October 2015

REPORT

## ALLIANCE GROUP LIMITED, LORNEVILLE

# Process Odour Mitigation

**Submitted to:**
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**Report Number.** 1378104044-013-R-Rev4-090

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# 1.0 INTRODUCTION

This report[1] provides an assessment of the effectiveness of odour mitigation systems employed to minimise off-site odour effects from meat processing operations and associated activities at the Alliance Group Ltd (Alliance) plant at Lorneville, Southland.

The information within this report is required to assist in the preparation of an application for renewal of the site's existing air discharge permit (Environment Southland Consent No. 95077) that expires on 7 August 2016. The scope of this mitigation assessment includes the site's blood processing, low temperature rendering, pelt-processing (Fellmongery) and soup stock facilities, as well as the stockyards. These processes are located in areas that are labelled in Figure 1. The assessment of odour mitigation systems associated with wastewater primary and secondary treatment systems is provided in a separate report (Golder 2015).

The assessment approach was based on a consideration of the Best Practicable Option (BPO) for minimising the odour emissions. This requires practical measures to be implemented to an extent that accounts for the actual effects and economic feasibility. The mitigation assessment included several field visits to review the rendering, Fellmongery and other site processes listed above. These visits enabled the various odour sources and associated method of mitigation to be documented and the effectiveness of these systems to be assessed and compared to good industry practices.

The main component of mitigation assessment was the completion of an onsite audit - undertaken by Golder Associates (NZ) Ltd (Golder) during May 2014. This enabled the review of available information on piping and instrumentation diagrams (P&IDs), process documentation, and the process control systems. During and after the audit, the direct measurement of key odour control parameters was undertaken (e.g., temperatures, vacuums, and biofilter media parameters). Golder also interviewed operators regarding day-to-day management of key facilities and the operation parameters they routinely monitored and controlled.

The following sections provide process descriptions, odour sources and assessments of odour mitigation systems for the following facilities at Lorneville:

- Stockyards
- Soup Stock
- Wool Hydrolysing
- Blood Processing
- Rendering
- Fellmongery

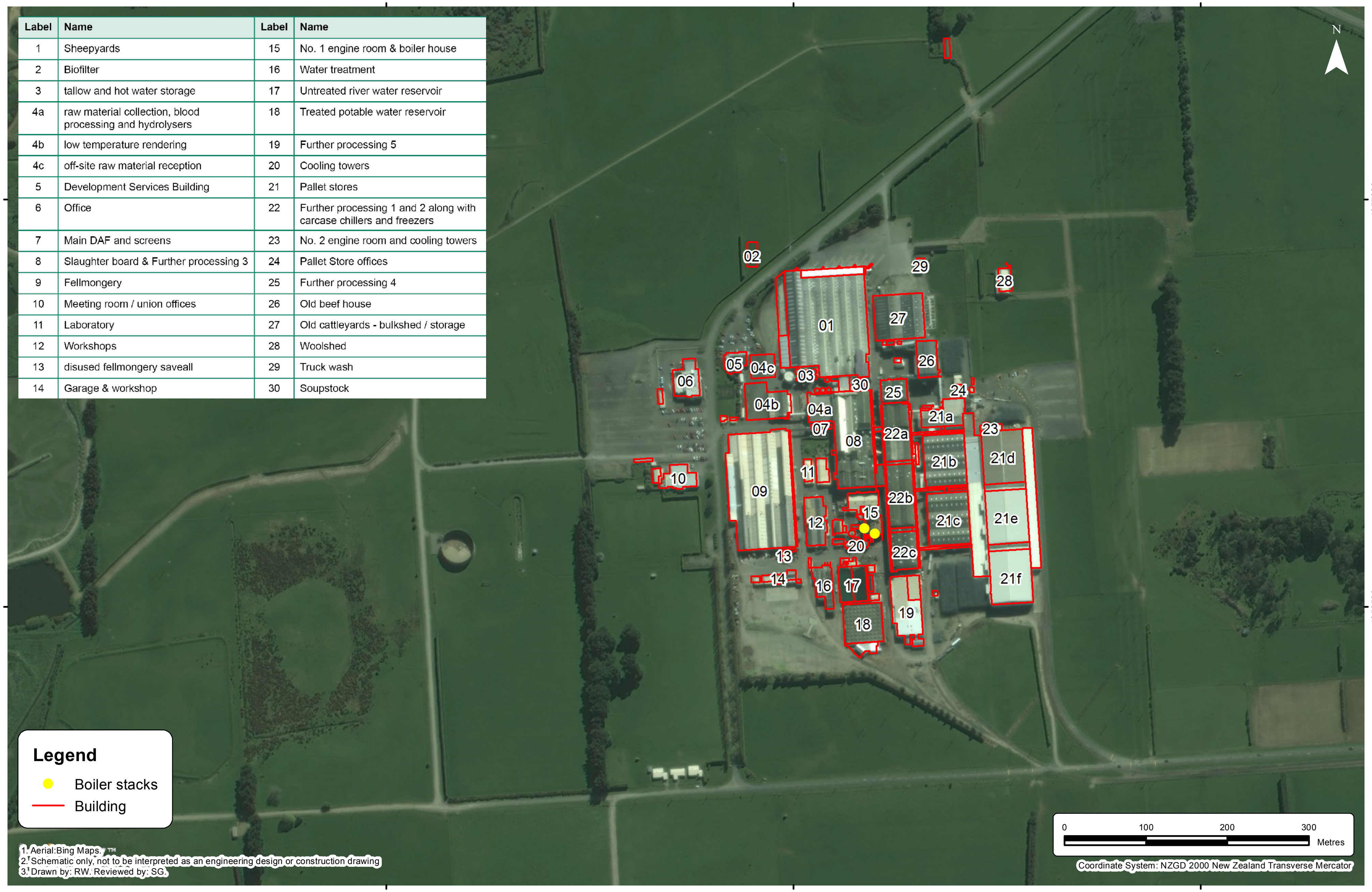
# 2.0 STOCKYARDS

## 2.1 Description

Sheep and bobby calves (during seasonal processing) are delivered to yards for housing prior to processing. The covered yards are shown as item "1" on Figure 1. The yards are raised with urine and faeces dropping through grating to a collection area where they can be periodically hosed down towards a sump prior to discharging to the wastewater treatment plant (WWTP) via the southern discharge drain. Solids can be scraped out and discharged to land. Alliance holds a consent for this activity although only exercise this occasionally. Alliance are currently investigating options for more regularly removal of solids and discharging these off-site.

[1] Subject to limitations specified in Appendix A of this Report.

| Label | Name | Label | Name |
| --- | --- | --- | --- |
| 1 | Sheepyards | 15 | No. 1 engine room & boiler house |
| 2 | Biofilter | 16 | Water treatment |
| 3 | tallow and hot water storage | 17 | Untreated river water reservoir |
| 4a | raw material collection, blood processing and hydrolysers | 18 | Treated potable water reservoir |
| 4b | low temperature rendering | 19 | Further processing 5 |
| 4c | off-site raw material reception | 20 | Cooling towers |
| 5 | Development Services Building | 21 | Pallet stores |
| 6 | Office | 22 | Further processing 1 and 2 along with carcase chillers and freezers |
| 7 | Main DAF and screens | 23 | No. 2 engine room and cooling towers |
| 8 | Slaughter board & Further processing 3 | 24 | Pallet Store offices |
| 9 | Fellmongery | 25 | Further processing 4 |
| 10 | Meeting room / union offices | 26 | Old beef house |
| 11 | Laboratory | 27 | Old cattleyards - bulkshed / storage |
| 12 | Workshops | 28 | Woolshed |
| 13 | disused fellmongery saveall | 29 | Truck wash |
| 14 | Garage & workshop | 30 | Soupstock |






Golder Associates

TITLE PROCESSING SITE LAYOUT

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## 2.2 Sources of Odour

Sheep yards have a distinct odour characteristic that is synonymous with farm woolsheds. The odour is due to the animal's urine, faeces and the sheep themselves have a distinct smell. The dominating compounds of the odour are ammonia, amines and other nitrogen related compounds. A characteristic feature of these types of odour is that they tend to rapidly reduce in intensity as they disperse and dilute in the atmosphere.

## 2.3 Mitigation

The stockyards are regularly cleaned by hosing down and chlorine dioxide is sprayed below floor level as required to reduce the ammonia concentrations in the air to help reduce ammonia levels in the yards to protect worker safety. This also has the benefit of reducing the potential to cause off-site odours.

Cleaning of stockyards is carried out daily in high use areas, with overall cleaning being carried once per week and more frequently if ammonia levels are high. Monitoring of ammonia levels is undertaken using Occupational Safety and Health (OSH) type monitors that alarm when exposure limits are exceeded to protect worker health. Levels are monitored daily within high use areas and the use of suppressing spray is determined by the supervisor based both on monitored concentrations and what is being experienced by workers.

In addition to regular hosing down of animal waste and the chlorine dioxide dosing system, the potential for stockyards to cause odour effects is effectively mitigated by the significant distance from the yards to neighbouring residential dwellings.

## 2.4 Recommendations

The stock yards odours were not observed offsite and it is considered that the current mitigation measures are sufficient. No further mitigation measures are considered necessary.

# 3.0 SOUP STOCK

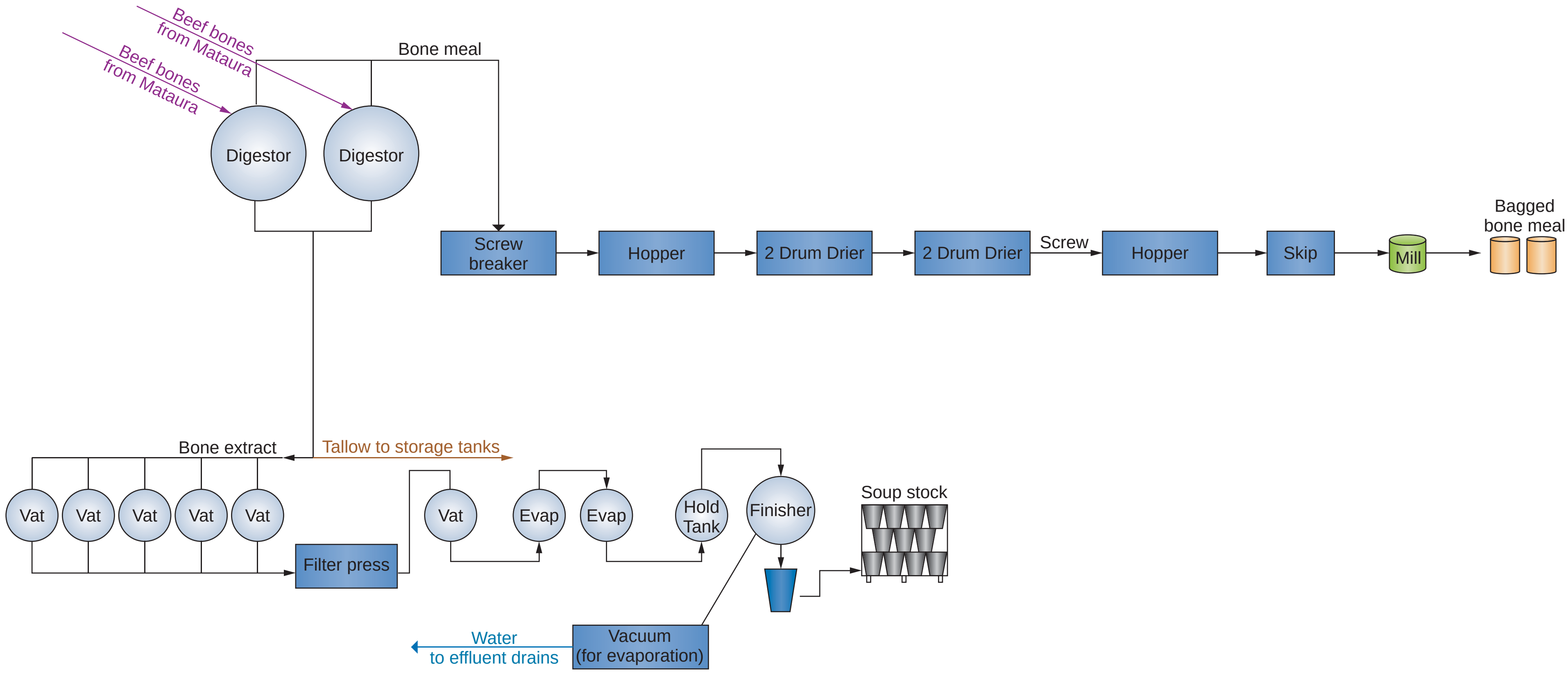
The site operates the soup stock process within the area labelled "30" in Figure 1. The soup stock processes 100-140 tonnes/week of fresh beef bones from offsite into soup stock, edible tallow and bagged bone meal. This batch process involves the cooking of the bones in one of two digesters (effectively large pressure cookers). The cooked bones are dried, milled then bagged. The liquid extract is split into tallow and bone extract. The bone extract is concentrated through two evaporators and a finisher before being put into tubs as concentrated liquid stock product. A process flow diagram is shown in Figure 2.

The digestors' exhaust gases during different parts of the approximately 8 hour cooking cycle are condensed and discharged via a roof vent. At the end of the cooking process steamy emissions are released when digestors are opened for the manual removal of the beef bones into the covered screw conveyor; these are extracted and discharged via roof vents.

Where there are steamy discharges from the bone meal and liquid processes (such as above the evaporator drains, the drum dryer and the digestors), extraction hoods are installed and the discharge is vented from the buildings via roof vents. Dust from the dried bone meal mill area is also discharged via a separate roof vent.

It is noted that soup stock is a source of odour emission on site but is not likely to be a significant cause of any odour effects off-site. It is considered that soup stock odours effects are likely to be minor.

The odour associated with the discharge from the soup stock process has a relatively neutral character consistent with beef stock being cooked. During site visits this odour was not noticeable onsite except immediately adjacent to the process during the bone meal removal from the digestors. As such it is concluded that this process is unlikely to cause odour effects beyond the site boundary, and therefore further odour mitigation is not recommended by this report.




1. Schematic only, not to be interpreted as an engineering design or construction drawing
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Golder Associates

TITLE SOUP STOCK PROCESS

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# 4.0 WOOL HYDROLYSING

The site operates two hydrolysers, one batch and one continuous, within the area labelled “4a” in Figure 1. These remove wool from heads, hocks and skin pieces from the fellmongery process that are produced at the site before the heads, hocks and skin pieces are sent to the low temperature rendering plant (discussed below). The hydrolysers’ exhaust gases are discharged to the coal-fired boiler house for odour destruction via combustion. This is achieved by mixing the hydrolyser stream with the inlet primary combustion air stream to the boilers. The odour associated with the periodic discharge from the hydrolysers has a distinct character, however during downwind assessments this odour was not recognisable. As such it is concluded that the combustion of the exhaust gases is effective and this process is unlikely to cause odour effects beyond the site boundary, and therefore additional mitigation is not recommended by this report. Note that the new rendering plant receival area has provision for installation of a new hydrolyser plant, although there are no current plans to install this.

# 5.0 BLOOD PROCESSING

## 5.1 Description

Blood generated at the site, as well as that received in bins from Makarewa’s venison processing plant, is processed into meal within the area labelled “4a” in Figure 1. The process is relatively simple and involves the collection of blood from the slaughter board and storage in a tank before processing. Processing consists of in-line coagulation with steam, a cooling stage, decanting to produce a wet solid for drying (indirect contact steam dryer) followed by screening and bagging of the dried product. The blood drying process is schematically shown in Figure 3.

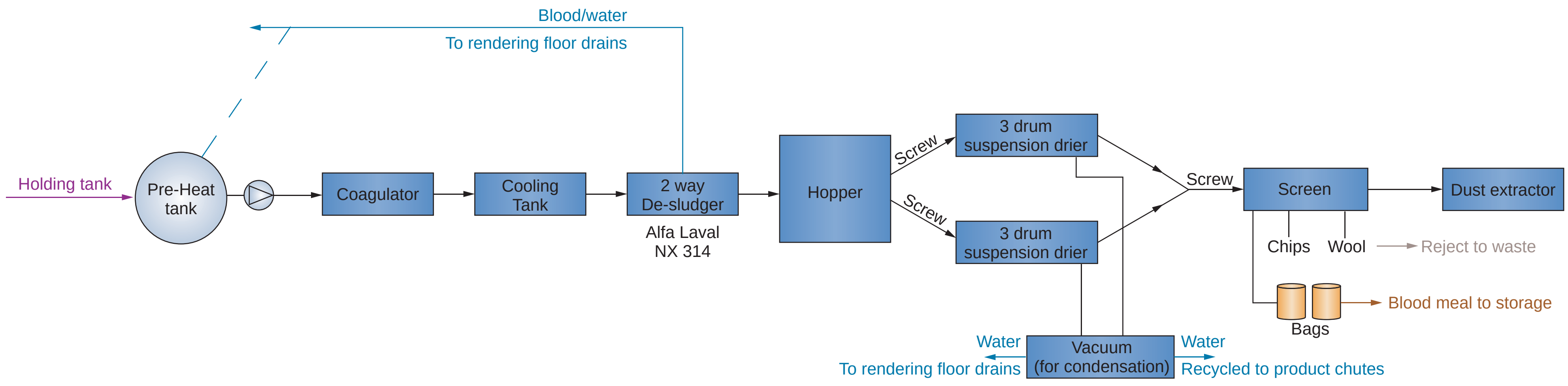
## 5.2 Sources of Odour

The only significant source of odour results from the drying process that generates a wet exhaust airstream that contains odorous organic volatile compounds. This exhaust stream is cooled by a water jacket heat exchanger and the resultant non-condensable air stream is relatively odorous – especially if the blood has been stored for more than a day.

## 5.3 Mitigation

The odorous non-condensable air stream is extracted to the coal-fired boiler house for odour destruction via combustion. This is achieved by mixing the non-condensable stream with the inlet primary combustion air stream to the boilers. As the blood is generated at the site and at the neighbouring Makarewa site, it is standard practice to process material within a day of it being generated from the slaughter boards.

The blood drying non-condensable stream is odorous even if the blood is less than a day old, however it is especially odorous when processing blood that has been stored for more than a day. Under normal processing conditions, blood is not held more than 24 hours prior to processing at the Alliance site. During low processing periods, especially during spring calf processing, blood will likely be processed the day following slaughter. In such cases, most blood will still be processed within or only few hours beyond the 24-hour period. Furthermore, with the effective extraction and combustion of the non-condensable gases (NCGs), the processing of blood that has stored for more than a day is not likely to result in odour effects off-site. A check on the blood exhaust gas extraction should be carried out annually.

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TITLE BLOOD PROCESSING

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## 5.4 Recommendation

The existing mitigation system operates effectively and blood drying odours are not considered likely to create any odour issues off-site. Annual checks upon the effectiveness of the water cooled heat exchanger for cooling / condensing the blood dryer exhaust are recommended. These includes checking the inlet and exit cooling water temperature and non-condensable air stream temperatures and confirming that the extraction of non-condensable gases (NCGs) to the boiler house is working effectively.

# 6.0 LOW TEMPERATURE RENDERING

## 6.1 Description

Historically, the Batch Iwell method of rendering the site's waste animal by-products was a source of offsite odours exposure. In 2012 a new low temperature rendering plant (LTRP) was installed and during the commissioning phase this new plant also caused off-site odours. These stemmed from the application of the low temperature rendering technology to relatively fresh and high moisture laden by-product material for which there had previously been little or no experience. With operational experience, the site appears to be successfully operating the new plant with its odour control system effectively working as designed.

During the peak season the LTRP operates for approximately 22 hours per day (h/day). The ovine and bovine lines process raw material at nominal rates of 8.5 and 8.7 tonnes per hour (t/h) respectively. For every tonne of raw bovine material processed, approximately 200 kg each of dried meal and tallow product are recovered. The processing of ovine material produces around 180 kg each of tallow and meal per tonne of raw material. Bovine and ovine meal products are relatively dry at approximately 1.6 to 2.2 wt% moisture and therefore rendering requires significant energy for cooking and especially the drying stage.

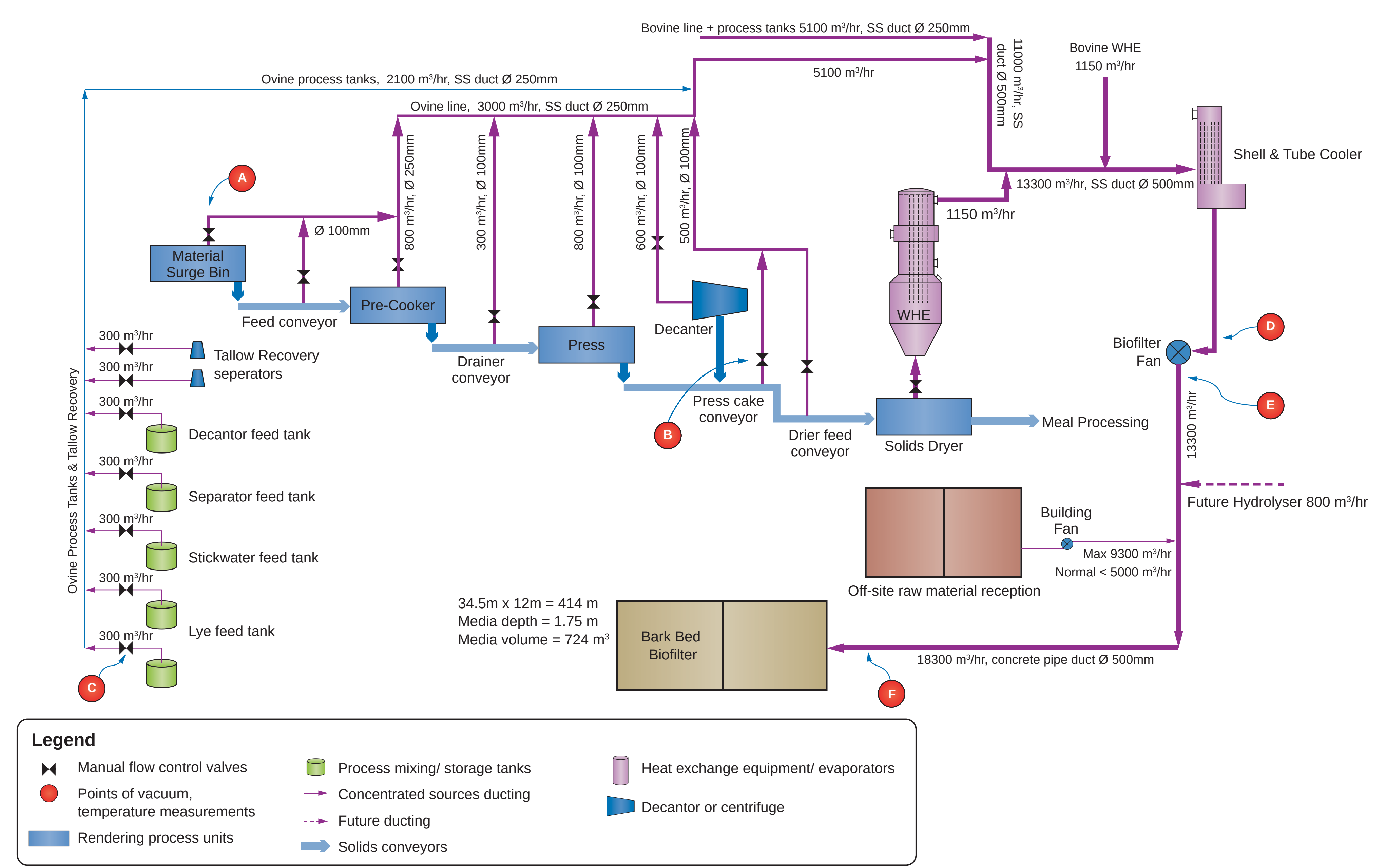
The new LTRP is located in "4b" as shown on Figure 1. The term low temperature relates to the cooking temperatures being below 100$^{o}$C, which is lower than the older Batch Iwell process where material cooking is undertaken above 100$^{o}$C.

The LTRP has various core processes that work together to produce dried meal and tallow product streams, whilst making use of the waste energy to concentrate and recycle wastewater (stick-water) as well as generate hot water that is directed back to the main processing site (which saves on the amount of coal needed to be burnt by the site's coal-fired boilers).

A process diagram for the ovine rendering line is shown in Figure 4 (this is identical to the bovine rendering line that runs parallel to the ovine line) and includes the following stages:

- Raw material reception and grinding
- Ground material storage
- Solids transfer
- Cooking / pressing
- Solids drying
- Milling / screening and dispatch
- Tallow recovery
- Waste heat evaporation

All of the above rendering process stages are fully or partially enclosed, as are the material conveyors or pipelines that transfer material between stages.

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TITLE LTRP ODOUR CONTROL SYSTEM

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### 6.1.1 Raw material reception

There are two raw material reception systems at the site. Ovine rendering material that is generated at the site is directed to the on-site raw material reception system that is located within the area labelled "4a" on Figure 1. Raw materials that are brought in from off-site (via truck) are unloaded at the off-site raw material reception building – the location of which is shown by labelled "4c" on Figure 1. The on-site raw material is ground then pumped to the ovine material bin within the low temperature rendering plant. The off-site raw material is ground then pumped to either the ovine or bovine material bins within the low temperature rendering plant, depending on type of material received from off-site.

### 6.1.2 Ground raw material storage

The ground raw material that is pumped from the on-site and off-site raw material reception areas is stored within the LTRP's bovine and ovine material bins. These bins provide the necessary buffer capacity to enable a steady feed rate of material to be supplied, via enclosed screw conveyors, to their respective rendering trains.

### 6.1.3 Solids transfer

The transfer of solid rendering materials from the raw material bins and successive rendering process stages (i.e. cooking, drying and milling) is undertaken by using enclosed screw conveyors. The point where these conveyors connect to process equipment provides an opening for process odour to escape via the conveyor itself.

### 6.1.4 Cooking, pressing and decanting

Ground raw ovine and bovine material is pumped respectively to the ovine and bovine raw material bins. Each bin feeds material to an identical and dedicated processing train. This allows the ovine and bovine meal products to be processed separately. From each bin, raw material is continuously conveyed into a steam heated pre-cooker, that continuously discharges cooked offal via a dewatering screw to a press. This produces pressed cooked solids and a stream of pressed liquor. This latter stream is treated by a decanter-centrifuge to recover fine solids for drying. The treated liquor is discharged to the tallow recovery plant.

### 6.1.5 Solids drying

The cooked solids from the press and those which are recovered by the decanter are conveyed into an indirect-steam heated rotary-meal-dryer. This discharges dried solids at approximately 1.6 wt. % to 2.2 wt. % moisture, which are conveyed to the meal plant for further physical processing.

### 6.1.6 Milling / screening

The dried solids from the ovine and bovine dryers are conveyed to parallel operated meal milling and screening plants that have separate dispatch conveyors. The two systems are identical and consist of conveyance of dried solids to an enclosed product surge bin which has air extracted and discharged via a bag-filter system. The surge bins supply meal to a milling plant that discharges milled product to a screening plant. Screened milled product is transferred to holding bin where it is recirculated using an under-screw system to withdraw meal and return to the top of the bin. This holding bin is also enclosed and has head space air extracted and discharged to the bag-filter system.

### 6.1.7 Tallow recovery

The press produces solids as well as a pressed flow of liquid "filtrate". The decanted press liquor is processed through the tallow recovery plant. The plant stores the liquor and heats to an optimal temperature (approximately 95$^{o}$C) and following acid addition the stream is treated through centrifuges that recover raw tallow. The liquor that is discharged from the centrifuges contains protein and residual emulsified tallow. This protein rich stream (referred to as stick liquor) is sufficiently concentrated via a waste heat evaporation plant to feed into the solids dryer.

### 6.1.8 Waste heat evaporation

The waste heat evaporation (WHE) plants (one dedicated to each of the bovine and ovine processing trains) utilises the hot exhaust air from the solids dryer to evaporate water from stick liquor. Stick liquor is stored in tanks that feed the WHE and the resultant concentrated stick liquor (CSL) is stored in another tank that has a metered discharge of CSL into the solids dryer.

The hot dryer exhaust contains a high level of moisture vapour from the drying of solids. The latent energy associated with this vapour (i.e., energy released as it condenses) is used to evaporate water and concentrate the stick liquor (ex. the tallow plant) as it recirculates within the "falling film" evaporator tubes. The evaporation occurs because the stick liquor is subject to vacuum conditions. The outside of the tubes are heated by the dryer exhaust as its vapour condenses on the tubes under atmospheric pressure. The remaining dryer exhaust stream is referred to as NCGs and these are further cooled with other hot process air streams before being discharged to a bark-bed biofilter.

## 6.2 Sources of Odour

All of the process stages of the LTRP described above, produce varying levels and character of odour. These sources and their associated odour are described in this section.

### 6.2.1 Raw material odours

The <u>on-site</u> raw material reception and grinding involve fresh material from the Lorneville processing site and produces a low level of odour that is unlikely to have any effects off-site. Apart from processing material that is produced on-site within a day, no further mitigation of emission is considered necessary.

The <u>off-site</u> raw material reception and grinding involve material that has been transferred from the Alliance Mataura processing site, as well as fallen stock and screened casing waste from around the Southland area. The unloading of this material requires large access doors to be opened. This combined with the dumping of new material into the storage bins results in raw offal odours being discharged from the building as trucks unload. On some occasions these odours may be observed by neighbours who live or work beyond the site boundary and they may have potential to cause objectionable or offensive effects. Therefore, in addition to the usual material management procedures, such as minimised processing times and use of stabilising chemicals, further mitigation measures have been implemented for new off-site material reception building.

The ovine and bovine material bins within the LTRP and their respective discharge conveyors have the potential to be a low to moderate source of offal type odour respectively. This is because the material entering the ovine bin is generally very fresh, as it is produced on site, while material entering the bovine bin comes from off-site and will typically be in a less fresh state. Both material bins have the potential to infrequently discharge a small flow of process steam vapour that has migrated back from their respective pre-cookers when empty (i.e., via the material bin discharge conveyors that connect to the pre-cookers).

### 6.2.2 Concentrated sources

The enclosed solid transfer conveyors that connect material flows between the cooker, press, decanters, dryer and the meal processing plant provide a fugitive odour escape route for all the main process stages. Without air extraction and containment of air from these conveyors the cooked offal odour emissions from conveyors can be significant.

Tallow recovery produces a moderate odour emission that also has a relatively neutral tone from the centrifuges, however steamy emissions from the heated liquid phase storage tanks can cause significant odour that are contained and treated.

All processes above, including connecting conveyors, but excluding the two dryer exhaust streams, are collectively referred to as "**concentrated sources**" (i.e., they are sources that have sufficient odour concentration to require containment and treatment). The steam heated solids dryers that operate on each rendering train produce the hottest and most odorous stream and are not included within the concentrated sources category – they are discussed below.

### 6.2.3 Solids dryer exhaust

The exhaust air from the solids drying stage is the largest and most significant potential source of odour from the LTRP. As discussed further in Section 6.3.4, this exhaust stream is cooled via several stages, and has its waste energy partially recovered via the WHE before being treated via a biofilter to remove odour.

### 6.2.4 Meal solids milling and screening

Milling, screening and dispatch of dry meal solids produce a meal odour that is moderate in strength and neutral in character (i.e., it has a character that is neither pleasant nor unpleasant for most people). Direct extraction and control of these odours is not likely to be necessary to avoid significant odour effects beyond the site boundary.

## 6.3 Mitigation

### 6.3.1 General

This section describes the mitigation measures for controlling odour emissions from the sources described above in Section 4.2 that require some level of control to avoid the potential for objectionable odour effects beyond the site boundary.

### 6.3.2 Raw material reception

The off-site raw material reception building is a potential source of fugitive odour emissions during truck unloading operations. This has been mitigated by installing a building air extraction system that discharges to the LTRP's bark bed biofilter. The extraction system is highlighted in Figure 4. This consists of one Ø500 mm air extraction manifold and dedicated building air extraction fan (building fan) and 11 kilowatt (kW) motor (with Variable speed drive (VSD) normally set at 30 %).

The inlet manifold extends across the full building width and near to its ceiling. Building air is extracted via seven Ø150 mm openings that are spaced along the manifold as well as from two Ø250 mm sub-manifolds that respectively extend down to lower basement and floor sump areas of the building.

The building fan is sized to discharge air at 9,300 $m^3$/hr at 230 mm water gauge. In practice a lower rate of extraction has been sufficient to avoid the build-up of odours (in the order of 3,000 $m^3$/hr) as the closed building is well sealed from the outside air. The ventilation acts to remove the build-up of odour compounds when the building is sealed and therefore avoids a sudden release of highly odorous air when the building doors are opened to allow for a truck to unload new material.

The alternative to the above system, that Alliance considered, involved the use of deodorising chemicals that were discharged into the building via fog / mist system. Golder considers these systems to be unproven in terms of their effectiveness to nullify odorous compounds and consider the ventilation / extraction system described above to be the best practicable option for minimising off site odour effects.

### 6.3.3 Concentrated sources

All significant process related sources of odour (referred to as concentrated sources) are shown in Figure 4. These emissions are contained by an extraction system, cooled and discharged via a bark-bed biofilter. The dryer exhaust air streams are included in this system but are discussed separately below as their extraction and cooling relies heavily upon the operation of the WHE (discussed in Section 6.3.4).

**Design extraction flowrates**

A summary of odour sources within the LTRP, their respective design air flow extraction rates and duct diameters are summarised in Table 1. These same odour sources are highlighted in Figure 4. It should be noted that design extraction flow rates are typically well above the actual operational rates. This is because the optimal extraction flow rate is the minimum rate necessary to contain the process emissions, while minimising the extent of hot process air that is ventilated. Excessive air extraction results in significant energy loss and increased steam and volatile organic loading into the ducting, downstream heat exchange equipment and ultimately on the bark bed biofilter.

**Table 1: Concentrated source extraction system - design flows and duct size component.**

| Odour Source | Design flow $m^3$/hr | Duct diameter (mm) |
|---|---|---|
| | | |
| Raw material surge bin | 100 | 100 |
| Pre-cook feed conveyor | 100 | 100 |
| Pre-cooker (including above lines) | 600 | 250 |
| Drainer conveyor | 300 | 100 |
| Solids press | 800 | 100 |
| Decanter | 600 | 100 |
| Press cake conveyor | 300 | 100 |
| Dryer feed conveyor | 200 | 100 |
| **Ovine line** | **3,000** | **250** |
| | | |
| Tallow recovery plant (2 separators) | 600 | 80 (2 ducts) |
| Liquor storage / mixing (5 Tanks) | 1,500 | 100 (5 ducts) |
| **Ovine process tanks including tallow recycling** | **2,100** | **250** |
| | | |
| Ovine line including process tanks | 5,100 | 250 |
| Bovine line and process tanks | 5,100 | 250 |
| Future hydrolyser | 800 | - |
| **Concentrated sources manifold** | **11,000** | **500** |
| | | |
| Ovine waste heat evaporator | 1150 | 200 |
| Bovine waste heat evaporator | 1150 | 200 |
| **Main inlet manifold** | **13,300** | **600** |
| | | |
| Proposed off-site material reception building | 5,000 | 400 |
| **Biofilter inlet duct (concrete pipe)** | **18,300** | **600** |

**Extraction vacuums**

The vacuum that is maintained within ducts where they connect to equipment is a good indicator of the odour extraction system performance along with the absence of visible steam laden process emissions. Maintaining duct vacuum in the order of 100 Pa gauge pressure, or higher indicates the extraction system is working effectively. During an audit of the LTRP's odour control system undertaken by Golder in May 2014 (as part of this assessment), the vacuums being generated throughout both the Ovine and Bovine lines' odour control system were measured.

The measurement locations where vacuums were measured are shown as points A, B, C and D on Figure 4. The results are summarised in Table 2. These indicate the odour system maintains a more than adequate level of suction on the key concentrated sources of rendering process odour. These monitoring locations provide information on the vacuum that is generated by the biofilter fan at locations that are close to the fan and at the extremities of the extraction duct network. As such, monitoring of vacuums at these locations would provide a good indication of the system ongoing performance and warning of problems due to either of the following:

- Biofilter clogging and high backpressure
- Duct blockages
- Fan failure or loss of performance

**Table 2: Summary of vacuum readings with odour control system.**

| Location | Description | Vacuum (Pa) gauge | Flow valve position |
|---|---|---|---|
| *Ovine Odour Control System* | | | |
| **A** | Material surge bin | -520 | 100 % open |
| **B** | Press cake conveyor | -310 | 50 % open |
| **C** | CIP tank | Not measured | 100 % open |
| **D** | Biofilter fan inlet duct | -850 | n/a |
| *Bovine Odour Control System* | | | |
| **A** | Material surge bin | -440 | 100 % open |
| **B** | Press cake conveyor | -430 | 100 % open |
| **C** | CIP tank | -470 | 100 % open |
| **D** | Biofilter fan inlet duct | -850 | n/a |

**Biofilter fan**

The biofilter fan drives the concentrated sources extraction system and is powered by a 45 kW motor with VSD (normally set at 40%). This appears to be a relatively large motor size given the extraction air flowrate of 13,300 $m^3$/hr (see Figure 4) and allowing for the discharge exiting through the bark-bed biofilter. During the May 2014 LTRP audit the duct pressures were measured at -850 Pa (fan inlet) and 60 Pa (fan discharge). These locations are shown as measurement points "D" and "E" respectively on Figure 4. The vacuum within the inlet to the fan is relatively high (i.e., -850 Pa) and explains the good level of vacuum recorded in different locations through the extraction system (shown in Table 2).

**Air cooling heat exchanger**

It is important to have sufficient cooling capacity to condense vapours from the concentrated source stream and cool the humid air down to around 35$^{o}$C. A water cooled vertical shell & tube heat exchanger (shown in Figure 4) receives all concentrated sources flows (including non-condensable dryer exhaust flows from the WHE) and condenses vapours and cools the humid air stream. LTRP data records indicated the discharge temperature of the cooled concentrated sources flow is typically below 35$^{o}$C with both ovine and bovine rendering lines in operation.

### 6.3.4 Dryer exhaust

The most significant concentrated odour source is associated with the solids dryer exhaust air stream. This undergoes a pre-cooling / condensing stage via the WHE as described in Section 4.1.8. The effective condensing of vapour within the WHE is important to ensure an adequate vacuum is applied to the dryer exhaust and to ensure adequate pre-cooling. The resultant non-condensable gases (NCGs) are pulled from the WHE and further cooled by the LTRP concentrated source extraction and cooling system (see Figure 4).

Ensuring that the WHE extracts and cools dryer exhaust effectively is the most important aspect of the LTRP odour control system. To this end the following three WHE operational parameters are important to control:

- Evaporator vacuum (stick liquor side)
- Stickwater level within the evaporator
- Final stickwater concentration

The first two parameters above are continuously monitored and the second automatically controlled. The stickwater concentration is manually measured and the concentrate discharge pump rate adjusted to achieve a desired value. Maintaining the above three operational parameters within normal operating ranges allows for the steady extraction and cooling of dryer exhaust – therefore ensuring this does not cause odorous fugitive emissions to atmosphere.

There are other operational parameters whose values and or trends provide operators with key information regarding the WHE operation and warning of abnormal operation, including the need for maintenance or investigation of system components. These operational parameters are continuously monitored and can be viewed by operators and include the following:

- **Stick liquor recirculation pump amps** (high levels warn of possible pump issues or excessive concentration of stick liquor)
- **Condenser hot water outlet temperature** (low levels warn of poor heat transfer in condenser or the WHE)
- **Condenser cold water inlet temperature** (high levels on hot days warn of reduced condensing capacity)
- **Non condensable gas (NCG) temperature** (high values indicate poor heat transfer in the WHE)
- **Stick liquor temperature in WHE** (low values indicate poor heat transfer in the WHE)
- **WHE vapour temperature** (low values indicate poor heat transfer in the WHE)

### 6.3.5 Biofilter

The bark-bed biofilter (consisting of two cells) treats the combined flows of cooled concentrated sources from the LTRP and ambient air that is extracted from the off-site raw material reception building. The original design flow for this biofilter was 22,000 $m^3$/hr, although for this assessment the design flow has been revised down to 18,300 $m^3$/hr, based on flow information provided by the supplier (Rendertech). This results in an air loading rate of 25 $m^3_{air}$/hr per $m^3_{media}$ for a biofilter.

The media within the bed consists of a 1.5 m layer of screened pinus radiata bark (3 mm to 10 mm) on top of a 0.25 m layer of coarse bark (25 mm to 75 mm). The bed dimensions and design air flow loading rate are as follows:

- Bed length: 35 m
- Bed width: 12 m
- Media depth: 1.75 m
- Media volume: 735 m3
- Design loading rate: 25 m3air/hr per m3media

For an air stream that is routinely below 35°C, the above loading rate is sufficiently low to ensure that odour removal from the inlet air stream is very effective. Therefore no odour associated with the discharge of treated air from the biofilter surface is expected to be detectable at or beyond Alliance's property boundary.

Comments on design and operational parameters and observations of the biofilter during Golder's May 2014 audit are provided in sections 6.3.6 and 6.3.9 respectively.

### 6.3.6 Operating & design parameters

This section lists typical "target" operating parameters for different components of the odour control system (OCS) that includes odour extraction, cooling, and the biofilter system (see Table 3). Key design parameters are also listed for future reference. The target values provide general guideline values that can be incorporated into an OCS management plan and this would ideally be revised and updated as experience with system is gained over time. As with the design air extraction flows in Table 2, these values do not necessarily need to be achieved for efficient operation of the OCS – they are guidelines.

**Table 3: Operating parameters - OCS components.**

| Component | Target values | Method & frequency | Location |
|---|---|---|---|
| **Main inlet manifolds** to biofilter and material reception building fans | - 500 Pa gauge (-50 mm WG) | Installed vacuum gauge ***Weekly*** | Fan inlet duct via installed 20 mm diam. access port and plug |
| **Discharge ducts from** LTRP biofilter and material reception building fans | 1500 Pa gauge (150 mm WG) | Installed pressure gauge ***Weekly*** | Fan inlet duct via installed 20 mm diam. access port and plug |
| **Manifold connections** to process equipment, conveyors, and bins. | -100 Pa gauge (-10mm WG) | Handheld differential pressure measurement (or vacuum gauge) ***Annual*** | Within the connection duct and between its damper valve and connection to the equipment or conveyor. Via installed Ø10 mm access port and plug |
| **Biofilter Inlet Duct** | | | |
| Inlet flow | Nominal design flow 18,300 $m^3$/hr | Pitot tube* (access via 2 x Ø100mm BSP fittings to be installed at 90$^o$ from each other) ***Annual*** | Inlet duct to the biofilters (between the drainage sump and the bed). |
| Back pressure | < 150 mm water gauge | Installed U-tube manometer ***Weekly*** | Biofilter inlet duct |
| Temperature | < 35$^o$C for more than 95 % time; < 40$^o$C for more than 99 % time; Maximum: 50$^o$C | Continuous temperature probe ***Continuous*** | Inlet duct to the biofilters (between the drainage sump and the bed)# |

| Component | Target values | Method & frequency | Location |
|---|---|---|---|
| **Biofilter Media** | | | |
| Back pressure | <50 mm water gauge | Installed U-tube manometer ***Weekly*** | Biofilter beds 1 & 2 |
| Moisture content | 50 wt. % to 65 wt. % | Oven drying at 100$^{o}$C ***Monthly*** | Biofilter beds 1 & 2 |
| pH | pH 5‡ or higher (top 2/3 layer) | Soil pH ## ***3-Monthly*** | Biofilter beds 1 & 2 |
| Air loading rate | 25 $m^3_{air}$/hr per $m^3_{media}$ | From annual flow data ***Annual*** | As for annual inlet flow measurement above |
| Media depth | 1.5 m screen bark<br>0.25 m coarse bark | Four core samples down to washed river gravel layer<br>***Biannually (2 Years)*** | Anywhere within each quadrant of the bed |
| Media composition & size distribution | Top layer: screened bark, 3-10 mm (1.5 m depth),<br>Bottom layer: coarse bark, 25-75 mm (0.25 m depth) | Mass-size distribution of Bark: Bark oven dried, sieved using a Fritsch analysette 3 at 2 mm amplitude 5 minutes.<br>***Biannually (2 Years)*** | As above |
| Organic carbon:nitrogen ratio | 50:1 | Landcare method 114<br>***Biannually (2 Years)*** | As above for media composition |

**Notes:** **IS0 10780 Measurement of Velocity and Flow Rate*, or equivalent method. NB: 2 access ports to be installed for sampling at 90$^{o}$ (side and top of ducts).

# *the current location of the temperature probe near to the LTRP biofilter fan is also appropriate and will be conservative as there will be further cooling within the concrete pipe and due to mixing with the reception building air stream – as such less conservative temperature targets for this location can be established in time.*

## *Sub-sample 10 grams of media and add 50 ml de-ionised water. Stir for 60 seconds and allow solids to settle. Measure pH of clarified water after 3 hours of settling time.*

‡ *Although an ideal pH range between 6 to 8 has been assumed for biofilters, from experience Golder is aware of biofilters in New Zealand operating effectively at pH levels around 5. The other consideration is that a number of biofilter installations struggle to maintain pH levels above 6 despite significant additions of lime. Therefore Golder has revised its recommended criteria for minimum bed pH to a level that is associated with effective odour removal performance while not imposing operating targets that appear difficult to achieve.*

### 6.3.7 Performance monitoring

The key parameters to monitor so to ensure the OCS is operating normally are mostly listed in Table 3. In addition to these there are performance monitoring methods listed below. These procedures combined with the monitoring of operational parameters listed in Table 3 could be included as part of an odour management plan (OMP) for the LTRP. The OMP could also include all other sources of odour discharge at the site, which require active management to ensure no objectionable or offensive odour effects beyond the Alliance property boundary. Additional performance monitoring procedures for the OCS are listed below and all include observations:

- **Daily:** Operators record any significant process emissions (evident by steamy discharge) that discharge into the LTRP building.
- **Weekly:** Observations of any odour from the biofilter bed (see if any recognisable rendering odour can be observed).
- **Monthly:** LTRP biofilter and raw material reception building fan motor current draw (amps), and motor and cooling fan hours (hours).
- **Monthly:** Biofilter bed flow distribution (assessed visually on cool mornings – take a photograph).
- **Annually:** Undertake downwind assessments[#] of odour from the LTRP (stand several hundred metres down wind and record odour observations).
- **Annually:** Review odour complaint records.

[#] For experienced odour assessors it should be easy to distinguish these sources, as they have distinct odour characters. This is irrespective of our view that the local community can incorrectly attribute fellmongery odours to rendering.

### 6.3.8 LTRP meal processing

The meal processing room's building air is discharged to air via roof vents. Suspended dust within this air as well as volatiles creates the meal type odour that is associated with this discharge. The extraction of air from surge and the meal holding bins and treatment through a bag-house filter mitigates the discharge of suspended dust and its odour potential. Hoods are also placed over the screens with canvas curtains on three sides. It is planned to extract air from these hoods and direct to a holding/loading bin – this is scheduled for mid-2015.

In addition to this, the extent of buffer distances from the rendering plant to property boundary is likely to ensure that odours associated with meal processing are minor, or less.

### 6.3.9 Audit findings

The key findings from Golder's audit of the LTRP odour controls (undertaken in May 2014) are summarised as follows:

- The odour control system and biofilter were working very effectively to contain and then fully treat all process / cooking type odour and only meal type odour was liberated from the new LTRP.
- The LTRP's odour control system is one of the best examples that exists in Australasia and would be the best system operated in New Zealand by any rendering facility.
- The blood dryer exhaust appears to be well contained and destroyed by extraction to the coal-fired boiler plant which uses this exhaust stream as combustion air.
- Key process parameters relating to the performance of the Waste Heat Evaporation (WHE) plant are being monitored by the SCADA system and manually recorded by operators. These parameters include recirculation pump amperage, WHE vacuums, and liquor / water stream temperatures.
- Parameters that directly measure the odour extraction system performance are not monitored by the SCADA system and these would ideally be added to enable trends to be monitored.
- The bark bed biofilter pH was 4.7 and 4.8 in each of the respective beds which is consistent with recent Alliance results (i.e., pH 4.3 to 5.3).
- The biofilter media was in good uncompact condition with a low portion of bark fines. The key focus for Alliance is to maintain the existing system performance. This will require monitoring of the key process

parameters and biofilter conditions over time to ensure pro-active maintenance of the odour control systems.

## 6.4 Recommendations

Further odour mitigation measures are recommended for the Alliance LTRP and include:

- Install manometers for indicating the vacuum at measurement locations A, B, C and D as shown in Figure 4, or similar locations within both the Ovine and Bovine odour extraction ducts. Record the vacuum readings manually over time when both rendering lines are operating at normal capacity and once a week. Enter recorded values into the LTRP process logging system.
- Install manometers on the discharges of both the main biofilter and off-site material reception building fans. Record the vacuum readings manually over time and log as per above.
- Install airflow measurement sampling ports at the inlet to the bark biofilter and new manometers for measuring inlet duct pressure and bed media pressure drop.
- Check air flow entering the rendering biofilter early on each process season.
- Undertake an annual review of an odour extraction and biofilter management plan and revise as necessary.

# 7.0 FELLMONGERY

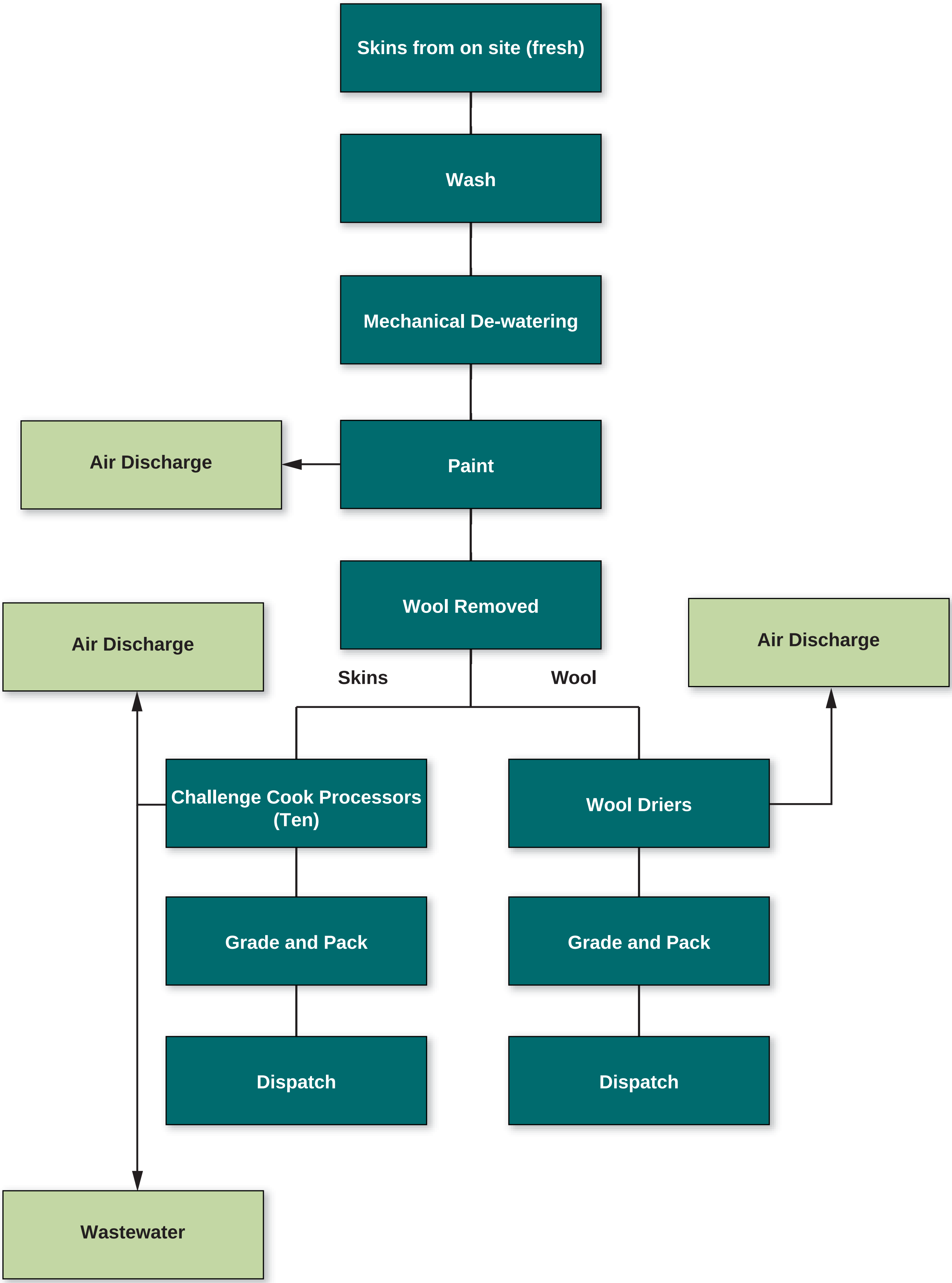
## 7.1 Description

The Fellmongery at Lorneville is relatively large and typically processes 24,500 fresh skins/day from Lorneville processing or on occasions salted skins from other Alliance plants, covering both the day and night shifts. The overall operation employs approximately 100 staff. The main product from the Fellmongery is pickled pelts; the main feedstock that is exported to leather manufacturers. During the off-peak season, the site can on infrequent occasions receive salted skins from other sites. These are washed and processed.

The day shift starts at 7 am and finishes at 4:30 pm then the nightshift commences at 5 pm and finishes at 1:30 am. Several staff operate the process drums between 1:30 am and 7:00 am. The plant includes ten Challenge Cooke rotary drums for processing slats into pickled pelts for export, and other equipment for skin washing, wool removal, wool drying, salting of pelts, grading and dispatch. The resulting products are green salted skins and pickled pelts.

A schematic of the Fellmongery processes is set out in Figure 5, these include:

- Skin wash
- Wool removal
- Wool drying
- Pelt processing




1. DRAWN BY: AP REVIEWED BY: RW

Golder Associates

TITLE FELLMONGERY PROCESS FLOW DIAGRAM

OCTOBER 2015

PROJECT 1378104_044

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### 7.1.1 Washing / wool removal

Skin wash / pre-fleshing involves washing the sheep skins and physical removal of the fatty layers from the skin surface ahead of the application of the sulphide depilatory paint. The depilatory paint consists of a strong solution of sodium sulphide and some enzyme in water. Washed and de-fleshed skins are sprayed with the depilatory paint at the paint table. The painted pelts are then held for 7 to 8 hours on wheeled barrows. During this time the sulphide ions from the paint penetrate the epidermis layer of the skin. This then partially breaks down the keratin protein hair, or wool fibre root, to allow for their mechanical removal the next day. This produces a slat that is ready for pelt processing.

The initial skin preparation, depilatory painting and wool removal stages produce relatively minor odour emissions compared to the latter stages. This is mainly because the depilatory solution is highly alkaline and therefore the hydrogen sulphide remains in solution. This operation is completed under an enclosed space, where emissions are discharged to atmosphere via an extractor fan and roof top vent.

### 7.1.2 Wool drying

Wool that has been pulled from the skins (referred to as Slipe Wool) is dried directly through two or three steam heated dryers that use steam supplied from the coal-fired boilers. The third dryer is only used when processing in the peak season. Second-grade wool is washed before drying. All dryers are fitted with extraction systems that include a bag filter unit to capture wool fibres and dust from the water vapour that is produced in the dryers. Wool dryers produce a warm moist exhaust air stream that has a wet-wool odour character. This odour typically dissipates within 50 to 100 metres under most atmospheric conditions. Worst case emissions can occur when drying wool that has been stored in a pile for many days and has started to degrade – this situation does not occur at Lorneville as the wool generated on the site is washed and dried without requiring any significant storage times. Consequently, wool dryer odour emissions are not expected to be detectable beyond the site boundary.

### 7.1.3 Pelt processing

The production of pickled pelts from the slats involves several steps. Firstly, the de-wooled skins (slats) are transferred to the Challenge Cook drums (7 tonnes slats/load) for processing in batches through to pickled pelts.

The key drum processing steps are:

- **Liming:** De-wooled skins (slats) are immersed in a strong alkaline solution of lime ($Ca(OH)_2$), sodium sulphide ($Na_2S$). The waste liquors from the liming stage contain the main load of sulphide resulting from the chemicals used and the break-down of the wool fibre. The highly alkaline condition of liming liquors (pH ≈ 13.0) ensures that there is minimal free hydrogen sulphide within the solution, which instead exists in the ionised $HS^-$ form that remains dissolved in solution.
- **De-liming:** The highly alkaline liming liquor has the pH reduced to approximately 9.0 during de-liming. This was achieved by adding boric acid – although the latter weak acid is no longer used and has been replaced with a sodium acetate solution. The soluble salts are washed out with subsequent warm flushes of water, along with the remaining solubilized protein and fat. As the pH of the liquor is reduced, the dissolved sulphide ions come out of solution and release as hydrogen sulphide ($H_2S$) gas. These emissions of $H_2S$ are extracted from the opening of each drum and discharged to atmosphere via discharge fan and roofline vents that are dedicated to each drum. For some New Zealand Fellmongery sites which are situated close to urban areas, these collective discharges are contained and scrubbed to remove these odorous compounds before discharge to air. However, at Lorneville, the significant distances to the property boundary of the site means that this expensive measure should not be necessary to avoid recognisable Fellmongery odours occurring beyond the property boundary.
- **Bating:** Further break down of protein and collagen is performed by adding pancreatic enzymes to the de-limed drum liquors (known as “bating”). Compared to the liming and de-liming stages, bating does not produce significant odour emissions.

- **Pickling:** The pelts are finally washed in sulphuric acid solution and salt solution at a pH of approximately 3.0 to 3.5. Any residual sulphide ions at this stage are quickly converted to sulphide. Consequently, this stage can also release $H_2S$ gas – however these levels are also very low compared to the liming stages.
- **Grading and Packing:** Pickled pelts are allowed to drain, are graded, stacked, shrink-wrapped and temporarily stored before being dispatched from the site. The potential for fugitive odours from the finished pickled-pelt product is very low.

## 7.2 Sources of Odour

### 7.2.1 General

There are several main sources of odour from the Fellmongery operation including the discharges from the Challenge Cook processing drums and fugitive emissions from the Fellmongery's wastewater reticulation system.

### 7.2.2 Process drums

While the odour emissions to air from the ten process drums are a significant source, they are not expected to be causing recognisable odours beyond the site boundary because of the buffer distances between the Fellmongery and the property boundary (i.e., > 600 metres). APPENDIX B provides details of the modelling based odour impact assessment that was carried out based on test results of hydrogen sulphide discharges from the drums. This assessment is considered be conservative and the results support the expectation of there being only a minor potential for off-site odour effects due to routine emissions to air from the processing drums at Alliance Lorneville.

### 7.2.3 Fugitive emissions from drains

The release of $H_2S$ from the Fellmongery wastewater reticulation system is considered to be the main source of odour from the Fellmongery. Currently the lime wash and pickle discharge lines join into a common pipe line at the south eastern corner of the Fellmongery. The subsequent release of $H_2S$ from the wastewater reticulation system due to the mixing of these liquors is the most likely cause of rotten egg type odour around the Fellmongery area on some Monday mornings. On these mornings a number of process drums have liquors simultaneously discharged to drain over a short period of time - these liquors have sat within the process drums since the weekend.

## 7.3 Mitigation

### 7.3.1 Procedural changes

It was considered that the events of elevated hydrogen sulphide odours occurring on Monday mornings could be mitigated by procedural changes that avoided a number of processing drums having their process liquors discharged simultaneously to drain. Golder subsequently recommended that Alliance investigate this option for reducing the intensity and rate of odour emissions being liberated from the reticulation system. In 2015, Alliance implemented the recommended procedural changes for managing the staggered discharge of process liquors from drums on Monday mornings. The anecdotal evidence from site management indicates this change has been successful in eliminating these events of elevated hydrogen sulphide odours occurring from the Fellmongery area on Monday morning periods.

### 7.3.2 Segregation of discharged liquors

Alliance used to reticulate the pickle liquor separately and discharge it beyond the aerated zone of the WWTP's Pond 1. It would be worthwhile reinstating this arrangement as it would avoid odours being liberated as a result of alkaline lime wash liquors mixing with acidic pickle liquors. Although this measure will not avoid sulphides in the lime wash liquor being liberated from the anaerobic pond, the intensity of this release would be significantly dampened.

### 7.3.3 Lime liquor treatment

A more long term solution could be the pre-oxidation of the sulphides within the waste lime wash liquors (using a conventional manganese catalysed oxidation process). This would significantly reduce the discharge of $H_2S$ from within the wastewater reticulation system. This option would be best implemented as part of any future wastewater treatment plant (WWTP) upgrade such as the anaerobic / BNR treatment process as described by PDP (2014). This is because even with the oxidation of the lime wash, all of the oxidized sulphides will convert back to odorous sulphides within the existing anaerobic pond. The subsequent sulphide odour would be liberated within the first stage of the aerated loop and from the anaerobic pond itself. Therefore this oxidation process is not likely to be effective unless there are alternative aerobic type wastewater treatment processes employed to treat lime wash and other waste streams. These changes are likely to result from future up-grades of the WWTP.

Another potential long term option for pre-treatment of lime liquors is to removal sulphide from this stream by strong oxidation or chemically assisted precipitation. The economic feasibility of these options and cost benefit compared to conventional catalytic oxidation processes is being investigated by Alliance.

### 7.3.4 Process drum emissions

As discussed, the odour emissions associated with air discharges from the process drums are not expected to be a significant source of recognisable Fellmongery odour beyond the property boundary and this is supported by the emissions quantification / modelling based assessment provided in APPENDIX B. This further confirms that there is a sufficiently large buffer distance from the Fellmongery to the Alliance property boundary to mitigate the potential effects of Fellmongery process odours to a minor level.

## 8.0 DISCUSSION AND CONCLUSIONS

This report has assessed the odour mitigation systems and measures at the Alliance Lorneville processing site (excluding the WWTP) for activities that produce odour emissions that have the potential to cause effects beyond the property boundary. The assessment approach was based on a consideration of the Best Practicable Option (BPO) for minimising the odour emissions. This requires practical measures to be implemented to an extent that accounts for the actual effects and economic feasibility.

It is concluded that the BPO is effectively employed for the main odour producing processes at the site. In general the level of odour control for each process / plant is in keeping with the potential significance of the odour emissions in each case with LTRP as the main potential source of odour having the greatest level of control.

The discharge of cooking type odours from the LTRP is minimised via targeted and building air extraction and treatment of the extracted air by biofiltration. Alliance has a well installed extraction system in combination with a sufficient level of cooling and an appropriately sized effective biofilter. Therefore the level of odour control that Alliance has employed at the new LTRP is considered to readily meet the level of BPO and it is concluded that the controls at this plant would be the best example to be found in the New Zealand rendering industry.

The discharge of meal processing odours is controlled by the filtering of meal dust and the significant buffer distance between the new meal processing plant (part of the LTRP installation) and the property boundary. Therefore it is concluded that meal odour emissions are controlled at Alliance Lorneville using the BPO.

The level of odour control employed for the Fellmongery operation is less than at some other sites in NZ, as there is no containment and treatment of process drum emissions or pre-oxidation of lime-wash liquors. However, the buffer distance from the Fellmongery to the property boundary at Lorneville is large compared to most other sites in NZ. Therefore, treatment of process drum discharges is not likely to be necessary to avoid any significant odour effects. However, further mitigation of odours generated from mixing of lime-liquors and acidic waste streams is recommended to minimise odour emissions from the Fellmongery wastewater reticulation system. The approach for achieving this (direct discharge of acidic pickling liquors to the aerated loop) is recommended by Golder (2015).

For all the other key odour producing activities and processes at the site including blood drying and wool hydrolysing, it is concluded that the BPO for odour control is effectively achieved by extraction of odour emissions, cooling and combustion of the gas stream within the coal-fired boilers. For the odours generated from soup stock production at the site, there is adequate control of odours via the buffer distance between this process and the property boundary as the odour generation is relatively low and of neutral character.

## 9.0 REFERENCES

Golder 2015. Wastewater Treatment Odour Mitigation - Alliance Group Limited – Lorneville. Report No. 13781044-015-R-Rev3-100, March, 2015. Report prepared for Alliance Group Limited by Golder Associates (NZ) Limited.

PDP 2014. Lorneville Plant Wastewater Treatment Issues and Options - Alliance Group Limited - Lorneville Plant, September, 2014. Report prepared for Alliance Group Limited by Pattle Delamore Partners Ltd.

# APPENDIX A

## Report Limitations

## Report Limitations

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# APPENDIX B

## Fellmongery Process Odour Impact Assessment

This appendix summarises a modelling based assessment of potential odour effects from hydrogen sulfide emissions that are discharged from the Alliance Group Limited's Fellmongery operation at Lorneville, Invercargill. This assessment provides further information to confirm, or otherwise, the preliminary assumption, described in the main report, that process odour emissions from the Fellmongery were likely to have only a minor potential to cause adverse effects beyond the site boundary.

## Assessment Methodology

The methodology used for this assessment is based on estimation of hydrogen sulfide ($H_2S$) emissions from the process drums and prediction of the resultant off-site ambient exposure levels of odour associated with these emissions. This involved the following steps:

- Establish hydrogen sulfide ($H_2S$) concentrations and associated flows from various drum roofline vents including diameters and velocities of the discharges to air from the Alliance fellmongery roofline.
- Establish a representative profile of $H_2S$ mass emission rates across the ten discharge vents and convert these values into odour unit per second ($OU_d/s$) for each vent based on the *odour detection threshold* concentration for hydrogen sulfide (0.5 ppb).
- Predict the odour percentile ($C_{99.5}$ and $C_{99.9}$) concentrations ($OU_c /m^3$) (i.e., based on certainty odour thresholds) that would occur at nearby residential dwellings when assuming this odour emission profile occurring constantly over time.
- Assess the predictions of odour concentrations against appropriate Ministry for the Environment (MfE) guideline values (MfE, 2003) that are based on *certainty odour thresholds*. For this assessment the following criteria are considered to be appropriate:
  - 99.9 percentile hourly average odour concentration ($C_{99.9}$) of 5 $OU_c /m^3$
  - 99.5 percentile hourly average odour concentration ($C9_{9.5}$) of 2 $OU_c /m^3$

## Sulfide / Odour Emissions Data

Coal Research Ltd (CRL) measured concentrations of $H_2S$ and air velocities from the Ø600mm drum roofline vents on the 25th February 2015. The concentrations were measured with the gas-detector VENTIS MX4, which has a $H_2S$ measuring range of 0 to 500 ppm, in 0.1 ppm increments. CRL made the measurements during normal Fellmongery operations whereby process drums were operating under a range of process stages. These stages are described in the main report and include liming, de-liming, bating, and pickling. The de-liming stage is expected to produce the most significant sulfide and therefore odour emission.

The data recorded and associated process information provided by CRL is very general except for process drum 4 which was going through a pH reduction cycle (de-liming) and ahead of the Bating process stage. This is when the main discharge of $H_2S$ is expected to occur. Using concentration versus time data from various drums, duct air velocity measurements and the assumed odour detection of 0.5 ppb for $H_2S$, the odour emission data was established by Golder as shown in Table 1.

**Table 1: Summary of sulfide / odour emissions data established for Fellmongery process drums.**

| Drum No. | Time | $H_2S$ concentration - peak readings‡ | | Air Flow‡ | $H_2S$ emission rate | Odour emission† |
|---|---|---|---|---|---|---|
| | | ppm | mg/m$^3$ | m$^3$/s | mg/s | OU$_d$/s |
| 4 | 5:39:00 | 83.8 | 125.7 | 1.81 | 227.46 | 322,640 |
| 4 | 5:46:41 | 18.8 | 28.2 | 1.81 | 51.03 | 72,382 |
| 4 | 5:47:20 | 14.6 | 21.9 | 1.81 | 39.63 | 56,212 |
| 4 | 5:47:59 | 14.7 | 22.05 | 1.81 | 39.90 | 56,597 |
| 4 | 5:48:48 | 11.7 | 17.55 | 1.81 | 31.76 | 45,046 |
| 4 | 5:49:13 | 13.2 | 19.8 | 1.81 | 35.83 | 50,822 |
| 4 | 5:49:47 | 10 | 15 | 1.81 | 27.14 | 38,501 |
| 4 | 5:50:03 | 10.4 | 15.6 | 1.81 | 28.23 | 40,041 |
| 4 | 5:50:12 | 10 | 15 | 1.81 | 27.14 | 38,501 |
| 4 | 6:13:30 | 10.8 | 16.2 | 1.81 | 29.31 | 41,581 |
| 4 | 6:14:41 | 21.6 | 32.4 | 1.81 | 58.63 | 83,163 |
| 4 | 6:15:09 | 36 | 54 | 1.81 | 97.72 | 138,604 |
| 4 | 6:20:44 | 21.2 | 31.8 | 1.81 | 57.54 | 81,623 |
| 1 | n/a | 3 | 4.5 | 1.67 | 7.51 | 10,648 |
| 2 | n/a | 3 | 4.5 | Not running | - | - |
| 3 | n/a | 3 | 4.5 | 1.47 | 6.62 | 9,385 |
| 5 | n/a | 3 | 4.5 | 1.81 | 8.14 | 11,550 |
| 6 | n/a | 3 | 4.5 | Not running | - | - |
| 7 | n/a | 3 | 4.5 | 1.30 | 5.85 | 8,302 |
| 8 | n/a | 3 | 4.5 | 1.64 | 7.38 | 10,468 |
| 9 | n/a | 3 | 4.5 | Not running | - | - |
| 10 | n/a | 3 | 4.5 | 1.78 | 8.02 | 11,370 |

**Notes:** ‡ Based on information provided by CRL in email sent from Andy Englefield (CRL) to Roger Cudmore (Golder) on 4/03/2015 11:22 a.m.

† Calculated based on the ***odour detection threshold*** concentration for hydrogen sulfide of 0.5 ppb, which equates to approximately 0.7 µg/m$^3$.

## Odour Emission Modelling

### *Certainty versus detection odour thresholds*

The good practice odour guideline (MfE, 2003) discusses the difference between detection, certainty and recognition odour thresholds. The guideline incorrectly defines certainty and recognition thresholds as being equivalent, however certainty threshold concentrations is what the current Australian / NZ Standard 4323.3.2001 measures and these do not relate to recognition of odour character. A correct explanation of this difference is provided by MfE (2002, section 7.3). The MfE odour guidelines for odour concentrations listed above are based on certainty threshold concentrations ($OU_c/m^3$) and these are typically 33 % to 50 % of the equivalent detection threshold concentration ($OU_c/m^3$). Section 7.3 of MfE (2002) indicates that assuming the 50 % figure is likely to be conservative. Therefore the odour emission data summarised in Table 1 needs to be divided by a factor of 2 to convert to a certainty threshold and allow for an equivalent comparison to the odour modelling guidelines specified by MfE (2003).

### *Emission profile assumptions*

As discussed, during normal Fellmongery operations the process drums operate under a range of process stages. The de-liming cycle is expected to produce the most significant sulfide and therefore odour emissions. This is consistent with the results from the sulfide monitoring provided in Table 1 for process drum no. 4.

For this modelling assessment, it was assumed that one drum would be operating during the de-liming cycle, while the other nine drums would be operating in any of the other process stages. Based on the peak readings provided in Table 1, an average odour emission rate of 50,000 $OU_c/s$ (based on certainty odour threshold) was assigned to one drum (based on $H_2S$ discharges during de-liming), and an odour emission of 5,000 $OU_c/s$ was assigned to all other nine drums. This equates to a combined emission rate for all ten drums of 95,000 $OU_c/s$.

In practice there may be several drums undergoing a de-liming cycle at once, whilst other drums have effective zero odour emissions, or odour emissions well below 5,000 $OU_c/s$. Therefore the assumption of a continuous discharge of 95,000 $OU_c/s$ accounts for the uncertainty in peak and variable emissions and is expected to be conservative with respect to the prediction of 99.5 percentile odour concentrations ($C_{99.5}$, $OU_c/m^3$) off-site, but not conservative for 99.9 percentile ($C_{99.9}$, $OU_c/m^3$) values that relate to the more infrequent peak values.

### *Atmospheric dispersion modelling*

The modelling method for predicting off site hourly average odour concentrations was the same as that described by Golder (2015) using two years of hourly meteorological information. The CALMET and CALPUFF model configurations described by Golder (2015) were used. However the latter file was modified so that a single roof line discharge vent was defined at the centre of the Fellmongery building roof. In practice the ten drums have individual roofline vents that are positioned along the Fellmongery roof. The modelling simplified the odour emissions from these vents by assuming that all the odour was discharged from a single vent that extends 1.0 metre above the roofline. This conservatism combined with the continuous emission assumption of 95,000 $OU_c/s$ helps counter the uncertainty in the actual peak odour emission rate. Building downwash effects have been accounted for by including the plant buildings modelled by Golder (2015) as well as the fellmongery building itself.

The following additional point source input parameters were used for the modelling assessment:

- Stack height: 11 m (above ground level)
- Exit diameter: 0.6 m
- Exit velocity: 6 m/s
- Temperature: 298 K

- Building downwash: PRIME method
- Fellmongery building height: 10 m

### *Predicted odour concentrations*

The odour emissions modelling described above indicated the most impacted residence would be the closest one to the site, located at about 800 m to the east of the Fellmongery building (shown as a blue cross in Figure 1 and Figure 2 below. All other residences are predicted to experience lower odour concentrations due to the Fellmongery drum emissions.

The following hourly average odour concentrations were predicted at the most impacted residence, represented by the blue cross in Figure 1 (NB: this is the same off-site dwelling that is most impacted by the coal-fired boiler emissions):

- 99.9$^{th}$ percentile 1-hour average GLC: 3.5 $OU_c/m^3$
- 99.5$^{th}$ percentile 1-hour average GLC: 2.3 $OU_c/m^3$

At the nearest off-site private house, the predicted 99.9 percentile odour concentration is below the MfE criteria of 5 $OU_c/m^3$, whereas the predicted 99.5 percentile concentration at this location is effectively the same value as the conservative guideline value of 2 $OU_c/m^3$.

For all other areas surrounding the Alliance site, the predicted 99.9 and 99.5 percentile concentrations are shown in Figures 1 and 2 respectively.

It is noted that the modelled concentrations discussed above relate to impacts beyond the Alliance property boundary. The predicted impact of concentrations > 8 $OU_c/m^3$ (see Figure 1 and Figure 2) occurs at a public road within the Alliance property, which is not considered to be a sensitive location to fellmongery process odours.

## Assessment of Odour Effects

The modelling predictions in Figure 1 and Figure 2 as well as the results from the most impacted private residential dwelling are considered to be conservative because of the continuous odour discharge assumption, the use of a conservative factor for converting detection threshold concentrations to certainty thresholds and especially the use of a 1-hour average 99.5 percentile concentration guideline of 2 $OU_c/m^3$ (e.g., for the some rural activities including broilers sheds, a much higher value of 5 $OU_c/m^3$ would be more appropriate). These conservative assumptions are expected to counter the uncertainty inherent in the emissions data and therefore the modelling results support the conclusion, described in the main report, that odour emissions from the Fellmongery process drums are likely to have a minor potential for causing any objectionable or offensive odour effects.

## Conclusion

It is concluded that the results of this modelling based assessment of hydrogen sulfide based emissions indicates only a minor potential for any objectionable or offensive odour effects as a result of discharges to air from the Alliance Lorneville Fellmongery processes.

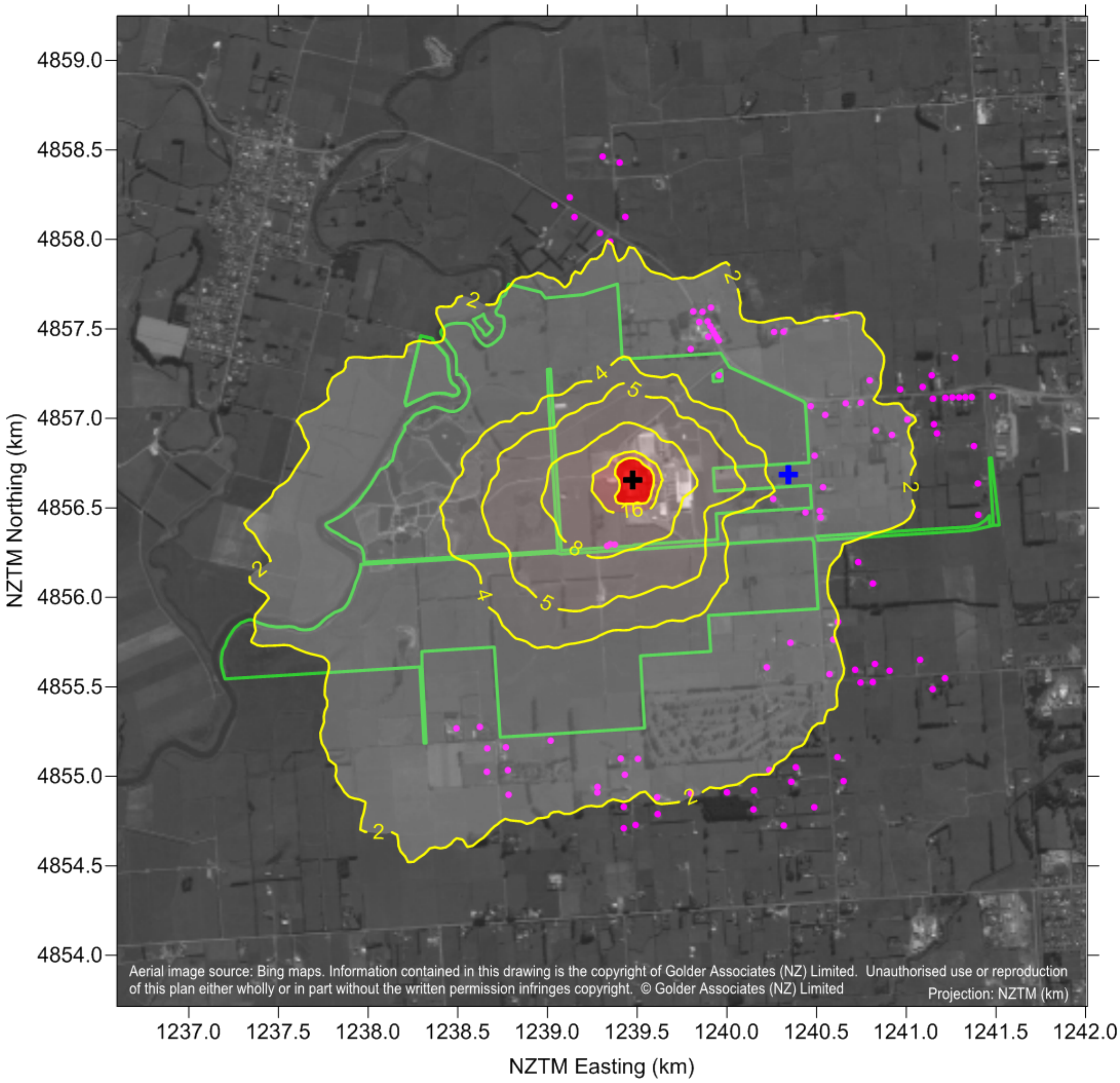


*Figure 1: 99.9 percentile 1-hour averaged odour concentration contours ($OU_c/m^3$)*

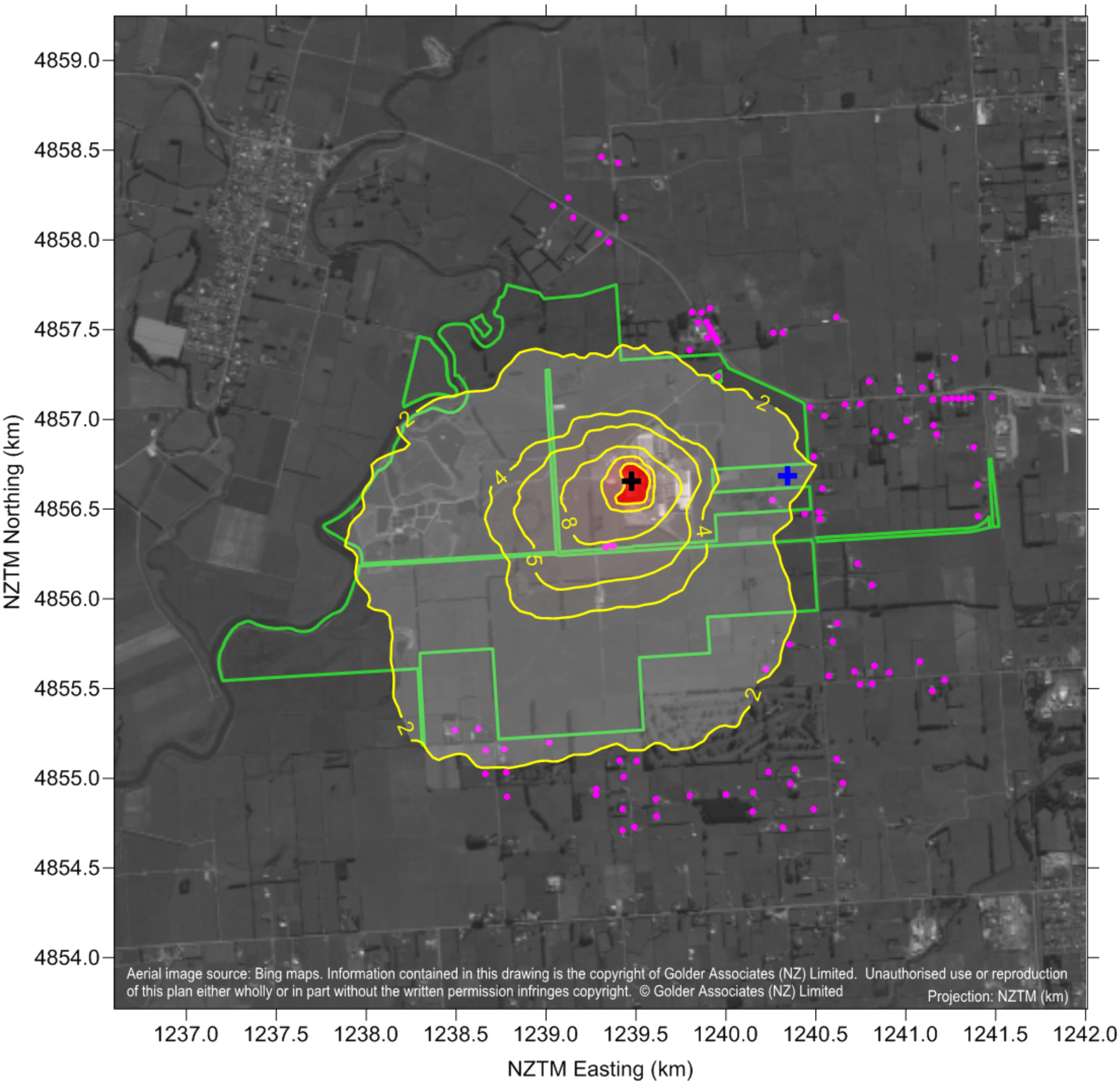


*Figure 2: 99.5 percentile 1-hour averaged odour concentration contours ($OU_E/m^3$)*

## References

Golder 2015. Assessment of Coal-Fired Boiler Air Emissions. Report Number 1378104044_016_R_RevA_060 prepared by Golder Associates (NZ) Limited for Alliance Group Limited, Lorneville. March 2015.

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