March 2015

REPORT

ALLIANCE GROUP LIMITED, LORNEVILLE

Wastewater Treatment Odour Mitigation

Submitted to:
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Lorneville, Southland

Report Number. 1378104044-015-R-Rev3-100

Golder Associates

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1.0 INTRODUCTION

This report[1] provides an assessment of odour mitigation systems that may be required to minimise off-site odour effects from the future treatment of wastewater discharges that result from meat processing operations and associated activities at the Alliance Group Ltd (Alliance) plant at Lorneville, Southland.

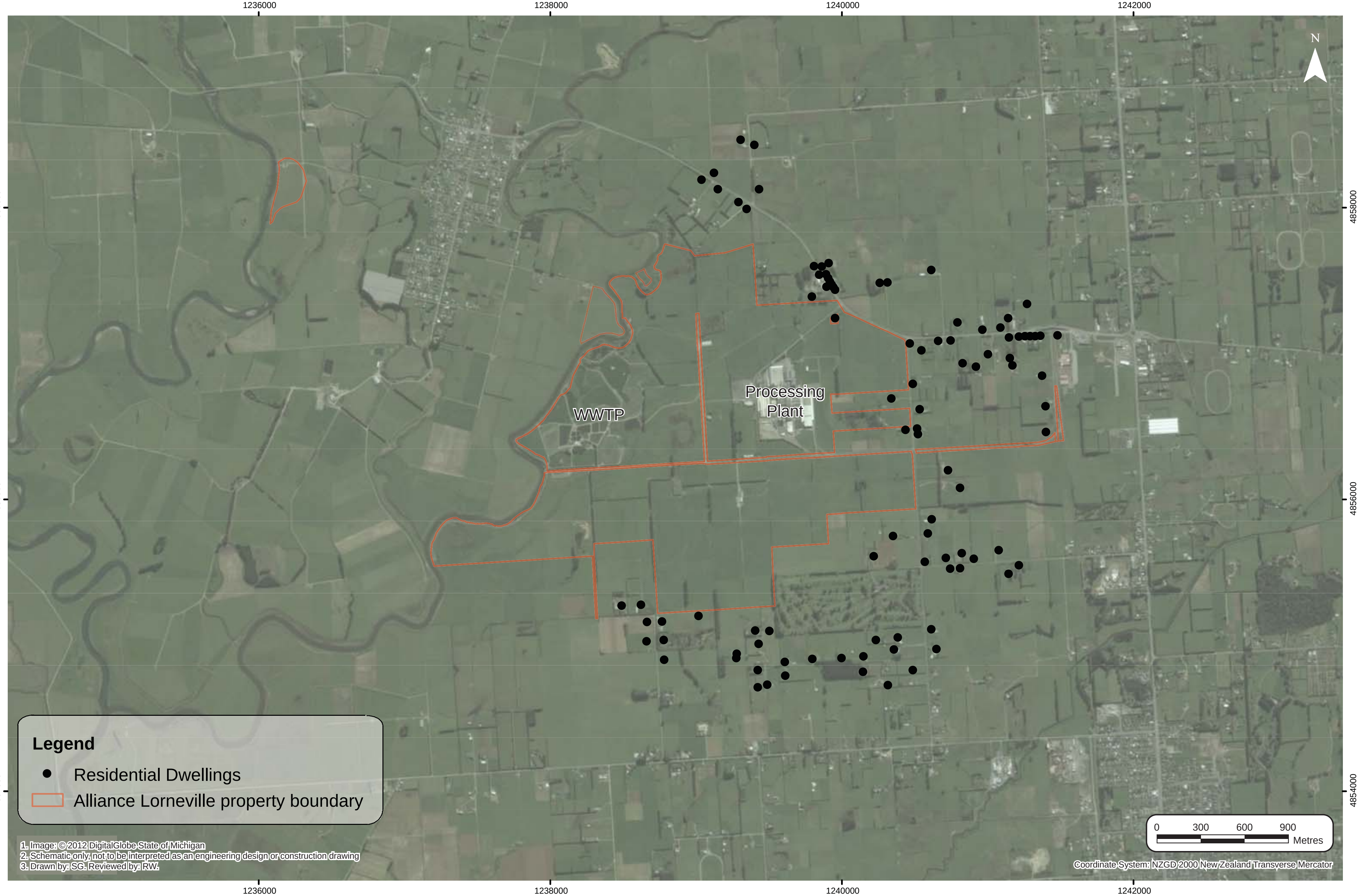
The information within this report is required to assist in the preparation of an application for renewal of the site's existing air discharge consent (Environment Southland Consent No. 95077) that expires on 7 August 2016.

The scope of this mitigation assessment includes the existing wastewater treatment system as well as future upgrades that Alliance may install in time to meet water discharge quality requirements. An annotated aerial photograph of the Alliance site and its site boundaries are shown in Figure 1. This shows the general location of the processing site and boiler plant location. The existing wastewater treatment pond (WWTP) system lies to the west of the processing site.

Figure 2 shows the layout of the WWTP system. The future upgraded treatment plant facility is likely to be located on Alliance owned land that is situated between existing WWTP and the processing site.

The assessment of mitigation systems controlling process odour emissions from various sources shown in is the subject of a separate report (Golder 2015).

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



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2.0 EXISTING WASTE WATER TREATMENT SYSTEM

2.1 General

A detailed description of the existing primary wastewater treatment plant and the WWTP system has been presented by Pattle Delamore Partners (PDP) Limited (2013). A general summary is provided in this report.

Approximately 20,000 m^3/day of wastewater is generated during the peak of the processing season at Alliance. The total flow is made up of both low and high strength wastewater streams. Rendering and some other processing wastewater streams are treated to remove fat and oil via a dissolved air flotation (DAF) system (referred to as primary treatment). The primary treated wastewater with wastewater from other processes arrives at the WWTP via two separate pipe lines (north and south lines), with relatively high loads of organic material (including protein, fat and oil), and suspended solids.

The existing WWTP system has an initial anaerobic pond stage which removes in excess of 80 % of the inlet organic material. This is followed by treatment within mechanically, then naturally, aerated ponds before discharging to the river. The odour generated from the anaerobic pond and, to a lesser extent, the first stage of the aerated ponds has reduced by an order of magnitude since the late 1990s. The anaerobic pond remains as the main source of odour from the WWTP – the first stage of the aerated pond system (the loop) is thought to be another source of wastewater odour, albeit far less significant than the anaerobic pond.

2.2 Existing Odour Effects

A community survey based assessment of all process and wastewater treatment related odour effects was undertaken during 2013 and 2014 and was reported by Golder (2014). This concluded, that for some residents (especially those living closest to the southern property boundary of the Alliance site), there are some isolated occasions when the odour discharges from the WWTP's anaerobic pond are likely to be causing objectionable and / or offensive effects. This generally occurs in the autumn period when the anaerobic pond is still relatively active, and when more still atmospheric conditions are establishing.

Local residents who live in Wallacetown, and residential dwellings to the northeast and south to southeast of the WWTP (see Figure 1) are likely to observe occasional off-site odours that are mainly generated from the anaerobic pond. However Golder (2014) concluded that these residents and others surrounding Alliance's Lorneville property (except for those discussed above) are generally not exposed to objectionable or offensive odours from the Alliance WWTP. Specifically it was concluded that these off-site odours were likely to be at a sufficiently low frequency, duration and intensity (either on a long term basis, or specific events), to not be objectionable or offensive.

2.3 Mitigation - Existing Odour Effects

Further reduction in odour via the Best Practicable Option (BPO) as defined under the Resource Management Act (1991) is a reasonable expectation for the existing and any future upgrades to the Alliance WWTP.

There are three main areas where WWTP odour emissions can be further reduced and that are considered to represent the BPO. These include achieving practical reductions in organic loading to the ponds, reduced sulfide and sulfate loadings to the WWTP and maintenance of optimal pond conditions that help to minimise the discharge of odours.

2.3.1 Reduction of organic load

Improved removal of organic load via the primary treatment systems at the processing plant is likely to reduce odour emissions from the downstream anaerobic pond. The organic load in terms of kilograms per day (kg/day) of biological oxygen demand (BOD) is the key driver of odour that is generated from the microbial breakdown of the organic load. Reduce the BOD (kg/day) and the odour generation potential is likewise reduced. It is important that reduction in load targets protein as opposed to floatable fats so to ensure that the anaerobic pond natural scum covering does not disintegrate. There are number of existing and possibly new initiatives that can achieve organic load reductions to the WWTP system. Options for reducing organic load from the rendering plant and via waste segregation and further treatment are discussed further below.

Rendering plant

The new rendering plant facility (described by Golder 2015) already recycles stick liquor that is generated within the process. As discussed in detail by Golder (2015), maintaining effective operation of the rendering plant waste heat and protein recovery system (via the waste heat evaporation plant) is a key measure for minimising WWTP odours.

Primary treatment

Currently all of the plant's meat processing wastewater, including high strength (HS) and low strength (LS) wastewater streams, discharges to the existing main DAF system. According to PDP (2013) this system is hydraulically overloaded and this leads to poor organic solids removal.

PDP's recommendation is for the LS streams (that have high flow rates) to by-pass the DAF and enable the HS streams to be more effectively treated through the DAF. An alternative recommendation is that the HS waste streams are segregated for separate treatment.

The current primary treatment upgrade involves the separate treatment of high strength (HS) waste streams associated with rendering (e.g., screw and hopper drainage, blood condensate, hydrolyser waste, soup stock waste). This includes the installation of a dedicated DAF for treating all or part of these HS waste streams with additional opportunities to recover organic load through the waste heat evaporator or via centrifugation. The recovered organic load (in the form of sludge) can be recycled to the rendering plant. According to PDP (2013) these high strength waste streams contain approximately 30 % of the site's BOD discharge within only 1 % of the site's total flow. The segregation of these streams is likely to significantly reduce the odour generation potential within the WWTP's anaerobic pond. It is concluded that these measures are likely to represent part of the current BPO for minimising WWTP odour emissions.

2.3.2 Reduction of sulphides / sulfates

The reduction of sulfides and / or sulfate loads (kg/day) into the WWTP reduces the potential odour that is generated from the conversion of these compounds into odorous hydrogen sulfide. This is likely to occur within the environment of the anaerobic pond.

The current estimate of the total sulfate / sulfide load to the existing WWTP is approximately 1100 kg/day (PDP, 2014a). This results from the combined discharges of alkaline sulfide bearing liquors (lime wash and paint table) and the strongly acidic pickling waste liquors – all of which are discharged from the Alliance fellmongery.

The acidic pickle liquors are currently discharged with all other wastewater streams from the fellmongery (including lime wash and paint table liquors) and contribute almost 40 % of the total sulphate / sulfide loading to the WWTP (i.e., 410 kg/day) according to data in Table 1 of PDP (2014a). Because the pickle liquor stream has a low organic content, it can be discharged directly to the aerated loop section of the pond treatment system. This would significantly reduce the potential for hydrogen sulfide odour production with anaerobic pond. It is concluded that this measure is likely to represent part of the current BPO for minimising WWTP odour emissions.

PDP (2014a) also investigated options for removal, or oxidation of high sulfide-bearing waste streams from the fellmongery (i.e., the paint table and lime wash streams). Removal of sulfide could be achieved by precipitation with ferric chloride, which PDP (2014a) conclude to be too expensive in terms of operating cost.

The use of a sulfuric acid stripper / caustic soda scrubbing system can be used to recover sulfide chemical and re-use this within fellmongery process. However according to PDP (2014a) the industry experience of operating this recovery system suggests it is not operationally reliable.

The other sulfide treatment option considered by PDP (2014a) for the future upgraded WWTP, includes partial, or complete oxidation of sulfides within the fellmongery lime wash and paint table waste streams before discharging to the upgraded WWTP (see Section 3.0). However, the benefit of undertaking this oxidation process for the existing WWTP system is negated by the anaerobic pond. The anaerobic pond will reduce the partially oxidised thio-sulfides as well as the fully oxidised sulfates back into sulfide. This can then be liberated to air as odorous hydrogen sulfide gas from the anaerobic pond as well as upon entry to the aerated loop.

Therefore the potential for reduced odour via the use of conventional sulfide oxidation processes would be only be realised following a future upgrade to the WWTP that would allow pre-oxidised sulfide bearing wastewater streams to avoid any anaerobic treatment stage. As such, the installation of this oxidation process is not recommended as existing BPO. This technology would be considered as being part of the BPO if the existing WWTP was upgraded to include a biological nitrogen removal (BNR) process as described by PDP (2013).

2.3.3 Anaerobic pond

The maintenance of an organic crust layer on the anaerobic pond provides a significant level of control over the emission of odorous compounds that are generated within the liquid column and bottom sludge layers. Allowing floatable solids and fat into the pond since the late 1990's has helped the progressive establishment of the crust layer (about one third of which is covered in grasses), which is likely to have been a key factor in reducing the odours from the WWTP, which the community mostly acknowledge (Golder 2014).

The reduction in organic loading to the anaerobic pond discussed in 2.3.1, is expected to be a cost effective means for minimising the odour generation potential. The improvement in primary treatment systems that would achieve a significant reduction in organic load should be undertaken while the anaerobic pond crust layer is monitored for any breaking up and disintegration. Given the large annual build-up of fatty solid material within the entrance channel to the pond, then significant reductions in the loading of fat type material can probably occur before any crust destabilisation results.

2.3.4 Aerated pond

Sludge management

It is important to ensure that aerated pond systems do not have excessive sludge build-up and therefore periodic de-sludging operations occur during winter months when the sludge layer is relatively inactive and has a low level of odour. Once sludge levels build up to within approximately one metre or less of the clear surface, then the onset of warm summer weather can result in the bottom sludge layer becoming unstable and mobile due to increase gas generation.

Sulfide stripping

The first section of the aerobic pond system is mechanically aerated. This encourages some of the sulfide within the anaerobic pond effluent to be liberated to air within an area near to the inlet of the aerated pond (referred to as "the loop" section). Odours that have been observed by Golder downwind of the aerated loop have a "musty / damp" type character, whereas the anaerobic pond odour has more of a pong / decayed type character – the latter character is what Golder have typically observed downwind of the WWTP. At this stage, it is not clear if the level of sulfide emission from the inlet to the aerated loop is significant, especially in comparison to anaerobic pond odour emissions.

If in the future it became clear that sulfide odours from the inlet of the aerated loop were causing significant off-site odour then forced air-sparging of anaerobic pond effluent prior to discharge into the aerated loop, and collecting the resultant sulfide-laden air for treatment, is a contingency measure that could be implemented to minimise this potential odour source. Currently this is not justified and any future upgrade to the existing WWTP would most likely make such a mitigation measure redundant, as pre-oxidised sulfide streams would likely bypass any anaerobic treatment stages.

3.0 UPGRADED WASTE WATER TREATMENT SYSTEM

3.1 General

Options for improving primary treatment systems are described by PDP (2013) and have been discussed in Section 2.3. Upgrading of the WWTP may be needed in the future to reduce existing nutrient levels within the Alliance's final river discharge. Such an upgrade is likely to positively impact on existing WWTP odour sources while creating potential new sources that are very likely to be manageable. These changes and practical mitigation measures that could represent the BPO in future are discussed below for the option of installing a new covered anaerobic pond and BNR pond as described by PDP (2013).

3.2 Description of Potential Upgrade

3.2.1 General

PDP (2013) describe WWTP upgrade options involving BNR system that effectively uses aerobic / anoxic treatment regimes that removes nutrients from the wastewater stream as wasted activated sludge (WAS).

3.2.2 Primary treatment

The first stage of any WWTP upgrade involves the improved primary treatment of waste streams associated with rendering discussed in Section 2.3.1.

3.2.3 New biological treatment stages

The second stage of the upgrade is likely to entail the initial separation of HS waste streams equating to 25 % of the total site's wastewater stream of about 20,000 m^3/day followed by biological treatment through a new covered anaerobic lagoon. The treated discharge from this lagoon and the pre-oxidised lime wash and paint table streams ex the fellmongery would then be co-treated within a BNR pond. As discussed, the preferred method for pre-oxidising the lime wash and paint table flows would be via the manganese catalysed aeration process that is standard for the fellmongery industry (PDP, 2014a).

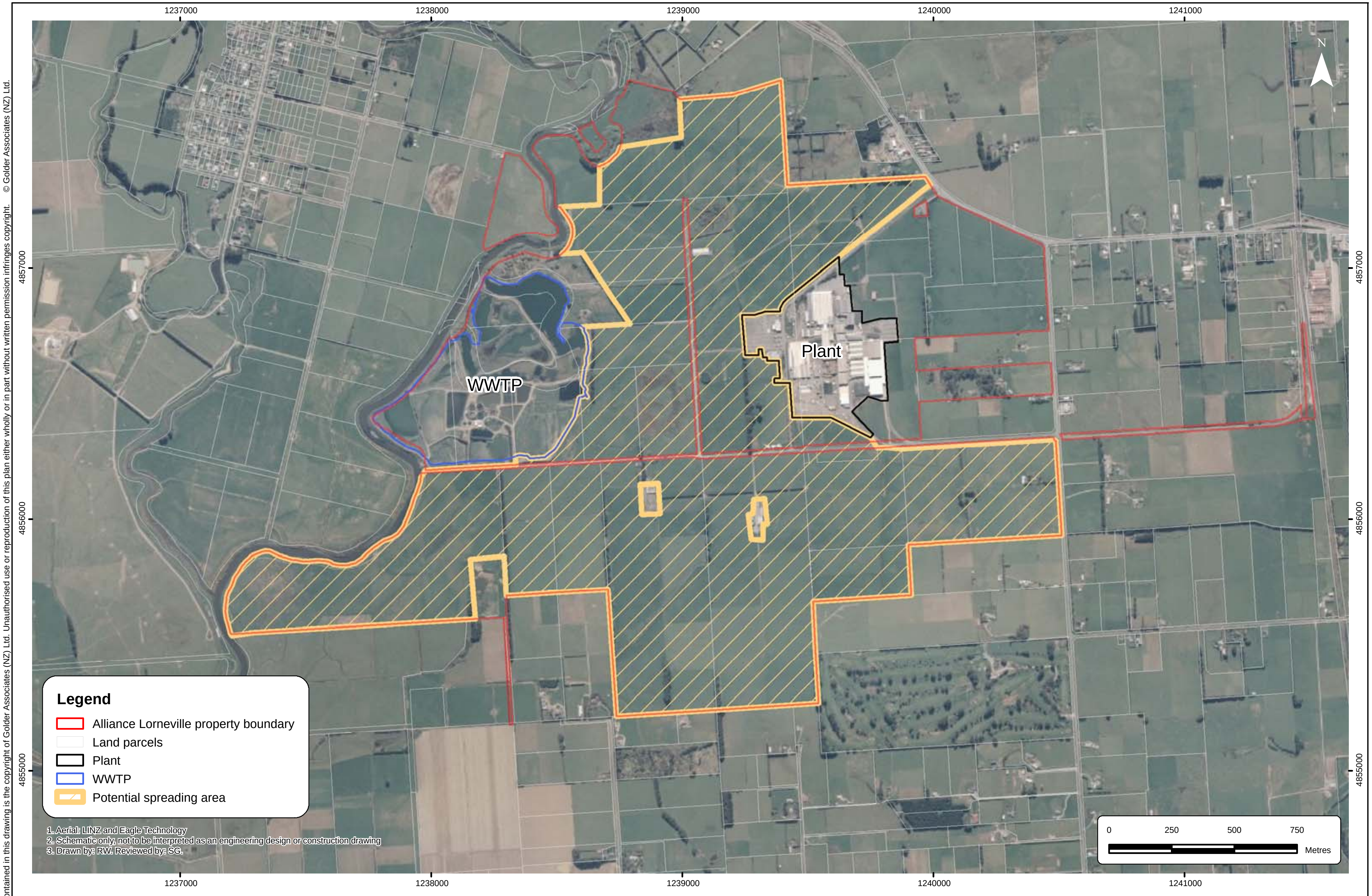
The remainder of the site's raw wastewater flows (approximately 15,000 m^3/day) would continue to discharge to the WWTP's existing anaerobic pond/ aerobic pond system. The aerated loop would therefore receive a much high quality discharge from the existing anaerobic pond as well as the treated wastewater stream from the BNR pond.

3.2.4 Biosolids

The BNR pond would generate approximately 700 m^3/day of WAS (also referred to as Biosolids) with an estimated solids content of 1 wt% (PDP, 2013). Biosolids management options have been evaluated by PDP (2014b) and PDP subsequently recommended the option of centrifuge-dewatering of Biosolids to about 18 wt% solids content, followed by either land spreading, or discharge to a new onsite Monofill. The Monofill site is likely to be located within the area of the existing WWTP ponds.

PDP (2014c) provides a map of different soil types for areas that may be suitable for land spreading of dewatered Biosolids. PDP (2015) provides a map indicating the likely location at the WWTP, for a Monofill. The overall area available for Biosolids spreading is also indicated in Figure 3.

Other options for Biosolids management detailed by PDP (2014b) include on-site, off-site composting of centrifuged solids, use of solar drying beds to achieve relatively dry solids at about 70 wt%, which can be sent to the new Monofill or an off-site landfill.



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TITLE ALLIANCE OWNED LAND POTENTIALLY AVAILABLE FOR BIOSOLIDS SPREADING

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3.3 Potential Impacts - Existing Odour Sources

3.3.1 Existing anaerobic pond

The upgraded WWTP described above would significantly reduce the loading of BOD to the existing anaerobic pond and also effectively eliminate the loading of sulfides due to the use of sodium sulfide within the fellmongery. The reduction in odour generation from the existing anaerobic pond should be substantial – that is in the order of 80 % or higher. This could therefore result in an effective mitigation of the main remaining source of WWTP odour emission at Alliance as long as the pond's natural crust cover is retained. However, there is a chance that as a result of the reduced organic load that the existing anaerobic pond's natural crust layer would disintegrate. If this were to occur it would counter the substantive gains made in respect to reduced odour generation. The likelihood of the pond crust layer breaking up is expected to be low given that Alliance regularly monitors the pond surface as fat loads are reduced over time. Furthermore, it is likely that a significant reduction in the existing fat loading to the pond can occur whilst the crust remains stable as the existing loading of fat is very high. This aside, measures for mitigation against this scenario occurring and then to employ, should it occur, are detailed in Section 3.5.2.

3.3.2 Aerated loop

The completed upgrade to the WWTP (installing both modified primary and new biological treatment processes) would also eliminate the generation of sulfide odours within the first stage of the aerated loop due to fellmongery waste streams. Instead, lime wash and paint table waste streams would be pre-oxidised before the BNR pond process that is inherently aerobic. As such the ability for thio-sulfides or sulfates (within a pre-oxidised fellmongery waste stream), to convert back into odorous sulfides (as would currently occur within the anaerobic pond), could be avoided in both in the BNR pond, the aerated loop and down-stream facultative ponds.

3.3.3 Summary

In summary, the proposed upgrade of the WWTP to incorporate nutrient removal (i.e., nitrogen and phosphorus) is expected to result in a significant reduction in odours from existing anaerobic pond. Furthermore, sulfide odours currently resulting from the vigorous aeration of anaerobic pond effluent are likely to be drastically reduced, if not eliminated altogether.

3.4 Potential Impacts - New Odour Sources

3.4.1 Covered anaerobic lagoon

It is proposed that any new anaerobic lagoon that is required by an upgrade be enclosed by an engineered cover. Note that for the existing anaerobic pond, odorous gases diffuse through the organic crust layer cover and in the process they are partially oxidised before discharging to atmosphere. For the new anaerobic pond, the cover will be impervious to odours and therefore these will need a controlled discharge to atmosphere. This is discussed in Section 3.5.4.

3.4.2 Biological nitrogen removal

It is expected that the BNR pond and secondary clarifier (that produces WAS) should produce minimal odour as the process operates within aerobic and anoxic regimes. However in practice these systems support anaerobic environments within flocs of solids that are suspended within the pond. Given the pre-oxidation of fellmongery sulfide bearing liquors via the industry standard manganese catalysed aeration process, the thio-sulfides are not expected to convert back to odorous sulfide forms within the BNR pond to any significant extent.

3.4.3 Biosolids management

Storage and Dewatering

The storage of dilute Biosolids in a lagoon or tank, subsequent dewatering and storage of dewatered Biosolids has the potential to generate localised odour emissions that could cause off-site odour effects.

Land Spreading

The potentially more significant source of odour associated with Biosolids management is likely to be associated with the land spreading of dewatered Biosolids. PDP (2014c) have identified potential areas that are within 100 to 200 metres of existing privately owned residential dwellings. These are also shown in Figure 3 that highlights the areas of Alliance owned land that may be utilised for land spreading of Biosolids.

Biosolids Transfer and Mono-filling

The transfer of dewatered biosolids to an onsite Monofill could create some odour as a result of the initial storage and unloading operations however this is expected to be at a low level.

3.5 Mitigation – Future Odour Sources

3.5.1 General

This section discusses odour mitigation measures that may be required following any upgrade of the WWTP and recommends what could represent Best Practicable Option (BPO) in the future.

3.5.2 Existing anaerobic pond

Should the existing anaerobic pond's organic crust layer begin to disintegrate and result in significant odour emissions despite the large organic load reduction, then the BPO for mitigation could be to conduct this stage within a smaller pond and install an artificial cover and flare system. Another available option would be to manipulate the floating fat loading to the existing pond so that the existing crust layer is maintained or re-established.

3.5.3 Aerated loop

The upgraded WWTP is likely to result in the existing moderate level of odour from this secondary WWTP source, being effectively eliminated by the removal of reduced sulfide loads to the aerated loop.

3.5.4 New covered anaerobic pond

It is standard practice to mitigate the potential for off-site odour effects from such discharges by capturing the off-gas and burning it either in a biogas flare, or for energy recovery such as cogeneration – the latter would entail hydrogen sulfide-stripping. This would effectively incinerate odorous compounds and has the potential to provide some waste to energy opportunity for Alliance. This is considered the BPO for mitigation of biogas odour. Any consenting ramifications associated with this method will be considered closer to the time of implementation.

3.5.5 Biological nutrient removal

Should the partially oxidised thio-sulfides within the pre-oxidised fellmongery liquors convert back to odorous sulfide forms within the BNR pond and cause off-site odour issues, then more complete oxidation of sulfides can be implemented to overcome this – see PDP (2014a). For example the use of hydrogen peroxide to oxidise sulfides to a higher degree is likely to be the BPO in this instance.

The above additional mitigation is not likely to be necessary. However the operation and maintenance of good quality wastewater water monitoring instrumentation and automatic oxygen control are likely to be necessary to avoid abnormal operating conditions and associated generation of odour. Use of state of the art instrumentation and process control is likely to represent the BPO for controlling the BNR pond odours to a minor level.

3.5.6 Biosolids management

Biosolids Storage

There will be typical maximum time for the storage of raw Biosolids (transferred from the secondary clarifier as WAS) and prior to centrifugation, which if exceeded could require lime stabilisation. Alternatively the use of forced aeration within a sludge buffer tank could be employed to allow for much long storage retention times of raw Biosolids before they are dewatered. Avoiding raw and dewatered Biosolids from becoming anaerobic through short storage retention times, lime stabilisation or use of aeration may well be necessary and represent the BPO for avoiding adverse offsite odour effects.

It will be important to centrifuge non odorous Biosolids (have not become anaerobic) prior to spreading to land. Therefore the above suggested BPO would also apply in this case for ensuring that the production and storage of dewatered Biosolids are themselves not odorous.

In summary, operational experience will be necessary to establish suitable maximum storage times and stabilisation procedures of raw and dewatered Biosolids ahead of land spreading and landfilling operations to ensure the appropriate management of potential odour effects. This will be a strong function of the extent of agitation/aeration that is installed into the raw Biosolids storage lagoon.

Land Spreading of Biosolids

As discussed above, it will be important to only land spread Biosolids that have not turned anaerobic and become odorous. This will require the adoption of good practice management techniques including for example, restrictions on storage time, maximum instantaneous BOD loading rates (kg-BOD/ha/application), accounting for forecast wind conditions during the day of spreading, and appropriate buffer zones to help avoid adverse odour effects. Given the separation distances between areas that could receive Biosolids and off-site residential properties and local meteorology (especially cool air drainage flows), should the use of these measures still not avoid significant odour effects occurring beyond the site boundary then contingency measures would need to be considered. Alternative Biosolids management / disposal options such as landfilling, composting (off-site or on-site), could be implemented if required and can therefore be seen as contingency measures.

Monofill Design / Management

The design of the Monofill and ability to cover and contain odours from anaerobic Biosolids will also influence the extent of odour emissions from this area. Ensuring that the active face at the Monofill can be covered, the use of lime to neutralise anaerobic odours from uncovered material as well as soil to ensure odorous gas leaks are not significant are all standard measures that can be employed as necessary to control odours to an acceptably low level.

Finally, the siting of the Monofill away from residential houses and the site boundary as far as practical would represent part of the overall BPO.

Adaptive management

The BPO for managing odour effects from Biosolids processing, spreading or landfilling is to operate an adaptive management regime. This likely to be essential to ensure the environmental performance of storage, spreading and landfilling procedures and infrastructure are reviewed and adapted over time as experience is gained and environment effects are reviewed. Having an adaptive management regime would also ensure the alternative options discussed below are duly considered by Alliance.

Other measures

The use of covered drying beds, off-site disposal, or composting dewater solids off-site (or in the most remote onsite location to the south west of Alliance owned land, are all alternative Biosolid management options that could in time represent the BPO for minimising odour effects based on the success of the measures discussed above.

4.0 DISCUSSION AND CONCLUSIONS

4.1 General

This report has assessed the potential sources of odour from the Alliance Lorneville existing WWTP and following future upgrades. The assessment approach has been based on a consideration of the Best Practicable Option (BPO) for minimising the odour emissions both pre and post any upgrading of the WWTP.

With the use of the mitigation measures outlined in this report, it is concluded that Alliance can reduce odour effects from its existing WWTP to a practical minimum that is significantly lower than the current offsite level.

4.2 Existing WWTP

It is apparent that the existing WWTP's anaerobic pond creates objectionable odour impacts on a minority of neighbours and on isolated occasions throughout the process season. To this end the BPO for minimising odour effects from this existing system is considered to result from the practical reduction of organic loads via the upgrading of primary wastewater treatment systems at the processing site. Secondly the direct discharge of acid pickling liquors from the fellmongery to the aerated loop section of the WWTP is also considered to represent part of the overall BPO.

It is concluded that the implementation of further measures such as anaerobic effluent sulfide stripping, and pre-oxidation of sulfide bearing fellmongery liquors do not represent the BPO for controlling odours at this stage. That aside, an adaptive management strategy that is recommended for controlling future Biosolids odours also applies in this instance and these options should be reviewed periodically over the life of the consent.

4.3 Upgraded WWTP

It is concluded that an upgrade to the existing WWTP is likely be associated with significant reduction in odour emissions from the anaerobic pond. Although not expected, should the existing anaerobic pond crust becoming destabilised and counter the benefits of reduced organic loading, then additional mitigation options are available – for example use of a smaller pond that is covered and employs biogas combustion, or else simply making primary treatment changes to ensure the crust layer is maintained.

This WWTP upgrade is likely to be in conjunction with the use of standard sulfide oxidation technology being employed for sulfide bearing fellmongery waste liquors, which will also mitigate the potential for sulfide odours to be liberated from the aerated loop section of the WWTP.

It is concluded that any upgrade to the WWTP is likely to positively impact on existing WWTP odours while creating some potential new sources of odour such as the covered anaerobic lagoon, the BNR pond and its clarifier, for which their odour emissions should be readily controlled to minor levels via standard BPO controls. This would include gas flaring or utilisation for the covered anaerobic lagoon and best practice instrumentation and process control of the BNR pond process parameters.

4.4 Biosolids Management

The management of the 700 m^3/day of dilute WAS from the BNR plant including dewatering and the storage, onsite landfilling and especially land spreading of the dewatered material, will create the greatest potential for odours from an upgraded WWTP.

It is concluded that odours from these operations can be effectively controlled via appropriate management of storage conditions and retention times of raw and dewatered Biosolids in conjunction with an adaptive management approach that reviews environmental performance and the adequacy of operational procedures.

Such an approach would help identify the need or otherwise to adopt an alternative Biosolids management option such as off-site disposal / composting as this may represent the future BPO for minimising odour effects.

5.0 REFERENCES

Golder Associates (2014): *Baseline Odour Survey Update – Alliance Lorneville*. Golder Report No. 1378104044-Rev0-030.

Golder Associates (2015): *Process Odour Mitigation – Alliance Lorneville*. Golder Report No. 1378104044-013-Rev1-090.

PDP (2013): *Lorneville Plant Wastewater Treatment Issues and Options - Alliance Group Limited - Lorneville Plant*, Prepared by Pattle-Delamore Partners Limited. September, 2014.

PDP (2014a): *Sulfide Removal from Wastewater – Feasibility Investigation*, Alliance Group Limited - Lorneville Plant, Prepared by Pattle-Delamore Partners Limited. September, 2014.

PDP (2014b): *Lorneville Plant Biosolids Management Options,* Alliance Group Limited - Lorneville Plant, Prepared by Pattle-Delamore Partners Limited. November, 2014.

PDP (2014c): *Biosolids Land Disposal Assessment,* Alliance Group Limited - Lorneville Plant, Prepared by Pattle-Delamore Partners Limited. November, 2014.

PDP (2015): *Proposed Contingency Biosolids/Sheep Manure Solids Monofill – Technical AEE,* Alliance Group Limited - Lorneville Plant, Prepared by Pattle-Delamore Partners Limited. Marchr, 2015.

Resource Management Act (1991). Retrieved from http://www.legislation.govt.nz/act/public/1991/0069/latest/whole.html. Accessed February 2015.

APPENDIX A

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