks to address current areas of concern and the potential solution outcomes that can be implemented. This is an active (and effective) management approach that will result in a continual improvement in gas capture efficiency and ultimately reduce odour/landfill gas emissions from the Void. The Audit endorses this strategy as the primary measure to reduce odour emissions from the Void and recommends that Veolia continues the implementation of the gas systems detailed in the WIP 2020, including:

- The augmentation of additional pipe work and booster/flare/engine to the current capacity at the Site. In principle, the addition of the power station engines will increase landfill gas usage capacity, further facilitate in the optimisation and minimisation of fugitive landfill gas release from the Void surface;
- the planned infrastructure instalments within each waste lift;

- the continuous improvement to leachate extraction, treatment performance, capacity and efficiency. This supported by the implementation of the long-term leachate solution in the form of the LTP that is the process-proving phase of operation;
- the continuous improvement in the waste tipping profile, covering and expansion and optimisation of the landfill gas infrastructure;
- the continuous monitoring of leachate and gas extraction;
- Remediation actions in the event of equipment failure and process upset in the Void;
- The implementation of operational management programs, including:
  - Leachate management;
  - Pumps and pumping solutions; and
  - The expansion of wells in the Void for improved/minimisation of leachate recirculation and landfill gas extraction.

It should be noted that the WIP 2020 is a live document that will be continually updated. Therefore, it will continue to remain a part of the IOA.

10.2.2 Leachate Management System

Continue to adequately maintain and manage the upgraded LMS to ensure it is operating in an optimum state and meeting the leachate quality monitoring targets as outlined in the *Leachate Treatment Operation Manual* and recommended by Veolia Water. Moreover, continue the implementations planned in the WIP 2020. Both the manual and WIP 2020 should be considered as a 'live' document to reflect any variation in quality and operational demands and identifications of new constraints and/or issues. This should continue to attenuate the potential for significant odour generation from the leachate stored in ED3N & ED3S Pond Systems both now and in the future.

The Audit finds that the LTP has provided additional leachate treatment capacity at the Site. Moreover, the treated leachate flowing to ED1 coffer dam from the LTP is of a very high quality, as supported by the LOM results. The inclusive of additional leachate treatment capacity will have a significant effect on the minimisation of odour from the Void and LMS in the medium to long-term. In collaboration with Veolia, the next Audit will make provisions for safe access to enable sampling of the ED1 coffer dam.

10.2.3 Active Tipping Face

Veolia should continue to develop strategies for the minimising of the exposed active tipping face surface area. It should also proceed and continue with the details in the WIP 2020.

10.3 NON-MANDATORY RECOMMENDATIONS

The non-mandatory recommendations in this Audit revolve around odour mitigation strategies for the Void, odour complaints, and fugitive gas emissions from the Void. This has been discussed in the following sections.

10.3.1 Refine Investigation of Odour Issues in the Community

Given the significant improvement in landfill gas extraction in the Void and expansion and improvement in the leachate management system through optimisation of surface water catchments, landfill gas infrastructure design, active tipping practices and increased leachate treatment capacity via the commissioning of the LTP, the odour complaints trend appears to have realised the benefits from the continuous improvement plans implemented at the Site. This is an excellent outcome for a complex operation such as the Site.

Notwithstanding the substantial reduction in odour complaints, the Audit recommends that Veolia continue its active engagement with the community through its existing odour complaints and response management strategy. The handling and management of odour complaints will be reassessed in the next IOA to evaluate the need for additional forms of community engagement, given that the number of complaints remains historically low. As such, the refinement in community engagement remains as a non-mandatory recommendation in the Audit to ensure this matter is provided with the opportunity of continuous improvement. Specifically, Veolia should consider refining its investigation of odour issues in the community, particularly surrounding the most common complainants, as to assess the extent to which odour is present in the community. Such an investigation could include:

- potential odour transport pathways;
- undertaking of field odour surveys;
- assess the topography of surrounding land and analysis of climatic data; and
- a detailed review of odour complaint data.

10.3.2 IMF and Waste Transport Activities

Based on TOU observations, the Audit suggests that Veolia continue to review the following aspects relating to the use of the IMF and waste transport activities to further improve its odour performance as a minor and transient source of odour:

- The washing practice associated with the sealed containers; and
- The maintenance of the sealed containers.

10.3.3 Odour Mitigation from the MBT Facility

The Audit recommends a heightened awareness of the operability and maintenance of the biofilter-based odour control system at the MBT Facility, which should be consistent with the Biofilter Manual to ensure optimal and sustained odour removal performance. Given that the MBT Facility operation is a recent addition to the Audit, a benchmark process will be developed and reviewed as part of subsequent IOAs to assess the operability and odour performance of the biofilter-based odour control system with the objective of continuous improvement in odour mitigation and optimisation.

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REPORT SIGNATURE PAGE

The Odour Unit Pty Ltd

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W: www.odourunit.com.au

ABN: 53 091 165 061

Signed by:

Michael Assal MEngSc, B. Eng (Hon)/B.Sc, AMIChemE, MIEAust, CAQP
Senior Engineer & Consultant

Steven Hayes B.Sc., CAQP
Senior Atmospheric Scientist & Consultant

Veolia Australia & New Zealand

Woodlawn Bioreactor Expansion Project

Independent Odour Audit #8

September 2020

Appendix

APPENDIX A:

RECORD OF CORRESPONDENCE WITH NSW EPA & DPE

Michael Assal

Subject: RE: Veolia Woodlawn Bioreactor Odour Audit #8 (DA 10_0012) - Consultation

From: [redacted]
Sent: Monday, 10 February 2020 8:11 AM
To: Michael Assal <massal@odourunit.com.au>
Cc: [redacted]
Subject: RE: Veolia Woodlawn Bioreactor Odour Audit #8 (DA 10_0012) - Consultation

To Michael

Sorry for the delay in my response. In relation to the independent odour audit (the Odour Audit) at the Woodlawn Bioreactor Facility, Tarago, NSW (the Woodlawn Facility) the Department provides the following advice and/or feedback.

The Odour Audit needs to ensure that it addresses all the requirements outlined in Schedule 4 Condition 7 of the approval.

Furthermore, the audit should consider the number of complaints that were received in relation to odour and compare it to previous years.

The environmental parameters associated for these complaints should also be assessed, for example:
• what were the prevailing winds when the complaint was made;
• was the complaint due to a system breakdown at Woodlawn or the Intermodal;
• was there a leachate incident that lead to an increase in complaints; and
• did the biroreactor process a certain type or waste/high processing capacity at the time the complaint was made.

An analysis of whether the leachate treatment plant has led to a reduction in complaints should also be considered.

Consideration should also be given as to which residents are making the complaints and what operational changes Veolia Environmental Services can make to reduce the odour impacts to those residents.

Should you have any further questions, please feel free to give me a call on the details below.

[redacted]

[redacted]

www.dpie.nsw.gov.au

NSW GOVERNMENT | Planning, Industry & Environment

The Department of Planning, Industry and Environment acknowledges that it stands on Aboriginal land. We acknowledge the traditional custodians of the land and we show our respect for elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

If you are submitting a compliance document or request as required under the conditions of consent or approval, please note that the Department is no longer accepting lodgement via compliance@planning.nsw.gov.au.

The Department has recently upgraded the Major Projects Website to improve the timeliness and transparency of its post approval and compliance functions. As part of this upgrade, proponents are now requested to submit all post approval and compliance documents online, via the Major Projects Website. To do this, please refer to the instructions available here.

From: Michael Assal
Sent: Friday, 24 January 2020 1:26 PM
To: [redacted] <waste.operations@epa.nsw.gov.au>; [redacted]
Subject: Veolia Woodlawn Bioreactor Odour Audit #8 (DA 10_0012) - Consultation
Importance: High

[redacted]

RE: Woodlawn Bioreactor Facility Odour Audit #8

Relevant Background

We, The Odour Unit (**TOU**), have been engaged by Veolia Environmental Services (**Veolia**) to conduct the eighth (8^{th}) independent odour audit (**the Odour Audit**) at the Woodlawn Bioreactor Facility, Tarago, NSW (**the Woodlawn Facility**). In accordance with the project approval requirements outlined in *Condition 7* of *Schedule 4* in the *Specific Environmental Conditions - Landfill sites* (DA 10_0012), which states that we need to *Consult with the Environment Protection Authority (EPA) and the Department of Planning, Industry and Environment (DPIE),* please regard this email as our formal notification for consultation with the relevant regulatory departments for the Odour Audit.

The Odour Audit Proposal

Please find **attached** our proposal as addressed and issued to Veolia for the undertaking of the Odour Audit at the Woodlawn Facility. The attached proposal details our scope of works, the audit team, deliverables, timeframe and other details relating to the undertaking of the Odour Audit.

Consultation Timing

As you will gather from the attached proposal, we have scheduled the fieldwork component of the Odour Audit to be completed between **17 February 2020 and 20 February 2020**. As such, it will be appreciated if we can receive any advice or feedback on or before **Wednesday**, **5 February 2020**.

We look forward to hearing from you soon. Please do not hesitate to contact us if you have any enquiries.

Regards,

Michael Assal MEngSc, B. Eng (Hon)/B.Sc, AMIChemE, MIEAust, CAQP
Operations Manager, Senior Engineer & Consultant

THE ODOUR UNIT

The Odour Unit Pty Ltd
Level 3, 12/56 Church Avenue
MASCOT NSW 2020

T: +61 2 9209 4420 **T(D):** +61 2 9209 4394
M: +61 430 097 202
W: http://www.odourunit.com.au

Michael Assal

Subject: RE: HPE CM: RE: Veolia Woodlawn Bioreactor Odour Audit #8 (DA 10_0012) - Consultation

From: [redacted] **On Behalf Of** EPA WARR Waste Operations Mailbox
Sent: Friday, 7 February 2020 12:01 PM
To: Michael Assal <massal@odourunit.com.au>
Subject: HPE CM: RE: Veolia Woodlawn Bioreactor Odour Audit #8 (DA 10_0012) - Consultation

Dear Sir/Madam,

Thank you for your email to the EPA's Waste Operations Section.

The EPA acknowledges receipt of your correspondence and will review the information as soon as possible. If the EPA requires any further information from you, or if it is determined that an EPA response is required, the EPA will respond to you in writing.

If you have any questions regarding this matter, please email the Waste Operations Mailbox.

Yours sincerely.

Email: waste.operations@epa.nsw.gov.au
Web: www.epa.nsw.gov.au
Report pollution and environmental incidents 131 555 (NSW only) or +61 2 9995 5555

From: Michael Assal
Sent: Friday, 24 January 2020 1:26 PM
To: [redacted] 'waste.operations@epa.nsw.gov.au' <waste.operations@epa.nsw.gov.au> [redacted]
Subject: Veolia Woodlawn Bioreactor Odour Audit #8 (DA 10_0012) - Consultation
Importance: High

[redacted]

RE: Woodlawn Bioreactor Facility Odour Audit #8

Relevant Background

We, The Odour Unit (**TOU**), have been engaged by Veolia Environmental Services (**Veolia**) to conduct the eighth (8^{th}) independent odour audit (**the Odour Audit**) at the Woodlawn Bioreactor Facility, Tarago, NSW (**the Woodlawn Facility**). In accordance with the project approval requirements outlined in *Condition 7* of *Schedule 4* in the *Specific Environmental Conditions - Landfill sites* (DA 10_0012), which states that we need to *Consult with the Environment Protection Authority (EPA) and the Department of Planning, Industry and Environment (DPIE),* please regard this email as our formal notification for consultation with the relevant regulatory departments for the Odour Audit.

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We look forward to hearing from you soon. Please do not hesitate to contact us if you have any enquiries.

Regards,

Michael Assal MEngSc, B. Eng (Hon)/B.Sc, AMIChemE, MIEAust, CAQP
Operations Manager, Senior Engineer & Consultant

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APPENDIX B:

ODOUR CONCENTRATION LABORATORY TESTING RESULT SHEETS

THE ODOUR UNIT (QLD) PTY LTD

THE ODOUR UNIT

PO Box 365,
CAPALABA, Qld 4157

2/57 Neumann Rd,
CAPALABA, Qld 4157

Phone: +61 7 3245 1700
Facsimile: +61 7 3245 1800
Email: QLDinfo@odourunit.com.au
Internet: www.odourunit.com.au
ABN: 87 102 255 765

NATA

Accreditation Number: 14974

Odour Concentration Measurement Report

The measurement was commissioned by:

Organisation	Veolia Environmental Services	Telephone	+61 436 120 128
Contact	Ark Du	Facsimile	--
Sampling Site	Woodlawn Bioreactor Facility	Email	ark.du@veolia.com
Sampling Method	Isolation flux chamber	Sampling Team	TOU

Order details:

Order requested by	Ark Du	Order accepted by	M. Assal
Date of order	13.02.2020	TOU Project #	N1806L.03
Order number	7100210575	Project Manager	M. Assal
Signed by	Ark Du	Testing operator	S. Munro

Investigated Item	Odour concentration in odour units ‘ou’, determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian/New Zealand Standard: Stationary source emissions – Part 3: ‘*Determination of odour concentration by dynamic olfactometry* (AS/NZS4323.3:2001). The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the ‘Comments’ section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained at 22 ºC ±3 ºC.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: TOU-OLF-004
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the AS/NZS4323.3:2001. TOU-OLF-004: $r = 0.439$ (Nov 2019), Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the AS/NZS4323.3:2001. TOU-OLF-004: $A = 0.110$ (Nov 2019), Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou (4 times the lowest dilution setting)
Traceability	The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen. Note Disclaimers on last page of this document.

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.
This report shall not be reproduced, except in full.

Date: Tuesday, 18 February 2020 Panel Roster Number: BNE20200218_013

SMunro

S. Munro
Authorised Signatory

THE ODOUR UNIT (QLD) PTY LTD

Accreditation Number:
14974

Odour Sample Measurement Results
Panel Roster Number: BNE20200218_013

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Sample Odour Concentration (ou)
Sample 1 - ED3S	BC20057	17/02/2020 16:00 AEDT	18/02/2020 09:56 AEST	4	8	181
Sample 2 - ED3S	BC20058	17/02/2020 16:43 AEDT	18/02/2020 10:19 AEST	4	8	140
Sample 3 - ED3N-3	BC20059	17/02/2020 16:06 AEDT	18/02/2020 10:43 AEST	4	8	108
Sample 4 - ED3N-3	BC20060	17/02/2020 16:43 AEDT	18/02/2020 11:04 AEST	4	8	76
Sample 5 - ED3N-3	BC20061	17/02/2020 16:20 AEDT	18/02/2020 11:24 AEST	4	8	128
Sample 6 - ED3N-2	BC20062	17/02/2020 16:58 AEDT	18/02/2020 11:45 AEST	4	8	140
Sample 7 - ED3N-2	BC20063	17/02/2020 16:25 AEDT	18/02/2020 12:05 AEST	4	8	139
Sample 8 - ED3N-2	BC20064	17/02/2020 17:08 AEDT	18/02/2020 13:01 AEST	4	8	166

Samples Received in Laboratory – From: Stephen Munro Date: 18/02/2020 Time: 08:00

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	BNE20200218_013	51,100	$20 \leq \chi \leq 80$	1,218	42	Yes

Comments

Odour characters (non-NATA accredited) as determined by odour laboratory panel:

BC20057	rubber tyres
BC20058	rubber tyres
BC20059	oily, gravel
BC20060	nutty, bitumen
BC20061	nutty
BC20062	oily, nutty, roast pan scrapings
BC20063	oily, nutty, roast pan scrapings
BC20064	cooking oil, roast pan scrapings

Disclaimers

1. Parties, other than The Odour Unit Pty Ltd, responsible for collecting odour samples have advised that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing.
2. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.
3. Any comments included in, or attachments to, this Report are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd.
4. This report shall not be reproduced, except in full, without written approval of The Odour Unit Pty Ltd.

END OF DOCUMENT

THE ODOUR UNIT (QLD) PTY LTD

THE ODOUR UNIT

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NATA
Accreditation Number:
14974

Odour Concentration Measurement Report

The measurement was commissioned by:

Organisation	Veolia Environmental Services	Telephone	+61 436 120 128
Contact	Ark Du	Facsimile	--
Sampling Site	Woodlawn Bioreactor Facility	Email	ark.du@veolia.com
Sampling Method	Isolation flux chamber	Sampling Team	TOU

Order details:

Order requested by	Ark Du	Order accepted by	M. Assal
Date of order	13.02.2020	TOU Project #	N1806L.03
Order number	7100210575	Project Manager	M. Assal
Signed by	Ark Du	Testing operator	S. Munro

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian/New Zealand Standard: Stationary source emissions – Part 3: '*Determination of odour concentration by dynamic olfactometry* (AS/NZS4323.3:2001). The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \le \chi \le 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained at 22 °C ±3 °C.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: TOU-OLF-004
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \le 0.477$ in accordance with the AS/NZS4323.3:2001. TOU-OLF-004: $r = 0.439$ (Nov 2019), Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \le 0.217$ in accordance with the AS/NZS4323.3:2001. TOU-OLF-004: $A = 0.110$ (Nov 2019), Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou (4 times the lowest dilution setting)
Traceability	The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen. Note Disclaimers on last page of this document.

NATA

Accredited for compliance with ISO/IEC 17025 - Testing.
This report shall not be reproduced, except in full.

Date: Wednesday, 19 February 2020 Panel Roster Number: BNE20200219_014

SMunro

S. Munro
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: BNE20200219_014

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Sample Odour Concentration (ou)
Sample 13 - ED3N-4	BC20068	18/02/2020 09:04 AEDT	19/02/2020 09:56 AEST	4	8	128
Sample 14 - ED3N-4	BC20069	18/02/2020 09:55 AEDT	19/02/2020 10:17 AEST	4	8	128
Sample 15 - ED3N-4	BC20070	18/02/2020 10:48 AEDT	19/02/2020 10:39 AEST	4	8	139
Sample 16 - ED3S-S	BC20071	18/02/2020 09:20 AEDT	19/02/2020 11:01 AEST	4	8	664
Sample 17 - ED3S-S	BC20072	18/02/2020 10:01 AEDT	19/02/2020 11:21 AEST	4	8	1,020
Sample 18 - ED3S-S	BC20073	18/02/2020 10:42 AEDT	19/02/2020 11:42 AEST	4	8	1,020

Samples Received in Laboratory – From: Brendon Smith Date: 19/02/2020 Time: 09:30

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

THE ODOUR UNIT (QLD) PTY LTD

Accreditation Number: 14974

Odour Sample Measurement Results
Panel Roster Number: BNE20200219_014

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Sample Odour Concentration (ou)
Sample 19 - Leachate Treatment Dam: Anoxic Zone	BC20074	18/02/2020 09:43 AEDT	19/02/2020 12:02 AEST	4	8	8,930
Sample 20 - Leachate Treatment Dam: Aerobic Zone	BC20075	18/02/2020 10:10 AEDT	19/02/2020 12:59 AEST	4	8	19,500
Sample 21 - MBT Maturation Pad: Unscreened 4 - 6 months	BC20076	18/02/2020 13:46 AEDT	19/02/2020 14:55 AEST	4	8	5,790
Sample 22 - MBT Maturation Pad: Screened 3 months	BC20077	18/02/2020 13:55 AEDT	19/02/2020 14:05 AEST	4	8	861
Sample 23 - MBT Maturation Pad: Screened 1 month	BC20078	18/02/2020 14:03 AEDT	19/02/2020 14:22AEST	4	8	11,600
Sample 24 - MBT Maturation Pad: Screened 2 months	BC20079	18/02/2020 14:22 AEDT	19/02/2020 14:47 AEST	4	8	2,440

Samples Received in Laboratory – From: Brendon Smith Date: 19/02/2020 Time: 09:30

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

THE ODOUR UNIT (QLD) PTY LTD

Accreditation Number: 14974

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	BNE20200219_014	51,100	$20 \le \chi \le 80$	1,218	42	Yes

Comments

Odour characters (non-NATA accredited) as determined by odour laboratory panel:

BC20068	earthy	BC20074	sewage, ammoniacal
BC20069	earthy	BC20075	sewage, ammoniacal
BC20070	fatty	BC20076	cooked, burnt fat, rancid
BC20071	fatty	BC20077	light leafy, herbaceous, earthy, soil
BC20072	sewage, septic	BC20078	pickles, vinegar, sour
BC20073	sewage	BC20079	roasted fat, woolstore

Disclaimers

1. Parties, other than The Odour Unit Pty Ltd, responsible for collecting odour samples have advised that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing.
2. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.
3. Any comments included in, or attachments to, this Report are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd.
4. This report shall not be reproduced, except in full, without written approval of The Odour Unit Pty Ltd.

END OF DOCUMENT

THE ODOUR UNIT (QLD) PTY LTD

THE ODOUR UNIT

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Facsimile: +61 7 3245 1800
Email: QLDinfo@odourunit.com.au
Internet: www.odourunit.com.au
ABN: 87 102 255 765

Accreditation Number:
14974

Odour Concentration Measurement Report

The measurement was commissioned by:

Organisation	Veolia Environmental Services	Telephone	+61 436 120 128
Contact	Ark Du	Facsimile	--
Sampling Site	Woodlawn Bioreactor Facility	Email	ark.du@veolia.com
Sampling Method	Isolation flux chamber	Sampling Team	TOU

Order details:

Order requested by	Ark Du	Order accepted by	M. Assal
Date of order	13.02.2020	TOU Project #	N1806L.03
Order number	7100210575	Project Manager	M. Assal
Signed by	Ark Du	Testing operator	S. Munro

Investigated Item	Odour concentration in odour units ‘ou’, determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian/New Zealand Standard: Stationary source emissions – Part 3: ‘*Determination of odour concentration by dynamic olfactometry* (AS/NZS4323.3:2001). The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the ‘Comments’ section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained at 22 ºC ±3 ºC.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: TOU-OLF-004
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the AS/NZS4323.3:2001. TOU-OLF-004: $r = 0.439$ (Nov 2019), Compliance – Yes
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Traceability	The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen. Note Disclaimers on last page of this document.

Accredited for compliance with ISO/IEC 17025 - Testing.
This report shall not be reproduced, except in full.

Date: Thursday, 20 February 2020

Panel Roster Number: BNE20200220_015

SMunro

S. Munro
Authorised Signatory

THE ODOUR UNIT (QLD) PTY LTD

Accreditation Number:
14974

Odour Sample Measurement Results
Panel Roster Number: BNE20200220_015

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Sample Odour Concentration (ou)
Sample 25 - Active Tipping Face: Less than one day old	BC20080	19/02/2020 10:12 AEDT	20/02/2020 09:08 AEST	4	8	5,790
Sample 26 - Active Tipping Face: Less than one day old	BC20081	19/02/2020 10:12 AEDT	20/02/2020 09:32 AEST	4	8	9,740
Sample 27 - Active Tipping Face: Less than one day old	BC20082	19/02/2020 10:12 AEDT	20/02/2020 09:58 AEST	4	8	11,600
Sample 28 - Waste Covered Area: 150 mm	BC20083	19/02/2020 10:24 AEDT	20/02/2020 10:36 AEST	4	8	664
Sample 29 - Waste Covered Area: 150 mm	BC20084	19/02/2020 11:15 AEDT	20/02/2020 11:05 AEST	4	8	431
Sample 30 - Waste Covered Area: 300 mm	BC20085	19/02/2020 11:52 AEDT	20/02/2020 11:37 AEST	4	8	558
Sample 31 - Waste Covered Area: 300 mm	BC20086	19/02/2020 11:30 AEDT	20/02/2020 12:04 AEST	4	8	430

Samples Received in Laboratory – From: Steve Hayes Date: 20/02/2020 Time: 08:00

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

Odour Sample Measurement Results
Panel Roster Number: BNE20200220_015

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Sample Odour Concentration (ou)
Sample 32 - Waste Covered Area: 300 mm	BC20087	19/02/2020 11:58 AEDT	20/02/2020 13:04 AEST	4	8	362
Sample 33 - Waste Covered Area: 300 mm	BC20088	19/02/2020 12:05 AEDT	20/02/2020 13:29 AEST	4	8	304
Sample 34 - MBT Biofilter 1: Cell 1 Composite (Closet to fan)	BC20089	19/02/2020 14:55 AEDT	20/02/2020 14:00 AEST	4	8	395
Sample 35 - MBT Biofilter 1: Cell 2 Composite (Middle)	BC20090	19/02/2020 15:05 AEDT	20/02/2020 14:27 AEST	4	8	470
Sample 36 - MBT Biofilter 1: Cell 3 Composite (Furthest from fan)	BC20091	19/02/2020 15:15 AEDT	20/02/2020 14:55 AEST	4	8	4,470
Sample 37 - MBT Biofilter 1: Common Inlet	BC20092	19/02/2020 15:18 AEDT	20/02/2020 15:29 AEST	4	8	6,890

Samples Received in Laboratory – From: Steve Hayes Date: 20/02/2020 Time: 08:00

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	BNE20200220_015	51,100	$20 \leq \chi \leq 80$	861	59	Yes

Comments

Odour characters (non-NATA accredited) as determined by odour laboratory panel:

BC20080	vegetation	BC20087	rotten sweet fruit, vomit
BC20081	earthy, vegetation, undergrowth	BC20088	dirty clothes, wet shoes
BC20082	vegetation, leafy	BC20089	earthy
BC20083	musty, rotten sweet	BC20090	earthy, soil
BC20084	sweet fruit	BC20091	silage, wet cereal
BC20085	vomit, rancid	BC20092	bin juice, compost, vegetation
BC20086	dirty clothes		

Disclaimers

1. Parties, other than The Odour Unit Pty Ltd, responsible for collecting odour samples have advised that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing.
2. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.
3. Any comments included in, or attachments to, this Report are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd.
4. This report shall not be reproduced, except in full, without written approval of The Odour Unit Pty Ltd.

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THE ODOUR UNIT (QLD) PTY LTD

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Internet: www.odourunit.com.au
ABN: 87 102 255 765

NATA
Accreditation Number: 14974

Odour Concentration Measurement Report

The measurement was commissioned by:

Organisation	Veolia Environmental Services	Telephone	+61 436 120 128
Contact	Ark Du	Facsimile	--
Sampling Site	Woodlawn Bioreactor Facility	Email	ark.du@veolia.com
Sampling Method	Isolation flux chamber	Sampling Team	TOU

Order details:

Order requested by	Ark Du	Order accepted by	M. Assal
Date of order	13.02.2020	TOU Project #	N1806L.03
Order number	7100210575	Project Manager	M. Assal
Signed by	Ark Du	Testing operator	S. Munro

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian/New Zealand Standard: Stationary source emissions – Part 3: '*Determination of odour concentration by dynamic olfactometry* (AS/NZS4323.3:2001). The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained at 22 ºC ±3 ºC.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: TOU-OLF-004
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the AS/NZS4323.3:2001. TOU-OLF-004: $r = 0.439$ (Nov 2019), Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the AS/NZS4323.3:2001. TOU-OLF-004: $A = 0.110$ (Nov 2019), Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou (4 times the lowest dilution setting)
Traceability	The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen. Note Disclaimers on last page of this document.

NATA

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Date: Friday, 21 February 2020

Panel Roster Number: BNE20200221_016

SMunro

S. Munro
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: BNE20200221_016

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Sample Odour Concentration (ou)
Sample 38 - MBT Biofilter 2: Western Cell Outlet Composite (Closet to inlet)	BC20097	20/02/2020 09:49 AEDT	21/02/2020 10:48 AEST	4	8	2,900
Sample 39 - MBT Biofilter 2: Western Cell Outlet Composite (Furthest from inlet)	BC20098	20/02/2020 09:54 AEDT	21/02/2020 11:11 AEST	4	8	5,790
Sample 40 - MBT Biofilter 2: Eastern Cell Outlet Composite (Furthest from inlet)	BC20099	20/02/2020 10:03 AEDT	21/02/2020 11:37 AEST	4	8	5,310
Sample 41 - MBT Biofilter 2: Eastern Cell Outlet Composite (Closet to inlet)	BC20100	20/02/2020 10:10 AEDT	21/02/2020 12:37 AEST	4	8	2,660
Sample 42 - MBT Biofilter 2: Common Inlet	BC20101	20/02/2020 10:16 AEDT	21/02/2020 13:26 AEST	4	8	5,310

Samples Received in Laboratory – From: Brendon Smith (ex Brisbane TNT depot) Date: 21/02/2020 Time: 10:00 hrs

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	BNE20200221_016	51,100	$20 \leq \chi \leq 80$	861	59	Yes

Comments

Odour characters (non-NATA accredited) as determined by odour laboratory panel:

BC20097	nutty, compost
BC20098	nutty, compost
BC20099	nutty, compost
BC20100	nutty, compost, soil, light pickles
BC20101	nutty, compost, soil

Disclaimers

1. Parties, other than The Odour Unit Pty Ltd, responsible for collecting odour samples have advised that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing.
2. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.
3. Any comments included in, or attachments to, this Report are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd.
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Internet: www.odourunit.com.au
ABN: 53 091 163 061

Accreditation Number: 14974

Odour Concentration Measurement Results

The measurement was commissioned by:

Organisation	Veolia Environmental Services	Telephone	+61 436 120 128
Contact	Ark Du	Facsimile	--
Sampling Site	Woodlawn Bioreactor Facility	Email	ark.du@veolia.com
Sampling Method	Liquid Odour Method	Sampling Team	TOU

Order details:

Order requested by	Ark Du	Order accepted by	M. Assal
Date of order	13.02.2020	TOU Project #	N1806L.03
Order number	7100210575	Project Manager	M. Assal
Signed by	Ark Du	Testing operator	A. Schulz

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian/New Zealand Standard: Stationary source emissions – Part 3: '*Determination of odour concentration by dynamic olfactometry* (**AS/NZS4323.3:2001**). The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained at 22 °C ±3 °C.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: ODORMAT V01.
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the AS/NZS4323.3:2001. ODORMAT V01: r = 0.280 (October 2019) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the AS/NZS4323.3:2001. ODORMAT V01: A = 0.076 (October 2019) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou, which is 4 times the lowest dilution setting.
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

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Date: Monday, 16 March 2020

Panel Roster Number: SYD20200302_024

A. Schulz
NSW Laboratory Coordinator

D. Hepple
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20200302_024

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	*Specific Odour Emission Rate ($ou.m^3/m^2/s$) (See Note:1)*
Sample 3 – ED3N-3	SC20196	02.03.2020 0950 hrs	02.03.2020 1127 hrs	4	8	--	--	166	166	--
Sample 4 – ED3N-3	SC20197	02.03.2020 1000 hrs	02.03.2020 1212 hrs	4	8	--	--	118	118	--
Sample 5 – ED3N-3	SC20198	02.03.2020 1015 hrs	02.03.2020 1244 hrs	4	8	--	--	108	108	--
Sample 6 – ED3N-2	SC20199	02.03.2020 1025 hrs	02.03.2020 1358 hrs	4	8	--	--	91	91	--
Sample 7 – ED3N-2	SC20200	02.03.2020 1255 hrs	02.03.2020 1432 hrs	4	8	--	--	118	118	--

Samples Received in Laboratory – From: TOU Laboratory Date: 02.03.2020 Time: ---- hrs

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (**IFH**) samples and the calculation of the Specific Odour Emission Rate (**SOER**).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

Odour Sample Measurement Results
Panel Roster Number: SYD20200302_024

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	*Specific Odour Emission Rate (ou.m³/m²/s) (See Note:1)*
Sample 8 – ED3N-2	SC20201	02.03.2020 1300 hrs	02.03.2020 1508 hrs	4	8	--	--	99	99	--
Sample 13 – ED3N-4	SC20202	02.03.2020 1305 hrs	02.03.2020 1543 hrs	4	8	--	--	64	64	--
Sample 14 – ED3N-4	SC20203	02.03.2020 1407 hrs	02.03.2020 1618 hrs	4	8	--	--	49	49	--
Sample 15 – ED3N-4	SC20204	02.03.2020 1413 hrs	02.03.2020 1655 hrs	4	8	--	--	54	54	--
ED1 Coffer Dam	SC20205	02.03.2020 1418 hrs	02.03.2020 1734 hrs	4	8	--	--	45	45	--

Samples Received in Laboratory – From: TOU Laboratory Date: 02.03.2020 Time: ---- hrs

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (**IFH**) samples and the calculation of the Specific Odour Emission Rate (**SOER**).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

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Accreditation Number: 14974

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	SYD20200302_024	51,400	$20 \leq \chi \leq 80$	724	71	Yes

Comments

Odour characters (non-NATA accredited) as determined by odour laboratory panel:

SC20196 musty, muddy water
SC20197 musty, muddy water
SC20198 musty, muddy water
SC20199 musty, muddy water
SC20200 musty, muddy water
SC20201 musty, muddy water
SC20202 musty, muddy water
SC20203 musty, muddy water
SC20204 musty, muddy water
SC20205 musty, muddy water

Disclaimers

1. Parties, other than The Odour Unit Pty Ltd, responsible for collecting odour samples have advised that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing.
2. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.
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ABN: 53 091 163 061

Accreditation Number: 14974

Odour Concentration Measurement Results

The measurement was commissioned by:

Organisation	Veolia Environmental Services	Telephone	+61 436 120 128
Contact	Ark Du	Facsimile	--
Sampling Site	Woodlawn Bioreactor Facility	Email	ark.du@veolia.com
Sampling Method	Liquid Odour Method	Sampling Team	TOU

Order details:

Order requested by	Ark Du	Order accepted by	M. Assal
Date of order	13.02.2020	TOU Project #	N1806L.03
Order number	7100210575	Project Manager	M. Assal
Signed by	Ark Du	Testing operator	A. Schulz

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian/New Zealand Standard: Stationary source emissions – Part 3: '*Determination of odour concentration by dynamic olfactometry* (**AS/NZS4323.3:2001**). The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained at 22 °C ±3 °C.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: ODORMAT V01.
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the AS/NZS4323.3:2001. ODORMAT V01: r = 0.280 (October 2019) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the AS/NZS4323.3:2001. ODORMAT V01: A = 0.076 (October 2019) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou, which is 4 times the lowest dilution setting.
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

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Date: Monday, 16 March 2020

Panel Roster Number: SYD20200306_027

A. Schulz
NSW Laboratory Coordinator

D. Hepple
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20200306_027

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	*Specific Odour Emission Rate (ou.m³/m²/s) (See Note:1)*
Sample 17 - ED3SS	SC20222	06.03.2020 1057 hrs	06.03.2020 1334 hrs	5	8	--	--	470	470	--
Sample 16 - ED3SS	SC20223	06.03.2020 1100 hrs	06.03.2020 1419 hrs	5	8	--	--	181	181	--
Sample 18 - ED3SS	SC20224	06.03.2020 1236 hrs	06.03.2020 1504 hrs	5	10	--	--	39	39	--
Leachate Treatment Plant Effluent	SC20225	06.03.2020 1230 hrs	06.03.2020 1539 hrs	5	10	--	--	56	56	--

Samples Received in Laboratory – From: TOU Laboratory Date: 06.03.2020 Time: ---- hrs

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (**IFH**) samples and the calculation of the Specific Odour Emission Rate (**SOER**).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd have performed the dilution of samples.

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	SYD20200306_027	51,400	$20 \leq \chi \leq 80$	956	54	Yes

Comments

Odour characters (non-NATA accredited) as determined by odour laboratory panel:

SC20222 muddy water
SC20223 muddy water
SC20224 musty
SC20225 musty

Disclaimers

1. Parties, other than The Odour Unit Pty Ltd, responsible for collecting odour samples have advised that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing.
2. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.
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APPENDIX C:

TECHNICAL DOCUMENTATION RELEVANT TO THE AUDIT

THE ODOUR UNIT

ODOUR COMPLAINTS REGISTER:

1 APRIL 2019 AND 31 MARCH 2020

Date	Complaint lodged	EPL	Method	Type	Response	Location	Description	Duration	Response/action taken to resolve the complaint
20/3/2020	6:30:00 am	11436	EPA Environmental Line	Odour	Letter	Leahys Lane, Tarago	The complainant reported through the EPA Environmental Line that they had been impacted by offensive odours allegedly coming from the Woodlawn Bioreactor on the mornings of 9/3/20, 18/3/20 and 19/3/20 from about 6:30 to about 9:30am. The caller noted that the odour is regularly present on still, foggy mornings.	3 hours at a time over the 3 mornings	Veolia has identified an opportunity to improve the way in which we attend to any future gas sensor failures. This has been communicated with all new power station staff to ensure that the gas extraction system, in its entirety, is monitored with any discrepancies identified, investigated, and rectified in a timely manner ensuring it is operating at maximum efficiency. Veolia is in the final stages of installing a Stormwater Management System that will vastly improve our ability to remove stormwater from the void before it has a chance to interact with any waste.
19/3/2020	8:21:00 am	11436	EPA Environmental Line	Odour	Letter	6 Rosebery Street, Tarago	The complainant reported to the Environmental Line through EPA that there was "a strong smell of rotting garbage. The odour has been strong for the past 3 days. Odour is worse in the morning. Odour is coming into the house."	3 days particularly in the morning	Veolia has identified an opportunity to improve the way in which we attend to any future gas sensor failures. This has been communicated with all new power station staff to ensure that the gas extraction system, in its entirety, is monitored with any discrepancies identified, investigated, and rectified in a timely manner ensuring it is operating at maximum efficiency. Veolia is in the final stages of installing a Stormwater Management System that will vastly improve our ability to remove stormwater from the void before it has a chance to interact with any waste.
19/3/2020	8:01:00 am	11436	EPA Environmental Line	Odour	Letter	Mulwaree St, Tarago	The complainant reported to the Environmental Line through EPA that they smelt as a "rotting vegetable smell and terrible stench". The resident did not wish to pass their details on.	Not specified	Veolia has identified an opportunity to improve the way in which we attend to any future gas sensor failures. This will be communicated with all new power station staff to ensure that the gas extraction system, in its entirety, is monitored with any discrepancies identified, investigated, and rectified in a timely manner ensuring it is operating at maximum efficiency. Veolia is in the final stages of installing a Stormwater Management System that will vastly improve our ability to remove stormwater from the void before it has a chance to interact with any waste.
23/8/2019	6:04:00 pm				Letter	King Street, Tarago	The complainant reported to the Environmental line through EPA that they experienced "a very pungent odour dominant in the air and it smells like rubbish disposal ".	Not specified	The power station had 6 engines operating as the site was undergoing maintenance on the seventh one, during this time the flare was also used to ensure consistent extraction and flow of gas from the Bioreactor. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 220m3 of raw leachate per day. The existing treatment plant is still in operation.
1/8/2019	9:50:00 am				Letter	Rosebery Street, Tarago	The complainant reported to the Environmental line through EPA that they "they were being affected by an offensive odour which started early this morning, it was a very strong odour, there was no wind at the time. They said the offensive odour has been on and off for the last 4 weeks".	Not specified	A review of the dewatering process has commenced in an effort to maintain Veolia's commitment to continuous improvement. The site is experiencing record levels of gas capture, with all seven engines operating. The focus over the previous months has been the ongoing development of the Woodlawn Infrastructure Plan and installation of new gas extraction systems around the bioreactor. The result has been a positive outcome for the operations team and our ongoing compliance commitment. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 120m3 of raw leachate per day. The existing treatment plant is still in operation.
18/6/2019	3:39:00 pm				Letter	Mayfield Road, Tarago	The complainant reported to the Environmental line through EPA that they were affected by "a putrid offensive odour at approximately 7:45am that morning. They said the odour was very strong in the air for about 2 hours before dissipating. The wind was still."	2 hours	The site is experiencing record levels of gas capture, with all seven engines operating. The focus over the previous months has been the ongoing development of the Woodlawn Infrastructure Plan and installation of new gas extraction systems around the bioreactor. The result has been a positive outcome for the operations team and our ongoing compliance commitment. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 180m3 of raw leachate per day. The existing treatment plant is still operating at capacity. Veolia had a Community Liaison Meeting on the 19/06/2019, to discuss the updates on site.

11/6/2019	12:52:00 pm				Letter	Braidwood Road, Lake Bathurst	The complainant reported to the Environmental line through EPA that they detected a "strong sour, fermenting, rotten cabbage smell at approx. 11: 55am today outside their home on Braidwood Road."	Not specified	The site is experiencing record levels of gas capture, with all seven engines operating. The focus over the previous months has been the ongoing development of the Woodlawn Infrastructure Plan and installation of new gas extraction systems around the bioreactor. The result has been a positive outcome for the operations team and our ongoing compliance commitment. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 180m3 of raw leachate per day. The existing treatment plant is still operating at capacity.
13/5/2019	8:43:00 pm				Letter	Leahys Lane, Tarago	The complainant reported to the Environmental line through EPA that there is a " very strong smell of rotting garbage from the Woodlawn Bioreactor from 7:30pm".	Not specified	The site is experiencing record levels of gas capture, with all seven engines operating. The focus over the previous months has been the ongoing development of the Woodlawn Infrastructure Plan and installation of new gas extraction systems around the bioreactor. The result has been a positive outcome for the operations team and our ongoing compliance commitment. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 150m3 of raw leachate per day. The existing treatment plant is still operating at capacity.
6/5/2019	10:11:00 pm				Letter	Leahys Lane, Tarago	The complainant reported to the Environmental line through EPA that there is a " very strong smell of rotting garbage from the Woodlawn Bioreactor".	Not specified	The site is experiencing record levels of gas capture, with all seven engines operating. The focus over the previous months has been the ongoing development of the Woodlawn Infrastructure Plan and installation of new gas extraction systems around the bioreactor. The result has been a positive outcome for the operations team and our ongoing compliance commitment. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 100m3 of raw leachate per day. The existing treatment plant is still operating at capacity. The odour audit was conducted at the end of February; Veolia is currently reviewing initial results from the Odour Unit.
3/4/2019	8:38:00 am				Letter	Rosebery Street, Tarago	The complainant reported to the Environmental line through EPA that there was "a stinking garbage smell present at his house".	30 minutes	The site is experiencing record levels of gas capture, with all seven engines operating. The focus over the previous months has been the ongoing development of the Woodlawn Infrastructure Plan and installation of new gas extraction systems around the bioreactor. The result has been a positive outcome for the operations team and our ongoing compliance commitment. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 100m3 of raw leachate per day. The existing treatment plant is still operating at capacity. The odour audit was conducted at the end of February; Veolia is awaiting the outcomes from the independent auditors.
24/3/2019	8:32:00 am				Letter	Rosebery Street, Tarago	The complainant reported to the Environmental line through EPA that there was "a very potent landfill smell".	Not specified	The site is experiencing record levels of gas capture, with all seven engines operating. The focus over the previous months has been the ongoing development of the Woodlawn Infrastructure Plan and installation of new gas extraction systems around the bioreactor. The result has been a positive outcome for the operations team and our ongoing compliance commitment. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 100m3 of raw leachate per day. The existing treatment plant is still operating at capacity. The odour audit was conducted at the end of February; Veolia is awaiting the outcomes from the independent auditors.
24/3/2019	8:04:00 am				Letter	Rosebery Street, Tarago	The complainant reported to the Environmental line through EPA that there was "a strong pungent odour present at his house and he had to close all the windows".	Not specified	The site is experiencing record levels of gas capture, with all seven engines operating. The focus over the previous months has been the ongoing development of the Woodlawn Infrastructure Plan and installation of new gas extraction systems around the bioreactor. The result has been a positive outcome for the operations team and our ongoing compliance commitment. The Leachate Treatment Plant is in the process-proving phase and is currently treating leachate around 100m3 of raw leachate per day. The existing treatment plant is still operating at capacity. The odour audit was conducted at the end of February; Veolia is awaiting the outcomes from the independent auditors.

18/2/2019	8:59:00 pm				Letter	Willandra Lane, Tarago	The complainant reported to community feedback line that she "detected a slight odour."	Not specified	Veolia continues to address the challenges of water management within the Bioreactor and is attempting to address this with the development and implementation of a longer term treatment solution being advanced by Veolia's water division. The Leachate Treatment Plant is in the mid commissioning phase and is currently treating leachate at small quantities. The existing treatment plant is still operating at capacity. A bio-filter is also used to manage any fugitive gas between the void's wall and waste mass. The next Independent Odour Audit has been scheduled and is on the 19th Feb. 2019, which will outline the current performance of the site. We are constantly reviewing our tipping sequence in an attempt to further improve gas collection.
18/2/2019	11:00:00 am				Letter	King Street, Tarago	The complainant reported to the community feedback line that he "detected a sweet, sickly smell on Sunday morning and this morning."	Not specified	Veolia continues to address the challenges of water management within the Bioreactor and is attempting to address this with the development and implementation of a longer term treatment solution being advanced by Veolia's water division. The Leachate Treatment Plant is in the mid commissioning phase and is currently treating leachate at small quantities. The existing treatment plant is still operating at capacity. A bio-filter is also used to manage any fugitive gas between the void's wall and waste mass. The next Independent Odour Audit has been scheduled and is on the 19th Feb. 2019, which will outline the current performance of the site. We are constantly reviewing our tipping sequence in an attempt to further improve gas collection.
8/2/2019	8:29:00 pm				Letter	Tarago	The complainant reported to community feedback line that she "Detected an odour at her house which was around for about 30 mins."	30 minutes	Veolia continues to address the challenges of water management within the Bioreactor and is attempting to address this with the development and implementation of a longer term treatment solution being advanced by Veolia's water division. The Leachate Treatment Plant is in the mid commissioning phase and is currently treating leachate at small quantities. The existing treatment plant is still operating at capacity. A bio-filter is also used to manage any fugitive gas between the void's wall and waste mass. The next Independent Odour Audit has been scheduled and is on the 19th Feb. 2019, which will outline the current performance of the site. We are constantly reviewing our tipping sequence in an attempt to further improve gas collection.
4/2/2019	7:30:00 am				Letter	Willandra Lane, Tarago	The complainant reported to community feedback line that she had to "close her house up due to the rubbish smell."	Detected at time of call.	Veolia continues to address the challenges of water management within the Bioreactor and is attempting to address this with the development and implementation of a longer term treatment solution being advanced by Veolia's water division. The Leachate Treatment Plant is in the mid commissioning phase and is currently treating leachate at small quantities. The existing treatment plant is still operating at capacity. A bio-filter is also used to manage any fugitive gas between the void's wall and waste mass. The next Independent Odour Audit is scheduled to begin this month, which will outline the current performance of the site. We are constantly reviewing our tipping sequence in an attempt to further improve gas collection.
25/1/2019	7:52:00 am				Letter	Rosebery Street, Tarago	The complainant reported to the Environmental line through EPA that there was "a foul odour present at her house from about 6:30am."	1 hour 30 minutes	Veolia continues to address the challenges of water management within the Bioreactor and is attempting to address this with the development and implementation of a longer term treatment solution being advanced by Veolia's water division. The Leachate Treatment Plant is in the mid commissioning phase and is currently treating leachate at small quantities. The existing treatment plant is still operating at capacity. A bio-filter is also used to manage any fugitive gas between the void's wall and waste mass. The next Independent Odour Audit is scheduled to begin next month, which will outline the current performance of the site. We are constantly reviewing our tipping sequence in an attempt to further improve gas collection.
23/1/2019	8:42:00 am				Letter	Rosebery Street, Tarago	The complainant reported to the Environmental line through EPA that there was an "offensive rotten garbage odour and he had to shut the windows to his house to stop the odour coming in."	7 hours	Veolia continues to address the challenges of water management within the Bioreactor and is attempting to address this with the development and implementation of a longer term treatment solution being advanced by Veolia's water division. The Leachate Treatment Plant is in the mid commissioning phase and is currently treating leachate at small quantities. The existing treatment plant is still operating at capacity. A bio-filter is also used to manage any fugitive gas between the void's wall and waste mass. The next Independent Odour Audit is scheduled to begin next month, which will outline the current performance of the site. We are constantly reviewing our tipping sequence in an attempt to further improve gas collection.

EMISSIONS TESTING REPORT: WOODLAWN BIOGAS POWER STATION (R008159):

30 SEPTEMBER 2019

REPORT NUMBER R008159

Emission Testing Report
Veolia Environmental Services (Australia) Pty Ltd

Woodlawn Biogas Power Station, Tarago

Document Information

Client Name:	Veolia Environmental Services (Australia) Pty Ltd (NSW)
Report Number:	R008159
Date of Issue:	30 September 2019
Attention:	Sureka Withanage
Address:	619 Collector Rd Tarago NSW 2580
Testing Laboratory:	Ektimo Pty Ltd, ABN 86 600 381 413

Report Authorisation

Aaron Davis
Ektimo Signatory

NATA Accredited Laboratory
No. 14601

Accredited for compliance with ISO/IEC 17025 - Testing. NATA is a signatory to the ILAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

Table of Contents

1 EXECUTIVE SUMMARY

1.1 *Background*

Ektimo was engaged by Veolia Environmental Services (Australia) Pty Ltd to perform emission testing at their Tarago plant. Testing was carried out in accordance with environmental protection licence 11436.

1.2 *Project objectives*

The objectives of the project were to conduct a monitoring programme to quantify emissions from 2 discharge points to determine whether they were in compliance with Veolia Environmental Services (Australia) Pty Ltd's environmental protection licence 11436.

Location	Test Date	Test Parameters*
EPA Point 8 – Generator Exhaust	5 September 2019	Hydrogen sulfide Sulfuric acid mist and sulfur trioxide (as SO_3) Carbon dioxide, carbon monoxide, nitrogen oxides, oxygen, sulfur dioxide Volatile organic compounds (VOCs) Destruction efficiency C_1-C_4 hydrocarbons
EPA Point 5 - LFG Supply		Carbon dioxide, oxygen Volatile organic compounds (VOCs) C_1-C_4 hydrocarbons

* Flow rate, velocity, temperature and moisture were also determined.

All results are reported on a dry basis at STP.

Plant operating conditions have been noted in the report.

2 LICENCE COMPARISON

The following licence comparison table shows that all analytes highlighted in green are within the licence limit and all analytes highlighted orange are within the experimental error margin (19%) of the methods and cannot be deemed definitively compliant or non-compliant.

The experimental error margin associated with the test results (defined as the 95% confidence interval) was considered when determining whether the results were compliant or non-compliant.

The 95% confidence interval is a range of values that contains the true result with 95% certainty. This means there is a 5% risk that the true result is outside this range.

Refer to the Test Methods table for the error margins.

Monitoring results are summarized in the following table:

EPA No.	Location Description	Pollutant	Units	Licence Limit	Detected Values
8	Engine 2 Exhaust Stack	Hydrogen Sulfide	mg/m^3	5	<0.01
		Sulfuric acid mist and sulfur trioxide (as SO_3)	mg/m^3	100	1.9
		Nitrogen Oxides	mg/m^3 @ 7% O_2	450	280
		Volatile organic compound destruction efficiency	%	≥ 98	98

3 SAMPLE PLANE COMPLIANCE

Ektimo assessed the engine exhaust stack sampling plane criteria and selection of sampling points outlined in NSW TM-1 (Australian Standard 4323.1 -1995). In this method, the selection of sampling plane position calls for an Ideal sampling plane to be located in a straight, preferably vertical section of stack or duct away from any flow obstructions which may cause a disturbance or other instability to the gas flow. This position will be found to exist at 7-8 hydraulic diameters downstream and 2-3 hydraulic diameters upstream from a flow disturbance. In the case of the EPA point 8 engine exhaust stack, the sampling plane is located 4 hydraulic diameters downstream of a junction and 2 hydraulic diameters from the exit. See table 1 for details.

TABLE 1
CRITERIA FOR SELECTION OF SAMPLING PLANES

Type of flow disturbance	Minimum distance upstream from disturbance, diameters (*D*)	Minimum distance downstream from disturbance, diameters (*D*)
Bend, connection, junction, direction change	>2*D*	>6*D*
Louvre, butterfly damper (partially closed or closed)	>3*D*	>6*D*
Axial fan	>3*D*	>8*D* (see Note)
Centrifugal fan	>3*D*	>6*D*

NOTE: The plane should be selected as far as practicable from a fan. Flow straighteners may be required to ensure the position chosen meets the check criteria listed in Items (a) to (f) below.

In addition the following criteria must be met.

a) The gas velocity is basically in the same direction at all points along each sampling traverse.
b) The gas velocity at all sampling points is greater than 3 m/s.
c) The gas flow profile at the sampling plane shall be steady, evenly distributed and not have a cyclonic component which exceeds an angle of 15° to the duct axis, when measured near the periphery of a circular sampling plane
d) The temperature difference between adjacent points of the survey along each sampling traverse is less than 10% of the absolute temperature, and the temperature at any point differs by less than 10% from the mean.
e) The ratio of the highest to lowest pitot pressure difference shall not exceed 9:1 and the ratio of highest to lowest gas velocities shall not exceed 3:1. For isokinetic testing the use of impingers, the gas velocity ratio across the sampling plane should not exceed 1.6:1
f) The gas temperature at the sampling plane should preferably be above the dewpoint.

If the criteria of items (a) to (f) cannot be achieved a new sampling position shall be selected. The EPA point 8 engine exhaust stack meets all criteria of (a) to (f) and is suitable, therefore a new sampling position is not required, although an increased number of sampling points shall be used in accordance with clause 4.2 (non-ideal sampling positions) of AS 4323.1-1995.

Clause 4.2 proposes that if the criteria of table 1 cannot be met then a greater number of points shall be used in order to retain as much accuracy as is practicable, by applying the appropriate sampling point factors from *table 2*. The product of both the upstream and downstream factors multiplied by the total number of sampling points from *table 3* should then be raised to the next even number of sampling points for each sampling traverse.

TABLE 2
SAMPLING POINT FACTORS

Non-ideal situation	Sampling point factors
Sampling plane downstream from disturbance:	
Diameters less than Table 1	
0	1.00
1	1.05
2	1.10
3	1.15
4 or more	1.20
Sampling plane upstream from disturbance:	
Diameters less than Table 1	
0	1.00
0.5	1.05
1.0	1.10
1.5 or more	1.15

TABLE 3
MINIMUM NUMBER OF SAMPLING POINTS FOR CIRCULAR SAMPLING PLANES

Sampling plane diameter m	Minimum number of sampling traverses	Minimum number of access holes	Minimum number of sampling points per radius	Minimum total number of sampling points
>0.20 ≤0.35	2	2	1	4
>0.35 ≤0.70	2	2	2	8
>0.70 ≤1.50	2	2	3	12
>1.50 ≤2.50	2	4	4	16
>2.50 ≤4.00	2	4	6	24
>4.00 ≤6.00	3	6	5	30
>6.00	3	6	6	36

By example, the EPA point 8 engine exhaust stack has a sampling plane diameter of 350mm. If an ideal sampling plane was available the total number of sampling points would equate to 4. For this location, we have used a sampling point factor of 1.10 which yields a total number of sampling points of 8.

4 RESULTS

4.1 *EPA Point 8 – (Engine 1 Exhaust Stack)*

Date	5/09/2019	**Client**	Veolia Environmental Services (Australia) Pty Ltd
Report	R008159	**Stack ID**	EPA Point 8 - (Engine 1 Exhaust Stack)
Licence No.	11436	**Location**	Tarago
Ektimo Staff	Scott Woods & Zoe Parker	**State**	NSW
Process Conditions	Load: 1065kw		190902

Sampling Plane Details	
Sampling plane dimensions	350 mm
Sampling plane area	0.0962 m²
Sampling port size, number	2" BSP (x2)
Access & height of ports	Elevated work platform 10 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 3 D
Upstream disturbance	Junction 3 D
No. traverses & points sampled	2 8
Sample plane compliance to AS4323.1	Compliant but non-ideal

Comments
No. of engines operating: 6
Pre chiller temperature 42C
Post chiller temperature 1.9C
The sampling plane is deemed to be non-ideal due to the following reasons:
The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D

Stack Parameters		
Moisture content, %v/v	11	
Gas molecular weight, g/g mole	28.8 (wet)	30.2 (dry)
Gas density at STP, kg/m³	1.29 (wet)	1.35 (dry)
% Oxygen correction & Factor	7 %	1.11

Gas Flow Parameters	
Flow measurement time(s) (hhmm)	1038 & 1058
Temperature, °C	446
Temperature, K	719
Velocity at sampling plane, m/s	53
Volumetric flow rate, actual, m³/s	5.1
Volumetric flow rate, actual, m³/hour	18000
Volumetric flow rate (wet STP), m³/s	1.8
Volumetric flow rate (wet STP), m³/hour	6300
Volumetric flow rate (dry STP), m³/s	1.6
Volumetric flow rate (dry STP), m³/hour	5600
Mass flow rate (wet basis), kg/hour	8100

Gas Analyser Results	Average			Minimum			Maximum		
Sampling time	1041 - 1150			1041 - 1150			1041 - 1150		
Combustion Gases	Concentration mg/m³	Corrected to 7% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 7% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 7% O2 mg/m³	Mass Rate g/min
Nitrogen oxides (as NO_2)	250	280	23	230	260	22	260	290	24
Sulfur dioxide	83		7.8	74		6.9	89		8.3
Carbon monoxide	540		51	520		48	570		53
	Concentration % v/v			Concentration % v/v			Concentration % v/v		
Carbon dioxide	11.1			10.6			11.3		
Oxygen	8.4			8.2			8.9		

Hydrogen sulfide	Results	
Sampling time	1120-1212	
	Concentration mg/m³	Mass Rate g/min
Hydrogen sulfide	<0.01	<0.001

Isokinetic Results	Results	
Sampling time	1041-1155	
	Concentration mg/m³	Mass Rate g/min
Sulfur trioxide and/or Sulfuric acid (as SO3)	1.9	0.18
Isokinetic Sampling Parameters		
Sampling time, min	72	
Isokinetic rate, %	102	
Velocity difference, %	1	

Date	5/09/2019	Client	Veolia Environmental Services (Australia) Pty Ltd
Report	R008159	Stack ID	EPA Point 8 - (Engine 1 Exhaust Stack)
Licence No.	11436	Location	Tarago
Ektimo Staff	Scott Woods & Zoe Parker	State	NSW
Process Conditions	Load: 1065kw		190902

Total VOCs (as n-Propane) Lower Bound	Results	
	Concentration mg/m³	Mass Rate g/min
C1-C4 (excluding methane)	18	1.7
C5-C20	1.6	0.15
Total	20	1.8

VOC's C1-C4	Results		
Sampling time	1045-1057		
	Concentration mg/m³	Concentration %	Mass Rate g/min
Methane	770	0.11	72
Ethane	2.6		0.24
Ethylene	9.1		0.85
Acetylene	<1		<0.1
Propane	<2		<0.2
Propylene	<2		<0.2
Cyclopropane	<2		<0.2
Isobutane	<3		<0.2
n-Butane	<3		<0.2
Propadiene	<2		<0.2
1-Butene	<3		<0.2
Propyne	<2		<0.2
trans-2-Butene	<3		<0.2
cis-2-Butene	<3		<0.2
1,3-Butadiene	<2		<0.2

VOC (speciated)	Results	
Sampling time	1051-1118	
	Concentration mg/m³	Mass Rate g/min
Detection limit(1)	<0.2	<0.02
Benzene	0.63	0.059
Toluene	1.6	0.15
m + p-Xylene	0.61	0.057
Pentane	0.38	0.035

(1) Unless otherwise reported, the following target compounds were found to be below detection:
Ethanol, Isopropanol, 1,1-Dichloroethene, Dichloromethane, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene, Chloroform, 1,1,1-Trichloroethane, 1,2-Dichloroethane, Carbon tetrachloride, Butanol, 1-Methoxy-2-propanol, Trichloroethylene, 1,1,2-Trichloroethane, Tetrachloroethene, Chlorobenzene, Ethylbenzene, Styrene, o-Xylene, 2-Butoxyethanol, 1,1,2,2-Tetrachloroethane, Isopropylbenzene, Propylbenzene, 1,3,5-Trimethylbenzene, tert-Butylbenzene, 1,2,4-Trimethylbenzene, 1,2,3-Trimethylbenzene, Acetone, Acrylonitrile, Methyl ethyl ketone, n-Hexane, Ethyl acetate, Cyclohexane, Isopropyl acetate, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Heptane, Ethyl acrylate, Methyl methacrylate, Propyl acetate, Methylcyclohexane, Methyl Isobutyl Ketone, 2-Hexanone, Octane, Butyl acetate, 1-Methoxy-2-propyl acetate, Butyl acrylate, Nonane, Cellosolve acetate, α-Pinene, β-Pinene, Decane, 3-Carene, D-Limonene, Undecane, Dodecane, Tridecane, Tetradecane

Testing Parameter	Total Hydrocarbons (g/min)		
	LFG Inlet	Stack Outlet	Destruction Efficiency %
EPA Point 8 (Engine 2) Stack	56	1.8	98

4.2 *EPA Point 5 – (LFG Supply)*

Date	5/09/2019	**Client**	Veolia Environmental Services (Australia) Pty Ltd
Report	R008159	**Stack ID**	EPA Point 5 - LFG Supply
Licence No.	11436	**Location**	Tarago
Ektimo Staff	Zoe Parker & Scott Woods	**State**	NSW
Process Conditions	Please refer to client records.		190902

Sampling Plane Details	
Sampling plane dimensions	370 mm
Sampling plane area	0.108 m²
Sampling port size, number	1" BSP (x1)
Access & height of ports	Ground level 1.5 m
Duct orientation & shape	Horizontal Circular
Downstream disturbance	Change in diameter 2.2 D
Upstream disturbance	Connection 1.3 D
No. traverses & points sampled	1 1
Sample plane compliance to AS4323.1	Non-compliant

Comments
The number of traverses sampled is less than the requirement
The number of points sampled is less than the requirement

The sampling plane is deemed to be non-compliant due to the following reasons:
The upstream disturbance is <2D from the sampling plane
The stack or duct does not have the required number of access holes (ports)

Stack Parameters		
Moisture content, %v/v	0.45	
Gas molecular weight, g/g mole	34.2 (wet)	34.2 (dry)
Gas density at STP, kg/m³	1.52 (wet)	1.53 (dry)

Gas Flow Parameters	
Flow measurement time(s) (hhmm)	1055 & 1120
Temperature, °C	2
Temperature, K	275
Velocity at sampling plane, m/s	7.8
Volumetric flow rate, actual, m³/s	0.84
Volumetric flow rate, actual, m³/hour	3000
Volumetric flow rate (wet STP), m³/s	0.9
Volumetric flow rate (wet STP), m³/hour	3200
Volumetric flow rate (dry STP), m³/s	0.9
Volumetric flow rate (dry STP), m³/hour	3200
Mass flow rate (wet basis), kg/hour	4900
Velocity difference, %	<1

Gas Analyser Results	Average	Minimum	Maximum
Sampling time	1100 - 1201	1100 - 1201	1100 - 1201
	Concentration % v/v	Concentration % v/v	Concentration % v/v
Carbon dioxide	37.8	37.5	38.2
Oxygen	1.9	1.8	2.1

Date	5/09/2019	**Client**	Veolia Environmental Services (Australia) Pty Ltd
Report	R008159	**Stack ID**	EPA Point 5 - LFG Supply
Licence No.	11436	**Location**	Tarago
Ektimo Staff	Zoe Parker & Scott Woods	**State**	NSW
Process Conditions	Please refer to client records.		*190902*

Total VOCs (as n-Propane) **Lower Bound**	Results	
	Concentration mg/m³	Mass Rate g/min
C1-C4 (excluding methane)	190	10
C5-C20	860	46
Total	1000	56

VOC's C1-C4	Results		
Sampling time	1117-1120		
	Concentration mg/m³	Concentration %	Mass Rate g/min
Methane	390000	55	21000
Ethane	1.6		0.084
Ethylene	5.4		0.29
Acetylene	<1		<0.06
Propane	35		1.9
Propylene	<2		<0.1
Cyclopropane	16		0.86
Isobutane	<3		<0.1
n-Butane	57		3.1
Propadiene	52		2.8
1-Butene	<3		<0.1
Propyne	<2		<0.1
trans-2-Butene	<3		<0.1
cis-2-Butene	<3		<0.1
1,3-Butadiene	34		1.8

Date	5/09/2019	**Client**	Veolia Environmental Services (Australia) Pty Ltd
Report	R008159	**Stack ID**	EPA Point 5 - LFG Supply
Licence No.	11436	**Location**	Tarago
Ektimo Staff	Zoe Parker & Scott Woods	**State**	NSW
Process Conditions	Please refer to client records.		190902

VOC (speciated)	Results	
Sampling time	1059-1116	
	Concentration mg/m³	Mass Rate g/min
Detection limit(1)	<0.1	<0.008
Ethanol	340	18
1,2-Dichloroethane	1.8	0.095
Butanol	180	9.7
Toluene	65	3.5
Tetrachloroethene	3	0.16
Ethylbenzene	34	1.9
m + p-Xylene	59	3.2
Styrene	2.7	0.15
o-Xylene	23	1.2
Propylbenzene	3.8	0.2
1,3,5-Trimethylbenzene	5.9	0.32
1,2,4-Trimethylbenzene	17	0.93
1,2,3-Trimethylbenzene	2.9	0.16
Acetone	60	3.2
Methyl ethyl ketone	160	8.7
Ethyl acetate	51	2.7
Cyclohexane	7	0.37
2-Methylhexane	14	0.76
2,3-Dimethylpentane	67	3.6
Heptane	12	0.64
Propyl acetate	21	1.1
Methylcyclohexane	9.5	0.51
Methyl Isobutyl Ketone	8.7	0.47
2-Hexanone	1.1	0.061
Octane	9.1	0.49
Butyl acetate	14	0.74
α-Pinene	53	2.9
β-Pinene	34	1.8
3-Carene	4.9	0.27
D-Limonene	190	10
Undecane	7.5	0.41
Dodecane	1.9	0.1
Tridecane	0.49	0.026

(1) Unless otherwise reported, the following target compounds were found to be below detection:
Isopropanol, 1,1-Dichloroethene, Dichloromethane, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene, Chloroform, 1,1,1-Trichloroethane, Benzene, Carbon tetrachloride, 1-Methoxy-2-propanol, Trichloroethylene, 1,1,2-Trichloroethane, Chlorobenzene, 2-Butoxyethanol, 1,1,2,2-Tetrachloroethane, Isopropylbenzene, tert-Butylbenzene, Pentane, Acrylonitrile, n-Hexane, Isopropyl acetate, 3-Methylhexane, Ethyl acrylate, Methyl methacrylate, 1-Methoxy-2-propyl acetate, Butyl acrylate, Nonane, Cellosolve acetate, Decane, Tetradecane

5 PLANT OPERATING CONDITIONS

See Veolia Environmental Services (Australia) Pty Ltd's records for complete process conditions.

6 TEST METHODS

All sampling and analysis was performed by Ektimo unless otherwise specified. Specific details of the methods are available upon request.

Parameter	Sampling Method	Analysis Method	Uncertainty*	NATA Accredited	
				Sampling	Analysis
Sample plane criteria	NSW TM-1	NA	NA	✓	NA
Flow rate, temperature and velocity	NA	NSW TM-2	8%, 2%, 7%	NA	✓
Moisture content	NSW TM-22	NSW TM-22	19%	✓	✓
Carbon dioxide	NSW TM-24	NSW TM-24	13%	✓	✓
Carbon monoxide	NSW TM-32	NSW TM-32	12%	✓	✓
Nitrogen oxides	NSW TM-11	NSW TM-11	12%	✓	✓
Oxygen	NSW TM-25	NSW TM-25	13%	✓	✓
Sulfur dioxide	NSW TM-4	NSW TM-4	12%	✓	✓
C_1-C_4 Hydrocarbons	Ektimo 200	Ektimo 340	19%	✓	✓†
Hydrogen sulfide	NSW TM-5	NSW TM-5	not specified	✓	✓†
Speciated volatile organic compounds (VOC's)	NSW TM-34[d]	Ektimo 344	19%	✓	✓†
Sulfuric acid mist and/or sulfur trioxide	NSW TM-3	Ektimo 235	16%	✓	✓†

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* Uncertainty values cited in this table are calculated at the 95% confidence level (coverage factor = 2)

† Analysis conducted at the Ektimo Mitcham, VIC laboratory, NATA accreditation number 14601. Results were reported to Ektimo on
20 September 2019 in report number R008159_C1-C4
9 September 2019 in report number R008159-H2S
18 September 2019 in report number R008159-SOx
24 September 2019 in report number R008159-VOCs

d Excludes recovery study as specified in section 8.4.3 of USEPA Test Method 18.

7 QUALITY ASSURANCE/QUALITY CONTROL INFORMATION

Ektimo is accredited by the National Association of Testing Authorities (NATA) for the sampling and analysis of air pollutants from industrial sources. Unless otherwise stated test methods used are accredited with the National Association of Testing Authorities. For full details, search for Ektimo at NATA's website www.nata.com.au.

Ektimo is accredited by NATA (National Association of Testing Authorities) to ISO/IEC 17025 - Testing. ISO/IEC 17025 - Testing requires that a laboratory have adequate equipment to perform the testing, as well as laboratory personnel with the competence to perform the testing. This quality assurance system is administered and maintained by the Quality Director.

NATA is a member of APLAC (Asia Pacific Laboratory Accreditation Co-operation) and of ILAC (International Laboratory Accreditation Co-operation). Through the mutual recognition arrangements with both of these organisations, NATA accreditation is recognised worldwide.

8 DEFINITIONS

The following symbols and abbreviations may be used in this test report:

% v/v	Volume to volume ratio, dry or wet basis
~	Approximately
<	Less than
>	Greater than
≥	Greater than or equal to
APHA	American public health association, Standard Methods for the Examination of Water and Waste Water
AS	Australian Standard
BSP	British standard pipe
CARB	Californian Air Resources Board
CEM	Continuous Emission Monitoring
CEMS	Continuous Emission Monitoring System
CTM	Conditional test method
D	Duct diameter or equivalent duct diameter for rectangular ducts
D_{50}	'Cut size' of a cyclone defined as the particle diameter at which the cyclone achieves a 50% collection efficiency ie. half of the particles are retained by the cyclone and half are not and pass through it to the next stage. The D_{50} method simplifies the capture efficiency distribution by assuming that a given cyclone stage captures all of the particles with a diameter equal to or greater than the D_{50} of that cyclone and less than the D_{50} of the preceding cyclone.
DECC	Department of Environment & Climate Change (NSW)
Disturbance	A flow obstruction or instability in the direction of the flow which may impede accurate flow determination. This includes centrifugal fans, axial fans, partially closed or closed dampers, louvres, bends, connections, junctions, direction changes or changes in pipe diameter.
DWER	Department of Water and Environmental Regulation (WA)
DEHP	Department of Environment and Heritage Protection (QLD)
EPA	Environment Protection Authority
FTIR	Fourier Transform Infra-red
ISC	Intersociety committee, Methods of Air Sampling and Analysis
ISO	International Organisation for Standardisation
Lower Bound	Defines values reported below detection as equal to zero.
Medium Bound	Defines values reported below detection are equal to half the detection limit.
NA	Not applicable
NATA	National Association of Testing Authorities
NIOSH	National Institute of Occupational Safety and Health
NT	Not tested or results not required
OM	Other approved method
OU	The number of odour units per unit of volume. The numerical value of the odour concentration is equal to the number of dilutions to arrive at the odour threshold (50% panel response).
PM_{10}	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 10 microns (µm).
$PM_{2.5}$	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 2.5 microns (µm).
PSA	Particle size analysis
RATA	Relative Accuracy Test Audit
Semi-quantified VOCs	Unknown VOCs (those not matching a standard compound), are identified by matching the mass spectrum of the chromatographic peak to the NIST Standard Reference Database (version 14.0), with a match quality exceeding 70%. An estimated concentration will be determined by matching the integrated area of the peak with the nearest suitable compound in the analytical calibration standard mixture.
STP	Standard temperature and pressure. Gas volumes and concentrations are expressed on a dry basis at 0°C, at discharge oxygen concentration and an absolute pressure of 101.325 kPa, unless otherwise specified.
TM	Test Method
TOC	The sum of all compounds of carbon which contain at least one carbon to carbon bond, plus methane and its derivatives.
USEPA	United States Environmental Protection Agency
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
Velocity Difference	The percentage difference between the average of initial flows and afterflows.
Vic EPA	Victorian Environment Protection Authority
VOC	Any chemical compound based on carbon with a vapour pressure of at least 0.010 kPa at 25°C or having a corresponding volatility under the particular conditions of use. These compounds may contain oxygen, nitrogen and other elements, but specifically excluded are carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts.
XRD	X-ray Diffractometry
Upper Bound	Defines values reported below detection are equal to the detection limit.
95% confidence interval	Range of values that contains the true result with 95% certainty. This means there is a 5% risk that the true result is outside this range.

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EVAPORATION DATA SUPPLIED BY VEOLIA:

MAY 2007 TO JUNE 2012

Evaporation	2006								2006				2007					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	5.60	6.80	5.00	3.00	1.50	1.41
2	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	2.20	2.60	4.80	3.60	2.40	1.04
3	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	2.60	5.00	3.80	3.80	3.19	1.16
4	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	5.00	6.40	7.60	2.80	4.52	1.30
5	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	6.80	7.40	6.60	3.00	2.68	0.69
6	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.20	8.20	3.60	4.60	2.52	1.00
7	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.60	7.00	5.00	2.40	2.43	0.67
8	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	5.80	4.60	3.60	1.40	1.87	0.83
9	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	6.60	6.80	5.00	2.40	1.37	0.48
10	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.40	5.20	4.80	2.00	1.41	0.73
11	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.60	3.60	5.40	3.20	1.48	1.24
12	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	11.40	2.20	7.00	3.60	1.74	0.77
13	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	13.40	3.80	3.60	2.60	2.19	1.23
14	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.40	4.40	2.80	3.00	1.51	1.02
15	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.80	5.80	4.80	3.60	2.03	0.43
16	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.40	6.20	6.20	4.00	2.09	0.64
17	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.80	3.80	4.60	2.80	1.47	0.84
18	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.20	5.60	2.40	3.40	1.49	0.75
19	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	6.00	1.60	2.00	3.80	0.72	0.63
20	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.60	3.60	0.20	2.20	1.53	0.43
21	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	11.00	6.80	2.20	2.60	2.14	1.13
22	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.40	7.40	3.40	2.60	2.21	1.12
23	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.60	5.60	4.40	2.60	1.69	1.35
24	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	9.40	5.20	4.80	1.80	1.59	1.11
25	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.20	4.60	4.00	0.60	1.81	1.16
26	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.00	4.20	2.60	1.20	1.75	0.57
27	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	12.40	3.60	2.80	2.40	1.56	0.27
28	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	10.60	3.00	2.80	1.40	2.20	0.42
29	8.20		4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.80		4.20	1.40	1.75	0.79
30	8.20		4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.00		3.00	1.80	2.65	1.27
31	8.20		4.10		1.70		1.20	1.90		3.90		6.20	10.00		3.40		1.24	
Total Month	**203.8**	**151.2**	**127.1**	**78**	**52.7**	**33**	**37.2**	**58.9**	**84**	**120.9**	**150**	**192.2**	**246.8**	**141**	**126.4**	**79.6**	**60.68**	**26.47**
Accumulated Year	**204**	**355**	**482.1**	**560.1**	**612.8**	**645.8**	**683**	**741.9**	**825.9**	**946.8**	**1096.8**	**1289**	**246.8**	**387.8**	**514.2**	**593.8**	**654.48**	**681**

Evaporation data recorded from the Goulburn Tafe W

						2008												2009	
Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
1.21	1.13	4.17	4.49	2.73	2.82	7.058	4.079	4.42	3.876	2.082	1.889	2.563	2.158	1.339	3.822	8.25	5.487	6.915	7.353
0.82	1.27	2.87	5.04	4.66	2.286	7.126	2.908	4.566	3.485	1.918	0.485	1.146	0.953	2.667	4.838	2.408	7.579	8.11	6.754
1.21	2.29	3.26	5.41	4.31	5.675	7.446	4.000	4.257	5.316	1.977	0.828	1.139	1.469	2.828	6.486	3.711	6.729	6.339	6.712
1.75	0.94	2.94	8.39	1.49	4.147	2.006	4.788	4.536	2.663	2.314	0.46	1.32	1.967	1.616	6.588	3.963	6.955	5.254	5.055
1.18	1.59	2.46	5.05	3.30	4.956	7.4	1.496	4.274	3.13	2.225	0.771	0.847	1.659	1.006	1.318	5.035	5.046	6.369	4.618
0.72	1.67	1.44	5.48	2.40	1.109	6.6	1.512	4.457	3.239	2.423	0.76	1.387	1.263	1.288	2.328	3.928	5.442	8.86	6.982
1.06	1.65	1.87	5.68	4.5	4.2	6.883	4.498	5.111	2.656	2.177	1.026	1.22	1.656	1.162	3.205	6.31	7.507	8.46	7.344
1.02	1.71	1.38	3.90	2.097	3.395	6.251	3.381	3.829	2.231	2.323	1.351	1.312	1.147	2.65	3.387	3.199	6.765	8.21	8.81
0.70	2.11	1.61	3.89	2.106	4.31	6.6	2.689	4.053	1.712	2.209	0.5	1.227	1.663	2.508	4.196	3.801	6.172	3.146	8.3
0.90	2.39	2.04	3.91	2.929	6.974	5.175	2.861	4.623	1.81	2.056	1.211	0.51	1.35	3.038	4.017	5.71	6.895	4.802	2.73
1.19	3.15	2.55	4.12	4.648	3.645	6.945	4.415	4.768	2.685	2.026	0.588	0.875	0.664	2.896	4.264	5.541	3.662	4.78	1.038
1.44	3.09	1.69	4.89	5.543	1.426	7.747	4.853	4.954	3.052	1.296	0.865	1.079	1.452	3.56	3.963	5.464	1.874	4.981	4.292
1.09	2.27	2.29	3.87	5.421	5.00	5.179	3	4.862	2.614	1.532	1.672	1.215	1.511	4.341	4.769	6.244	0.951	4.415	1.801
1.02	1.69	3.53	4.15	6.033	4.40	7.447	1.161	4.992	2.11	1.757	1.089	1.621	1.801	5.149	4.463	6.274	4.303	6.69	3.05
0.86	1.02	4.08	4.78	6.794	5.362	1.344	3.54	4.861	2.854	1.874	1.572	2.064	1.693	2.177	1.793	6.243	3.726	9	2.4
1.06	1.08	3.46	6.31	6.455	5.385	6.369	5.299	5.892	2.901	1.997	1.141	1.281	1.726	4.05	3.63	6.192	5.567	9.69	2.225
1.04	1.87	3.82	7.67	5.901	0.933	4.194	5.042	4.894	2.611	1.468	0.794	1.247	1.834	2.663	4.097	4.685	6.225	7.435	3.11
1.34	0.82	2.25	4.52	6.297	4.659	4.4	4.186	4.841	1.902	1.245	1.042	1.28	2.186	2.098	4.755	5.378	3.919	6.079	2.313
1.30	0.95	3.21	4.95	5.31	4.40	2.054	4.73	5.056	2.09	1.432	1.056	1.051	1.361	3.326	4.845	3.55	4.689	6.418	3.187
1.52	0.78	4.30	5.30	6.444	2.116	1.72	4.48	2.672	1.27	1.881	0.842	1.652	2.009	4.809	5.672	2.603	5.48	7.43	5.529
1.49	0.94	1.92	5.45	6.425	1.79	3.779	5.237	4.843	1.596	1.602	0.297	1.258	2.209	5.661	4.572	3.418	4.656	7.28	3.265
1.15	1.14	3.13	7.20	6.425	5.306	2.357	2.445	1.335	2.494	1.74	1.192	1.394	2.44	4.423	3.561	5.702	5.765	7.637	4.303
0.78	0.88	3.23	6.92	0.573	2.921	4.681	5.397	1.763	1.229	1.673	1.271	1.551	1.138	4.422	3.28	2.389	6.683	5.991	3.535
1.51	1.16	3.62	4.15	1.268	4.309	5.547	6.058	3.212	2.211	1.193	1.118	1.17	1.594	2.527	3.602	2.16	3.337	6.481	4.391
1.60	1.70	4.87	1.97	2.786	4.859	6.208	5.649	1.777	1.685	1.456	1.126	1.146	2.284	2.461	4.178	5.332	1.37	7.481	6.763
1.99	2.03	4.68	1.29	5.691	5.20	4.636	4.078	0.872	1.569	1.499	1.623	1.547	2.553	3.68	5.96	4.286	6.181	4.449	5.653
1.86	2.98	3.07	2.36	4.37	6.216	6.022	5.26	2.734	3.338	1.253	1.242	1.2	2.669	4.221	5.949	3.299	7.006	6.364	5.124
1.30	3.73	3.92	4.32	6.6	3.844	6.413	3.85	3.058	2.642	1.484	1.607	0.866	2.212	5.675	8	5.683	4.365	4.688	4.802
1.73	4.86	5.73	4.75	5.35	6.515	5.972	0.894	2.139	1.338	1.37	1.198	1.235	1.744	6.15	5.297	3.178	5.461	6.868	
1.18	3.51	3.62	5.87	3.106	6.941	6.752		3.646	2.208	1.425	1.927	1.503	1.283	3.495	1.819	5.458	7.121	7.29	
1.56	3.98		5.56		7.736	6.868		3.861		1.726		1.703	2.13		5.019		6.405	7.182	
38.56	**60.372**	**92.97**	**151.606**	**131.946**	**132.835**	**169.179**	**111.786**	**121.158**	**74.517**	**54.633**	**32.543**	**40.609**	**53.778**	**97.886**	**133.673**	**139.394**	**163.323**	**205.09**	**131.44**
719.5	**779.88**	**872.8**	**1024.45**	**1156.4**	**1289.23**	**169**	**280.965**	**402.123**	**476.64**	**531.273**	**563.816**	**604.425**	**658.203**	**756.089**	**889.762**	**1029.16**	**1192.48**	**205**	**336.533**

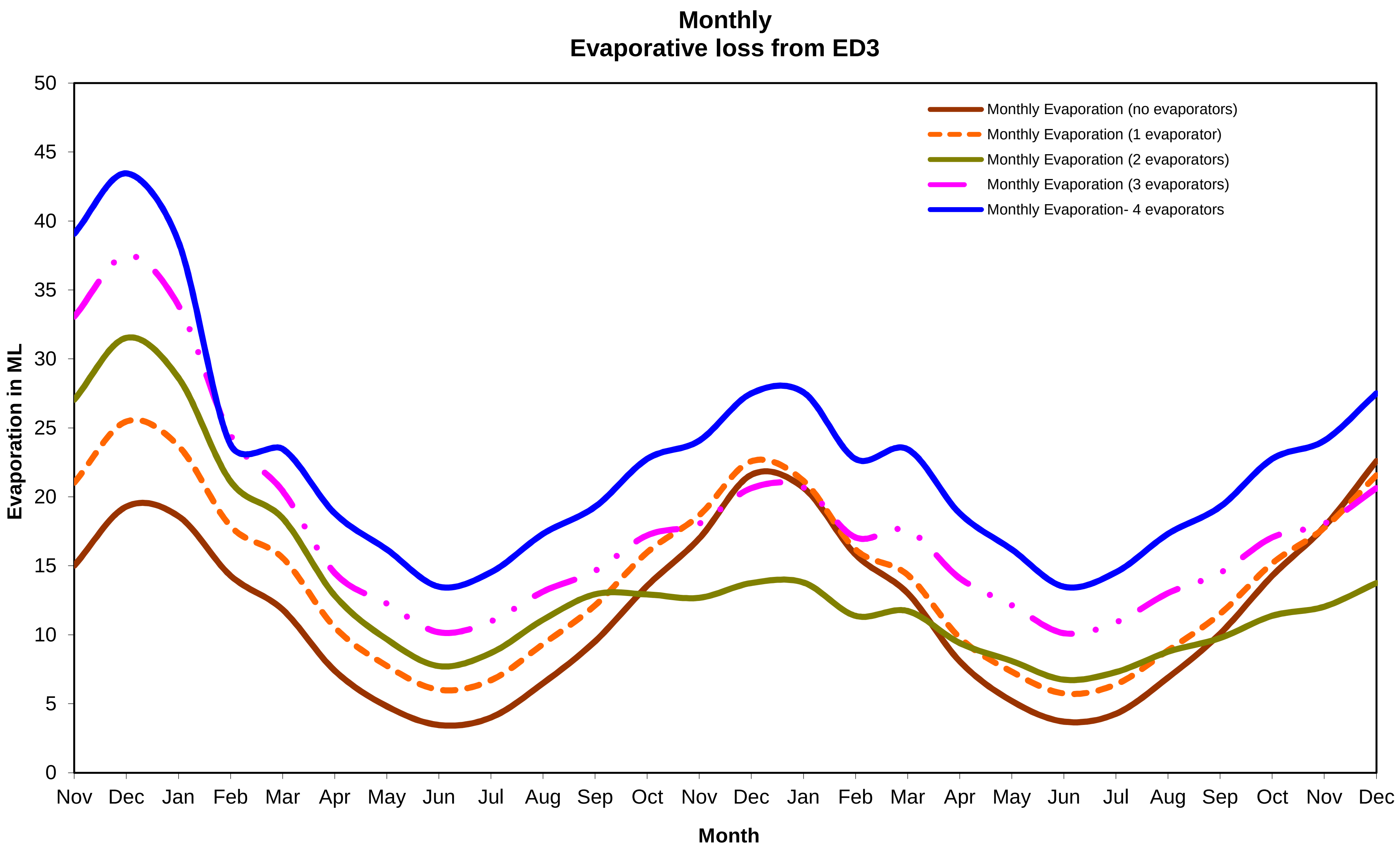
eather Station

										2010					
Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
6.917	2.423	1.755	1.077	1.847	1.551	1.984	4.057	4.662	2.028	3.998	5.099	3.148	2.332	1.695	0.878
4.472	1.71	2.372	0.801	1.384	1.814	2.912	6.426	5.645	5.513	6.6	6.074	1.88	3.354	1.916	1.125
3.878	1.453	1.88	0.787	1.089	1.202	2.841	1.895	5.112	5.577	4.735	5.207	2.762	2.975	2.831	1.087
3.498	3.908	2.072	0.56	1.165	2.058	1.365	0.766	7.929	7.173	4.158	3.146	3.891	2.655	1.683	0.855
5.725	2.928	2.129	0.701	1.104	1.529	2.454	1.152	5.29	6.583	4.044	3.664	4.055	2.152	2.958	0.907
4.923	3.621	1.981	1.211	1.493	1.623	3.174	2.186	1.641	6.23	5.176	2.508	1.321	3.063	1.433	1.303
4.612	2.546	2.117	1.313	0.921	1.996	3.339	2.677	2.032	6.638	7.148	2.434	3.007	1.81	2.05	1.055
4.945	2.97	2.058	0.786	1.202	2.192	1.115	1.318	4.208	7.695	3.889	1.551	1.534	1.5	1.903	1.346
2.91	3.12	1.763	1.105	0.611	2.206	2.108	3.38	5.156	7.358	5.272	1.77	3.112	3.291	1.955	1.332
3.338	3.284	2.182	0.895	0.771	1.865	1.68	2.502	6.205	4.17	7.378	5.177	3.092	2.66	1.906	0.827
3.617	1.841	1.215	1.285	0.927	1.887	2.787	2.709	6.607	6.303	7.771	4.201	2.743	3.463	2.485	1.431
4.376	2.073	1.848	1.049	0.982	1.502	3.644	2.501	6.865	6.729	7.485	6.063	3.919	3.058	3.087	1.381
3.763	2.514	1.946	0.691	2.192	1.643	5.067	1.654	6.934	7.03	9.3	4.934	2.812	3.207	1.911	1.201
1.961	0.469	2.119	1.578	1.559	2.055	6.87	3.239	4.736	6.693	5.012	0.81	3.277	2.865	2.033	1.074
3.811	1.969	1.581	1.521	0.818	1.996	2.964	2.22	6.605	3.489	2.788	0.918	2.577	3.386	1.734	1.141
4.779	4.187	1.602	1.015	1.049	2.365	3.78	2.346	5.514	6.185	3.759	3.496	3.634	2.66	1.728	1.179
4.66	3.699	1.789	0.784	1.013	3.062	3.287	3.11	7.546	8	3.442	4.03	4.26	2.696	1.379	1.443
4.282	2.983	1.842	1.059	1.434	2.581	3.727	3.306	5.807	11.73	6.841	5.162	4.197	2.758	0.917	0.864
4.783	2.608	1.432	1.027	1.474	2.222	2.763	3.298	5.604	1.331	4.313	4.24	4.181	2.507	1.724	1.379
3.871	1.738	1.076	1.456	1.814	2.725	3.061	4.18	6.838	6.966	6.507	3.96	3.73	2.511	1.701	0.776
4.548	1.094	1.284	1.107	2.203	2.918	3.498	5.517	8	3.649	7.994	4.726	4.999	2.921	0.885	1.32
4.535	1.638	1.287	0.589	2.459	1.673	3.687	5.776	4.833	7.337	7.766	6.52	4.999	2.688	1.165	1.185
4.201	1.488	0.719	1.161	2.013	2.523	2.501	4.272	6.697	6.719	9.95	6.017	3.975	2.918	1.664	0.491
5.067	1.991	1.288	0.863	0.761	2.127	1.283	5.039	0.884	7.524	9.65	5.734	4.213	3.392	1.157	1.154
6.118	1.73	1.478	0.824	1.547	1.984	3.13	5.359	1.841	8.85	4.516	4.929	3.705	1.498	0.839	0.983
5.434	1.438	1.413	1.087	1.784	2.257	4.556	1.522	6.292	0.754	6.134	4.726	4.034	2.387	0.64	1.076
3.611	1.52	0.777	0.838	0.859	2.071	1.988	1.903	5.591	0.895	7.369	4.487	4.923	2.272	0.491	0.995
2.982	1.68	1.037	1.244	1.546	3.473	1.579	2.641	4.326	3.024	6.039	4.945	4.015	1.531	0.891	1.21
3.861	1.917	0.689	0.798	1.562	4.048	2.576	4.087	8.2	4.501	3.961		4.129	2.867	1.166	1.24
4.352	1.667	0.843	0.898	1.621	1.767	3.663	2.571	3.657	6.765	6.124		1.592	2.643	0.628	1.417
2.855		0.777		1.283	2.321		5.037		6.318	3.125		0.785		0.27	
132.69	**68.21**	**48.35**	**30.11**	**42.49**	**67.24**	**89.38**	**98.65**	**161.26**	**179.76**	**182.24**	**116.53**	**104.50**	**80.02**	**48.83**	**33.66**
469.218	**537.425**	**585.776**	**615.886**	**658.373**	**725.609**	**814.992**	**913.638**	**1074.895**	**1254.652**	**182**	**298.77**	**403.27**	**483.29**	**532.12**	**565.77**

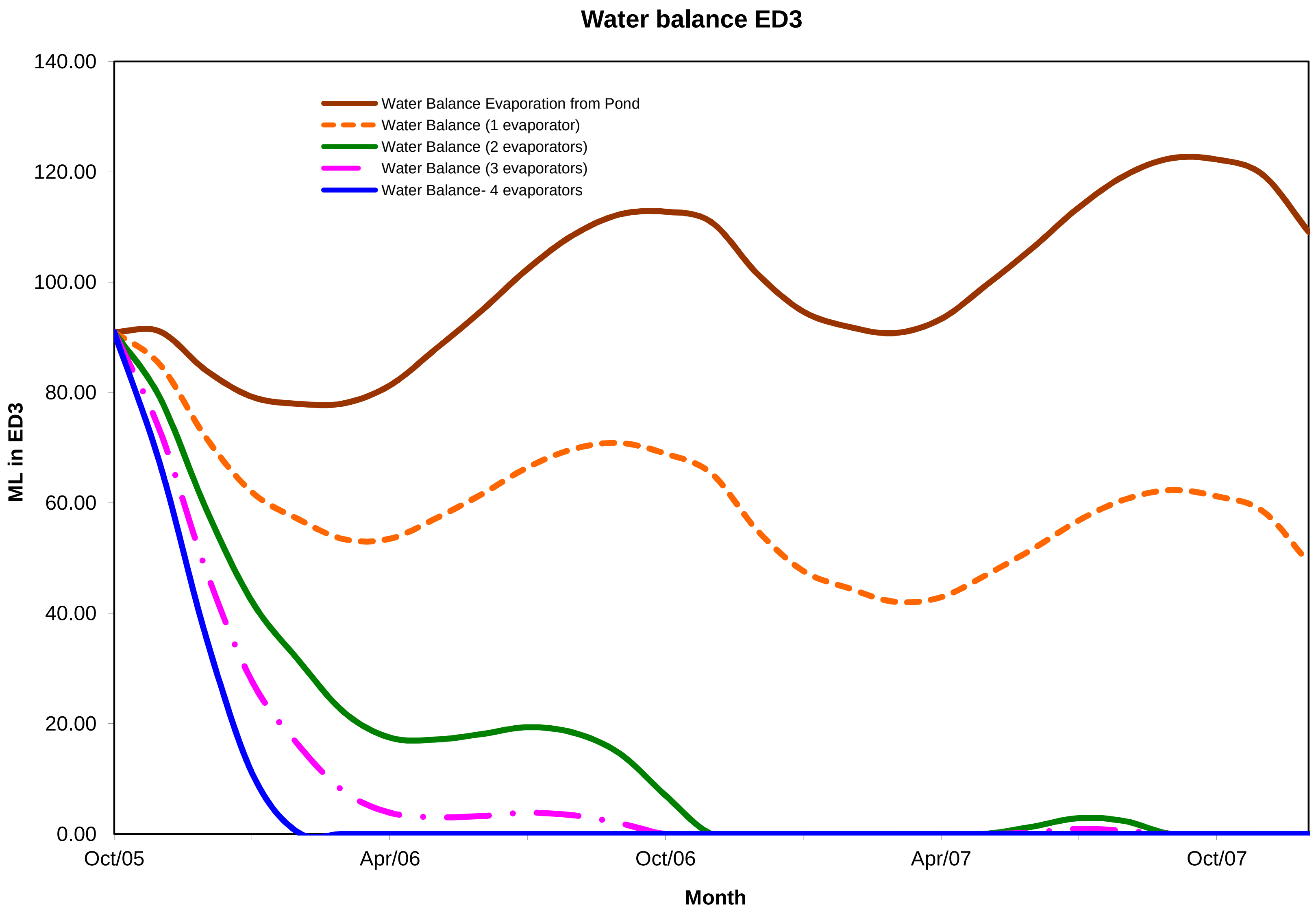
						2011							
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
1.268	1.296	2.57	3.375	4.13	1.186	7.051	7.012	2.274	1.106	1.672	0.987	1.048	1.254
1.044	1.432	3.342	2.595	1.913	1.338	7.866	9.26	4.678	3.107	1.878	1.056	0.911	2.284
0.452	1.033	0.811	2.4	2.259	3.215	3.502	5.421	3.477	3.304	0.655	1.016	1.027	1.942
1.215	1.468	1.109	1.091	4.22	2.258	0.963	3.908	5.296	3.294	1.914	1.53	1.616	3.34
1.111	1.031	0.862	2.602	1.355	3.228	2.593	2.614	5.187	3.215	2.064	0.861	1.293	3.226
1.077	1.714	1.645	4.097	1.948	4.476	5.333	6.545	3.419	1.963	2.11	1.51	1.004	3.188
0.573	1.737	1.99	3.927	2.165	3.351	3.727	1.692	3.268	1.802	1.676	1.527	0.864	1.604
1.348	1.679	2.243	3.864	4.228	5.486	3.458	4.228	4.416	2.223	2.087	1.093	1.247	1.912
1.326	1.577	2.275	3.793	4.414	4.11	4.247	3.948	4.142	3.183	2.375	0.862	1.228	0.946
0.814	1.94	1.779	2.713	3.68	1.728	2.307	3.324	3.978	3.395	1.6	1.092	1.16	1.769
0.855	0.94	2.288	2.238	3.89	4.773	2.736	4.659	1.385	1.308	2.051	1.078	1.079	1.23
0.7	0.917	1.423	2.36	5.513	5.854	1.677	2.874	1.6	2.148	1.193	1.34	1.41	0.462
1.493	0.976	1.389	3.446	5.371	5.957	4.233	2.073	3.28	1.747	1.684	0.956	1.458	1.427
0.631	2.024	1.307	1.812	6.154	5.745	3.408	1.502	4.49	1.923	1.434	0.744	0.815	1.582
1.03	1.39	0.437	3.58	3.953	4.113	3.981	4.138	0.749	2.724	1.743	0.804	1.333	1.771
1.381	1.588	1.027	1.264	1.957	6.395	5.885	3.005	2.157	2.568	1.959	0.557	1.19	1.495
1.225	1.2	3.789	2.281	4.89	3.684	6.391	1.15	2.357	2.236	1.344	0.813	0.589	1.994
1.302	1.883	2.998	3.349	4.525	5.331	7.255	3.479	1.534	2.029	1.467	1.074	1.178	0.561
1.433	1.683	2.743	3.847	6.084	3.731	5.497	2.893	0.69	2.608	1.735	1.222	0.831	0.867
0.826	1.684	2.645	3.02	2.109	3.686	4.004	3.746	1.547	2.338	1.71	1.208	0.475	0.819
1.377	1.882	2.91	3.964	5.642	2.636	4.759	4.729	1.814	1.341	1.56	1.517	1.369	0.957
1.379	1.539	3.202	4.17	6.288	5.074	6.263	4.947	0.758	2.355	1.738	0.914	0.853	1.532
1.336	2.092	2.737	4.903	5.996	5.285	4.855	4.657	3.055	2.246	1.803	0.864	0.721	1.235
1.201	1.533	2.271	3.476	4.515	6.343	6.291	4.763	2.44	2.209	0.854	1.412	1.208	1.695
1.573	1.865	3.718	2.227	5.96	2.143	5.118	4.651	2.026	2.329	1.129	1.207	0.621	2.437
1.431	1.816	2.922	2.794	5.9	5.442	6.436	4.057	3.047	1.251	1.797	1.25	0.674	3.024
1.326	1.186	4.061	4.945	4.33	3.951	7.204	5.033	2.824	1.474	1.694	1.653	1.431	3.163
1.452	1.803	3.858	4.318	5.672	3.478	6.509	2.284	2.365	1.764	1.191	1.369	1.506	2.636
0.515	2.243	3.876	3.221	1.734	5.219	5.086	[redacted]	3.328	1.206	1.303	0.969	2.089	2.91
0.838	2.186	3.174	4.233	1.189	6.065	5.724	[redacted]	2.678	1.313	1.275	0.918	2.003	2.894
0.86	1.966	[redacted]	4.17	[redacted]	6.422	6.781	[redacted]	3.709	[redacted]	0.946	[redacted]	2.083	1.518
34.39	**49.30**	**71.40**	**100.08**	**121.98**	**131.70**	**151.14**	**112.592**	**87.968**	**65.709**	**49.641**	**33.403**	**36.314**	**57.674**
600.17	**649.47**	**720.87**	**820.94**	**942.93**	**1074.63**	**151.14**	**263.732**	**351.7**	**417.409**	**467.05**	**500.453**	**536.767**	**594.441**

				2012									
Sep	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
2.471	2.435	4.777	2.325	5.891	5.284	0.9	3.54	1.227	1.373	1.384			
2.241	1.588	4.316	4.913	6.209	2.501	1.154	2.845	2.177	0.793	0.822			
2.59	1.69	3.187	3.823	6.572	0.926	0.938	2.605	1.285	0.278	1.289			
3.132	3.258	2.896	5.667	7.179	1.351	0.919	3.164	2.134	0.594	1.277			
3.208	3.717	5.035	2.502	3.869	5.308	1.289	2.861	1.909	1.126				
2.879	2.781	6.021	4.276	5.369	6.111	4.487	2.241	1.845	0.44				
3.472	1.184	5.481	2.521	4.112	3.608	2.485	3.182	1.434	1.351				
2.624	1.667	4.105	4.129	6.458	1.226	1.009	3.775	1.077	1.279				
2.148	2.349	3.484	1.996	2.415	1.754	1.291	3.02	2.012	1.112				
1.354	2.354	4.679	5.002	6.068	2.106	3.155	2.901	2.752	1.18				
2.113	3.671	3.949	4.417	5.436	4.055	4.215	2.367	3.317	1.241				
1.992	2.976	4.623	3.436	3.858	2.691	3.676	2.476	2.556	0.629				
3.06	3.96	5.283	2.506	5.435	3.405	1.858	2.471	2.095	0.589				
2.947	3.783	4.932	2.187	6.049	3.371	3.285	2.797	1.384	1.253				
3.867	2.61	7.31	4.185	2.996	4.062	2.97	1.622	1.75	1.101				
3.495	3.47	6.555	5.44	2.083	4.704	4.013	2.658	1.504	1.735				
4.641	4.797	1.852	2.785	4.367	5.012	3.449	2.979	1.687	0.388				
4.808	4.456	4.183	5.786	5.552	3.774	2.386	1.349	1.343	1.027				
5.481	4.215	5.886	3.902	6.141	3.874	3.566	1.094	1.883	1.354				
5.343	4.925	7.084	1.302	6.487	4.644	2.513	2.241	1.763	1.264				
2.999	5.604	2.288	4.018	4.825	2.77	3.803	2.089	0.999	1.125				
3.491	5.794	4.966	2.69	4.856	4.255	4.005	1.749	1.613	1.895				
4.132	4.353	1.416	4.248	4.142	3.313	1.574	1.236	2.124	0.979				
5.552	5.458	2.959	5.868	3.036	4.821	3.37	2.224	2.66	1.068				
0.677	6.477	1.808	6.049	4.872	5.508	3.169	1.13	1.581	1.355				
1.441	0.997	0.889	6.216	2.176	5.785	2.475	0.934	1.061	1.264				
2.871	1.547	4.708	2.701	3.709	2.374	3.162	1.885	0.925	0.88				
3.301	2.761	4.889	4.081	2.485	2.673	1.564	1.73	1.416	0.587				
1.057	4.003	5.752	4.757	4.831	1.274	1.226	2.061	0.983	1.278				
1.649	2.008	5.654	6.255	5.77		3.304	1.868	1.428	1.283				
	4.498		3.977	2.548		3.262		1.146					
91.036	**105.386**	**130.967**	**123.96**	**145.796**	**102.54**	**80.472**	**69.094**	**53.07**	**31.821**	**4.772**	**0**	**0**	**0**
685.477	**790.863**	**921.83**	**1045.79**	**145.796**	**248.336**	**328.808**	**397.902**	**450.972**	**482.793**	**487.565**	**487.565**	**487.565**	**487.565**

Nov	Dec
0	0
487.565	487.565



Monthly
Evaporative loss from ED3
Evaporation in ML
50
45
40
35
30
25
20
15
10
5
0
Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
Monthly Evaporation (no evaporators)
Monthly Evaporation (1 evaporator)
Monthly Evaporation (2 evaporators)
Monthly Evaporation (3 evaporators)
Monthly Evaporation- 4 evaporators



Water balance ED3
Water Balance Evaporation from Pond
Water Balance (1 evaporator)
Water Balance (2 evaporators)
Water Balance (3 evaporators)
Water Balance- 4 evaporators
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ML in ED3
Oct/05
Apr/06
Oct/06
Apr/07
Oct/07
Month

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
	November	December	January	February	March	April	May	June	July	August	September	October
	30	31	31	28	31	30	31	30	31	31	30	31
	58.7	46.1	59.8	51.2	55.6	49.3	47.5	37.9	52.4	47.6	65.2	61.9
	5	6.2	6.3	5.5	4.1	2.6	1.6	1.1	1.2	1.9	2.8	3.8
Average Monthly Pan Evaporation (mm- total)	0.1725	0.22165	0.2232	0.1778	0.1488	0.093	0.0589	0.0405	0.04495	0.06975	0.099	0.13795
Estimated monthly evaporation (M3) attributed to 1 evaporator (350 l/min)	6019	6875	6895	5686	5862	4701	4046	3371	3632	4330	4820	5687
Estimated monthly evaporation (M3) attributed to 2 evaporators (350 l/min)	12037	13751	13789	11372	11725	9402	8093	6742	7264	8659	9640	11375
Estimated monthly evaporation (M3) attributed to 3 evaporators (350 l/min)	18056	20626	20684	17058	17587	14103	12139	10113	10895	12989	14460	17062
Estimated monthly evaporation (M3) attributed to 4 evaporator(s) (350 l/min)	24075	27502	27578	22744	23449	18804	16186	13484	14527	17318	19280	22750
Estimated Evaporation (M3) attributed to surface evaporation (no evaporator)	15006.3	19291.2	18596.0	14286.3	11827.1	7397.5	4816.0	3457.6	4001.9	6488.1	9529.3	13544.4
Estimated Evaporation (M3) attributed to surface evaporation (1 evaporator)	15006.3	18586.8	16798.5	12188.2	9715.6	5845.2	3705.0	2647.1	3070.1	4994.2	7313.1	10292.7
Estimated Evaporation (M3) attributed to surface evaporation (2 evaporator)	15006.3	17777.3	14847.0	9755.6	6725.4	3443.3	1581.8	988.8	1414.3	2427.2	3296.7	1550.3
Estimated Evaporation (M3) attributed to surface evaporation (3 evaporator)	15006.3	16861.3	13193.4	7424.1	2837.6	382.6	121.3	65.6	78.0	143.4	178.4	144.2
Estimated Evaporation (M3) attributed to surface evaporation (4 evaporator(s))	15006.3	15950.5	10922.7	1049.4	25.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Evaporator evaporation as % of Surface Evaporation (1 evaporator)	40.1%	35.6%	37.1%	39.8%	49.6%	63.5%	84.0%	97.5%	90.8%	66.7%	50.6%	42.0%
Evaporator evaporation as % of Surface Evaporation (2 evaporators)	80.2%	71.3%	74.2%	79.6%	99.1%	127.1%	168.0%	195.0%	181.5%	133.5%	101.2%	84.0%
Evaporator evaporation as % of Surface Evaporation (3 evaporator(s))	120.3%	106.9%	111.2%	119.4%	148.7%	190.6%	252.1%	292.5%	272.3%	200.2%	151.7%	126.0%
Evaporator evaporation as % of Surface Evaporation (4 evaporator(s))	160.4%	142.6%	148.3%	159.2%	198.3%	254.2%	336.1%	390.0%	363.0%	266.9%	202.3%	168.0%
Evaporation from Pond	15006.33158	19291.2246	18595.96903	14286.305	11827.0785	7397.5361	4815.98473	3457.57676	4001.9273	6488.09051	9529.31306	13544.40844
Incident Rainfall	10081.5	7243.5	8819.25	8027.25	6913.5	5626.5	6435	5395.5	6575.25	7656	8217	9050.25
Water Pumped In	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	November	December	January	February	March	April	May	June	July	August	September	October	November	December
	30	31	31	28	31	30	31	30	31	31	30	31	30	31
	58.7	46.1	59.8	51.2	55.6	49.3	47.5	37.9	52.4	47.6	65.2	61.9	58.7	46.1
	5	6.2	6.3	5.5	4.1	2.6	1.6	1.1	1.2	1.9	2.8	3.8	5	6.2
Average Monthly Pan Evaporation (mm- total)	0.1725	0.22165	0.2232	0.1778	0.1488	0.093	0.0589	0.0405	0.04495	0.06975	0.099	0.13795	0.1725	0.22165
Estimated monthly evaporation (M3) attributed to 1 evaporator (350 l/min)	6019	6875	6895	5686	5862	4701	4046	3371	3632	4330	4820	5687	6019	6875
Estimated monthly evaporation (M3) attributed to 2 evaporators (350 l/min)	12037	13751	13789	11372	11725	9402	8093	6742	7264	8659	9640	11375	12037	13751
Estimated monthly evaporation (M3) attributed to 3 evaporators (350 l/min)	18056	20626	20684	17058	17587	14103	12139	10113	10895	12989	14460	17062	18056	20626
Estimated monthly evaporation (M3) attributed to 4 evaporator(s) (350 l/min)	24075	27502	27578	22744	23449	18804	16186	13484	14527	17318	19280	22750	24075	27502
Estimated Evaporation (M3) attributed to surface evaporation (no evaporator)	16982.3	21601.0	20657.1	15814.9	13016.6	8081.2	5197.2	3706.7	4272.1	6895.5	10083.4	14273.9	17829.0	22594.3
Estimated Evaporation (M3) attributed to surface evaporation (1 evaporator)	12643.1	15705.6	14263.7	10500.7	8482.3	5096.7	3274.3	2374.8	2773.1	4542.8	6698.9	9492.6	11738.3	14684.1
Estimated Evaporation (M3) attributed to surface evaporation (2 evaporator)	643.3	0.0	0.0	0.0	0.0	0.0	0.0	1.5	32.2	107.1	123.3	0.0	0.0	0.0
Estimated Evaporation (M3) attributed to surface evaporation (3 evaporator)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	35.5	30.9	0.0	0.0	0.0
Estimated Evaporation (M3) attributed to surface evaporation (4 evaporator(s))	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Evaporator evaporation as % of Surface Evaporation (1 evaporator)	35.4%	31.8%	33.4%	36.0%	45.0%	58.2%	77.9%	90.9%	85.0%	62.8%	47.8%	39.8%	33.8%	30.4%
Evaporator evaporation as % of Surface Evaporation (2 evaporators)	70.9%	63.7%	66.8%	71.9%	90.1%	116.3%	155.7%	181.9%	170.0%	125.6%	95.6%	79.7%	67.5%	60.9%
Evaporator evaporation as % of Surface Evaporation (3 evaporator(s))	106.3%	95.5%	100.1%	107.9%	135.1%	174.5%	233.6%	272.8%	255.0%	188.4%	143.4%	119.5%	101.3%	91.3%
Evaporator evaporation as % of Surface Evaporation (4 evaporator(s))	141.8%	127.3%	133.5%	143.8%	180.1%	232.7%	311.4%	363.8%	340.0%	251.2%	191.2%	159.4%	135.0%	121.7%
Evaporation from Pond	16982.28	21600.97867	20657.05538	15814.9363	13016.6113	8081.18995	5197.22556	3706.71156	4272.10208	6895.50571	10083.4006	14273.9441	17829.0205	22594.3205
Incident Rainfall	10081.5	7243.5	8819.25	8027.25	6913.5	5626.5	6435	5395.5	6575.25	7656	8217	9050.25	10081.5	7243.5
Water Pumped In	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000

	Initial Volume stored in ED3	1/11/2005	1/12/2005	1/01/2006	1/02/2006	1/03/2006	1/04/2006	1/05/2006	1/06/2006	1/07/2006	1/08/2006	1/09/2006	1/10/2006
Progressive Water Balance (no evaporators)	90976	91051	84003	79226	77967	78054	81283	87902	94840	102413	108581	112268	112774
Progressive RL of dam	789.09	789.09	789.02	788.96	788.95	788.95	788.99	789.06	789.13	789.21	789.27	789.31	789.31
Progressive Water Balance (1 evaporator)	90976	85032	71813	61939	57093	53428	53509	57192	61569	66443	69775	70859	68929
Progressive RL of dam	789.09	789.03	788.87	788.73	788.67	788.62	788.62	788.67	788.73	788.79	788.84	788.85	788.83
Progressive Water Balance (2 evaporators)	90976	79013	58919	42151	31618	22091	17471	17108	18114	19355	18358	14622	7005
Progressive RL of dam	789.09	788.96	788.70	788.46	788.26	788.07	787.81	787.75	787.93	788.02	787.98	787.28	785.83
Progressive Water Balance (3 evaporators)	90976	72995	47751	27693	16238	7727	3868	3042	3259	3861	3385	1963	0
Progressive RL of dam	789.09	788.88	788.55	788.18	787.58	785.97	785.23	785.08	785.12	785.23	785.14	784.87	784.50
Progressive Water Balance- 4 evaporators	90976	66976	35767	11085	320	0	0	0	0	0	0	0	0
Progressive RL of dam	789.09	788.80	788.34	786.60	784.56	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50
Monthly Evaporation (no evaporators)		15.006	19.291	18.596	14.286	11.827	7.398	4.816	3.458	4.002	6.488	9.529	13.544
Monthly Evaporation (1 evaporator)		21.025	25.462	23.693	17.874	15.578	10.546	7.752	6.018	6.702	9.324	12.133	15.980
Monthly Evaporation (2 evaporators)		27.044	31.528	28.636	21.127	18.450	12.845	9.675	7.731	8.678	11.086	12.937	12.925
Monthly Evaporation (3 evaporators)		33.063	37.487	33.877	24.482	20.425	14.485	12.261	10.179	10.973	13.132	14.638	17.207
Monthly Evaporation- 4 evaporators		39.081	43.452	38.501	23.793	23.475	18.804	16.186	13.484	14.527	17.318	19.280	22.750

	1/11/2006	1/12/2006	1/01/2007	1/02/2007	1/03/2007	1/04/2007	1/05/2007	1/06/2007	1/07/2007	1/08/2007	1/09/2007	1/10/2007	1/11/2007	1/12/2007
Progressive Water Balance (no evaporators)	110874	101516	94678	91891	90787	93333	99571	106259	113562	119323	122457	122233	119485	109135
Progressive RL of dam	789.29	789.20	789.13	789.10	789.09	789.11	789.18	789.25	789.32	789.38	789.41	789.41	789.38	789.27
Progressive Water Balance (1 evaporator)	65349	55011	47672	44513	42082	42911	47025	51674	56845	60628	62327	61197	58521	49205
Progressive RL of dam	788.78	788.64	788.55	788.50	788.46	788.48	788.54	788.60	788.67	788.72	788.74	788.73	788.69	788.57
Progressive Water Balance (2 evaporators)	0	0	0	0	0	0	68	1346	2885	2339	0	0	0	0
Progressive RL of dam	784.50	784.50	784.50	784.50	784.50	784.50	784.51	784.76	785.05	784.94	784.50	784.50	784.50	784.50
Progressive Water Balance (3 evaporators)	0	0	0	0	0	0	0	282	955	587	0	0	0	0
Progressive RL of dam	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.55	784.68	784.61	784.50	784.50	784.50	784.50
Progressive Water Balance- 4 evaporators	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Progressive RL of dam	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50
Monthly Evaporation (no evaporators)	16.982	21.601	20.657	15.815	13.017	8.081	5.197	3.707	4.272	6.896	10.083	14.274	17.829	22.594
Monthly Evaporation (1 evaporator)	18.662	22.581	21.158	16.187	14.345	9.798	7.321	5.746	6.405	8.872	11.519	15.180	17.757	21.560
Monthly Evaporation (2 evaporators)	12.681	13.751	13.789	11.372	11.725	9.402	8.093	6.744	7.296	8.766	9.763	11.375	12.037	13.751
Monthly Evaporation (3 evaporators)	18.056	20.626	20.684	17.058	17.587	14.103	12.139	10.113	10.902	13.024	14.491	17.062	18.056	20.626
Monthly Evaporation- 4 evaporators	24.075	27.502	27.578	22.744	23.449	18.804	16.186	13.484	14.527	17.318	19.280	22.750	24.075	27.502

Net pan evaporation (inches/month)	Percentage of volume pumped by evaporator	Net pan evaporation (inches/month)	Percentage of volume pumped by evaporator
1.5	20	7.0	40
2.0	28	7.5	41
2.5	29	8.0	42
3.0	30	8.5	43
3.5	32	9.0	44
4.0	34	9.5	45
4.5	35	10	46
5.0	36	10.5	47
5.5	37	11	48
6.0	38	11.5	49
6.5	39	12	50
7.0	40	12+	up to 85

Net pan evaporation	Percentage of volume pumped by evaporator (from manufacturer specifications)			
1.5	20%	38.1	21.8%	21.8%
2	28%	50.8	24.4%	24.4%
2.5	29%	63.5	26.7%	26.7%
3	30%	76.2	28.7%	28.7%
3.5	32%	88.9	30.5%	30.5%
4	34%	101.6	32.2%	32.2%
4.5	35%	114.3	33.8%	33.8%
5	36%	127	35.2%	35.2%
5.5	37%	139.7	36.6%	36.6%
6	38%	152.4	37.9%	37.9%
6.5	39%	165.1	39.1%	39.1%
7	40%	177.8	40.3%	40.3%
7.5	41%	190.5	41.4%	41.4%
8	42%	203.2	42.5%	42.5%
8.5	43%	215.9	43.5%	43.5%
9	44%	228.6	44.6%	44.6%
9.5	45%	241.3	45.5%	45.5%
10	46%	254	46.5%	46.5%
10.5	47%	266.7	47.4%	47.4%
11	48%	279.4	48.3%	48.3%
11.5	49%	292.1	49.1%	49.1%
12	50%	304.8	50.0%	50.0%
12+	up to 86			

MONTHLY WASTE TONNAGE DATE:

FEBRUARY 2019 – FEBRUARY 2020

	February	March 1st - 15th	31st	April	May	June	July	August	September	October	November	December	January	February
Total Tonnage to WBR (t)	72,299.44	35,380.33	33,829.46	71,977.58	74,726.81	62,684.00	76,765.75	73,068.09	74,015.96	80,104.01	77,022.88	78,795.46	77,607.38	76,129.45

APPENDIX D:

LIQUID ODOUR MEASUREMENT METHODOLOGY

Methodology

The Liquid Odour Method (**LOM**) is comprised of the following components:

- Evaporation of a known amount of liquid in a known volume of dry nitrogen contained in a Nalophan odour sample bag;
- Determination of the odour concentration of the gaseous sample by Dynamic Dilution Olfactometry following AS4323.3:2001; and
- Calculation of the odour concentration in the liquid from the gaseous odour concentration (ou/m^3) and the volume of liquid evaporated to produce the gaseous sample.

Procedure

Liquid Sample Storage

The liquid samples analysed from the Woodlawn Bioreactor Facility were collected from stored leachate in lagoons ED3N-1, ED3N-2, ED3N-3, ED3N-4 and ED3S-S. These were refrigerated prior to testing. A liquid sample was extracted immediately from the refrigerated sample bottle and not allowed to warm to room temperature. This is the general procedure when carrying out the liquid odour measurement method for aqueous samples.

Liquid Sample Size

The volume of liquid is determined by the requirement to produce a gaseous sample with a relative humidity of less than 100%. This equates to less than 2.3% v/v water at 20º C, or for a 25 L sample, 413 µL of aqueous sample. The method development work carried out to date has shown that 413 µL of liquid sample in 25 L dry nitrogen will evaporate in approximately 30 mins. The nominal liquid sample size required for the Liquid Odour method can be specified as 340-413 µL, which provides a gaseous sample with 80-100% RH. For the liquids samples collected at the Woodlawn Bioreactor Facility, 413 µL of liquid sample was used in 25 L dry nitrogen.

Table D1 details a range of liquid volumes and approximate evaporation times observed from the method development work carried out to date.

Table D1 - Liquid sample volumes, evaporation and equilibration time

Volume µL (% saturation)	Approximate evaporation time (in 25 L dry nitrogen)	Recommended equilibration time (in 25 L dry nitrogen)
280 µL (60%)	20-30 min	60 min
340 µL (80%)	30-40 min	60 min
413 µL (100%)	40-60 min	60 min

Sample Equilibration and Ageing

The development work to date has shown that condensate derived odour samples are not stable and degrade significantly over time. However, the degradation appears insignificant in the first 2-4 hours after preparation of the gaseous samples. Therefore, samples must be tested within that time period after preparation. For samples prepared at 100% saturation or below, the equilibration time can be standardised to 1 hour.

Sample Preparation and Odour Testing Procedure

The gaseous sample for odour testing is prepared as follows:

1. Dispense 25 L of dry nitrogen into a conditioned Nalophan bag.

2. Place a piece of clear packaging tape (approximately 100 mm long) onto the wall of the bag halfway between the ends. Ensure that the a least a 1 cm^2 section of tape completely adheres to the bag with no air bubbles trapped between the tape and bag that could allow a leak of gas to the edge of the tape.

3. Remove the liquid sample from cold storage.

4. Rinse the microlitre syringe (5 x) with the liquid sample.

5. Draw up the required volume of liquid sample (see **Liquid Sample Size** and **Table D1**) and record the exact volume in the syringe.

6. Inject the liquid through the tape and wall of the bag at the point where the tape has completely adhered to the bag. Tap the syringe to displace residual drop that adheres to the needle and withdraw the syringe from the bag.

7. Place the second piece of packaging tape over the first piece such that the puncture hole is sealed. Ensure no air bubbles are trapped between the layers of tape such that a leak could occur.

8. Vigorously shake the bag to disperse the liquid droplets inside the bag (to aid in the evaporation rate).

9. Store the bag in the laboratory for the prescribed equilibration time (see **Sample Equilibration and Ageing** and **Table D1**) to allow all the liquid to evaporate.

10. At the completion of the equilibration time, carry out the measurement of odour concentration using AS4323.3:2001.

Calculation of Liquid Odour Concentration

The odour concentration from a liquid (ou per mL) is calculated from the gaseous sample odour concentration, the volume of liquid used to prepare the gaseous sample and the volume of dry nitrogen:

$$[odour]_{liquid} = \frac{\left(\frac{OU}{m^3} \times \frac{litres_{Nitrogen}}{1000}\right)}{mL_{liquid}}$$

An example of the calculation is presented in **Table D2**.

Table D2 – Example calculation of liquid odour concentration for ED3N-4		
Parameter	**Value**	**Unit**
Volume of liquid from ED3N-4	0.413	mL
Volume of dry N_2	25	L
Measured odour concentration	64^	ou
Calculated liquid odour concentration	= (64 x 25/1000)/0.413 = 3.87	ou.m^3/mL

^ TOU Sample Number SC20202– see **Table 6.5** in Main Report

Calculation of Odour Emission Rates from Evaporation of Liquids

A primary driver for the development of a liquid odour measurement is the requirement to predict odour emission rates from liquids area sources (such as storage ponds) as well as condensates. In particular, evaporation of condensates or other odorous refinery waters in cooling towers has been implicated as a significant contributor to refinery odour. With a measurement of the odour from liquids now available, the estimation of emission rates can be considered.

An example is presented below for treated leachate stored in ED3N-4 (SC20202) which returned a measured odour concentration of 3.87 ou.m^3/mL (see **Table D2**) with an evaporation rate of 1.418 L/s (based on on-site evaporation data collected by Veolia between May 2007 and June 2012):

Odour concentration	= 3.87 ou.m^3/mL
Ambient pond evaporation rate	= 1.418 L/s
Odour emission rate	= 3.87 ou.m^3/mL x 1,418 mL/s = 5,490 ou.m^3/sec (see **Table 6.5** in Main Report)

APPENDIX E:

FAOA SURVEY LOGSHEETS

FAOA Survey 1 - Session Summary (Odour Intensity)

THE ODOUR UNIT

Date: 17/02/2020 **Start Time:** 9:40 PM **End Time:** 10:40 PM

Assessment Area: Woodlawn, NSW **Intensity ≥** 1 **Frequency ≥** 10%

Location	1		2		3		4		5		6	
Intensity	1 & 2	%	1 & 2	%	1 & 2	%	1 & 2	%	1 & 2	%	1 & 2	%
0	30	100%	30	100%	30	100%	17	57%	4	13%	17	57%
1	0	0%	0	0%	0	0%	10	33%	11	37%	1	3%
2	0	0%	0	0%	0	0%	2	7%	5	17%	0	0%
3	0	0%	0	0%	0	0%	1	3%	10	33%	12	40%
4	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
5	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
6	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
≥ 1's	0	0%	0	0%	0	0%	13	43%	26	87%	13	43%
Freq Exceeded?	NO		NO		NO		YES		YES		YES	
≥ 2's	0	0%	0	0%	0	0%	3	10%	15	50%	12	40%
Freq Exceeded?	NO		NO		NO		YES		YES		YES	

FAOA Survey 1 - Field Data Record Sheet (Odour Intensity & Quality)

THE ODOUR UNIT

Name: M. Assal / A. Schulz **Member ID:** 1 & 2 **Date:** 17/02/2020

Assessment Area: Veolia Woodlawn **Start Time:** 9:40 PM **End Time:** 10:40 PM

Measurement Point: **1**
Wind Speed and Direction: ENE 2 - 3 m/s
Start: 9:40 PM End: 9:45 PM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: **2**
Wind Speed and Direction: NE 1 - 3 m/s
Start: 9:53 PM 9:58 PM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: **3**
Wind Speed and Direction: ENE 1 - 3 m/s
Start: 10:09 PM 10:14 PM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Field comments:

Measurement Point: **4**
Wind Speed and Direction: ENE - E 1 - 2 m/s
Start: 10:19 PM 10:24 PM

min-1	0	0	1	0	0	0
min-2	0	2	1	1	1	0
min-3	0	2	3	0	0	0
min-4	0	0	0	0	0	0
min-5	1	1	1	1	1	1
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: **5**
Wind Speed and Direction: ENE - E 1 - 3 m/s
Start: 10:28 PM 10:33 PM

min-1	3	3	3	3	1	1
min-2	2	1	0	3	0	3
min-3	1	2	3	3	3	2
min-4	1	3	2	1	2	1
min-5	1	1	0	1	0	1
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: **6**
Wind Speed and Direction: ENE - E 1 - 2 m/s
Start: 10:35 PM 10:40 PM

min-1	3	3	3	3	3	3
min-2	3	3	3	3	3	3
min-3	1	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Weather conditions: 18-19°C, Atmospheric Pressure = 936 hPa

Key Odour Descriptors:

A = bin juice, fermented garbage, sweet

B = compost, fermented

FAOA Survey 2 (1 of 2) - Session Summary (Odour Intensity)

Date: 18/02/2020 **Start Time:** 6:30 AM **End Time** 7:19 AM

THE ODOUR UNIT

Assessment Area: Woodlawn, NSW **Intensity ≥** 1 **Frequency ≥** 10%

Location	1		2		3		4		5		6	
Intensity	1, 2 & 3	%	1, 2 & 3	%	1, 2 & 3	%	1, 2 & 3	%	1, 2 & 3	%	1, 2 & 3	%
0	30	100%	30	100%	20	67%	30	100%	20	67%	20	67%
1	0	0%	0	0%	9	30%	0	0%	2	7%	10	33%
2	0	0%	0	0%	1	3%	0	0%	3	10%	0	0%
3	0	0%	0	0%	0	0%	0	0%	5	17%	0	0%
4	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
5	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
6	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
≥ 1's	0	0%	0	0%	10	33%	0	0%	10	33%	10	33%
Freq Exceeded?	NO		NO		YES		NO		YES		YES	
≥ 2's	0	0%	0	0%	1	3%	0	0%	8	27%	0	0%
Freq Exceeded?	NO		NO		NO		NO		YES		NO	

FAOA Survey 2 (1 of 2) - Field Data Record Sheet (Odour Intensity & Quality)

Name: M. Assal / A. Schulz / S. Hayes **Member ID:** 1, 2 & 3 **Date:** 18/02/2020

Assessment Area: Woodlawn, NSW **Start Time:** 6:30 AM **End Time:** 07:19 hrs

Measurement Point: **1**
Wind Speed and Direction: NNE 2 - 4 m/s
Start: 6:30 AM End: 6:35 AM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0

Descriptor(s):					
	A	B	C	D	E
	F	G	H	I	J

Measurement Point: **2**
Wind Speed and Direction: NNE 2 - 4 m/s
Start: 6:45 AM 6:50 AM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0

Descriptor(s):					
	A	B	C	D	E
	F	G	H	I	J

Measurement Point: **3**
Wind Speed and Direction: NNE 1 - 2 m/s
Start: 6:51 AM 6:56 AM

min-1	0	1	1	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	1	1	0	0
min-4	1	1	0	0	0	0
min-5	0	0	1	2	1	1

Descriptor(s):					
	A	B	C	D	E
	F	G	H	I	J

Measurement Point: **4**
Wind Speed and Direction: Calm
Start: 6:59 AM 7:04 AM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0

Descriptor(s):					
	A	B	C	D	E
	F	G	H	I	J

Measurement Point: **5**
Wind Speed and Direction: Calm
Start: 7:06 AM 7:11 AM

min-1	3	3	3	3	2	2
min-2	2	3	1	0	0	0
min-3	0	0	0	0	0	0
min-4	1	0	0	0	0	0
min-5	0	0	0	0	0	0

Descriptor(s):					
	A	B	C	D	E
	F	G	H	I	J

Measurement Point: **6**
Wind Speed and Direction: Calm
Start: 7:14 AM 7:19 AM

min-1	0	0	1	1	0	0
min-2	1	1	0	0	0	0
min-3	1	1	0	0	1	1
min-4	0	0	0	0	0	0
min-5	0	1	1	0	0	0

Descriptor(s):					
	A	B	C	D	E
	F	G	H	I	J

Weather conditions: 18°C

Key Odour Descriptors:

A = bin juice, fermented garbage, sweet

B = compost, fermented

FAOA Survey 2 (2 of 2)- Session Summary (Odour Intensity)

THE ODOUR UNIT

Date: 18/02/2020 **Start Time:** 7:23 AM **End Time:** 7:30 AM

Assessment Area: Woodlawn, NSW **Intensity ≥** 1 **Frequency ≥** 10%

Location	7										
Intensity	MA/AS/SH	%									
0	30	100%									
1	0	0%									
2	0	0%									
3	0	0%									
4	0	0%									
5	0	0%									
6	0	0%									
≥ 1's	0	0%									
Freq Exceeded?	NO										
≥ 2's	0	0%									
Freq Exceeded?	YES										

FAOA Survey 2 (2 of 2)- Field Data Record Sheet (Odour Intensity & Quality)

THE ODOUR UNIT

Name: M. Assal / A. Schulz / S. Hayes **Member ID:** MA/AS/SH **Date:** 18/02/2020

Assessment Area: Woodlawn, NSW **Start Time:** 7:23 AM **End Time:** 7:30 AM

Measurement Point: **7**
Wind Speed and Direction: Calm to ENE 1-2 m/s
Start: 7:25 AM End: 7:30 AM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point:
Wind Speed and Direction
Start:

min-1						
min-2						
min-3						
min-4						
min-5						
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point:
Wind Speed and Direction
Start:

min-1						
min-2						
min-3						
min-4						
min-5						
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Field comments: Local wind variability high

Measurement Point:
Wind Speed and Direction
Start:

min-1						
min-2						
min-3						
min-4						
min-5						
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point:
Wind Speed and Direction
Start:

min-1						
min-2						
min-3						
min-4						
min-5						
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point:
Wind Speed and Direction
Start:

min-1						
min-2						
min-3						
min-4						
min-5						
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Weather conditions: 18^{o}C

Key Odour Descriptors:

A = bin juice, fermented garbage, sweet

B = compost, fermented

FAOA Survey 3 (1 of 2) - Session Summary (Odour Intensity)

THE ODOUR UNIT

Date: 20/02/2020 **Start Time:** 12:20 PM **End Time:** 1:19 PM

Assessment Area: Woodlawn, NSW **Intensity ≥** 1 **Frequency ≥** 10%

Location	1		2		3		4		5		6	
Intensity	1 & 2	%	1 & 2	%	1 & 2	%	1 & 2	%	1 & 2	%	1 & 2	%
0	30	100%	30	100%	30	100%	30	100%	30	100%	25	83%
1	0	0%	0	0%	0	0%	0	0%	0	0%	5	17%
2	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
3	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
4	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
5	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
6	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
≥ 1's	0	0%	0	0%	0	0%	0	0%	0	0%	5	17%
Freq Exceeded?	NO		NO		NO		NO		NO		NO	
≥ 2's	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Freq Exceeded?	NO		NO		NO		NO		NO		NO	

FAOA Survey 3 (1 of 2) - Field Data Record Sheet (Odour Intensity & Quality)

Name: M. Assal / A. Schulz **Member ID:** 1 & 2 **Date:** 20/02/2020

Assessment Area: Woodlawn, NSW **Start Time:** 12:20 PM **End Time:** 1:22 PM

Measurement Point: 1
Wind Speed and Direction SSW calm to light
Start: 12:20 PM End: 12:25 PM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: 2
Wind Speed and Direction SW - W
Start: 12:32 PM 12:37 PM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: 3
Wind Speed and Direction Calm SW - W
Start: 12:39 PM 12:44 PM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: 4
Wind Speed and Direction WSW 0 - 1 m/s
Start: 10:19 PM 10:24 PM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: 5
Wind Speed and Direction WSW calm to moderate
Start: 12:53 PM 12:58 PM

min-1	0	0	0	0	0	0
min-2	0	0	0	0	0	0
0	0	0	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Measurement Point: 6
Wind Speed and Direction WSW calm to moderate
Start: 1:00 PM 1:05 PM

min-1	0	1	0	0	0	0
min-2	0	0	1	1	1	0
min-3	0	1	0	0	0	0
min-4	0	0	0	0	0	0
min-5	0	0	0	0	0	0
Descriptor(s):	A	B	C	D	E	
	F	G	H	I	J	

Weather conditions: Atmospheric Pressure = 929 hPa

Key Odour Descriptors:

A = bin juice, fermented garbage, sweet

B = compost, fermented

FAOA Survey 3 (2 of 2) - Session Summary (Odour Intensity)

THE ODOUR UNIT

Date: 20/02/2020 **Start Time:** 12:20 PM **End Time:** 1:19 PM

Assessment Area: Woodlawn, NSW **Intensity ≥** 1 **Frequency ≥** 10%

Location	7		8		0		0		0		0	
Intensity	MA/AS	%	MA/AS	%								
0	22	73%	19	63%								
1	2	7%	4	13%								
2	2	7%	4	13%								
3	4	13%	3	10%								
4	0	0%	0	0%								
5	0	0%	0	0%								
6	0	0%	0	0%								
≥ 1's	8	27%	11	37%								
Freq Exceeded?	YES		YES									
≥ 2's	6	20%	7	23%								
Freq Exceeded?	YES		YES									

FAOA Survey 3 (2 of 2) - Field Data Record Sheet (Odour Intensity & Quality)

Name: M. Assal / A. Schulz **Member ID:** MA/AS **Date:** 20/02/2020

Assessment Area: Woodlawn, NSW **Start Time:** 1:07 PM **End Time:** 1:19 PM

Measurement Point: 7
Wind Speed and Direction WSW - SW calm to light
Start: 13:07 End: 1:12 PM

min-1	0	3	3	0	0	0
min-2	0	0	0	0	0	0
min-3	0	0	0	0	0	0
min-4	3	3	2	0	0	0
min-5	1	0	0	0	2	1

Descriptor(s):	A	B	C	D	E
	F	G	H	I	J

Measurement Point: 8
Wind Speed and Direction WSW light - moderate
Start: 1:14 PM 1:19 PM

min-1	0	3	3	2	2	0
min-2	2	0	0	0	0	0
min-3	0	0	0	1	1	0
min-4	0	0	1	1	0	0
min-5	0	0	3	2	0	0

Descriptor(s):	A	B	C	D	E
	F	G	H	I	J

Measurement Point:
Wind Speed and Direction
Start:

min-1						
min-2						
min-3						
min-4						
min-5						

Descriptor(s):	A	B	C	D	E
	F	G	H	I	J

Field comments: Trucks active

Measurement Point:
Wind Speed and Direction
Start: 4:52 PM

min-1						
min-2						
min-3						
min-4						
min-5						

Descriptor(s):	A	B	C	D	E
	F	G	H	I	J

Measurement Point:
Wind Speed and Direction
Start:

min-1						
min-2						
min-3						
min-4						
min-5						

Descriptor(s):	A	B	C	D	E
	F	G	H	I	J

Measurement Point:
Wind Speed and Direction
Start:

min-1						
min-2						
min-3						
min-4						
min-5						

Descriptor(s):	A	B	C	D	E
	F	G	H	I	J

Weather conditions: Atmospheric Pressure = 929 hPa

Key Odour Descriptors:

A = bin juice, fermented garbage, sweet

B = compost, fermented