Assessment of Potential Odour Effects

Proposed Fonterra Wastewater Treatment Facility, Hautapu

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Abbreviation List

WWTP	Wastewater treatment facility
EBPR	Enhanced biological phosphorus removal
DAF	Dissolved air flotation
SBR	Sequencing batch reactor
COD	Chemical oxygen demand
PAOs	Phosphorus accumulating organisms
RAS	Recycled activated sludge
WAS	Waste activated sludge
MBR	Membrane bioreactor
UF	Ultra-filtration
MLSS	Mixed liquid suspended solids
GLC	Ground level concentration
DO	Dissolved oxygen

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1.0 INTRODUCTION

This report[1] provides an odour impact assessment associated with a proposal to operate a new wastewater treatment facility (WWTF) at the Fonterra Hautapu, Waikato manufacturing site. The proposed WWTF process will utilise a series of anoxic, anaerobic and aerobic steps to enable denitrification and enhanced biological phosphorus removal (EBPR), thus treating the wastewater to a very high standard. These processes would be performed within a tank-based system. The proposed facility would include waste sludge management and be located within the property boundary of the existing Fonterra Hautapu site - immediately northwest of the milk processing plant.

Golder (2018) previously reported on an odour impact assessment for a similar proposal, when located on Fencourt Road at Fonterra's Buxton farm (several kilometres to east of the milk processing plant). Following community consultation, the Hautapu WWTF is now being proposed by Fonterra to be located adjacent to its Hautapu manufacturing site.

The scope of this report[1] includes a general description of the proposed WWTF, sources of odour, sensitivity of the receiving environment, and an assessment of the potential to cause adverse odour related effects beyond the site boundary. It also includes a description and independent assessment of key odour mitigation measures which Fonterra has proposed.

The potential for adverse odour effects due to short term episodes of odour discharge, as well as long term exposure to recognisable WWTF odours, are both accounted for within the scope of this assessment.

2.0 PROCESS DESCRIPTION

2.1 Overview

A summary of the wastewater management strategy, which would be allowed for by the proposed WWTF is provided in Figure 1. This highlights that the total wastewater flow from the milk processing site is made up of low, medium and high strength streams. The combined low strength and moderate strength streams are proposed to be treated by the new WWTF, whereas high strength streams, will continue to be segregated and transferred offsite via tanker for land spreading.

There is currently pre-treatment of some medium strength waste streams occurring, and for this assessment it is assumed that these will continue to operate at the milking processing site. This includes the use of dissolved air flotation (DAF) to pre-treat medium strength streams and an activated sludge treatment process (a small sequencing batch reactor) dedicated for pre-treating one relatively small waste stream.

Sludge produced from the DAF is transferred to Fonterra's nearby DairyFert operations, where it is stored in silos with other high stream waste streams, before being transferred offsite (via tankers) for land treatment.

The treated wastewater stream produced by the new WWTF, will be discharged to land, or the Waikato River (see Figure 1).

The existing discharges to air from the sequencing batch reactor (SBR), DAF and associated buffer tanks are authorised by Fonterra Hautapu's existing air discharge consent (AUTH119618.01.05). For the assessment

[1] This report is subject to the limitations contained in Appendix A.

of odour discharges from the WWTF, these existing sources of odour and those from the activities associated with the milk processing site are treated as part of the existing environment.

The maximum daily wastewater volume generated by the milk processing site during peak season is expected to be 9,500 m³/day, with a maximum chemical oxygen demand (COD) load of approximately 20,000 kg/day. Given the continuous nature of the dairy season, from the commencement of the season in early to mid-July and its conclusion towards the end of May the following year, the WWTF will operate 24 hours per day and seven days per week. The peak of the milk processing season is usually from mid-September to mid-December, although this can be extended depending on specific product demand. However, on the shoulders of the season the daily organic loading to the WWTF will decrease.

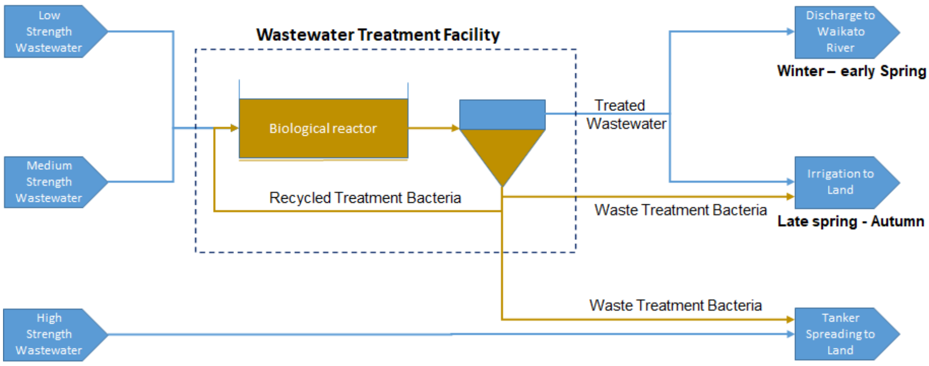


Figure 1: Schematic of the proposed wastewater management strategy (provided by Fonterra).

2.2 Proposed WWTF

The proposed WWTF is a type of activated sludge plant incorporating denitrification and EBPR processes to provide a high level of reduction in organic and nutrient loads. The wastewater treatment process design is specified to achieve high levels of nitrogen and phosphorus removal.

Fonterra has assessed options and proposed a conceptual process design and layout for the WWTF, which would enable the treated wastewater quality to meet the proposed resource consent conditions. This conceptual process design and layout have been assumed for this assessment of potential odour effects. It is understood that during any detailed design phase, that some aspects of the WWTF's process and equipment may change. However, it is anticipated that these changes would not materially impact on the assessed potential for odour emissions (except for possible reductions) from the proposed WWTF, or materially change the risk of abnormal odour discharges (except for a reduction in this risk), when accounting for the WWTF's proposed odour mitigation measures.

The incoming wastewater stream (ex the milk processing wastewater pre-treatment system) will enter two balance tanks to provide a steady flow to the biological treatment plant. This will consist of two parallel multiple stage tank reactors, each of which has six consecutive treatment stages including:

- Pre-anoxic stage
- Anaerobic stage
- 2nd anoxic stage
- Large aerobic stage

- 3rd anoxic stage
- A final aerobic stage

These stages are shown in Figure 2 and Figure 10. The aeration treatment reactors (including the large tanks and one smaller final stage) are estimated to have a surface area of 3,720 m^2, which is expected to have a COD surface loading rate of approximately 5 kg COD/m^2 per day. The aerobic reactors would be fitted with a submerged fine air bubble diffuser array connected to six blowers with a total electrical energy input of approximately 484 kW.

Besides nitrogen removal under anoxic and aerobic stages, the proposed system also incorporates biological phosphorus removal by introducing an anaerobic phase ahead of the aerobic/anoxic stages. The anaerobic stage involves several complex biochemical processes, where phosphorus is converted to a soluble form. The soluble phosphorus would be assimilated by phosphorus accumulating organisms (PAOs) and stored in the form of phosphorus accumulating biomass during the aerobic stage. This biomass is separated from the treated wastewater by the clarifier following the biological treatment reactors.

The clarifier also recycles the activated sludge (RAS) to the pre-anoxic stages. The waste activated sludge (WAS) will be collected in an enclosed WAS storage tank, that includes aeration, prior to the WAS being dewatered. The sludge dewatering operation will be undertaken within a dedicated building. Both the WAS storage tank and process equipment within the sludge dewatering building would have air extraction and subsequent treatment of the extracted air flows via a Biofilter or equivalent odour treatment system. The WAS production is estimated to be 4,050 kg dry solids per day during peak season and 3,250 kg dry solids per day on average. The concentrates from the sludge centrifuge would be returned to the pre-anoxic stage.

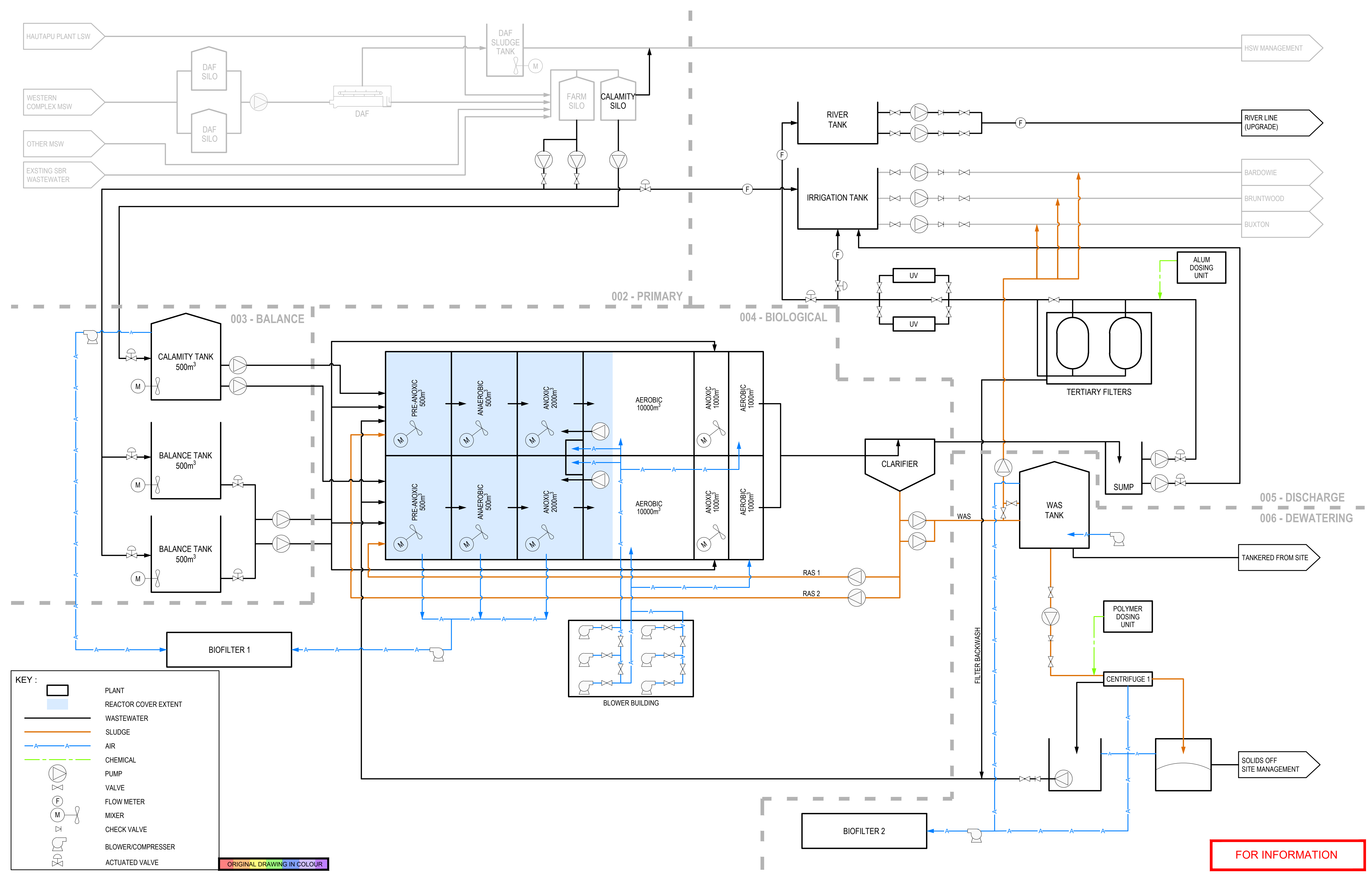
The wastewater exiting the clarifier can be further treated by tertiary filters, followed by UV disinfection if the treated wastewater is to be discharged to the Waikato River. All treated water can be temporarily stored in either the river tank, or the irrigation tank prior to being discharged to the Waikato River, or to land, or a combination of the two.

The calamity tank, pre-anoxic, anaerobic, and 2nd anoxic tanks, WAS tank and sludge dewatering, that could cause significant odour emissions, will be covered and have air extracted to a Biofilter. The summary of key WWTF design parameters is shown in Table 1.

Table 1: Key design parameters for aeration stage.

Parameters	Value
COD input (kg/day)	20,000 (maximum), 18,500 (95th percentile)
COD loading rate (kg/day per m^2 wastewater)	5
Aeration energy (kW)	484
Aeration area (m^3)	3,720

Figure 2: Schematic flow chart of the proposed WWTF – provided by Fonterra is below.



NO.	REVISION	DATE	APP.
E	ISSUED FOR INFORMATION	JAN 21	
D	ISSUED FOR INFORMATION	JAN 21	
C	ISSUED FOR INFORMATION	DEC 20	
B	ISSUED FOR INFORMATION	DEC 20	
A	ISSUED FOR INFORMATION	DEC 20	

Fonterra

PATTLE DELAMORE PARTNERS

ace MEMBER

CLIENT: FONTERRA LIMITED

PROJECT: HAUTAPU WWTP SITE 8 CLASS 3 COSTING

DESIGNED	DESIGN REVIEW	DATE	APPROVED	DATE
D.I.		DEC 20		
DRAWN	DRAWING CHECK	DATE	THIS DRAWING IS NOT FOR CONSTRUCTION UNLESS SIGNED AS APPROVED	

CONCEPTUAL DESIGN PROCESS FLOW DIAGRAM

SCALE :	DRAWING NO. :	REV :
NTS	(A3) A02545207-DI-001	E

2.3 Odour Sources

The following processes/units associated with the WWTF were identified as potential odour sources:

- Balance tanks: These have the potential to produce localised organic type of odour if the wastewater is kept for more than three days and is not maintained in an aerobic state.
- Calamity tank: This is used very infrequently and stores any excess wastewater volume for extended periods while it gradually discharges this to the WWTF.
- Biological treatment reactors: The pre-anoxic, 2nd stage anoxic, and anaerobic tanks are expected to have the potential to cause significant odour emissions. Accordingly, these tanks will be covered and have head space air extracted to a biofilter. The fugitive odour emissions from these sources are expected to be negligible through the integrity of the tank/cover design and effective extraction system. Odour arising from the remaining uncovered aerobic and post anoxic tanks produce a very weak milky type of odour character and do not require containment and treatment.
- Clarifier: The clarifier can be a potential odour source if the clarifier is not designed or maintained properly, e.g., increased hydraulic retention times can encourage the formation of anoxic/anaerobic condition; inadequate scum removal can result in scum accumulation on the water surface/effluent weir, resulting in odour generation. A properly designed and maintained clarifier is likely to have a very low level of odour emission, which equates to the uncovered post anoxic stage, or lower.
- WAS storage tank and dewatering centrifuge: Without odour management controls, the WAS tank and sludge dewatering process have the potential to cause significant anaerobic odour. To avoid odours from the processing of the WAS, the WAS tank is to be enclosed and will be aerated with the head space air being extracted to a biofilter. The sludge dewatering equipment will also be housed within a building and will have point source extraction of odour from the equipment to a biofilter. This system can be readily designed such that fugitive odour emissions from these sources are negligible.

In summary, it is considered that under normal WWTF operation, the extent of fugitive odour emissions (i.e., odour leakages from covered or enclosed processes) including the covered biological treatment reactors, calamity and WAS storage tanks and dewatering processes is likely to be negligible given best practice design of containment/extraction systems. Given this, residual fugitive odour emissions from covered and enclosed processes would not cause a material contribution to off-site odour exposure levels and do not need to be accounted for within the modelling assessment of normal odour emissions from the WWTF.

The balance tanks, uncovered aerobic and post anoxic tanks, clarifier are the only processes which release odour directly to atmosphere. Accordingly, these odour sources need to be included within the odour modelling-based assessment of chronic odour exposure levels.

3.0 ENVIRONMENTAL SETTING

The following sections discuss the site location, residential dwellings, commercial and other industrial activities at the vicinity of the site that are potentially sensitive to the site’s odour discharge, current irrigation of wastewater from the Fonterra Hautapu processing plant, existing onsite odour sources, the effect of existing amenity, and the topography and meteorology of the area surrounding the WWTF.

3.1 Location of WWTF

The proposed WWTF is to be located, approximately 3 km north of the Cambridge township, on land owned by Fonterra that is zoned under the Waipa District Plan as Specialised Dairy Industrial. This location is advantageous in being adjacent to the northwest of the Hautapu processing plant. Figure 3 shows the proposed building consent envelope for the proposed WWTF, that includes the influent balance tanks, calamity tank and the sludge process building which are located to the east of the biological plant. The sheds near the centre of the envelope are indicative of the biological plant location. Figure 4 shows that the proposed WWTF is located within the Industrial Zone ("Specialised Dairy Industrial Area") in the Waipa District Plan.

3.2 Sensitive Locations

3.2.1 Residential dwellings / community buildings

The site is surrounded by residential dwellings to the north, west and south of the site (see Figure 3). At the time of preparing this assessment (noting that the area is undergoing changes with the development and expansion of primarily industrial activities), there are four residential dwellings and a community hall within 250 m of the WWTF boundary envelope. The nearest residential dwelling's notional boundary[2] (90 Hautapu Road) is approximately 180 m to the southwest of the WWTF boundary envelope. The next nearest residential dwelling's notional boundary (65 Hautapu Road) is located approximately 215 m to the south of the proposed WWTF boundary envelope. Given the proposed positioning of the biological treatment tanks and sludge processing building within the envelope boundary, the two closest residential dwellings are approximately 220 m and 280 m from the biological plant for the southwestern and the southern dwellings, respectively. Both dwellings would be 300 m or further from the sludge processing building.

These two nearest properties are expected to be the most potentially impacted receptors with respect to odour emissions.

3.2.2 Commercial/retail

There are 11 commercial/industrial premises within 250 m of the WWTF boundary envelope. The nearest commercial/industrial premises within 120 m include a landscape supplier (Florida Ltd), a rural supplies branch store (Farmlands Co-operative), a specialist welding services provider, an industrial yard and a sports turf and lifestyle lawn provider yard and office (Parklands Turf Ltd), all being located to the south of the proposed WWTF location.

These types of activities have a lower inherent sensitivity to environmental odour than residential dwellings. However, in this instance, these activities are much closer to the WWTF than the nearest residential dwelling – this is reinforced by the MfE odour guideline (MfE 2016). As such, the nearest commercial activities are likely to be as sensitive to emissions from the particular proposal, as are the occupants of the nearest residential dwellings.

3.2.3 Other sensitive land uses

There is a cemetery located approximately 650 m to the southeast of the WWTF boundary envelope. Golder is not aware of any schools, health centres, or similar sensitive activities within the surround of one kilometre of the proposed WWTF envelope boundary.

[2] The notional boundary surrounds a residential dwelling and is located 20 metres from the edge of the dwelling.

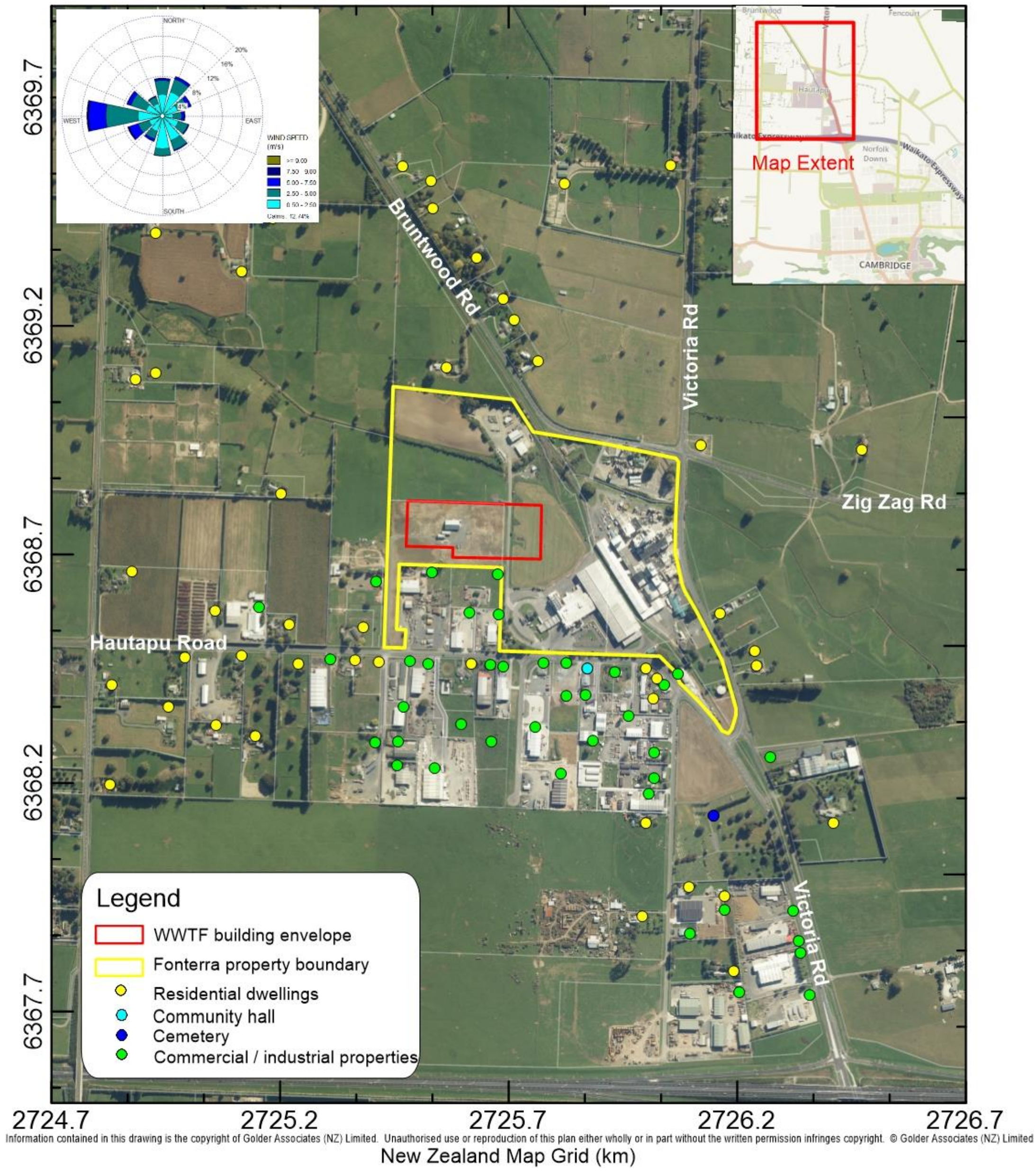


Figure 3: Proposed Hautapu WWTF location (note the base map image was sourced from LINZ data base for 2016 to 2019). Highlighted dwellings and properties are based on Google Earth information dated 2021 and verified via site visit December 2020.

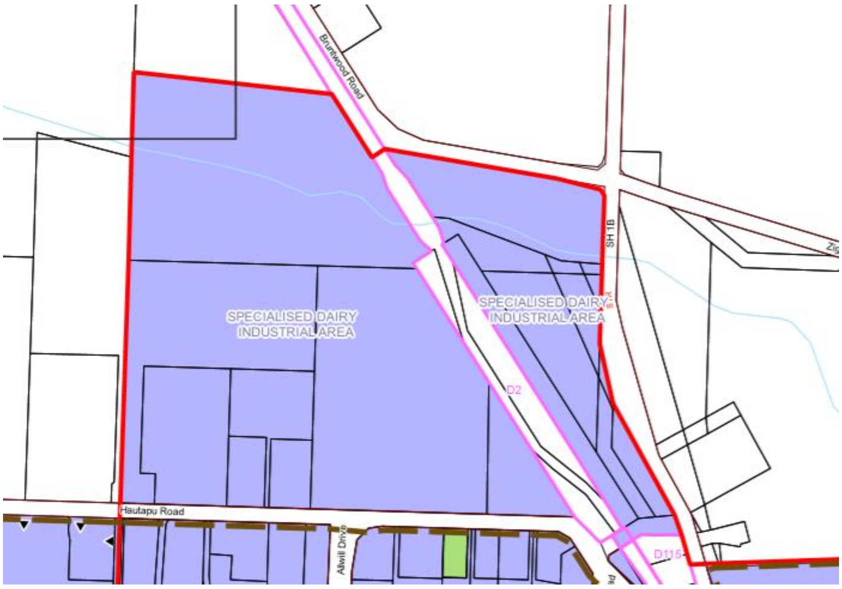


Figure 4: Extract from Planning Map 22 (Zones) in the Waipa District Plan. Purple area shows "Industrial Zone" and area outlined in red is a specialised dairy industrial area.

3.3 Existing Odour Sources

3.3.1 Milk processing site

The potential milk processing site odour sources include process plant emissions to air and pre-treatment of moderate wastewater streams. The latter one includes the small sequencing batch reactor plant (SBR), buffer tanks, dissolved aeration flotation (DAF) clarifier. It is understood that there have been no complaints from the public associated with odour discharges from the Hautapu processing plant in the last eight years.

3.3.2 Wastewater storage/dispatch

It is also understood that there have been no complaints from the public associated with odour discharges from the Dairy Fert site in the last eight years, from which it can be concluded that site odour discharges have not caused concerns with surrounding neighbours. Note, this site is located within the Fonterra Hautapu processing site boundary (see Figure 3).

3.3.3 Cumulative odour effects of existing on-site activities

Golder's observations of odour around the Fonterra Hautapu site boundary (visits during 2017 and October and December 2020) found no recognisable odour downwind of the milk processing or DairyFert sites. Given these observations and absence of odour complaints for the last eight years, it is concluded that cumulative odour effects due to Fonterra Hautapu site activities, are less than minor at residential and commercial activities surrounding the proposed WWTF location (shown in Figure 3).

3.3.4 Wastewater irrigation

The irrigation of moderate to high strength waste streams (discussed above) onto land surrounding the Hautapu site has resulted in odour complaints being lodged with WRC. The odour impacts from this activity appears to be an issue for residents living within the surrounding area. This proposal by Fonterra to construct and operate the WWTF will result in the irrigation of only treated wastewater with excess biosolids to land, once the WWTF is fully commissioned and the discharge performance standards apply. Therefore, any odour from the irrigation of treated wastewater will be less distinct and is expected to be of low intensity. As a result, it can be safely assumed that the existing level of odour effects from wastewater irrigation will decrease significantly from the current levels which are experienced.

Given the above, then the areas of farmland which would be used in the future for irrigating treated wastewater are very likely to only cause less than minor, or negligible odour effects within areas surrounding the proposed WWTF location and when this is operational.

3.3.5 Other activities

There are other activities within the immediately surrounding area that are likely to produce odours, including the mulches and bark stored at the Florida Ltd, landscape supplies company (60 Hautapu Rd). The associated neutral bark type odour produced from this site is consistent with a rural zone.

Rural odour sources which can be noticeable on occasion include hay and silage making, dairy shed effluent irrigation and farm ponds.

All of these existing rural and commercial activities are expected to be less than minor potential for odour effects on sensitive activities which are within approximately 300 m of the proposed WWTF location.

3.4 Topography and Meteorology

The site area is largely flat, with the nearest significant terrain being approximately 5 km to the north-east of the site. The Waikato River is approximately 4 km to the south.

The prevailing winds at the WWTF site are typically from the west as shown by the wind rose in Figure 5. It was generated by using a CALMET meteorological dataset previously developed by Golder for the dispersion modelling of the Fonterra Hautapu manufacturing site (Golder 2009). The CALMET dataset includes measured wind data from nearby monitoring stations for the period from 1 January 2003 to 31 December 2003.

It also shows that the winds from the south and south-south-east are relatively frequent and typically lighter, and that drainage flows from the general north-east direction account for 5 % of the time. Figure 5 also shows a high prevalence of calm condition (13 %), which is typical of much of the central Waikato, where a relatively high frequency of calm weather condition is experienced.

Wind roses for specific times of the day are provided in items (b), (c) and (d) of Figure 5. These show the following:

- Morning - from 00:00 to 08:00 hours, winds are most frequent from the south and south-southeast. They are typically very light. Drainage flows (north-easterly wind) occur for approximately 5 % of the time during these hours.
- Daytime - from 8:00 to 18:00 hours, prevailing winds are typically moderate to strong westerly winds.
- Evening - from 18:00 to 23:59 hours, prevailing winds are also typically northerly and westerly winds, and north-easterly drainage flows are starting to re-establish and occur for approximately 7 % of the time during these hours.

Items (a), (b), (c) and (d) of Figure 6 present wind roses for each season of the year, which indicate the following:

- Summer: Winds are typically moderate to strong westerly winds.

- Autumn: Winds are typically either moderate to light north-easterly winds or light south-south-easterly winds, with relatively high calm condition (20 %).
- Winter: Winds are typically light south and south-south-easterly winds, with relatively high calm condition (15 %).
- Spring: Winds are typically moderate to strong westerly winds, ranging from the north-west to south-west directions.

Given the above, either early morning or night conditions are likely to provide for the poorest dispersion of odours generated by the biological treatment reactors, whereas conditions during the middle of the day are more likely to provide for better dispersion. With regard to the seasons, spring and summer typically have a much higher proportion of strong winds where odours would be more readily dispersed and diluted, whereas winter is more characteristic of lighter winds.

Golder has also reviewed the historic Hamilton meteorological data from 2001 to 2019. A summary of these data is shown in Appendix B. It indicates that the 2003 meteorological conditions are generally consistent with the 19 years of meteorological data for Hamilton City. There is no material difference between 2003 and the later years. Therefore, the meteorological conditions contained within the 2003 CALMET data set provides a representative range of ambient conditions (including worst case conditions) that will occur at the site.

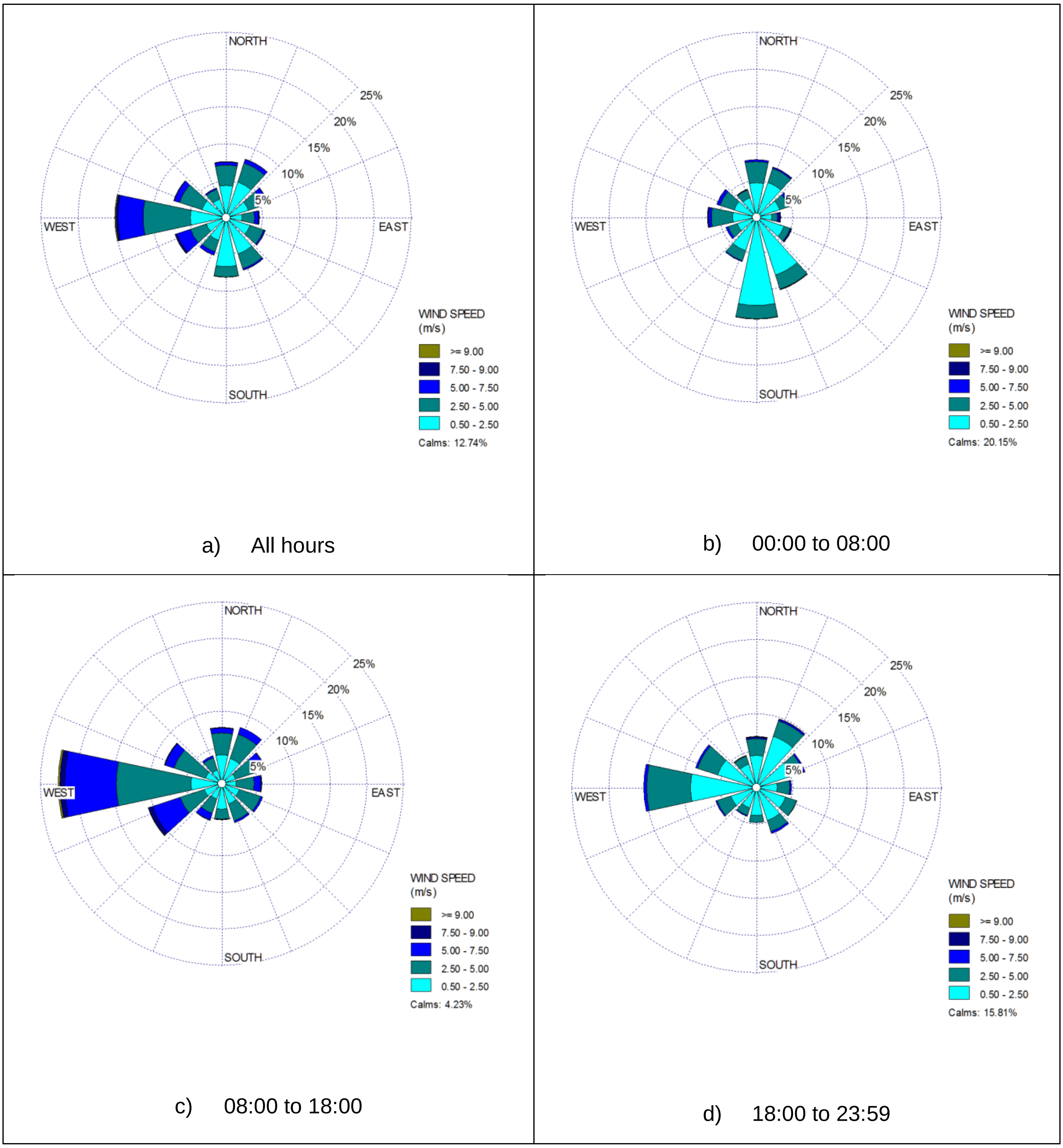


Figure 5: Wind rose from Hautapu CALMET model for different periods of the day (January 2003 to December 2013).

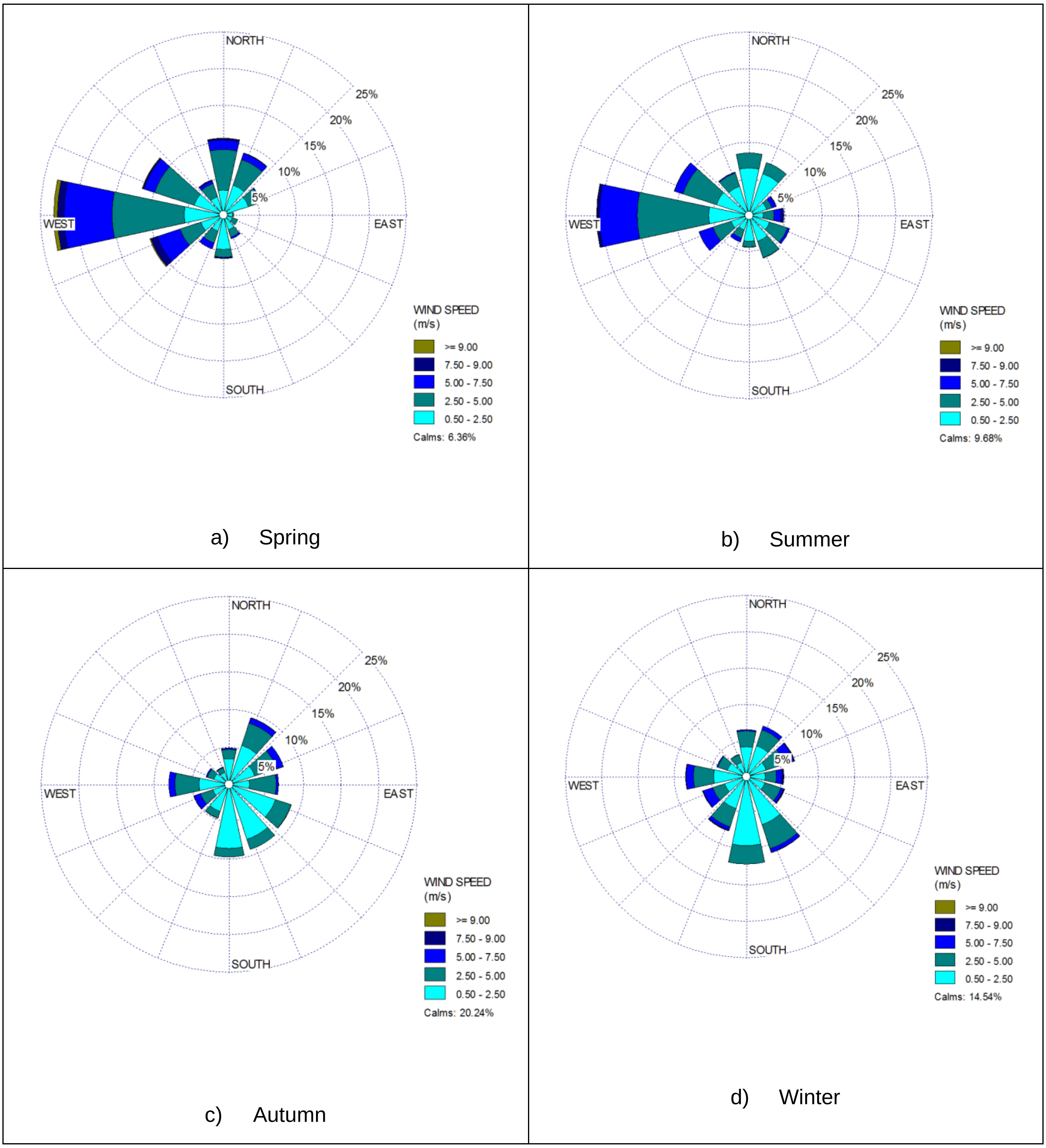


Figure 6: Wind rose from Hautapu CALMET model for different seasons (January 2003 to December 2013).

4.0 ASSESSMENT METHODOLOGY

4.1 Overview

The significance of odour exposure effects is related to the FIDOL factors (MfE 2016) - the combination of the five factors (frequency, intensity, duration, offensiveness and location) of odour events that need to be accounted for with the assessment. The last factor (L) relates to the location where the odour exposures occur. In this instance, locations include people working/visiting industrial/commercial and rural properties, as well as occupants of rural residential dwellings.

There are two types of odour exposure considered. These include chronic and acute exposures.

Chronic odour exposures are recognisable occurrences of odour that are repeated over a long-term period (typically for a year or more). Chronic odour exposures may lead to excessive annoyance/stress within an exposed population. Avoiding adverse chronic odour effects is considered to be essential for avoiding odour complaints from neighbours and accumulated odour impacts on them, which are not sustainable.

In this instance the long term FIDOL factors are relevant and can be accounted for by modelling odour impacts using a long term hourly varying meteorological data set.

The long term FIDOL factors and the significance of the combined cumulative impact of these, over time, is accounted for via robust modelling of the 99.5th and 99.9th percentile 1-hour odour concentrations at sensitive receptor locations.

Acute odour exposures relate to a single event (minutes to a number of hours) of odour that can be distinct or much stronger in its intensity and exhibiting an unpleasant character. The acute odour typically arises from abnormal or upset conditions. An adverse acute odour event can be reasonably equated to be an objectionable or offensive odour episode. In this instance the short term FIDOL factors (typically occurring for over several hours, or less) are relevant and determinant of the extent to which a specific *episode* of odour is objectionable or offensive (i.e., odour exposures which normally occur for several hours, or more on specific day).

Quantifying the odour emission from abnormal conditions is impractical, if not very difficult to achieve reliably. Likewise, the prediction of short term FIDOL factors (for periods of several hours or less) for a greenfield WWTF proposal is impractical, as this requires downwind assessments of the WWTF when operating under abnormal conditions. Further, there are no accepted criteria (either modelled 1-hour odour concentration values, or combination of individual factors) to assess the significance of any short-term odour episode, as defined by some specified FIDOL factors for any location.

Given the issues in defining and evaluating short term FIDOL factors for neighbouring sensitive activities, it is necessary to rely on a qualitative type assessment of objectionable odour risk, when accounting for the various levels of mitigation provided via the design, process controls/monitoring and odour capture/treatment systems.

Therefore, for this assessment, different methods were used to assess the potential for chronic and acute odour effects and these methods align with the above background discussion.

4.2 Chronic Odour Effects

An odour exposure modelling based assessment has been carried out to predict the long-term chronic odour effects anticipated to arise from the operation of the proposed WWTF. This assessment utilised new odour emission flux data obtained from the Fonterra Stirling WWTF. Section 6.0 provides details of the modelling set-up, inputs and criteria used to evaluate results.

4.3 Acute Odour Effects

An assessment of design aspects, process control and odour capture/treatment methods were used to assess the potential acute odour exposures. Golder participated in three rounds of workshops with Fonterra and their wastewater advisors to discuss the odour risk mitigation measures to be incorporated into the proposed WWTF proposal. These measures will avoid the risk of uncontrolled or abnormal discharges to air causing objectionable odour, as well as controlling normal odour emissions, that might cause minor chronic exposure effects, by attention to operational process control.

These workshops involved a review of site layout to maximise separation distances to sensitive offsite activities, review of options for odour minimisation, containment and treatment, and consideration of alternative odour treatment technologies. Golder reviewed the final list of mitigation measures and our recommendations are presented in this report. Note, that measures to mitigate against the risk of there being objectionable episodes of odour, also reduce the magnitude of normal odour emissions from the WWTF process and therefore the potential for chronic odour exposure to cause an adverse effect beyond the site boundary.

The above approach is considered to be consistent with the odour assessment tools for evaluating new/greenfield industrial activities as recommended by the Ministry for the Environment's Good Practice Guide for Assessing and Managing Odour in New Zealand (MfE 2016).

4.4 Cumulative Odour Effects

The proposal is atypical with respect to the cumulative assessment of odour effects, as the operation of the WWTF would positively influence the background level of ambient odour – that is, it would significantly reduce the most significant source of background odour which currently results from the irrigation of Fonterra's existing wastewater streams which are generated at the Hautapu site.

For the sensitive activities surrounding the proposed WWTF (within approximately 300 m of the WWTF site boundary), it is anticipated that occasional events of odour may already be experienced as a result of Fonterra's existing onsite activities, and other agricultural activities. When operating the proposed WWTF, the wastewater irrigation activity can be fully expected to cause a significantly lower potential for irrigation related odour effect within areas surrounding the WWTF, than which currently occurs.

Given the above, the odour emissions associated with the proposed WWTF itself, are not likely to cause significant cumulative effects with the reduced background levels of ambient odour at sensitive receptor locations, which would be within the vicinity of the proposed WWTF. As such, the potential for odour effects from the WWTF on nearby sensitive receptor locations (within 300 m of the WWTF) can be reliably assessed without the need to allow for additional impacts from reduced background levels.

5.0 ODOUR FLUX MEASUREMENT PROGRAMME

5.1 Overview

Prior to the preparation of this assessment, the only available dairy WWTF odour emission data was from Fonterra Australia Pty Ltd's Dennington WWTF, which is located in Victoria, Australia. Golder reviewed the odour emission data for the Dennington site and its configuration. From this it was concluded that the use of odour emissions data from the Dennington site would not be sufficiently robust for assessing normal odour emissions from the proposed Hautapu WWTF given the high sensitivity of the environmental settings surrounding the proposed site.

Given the above, it was necessary to select an appropriate Fonterra WWTF in New Zealand and obtain more robust data on normal anoxic and aerated surface odour flux rates. This was necessary to allow for a robust assessment of the potential for chronic odour exposure due to the WWTF operation to cause adverse effects.

5.2 Test Site Selection

To select the most appropriate site, Golder has reviewed the key parameters for four Fonterra's WWTFs in New Zealand. A summary of the key parameters for each site is shown in Table 2. It indicates that the Fonterra Stirling site in Otago has waste streams from cheese and whey production and therefore would be of a similar character to the Fonterra Hautapu raw wastewater stream.

Fonterra advised that their Stirling WWTF operates at a maximum inlet flow of 3,500 m³/day wastewater with a COD load of 4,900 kg/day. The equivalent COD surface loading rate is 19.4 kg/m²/day, which is almost 4 times higher than that established for the proposed WWTF at Hautapu (i.e., 5 kg/m²/day). Furthermore, the design mixed liquid suspended solids (MLSS) concentration at Stirling site is 10,000 g/m³, which is higher than 4,000 g/m³ for the proposed Hautapu WWTF.

Table 2: Key parameters of Fonterra's WWTFs.

Site	Production	Flow (m³/day)	COD (kg/day)	COD loading (kg COD/m²/day)	MLSS (g/m³)
Dennington, Victoria	Milk powder Cream	1,200	6,040 (95th percentile)	10.5	Not confirmed
Proposed Hautapu WWTF (Site 8)	Cheese Casein MPC WPC Lactose	9,000 (95th percentile)	18,500 (95th percentile)	5	4,000
Stirling, Otago	Cheese WPC	3,500	4,900	19.4	10,000

Site	Production	Flow (m^3/day)	COD (kg/day)	COD loading (kg COD/m^2/day)	MLSS (g/m^3)
Te Rapa	Milk Powder Cream Products Cream Cheese	5,600	8,500	3	3,100
Te Awamutu	Milk Powder Cream Products	3,600	7,000	0.8	3,500
Lichfield	Cheese WPC/WPI Milk Powder	9,800	21,000	1.4	3,500

The higher COD loading rate and MLSS concentration at Stirling WWTF compared to other plants shown in Table 2 indicates that any measured odour emission flux rate at this site, would provide a conservative/reliable indication of odour fluxes associated with the proposed Fonterra Hautapu WWTF. The other Fonterra plants operated pond-based systems, or otherwise had significantly different products and therefore different wastewater characteristics.

As such, the Fonterra Stirling site at Balclutha, Otago, was considered to be the most appropriate Fonterra WWTF site for obtaining odour flux emission data, which could be used for assessing odour emissions from the proposed WWTF.

5.3 Fonterra Stirling

The Stirling WWTF also employs a similar tank-based system to that as proposed for Hautapu WWTF. The main process units of the Stirling WWTF comprise of two balance tanks, a DAF tank, an anoxic tank, a side-stream membrane bioreactor (MBR) system, including an aeration tank and Ultra Filtration (UF) membranes, and a sludge decanter. Wastewater is stored in the balance tanks first and then treated by the dissolved air flotation (DAF) clarifier. The DAF treated wastewater enters the anoxic tank where it is mixed with recycled activated sludge. This is followed by a larger intensive aeration stage within an aeration tank using submerged fine bubble diffusers as proposed for the Hautapu WWTF.

Activated sludge is removed from the aeration tank and stored in a waste activated sludge (WAS) storage tank inside a sludge dewatering building. The layout of the WWTF is shown in Figure 7 and a process diagram is presented in Figure 8.

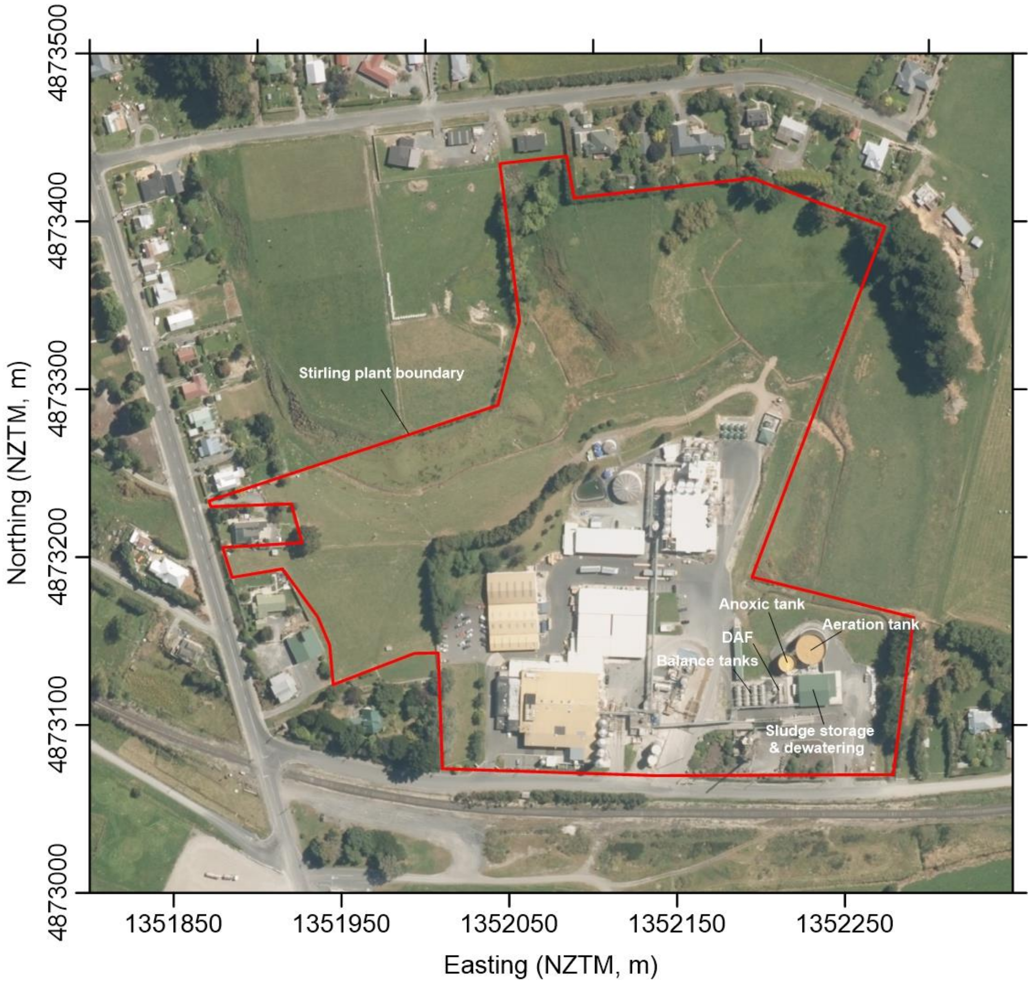


Figure 7: Layout of Fonterra Stirling WWTF.

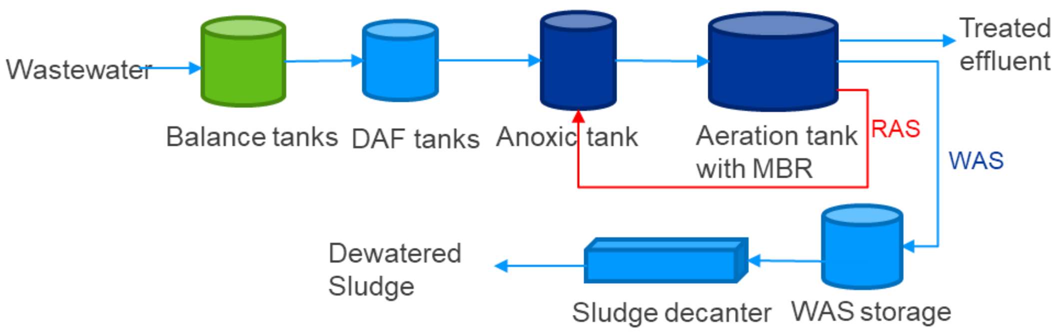


Figure 8: Fonterra Stirling WWTF process diagram.

5.4 Odour Sampling & Analysis

The Fonterra Stirling plant is located at Stirling township, Clutha district of South Otago. Peak production season typically occurs between November and December.

Golder conducted odour flux sampling at Fonterra Stirling WWTF on 1st, 2nd and 3rd December 2020 using a US EPA standard flux hood (specified in Appendix B of AS/NZS 4323.4: 2009, "*Method 4: Area Source Sampling – Flux Chamber Technique*"). The flux chamber was used to sample surface odour emissions from the aeration and anoxic tank surfaces. Key sampling parameters included:

- Sweep gas: Instrument-grade nitrogen
- Sweep flowrate: 5 L/min nitrogen
- Sample bags: Nalophan and stainless steel fittings
- Sample tubing: Polytetrafluoroethylene (PTFE)
- Hood equilibration: 24 minutes for each placement of cleaned hood onto tank surface
- Bag purging time: 5 minutes at 2 L/min of odour sample
- Odour sampling rate: 2 L/min
- Sampling time: 10 minutes
- Target sample volume: 20 L

The sampling hood and associated equipment are shown in Figure 9.

A total of 15 samples were collected over three consecutive days, including two blanks. Seven were collected from the aeration tank and six from the anoxic tank.

Samples were collected from 10 am to 3:00 pm each day, packaged in a cardboard container, transported to Dunedin airport and couriered to Auckland airport overnight. Samples were collected from Auckland airport in the morning of the following day and transported to the Watercare Laboratory in Mangere for olfactometric analysis.

Odour concentration (OU/m³) was analysed in accordance with AS/NZS 4323.3:2001: "Determination of odour concentration by dynamic olfactometry". Testing of all samples was completed within 30 hours of the sample collection time as required by the standard.

Figure 9: Sampling hood and associated sampling equipment.

5.5 Odour Flux Calculation

The odour concentration (OU/m³) results analysed by Watercare are provided in Appendix C. Those results were converted into odour flux emission rate (OU/m²/s) based on the quantified total flow rate and flux chamber area (0.13 m²). The total flow consisted of the surface aeration flux plus the nitrogen sweep air flow (5 L/min) for the diffuse aerated tank. For the anoxic tank, the total flow rate is the nitrogen sweep air flow of 5 L/min.

Surface flow from the aerated tank was established separately to the sweep air flow rate using the measured flux hood pressure drop (across the hood exit hole, when reduced to 6 mm) and whilst placed on the aerated tank surface. Standard orifice pressure drop flow calculations were used to calculate the aerated surface flowrate and flux, when supported by flow vs pressure drop calibration curve for the hood. The hood-based flow measurements established a surface flux flow rate of 25 L/min during the odour sampling programme. This was scaled up to 3.85 L/s/m² to allow for blowers operating at 20 % higher airflow rate (36 Hz average for three blowers).

The aerated tank surface flux flow (established using the flux hood pressure drop) was compared to the air flow established using the aeration tank blower fan curves and documented fan operating rate during the odour sampling (29 Hz average for three blowers). This indicated an aerated surface flowrate of 3.59 L/s/m² (equivalent to 28 L/min flow into the flux hood). This indicates the use of fan curves overstated the actual flow by about 15 %.

For the aerated tank odour emission calculations (i.e., total flow x concentration), the higher flowrate of 3.85 L/s/m² (i.e., 30 L/min flow into the flux hood) was assumed for an aeration flux rate and therefore the total assumed flow rate is 4.5 L/s/m² (i.e., 35 L/min including the nitrogen flow of 5 L/min).

Note, all above flows are then corrected to a standardised temperature of 23 ºC and atmosphere pressure so to match the sample conditions during testing at the lab and therefore be consistent with the basis for the odour concentration test results.

All individual odour test results for each tank, were used to calculate a point estimate of the odour flux emission rate from that tank. Therefore, the programme generated 6 and 7 estimates of this value for the anoxic and aerated tanks respectively and collected over three warm summer days.

A summary of the calculated odour flux results is shown in Table 3.

Table 3: Odour flux test results at Fonterra Stirling WWTF (OU/m²/s).

Source	Concentration (OU/m³)	Flow rate (m³/s/m²)	Odour flux emission rate (OU/m²/s)
Aeration tank	108	0.0044	0.47
	68	0.0044	0.30
	21	0.0044	0.09
	36	0.0044	0.16
	34	0.0044	0.15
	71	0.0044	0.31
	53	0.0044	0.23
Maximum			0.47

Source	Concentration (OU/m³)	Flow rate (m³/s/m²)	Odour flux emission rate (OU/m²/s)
95th percentile			**0.36**
Anoxic tank	53	0.0006	0.033
	48	0.0006	0.03
	106	0.0006	0.066
	98	0.0006	0.06
	119	0.0006	0.074
	30	0.0006	0.019
Maximum			0.074
95th percentile			**0.071**

5.6 Odour Flux Rates - Hautapu WWTF

It is assumed that the balance tanks, 3rd open anoxic zone and clarifier at the proposed Hautapu WWTF would have an odour flux rate (OU/m²/s) similar to that of the Stirling anoxic tank, as these tanks are likely to be maintained in anoxic conditions or better. The Hautapu aeration zone is assumed to have an odour flux rate similar to that of the Stirling aeration tank. As discussed in Section 5.2, these assumptions are likely to be conservative as the Stirling WWTF has higher COD loading rate and MLSS content.

The calculated 95th percentile odour flux rates were used to establish the odour emissions for the proposed Hautapu WWTF, and these are summarised in Table 4.

Table 4: Odour flux emission rates (OU/m²/s) established for the Hautapu WWTF.

Source	Odour flux emission rate (OU/m²/s)	Surface area (m²)	Odour emission (OU/s)
Open aeration zone	0.36	3,720	1,348
3rd open anoxic zone	0.071	320	23
Balance tank	0.071	142	10
Clarifier	0.071	962	68
Total emission			**1,450**

5.7 Comparison to Existing Data

The odour flux emissions measured at Dennington and Stirling WWTFs are summarised in Table 5. It shows that the odour flux emission measured at the Stirling aeration tank is higher than that measured at Dennington aeration tank. This is likely to be driven by higher COD loading rate and MLSS content at the Stirling WWTF. Anoxic tank odour flux emission at Stirling is similar to that measured from the Dennington clarifier.

It is also noted that the Dennington balance tank flux emission rate is 100 times higher than that measured at Stirling anoxic tank. This is likely to be caused by the recycle of anaerobic supernatant liquid from the digester to the balance tank. The relatively high odour flux emissions measured for the Dennington wastewater/condensate storage tanks are likely to be associated with long storage time and warm environmental conditions in Australia.

Table 5: Odour flux measurements for Dennington and Stirling sites.

Site	Tank	Surface area (m^2)	Odour flux emission ($OU/m^2/s$)
Fonterra Stirling, Otago	Aeration tank	252	0.36
	Anoxic tank	75	0.071
Fonterra Dennington, Victoria	Aeration tank	576	0.11
	Anoxic tank	-	-
	Clarifier	64	0.069
	Balance tanks	144	7.1*
	Digester	144	5.5
	Condensate storage tank	28	2#
	Wastewater storage tank	28	1.7#

* The Dennington balance tank has a high odour flux emission. This is likely to be a result of anaerobic supernatant liquid from the digester being returned to the balance tank at the head of the plant.

The values are also relatively high and indicative long storage time and warm environmental conditions.

5.8 Field Ambient Odour Surveys (Stirling)

5.8.1 Overview

While conducting odour flux sampling, Golder also completed eight downwind field odour surveys at locations within 50 m to 100 m to the Stirling WWTF. Golder's ambient odour assessors are trained in the completion of field odour surveys as described by MfE (2016) and regularly train other parties to conduct such surveys. The field odour survey method employed by Golder is in accordance with the approach recommended by the MfE guide, which utilises aspects of ("VDI") standards for carrying out ambient odour assessments. Each field odour survey involved the recording of odour intensity (I) every 10 seconds for 10 minutes at a single location. The rating of odour intensity by assessors downwind of WWTF followed the intensity scale specified by VDI standard 3882 Part 1 (VDI 3882), also as recommended by MfE (2016).

5.8.2 Summary of field odour survey results

Golder staff carried out eight field odour surveys when the odour flux was sampled. The weather was fine and warm on all three days. Observations were made when standing 50 m to 100 m downwind of the anoxic and aerobic tanks. The field odour survey sheets are shown in Appendix D and the results are summarised as follows:

- On 1st December 2020, the weather was sunny and warm with very light winds shifting between southeast and south. Only very weak milky odour for 10 to 20 seconds at a time was observed at approximately 100 m north of the WWTF (close to the calamity tank bund). This odour was expected to be associated with site production. During the observation, the odour flux was sampled from the anoxic tank.

- On 2nd December 2020, the weather was warm with calm to light breeze. Very weak to weak sheep manure odour and very weak sour milk odour were observed for 10 to 20 seconds. During the observation, the odour flux was sampled from the aeration tank.
- On 3rd December 2020, the weather was warm with strong breeze drifting from west to northwest. Very weak to weak DAF type odour (fatty) was noted for approximately 60 seconds during a 10-minute period observation. Very weak sweet tank/sour milk odour was observed occasionally at approximately 50 m to 100 m southeast/east of the WWTF. During the observation, the odour flux was sampled from the aeration and anoxic tank.

6.0 ODOUR MODELLING ASSESSMENT

6.1 Odour Concentration Guideline

The Ministry for the Environment (MfE 2016) recommended odour modelling guideline values to be summarised in Table 6. For the purpose of this assessment, the guideline value representing a high sensitivity receiving environment under neutral to stable conditions has been used (i.e., 2 OU/m^3) and evaluated against the 99.9th and 99.5th percentile. This reflects the need to consider a sensitive receiving environment and meteorological conditions in Hautapu best described as having a high frequency of neutral to stable conditions. While there may be a case for a higher guideline value being selected, for the purposes of this assessment, a conservative value was considered the most appropriate.

The most stringent criteria in Table 6 was specified for the assessment of potential odour effects resulting from intermittent short-term peaks in odour when discharged from tall stacks and resulting from convective downdrafts of air during unstable to semi-unstable atmospheric conditions. In particular, the 1 OU/m^3 (1 hour average) criteria was developed following experiences of odour impacts from the Stuart Oil Shale plant near Gladstone, Queensland in the late 1990s. As such, this criterion was developed for tall stack discharges with worst case impacts during sunny conditions with light wind. The Stuart Oil Shale case study is discussed by MfE (2002)[3].

Table 6: Odour modelling guideline values (MfE 2016).

Sensitivity of the receiving environment	Concentration	Percentile of 1-hour average model results*
High (worst-case impacts during unstable to semi-unstable conditions)	1 OU/m^3	0.1 % and 0.5 %
High (worst-case impacts during neutral to stable conditions)	**2 OU/m^3**	**0.1 % and 0.5 %**
Moderate (all conditions)	5 OU/m^3	0.1 % and 0.5 %
Low (all conditions)	5 – 10 OU/m^3	0.5 %

[3] MfE (2002): Section 9.2.3, Odour Management under the RMA – Technical Background Report No. 24, Tracy Freeman and Roger Cudmore for the Ministry for the Environment.

6.2 Odour Exposure Modelling

6.2.1 Model selection

Air dispersion modelling was used to predict odour ground level concentrations (expressed as odour units per cubic metre OU/m³) that are likely to arise from the proposed for the Hautapu WWTF. The CALPUFF dispersion model (version 7.2.0) was selected due to the high percentage of calm wind conditions in the Hautapu area. Steady state models such as AERMOD are considered to be inappropriate as these are unable to reliably model odour impacts during calm (worst case) atmospheric conditions. The CALPUFF model when combined with 3-dimensional non-steady state wind field data can adequately simulate these conditions.

6.2.2 Model set-up

Modelled odour ground level concentrations were predicted over a series of nested gridded receptors centred on the biological treatment reactors as follows:

- 250 × 250 m at 25 m spacing
- 500 × 500 m at 50 m spacing
- 1200 × 1200 m at 100 m spacing

The model used a minimum horizontal turbulence velocity *(σ_v)* of 0.5 m/s. It is a default CALPUFF setting in New Zealand when modelling 1-hour odour concentrations and also recommended by the CALPUFF user's guidance (Scire et al. 2000). Details of the other parameters used in CALPUFF model are presented in Appendix E. The model results are presented in Section 6.3 and then compared against the criteria discussed in Section 6.1.

6.2.3 Meteorological data

The assessment makes use of a CALMET meteorological dataset previously developed by Golder for the dispersion modelling of the Fonterra Hautapu manufacturing site (Golder 2009). The CALMET dataset provides three-dimensional meteorology information for the year of 2003 and includes measured data from nearby monitoring stations. Golder has reviewed the long-term meteorological data obtained from the Hamilton Ruakura weather stations and concluded that the 2003 meteorological conditions are representative of general climate of Waikato region. Furthermore, the long-term weather conditions in the project area are not expected to have substantial changes compared to 2003. A summary of historic meteorological data is presented in Appendix B.

6.2.4 Odour emissions

Odour emissions from the balance tanks, aeration tanks, anoxic tanks and clarifier were represented in the dispersion model as area sources. As such, the established odour flux rates (summarised in Table 4) were applied to the applicable open tank areas, as shown in Figure 10. These resulted in the odour emission input rates for dispersion modelling, as summarised in Table 7.

These 99.5th percentile estimates of the odour emissions rates were fixed for the entire modelling period (one year). This approach is conservative given the purpose of assessing the potential for chronic odour effects (i.e., the use of the estimated average odour emission rates for each open area was justified).

Table 7: Odour flux emission rates (OU/m²/s) modelled for the Hautapu WWTF.

Source	Odour flux emission rate (OU/m²/s)	Surface area (m²)	Release height (m)	Odour emission (OU/s)
Open aeration zone	0.36	3,720	6	1,348
3rd open anoxic zone	0.071	320	6	23
Balance tanks	0.071	142	7	10
Clarifier	0.071	962	3	68

Figure 10: Site layout for the proposed WWTF Report– provided by Fonterra is below.

KEY :

- MAIN PIPELINE ROUTES [1]
- ACCESS ROAD AND HARDSTAND
- COVERED REACTORS
- LiDAR CONTOUR (0.5m INTERVAL) [2]
- FONTERRA HAUTAPU PROPERTY BOUNDARY

NOTES:
1. PROPOSED INTERNAL PIPES EXCLUDED FOR CLARITY.
2. CONTOUR DATA PRESENTED IN THIS DRAWING IS BASED ON LiDAR DATA COLLECTED IN 2007, SUPPLIED BY WRC. EARTHWORKS AND OTHER CHANGES TO LANDFORM SINCE THAT DATE ARE THEREFORE NOT REPRESENTED IN THIS FIGURE.
3. TELECOM LEASE AREA BOUNDARY DERIVED FROM MHAU-010813-SITE&LAND-DRAFT.pdf, REV A (FOR INFORMATION), BY AURECON, DATED JAN 2013. LOCATION MAY VARY ON SITE.
4. AERIAL IMAGERY (FLOWN 2018) SOURCED FROM WAIPA DISTRICT COUNCIL GIS VIEWER (MAY NOT BE SPACIALLY ACCURATE).

ORIGINAL DRAWING IN COLOUR

NO.	REVISION	DATE	APP.
E	ISSUED FOR INFORMATION	MAR 21	
D	ISSUED FOR INFORMATION	JAN 21	
C	ISSUED FOR INFORMATION	JAN 21	
B	ISSUED FOR INFORMATION	DEC 20	
A	ISSUED FOR INFORMATION	DEC 20	

PATTLE DELAMORE PARTNERS

ace MEMBER

CLIENT: FONTERRA LIMITED

PROJECT: HAUTAPU WWTP SITE 8 CLASS 3 COSTING

SITE 8 TANK SYSTEM
WWTP CONCEPTUAL SITE LAYOUT

DESIGNED	DESIGN REVIEW	DATE	APPROVED	DATE
D.I.		DEC 20		
DRAWN	DRAWING CHECK	DATE	THIS DRAWING IS NOT FOR CONSTRUCTION UNLESS SIGNED AS APPROVED	

SCALE :	DRAWING NO. :	REV :
1:1,000 (A3)	A02545207-SK-002	E

6.2.5 Sensitivity of balance tank emission assumptions

The balance tank odour emission at the Dennington site was orders of magnitude higher than the Stirling anoxic tank, which is attributed to anaerobic stream being directed to the balance tank at that site. As for the proposal, the process design for the Hautapu WWTF does not include anaerobic sludge digestion and associated recirculation of anaerobic liquors to the head of the WWTF. As such, the proposal's balance tank odour flux rates are expected to be very similar, to those measured from the first stage anoxic tank at Fonterra Stirling. This aside, a sensitivity analysis of the odour emission rate assumptions for the balance tanks was undertaken.

The modelling of odour contour from the WWTF was completed using an odour emission rates of 0.071 OU/m²/s and 0.5 OU/m²/s for the balance tanks, the former, lower value rate was determined for the anoxic tank at Stirling where pre-treated wastewater is mixed with return activated sludge. Other odour emission sources and discharge parameters for the proposed WWTF were unchanged.

A comparison of the odour contour plots (1-hour, 99.9th percentile) for the balance tank odour flux assumptions is shown in Figure 11. This shows that the cumulative odour concentrations at locations beyond the site boundary, only increase by a few percent in response to the assumed odour emission rate for each balance tank increasing by an order of magnitude (7x). For example, the nearest residential dwelling (No. 41), the predicted 99.9th 1-hour concentration has increased from 0.53 OU/m³ to 0.54 OU/m³.

When assuming the high odour emission of 7 OU/m²/s for the balance tanks (the emission measured at the Fonterra Dennington balance tanks, when receiving anaerobic liquors), the ground level odour concentration at Receptor No. 41 would be approximately 0.7 OU/m³, still well within the recommended criterion of 2 OU/m³ as a 99.9th 1-hour concentration.

Therefore, the extent of cumulative odour exposure predicted for the proposed WWTF is not sensitive to the assumed odour flux rate for the balance tanks at the head of the plant. The off-site 99.9th 1-hour odour concentration only increases by 1 % for a 300 % increase in the assumed odour emission rate for the balance tanks.

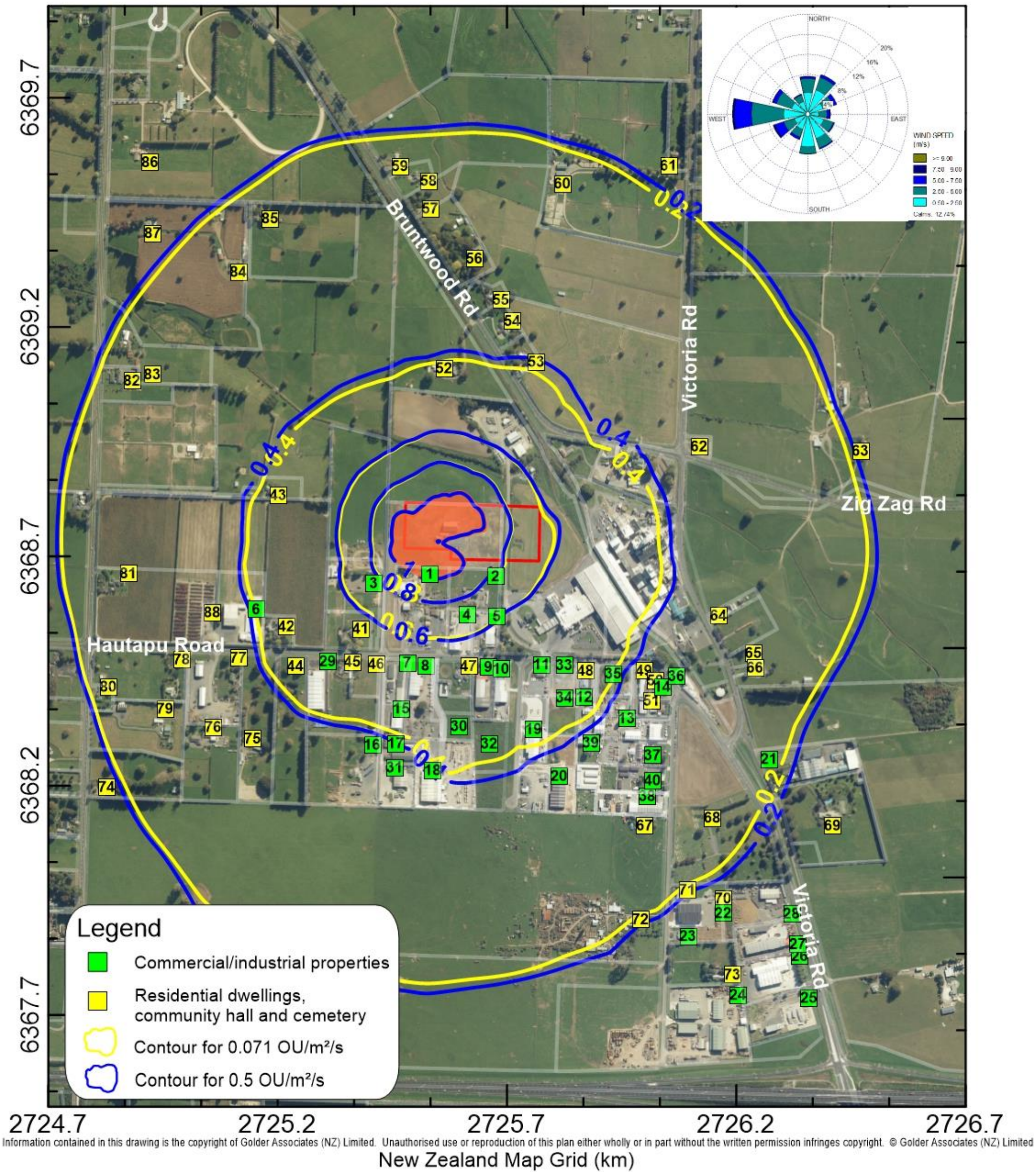


Figure 11: Comparison of predicted odour contour plots (1-hour 99.9th percentile).

6.3 Odour Modelling Results

Figure 12 and Figure 13 show the predicted 1-hour 99.9th and 99.5th percentile odour concentrations respectively when using the odour emission inputs as summarised in Table 7.

Both figures show that most of the area where the odour concentrations are predicted to be above 1 OU/m^3 (shaded in orange) is within the site boundary. For 99.9th percentile, it extends a few metres towards the nearest commercial property (Receptor No. 1). The predicted 1-hour 99.9th and 99.5th percentile odour ground level concentration (GLC) at Receptor No. 1 are approximately 1 OU/m^3 and less, no more than half of the MfE recommended assessment criterion of 2 OU/m^3. Other commercial or industrial activities are predicted to have an odour concentrations less than 0.8 OU/m^3. The maximum predicted odour concentration at the most impacted residential dwelling (Receptor No. 41) is approximately 0.53 OU/m^3 (99.9th percentile) and less at other nearby houses.

A summary of the predicted GLCs at the most impacted sensitive receptors is shown in Table 8, along with the modelled meteorological conditions. It shows that most of the highest predicted 1-hour odour concentrations mainly occur during low wind speed and stable conditions.

Table 8: Predicted odour concentrations (OU/m^3) at the most impacted receptors.

Receptor	Modelling results (OU/m^3)		Meteorological conditions*	
	99.9th percentile	99.5th percentile	Wind speed	Stability
R1	1	0.9	0.7	Stable
R2	0.8	0.68	0.7	Stable
R3	0.7	0.7	3.9	Slightly Stable
R4	0.7	0.6	0.7	Stable
R5	0.6	0.53	0.6	Stable
R41	0.53	0.52	0.6	Stable

* Meteorological conditions are extracted from CALMET dataset for the hour when the 99.9th 1-hour concentrations are predicted.

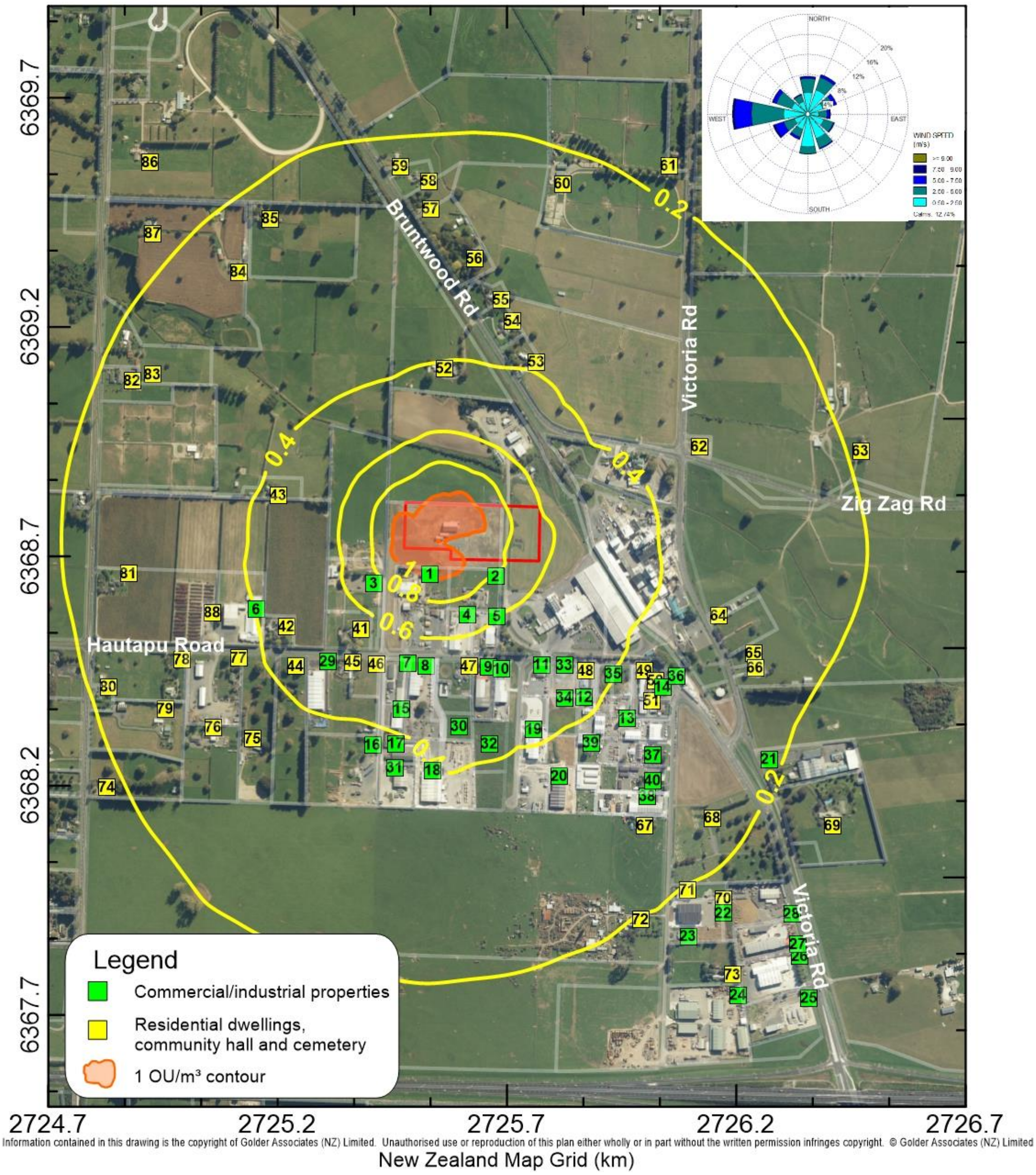


Figure 12: Predicted 1-hour 99.9th percentile odour concentration (OU/m³). Recommended odour assessment criteria: 2 OU/m³.

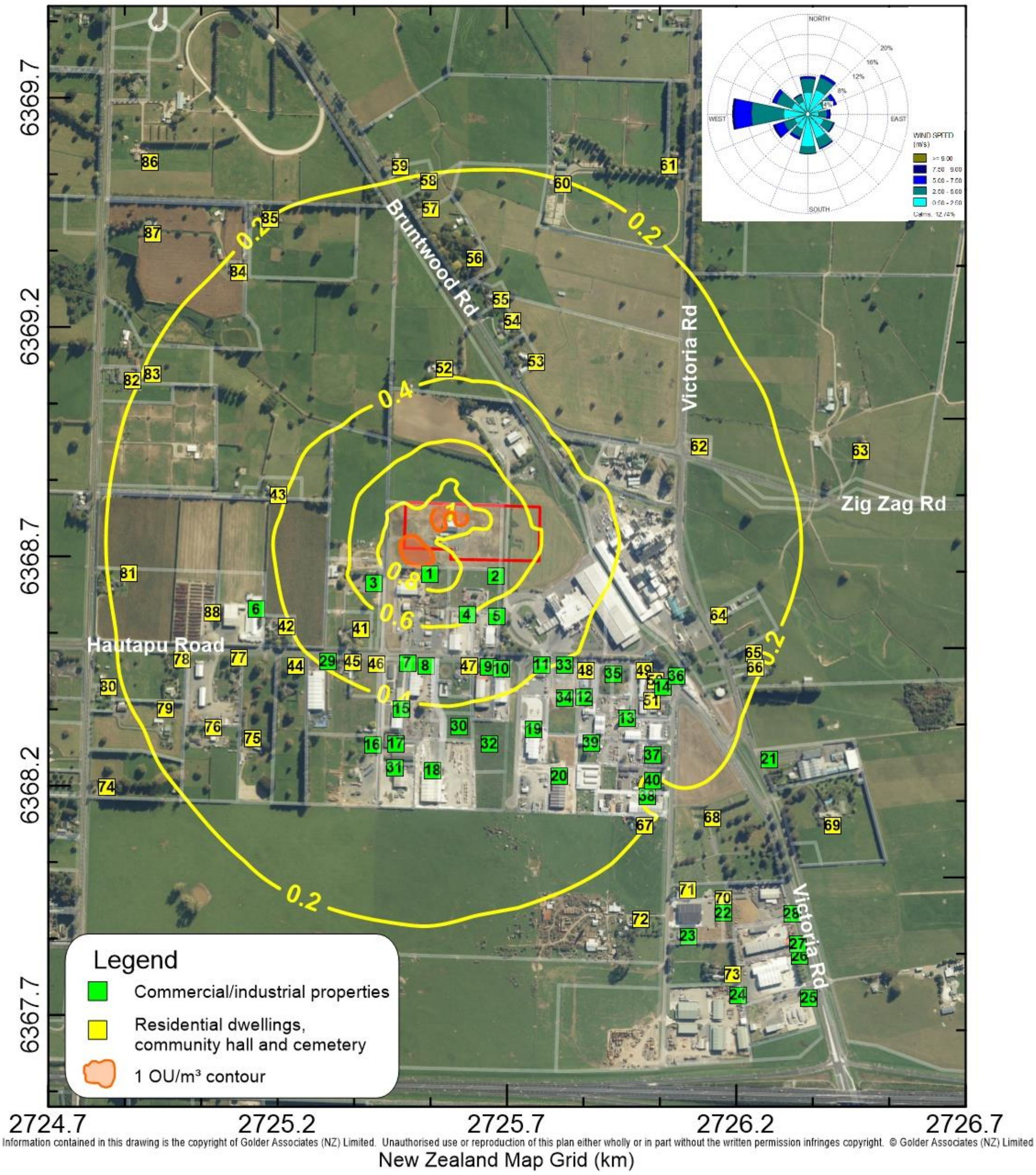


Figure 13: Predicted 1-hour 99.5th percentile odour concentration (OU/m^3). Recommended odour assessment criteria: 2 OU/m^3.

6.4 Assessment of Potential Chronic Odour Effects

In summary, the modelling assessment of measured odour emissions for the proposed WWTF indicates a level of chronic odour exposure from normal process plant emissions, that is less than minor for neighbouring residential dwellings.

However, given the much closer proximity of the nearest industrial/commercial activities (compared to residual dwellings) and consideration of the predicted odour concentrations for these receptors, then it is concluded that the chronic odour exposure from normal WWTF operating conditions, would be minor, or less.

7.0 ODOUR MITIGATION MEASURES

7.1 Introduction

The effective mitigation of uncontrolled/abnormal discharges of odour from the WWTF is achieved via a combination of process design of the WWTF components and its associated odour capture/treatment system, the process monitoring/control systems employed for both and contingency measures.

In this instance, the design and operation of an effective odour capture and treatment system, which target the anaerobic, first and second stages anoxic zones, will also ensure that normal and abnormal odour emission scenarios do not cause adverse odour effects beyond the site boundary.

Therefore, key design and process control aspects need to be considered for the WWTF treatment and sludge management processes as well as the odour containment, extraction and treatment systems.

7.2 Design Aspects

7.2.1 Wastewater management

The key processes that could give rise to the discharge of odour, including balance/calamity tanks, biological reactors, and sludge storage and dewatering. Aspects of the WWTF design and process control that Golders have taken into this assessment of potential odour effects are discussed below and in Section 7.3.1.

- The balance tanks are proposed to be open to atmosphere. This is to enable access for regular cleaning and maintenance. It is considered important to avoid anaerobic conditions occurring within this tank and subsequently discharging odorous wastewater to the biological treatment stages. Covering this tank and extracting air to a biofilter hinders the ability to ensure anaerobic wastewater conditions are routinely avoided.
- The calamity tank is only proposed to be required and used in response to abnormal operational scenarios such as power failures, spills or for milk and milk products that cannot be processed and need to be disposed of. This would likely result in a wastewater with a higher organic loading that could be treated as a 'slug' or discrete load. In these cases, the wastewater needs to be stored and then gradually fed into the WWTF system over time. Whilst this tank is required to be fully mixed and have a sloped or conical base to enable effective flushing and operate with hydraulic retention times minimised to avoid the risk of anaerobic conditions, the odour assessment has been completed on the basis this tank will be enclosed/covered and have its head space air treated via biofiltration.
- Biological treatment reactors are proposed as a series of concrete tank chambers. This enables the initial and potentially odorous treatment process stages (the 1st and 2nd anoxic stages and the anaerobic stage) to be covered/enclosed and their head space air extracted and treated via biofiltration.
- Air sparging wastewater prior to leaving the 3rd anaerobic stage and entering the aerated treatment stage is another key design aspect. This sparging is proposed to strip residual odorous volatiles from the wastewater following the 2nd stage anoxic treatment process. It is recommended that the aerated stage of the process includes enclosing or covering of the initial 5 metres of aerated tank zone – this is to ensure any residual odorous volatiles entering the aerated zone will be contained and treated via biofiltration.
- The aeration process stage would (except for the first 5 metres) be undertaken in large, uncovered aeration tanks. These would have air injected as fine bubbles via submerged diffuse aerators, which are located near the base of each aeration tank. The maintenance of these large open tanks under aerated

conditions (positive dissolved oxygen) will ensure very low levels of odour emission to air from the large aeration tanks.

- The third anoxic stage which immediately follows the aeration stage is designed to utilise readily available carbon within introduced raw and relatively odourless raw waste streams. The inlet stream to this stage would have undergone an extensive and prolonged aeration process and would exhibit a very low odour potential. These 3rd and final stage anoxic tanks would be sized to achieve a maximum residence/contact time, these tanks will include mixers to restrict the wastewater within this stage from becoming anaerobic. As such, the final design loading rate of raw waste stream 3rd anoxic stage and knowledge of its organic load is a key design aspect (to be finalised in the detailed design phase) to ensure anaerobic conditions are avoided.
- The size of the clarifier is determined based on the maximum loading rate and capacity of the excess RAS and WAS pumps. The clarifier is open to air and considered to be a low potential for odour emissions. Its key design features which ensure this includes the use of sloping walls and ability to continually remove settled sludge from its base so that the height of the sludge-liquor interface is maintained below a maximum limit. Continuous monitoring of sludge depths and removal of excess sludge is a standard practice for clarifier operation, and will be undertaken for both treated wastewater optimisation and sludge management.
- Sludge boundary height control (via effective pump sizing), continuous sludge blanket monitoring and operation within the volumetric design loading limit (approximately 10 m^3/m^2/day) helps anaerobic sludge conditions as well as avoiding occasions where the sludge blanket reaches the clarifier surface - and potentially causing an objectionable odour episode.
- Sludge storage and dewatering will not include any anaerobic digestion stage and associated odorous streams. Sludge processing will occur within an enclosed building and dewatered sludge will be discharged into an enclosed bin which has displacement air evacuation and treatment via a biofilter.
- The WAS tank will be enclosed/covered, equipped with automated flush system and will be aerated to avoid the onset of anaerobic conditions.

7.2.2 Odour extraction and treatment

The key design features ensure that there is effective odour containment and treatment, including the design of enclosure systems, target air changes/vacuums for enclosed processes, and layout of the air extraction systems and biofilters.

- The enclosure of the calamity and the WAS tanks, dewatered WAS storage bin and the initial anoxic and anaerobic biological treatment stages will require inlet air vents to be installed for controlled ingression of fresh air into these systems to replace odorous headspace air.
- To maintain these head spaces under a vacuum, the concept design has proposed to ventilate at 10 volume changes per hour, which will be confirmed during detailed design). Given a liquid seal is built into the design of the covered biological covered stages, this level of ventilation should be more than adequate to fully contain head space air (i.e., no fugitive leakage to atmosphere).
- For the operational phase, the maintenance of a headspace vacuum in the range of 5.0 to 10.0 Pa for all enclosed tanks and sludge processing equipment is considered to provide very effective containment of odour. As such inlet air vents can be sized to produce this range of pressure drops from the incoming air stream.
- Use of Biofilters for odour treatment:

  - Biofilters are considered to be a reliable method for treatment of extracted odour emissions from the WWTF process.
  - Other technologies, including bio-film reactors, afterburners, ozone scrubbers can also be effective and require far less space than biofilters, but require higher levels of operator expertise, real-time monitoring and maintenance to ensure reliable performance over time.
  - Ozone injection into enclosed headspaces may also be an effective option but currently is not a proven primary odour control method for dairy wastewater treatment plants.
  - Spraying of neutralizing/de-odorising chemicals is not recommended as a primary odour control method.
- The installation of separate extraction and biofilter treatment systems is recommended for the WWTF and the sludge processing building and WAS storage bin. This will better enable the appropriate level of air ventilation from the enclosed stages of the biological treatment system to be maintained. Likewise, a separate system for the sludge building will also help to ensure appropriate extraction flows are maintained on sludge decanters, the covered WAS tank and the final dewatered WAS sludge storage bin.
- The design specifications for the biofilters to treat the ventilated air from the biological plant and sludge processing building will be determined at the detailed design stage of the project. The draft design air loading rate is for an empty bed residence time of 60 seconds (i.e., 60 $m_{air}^3/hr/m^3_{media}$). This is similar to a maximum air loading rate of 50 $m_{air}^3/hr/m^3_{media.,}$ which is recommended by Golder.
- Other key recommended biofilter design parameters include:
  - Media pressure-drop limit of 50 mm water gauge (≤500 Pa)
  - Use of graded bark such that approximately 95 % is within 10 mm to 30 mm size range
  - Bed moisture of 50 wt. % to 65 wt. %
  - Media pH ≥5 at less than 600 mm from surface and pH ≥3.5 below 600 mm from surface

7.3 Process Control Aspects

7.3.1 Wastewater management

Key WWTF process control features which help ensure minimal odour emissions, and which have therefore been assumed for this assessment of potential odour effects include the following:

- Continuous level measurement for all tanks
- Continuous pH, dissolved oxygen (DO) and level measurement on the aeration tanks
- Aeration tank DO is automatically controlled to be maintained at or greater than 0.2 g/m^3
- Continuous measurement of inlet flow to WWTF and control within design ranges
- Periodic MLSS measurement and control of RAS rates to achieve acceptable MLSS operating range
- Sludge age management via controlled rate of discharge of WAS

The WWTF would be subject to detailed design, and as Fonterra proposes, will be subject to an independent external peer review process, and that operational setpoints could be revised once operational experience is gained. It is recommended (as discussed in Section 7.5 below) that an adaptive management approach is adopted for a WWTF Operational Monitoring and Management Plan in which key aspects of odour control and avoidance are detailed.

7.3.2 Odour extraction and treatment

Key odour extraction and treatment process control features which help ensure minimal odour emissions include the following:

- Continuous measurements including:
  - vacuum within extracted head spaces of targeted tanks
  - Biofilter fan air discharge pressure, humidity and temperature
  - Biofilter media pressure drop (post the air distribution system)
- Periodic manual measurement of biofilter operating parameters including:
  - Total flow (annually)
  - Media moisture (2 monthly)
  - Media pH (3 monthly)
  - Carbon: nitrogen ratio (biannually)
  - Media size distribution (biannually)

7.4 Key Contingency Measures

Key contingency measures proposed for the WWTF, sludge management and odour control systems include the installation of standby pumps and fans for key process items including:

- Balance tank
- Balance tank feed pump
- WWTF wastewater supply pump
- Aeration tank air blowers
- Biofilter fans
- RAS and WAS pumps
- Sludge dewatering feed pump
- Sludge dewatering centrate pump
- Essential process control instrumentation (DO, level sensors)
- Onsite generator (in event of power failure otherwise have 4 hours until odour generation)

7.5 Odour Management System

The preparation of an odour management section, within the complete WWTF Operational Management and Monitoring Plan, will allow an adaptive management approach. This Odour Management section, as with other sections of the plan, can be updated as the detailed design is completed and operational experience from plant commissioning and performance optimization is gained. The Odour Management section is suggested would be specific to the potential sources of odour discharge and the key controls employed to reduce risk of odour emissions so that firstly odours are minimised at source and that any odours do not cause an adverse effect beyond the site boundary and including how contingency matters are responded to.

The Odour Management section would identify/refer, but not being limited to, standard operational procedures, which impact on the potential levels of odour effects beyond the site boundary as follows:

- WWTF plant operation including specified operation limits for inlet flow, COD loading, MLSS, DO and pH
- Tank cleaning/flushing regimes
- Sludge dewatering plant operation
- Location of engineering drawings with specifications of the WWTF, biofilters, biofilter fans, motors, and ducting arrangements
- Odour extraction and biofilter system operating parameter ranges
- Key instrumentation (WWTF and odour control system), methods of monitoring, frequency and servicing requirements
- Reference to maintenance programme for WWTF, sludge dewatering and odour control system components
- Odour effects monitoring/community feedback and recording systems
- OMP performance reporting
- Document control and review procedures

7.6 Assessment of Potential Acute Odour Effects

It is considered that the proposed design features of the WWTF and level of odour source enclosure, ventilation and treatment for this, as well as the sludge dewatering system, means that only in rare and exceptional circumstances might there be uncontrolled releases of odour from the WWTF site. Therefore, it is concluded that uncontrolled discharges of odour to cause adverse acute odour effects can be reduced to a low risk through mitigation measures that are based on process design (to avoid and minimise odour emissions), effective process controls and finally, effective odour extraction and treatment and operational control plans.

The key assumption that underlines the above conclusion, is that the design outcomes and recommended process monitoring (as detailed in this report) are implemented to a best design standard. This can be achieved via a detailed design phase for the WWTF.

8.0 DISCUSSION & CONCLUSION

The potential for chronic and acute odour exposures due to the proposal to cause odour effects at nearby commercial and residential dwelling locations have been assessed via odour dispersion modelling and a detailed process and mitigation review, respectively. These are the appropriate methods to assess potential chronic and acute odour exposure effects for a greenfield proposal and are in accordance with the MfE odour assessment guide (MfE 2016). Furthermore, criteria and information requirements relevant to the assessment of potential odour effects from the proposal (as specified within Chapter 6.1 of the operative Waikato Regional Plan) have been assessed and are considered to have been met (a detailed summary is provided in Appendix F).

The odour emissions data set has been developed from a similar Fonterra WWTP, which is expected to provide conservative odour emission rate assumptions and therefore a reliable assessment of chronic odour exposure related effects. Likewise, the mitigation measures proposed for the WWTP have been developed via an extensive industry workshopping process and with the benefit of an assessment of past odour issues and causes with respect to Fonterra's existing WWTFs.

For this proposal, it is essential that the risk of process up-set conditions, anaerobic conditions occurring within incoming waste streams and/or sludge streams, is reduced via mitigation measures so these are avoided, or are only very rare events. As such there is a very high degree of proposed mitigation via design, process control and odour containment/treatment. Given the proposed WWTF is only at the conceptual design phase, it is important that the detailed design of systems to control odours at source meets best practice and is ultimately incorporated into the constructed facility. It is therefore recommended that an independent odour specialist(s) be invited to peer review the plant and process detailed design.

It is considered that the mitigation measures outlined in this report, when implemented to a high design standard, would ensure uncontrolled odour releases from the WWTF occur only in exceptional circumstances and for a short duration.

Following on from the above, key conclusions from the assessments are as follows:

- Chronic odour exposure from normal process plant emissions is likely to cause *less than minor* effects for neighbouring residential dwellings, whereas *minor* effects are likely for the nearest commercial activities to the south of the proposed WWTF site.
- Acute odour exposure events due to abnormal/uncontrolled process plant emissions are likely to be minor for neighbouring residential dwellings and for the nearest commercial activities to the south of the proposed WWTF site.
- It is also concluded that the proposal is likely to avoid causing objectionable, or offensive odour to an extent that causes an adverse effect beyond the site boundary.

The above conclusions are reached on the basis that the proposed mitigation measures are designed and implemented to a high engineering and process design standard, which can be enabled via the detailed design stage of the project.

The findings of this odour impact assessment are consistent with Golder's experience in the design of odour treatment systems and assessing the effects of odour emissions from wastewater treatment plants. It is also consistent with Golder's experience of Fonterra's operating activated sludge-based wastewater treatment plants, where odour issues tend to arise in association with process upsets, poor sludge and liquor storage management practices.

9.0 REFERENCES

Golder (2020). Report Addendum – Wastewater Treatment Plant Odour Impact Assessment for Fonterra Hautapu. 12 May 2020. Golder report number: 1787769_7403_005_R_Rev1.

Golder (2018). Wastewater Treatment Plant Odour Impact Assessment for Fonterra Hautapu. April 2018. Golder report number: 1787769_7403_003_R_Rev1.

Golder (2009). Resource Consent Application and Assessment of Effects on the Environment. Fonterra Hautapu – Discharge of Contaminants into Air. Golder report number: FONTE WKT 012.

MfE 2016. Good Practice Guide for Assessing and Managing Odour in New Zealand. Publication number: ME1278. Ministry for the Environment. November 2016.

Signature Page

Golder Associates (NZ) Limited

Iris Xu
Air Quality Consultant

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Principal | *Technical Director - Environment Team*

IX/RSC/mt

https://golderassociates.sharepoint.com/sites/128260/project files/6 deliverables/009_r/rev4/1787769-009-r-rev4 - asssessment of potential odour effects.docx

APPENDIX A

Report Limitations

Report Limitations

This Report/Document has been provided by Golder Associates (NZ) Limited ("Golder") subject to the following limitations:

i) This Report/Document has been prepared for the particular purpose outlined in Golder's proposal and no responsibility is accepted for the use of this Report/Document, in whole or in part, in other contexts or for any other purpose.

ii) The scope and the period of Golder's Services are as described in Golder's proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Report/Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regards to it.

iii) Conditions may exist which were undetectable given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Report/Document. Accordingly, if information in addition to that contained in this report is sought, additional studies and actions may be required.

iv) The passage of time affects the information and assessment provided in this Report/Document. Golder's opinions are based upon information that existed at the time of the production of the Report/Document. The Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

v) Any assessments, designs and advice made in this Report/Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Report/Document.

vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

vii) The Client acknowledges that Golder may have retained subconsultants affiliated with Golder to provide Services for the benefit of Golder. Golder will be fully responsible to the Client for the Services and work done by all of its subconsultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from Golder and not Golder's affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against Golder's affiliated companies, and their employees, officers and directors.

viii) This Report/Document is provided for sole use by the Client and is confidential to it. No responsibility whatsoever for the contents of this Report/Document will be accepted to any person other than the Client. Any use which a third party makes of this Report/Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this Report/Document.

APPENDIX B

Summary of Historic Hamilton Meteorological Data

Golder has reviewed the meteorological data obtained from the Hamilton Ruakura electronic weather station (EWS) (NIWA agent number 12616) for period from 2001 to 2006, inclusive and Hamilton Ruakura 2 EWS (NIWA agent number 26117) for period from 2006 to 2019, inclusive. Wind patterns for these periods were developed for both sites and presented in Figure 1 and Figure 2. These indicate that there is little variation between years at Ruakura EWS and Ruakura 2 EWS.

A summary of historic meteorological data (including wind speed, temperature and humidity) from 2001 to 2019 is presented in Table 1. It indicates the meteorological records in 2003 are generally consistent with the 19 years of meteorological data for Hamilton city. This indicates no material difference between 2003 and later years.

Based on the above, Golder considers the 2003 meteorological conditions are representative of general climate of Waikato region. Furthermore, the long-term weather conditions in the project area are not expected to have substantial changes compared to 2003 (which was used for our odour modelling assessment).

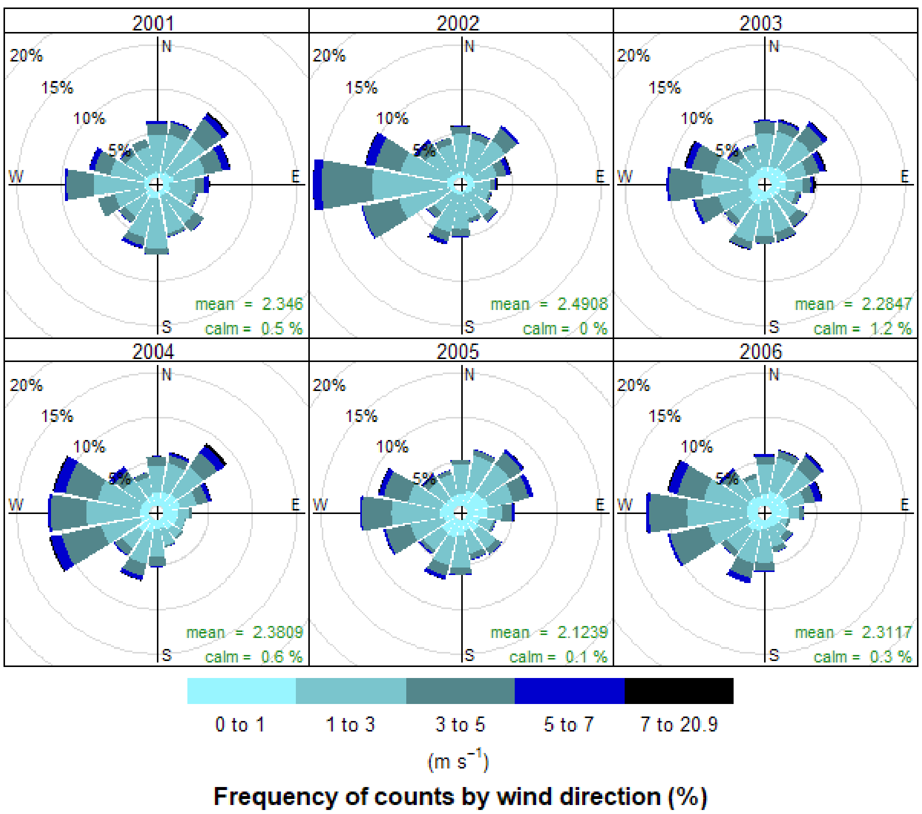


Figure 1: Wind roses at Hamilton Ruakura, EWS (2001 to 2006, inclusive).

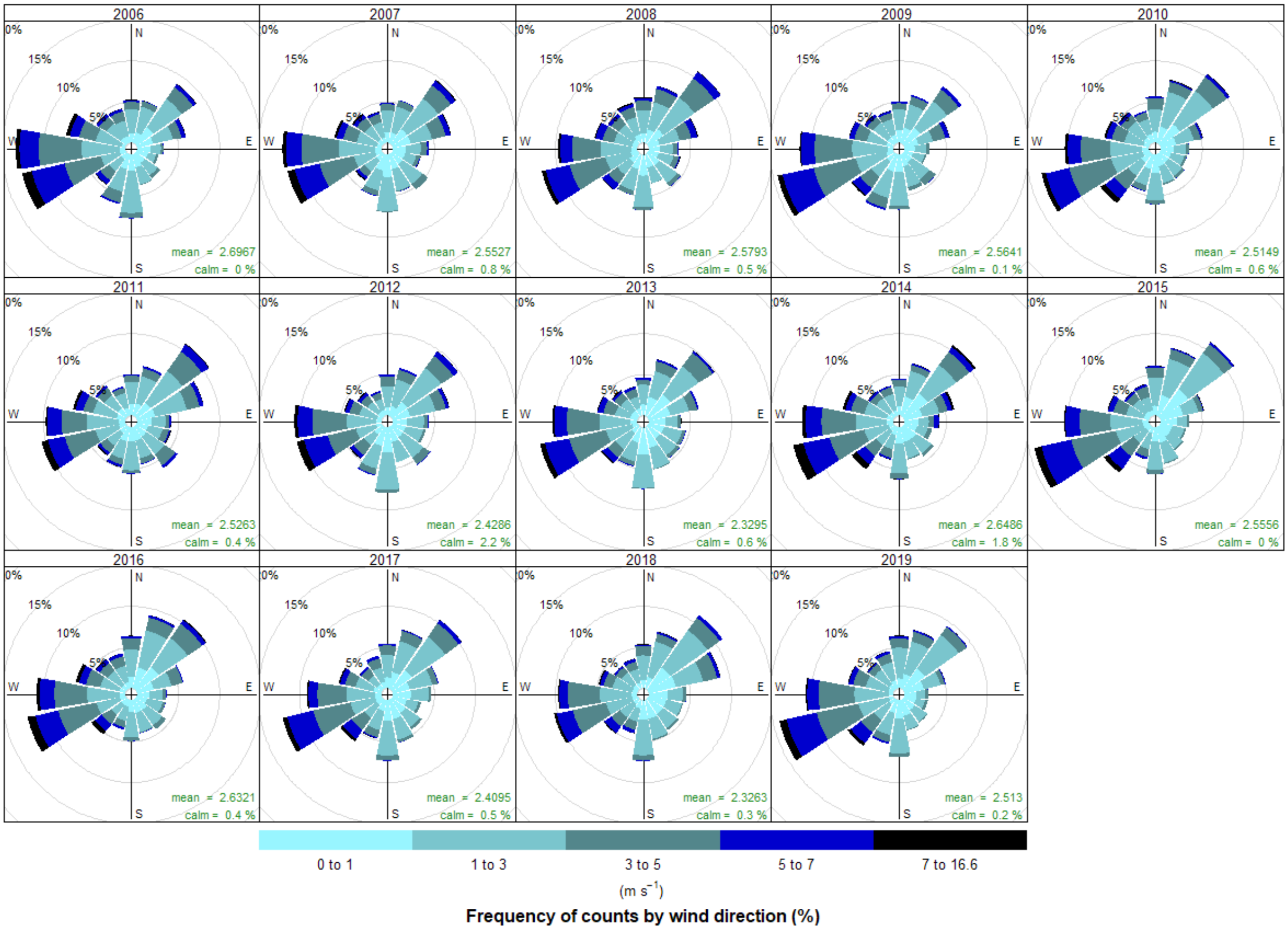


Figure 2: Wind roses at Hamilton Ruakura 2, EWS (2006 to 2019, inclusive).

Table 1: Summary of historic meteorological data from Hamilton Ruakura EWS (2001 to 2006, inclusive) and Ruakura 2 EWS (2006 to 2019, inclusive).

Year and station	Hourly average wind speed (m/s)	Hourly temp (ºC)	Hourly humidity (%)
2001 Hamilton Ruakura EWS	0 to 10.2 (average 2.3)	-4.3 to 29.1 (average 13.9)	35 to 99 (average 82.6)
2002 Hamilton Ruakura EWS	0 to 14.3 (average 2.5)	-1.4 to 26.5 (average 13.9)	32 to 99 (average 79.7)
2003 Hamilton Ruakura EWS	0 to 10.4 (average 2.3)	-2.9 to 27.3 (average 13.8)	27 to 100 (average 81.1)
2004 Hamilton Ruakura EWS	0 to 9.6 (average 2.4)	-3.1 to 27.8 (average 13)	36 to 100 (average 81.1)
2005	0 to 20.9	-3 to 29.7	33 to 100

Year and station	Hourly average wind speed (m/s)	Hourly temp (ºC)	Hourly humidity (%)
Hamilton Ruakura EWS	(average 2.1)	(average 13.8)	(average 81)
2006 Hamilton Ruakura EWS	0 to 11.3 (average 2.3)	-3.2 to 27.7 (average 13.1)	1 to 100 (average 80.7)
2006 Hamilton Ruakura 2 EWS	0 to 16.6 (average 2.7)	-3.3 to 27.6 (average 12.1)	23 to 100 (average 81.8)
2007 Hamilton Ruakura 2 EWS	0 to 16.6 (average 2.7)	-3.5 to 27.6 (average 13.7)	32 to 100 (average 80.9)
2008 Hamilton Ruakura 2 EWS	0 to 11.1 (average 2.6)	-3.9 to 30.5 (average 13.8)	24 to 99 (average 78.3)
2009 Hamilton Ruakura 2 EWS	0 to 9.7 (average 2.6)	-4.6 to 29.8 (average 12.8)	27 to 100 (average 80)
2010 Hamilton Ruakura 2 EWS	0 to 10.2 (average 2.6)	-3.2 to 29.8 (average 14)	23 to 100 (average 79.9)
2011 Hamilton Ruakura 2 EWS	0 to 10.8 (average 2.5)	-4.2 to 29.3 (average 13.1)	30 to 100 (average 81.2)
2012 Hamilton Ruakura 2 EWS	0 to 10.6 (average 2.5)	-4.3 to 26.3 (average 12.1)	33 to 100 (average 80)
2013 Hamilton Ruakura 2 EWS	0 to 10.8 (average 2.4)	-2.8 to 30.5 (average 14.2)	17 to 99 (average 70.5)
2014 Hamilton Ruakura 2 EWS	0 to 11.1 (average 2.3)	-3 to 28.5 (average 14.1)	27 to 100 (average 78.1)
2015 Hamilton Ruakura 2 EWS	0 to 11.3 (average 2.6)	-2.9 to 28.8 (average 14.1)	28 to 99 (average 79.5)
2016 Hamilton Ruakura 2 EWS	0.1 to 10.5 (average 2.6)	-3.1 to 29.8 (average 14.6)	34 to 99 (average 81.7)
2017 Hamilton Ruakura 2 EWS	0 to 10.6 (average 2.6)	-3.4 to 27.7 (average 14)	27 to 100 (average 82.1)
2018 Hamilton Ruakura 2 EWS	0 to 11.5 (average 2.4)	-2.1 to 29 (average 14.3)	30 to 100 (average 81.9)
2019 Hamilton Ruakura 2 EWS	0 to 12.1 (average 2.3)	-2.5 to 31.1 (average 14.4)	27 to 100 (average 80.6)

APPENDIX C

Odour Concentration Reports

Watercare Laboratory Services

Sensory Evaluation Unit

Olfactometry Results (Forced Choice)

Client:	Golder
Contact:	Roger Cudmore
Address:	Level 1, 214 Durham Street, Christchurch 8011
Date Received:	01/12/2020
Report Date:	14/12/2020
Report Number:	rp 20026s

- Odour concentration analysed in accordance with AS/NZS 4323.3:2001: "Determination of odour concentration by dynamic olfactometry" using Olfasense – TO-Evolution. Calibration set by Watercare in December 2020.

- Odour character analysed in accordance with Watercare Services Ltd: Method EM02.159 Section 4.6.

Panel Threshold for measurement (AS/NZS 4323.3:2001)[1]:

Panellist	Average Threshold (ppb)	Standard Deviation	Acceptable Range	Qualified
Panellist 1	1.56	44.1	Threshold range: 20-80ppb Standard Deviation: ≤ 2.3	Yes
Panellist 2	1.28	35.3		Yes
Panellist 3	1.51	43.4		Yes
Panellist 4	1.50	39.4		Yes
Panellist 5	1.97	53.0		Yes

[1]Average taken from 20 individual threshold estimates (ITEs) for reference gas (n-butanol 60ppm, ID: 030000048350/1).

Environmental Conditions for measurement (AS/NZS 4323.3:2001 Section 9.6)[2]:

Temperature Range	Ventilation	Environment odourless and pleasant	Noise or light Interference
22.4 °C – 22.8 °C	50.80 – 68.99 m^3/hr/person	Yes	No

[2]Section 9.6 (AS/NZS 4323.3:2001) states temperature fluctuations during the measuring process shall be less than Minimum ventilation rate of 4.4m^3/ hour per person.

Actual Sampling Conditions:

Lab Reference	Description	Temperature (°C)
201201-1	AER-1A	N/A
201201-2	AER-1B	N/A
201201-3	ANOX-1C	N/A
201201-4	ANOX-1D	N/A
201201-5	Blank-1E	N/A

Odour Concentration (AS/NZS 4323.3:2001):

Sample Date & Time[4]		Analysis Date & Time		Description	Results (OU)	Lab. Reference	Sampling Method
1/12/2020	11:15	2/12/2020	10:19	AER-1A	108	201201-1	N/A
1/12/2020	11:40	2/12/2020	10:31	AER-1B	68	201201-2	N/A
1/12/2020	13:30	2/12/2020	10:42	ANOX-1C	53	201201-3	N/A
1/12/2020	14:00	2/12/2020	10:52	ANOX-1D	48	201201-4	N/A
1/12/2020	15:00	2/12/2020	10:12	Blank-1E	< LOD[3]	201201-5	N/A

[3] < LOD is < 21 OU, the lowest detectable odour concentration that can be determined with 95% statistical confidence.
[4] Data supplied by customer

Odour Character (Watercare Services Ltd method EM02.159, section 4.6):

Laboratory Reference	Description of Odour
201201-1	Indiscernible
201201-2	Light - Sweet/chemical
201201-3	Light - Sweet/chemical
201201-4	Indiscernible
201201-5	Indiscernible

Comments:

1. All samples retrospectively screened.
2. For Description of Odour, the original sample was presented to the panellists.
3. Pre-dilution was not required prior to analysis.
4. All samples were collected by the client.

Deviations from AS/NZS 4323.3:2001:

1. AER-1A result based on 3 panellist submissions only.
2. Panellists were presented with at least 1 run.

Sara Abayaratne
Author

Bryan Grant
Peer Reviewer

Sensory Evaluation Unit

Olfactometry Results (Forced Choice)

Client:	Golder
Contact:	Roger Cudmore
Address:	Level 1, 214 Durham Street, Christchurch 8011
Date Received:	03/12/2020
Report Date:	10/12/2020
Report Number:	rp 20027s

- Odour concentration analysed in accordance with AS/NZS 4323.3:2001: "Determination of odour concentration by dynamic olfactometry" using Olfasense – TO-Evolution. Calibration set by Watercare in December 2020.

- Odour character analysed in accordance with Watercare Services Ltd: Method EM02.159 Section 4.6.

Panel Threshold for measurement (AS/NZS 4323.3:2001)[1]:

Panellist	Average Threshold (ppb)	Standard Deviation	Acceptable Range	Qualified
Panellist 1	1.56	44.1	Threshold range: 20-80ppb Standard Deviation: ≤ 2.3	Yes
Panellist 2	1.28	35.3		Yes
Panellist 3	1.51	43.4		Yes
Panellist 4	1.50	39.4		Yes
Panellist 5	1.97	53.0		Yes

[1]Average taken from 20 individual threshold estimates (ITEs) for reference gas (n-butanol 60ppm, ID: 030000048350/1).

Environmental Conditions for measurement (AS/NZS 4323.3:2001 Section 9.6)[2]:

Temperature Range	Ventilation	Environment odourless and pleasant	Noise or light Interference
22.4 °C – 22.9 °C	50.80 – 68.99 m^3/hr/person	Yes	No

[2]Section 9.6 (AS/NZS 4323.3:2001) states temperature fluctuations during the measuring process shall be less than Minimum ventilation rate of 4.4m^3/ hour per person.

Actual Sampling Conditions:

Lab Reference	Description	Temperature (°C)
201203-1	AER-2A	N/A
201203-2	AER-2B	N/A
201203-3	ANOX-2C	N/A
201203-4	ANOX-2D	N/A
201203-5	Blank-2E	N/A

Odour Concentration (AS/NZS 4323.3:2001):

Sample Date & Time[4]		Analysis Date & Time		Description	Results (OU)	Lab. Reference	Sampling Method
2/12/2020	10:37	3/12/2020	14:00	AER-2A	21	201203-1	N/A
2/12/2020	11:31	3/12/2020	14:26	AER-2B	36	201203-2	N/A
2/12/2020	13:22	3/12/2020	14:38	ANOX-2C	106	201203-3	N/A
2/12/2020	13:52	3/12/2020	14:46	ANOX-2D	98	201203-4	N/A
2/12/2020	15:04	3/12/2020	13:54	Blank-2E	< LOD[3]	201203-5	N/A

[3] < LOD is < 21 OU, the lowest detectable odour concentration that can be determined with 95% statistical confidence.
[4] Data supplied by customer

Odour Character (Watercare Services Ltd method EM02.159, section 4.6):

Laboratory Reference	Description of Odour
201203-1	Light - chemical
201203-2	Light - chemical
201203-3	Indiscernible
201203-4	Indiscernible
201203-5	Indiscernible

Comments:

1. All samples retrospectively screened.
2. For Description of Odour, the original sample was presented to the panellists.
3. Pre-dilution was not required prior to analysis.
4. All samples were collected by the client.

Deviations from AS/NZS 4323.3:2001:

1. AER-2A & ANOX-2C results based on 3 panellist submissions only.
2. Panellists were presented with at least 1 run.

Sara Abayaratne
Author

Bryan Grant
Peer Reviewer

ACCREDITED IANZ TESTING LABORATORY

Watercare Laboratory Services

Sensory Evaluation Unit

Olfactometry Results (Forced Choice)

Client:	Golder
Contact:	Roger Cudmore
Address:	Level 1, 214 Durham Street, Christchurch 8011
Date Received:	04/12/2020
Report Date:	10/12/2020
Report Number:	rp 20028s

- Odour concentration analysed in accordance with AS/NZS 4323.3:2001: "Determination of odour concentration by dynamic olfactometry" using Olfasense – TO-Evolution. Calibration set by Watercare in December 2020.

- Odour character analysed in accordance with Watercare Services Ltd: Method EM02.159 Section 4.6.

Panel Threshold for measurement (AS/NZS 4323.3:2001)[1]:

Panellist	Average Threshold (ppb)	Standard Deviation	Acceptable Range	Qualified
Panellist 1	1.56	44.1	Threshold range: 20-80ppb Standard Deviation: ≤ 2.3	Yes
Panellist 2	1.28	35.3		Yes
Panellist 3	1.51	43.4		Yes
Panellist 4	1.50	39.4		Yes
Panellist 5	1.97	53.0		Yes

[1]Average taken from 20 individual threshold estimates (ITEs) for reference gas (n-butanol 60ppm, ID: 030000048350/1).

Environmental Conditions for measurement (AS/NZS 4323.3:2001 Section 9.6)[2]:

Temperature Range	Ventilation	Environment odourless and pleasant	Noise or light Interference
22.5 °C – 23.0 °C	50.80 – 68.99 m^3/hr/person	Yes	No

[2]Section 9.6 (AS/NZS 4323.3:2001) states temperature fluctuations during the measuring process shall be less than Minimum ventilation rate of 4.4m^3/ hour per person.

Actual Sampling Conditions:

Lab Reference	Description	Temperature (°C)
201204-1	AER-3A	N/A
201204-2	AER-3B	N/A
201204-3	AER-3C	N/A
201204-4	ANOX-3D	N/A
201204-5	ANOX-3E	N/A

Laboratory Services – Watercare Services Limited
52 Aintree Avenue, Airport Oaks, Mangere, Manukau 2022, New Zealand
PO Box 107028 Airport Oaks, Manukau 2154, New Zealand
Telephone +64 9 539 7600 Facsimile +64 9 539 7620
www.watercarelabs.co.nz

Odour Concentration (AS/NZS 4323.3:2001)[4]:

Sample Date & Time[3]		Analysis Date & Time		Description	Results (OU)	Lab. Reference	Sampling Method
3/12/2020	10:20	4/12/2020	09:41	AER-3A	34	201204-1	N/A
3/12/2020	11:11	4/12/2020	09:52	AER-3B	71	201204-2	N/A
3/12/2020	12:04	4/12/2020	10:05	AER-3C	53	201204-3	N/A
3/12/2020	14:10	4/12/2020	10:27	ANOX-3D	119	201204-4	N/A
3/12/2020	14:35	4/12/2020	09:19	ANOX-3E	30	201204-5	N/A

[3]Data supplied by customer

Odour Character (Watercare Services Ltd method EM02.159, section 4.6):

Laboratory Reference	Description of Odour
201204-1	Indiscernible
201204-2	Indiscernible
201204-3	Very light - Earthy/chemical
201204-4	Indiscernible
201204-5	Indiscernible

Comments:

1. All samples retrospectively screened.
2. For Description of Odour, the original sample was presented to the panellists.
3. Pre-dilution was not required prior to analysis.
4. All samples were collected by the client.

Deviations from AS/NZS 4323.3:2001:

1. AER-3A & ANOX-3E results based on 3 panellist submissions only.
2. Panellists were presented with at least 1 run.

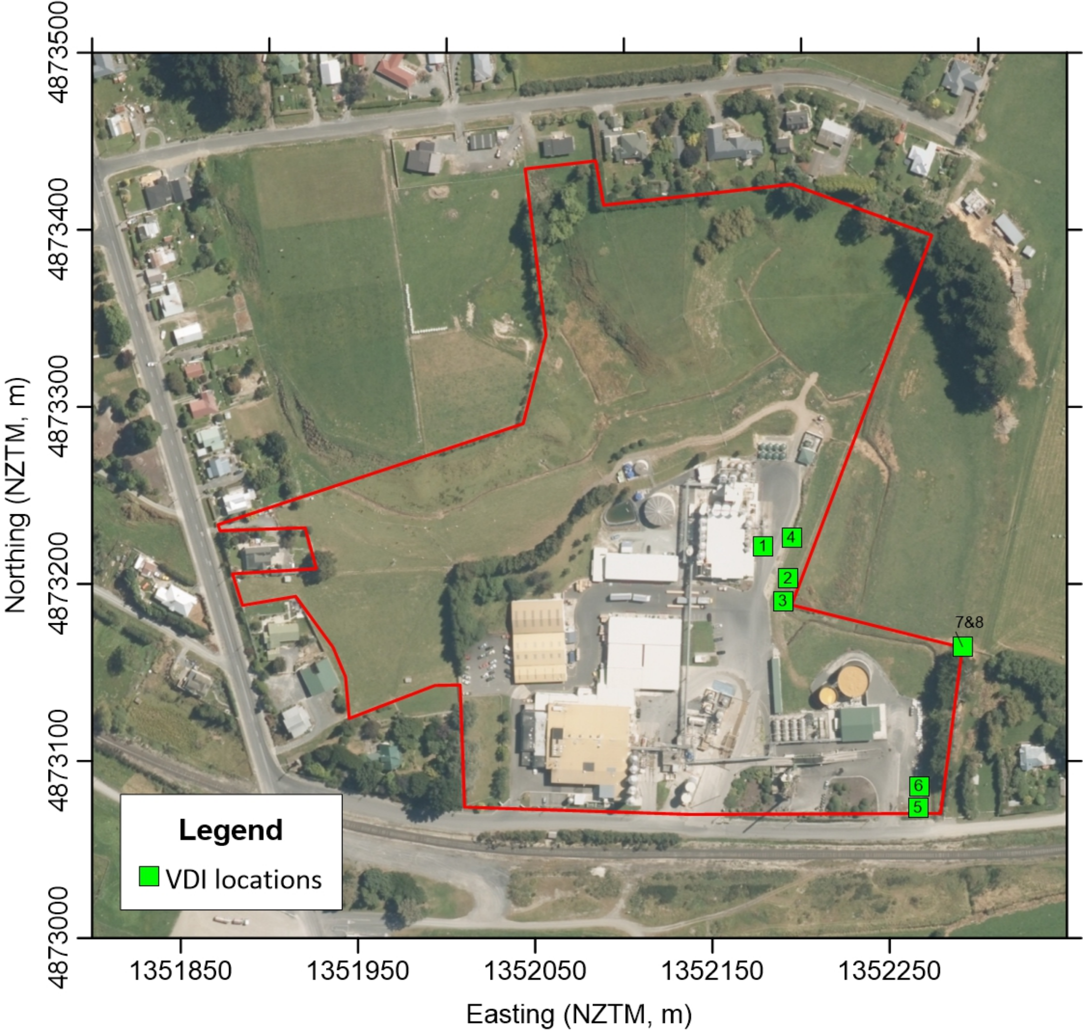
Sara Abayaratne
Author

Bryan Grant
Peer Reviewer

ACCREDITED
IANZ
TESTING LABORATORY

APPENDIX D

Field Odour Survey Sheets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4873100
4873000
Northing (NZTM, m)
1351850
1351950
1352050
1352150
1352250
Easting (NZTM, m)
1
2
3
4
5
6
7&8
Legend
VDI locations

110 / 107

FORM: Field Investigation of Odour Intensity

Lat / Long
-46.2494/169.7849

Location: Sub station See map on reverse site whey load out	Person: Roger	Date: ~~2~~ 1/12/2020	Time Commenced: 1:09
Wind Direction: SE	**Wind Speed:** lite	**Temperature:** warm	**Weather:** fine

Intensity scale is on reverse of this sheet

		Intensity	Duration (seconds)
1st min	0	0	
	10		
	20		
	30		
	40		
	50		
2nd min	0		
	10		
	20		
	30		
	40		
	50		
3rd min	0		
	10		
	20		
	30		
	40		
	50		
4th min	0		
	10	1	Milk reception
	20		
	30		
	40		
	50		
5th min	0		
	10		
	20		
	30		
	40		
	50		

		Intensity	Duration (seconds)
6th min	0		
	10		
	20		
	30		
	40		
	50		
7th min	0		
	10		
	20		
	30		
	40		
	50		
8th min	0		
	10		
	20		
	30		
	40		
	50		
9th min	0		
	10		
	20		
	30		
	40		
	50		
10th min	0		
	10		
	20		
	30		
	40		
	50	0	

Note initial odour character, and changes in odour character and/or wind direction that occurred during survey period (nature of change and time it occurred)

Very little odour at all
normal onsite milk odour

Status of site operations

Note what activities were occuring on site

1

110 / 164

FORM: Field Investigation of Odour Intensity

South of Calamity Tanks Bund

Location:	Person:	Date:	Time Commenced:
See map on reverse -46.2496 -169.7850	Roger	1/12/2020	~~12~~ 13:23
Wind Direction:	**Wind Speed:**	**Temperature:**	**Weather:**
SE	Very lite	warm	

Intensity scale is on reverse of this sheet

		Intensity	Duration (seconds)
1st min	0	0	
	10		
	20		
	30		
	40		
	50		
2nd min	0		
	10		
	20		
	30		
	40		
	50		
3rd min	0		
	10		
	20		
	30		
	40		
	50		
4th min	0		
	10		
	20		
	30		
	40		
	50		
5th min	0		
	10		
	20		
	30		
	40		
	50		

		Intensity	Duration (seconds)
6th min	0		
	10		
	20		
	30		
	40		
	50		
7th min	0		
	10		
	20		
	30		
	40		
	50		
8th min	0		
	10		
	20		
	30		
	40		
	50		
9th min	0		
	10		
	20		
	30		
	40		
	50		
10th min	0		
	10		
	20		
	30		
	40		
	50		0

Note initial odour character, and changes in odour character and/or wind direction that occurred during survey period (nature of change and time it occurred)

Directly down wind ≈ 80 m
Wind sock puts me directly D/W of Tanks.

Status of site operations

Note what activities were occuring on site

~~Wtr~~ WWTP operating

2

1787769

FORM: Field Investigation of Odour Intensity

15 m south of Chlamydia Terrace Bund

Location: See map on reverse -46.2497 169.7850	Person: Roger	Date: 1/12/2020	Time Commenced: ~~1:30~~ 13:35
Wind Direction: SE	**Wind Speed:** ~~very~~ lite	**Temperature:** warm /	**Weather:** warm / calm

Intensity scale is on reverse of this sheet

		Intensity	Duration (seconds)
1st min	0		
	10		
	20		
	30		
	40		
	50		
2nd min	0		
	10		
	20		
	30		
	40		
	50		
3rd min	0	1	Milky odour
	10		
	20		
	30		
	40		
	50		
4th min	0		
	10		
	20		
	30		
	40		
	50		
5th min	0		
	10		
	20		
	30		
	40		
	50	1	Milky

		Intensity	Duration (seconds)
6th min	0		
	10		
	20		
	30		
	40		
	50		
7th min	0		
	10		
	20		
	30		
	40		
	50		
8th min	0		
	10		
	20		
	30		
	40		
	50		
9th min	0		
	10		
	20		
	30		
	40		
	50		
10th min	0		
	10		
	20		
	30		
	40		
	50	2	— Sheep smell

Note initial odour character, and changes in odour character and/or wind direction that occurred during survey period (nature of change and time it occurred)

Wind swung @ 1:37 SE → S
Back to SE @ 1:39 S → SE

Status of site operations

Note what activities were occuring on site

3

1787769

FORM: Field Investigation of Odour Intensity

Location:	Person:	Date:	Time Commenced:
See map on reverse	Cathy	2/12/20	11.35
Wind Direction:	**Wind Speed:**	**Temperature:**	**Weather:**
Calm slight drift towards loca	calm ~~<0.1ms-1~~	≈20°C	Clear

Intensity scale is on reverse of this sheet

		Intensity	Duration (seconds)	
1st min	0			
	10			
	20			
	30			
	40			
	50			
2nd min	0	2		Sheep manure
	10			
	20			
	30			
	40			
	50			
3rd min	0			
	10			
	20			
	30			
	40	1		Sheep manure
	50			
4th min	0			
	10			
	20			
	30			
	40			
	50			
5th min	0			
	10			
	20			
	30			
	40			
	50			

		Intensity	Duration (seconds)	
6th min	0	1		Milk ~~sour~~ (sour)
	10			
	20			
	30			
	40	1		Sheep manure
	50			
7th min	0			
	10			
	20			
	30			
	40			
	50			
8th min	0			
	10			
	20			
	30			
	40			
	50			
9th min	0			
	10			
	20			
	30			
	40			
	50			
10th min	0			
	10			
	20			
	30			
	40			
	50			

Note initial odour character, and changes in odour character and/or wind direction that occurred during survey period (nature of change and time it occurred)

6 min 7 min 9 min

Air movement ~~Wind direction~~ variable from E → S – W → N → NW → S → NW

Status of site operations

Note what activities were occuring on site

Normal op. Odor sample AEROBIC tank Sample B.

4

FORM: Field Investigation of Odour Intensity

1787769

Location: See map on reverse	Person: Cathy	Date: 2/12	Time Commenced: 11:49
Wind Direction: NW	**Wind Speed:** 1-2ms⁻¹ gusting 3ms⁻¹	**Temperature:** 20°C	**Weather:** ~~Calm~~, hot, light wind, clear

Intensity scale is on reverse of this sheet

		Intensity	Duration (seconds)
1st min	0		
	10		
	20		
	30		
	40		
	50		
2nd min	0		
	10		
	20		
	30		
	40	1	Sour Milky
	50		
3rd min	0		
	10		
	20		
	30		
	40		
	50		
4th min	0		
	10		
	20		
	30		
	40		
	50		
5th min	0		
	10		
	20		
	30		
	40		
	50		

		Intensity	Duration (seconds)
6th min	0		
	10		
	20		
	30		
	40		
	50		
7th min	0		
	10		
	20		
	30		
	40		
	50		
8th min	0		
	10		
	20		
	30		
	40		
	50		
9th min	0		
	10		
	20		
	30		
	40		
	50		
10th min	0		
	10		
	20		
	30		
	40		
	50		

Note initial odour character, and changes in odour character and/or wind direction that occurred during survey period (nature of change and time it occurred)

no WWTP odour observed, wind fairly consistent from tanks

Status of site operations

Note what activities were occuring on site

Normal WW ops

5

1787769

FORM: Field Investigation of Odour Intensity

Location:	Person:	Date:	Time Commenced:
See map on reverse	Cathy	3/12	10.40
Wind Direction:	**Wind Speed:**	**Temperature:**	**Weather:**
NW	Gusty Strong Breeze	≈ 15°C	Clear Blue skies Windy gusty Strong gusty

Intensity scale is on reverse of this sheet

		Intensity	Duration (seconds)	
1st min	0			
	10			
	20			
	30			
	40	1		DAF fatty.
	50	2		DAF
2nd min	0			
	10			
	20			
	30			
	40			
	50			
3rd min	0	2		DAF fatty
	10			
	20	1		Sour Milk.
	30			
	40	1		DAF fatty
	50			
4th min	0	1		DAF
	10			
	20			
	30			
	40			
	50			
5th min	0			
	10	1		DAF
	20			
	30			
	40	1		Sweet tanks
	50			

		Intensity	Duration (seconds)	
6th min	0			
	10			
	20			
	30			
	40			
	50			
7th min	0			
	10			
	20			
	30			
	40			
	50			
8th min	0			
	10			
	20			
	30			
	40	1		Sweet tanks
	50			
9th min	0			
	10			
	20			Forklift
	30	2		LPG from forklift
	40			~~Ad...~~
	50			
10th min	0			
	10			
	20			
	30			
	40			
	50			

Note initial odour character, and changes in odour character and/or wind direction that occurred during survey period (nature of change and time it occurred)

Mainly DAF (fatty smell) occasion sweet smell like what smell of tanks.

Status of site operations

Note what activities were occuring on site

Normal except forklift as noted

6

118/164

FORM: Field Investigation of Odour Intensity

Location: See map on reverse	**Person:** Cath	**Date:** 3/12/20	**Time Commenced:** 2.01
Wind Direction: W WNW	**Wind Speed:** Strong breeze	**Temperature:** ≃14°C	**Weather:** Mild ~~Warm~~, Windy Clear

Intensity scale is on reverse of this sheet

		Intensity	Duration (seconds)	
1st min	0			
	10			
	20			
	30			
	40			
	50			
2nd min	0			
	10			
	20			
	30			
	40			
	50			
3rd min	0	1		Sheep Manure
	10			
	20			
	30			
	40			
	50			
4th min	0			
	10			
	20			
	30			
	40			
	50			
5th min	0			
	10			
	20	1		Sheep Manure
	30			
	40			
	50			

		Intensity	Duration (seconds)
6th min	0		
	10		
	20		
	30		
	40		
	50		
7th min	0		
	10		
	20		
	30		
	40		
	50		
8th min	0		
	10		
	20		
	30		
	40		
	50		
9th min	0		
	10		
	20		
	30		
	40		
	50		
10th min	0		
	10		
	20		
	30		
	40		
	50		

Note initial odour character, and changes in odour character and/or wind direction that occurred during survey period (nature of change and time it occurred)

No odour except occasional sheep.

Status of site operations

Note what activities were occuring on site

Normal op, anoxic tank sampling

Rams in paddock

7

1181167

FORM: Field Investigation of Odour Intensity

Location: See map on reverse	Person: Coffey	Date: 3/12/20	Time Commenced: 2.14
Wind Direction: W	**Wind Speed:** Beaufort 6	**Temperature:** ≈15	**Weather:** Clear, windy gusty

Intensity scale is on reverse of this sheet

		Intensity	Duration (seconds)	
1st min	0			
	10			
	20			
	30			
	40			
	50			
2nd min	0			
	10			
	20			
	30			
	40			
	50			
3rd min	0			
	10			
	20			
	30			
	40	1	1-2s	Sweet (tank)
	50			
4th min	0			
	10			
	20			
	30			
	40			
	50			
5th min	0			
	10			
	20			
	30			
	40			
	50			

		Intensity	Duration (seconds)
6th min	0		
	10		
	20		
	30		
	40		
	50		
7th min	0		
	10		
	20		
	30		
	40		
	50		
8th min	0		
	10		
	20		
	30		
	40		
	50		
9th min	0		
	10		
	20		
	30		
	40		
	50		
10th min	0		
	10		
	20		
	30		
	40		
	50		

Note initial odour character, and changes in odour character and/or wind direction that occurred during survey period (nature of change and time it occurred)

gusty

Status of site operations

Note what activities were occuring on site

normal Anoxic tank odour sampling

8

APPENDIX E

CALPUFF Configuration

1.0 INTRODUCTION

CALPUFF version 7.2.1 was run from 1 January to 31 December 2003. Most standard options were used, including the 'pdf' formulation for dispersion under convective conditions (Scire, Strimaitis & Yamartino 1999; TRC 2011). Odour concentrations were calculated at a number of discrete receptors, and on nested grids with 25 m, 50 m and 100 m spacing.

2.0 GENERIC CALPUFF PARAMETERS

A fuller list of parameters used in the CALPUFF runs is given in the following tables. Parameters not mentioned below should be assumed to take default values, or they relate to a particular feature of the model that is not used.

Table 1: CALPUFF start and end times.

Parameter		Value	
Start date/time		00:00	1 January 2003
End date/time		23:00	31 December 2003
Base time zone	XBTZ	-12 (NZST)	
Time step	NSECDT	3600 s	

Table 2: Pollutant specifications.

Parameter		Value	
Number of chemical species	NSPEC	1	
Number of emitted species	NSE	1	
Species;	modelled; emitted; deposited?	Odour	Yes; Yes; No
Chemical mechanism	MCHEM	0	(No chemistry)
Dry deposition	MDRY	0	(No dry deposition)
Wet deposition	MWET	0	(No wet deposition)

Table 3: Technical options.

Parameter		Value	
Dispersion coefficient calculation	MDISP	2	use micrometeorological variables
PDF for dispersion under convective conditions	MPDF	1	(On)
Building downwash	MBDW	2	Prime
Check parameters for regulatory settings		No	(they are USEPA-specific)
Minimum σv over land (default 0.5 m/s)		0.5 m/s	

Table 4: Map projection (parameters should match CALMET).

Parameter	Value
Map projection	Tangential Transverse Mercator (TTM)
Datum region	WGS-84
Projection origin	37.86S, 175.45E
False origin (NZMG coordinates)	(2726.0, 6369.0) km

Table 5: Grid control.

Parameter		Value
SW corner of grid cell (1,1)		(2680, 6340) km (NZMG)
Grid dimensions	NX x NY; DGRIDKM	90 x 70 grid cells at spacing 1 km
Vertical grid, number of layers		10
Cell-face heights for vertical grid (m)		0, 20, 40, 80, 120, 200, 400, 800, 1200, 2000, 3000
Use of sampling grid (gridded receptors)?		No
Use of nested grid receptors?		Yes
Nested grid centre		(2725.524, 6368.732) km NZMG
Nested grid 1 range / spacing		250 m x 250 m at 25 m spacing
Nested grid 2 range / spacing		500 m x 500 m at 50 m spacing
Nested grid 3 range / spacing		1200 m x 1200 m at 100 m spacing

Table 6: Discrete receptors.

Number	NZMG Easting (m)	NZMG Northing (m)	Ground Elev. (m)*
R_1	2725997.01	6368455.28	64.66
R_2	2725866.99	6368456.72	64.63
R_3	2725771.83	6368464.16	64.44
R_4	2726464.95	6368243.2	64.41
R_5	2725408.33	6368642.58	63.83
R_6	2725411.14	6368469.41	63.97
R_7	2725685.04	6368459.09	63.96
R_8	2725613.02	6368463.95	63.98
R_9	2725671.98	6368566.52	63.9
R_10	2725613.38	6368575.32	63.93
R_11	2725667.63	6368657.41	63.77
R_12	2725529.43	6368659.27	63.86
R_13	2726157.48	6368573.64	63.44
R_14	2726239.47	6368453.87	63.85
R_15	2726232.46	6368488.76	63.81
R_16	2726013.48	6368266.62	65.47
R_17	2726014	6368215	60
R_18	2725402.32	6368290.55	64.25
R_19	2725480.05	6368470.1	64
R_20	2726466.27	6368933.53	62.51
R_21	2725558.73	6369109.15	61.14
R_22	2725757.28	6369127.79	61.25
R_23	2725708.64	6369212.93	60.84
R_24	2726182	6369463	60
R_25	2725154.74	6368585.42	62.89
R_26	2724880	6369084.58	59.92
R_27	2725176.86	6368468.19	63.57
R_28	2726988.83	6368780.46	64.25
R_29	2725659.75	6368459.2	63.97
R_30	2726009.24	6368381.06	64.95
R_31	2726036.49	6368415.69	64.78
R_32	2725956.17	6368345.4	65.06
R_33	2725862.88	6368393.43	64.8
R_34	2725683.7	6369258.07	60.63
R_35	2725625.87	6369347.6	60.17

Number	NZMG Easting (m)	NZMG Northing (m)	Ground Elev. (m)*
R_36	2724871.18	6368663.41	60.55
R_37	2725233.48	6368460.85	63.76
R_38	2725110.3	6368480.8	63.23
R_39	2725057.35	6368327.93	63.28
R_40	2724989.61	6368476.97	62.34
R_41	2724829.45	6368415.51	61.06
R_42	2724824.5	6368197.19	62.3
R_43	2725529.09	6369460.02	60.01
R_44	2725521.94	6369515.93	60
R_45	2725465.33	6369549.9	60.01
R_46	2725818.83	6369515.01	60.33
R_47	2726051	6369549.7	60.6
R_48	2725198.38	6368834.81	61.84
R_49	2726272.05	6368079.53	66.78
R_50	2726092.01	6367973.23	68.21
R_51	2726170.06	6367954.7	68.48
R_52	2726169.06	6367926.52	68.76
R_53	2726092.06	6367872.67	69.41
R_54	2726314.65	6367916.59	69.19
R_55	2726335.15	6367831.5	70.31
R_56	2726355.54	6367737.98	71.41
R_57	2726198.55	6367743.82	70.85
R_58	2726187.52	6367789.31	70.43
R_59	2725989.65	6367909.08	68.95
R_60	2725940.58	6368455.97	64.68
R_61	2726030.45	6368437.55	64.72
R_62	2725383.02	6368548.43	63.92
R_63	2725462.76	6368378.42	63.99
R_64	2725500	6368468.05	64
R_65	2725353.8	6368472.33	63.92
R_66	2725215.24	6368559.94	63.29
R_67	2724972.47	6368345.8	62.58

Note: * Above mean sea level – height shown is that of the CALMET grid cell containing the receptor point.

3.0 STACK SOURCE PARAMETERS

Table 7: Modelled emission parameters and rates.

Source Name	Source surface area (m^2)	Release height (m)	Base elevation (m)	Initial sigma z (m)	Odour flux emission rates($OU/m^2/s$)
Aerobic phase I	3400	6	63.23	0.5	0.36
Aerobic phase II	320	6	63.23	0.5	0.36
Anoxic	320	6	63.23	0.5	0.071
Balance tank 1	17.7	7	62.81	0.5	0.071
Balance tank 2	17.7	7	62.79	0.5	0.071
Clarifier	240	3	63.66	0.5	0.071

4.0 REFERENCES

Scire JS, Strimaitis DG, Yamartino RJ 1999. A user's guide for the CALPUFF dispersion model (version 5.0). Earth Tech, Inc., Boston.

TRC 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'. Prepared for NSW Office of Environment and Heritage, Sydney, Australia, March 2011.

APPENDIX F

Analysis of Waikato Regional Plan Requirements - 8.1.5.1, Chapter 6.1

Waikato Regional Plan - 8.1.5.1 Chapter 6.1 – Discretionary and Non Complying Activity Rules

No.	Assessment criteria and information requirements	Analysis/Responses
a	The extent to which the Regional Ambient Air Quality Guidelines are complied with	*The discharge to air from the proposed WWTF only includes odour. There are no numeric ambient air quality guidelines for ambient odour within the Waikato Regional Air Plan. However, Objective 3 (b) requires that cumulative effects of discharges on ambient air quality do not cause odour that is objectionable to the extend it causes an adverse effect. The assessment concludes that this requirement is likely to be met by the Proposal.*
b	The extent to which the discharge will have an adverse effect on ambient air quality.	*There will be negligible effects on ambient air quality due to odour sources described in Section 2.3. The potential effects of odour are addressed below.*
c	The extent to which the discharge will have an actual or potential adverse effect on the existing air quality characteristics of an area.	*Air quality characteristics encompasses amenity effects from odour discharges. These are assessed to be minor, or less than minor (Section 6.4). Also, there would be a low risk of abnormal odour emissions to be objectionable or offensive to an extent that causes an adverse effect (Section 7.6).*
d	The extent to which the discharge will have an adverse effect on human health and the health of flora and fauna.	*Odour exposures need to cause significant and sustained high levels to cause significant stress within people. These are assessed to only cause a minor, or less effect beyond the site boundary (Section 6.4). Therefore, for the reasons discussed in Section 6.4, there is not expected to be any effects on human health or on the health of flora and fauna from the discharges to air.*
e	The extent to which the discharge will have an adverse effect on amenity values, including any objectionable effects as a result of an odour or particulate discharge (refer also to Guidelines for Assessment in Chapter 6.4).	*Given proposed mitigation detailed in Sections 7.2, 7.3 and 7.4. and their effective management (Section 7.5). The proposal would only create a low risk of abnormal odour emissions to be objectionable or offensive to an extent that causes an adverse effect (Section 7.6).*

f	The extent to which the frequency, intensity, duration, offensiveness and location of the discharge causes adverse effects.	*Minor, or less than minor (Sections 6.4 and 7.6).*
g	The extent to which the discharge will be reduced at source.	*Potential odour effects have been significantly reduced at source through the adoption of odour containment and treatment, controls on key processes (described in Sections 7.2 and 7.3), and a detailed and robust odour monitoring and management plan, as described in Section 7.5.*
h	The nature of the discharge and the extent to which it is hazardous (refer Hazardous Air Contaminants List in Chapter 6.7).	*Nature of discharge involves air with low levels of residual odour and associated volatile organic compounds. None of the discharges to air sought to be authorised by this consent are hazardous.*
i	The existing air discharge sources in the area (point and non-point).	*Described in Section 3.3.*
j	The influence of meteorology and topography on the discharge.	*Described in Section 3.4.*
k	The extent to which the method of discharge is the most efficient and effective means of carrying out an activity.	*The use of a biofilter to treat and discharge potentially odorous airstreams is considered to the most effect means for carrying out the activity. Other methods are considered less reliable (see Section 7.2.2).*
l	The extent to which any alternative location or method(s) of discharging any contaminant, such as into a different medium, was considered.	*See Section 3.1*
m	Whether the option minimises any adverse effects on the environment.	*The option significantly reduces the potential for adverse effects as discussed in Sections 3.3.4, 7.2 and 7.3.*
n	The extent to which tangata whenua as Kaitiaki concerns have been recognised and provided for.	*Response to be provided by others.*
o	The extent to which the activity will have the potential to affect significant heritage sites14 or areas of historic and cultural significance.	*Response to be provided by others.*

p	The extent to which the discharge creates actual or potential effects on other receiving environments (i.e., land or water).	*Response to be provided by others.*
q	The extent of any consultation undertaken (as per the reporting requirements in Schedule Four of the RMA).	*Response to be provided by others.*
r	The extent to which the discharge creates actual or potential effects on the global atmosphere (within the scope of central government policy).	*None. Potential for odour effects are localised to areas within the vicinity of the Proposal.*
s	The extent to which the discharge creates cumulative effect which may arise over time or in combination with other effects.	*Low potential for cumulative effects as discussed in Section 4.4.*
t	Any effects of low probability but high potential impact.	*Low risk of acute odour events as discussed in Section 7.6.*
u	Whether management plans and contingency plans have been provided.	*A draft odour management and contingency plan will be provided with the application. Matters which Golder recommends are addressed within management/contingency plans are discussed in Sections 7.4 and 7.5.*
v	The risk of abnormal emissions and the level of control employed.	*Low risk of abnormal emissions and a high level of control has been recommended in Section 7.2 and 7.3.*
w	The extent to which relevant codes of practice or other guidelines are adhered to.	*Assessment methods considered to be consistent with the Ministry for the Environment's Good Practice Guide for Assessing and Managing Odour in New Zealand (MfE 2016).*
x	The extent to which the discharge may affect aircraft safety.	*None.*

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