hepworth acoustics

DAIRY CREST WWTP, DAVIDSTOW

APRIL 2020 NOISE ASSESSMENT

On behalf of:

Dairy Crest Limited t/a Saputo Dairy UK

Report No: P20-150-R01v1
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DAIRY CREST WWTP, DAVIDSTOW

APRIL 2020 NOISE ASSESSMENT

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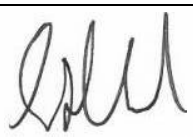
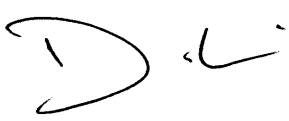
Report prepared by: Graham Bowland BSc MIOA – Technical Director	
Report checked by: Donald Quinn BSc FIOA – Managing Director	

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1.0 INTRODUCTION

1.1 Hepworth Acoustics Ltd was commissioned to carry out a noise assessment relating to the Wastewater Treatment Plant (WWTP) associated with the Davidstow Creamery, which is ~850m to the west of the WWTP.

1.2 This noise assessment has been commissioned to evaluate current operational noise emissions from the WWTP after completion of various improvements/alterations at the site since July/August 2018. As such, the noise assessment is similar in nature to a previous baseline assessment undertaken in July/August 2018, as set out in report ref: P18-098-R01v2, dated October 2018.

1.3 A key purpose of the noise assessment is to establish the refreshed baseline for noise emissions from the WWTP, against which any future ongoing improvements, if necessary, may be evaluated.

1.4 A detailed programme of noise measurements and weather monitoring has been undertaken on and around the WWTP site over an extended period.

1.5 The various noise units and indices referred to in this report are described in Appendix I. All noise levels mentioned in the text have been rounded to the nearest decibel, as fractions of decibels are imperceptible.

2.0 ACOUSTIC CRITERIA

BS 4142

2.1 Relevant guidance relating to assessment of noise from the WWTP is set out in British Standard 4142: 2014 +A1: 2019 *Methods for rating and assessing industrial and commercial sound*. The standard provides methods for rating and assessing sound of an industrial nature from industrial or commercial premises.

2.2 The 'rating' level is based on the 'specific' L_{Aeq} sound level attributable to the operation with an 'acoustic feature' penalty added for any sound sources which give rise to tonal, impulsive, intermittent, or other characteristics readily distinctive against the residual acoustic environment.

2.3 BS 4142 stipulates that impacts should be assessed over a reference time interval of 1-hour during the daytime (0700-2300hrs) and 15-minutes during the night-time (2300-0700hrs).

2.4 An initial numerical estimate of the impact of the operation is determined by subtracting the background level from the rating level. BS 4142 states that:

- Typically, the greater this difference, the greater the magnitude of the impact
- A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context
- A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context
- The lower the rating level is relative to the measured background level, the less likely it is that the operation 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.

2.5 Where the initial estimate of the impact needs to be modified due to the context, BS 4142 states that all pertinent factors should be taken into account in determining whether the initial estimate of the impact needs to be modified, including:

- The absolute level of noise
- The character and level of the residual noise
- The sensitivity of the receptor

2.6 Regarding background sound levels, BS 4142 requires *that "values are reliable and suitably represent the particular circumstances and periods of interest… the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods*". It is also stated that "*diurnal patterns can have a major influence on background sound levels and, for example, the middle of the night can be distinctly different (and potentially of lesser importance) compared to the start or end of the night-time period for sleep purposes*".

BS 8233

2.7 British Standard 8233: 2014 *Guidance on sound insulation and noise reduction for buildings,* recommends design criteria for acceptable noise levels within residential accommodation. BS 8233 guidelines for the daytime and night-time are summarised in Table 1.

Table 1 : BS 8233 Recommended Internal Noise Levels

Activity	Location	Internal Noise Levels	
		Daytime 0700-2300hrs	Night-time 2300-0700hrs
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 $L_{Aeq,8hr}$

2.8 BS 8233 clarifies that the above guidance relates only to noise without specific character (e.g. such as that which does not have a distinguishable, discrete and continuous tone, is irregular enough to attract attention, or has strong low-frequency content) and that where such characteristics are present, lower noise limits might be appropriate.

2.9 Regarding outdoor living areas, BS 8233 states that "*it is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB L_{Aeq}, which would be acceptable in noisier environments.*".

3.0 NOISE SURVEYS

Trewassa Noise Monitoring

3.1 Continuous noise monitoring was undertaken at a single location to the south of residential properties at Trewassa, which is a hamlet to the northwest/north-northwest of the WWTP, identified in Figure 1. The monitoring was undertaken in sequential 15-minute samples over a complete 7-day period commencing at 1500hrs on Thursday 9 April 2020.

3.2 The noise monitoring was undertaken by deployment of a Norsonic 140 Type 1 Integrating Sound Level Meter (serial no. 1406529). Field calibration checks were carried out before and after the monitoring using a Norsonic 1251 class 1 acoustical calibrator (serial no. 20804), and no variation in the calibration levels was observed.

3.3 The measurement microphone was fitted with a windshield and mounted at ~3m above local ground to ensure free-field conditions and to minimise any noise from wind in long grass on the adjacent Cornish hedge.

3.4 Continuous audio recording and weather monitoring was also undertaken over this period. The weather data was recorded by the WWTP system and the data passed to us.

3.5 It is understood that operations at the WWTP were generally normal and routine throughout the course of the noise monitoring period.

3.6 Table 2 provides the summary of the noise levels. To provide a suitable summary of the considerable quantity of data recorded, the range of $L_{Aeq,15min}$, $L_{Amax,15min}$ and $L_{A90,15min}$ values has been determined for each 1-hour period, along the logarithmic average of $L_{Aeq,15min}$ and arithmetic average of $L_{A90,15min}$. Accounting for the appropriate assessment time intervals prescribed by BS 4142, the hourly data has been considered for the night-time period, as this shows the range of 15-minute values in each hour, whereas for the daytime period, for ease this has been averaged further in to each daytime 4-hour period, hence still showing the range of 1-hour values and illustrating the general variations over time. This results in a larger quantity of data for the night-time period being presented than for the daytime.

3.7 All 15-minute $L_{Aeq,15min}$, $L_{Amax,15min}$ and $L_{A90,15min}$ values are plotted graphically in Appendix II.

3.8 The graph in Appendix II also includes the measured wind speed as well as an 'illustrative wind factor'. This is based upon the wind speed multiplied by either a positive or negative figure, of a magnitude relative to the wind direction, compared to the axis from the WWTP to the monitoring location at Trewassa. For ease, this has been corrected to be scaled in-between the noise data and wind speed data on the graph in Appendix II, centred at 30. The higher the 'illustrative wind factor' the greater the positive wind vector from the WWTP to the monitoring location, the lower the value the greater the negative vector, with a notional negligible effect occurring at a value of around 30.

Table 2 : Summary of Noise Measurements at Trewassa

Summary Time Period Start	Noise Level dB (T=15min)					Summary Time Period Start	Noise Level dB (T=15min)				
	$L_{Aeq,T}$		$L_{Amax,T}$	$L_{A90,T}$			$L_{Aeq,T}$		$L_{Amax,T}$	$L_{A90,T}$	
	Range	Ave.	Range	Range	Ave.		Range	Ave.	Range	Range	Ave.
09/04 1500	44-48	46	50-65	41-47	44	13/04 0300	48-49	48	53-63	46-47	46
09/04 1900	47-50	48	50-68	46-48	47	13/04 0400	48-49	48	54-60	46-47	47
09/04 2300	48-49	48	51-61	47-48	47	13/04 0500	48-51	49	54-64	47-48	47
10/04 0000	48-48	48	50-58	47-47	47	13/04 0600	48-49	49	54-59	47-47	47
10/04 0100	48-49	48	52-60	47-48	47	13/04 0700	49-53	50	60-72	47-49	48
10/04 0200	48-49	48	51-55	47-48	47	13/04 1100	48-51	49	58-67	45-48	47
10/04 0300	47-49	48	51-62	46-47	47	13/04 1500	47-48	48	55-63	45-47	46
10/04 0400	47-48	47	49-67	46-47	46	13/04 1900	47-48	48	51-58	46-47	46
10/04 0500	48-49	48	50-65	47-48	47	13/04 2300	48-48	48	51-56	47-47	47
10/04 0600	48-50	49	53-57	47-48	48	14/04 0000	48-49	48	52-55	47-47	47
10/04 0700	48-49	48	52-64	47-48	47	14/04 0100	48-48	48	52-55	46-47	47
10/04 1100	48-52	49	52-71	47-51	48	14/04 0200	48-48	48	52-57	47-47	47
10/04 1500	47-49	48	51-68	46-47	47	14/04 0300	48-48	48	51-58	47-47	47
10/04 1900	47-50	49	51-57	46-49	48	14/04 0400	47-48	48	52-53	47-47	47
10/04 2300	48-49	48	50-58	47-48	47	14/04 0500	47-51	49	52-59	46-48	47
11/04 0000	47-48	48	49-50	46-47	47	14/04 0600	49-49	49	55-74	47-48	48
11/04 0100	47-48	47	49-51	46-47	47	14/04 0700	48-50	49	51-65	47-48	47
11/04 0200	48-48	48	50-52	47-47	47	14/04 1100	48-50	48	53-73	45-48	47
11/04 0300	48-48	48	50-53	47-47	47	14/04 1500	47-48	48	52-65	46-47	47
11/04 0400	47-47	47	49-50	46-47	46	14/04 1900	47-49	48	50-56	46-48	47
11/04 0500	47-49	48	51-60	45-46	46	14/04 2300	49-49	49	52-54	48-48	48
11/04 0600	47-49	48	56-69	45-46	46	15/04 0000	48-49	49	51-53	47-48	48
11/04 0700	45-49	48	51-66	43-48	47	15/04 0100	49-49	49	52-55	48-48	48
11/04 1100	42-52	46	49-67	39-44	42	15/04 0200	49-49	49	52-53	47-48	47
11/04 1500	43-46	45	50-59	41-45	43	15/04 0300	48-49	48	52-53	47-48	47
11/04 1900	45-47	46	48-61	43-46	44	15/04 0400	48-49	48	52-56	47-48	47
11/04 2300	47-49	48	51-52	45-47	46	15/04 0500	48-50	49	52-56	47-48	48
12/04 0000	45-46	45	48-48	44-44	44	15/04 0600	49-50	49	58-61	48-48	48
12/04 0100	42-46	44	47-54	40-45	42	15/04 0700	49-50	49	53-71	47-48	47
12/04 0200	44-46	45	47-52	42-45	44	15/04 1100	47-49	48	53-71	46-47	46
12/04 0300	45-46	45	49-55	43-44	44	15/04 1500	47-50	49	52-75	45-47	46
12/04 0400	45-48	47	50-52	44-47	45	15/04 1900	47-49	48	50-61	46-48	47
12/04 0500	49-50	49	55-60	47-48	48	15/04 2300	47-48	48	50-53	47-47	47
12/04 0600	49-51	50	54-60	48-49	48	16/04 0000	47-48	47	51-52	46-47	46
12/04 0700	45-49	48	51-70	41-48	46	16/04 0100	47-48	48	51-55	46-47	47
12/04 1100	46-57	49	50-80	44-47	46	16/04 0200	48-48	48	50-55	47-47	47
12/04 1500	46-48	48	51-69	44-47	46	16/04 0300	48-49	49	52-55	47-48	48
12/04 1900	47-49	48	50-65	46-47	47	16/04 0400	48-48	48	51-53	47-47	47
12/04 2300	48-48	48	50-51	47-48	47	16/04 0500	48-49	49	51-58	47-48	48
13/04 0000	47-48	47	51-58	46-47	46	16/04 0600	49-49	49	54-71	48-48	48
13/04 0100	47-48	48	50-60	46-47	47	16/04 0700	48-50	49	53-68	46-49	47
13/04 0200	47-48	48	54-56	46-47	46	16/04 1100	48-50	49	55-69	46-48	47

3.9 The data in Table 2 demonstrates that generally noise levels were fairly steady over the monitoring period. Typically, the L_{Aeq} and corresponding L_{A90} values were also close in values, indicating that noise levels were generally steady over the course of individual 15-minute sample periods.

3.10 A notable period where a pronounced deviation between L_{Aeq} and corresponding L_{A90} values does occur during the period starting at 1445hrs on 12 April, however interrogation of the audio recording for this period reveals that this was due to aircraft/helicopter noise.

3.11 A less pronounced deviation between L_{Aeq} and corresponding L_{A90} values occurs during the period staring at 1315hrs on 12 April. Recordings indicate that this was likely due to a period of 6-7minutes of heavy vehicle activity, likely at the WWTP site, but potentially at Trewassa or within the intervening field.

3.12 Otherwise, in terms of variation in noise levels over the course of the monitoring period, as the graph in Appendix II indicates, wind speed and direction has clear influence on measured noise levels.

3.13 Consideration of the measured third octave band noise levels demonstrates little variation in the character of the noise, and also a general absence of tonal components. The noise is generally dominant across a broad mid-frequency range of 250Hz-2kHz.

On-site Noise Measurements

3.14 A set of reference noise level measurements was undertaken on Thursday 9 April 2020 at the WWTP site in locations near to individual fixed items of noise generating equipment, groups of fixed items, and buildings housing such items.

3.15 The on-site noise measurements were carried out using a Bruel & Kjaer 2260 Type 1 Integrating Sound Level Meter (serial no. 2467014). Field calibration checks were carried out before and after the measurements using a Bruel & Kjaer Acoustic Calibrator, Type 4231 (serial no. 2389221), and no variation in the calibration levels was observed. The measurement microphone was fitted with a windshield.

3.16 Several measurement locations are directly equivalent to locations used for a similar exercise in 2018, whereas others are new to this study. The measurement locations used for the 2020 on-site noise measurements are identified in Figure 2 and described in Table 3 along with the overall measured noise levels, and comparisons to 2018 noise levels where available.

3.17 The L_{eq} and L_{90} third octave band noise levels corresponding to each of the above measurements are provided in Appendix III.

Table 3 : Summary of On-Site Noise Measurements

2020 Location Number (as per Figure 2 of this report)	2018 Location Number (as per Fig 2 of P18-098-R01v2)	Description	Noise Level dB		
			2020		2018
			L_{Aeq}	L_{A90}	L_{A90}
1		5m in front of centrifuge, both operating, facing SW unit	65	63	
2	6	5m in front of centrifuge, both operating, between units	65	63	62
3		5m in front of centrifuge, both operating, facing NE unit	66	63	
4		On path NW of tank, facing loose pipe hanging down	64	63	
5	1	On gantry between BT1 and Divert	71	71	78
6	2	Ground level between BT1 and Diver	74	73	82
7	3	Midway between outside edges of BT1 and Divert	70	69	65
8	4	Above manhole set back from BT1 and Divert	65	64	60
9	5	At site boundary set back from BT1 and Divert	60	59	53
10		1m from new ground level pump towards W of Divert	79	78	
11		1m from new ground level pump towards N of Divert	76	75	
12	9	To rear of DAF 2	63	62	77
13	10	At boundary to rear of DAF 2	60	59	61
14	14	1m to foot of gantry at N of AT2	69	68	56
15		At boundary to N of AT2	62	62	
16	15	1m to foot of gantry at SE of AT2	76	75	50
17	16	At gantry level - running water	71	71	68
18	8	5m from open shutter of DAF2	64	63	72
19		1m from nearest exhaust turret of DAF1 extension	72	72	
20		1m to W right corner of DAF1 extension	67	67	
21		5m from front DAF1 extension	68	67	
22	17	1m from shorter of new ground level pumps	72	71	90
23	17	1m from longer of new ground level pumps	73	72	90
24		On metal steps over plinth wall	75	74	
25		1m pump to south of BT1	79	78	
26		1m from pump to N side of Siltbuster	84	83	
27		2m to E (rear) side of Siltbuster	76	76	
28	7	5m from open door to DAF1	70	69	71
29	19	Rear of DAF1	75	75	71
30		2m from unit, 1m from fan outlet	73	72	
31	12	On gantry - 1m from AT1a aerator (blower not operation)	78	78	67
32	13	On gantry - 1m from AT1a aerator/blower	71	70	78
33		2m from pumps	74	74	
34	20	At site boundary 2m from pumps	68	67	67

4.0 ASSESSMENT OF MEASURED NOISE LEVELS

4.1 The assessment undertaken in 2018 included an assessment in accordance with the guidelines set out in BS 4142. This firstly determined that, based on noise monitoring at Trewassa, a specific level of 48dB L_{Aeq} was representative of typical worst-case conditions, accounting for variations relating to plant operation and also wind conditions, but that in more favourable conditions, specific levels less than 45dB L_{Aeq} were common.

4.2 The assessment noted that the monitoring location at Trewassa is closer to the WWTP than any of the nearby residences. It is predicted that noise levels at the actual residential locations will be at least 2dB lower than those measured, i.e. a typical worst-case specific noise level of 46dB L_{Aeq}. This applies where line-of-sight exists. Elsewhere the noise levels will be reduced further due to acoustic barrier effects.

4.3 An acoustic feature penalty of +4dB was applied due to the tonal components to the noise, hence yielding a worst-case rating level of 50dB L_{Ar} at residential locations. This was principally due to the noise characteristics of the gantry level pipework between the BT1 and Divert tanks, which was present at that time.

4.4 The rating level was compared to background noise measurements taken at locations far remote from the monitoring location, in areas where WWTP noise was not substantially noticeable, to obtain a notional background noise level in the absence of any WWTP noise. In line with BS 4142, the initial estimate of the impact based on a notional background noise environment, which does not include WWTP noise, clearly indicated a significant adverse impact, depending on the context.

4.5 However, assessment on this basis needs to be treated with caution, as the WWTP is essentially a permanent noise source, so comparison to those background noise levels represents an artificial scenario, not one experienced at the actual receptors. Conversely, given that the background noise environment at actual receptors is in fact controlled by the same WWTP noise as the specific, any BS 4142 initial estimate of the impact assessment based on comparison to measurable background noise levels may tend towards an under-estimation of impact.

4.6 Accordingly, further assessment based on absolute noise levels was provided, as a potentially more appropriate measure of potential noise impact in this case. This concluded that, due to the predicted possible excess in internal noise levels within residences, with windows open, when assessed against BS 8233 guidelines, and also the character of the noise, further control WWTP noise levels was recommended.

4.7 In 2018, the most significant WWTP noise sources were considered to be those located close in between the BT1 and Divert tanks particularly noise from pipework at gantry level. Following our recommendations, this has since been removed and replaced with an alternative system, although this in itself has necessitated the introduction of further noise sources, for example pumps at ground level to the outside of BT1.

4.8 From the data set out in Table 3, for locations 5-11, it can be seen that noise levels very close between the BT1 and Divert tanks, both at ground and gantry levels, and are now about 7-9 dB lower than in 2018, with the pipework at gantry level and some associated ground level pumps removed. However, at locations a little further from the tanks, in the direction of Trewassa, noise levels are now in fact about 4-6dB higher. This is mainly due to the introduction of the pumps at ground level to the outside of BT1.

4.9 Another significant component of the overall noise at Trewassa, identified in 2018, albeit less distinct from the other accumulated noise, was the blowers located at gantry level around tanks, particularly those around AT1a and AT1b. It is noted from measurements at locations 31-32 that noise levels from this area remains effectively as before.

4.10 In 2018, noise levels around AT2 were relatively modest. From measurements at locations 14-17, undertaken on 9 April 2020, the corresponding noise levels were somewhat higher. Verification measurements were undertaken on 16 April 2020 and noise levels were unchanged from the previous week. The reason for this is not known, however it would seem that the aerators/blowers on AT2 were operating at a higher duty than as found during the 2018 survey. Some of the framework to the gantry steps around the tanks were caused to rattle, creating a noise noticeable at off-site locations, and this was not noted in 2018.

4.11 Noise emissions from the extension to DAF1, notably as per locations 19-21, relate to new sources. Although not dominant, partly due to acoustic screening effects of other on-site structurers, it is considered that noise from this area contributes to the overall noise from the WWTP at Trewassa, at least in subjective terms (i.e. switching this noise source in and out may or may not affect the overall noise levels, but would likely be noticeable). This may be due to the mid-low frequency noise emissions, which differs in characteristic to much of the other plant on site.

4.12 From the results of the 2020 noise monitoring at Trewassa, it is considered based on a review of the overall data set that a level of 48-50dB L_{Aeq} is representative of typical worst-case conditions at the monitoring location, accounting for variations relating to plant operation and also wind conditions.

4.13 Again, in more favourable conditions, lower levels commonly occur.

4.14 On this basis, noise levels from the 2020 monitoring are essentially the same, or perhaps fractionally higher but unlikely appreciably so, compared to those from the 2018 monitoring.

4.15 However, importantly, the tonal elements of the noise, principally from the gantry level pipework between the BT1 and Divert tanks have been removed, leaving a far more broadband and steady accumulated noise, of relatively benign characteristics, when experienced at Trewassa. Therefore no acoustic feature penalties or other corrections need to be taken into account in any revised assessment of the noise.

4.16 Accounting for removal of the +4dB acoustic feature penalty included in the 2018 assessment, the overall conclusion is therefore that emissions have improved by up to 4dB based on the 2020 monitoring.

4.17 Further to this, it is understood that a new 3m high acoustic barrier is scheduled to be installed at the site in close proximity to the BT1 and Divert tanks. As the new ground level pumps in this area are still a significant component of the overall noise at Trewassa, it is anticipated that a worthwhile measurable and appreciable further reduction in noise will occur as a result of this. However, the overall benefit will possibly be tempered slightly by negating current ground absorption effects from this plan, as well as more simply due to the overall noise from other sources.

4.18 In terms of potential further improvements, it is suggested that the reason for increases in noise from sources associated with AT2 should be investigated, and as a first measure, gantry fittings around this tank should be tightened/braced to negate rattling noise.

4.19 More generally, as advised in 2018, gantry level noise sources (including AT2 but also AT1a and AT1b) may be mitigated, potentially including full or partial encloser of the blower units associated with aerators in their current location, or relocation of the blower to ground level locations, which is likely to be beneficial on its own, and will potentially also make applying further mitigation (if necessary) more straightforward.

4.20 Noise emissions associated with the DAF1 extension may potentially be controlled, for example, by introduction of proprietary in-line silencers within the ductwork prior to the exhaust turrets on this building.

5.0 SUMMARY AND CONCLUSION

5.1 A noise assessment relating to the Wastewater Treatment Plant (WWTP) associated with the Davidstow Creamery has been carried out.

5.2 A detailed programme of noise measurements and weather monitoring has been undertaken on and around the WWTP site over an extended period.

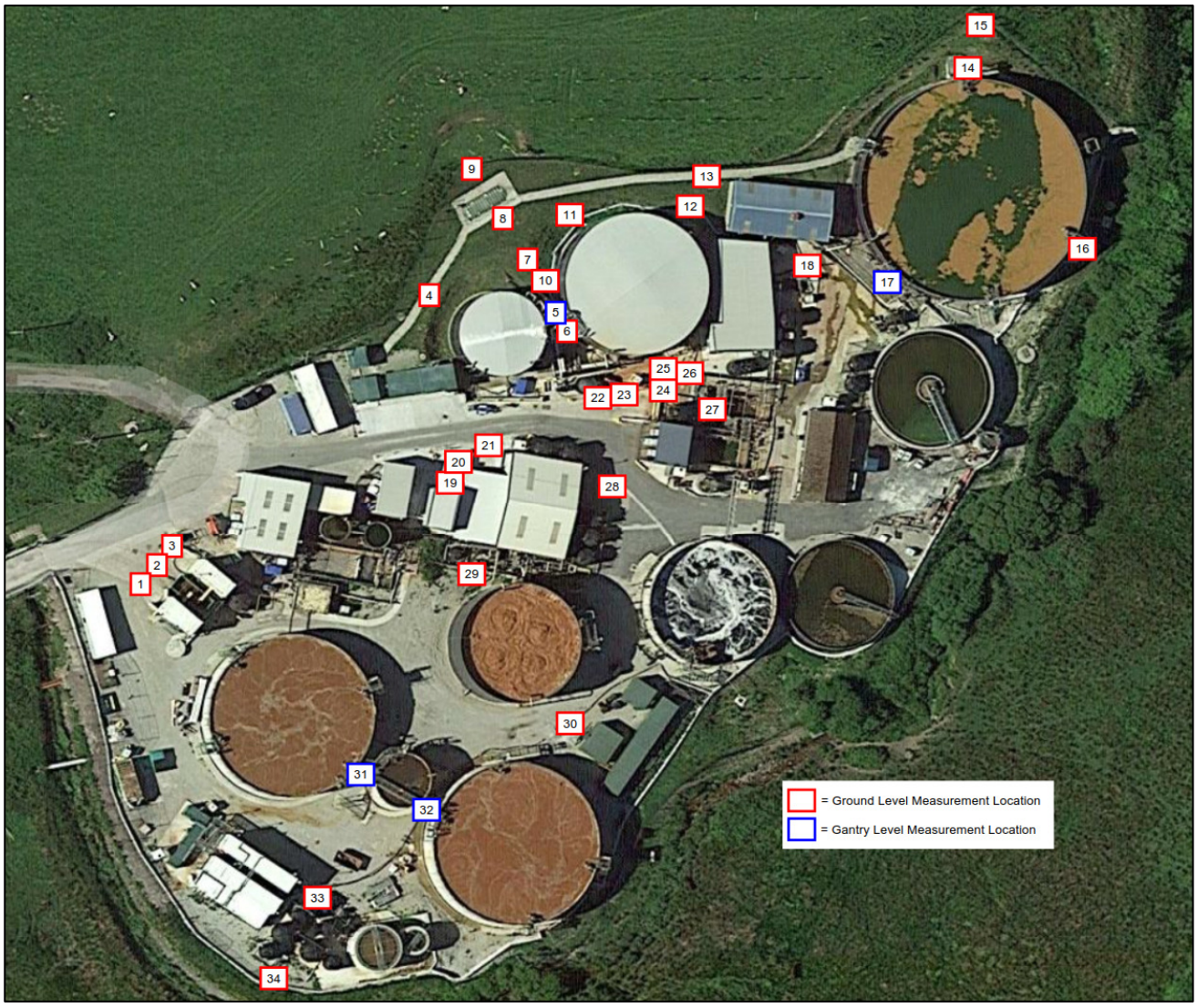
5.3 The measured data has been assessed with comparison to an earlier baseline noise assessment undertaken in 2018, and with reference to relevant British Standard guidelines.

5.4 It has been concluded that, although there are some notable changes to the noise emissions profile within the site, the overall noise levels at the nearest residences are comparable to those in 2018, but that, importantly, the characteristics of the noise emissions have changed beneficially. Further improvements are anticipated due to a proposed 3m high acoustic barrier to be installed at the site.

5.5 Some outline recommendations have been provided for other potential measures to reduce noise emissions further.

Figure 1: Off-Site Noise Measurement Location

Figure 2: On-Site Noise Measurement Locations



Appendix I: Noise Units & Indices

Sound and the decibel

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120dB (threshold of pain).

Due to the logarithmic nature of decibels, when two noises of the same level are combined together, the total noise level is (under normal circumstances) 3 dB(A) higher than each of the individual noise levels e.g. 60 dB(A) plus 60 dB(A) = 63 dB(A). In terms of perceived 'loudness', a 3 dB(A) variation in noise level is a relatively small (but nevertheless just noticeable) change. An increase in noise level of 10 dB(A) generally corresponds to a doubling of perceived loudness. Likewise, a reduction in noise level of 10 dB(A) generally corresponds to a halving of perceived loudness.

The ear is not equally sensitive to sound at all frequencies. It is less sensitive to sound at low and very high frequencies, compared with the frequencies in between. Therefore, when measuring a sound made up of different frequencies, it is often useful to 'weight' each frequency appropriately, so that the measurement correlates better with what a person would actually hear. This is usually achieved by using an electronic filter called the 'A' weighting, which is built into sound level meters. Noise levels measured using the 'A' weighting are denoted dB(A) or dBA.

Frequency and Hertz (Hz)

As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kiloHertz (kHz), where 1 kHz = 1000 Hz.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20 kHz. However, the upper frequency limit gradually reduces as a person gets older.

Glossary of Terms

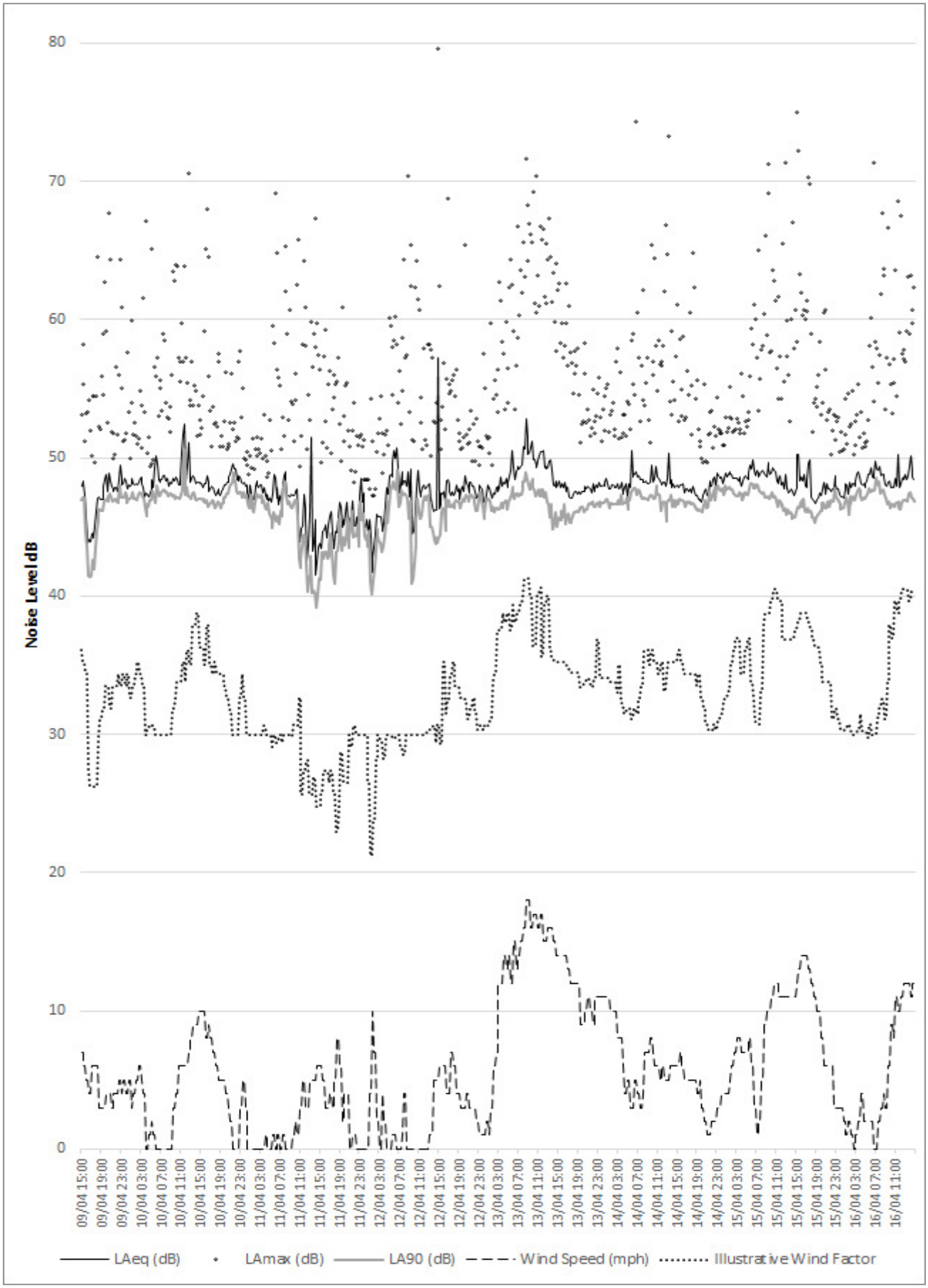
When a noise level is constant and does not fluctuate, it can be described adequately by measuring the dB(A) level. However, when the noise level varies with time, the measured dB(A) level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple dB(A) value. In order to describe noise where the level is continuously varying, a number of other indices can be used. The indices used in this report are described below.

L_{Aeq} This is the A–weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period. In other words, L_{Aeq} is the level of a continuous noise which has the same total (A–weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise.

L_{Amax} This is the maximum A–weighted noise level that was recorded during the monitoring period.

L_{A90} This is the A–weighted noise level exceeded for 90% of the time period. L_{A90} is used as a measure of background noise.

Appendix II: Off-site Noise Measurements and Wind Data



Appendix III: On-site Noise Measurements

Third Octave L_{eq} data

Location No. (Fig 2)	Noise Level L_{eq} dB																							
	Third Octave Band Centre Frequency (Hz)																							
	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
1	67	68	67	65	67	62	63	61	59	61	59	54	55	53	52	50	50	50	50	54	49	47	44	37
2	67	68	66	66	64	64	63	60	60	61	59	54	54	53	52	50	49	50	50	55	49	48	44	37
3	69	70	70	67	65	65	63	61	58	61	59	55	55	53	52	52	52	51	50	55	49	47	44	37
4	62	63	60	57	59	62	60	57	50	52	52	50	56	55	55	53	53	51	49	49	43	41	40	38
5	63	60	61	60	60	60	61	61	62	61	63	60	65	64	63	61	59	57	55	54	51	47	49	42
6	72	63	63	59	61	63	65	63	62	64	65	62	65	64	64	61	61	58	56	62	61	56	64	54
7	62	57	58	55	57	57	59	57	58	59	63	57	62	62	62	60	58	56	53	54	48	46	45	41
8	60	56	59	54	54	55	53	53	58	57	55	53	58	56	57	55	52	50	48	51	44	40	40	35
9	55	54	58	53	51	50	50	47	48	52	53	47	52	49	51	49	47	45	43	51	40	36	34	29
10	63	60	62	63	62	62	63	63	61	69	67	65	71	71	71	70	69	66	64	63	58	56	55	51
11	62	59	61	58	60	60	60	59	64	65	66	63	67	68	71	67	62	61	60	57	53	52	49	45
12	60	55	55	52	54	55	55	55	54	53	54	53	57	54	55	52	49	47	45	45	39	35	33	28
13	59	53	54	52	52	52	51	50	51	52	53	48	51	51	53	49	47	45	42	46	38	35	32	28
14	54	50	55	57	60	63	63	64	63	55	56	56	60	58	57	58	54	58	57	56	57	55	55	55
15	56	49	51	53	49	46	57	61	58	47	46	49	52	52	49	49	47	51	51	50	51	50	49	48
16	53	54	54	57	59	57	59	63	61	54	61	61	64	66	67	67	68	64	64	63	59	58	57	50
17	60	57	59	58	58	59	61	61	58	59	62	61	61	63	60	60	61	60	60	59	58	56	55	54
18	63	51	53	50	54	57	54	54	53	57	56	54	57	52	53	53	52	51	48	49	43	41	38	35
19	64	65	68	63	69	72	64	72	66	68	62	62	65	60	61	57	57	58	56	52	51	49	46	46
20	64	66	61	59	67	68	62	60	58	62	60	58	64	56	54	52	51	50	49	49	45	44	39	39
21	64	64	65	60	65	63	63	61	62	59	60	60	63	57	55	55	53	53	52	50	45	45	39	36
22	66	60	65	60	62	61	62	61	61	62	62	62	63	61	61	59	59	58	57	52	55	64	56	55
23	67	63	64	63	64	65	67	64	62	62	66	69	64	62	63	63	57	54	53	52	52	57	45	47
24	69	62	67	65	67	68	68	68	68	67	66	64	65	68	66	63	62	59	57	60	54	51	48	48
25	75	66	63	63	67	67	68	68	69	69	72	68	72	71	70	67	65	64	63	61	57	54	52	50
26	78	64	62	63	62	68	69	67	78	73	71	69	67	77	79	74	71	64	61	61	55	53	50	47
27	72	62	62	64	61	63	66	66	66	63	65	65	64	66	68	66	66	64	64	63	60	57	56	54
28	70	64	63	62	60	61	63	63	63	62	62	63	60	60	59	58	57	57	55	56	53	52	48	44
29	64	61	67	66	78	66	64	71	70	67	68	64	70	64	64	61	62	61	61	59	57	55	52	48
30	69	66	66	68	66	68	68	66	66	69	65	63	64	62	61	60	59	59	58	57	55	53	51	50
31	72	74	83	81	70	72	72	70	70	68	65	68	65	65	62	60	59	58	57	56	54	51	50	50
32	66	64	65	69	72	72	76	80	75	66	66	67	69	68	66	66	63	65	62	62	62	56	55	52
33	70	65	65	70	65	63	62	64	64	63	64	61	65	66	57	56	54	52	50	47	46	43	41	38
34	74	62	62	65	62	60	62	64	68	71	66	60	64	58	62	64	59	60	62	61	58	60	63	57

Third Octave L_{90} data

Location No. (Fig 2)	Noise Level L_{eq} dB																							
	Third Octave Band Centre Frequency (Hz)																							
	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
1	65	64	60	64	58	59	58	56	58	56	52	52	51	50	48	48	47	46	50	44	43	41	33	65
2	66	63	62	61	60	59	57	57	59	56	51	51	51	50	48	47	47	47	49	44	42	40	35	66
3	67	66	63	61	60	60	58	56	57	56	52	52	50	50	48	48	48	46	49	43	41	40	33	67
4	60	58	54	56	59	58	55	48	50	50	49	54	54	53	51	52	50	48	48	42	40	39	37	60
5	58	58	57	58	58	59	58	60	59	61	58	63	63	62	60	58	56	54	53	49	46	47	41	58
6	61	59	56	59	61	63	61	60	62	64	61	63	63	62	60	60	57	55	60	58	54	62	52	61
7	54	54	52	54	54	57	54	56	57	61	56	61	60	60	58	57	55	52	51	47	45	44	40	54
8	53	55	51	52	52	51	51	56	55	53	51	56	55	55	53	51	49	47	46	42	39	39	34	53
9	52	53	50	48	47	48	44	46	50	51	45	49	48	49	48	46	44	42	40	37	34	33	28	52
10	58	59	60	59	59	61	62	60	67	65	64	69	70	69	68	68	65	63	61	57	55	54	51	58
11	57	57	54	57	58	58	57	63	64	64	62	64	66	69	65	61	60	59	56	52	50	47	44	57
12	52	51	50	51	52	53	52	52	50	52	51	55	53	53	50	48	45	44	41	38	34	31	27	52
13	50	51	49	49	50	48	48	49	49	51	47	50	49	51	48	45	43	41	39	36	33	30	27	50
14	47	52	53	57	60	61	62	61	53	53	53	58	56	56	56	52	56	56	54	55	53	54	53	47
15	47	49	49	47	44	55	59	56	46	45	47	50	50	47	48	45	49	49	48	50	49	48	47	47
16	52	51	52	55	54	56	61	58	52	59	59	62	64	66	65	67	62	63	60	58	56	54	48	52
17	55	56	54	55	57	59	58	56	57	60	59	60	61	58	59	60	59	58	57	56	55	54	53	55
18	49	51	47	52	54	52	52	52	55	54	53	55	51	52	52	51	49	47	45	42	40	37	34	49
19	64	67	61	68	70	62	71	64	67	61	61	63	59	60	56	56	57	55	51	50	48	45	46	64
20	64	59	56	65	66	60	58	56	61	59	56	61	55	53	51	50	49	47	44	44	42	37	37	64
21	63	63	57	63	61	61	59	60	57	59	58	60	55	54	54	52	52	50	46	44	44	38	35	63
22	58	62	58	60	58	59	59	59	60	61	61	62	59	60	58	57	57	56	51	52	62	54	53	58
23	60	61	59	61	60	61	62	60	60	64	66	60	60	60	61	56	52	51	48	49	49	42	41	60
24	61	65	62	64	66	66	64	67	66	65	62	64	67	64	62	60	58	56	55	52	50	47	47	61
25	63	61	61	64	65	66	66	67	68	70	66	70	70	68	66	64	63	62	60	56	53	51	48	63
26	62	59	60	60	65	68	65	77	72	70	67	66	76	77	73	70	63	60	56	54	52	49	46	62
27	60	59	62	59	61	64	64	65	62	64	64	63	65	64	64	64	63	63	60	58	56	55	53	60
28	62	61	58	57	59	61	61	61	59	60	61	59	58	57	57	55	55	53	52	52	50	46	41	62
29	59	65	64	76	63	62	68	68	64	65	62	68	63	62	60	61	60	60	57	56	54	51	47	59
30	64	64	65	63	65	66	64	64	68	63	61	63	60	60	59	58	58	57	56	54	52	50	49	64
31	72	80	79	67	69	69	68	68	67	64	67	64	64	61	59	58	57	56	55	53	50	49	48	72
32	62	63	66	70	70	74	77	73	64	64	65	67	66	64	65	62	63	61	61	61	55	53	50	62
33	63	62	66	62	61	60	61	62	61	62	59	63	63	56	55	52	51	49	46	45	42	39	37	63
34	60	60	62	59	57	60	63	67	70	62	59	62	57	60	62	58	59	61	60	57	60	62	57	60