The Creamery, Aber-Arad

Dairy Partners Limited

BAT Noise Audit

2nd October 2020

First Issue

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Revision History

Version	Comments	Author	Date
First Issue	First issued version of the report	**Chris Parker-Jones** Director and Acoustic Consultant BSc (Hons) MSc MIOA	2nd October 2020

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Executive Summary

This document, a BAT Noise Audit, has been written to evaluate the noise contributions from each individual process, plant and machinery (that generates a significant amount of noise) at the nearby residential properties, in order to determine which are the main contributors, and therefore which will require further noise mitigation to reduce the level of impact.

The document also evaluates the existing mitigation measures (including those recently installed) and determines whether more action could feasibly be taken, i.e. are Best Available Techniques already being implemented and if not, how could they (and should they).

PJA attended site on the Thursday and Friday the 24th and 25th of September 2020 to conduct noise measurements and audit noise generating equipment/processes. PJA took measurements both close to the source of noise, and at the site boundary/outside residential properties. This information was then used in conjunction with noise mapping/modelling to determine specific noise contributions from each source at the closest/most affected residents and effectively rank the sources in order of disturbance. See Section 3.2.

Subsequently a review of the noise mitigation measures already applied and whether further BAT measures should be installed has been made. It is recognised that a number of measures have been implemented in the year prior to this report and that significant reductions in noise emissions have been made – however there still remains to be further improvements which could be made to reduce the level of adverse impact. A recommend schedule of noise mitigating actions is therefore given in Section 3.3, relating to ETP tankering, the chillers, cooling tower pumps, and the Borehole Pump Room.

Contents

1.0 Introduction

ParkerJones Acoustics Limited (PJA) has been instructed by Dairy Partners Limited (DP) to undertake a Best Available Techniques (BAT) Noise Audit, as requested by Natural Resources Wales (NRW) in regulating the existing Environmental Permit for the facility at The Creamery, Aber-Arad, Newcastle Emlyn, SA38 9DQ ('the site').

This document, a BAT Noise Audit, has been written to evaluate the noise contributions from each individual process, plant and machinery (that generates a significant amount of noise) at the nearby residential properties, in order to determine which are the main contributors, and therefore which will require further noise mitigation to reduce the level of impact.

The document also evaluates the existing mitigation measures (including those recently installed) and determines whether more action could feasibly be taken, i.e. are Best Available Techniques already being implemented and if not, how could they (and should they).

Note that whilst every attempt has been made to ensure that this report communicates effectively to a reader who might not have much knowledge of acoustics, some parts are necessarily technical. A glossary of acoustic terminology and concepts is provided in Appendix A.

2.0 Background Information

2.1 Site Description

The site is located at grid reference SN 31672 40106 (SN316401) in Aber-Arad, Newcastle Emlyn, with the main entrance to the site off the B4333 along the south boundary. The facility is on the outskirts of the town with residential receptors along the south and west boundaries, with some slightly further to the north.

The development is a dairy processing facility, operating for 24 hours a day, 365 days a year, with many items of plant running continuously throughout this. This includes heavy goods vehicles coming in and out of site around the clock, and an average batch cycle of approximately 35 hours (28 hours production, 7 hours cleaning).

2.2 Recent History

The site has been subject to various noise surveys and investigations in recent years due to complaints from residents in Aberarad about noise originating from the dairy processing plant. The facility is regulated by Natural Resources Wales (NRW) under an environmental permit since 2019. The site has generated several hundred complaints from two residential properties, mostly in 2019.

2.2.1 Noise Impact Assessment

During the summer of 2019, NRW undertook noise monitoring in response to complaints, resulting in a Noise Impact Assessment Report (NRW/1908/ABERARAD – December 2019). According to this report the complaints related specifically to:

- 1 - the refuelling of liquified natural gas (LNG);
- 2 - the tankering of product from the Effluent Treatment Plant (i.e. vehicle noise); and
- 3 - the operation of the dairy processing plant, specifically the sound generated by the chilling/cooling process.

At the time operational noise reached around 62 to 63 dB overnight, compared to a background sound level of 48 to 50 dB, indicating a significant adverse impact when assessed in accordance with BS 4142:2014 '*Methods for rating and assessing industrial and commercial sound*'. Works were then subsequently undertaken by DP to replace part of the cooling system by installing two new cooling towers with acoustic silencers. This reduced ambient day and night-time sound levels by 9 dB and 10 dB respectively.

2.2.2 Compliance Report

In March 2020, a Compliance Assessment Report was issued by NRW – assessing the current level of compliance against conditions in the Environmental Permit. This summarised the results of the Noise Impact Assessment and discussed what mitigation DP had subsequently installed in the intervening period.

1 – LNG Refuelling

In October 2019 DP confirmed that the LNG tankers were utilising a new pressure-based gas delivery system rather than a pump based delivery system. This seems to have made the process almost silent and have addressed the LNG refuelling noise problem.

2 – ETP Tankering

In 2019 the number of tankers at the site's ETP temporarily increased due to issues with the ETP performance. However, improvements to the ETP have been made which have reduced the tankering activity. DP is also applying for a new permit for a new ETP system which will require significantly less tankering than the current system.

3 – Chilling/Cooling Operations

DP carried out a series of improvements to help reduce noise impacts from chilling/cooling operations:

- installation of noise suppressing foam on the enclosure surrounding the chiller compound;
- purchase and installation of a third chiller to reduce demand on the existing chiller systems;
- purchase and installation of new cooling towers with noise silencers.

2.2.3 Further Actions Required

Best Available Techniques (BAT) Noise Audit

Whilst the improvements have seen a significant drop in noise levels from a *significant adverse impact*, NRW still believes that the site is causing an *adverse impact*.

In order to address this, NRW has requested that DP undertake a Best Available Techniques (BAT) Noise Audit (the purpose of this report).

"Operator to arrange for a BAT Noise Audit to be undertaken. The BAT Noise audit will:

- *Identify contributory site sound sources and characteristics (including tonality, impulsivity, intermittency);*
- *Rank these sources – both in terms of dB(A) and character at:*
    - *Complaint locations and;*
    - *At the site boundary;*
    - *Or other reference positions against existing background levels;*
- *Identify all potential noise sources within the dominant machine/process;*
- *Rank the sources – dB(A) and character;*
- *Establish the noise control options for the dominant source; repeat the exercise for the next most dominant sources etc;*
- *Draw up a schedule of noise reduction measures for submission to NRW."*

Cooling Tower Pumps

NRW requested that DP should either replace the cooling tower pumps or fit engineered acoustic enclosures around them by the end of 2019. The latter appears to be the case during PJA's site visits.

2.3 Noise Generating Plant/Processes

Whilst on-site, PJA spent several hours observing the various noise generating processes, plant and equipment. The main noise emitters (locations shown in Figure 2.1 overleaf) considered in this report are:

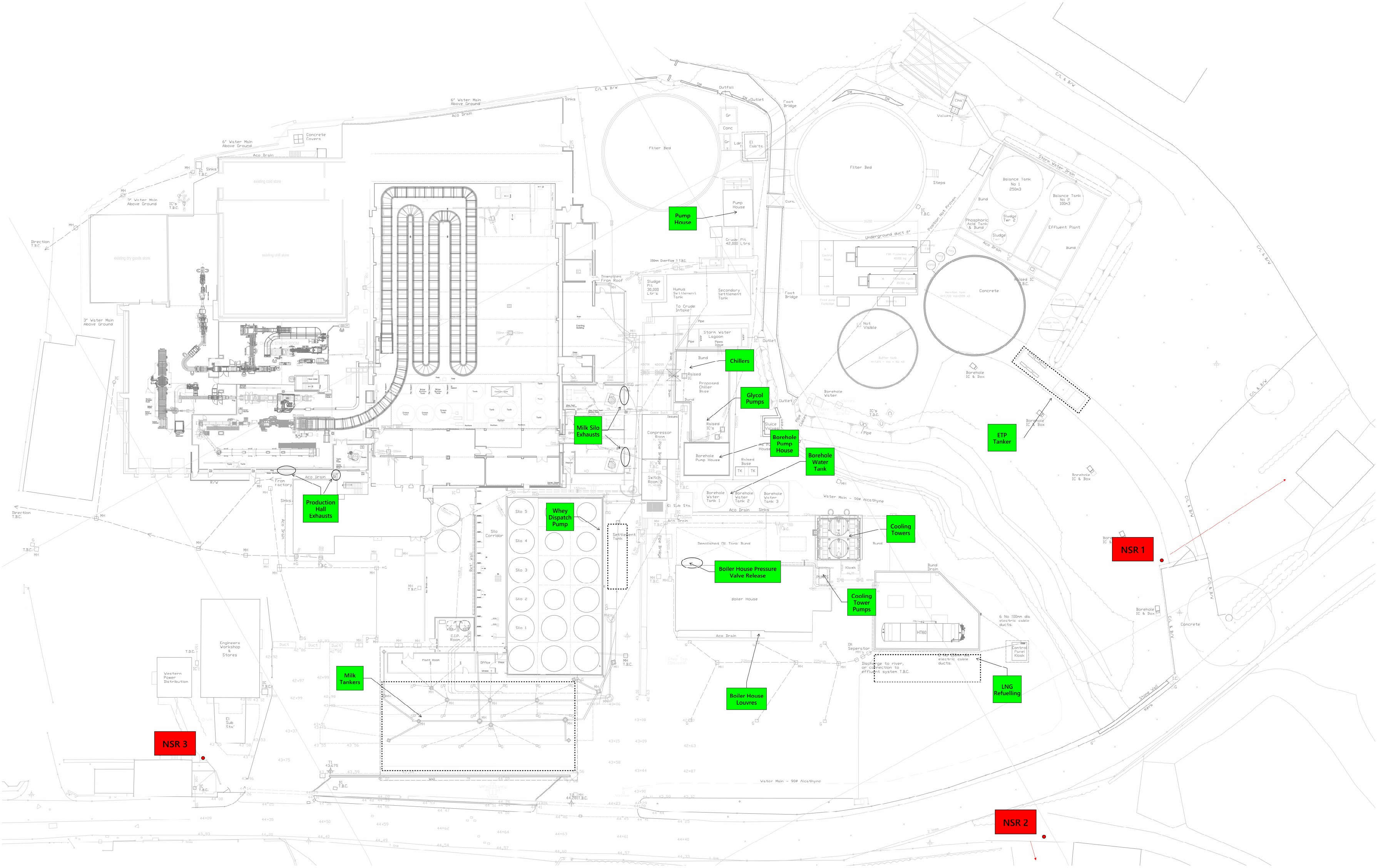
- ETP Tankers – tankers entering the site via the south-east entrance and collecting effluent from the tankers to take away from site and dispose of. Currently with the existing ETP plant, around 8 to 9 of these tankers are at site each day. The pumping process is the noisiest aspect, also requiring the tanker engine to idle, occurring for around 20 – 30 minutes at a time.
- Milk Tankers – delivering milk to the front of the site, there can be roughly 24 to 30 tankers per day with up to 6 at any one time.
- Chillers – within the chiller compound, running continuously but varying in noise as the load changes (depending on how much the temperature needs to be chilled, and whether all chillers are operational.
- Glycol Pumps – also within the chiller compound, running continuously at a steady load.
- Cooling Tower – recently replaced, two towers with a large set of acoustic attenuators on either side
- Cooling Tower Pumps – in a small open sided enclosure at the corner of the Boiler House and behind the Cooling Tower – running continuously at a steady load.
- Borehouse Pump Room – several pumps inside a small lightweight building beside the chiller compound – running continuously.
- Borehole Water Tank – next to the pump room, running continuously.
- Milk Silo Exhausts – two high level vents on the east elevation of the main production building above rooms appearing to contain milk silos – running continuously.
- Production Hall Exhausts – two high level vents on the west side of the production hall near to the dock levellers – running continuously.
- Boiler House Louvres – high level ventilation louvres on the south elevation – running continuously.
- Boiler House Pressure Valve Release – high level dog leg shaped exhaust flue on the north elevation – operating occasionally for a few minutes at a time.
- Whey Dispatch Pump – unloading tankers in through the main entrance 4 to 5 times a day per 30 minutes at a time.
- Pump House – set of 5 to 6 pumps on the north side of site which operate intermittently for a few minutes.
- LNG – refuelling of liquified natural gas tankers for approximately 5 hours per visit, once a week.

The existing ETP plant has been omitted as this will soon be decommissioned.

2.4 Noise Sensitive Receptors

For the purpose of this assessment, three noise-sensitive receptors (NSRs) have been defined overleaf in Figure 2.1. The locations represent positions close to the boundaries of residential properties were PJA were able to access and measure during the survey.

Figure 2.1 – Site plan showing locations of noise generating processes/equipment (green) and measurement positions (red) representing nearby noise sensitive receptors (NSRs)



3.0 Assessment

3.1 Methodology

PJA attended site on the Thursday and Friday the 24th and 25th of September 2020 to conduct noise measurements and audit noise generating equipment/processes. Measurements were taken both close to the source of noise, and at the site boundary/outside residential properties (in between vehicle passing's along the main road to the south), at the locations shown in Figure 2.1.

The site was in full/normal operation of the Thursday, with a 'stop day' scheduled on the Friday. The 'stop day' allowed the majority (though not all) of the noise sources to be switched off and then turned back on and measured in isolation (again at source, and at the boundary). PJA took measurements of each process on both days in case noise levels varied on the second day due to equipment not being under full load.

For a handful of the plant, it was possible to determine individual noise contributions at nearby residential properties through measurement in isolation. However, noise emissions from the majority of processes were either well below or close to the residual baseline noise level (from noise sources other than the site) when attempting to measure at the receptors. Therefore, the assessment has also utilised noise map modelling (based upon measurements taken close to source) to predict the individual noise contributions from each process at the receptors where they could not be conclusively determined through measurement alone. In many cases, the noise source was subjectively audible but required this additional modelling to determine the specific noise level.

A 2nd sound level meter was also used to measure baseline levels in a fixed position at NSR 1 throughout the two site visits (and overnight), to aid in determining the residual noise level. More information regarding the survey and modelling process is given in Appendix B.

The purpose of the assessment has been to satisfy the requirements of NRW as detailed in Section 2.2.3, page 7.

3.2 Operational Measurements/Observations

Table 3.1 overleaf presents the estimated noise contributions from each noise source at each of the three NSRs based upon the measurements, modelling, and subjective observations. Photographs from site and screenshots of the noise model are shown in Appendix B.3.

As best as possible, these are ranked in terms of impact at NSRs 1 and 2 (south-east corner of the site where it is believed the majority of complaints are from) based upon dB $L_{Aeq,T}$, regularity, and subjective disturbance (from annoying qualities like tonality, intermittency, and impulsivity). Evidentially the order of impact is different for NSR on the west side of site – which is mainly impacted by the Milk Tankers.

The noise contributions from the plant listed at 'Continuous – 24 hours a day' total to 51 dB at NSR 1, 49 dB at NSR 2, and 36 dB at NSR 3. This appears consistent with baseline L_{A90} levels measured from site of ≈51 dB at NSR 1 (see graph in Appendix B.4), ≈49 dB at NSR 2, and ≈42 dB at NSR 3 (other noise sources were more dominant at NSR 3).

Table 3.1 – Noise contributions and subjective observations from each source at nearby residential receptors

Source	Noise Contribution dB $L_{Aeq,T}$			Subjective Notes	Regularity
	NSR 1	NSR 2	NSR 3		
ETP Tankers (pumping)	72	60	39	Very loud and dominant at receptors close to the ETP site entrance. Fairly tonal noise.	30 minutes for up to 8 or 9 times a day
ETP Tankers (idling)	58	46	25	Low frequency hum, clearly audible though not as noticeable when pumping.	30 minutes for up to 8 or 9 times a day
Chillers	49	42	29	Clearly audible tonal qualities which vary in frequency depending on load – siren type quality.	Continuous - 24 hours a day
Cooling Tower Pumps	45	45	24	Slight whine can be heard at the receptors near the ETP site entrance.	Continuous - 24 hours a day
Milk Tankers (pumping and idling)	42	48	65	Pumps relatively quiet, the main noise is the tanker engines idling whilst pumping.	30 minutes for up to 30 times a day – can accommodate 4 – 6 tankers at the same time
Milk Silo Exhausts	40	45	20	Low-frequency hum with no tonal qualities – not distinguishable from other noise sources at the receptors.	Continuous - 24 hours a day
Borehole Pump Room	38	26	15	Constant low-mid frequency broadband noise emitting from the open door.	Continuous - 24 hours a day
Boiler House Pressure Valve Release	54	50	47	Clearly noticeable but relatively broadband noise without particularly annoying characteristics.	Once per day for a few minutes. Can occur overnight
LNG (alarm)*	21 – 45	40 – 64	21 - 45	Tonal alarm, very audible at the receptor across the road with the door open but muffled with the door closed.	5 hours – once a week – intermittent every 3 minutes for a few seconds
Cooling Towers	31	36	11	Slight mid-high frequency broadband noise but relatively quiet compared to other sources	Continuous - 24 hours a day

Source	Noise Contribution dB $L_{Aeq,T}$			Subjective Notes	Regularity
	NSR 1	NSR 2	NSR 3		
Glycol Pumps (Chiller Base)	33	25	17	Had a strong tonal element when measuring close to source but no tone audibles once outside the enclosure.	Continuous - 24 hours a day
Whey Dispatch Pump	38	32	30	High frequency tonal quality – but not that perceptible at the receptors.	30 minutes for up to 4 or 5 times a day
Boiler House Louvres	20	35	25	Low-frequency hum, not particularly noticeable or disturbing.	Continuous - 24 hours a day
Pump House	23	35	13	Constantly running but very intermittent, pumps run for a minute or so then turn off completely for another minute. Not noticeable at receptors.	Continuous/intermittent - 24 hours a day
Production Hall Exhausts	13	13	34	Low-frequency hum, not particularly noticeable or disturbing.	Continuous - 24 hours a day
LNG (pressure fill)	<17	<26	Negligible	Very quiet even close to source, wasn't immediately clear that the process was even running (it was, but no obvious noise from it).	5 hours – once a week
Borehole Water Tank	21	17	18	Broadband noise but not distinguishable from other sources when more than 5 – 10m away.	Continuous - 24 hours a day
*range depending on whether door to the case containing the alarm is closed or open.					

3.3 BAT Audit and Recommended Mitigation

Table 3.2 overleaf presents a review of the noise mitigation measures already installed to existing noise sources, determines where best available techniques (BAT) are already being applied, and if not, what BAT techniques could be applied, and lastly, where it is necessary to implement further mitigation on the basis of whether the noise is particular disturbing/requires reduction.

Processes listed as 'maybe' needing improvement are those where an improvement can be made but may not be necessary as either noise contributions are low at receptors relative to other sources, or they do not have tonal, intermittent, or impulsive characteristics.

In the first instance, those listed as 'yes' under needing improvement should be considered. The list of potential measures is not intended to be a list of measures which should be implemented right away, they are a list of options. As a first phase of improvements, PJA recommend the following measures:

- Reducing the number of ETP tankers – this is already planned as the new ETP plant will soon be operational which will lessen the requirement for effluent to be removed from site via tankers as the plant will be able to treat a much higher volume of effluent than before.
- Adding acoustic insulation lining/jackets to noise-generating components of the chillers. The oil separators appear to be the noisiest aspects, followed by the compressor of chiller 1 (closest to the enclosure door). All of these components lacked acoustic lagging (the compressors of the other two chillers *had* lagging). A 4 – 8 dB reduction could be achieved.
- Add similar lagging to the cooling tower pumps. Alternatively, the enclosure around these pumps could be extended, with a barrier built (with access door) on the south/east side to provide screening to residents in this direction.
- Close the door to the Borehole Pump Room. It was not immediately clear to PJA or engineers from DP why this door was left open, as there is an extract fan in the façade. Keeping the door open is an avoidable escape for noise.

Ultimately, DP will need to input on which measures are feasible and could be taken forward.

Once these measures have been put in place, the noise impact should be revaluated. If an *adverse impact* is still evident, then the other potential measures listed in the table could be taken forward.

Table 3.2 – Assessment of current noise control measurements and potential future BAT mitigation

<table>
<tr><th>Source</th><th>Noise generating parts (in order of dominance)</th><th>Current Noise Control Measures</th><th>Already employing BAT?</th><th>Potential BAT Measures</th><th>Recommended for Improvement?</th></tr>
<tr><td>ETP Tankers (pumping)</td><td rowspan="2">• Vacuum pump
• Hydraulic cooler
• Tanker engine idling</td><td rowspan="2">• Recent fixes made to the existing ETP to decrease the number of ETP tankers per day.
• ETP tankering does not occur at night.</td><td rowspan="2">No</td><td rowspan="2">• Reduce the number of ETP tankers - the new ETP plant is expected to be significantly more efficient than the existing plant and therefore should result in 1 tanker per day, rather than the current 8 to 9.
• Erect a portable screen/barrier at the side of the tanker. The barrier can be lifted into place around the vacuum pump and hydraulic cooler. Alternatively a more permanent structure could be constructed to form a bay for the tanker to reverse in to. The barrier should break the line of sight from the side of HGV to the residential properties.
• Position tanker vehicles so that the side where the vacuum pump and hydraulic cooler are facing north-westwards, with the tanker itself acting a noise barrier, out of sight from residents to the south-east.
• Install silencers on to vacuum pumps and hydraulic coolers if possible, or replace with quieter alternatives.</td><td rowspan="2">Yes

Improvements already planned with the new ETP to reduce the number of tankers.</td></tr>
<tr><td>ETP Tankers (idling)</td></tr>
<tr><td>Chillers</td><td>• Oil separator (2 per chiller)
• Chiller screw compressors

Tonal noise is created by the rotary components running at high speed (cooled water rotary screwed chiller)</td><td>• A third chiller was recently installed to reduce the load on the existing two.
• Installed in an open top enclosure with acoustic absorption installed to the walls.
• Acoustic insulation/lagging is installed across some of the components on 2 out of 3 of the chillers.</td><td>No</td><td>• Add further acoustic lagging/jackets around noise generating parts including the oil separators and screw compressors. Typical sound reduction with the installation of acoustic lagging/jackets is 4 – 8 dB when installed.
• Construct a full enclosure including roof to replace the chiller compound.
• Look for an alternative type of chiller (not a cooled water rotary screw chillers). High speed rotary components produce clear pure tone noises which can vary in frequency (giving the siren type quality in this case).</td><td>Yes

Acoustic lagging is already installed in some areas but should cover all high noise generating components.</td></tr>
</table>

Source	Noise generating parts (in order of dominance)	Current Noise Control Measures	Already employing BAT?	Potential BAT Measures	Recommended for Improvement?
Cooling Tower Pumps	• Rotary component (speed/vane passing frequency creates a whine)	• Partial enclosure installed around the pumps. • Contained at the corner of the Boiler House which provides some screening to residents to the west.	No	• Increasing the size of the enclosure, which had an open end and a roof which appear to cover around two-thirds of the pumps. A louvred panel could be placed over the open end. • Adding a secondary enclosure/barrier with door on the south-east side of the pumps. • Adding acoustic lagging/jackets to the pumps.	Yes Some acoustic lagging and enclosing is already installed but could be improved.
Milk Tankers (pumping and idling)	• Engine idling • Pumps	• Low noise emission pumps are installed (engine noise is dominant)	No	• An electric pumping system – noise emissions could be reduced by using an electric motor/pump system rather than powering pumps from the tankers diesel engine. Electric motors can be retrofitted to existing trucks and is charged while the vehicle is in motion.	Maybe Not a significant source of complaints to PJA's knowledge, but a significant source of noise at NSR 3.
Milk Silo Exhausts	• Exhaust (presumably fan driven)	• None to PJA's knowledge.	No	• Installing in-duct noise silencers between the fan and exhaust. • Replacing the existing louvres with acoustic louvres.	Maybe Broadband noise with no tonal qualities, not particularly disturbing at this stage compared to other noise sources.
Borehole Pump Room	• Several pumps	• Installed within a room rather than located outside	No	• The door was left open at all times whilst PJA were on site. Simply closing this door would significantly reduce noise breakout. A ventilation fan was present in the façade but did not appear to be in use. The room should be able to ventilate with the door closed.	Yes Noise emissions should be controlled by simply closing the door.

Source	Noise generating parts (in order of dominance)	Current Noise Control Measures	Already employing BAT?	Potential BAT Measures	Recommended for Improvement?
Boiler House Pressure Valve Release	• Valve	• Exhausts at the rear of the building without line of sight to most residents.	No	• An exhaust silencer could be installed on the flue.	Maybe As this only occasionally happens, it would not appear critical to treat this before other noise sources.
LNG (alarm)*	• Tonal alarm	• Alarm within a small box/enclosure – door can be closed	Yes	• Keeping the door on the alarm closed, with the operator nearby (alarm is loud enough to be heard without needing the door open).	No The alarm is necessary.
Cooling Towers	• Fans/airflow	• New cooling towers recently installed with acoustic silencers on all exhausts.	Yes	N/A	No Already improved recently
Glycol Pumps (Chiller Base)	• Rotary component (speed/vane passing frequency creates a whine)	• Installed in an open top enclosure with acoustic absorption installed to the walls. • Acoustic insulation/lagging is installed across some of the components on 2 out of 3 of the pumps.	No	• Add acoustic lagging/jackets to the middle pump. Two out of the three pumps already have this. The middle pump did not and was noticeably louder than the other two. • Construct a smaller enclosure around the pumps.	Maybe Acoustic lagging should be added to the middle pump if possible – though not a priority.
Whey Dispatch Pump	• Rotary component (speed/vane passing frequency creates a whine)	• Acoustic insulation/lagging is installed on some of the components.	No	• Add acoustic lagging/jackets to all noise generating parts. Parts appeared to have this already, but parts that did not were clearly noisier. • Construct a one-side enclosure or barrier around the pump on it's east side (between it and the tanker).	Maybe Not critical in comparison to other noise sources.

Source	Noise generating parts (in order of dominance)	Current Noise Control Measures	Already employing BAT?	Potential BAT Measures	Recommended for Improvement?
Boiler House Louvres	• General broadband noise from inside	• None to PJA's knowledge	No	• Replacing the existing louvres with acoustic louvres.	Maybe Not critical in comparison to other noise sources.
Pump House	• Several pumps	• None to PJA's knowledge	No	• The enclosure had no door and all windows were open. Installing a better ventilation system would enable a smaller façade open area through which noise escapes.	Maybe Not critical in comparison to other noise sources.
Production Hall Exhausts	• Fans/airflow	• None to PJA's knowledge.	No	• Installing in-duct noise silencers between the fan and exhaust. • Replacing the existing louvres with acoustic louvres.	No Not particularly loud or disturbing.
LNG (pressure fill)	• Valves on the rear of the tanker	• Recently changed from pumping mechanism to 'silent' pressure fill process.	Yes	N/A	No Already improved recently and not audible at residents
Borehole Water Tank	• Pump	• None to PJA's knowledge (though the pump is relatively well screened from residents)	No	• Enclosure could be constructed around the pump.	No Not particularly loud or disturbing.

Appendix A – Acoustic Terminology and Concepts

A.1 – Glossary

Table A.1 – Glossary of acoustic terminology

Term	Description
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio of the root-mean-square pressure of the sound and a reference pressure (2x10-5 Pa).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Frequency	Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63Hz to 4000Hz (4kHz). This is roughly equal to the range of frequencies on a piano. Frequency is often divided into ('first') octave bands for analysis, with the range above considered within 7 octave bands with centre frequencies at 63 Hz, 125 Hz, 250 Hz, 1 kHz, 2 kHz and 4 kHz. 'Third' octave bands split this further into smaller frequency bands. This is typically only referenced in assessment of tonality of a noise source by identifying peaks (tones) in the frequency spectrum, i.e. when applying a rating penalty for tonality within a BS 4142:2014 assessment.
$L_{Aeq,T}$	L_{Aeq} is defined as the notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period. This parameter is typically considered as a good representation of the 'average' overall noise level. It is referred to technically as the A-weighted equivalent continuous sound level and is a dB(A) as defined above.
$L_{A90,T}$	The A-weighted noise level that is exceeded for 90% of the measurement period T. This parameter is often considered as the 'average minimum level'.
$L_{A10,T}$	The A-weighted noise level that is exceeded for 10% of the measurement period T. This parameter is often considered as the 'average maximum level';
$L_{AFmax,T}$	The maximum A-weighted noise level during the measurement period T.

A.2 – Subjective Changes in Noise Level

Table A.2 – Subjective loudness from an increase or decrease in sound pressure level

Change in sound pressure level	Relative change in sound power energy (multiplier)		Change in apparent subjective loudness (for mid-frequency range)
	Decrease	Increase	
3 dB	1/2	2	'Just perceptible'
5 dB	1/3	3	'Clearly noticeable'
10 dB	1/10	10	'Half or twice as loud'
20 dB	1/100	100	'Much quieter, or louder'

Appendix B – Measurement/Modelling Details

B.1 – Survey Equipment

The monitoring equipment used for the baseline noise survey is detailed in the table below. The sound level meters were calibrated before and after the survey, with no significant drifts of greater than 0.5 dB observed. The sound level meters has been calibrated to a traceable standard within the 24 months preceding the survey, and the calibrators have been calibrated to a traceable standard within the 12 months preceding the survey. The equipment complies with the standards of as BS EN 60942:2003 Class 1 device.

Table B.1 – Equipment used for the noise survey

Name	Serial Number	Last Calibrated	Calibration Due
SVAN 949 Class 1 Sound Level Meter	9720	Oct-19	Oct-21
SV22 Class 1 Microphone	4012386	Oct-19	Oct-21
SVAN 949 Class 1 Sound Level Meter	9719	Oct-19	Oct-21
SV22 Class 1 Microphone	4011862	Oct-19	Oct-21
SV 30A Acoustic Calibrator	10511	Oct-19	Oct-21

B.2 – Noise Modelling

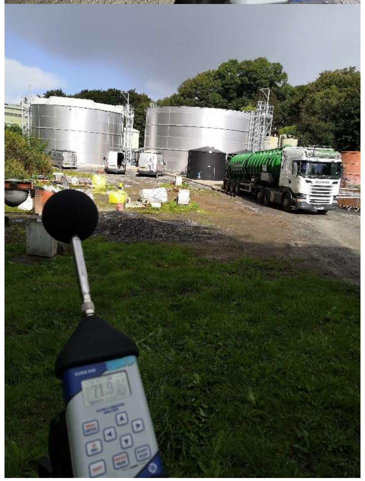
The noise predictions within this report have been undertaken using the proprietary software CadnaA® by DataKustik, a 3-D noise mapping package which implements a wide range of national and international standards, guidelines and calculation algorithms, including those set out in ISO 9613-2:1996.

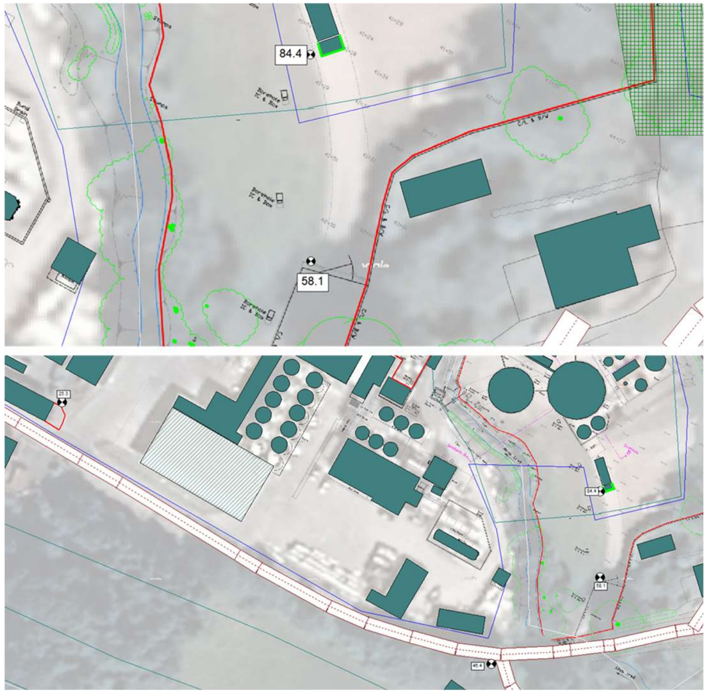
The noise model has been used to help predict noise contributions from each process/plant based upon measurements taken close to source. This is necessary as most noise sources are not loud enough to be dominant over the background noise at the nearby residents. The noise model has assumed:

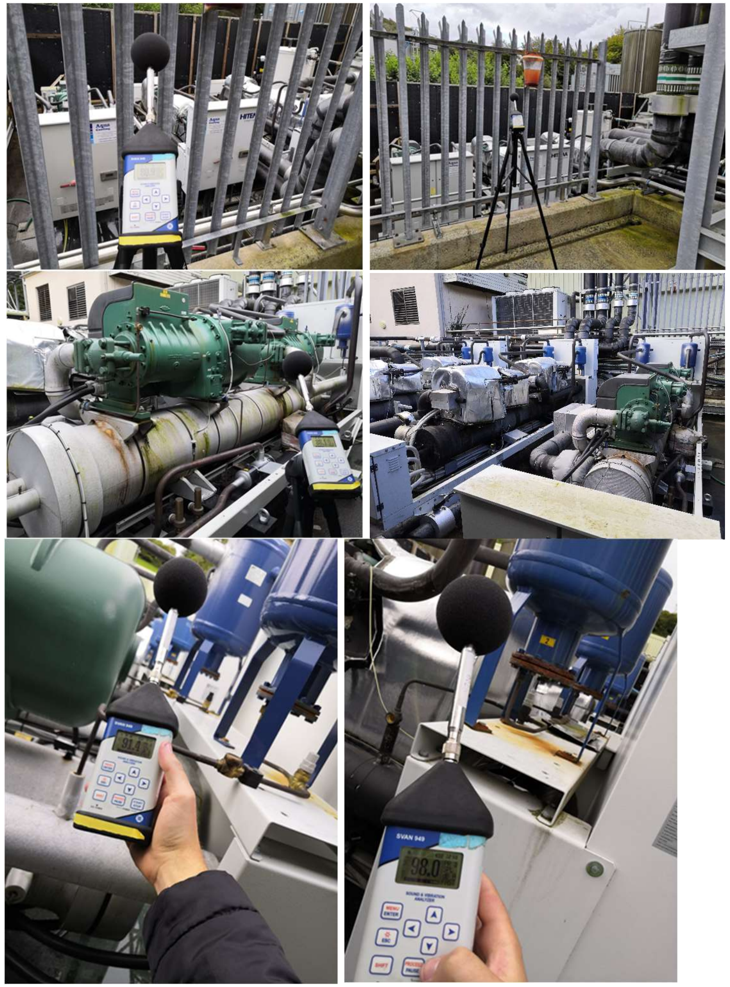
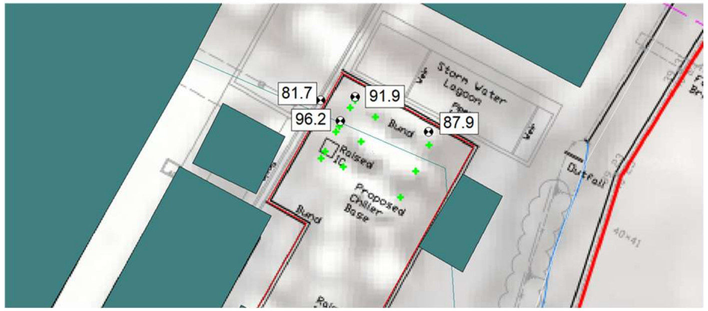
- downwind propagation, i.e. a wind direction that assists the propagation of sound from source to receptor;
- a ground absorption factor of 0 on any roads, car parks, buildings, and any tarmacked/concreted areas;
- a ground absorption factor of 1 on grassy areas;
- a maximum reflection factor of three where buildings and barriers are assumed to have a 'smooth' reflective façade, as a worst-case;
- atmospheric sound absorption based upon a temperate of 10°C and a humidity level of 70%, as per Table 2 of ISO 9613-2:1996.

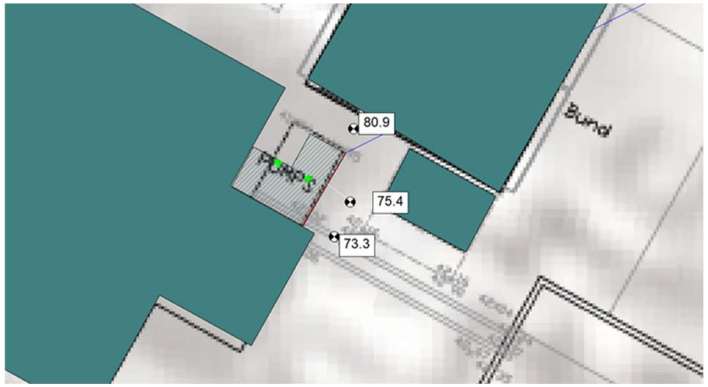
B.3 – Operational Noise Results

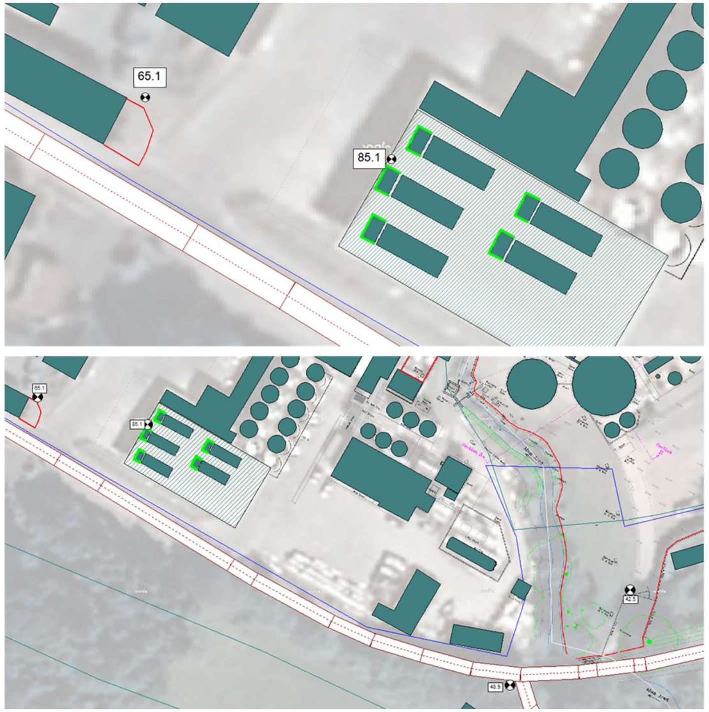
Shown on the subsequent pages.

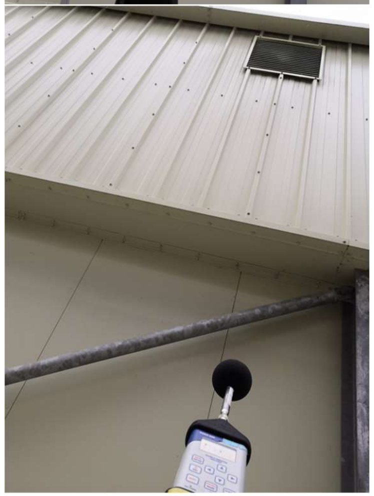
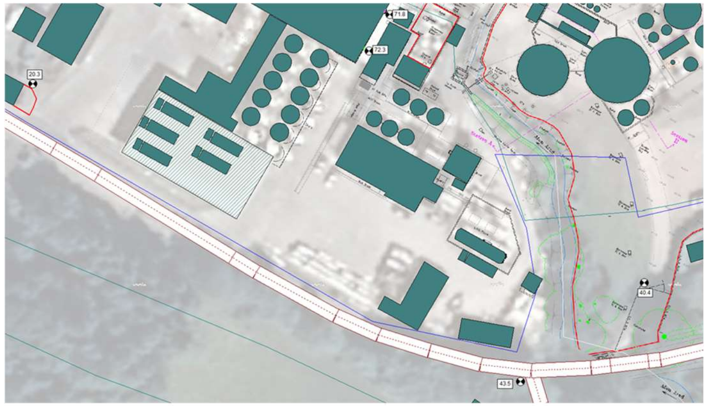
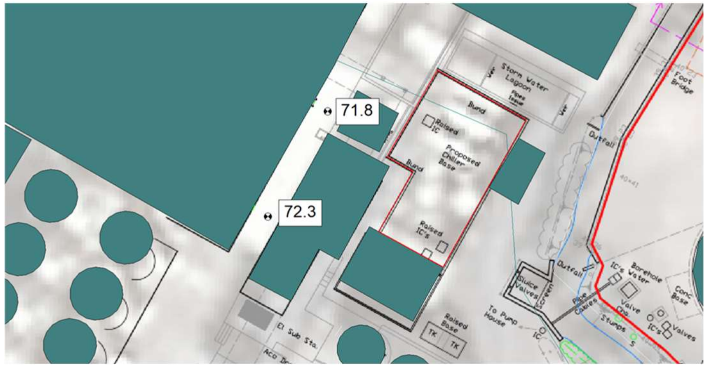
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
ETP Tankers (pumping)	**<u>Source</u>** 89 – 91 dB @ 2m from Vacuum Pump and Hydraulic Cooler **<u>NSR 1</u>** 72 dB (dominant) **<u>NSR 2</u>** 60 dB (dominant) **<u>NSR 3</u>** 39 dB (not perceptible the majority of the time)	   	Not required as noise source was dominant during the measurements.

Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
ETP Tankers (idling)	<u>**Source**</u> 85 dB @ 1m from front cab <u>**NSR 1**</u> 58 dB (dominant) <u>**NSR 2**</u> 46 dB (distinguishable) <u>**NSR 3**</u> 25 dB (not perceptible)		

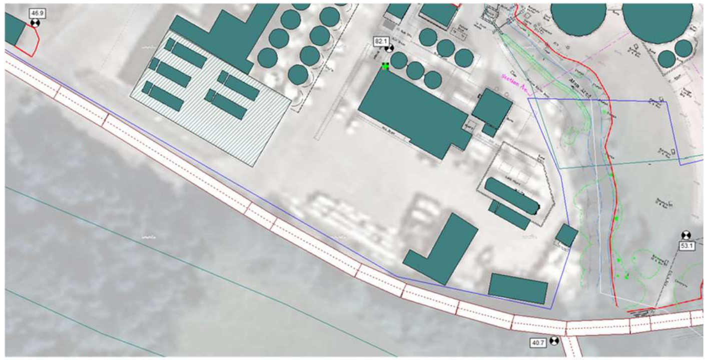
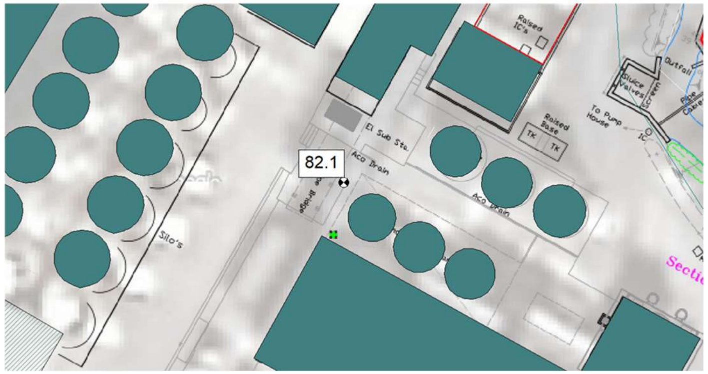
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Chillers	**<u>Source</u>** 85 - 90 dB average inside chiller compound depending on load. 92 dB by chiller 3 oil separator under high load 86 - 97 dB by chiller 2 oil separator depending upon load. **<u>NSR 1</u>** 49 dB (steady and dominant) **<u>NSR 2</u>** 42 dB (perceptible) **<u>NSR 3</u>** 29 dB (just perceptible)		 

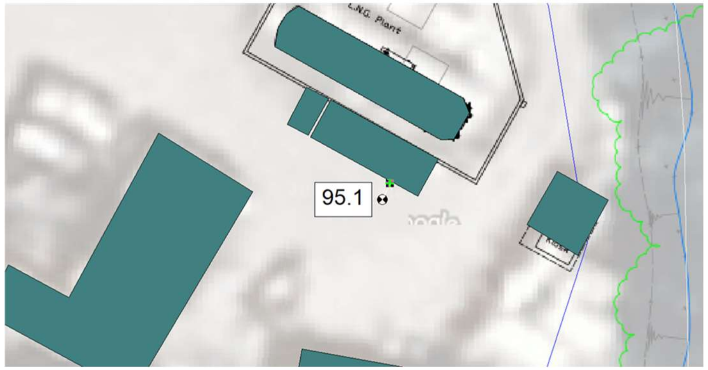
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Cooling Tower Pumps	<u>**Source**</u> 81 dB @ 1m in front of enclosure. 76 dB @ 1m to side of enclosure. 74 dB @ 1m to rear of enclosure. <u>**NSR 1**</u> 45 dB (perceptible) <u>**NSR 2**</u> ≈45 dB (perceptible during periods of low traffic) <u>**NSR 3**</u> 24 dB (not perceptible)	     	 

Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Milk Tankers (pumping and idling)	**<u>Source</u>** 85 dB @ 1m from front cab **<u>NSR 1</u>** 42 dB (barely perceptible) **<u>NSR 2</u>** 48 dB (perceptible during quiet periods of road traffic) **<u>NSR 3</u>** 65 dB (dominant)		

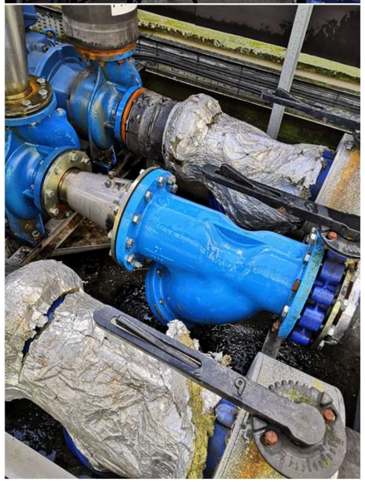
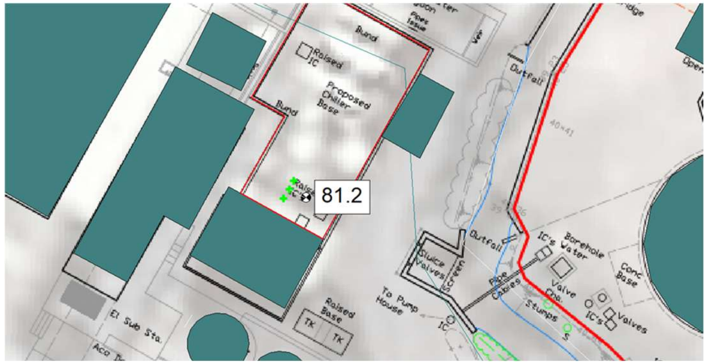
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Milk Silo Exhausts	<u>**Source**</u> 72 dB at ground level below <u>**NSR 1**</u> 40 dB (audible broadband noise – not distinguishable from other noise sources) <u>**NSR 2**</u> 45 dB (audible broadband noise – not distinguishable from other noise sources) <u>**NSR 3**</u> 20 dB (inaudible)	 	 

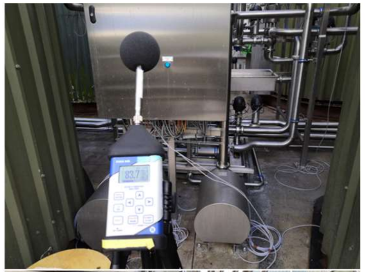
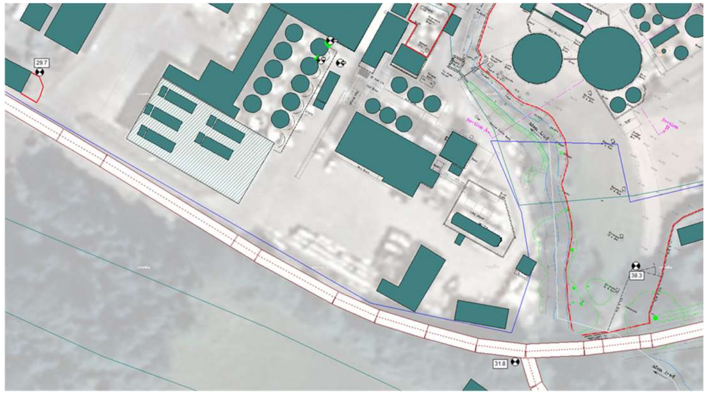
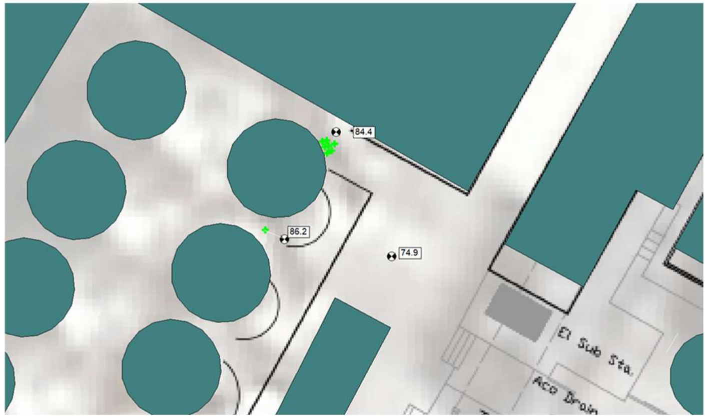
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Borehole Pump Room	<u>**Source**</u> 82 dB inside the pump room. 76 dB 1m outside open door. <u>**NSR 1**</u> 38 dB (perceptible broadband noise though not overly distinguishable from other sources) <u>**NSR 2**</u> 26 dB (barely perceptible) <u>**NSR 3**</u> 15 dB (inaudible)		 

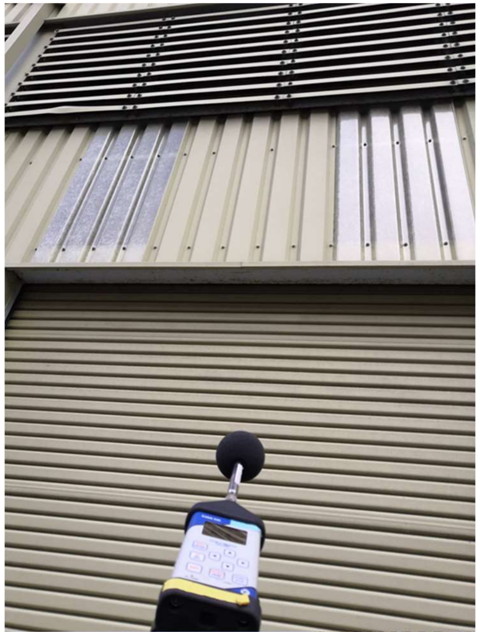
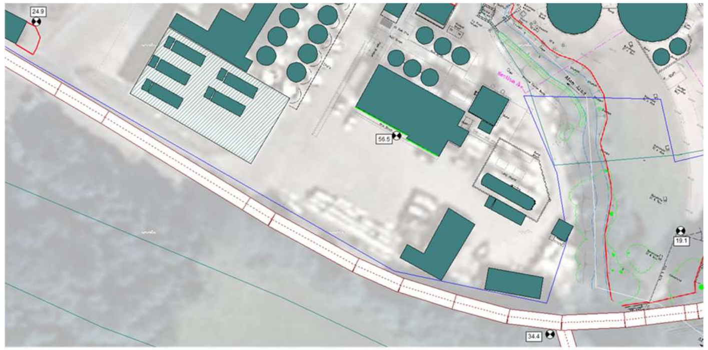
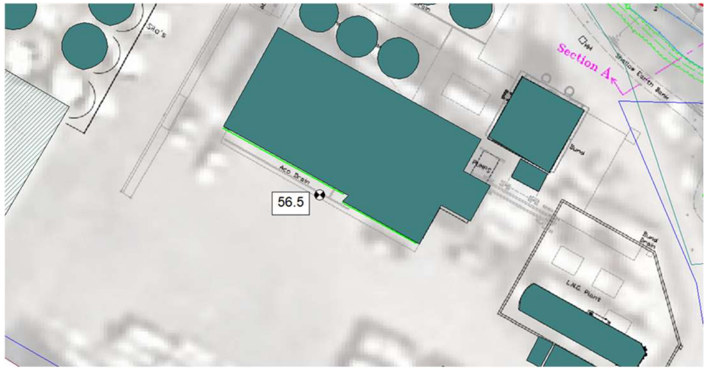
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Boiler House Pressure Valve Release	**Source** <82 dB at ground level beneath the exhaust **NSR 1** 54 dB when on (audible broadband noise – 49 dB when off) **NSR 2** 50 dB when on (audible broadband noise – 48 dB when off) **NSR 3** 47 dB (audible broadband noise)	 	 

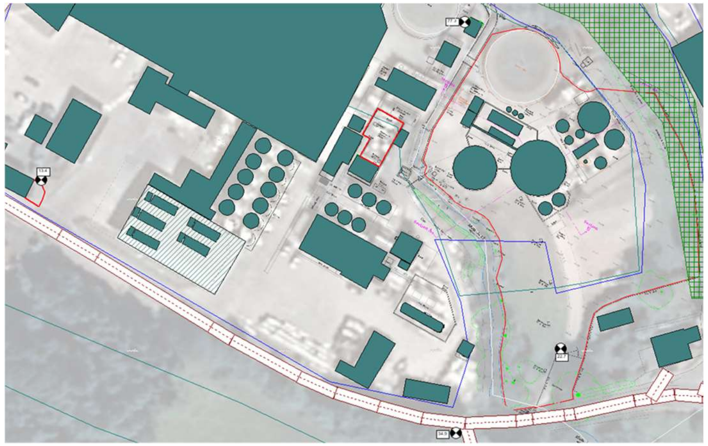
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
LNG (alarm)	<u>**Source**</u> 95 dB @ 1m from alarm (door open) 71 dB @ 1m from alarm (door closed) Alarm sounds for a couple of seconds every 3 minutes <u>**NSR 1**</u> 45 dB (open) 21 dB (closed) <u>**NSR 2**</u> 64 dB (open) 40 dB (closed) <u>**NSR 3**</u> 45 dB (open) 21 dB (closed)		 

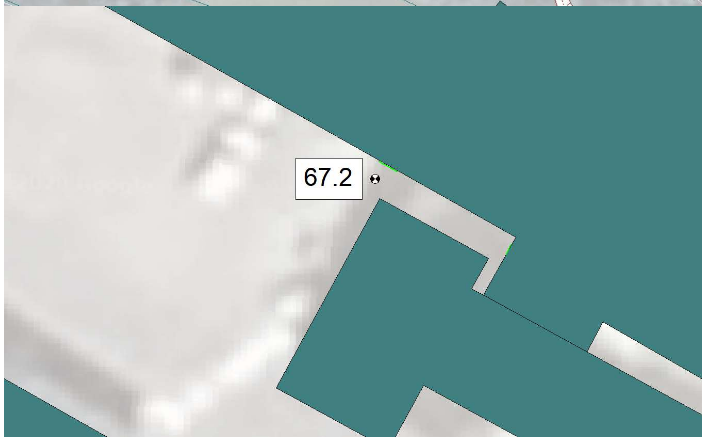
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Cooling Towers	**<u>Source</u>** ≈58 dB @ 3m **<u>NSR 1</u>** 31 dB (barely perceptible – broadband noise) **<u>NSR 2</u>** 36 dB (barely perceptible – broadband noise) **<u>NSR 3</u>** 11 dB (not audible)	 	 

Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Glycol Pumps (Chiller Base)	**Source** 81 dB @ 1m in front of 3 pumps **NSR 1** 33 dB (barely perceptible – slight tonal quality) **NSR 2** 25 dB (not perceptible) **NSR 3** 17 dB (inaudible)	   	 

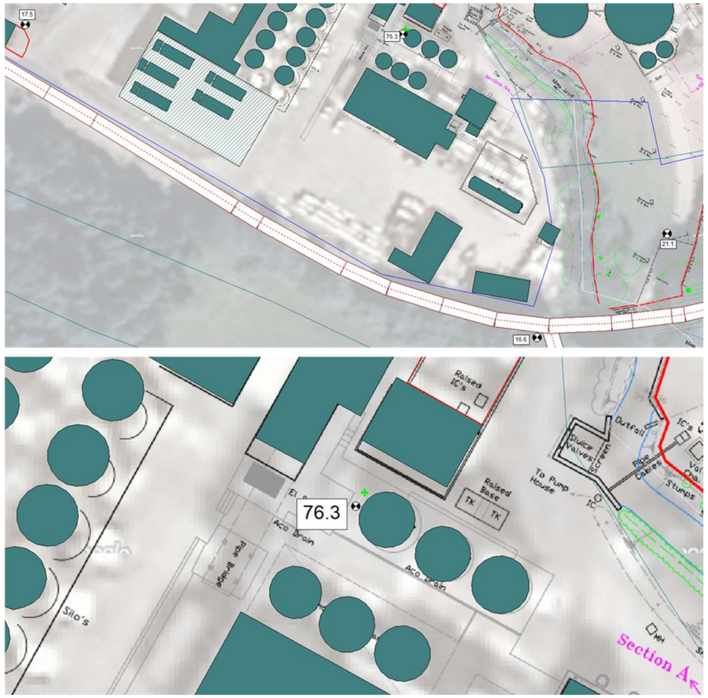
Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Whey Dispatch Pump	<u>**Source**</u> 86 dB at 1m from noisiest dispatch pump <u>**NSR 1**</u> 38 dB (just perceptible) <u>**NSR 2**</u> 32 dB (just perceptible) <u>**NSR 3**</u> 30 dB (just perceptible)	     	 

Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Boiler House Louvres	**Source** ≈55 dB at ground level beneath the exhaust **NSR 1** 20 dB (not perceptible) **NSR 2** 35 dB (just perceptible broadband noise thought not typically distinguishable from residual noise) **NSR 3** 25 dB (just perceptible)	 	 

Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Pump House	**Source** 88 dB inside when on – 53 dB when off. 78 dB 1m outside open door when on. **NSR 1** 23 dB (not perceptible) **NSR 2** 35 dB (barely perceptible but not distinguishable from residual noise) **NSR 3** 13 dB (dominant)		 

Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Production Hall Exhausts	**<u>Source</u>** <67 dB at ground level in sight of two exhausts **<u>NSR 1</u>** 13 dB (inaudible) **<u>NSR 2</u>** 13 dB (inaudible) **<u>NSR 3</u>** 34 dB (just perceptible)	 	 

Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
LNG (pressure fill)	<u>**Source**</u> ≈58 dB @ 1m (quiet – other noise sources influencing) <u>**NSR 1**</u> <17 dB (inaudible) <u>**NSR 2**</u> <26 dB (not perceptible) <u>**NSR 3**</u> Negligible	 	

Noise Source	Measured/ Predicted Noise Levels (L_{Aeq}) / Subjective Observations	Site Photographs	Noise Model Screenshots
Borehole Water Tank	<u>Source</u> 76 dB @ 1m <u>NSR 1</u> 21 dB (not perceptible) <u>NSR 2</u> 17 dB (not perceptible) <u>NSR 3</u> 18 dB (not perceptible)		

B.4 – Background Noise Monitor at Site Boundary/NSR 1

Figure B.1 – Baseline noise levels during operations at NSR 1

Appendix C – Relevant Guidelines

C.1 - Horizontal Guidance Note for Noise Assessment and Control

The purpose of the *Horizontal Guidance Note for Noise Assessment and Control* is to provide supplementary information, relevant to all sectors, to assist in preventing and minimising emissions of noise as described in the Sector Guidance Notes (or the General Sector Guidance Note).

The guidance is in two parts:

Part 1 – Regulation and Permitting – outlines the main considerations relating to the setting of Permit conditions and subsequent regulation of noise. Part 1 is aimed primarily at the information needs of regulators.

Part 2 – Noise Assessment and Control – describes the principles of noise measurement and prediction and the control of noise by design, by operational and management techniques and abatement technologies. Outline methods of noise control are provided such as:

- use of inherently quieter processes;
- selection of inherently quiet plant or "low-noise options";
- site layout to maximise natural screening, screening by buildings and separation distances;
- the orientation of directional noise sources away from sensitive receptors; and
- noise barriers or bunding.

C.2 - BS 4142:2014

BS 4142:2014 *'Methods for rating and assessing industrial and commercial sound'* is intended to be used to assess the potential adverse impact of sound of an industrial and/or commercial nature, at nearby noise-sensitive receptor (NSR) locations within the context of the existing sound environment. The method is based upon assessing the predicted noise emissions from plant against the existing background sound levels at NSRs. The predicted emissions are termed as a 'rating level', which is the specific sound level from plant, plus 'penalties' which account for whether the noise has distinguishing characteristics such as tonality, intermittency, impulsivity, or is generally distinguishable from the ambient noise environment. Such features may attract attention and be considered annoying, hence sounds with these qualities should be penalised over sounds at the same specific noise level which is less intrusive.

The significance of the impact of an industrial or commercial sound source depends on both the margin by which the rating level $L_{Ar,Tr}$ exceeds the background sound level $L_{A90,T}$ and the context in which the sound occurs. It is therefore essential to place the sound in context. But in general, *"the lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."* However, if the rating level does exceed the background sound level, "a difference of around + 5 dB is likely to be an indication of an adverse impact, depending on the context", and "a difference of around +10 dB or more is likely to be an indication of a significant adverse impact depending on the context."

C.3 - BS 8233:2014

BS 8233:2014 '*Guidance on Sound Insulation and Noise Reduction for Buildings*' suggests appropriate criteria and limits for different situations. This includes internal noise criteria for residential developments. The limits with BS 8233:2014 are similar to those in the WHO's '*Guidelines for Community Noise* and *Night Noise Guidelines for Europe*' document.

Table 4 of BS 8233:2014 provides internal ambient noise level (IANL) limits for dwellings from "*steady external noise sources*". These are summarised in Table 3.1 below.

Table C.1 – BS 8233:2014 internal ambient noise level (IANL) upper limits

Activity	Location	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Resting	Living Room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining Room/Area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

In Annex G.1 of BS 8233:2014 it suggests that "*if partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB*". Therefore, a noise limit directly outside of the nearest residential windows could be set based upon the values above plus 15 dB.

Therefore, to meet internal noise targets in nearby residential dwellings, noise from the proposed plant should not exceed 50 dB L_{Aeq} during the daytime and 45 dB L_{Aeq} during the night-time when measured/calculated directly outside of a residential bedroom or living room window.

C.4 - World Health Organisation (WHO) Environmental Noise Guidelines

The WHO document *Guidelines for Community Noise 1999* has recently been superseded by the *Environmental Noise Guidelines for the European Region*. However, the updated guidance states that '*all WHO guidelines for community noise (CNG) indoor guideline values and any values not covered by the current guidelines (such as industrial noise and shopping areas) should remain valid*'.

The document sets out guidance as to noise levels at which there will be an unacceptable impact on the local community. WHO guidelines state:

- To protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise.
- To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB $L_{Aeq.}$

Therefore, noise from the proposed plant should ideally be designed to not exceed 50 dB L_{Aeq} during the daytime when measured or calculated within a residential garden, patio, or balcony.

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