

**Anaerobic Digestion Facility
Gelliargwellt Uchaf Farm
Gelligaer
Nelson
CF82 8FY**

**Noise Commissioning
3781/COM1**

29th March 2017

For: **Bryn Power Ltd**
Gelliargwellt Uchaf Farm
Gelligaer
Nelson
CF82 8FY



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1.0 Introduction

The new Anaerobic Digestion Facility (ADF) at Gelliargwellt Uchaf Farm, Gelligaer, Nelson, CF82 8FY is now operational.

An environmental permit (EPR/AB3092ZE) has been issued for the site by Natural Resources Wales (NRW) that requires noise monitoring at the nearest local receptors.

Hunter Acoustics has therefore been commissioned by Bryn Power to assess the noise impact of the facility at the nearest local receptors, in line with the requirements of the NRW permit.

Acoustic Terminology is given in Appendix A.

2.0 Permit Requirements

The permit (EPR/AB3092ZE) issued by NRW states the following in relation to noise and vibration;

“3.4 Noise and vibration

3.4.1 *Emissions from the activities shall be free from noise and vibration at levels likely to cause pollution outside the site, as perceived by an authorized officer of Natural Resources Wales, unless the operator has used appropriate measures, including, but not limited to, those specified in any approved noise and vibration management plan to prevent or where that is not practicable to minimise the noise and vibration.*

3.4.2 *The operator shall:*

- (a) *if notified by Natural Resources Wales that the activities are giving rise to pollution outside the site due to noise and vibration, submit to Natural Resources Wales for approval within the period specified, a noise and vibration management plan which identifies and minimises the risks of pollution from noise and vibration;*
- (b) *implement the approved noise and vibration management plan, from the date of approval, unless otherwise agreed in writing by Natural Resources Wales.”*

Table S1.3 Pre-operation measures states;

POM3	Prior to commencement of operations the operator shall install the recommended noise attenuation measures as referenced in section seven of the Hunter Acoustics Environmental Noise Assessment Report – Ref 3781/Nia1_Rev1. This is to ensure that the installation operates within the proposed day time and night time environmental noise limits, at the four nearest sensitive receptors as specified in section 5 the report.
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Table S1.4 Improvement programme requirements states;

Table S1.4 Improvement programme requirements		
Reference	Requirement	Date
IC1	Following successful commissioning of the AD Plant, the Operator shall undertake noise monitoring at the four nearest local receptors. This shall include: - A full noise monitoring survey and assessment meeting the BS4142:2014 standard 1/3rd octave and narrow band (FFT) measurements to identify any tonal elements or low frequency noise Upon completion of the work, a written report shall be submitted to Natural Resources Wales. The report shall make reference to the Environmental Noise Limits proposed in Section 5 of the Hunter Acoustics Environmental Noise Assessment Report – Ref 3781/Nia1_Rev1. If rating levels associated with the AD Plant are detected which are likely to cause adverse impact at sensitive receptors, the report shall include an assessment of the most suitable abatement techniques, an estimate of the cost and a proposed timetable for their installation.	6 months from operations commencing

2.1 Proposed Noise Criteria

As referenced in the permit, section 5 of our report 3781/NIA1_Rev1 included the following proposed limits;

3781/T1 – Proposed Environmental Noise Limits

Location	Daytime (0700-2300hrs) $L_{Aeq,1hr}$	Night-time (2300-0700hrs) $L_{Aeq,15mins}$
Position A (Green Acres, Top Hill Farm)	39dB	28dB
Position B (Claerwen Estate)	41dB	25dB **
Position C (Llancaiach Isaf Farm)	37dB	26dB

** It is proposed to set criteria at Claerwen Estate at 25dB + 5dB rating penalty = 30dB. The proposed 30dB rating level when taking into account a 12dB loss through a partially open window, would result in internal noise levels well below the 30dB(A) World Health Organisation sleep disturbance threshold.

2.2 British Standard 4142:2014

British Standard 4142:2014 “Methods for rating and assessing industrial and commercial sound”

This standard describes a rating method comparing L_{Aeq} noise levels from the industrial source with pre-existing background L_{A90} levels at the residential receiver. It advises at a difference (industrial noise - background) of:

- +10dB or higher, likely to be an indication of a significant adverse impact, depending on the context.
- A difference of + 5dB, likely to be an indication of an adverse impact, depending on the context.
- 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.

A penalty of between 0dB and 9dB can be applied to the industrial noise depending on its characteristics (tonality/impulsivity/intermittency), as described in sections 9.2 and 9.3 of BS4142:2014.

3.0 Nearest Local Receptors

Closest residence or 'Noise sensitive premises' (NSPs) have been identified on site plan 3781/SP1 as described below.

- 1 **Top Hill (farm)** - Directly opposite entrance to the site, line of sight to facility removed by existing topography
Approximately 470m from the site
- 2 **Green Acres Bungalow (residential)** - At entrance to site, line of sight to facility removed by existing topography
Approximately 315m from the site
- 3 **Claerwen Housing Estate (residential)** - North east of site with line of sight completely removed by existing topography
Approximately 600m from the site
- 4 **Llanciach Isaf (farm)** - West of site with line of sight removed by existing topography
Approximately 1km from the site

3781/SP1 - Noise Sensitive Premises Highlighted



4.0 Noise Surveys

4.1 Methodology

4.1.1 Source Noise Measurements of Plant

During daytime hours, it was not possible to measure AD plant at the nearest receivers due to traffic noise and various other noise sources from the overall Bryn site.

The different items of plant also switch in and out, so to ensure a robust assessment, source measurements have been undertaken of the various pieces of equipment on site to allow predictions back to the nearest NSPs.

Source plant noise measurements were undertaken on 09/03/2017 between 1400-1630hrs and on 10/03/2017 between 0900-1100hrs.

Parameters including L_{Aeq} , $L_{Amax,F}$ and third-octave band spectra were logged.

4.1.2 Measurements at Nearest Receptors

Manned measurements were also taken at the nearest NSPs during night-time hours when existing ambient and background noise levels are quieter.

This also allowed for a subjective assessment to be made at the nearest receptors. These measurements were undertaken between 2250-0000hrs on 09/03/2017.

Note: Engineers had informed us that noisiest times of operation would be between 5minutes to the hours until around quarter past the hour, as this is when the Trioliet switches in. The first manned measurement was undertaken at the nearest receptor (Pos A) to allow a subjective assessment during this noisiest period.

Parameters including L_{Aeq} , $L_{Amax,F}$, L_{A90} and third-octave band spectra were logged.

Locations of night-time measurements are shown on site plan 3781/SP2 below;

3781/SP2 - Site Plan Showing Night-time Monitoring Positions



4.2 Equipment Used

3781/T2 - Equipment List

Make	Description	Model	Serial Number	Last Calibrated	Certificate No.
Norsonic AS	Calibrator (113.95dB @ 999.27Hz)	1251	24202	10-Aug-16	U22382
NTi	Type 1 - Sound Level Meter	XL2-TA	A2A-08723-E0	20-Dec-16	1612652
NTi	Preamplifier	MA220	1820	20-Dec-16	1612650
NTi	Filters	XL2-TA	A2A-08723-E0	20-Dec-16	1612651
NTi	Microphone	Capsule	9381	20-Dec-16	1612650

The measurement systems were calibrated before and after the surveys, no variation occurred.

4.3 Weather Conditions

Weather conditions were dry throughout the monitoring periods with no significant winds. Approximate weather conditions are shown in weather history graph 3781/WH1 in Appendix A.

5.0 Results

5.1 Source Sample Measurements

Results of source sample measurements are shown in table 3781/T3a below, Table 3781/T3b in Appendix A includes octave band data.

3781/T3a – Source Sample Measurement Results

Description	Distance (m)	Duration (secs)	L _{Aeq} (dB)
Macerator in shed start up	3	6	75.7
Macerator pump	1	5	75.5
Macerator running inside (daytime 2-4pm) start up at start of measurement	2	106	78.2
Macerator running loading shovel idling general level in building	3	84	76.1
Macerator shutting down (whine during shut down)	2	34	77.6
Drier exhaust (whine audible from gas engines)	5	15	71.4
Looking down at drier exhaust from high level 3-5m	3	7	70.4
Start-up of conveyor 1m from motor and 4m from belt	1	16	65.5
Conveyor belt (squeaking)	1	9	67
Next to slurry tank general noise from drier, gas engines and compressors (background for next measurement)	-	6	55
Slurry tank - pump in tank - measure outside tank at pump location	1	9	61.8
Slurry tank - 1/4 way round tank from where pump is located - drier audible	1	5	62.6
Trioliet fan	0.5	4	72
Trioliet fan with some noise from pump system next to measurement position	1	7	70.1
Temporary recirc pump next to Trioliet	1	8	77.6
Quick background level with just slurry tank running - pump below in drain cover, everything else off	-	4	63.4
Trioliet and macerator running	3	280	79.2
Trioliet mixer which cycles in and out for trioliet period of 5mins	1	14	81.5
End two Trioliet mixers running at same time - only happens when loading Trioliet in morning for around 5mins	3	35	81.8
Background measurement at ABP feed system with engines opposite running	-	4	60.4
ABP feed	1	37	78.8
ABP feed pump	1	7	79.2
ABP feed pumps	5	6	68.3
ABP tank compressor 1 running on its own at 1m	1	6	75.8
ABP tank compressor 1 and 2 running together at 1m	1	8	77.6
Digestate TT pump	1	6	72.7
Digestate discharge pump	1	6	66.9
Tank air fan at low level on secondary digester	1	9	74
Air fan on top of the primary digester	1	13	75.6
Measurement up on gantry between secondary and primary digesters with pumps running below	-	10	64.3
3 out of 5 biogas compressors running	1	6	77.7

Gas booster associated with flare at base approx. All kit running (flare off)	1	10	78.8
Measurement taken in yard near cabin, water falling behind, gas engine doors open	-	8	56.6
Loader drive by	5	7	71.6
Loader working and moving rotten material about	5	49	72.8
End louvre on Jenbacher gas engine facing AD Reception Building	1	10	73.7
CHP Biogas Booster on Jenbacher gas engine	1	10	82.8
End louvre on Jenbacher gas engine running	5	13	70.8
Side of Jenbacher engine, just below rad/cooling fans and side louvre	1	12	70.6
Rad/side louvre on Jenbacher engine	5	12	67.6
End facing north of Jenbacher engine	3	10	69.5
Between two gas engines, only Jenbacher running	-	12	76.2
Between two gas engines, only Jenbacher running - about 3m from CHP Biogas Booster near AD Reception end	-	10	78.8
30m north of the gas engine, just Jenbacher running - 10m from orange pump Pasteurisation Recirc Pump	-	20	67.2
Side of Jenbacher engine near rads	5	9	67
North of Jenbacher but hearing the compressors at this position	10	8	64.6
10m from Jenbacher (north)	10	10	65
Southern end of engines with both running	10	10	65.2
End of Edina engine (south)	1	8	63
End of Edina engine (south)	3	7	60.9
End of Edina engine (south)	10	10	60.1
Gas booster fan on side of Edina	1	9	74
Side of Edina, gas booster fan running	5	8	68
Side of Edina	10	10	65.1
Between containers north end, just Edina running	-	7	72.7
Between containers central, just Edina running	-	6	74.8
Between containers southern end, just Edina running	-	4	71.4
50m north of engines - tone from compressors dominant	50	27	67.3

5.2 Night-time Manned Measurements

Results of night-time manned measurements are shown in table 3781/T4a below, Table 3781/T4b in Appendix A includes octave band data.

3781/T4a – Night-time Manned Measurement Results

Description	Time (hh:mm:ss)	Duration (secs)	L _{Aeq} (dB)
Pos A - just south of bungalow - hum dominant	22:49:02	1885	46.4
Pos A - just north of bungalow near main road - hum dominant	23:24:36	15	41.1
Pos B - back of Claerwen estate, no plant audible	23:29:14	60	31.2
Pos A - just south of bungalow to confirm hum still present	23:38:30	10	43.2
Pos C - stream noise, no plant audible	23:46:28	90	35.6

6.0 Discussion

6.1 Night-time Assessment

Between 2250-2350hrs, plant noise was not audible at Claerwen or Llancaiach Farm. Where plant noise is not audible, it can be assumed to be at least 10dB below the measured ambient noise level.

Therefore;

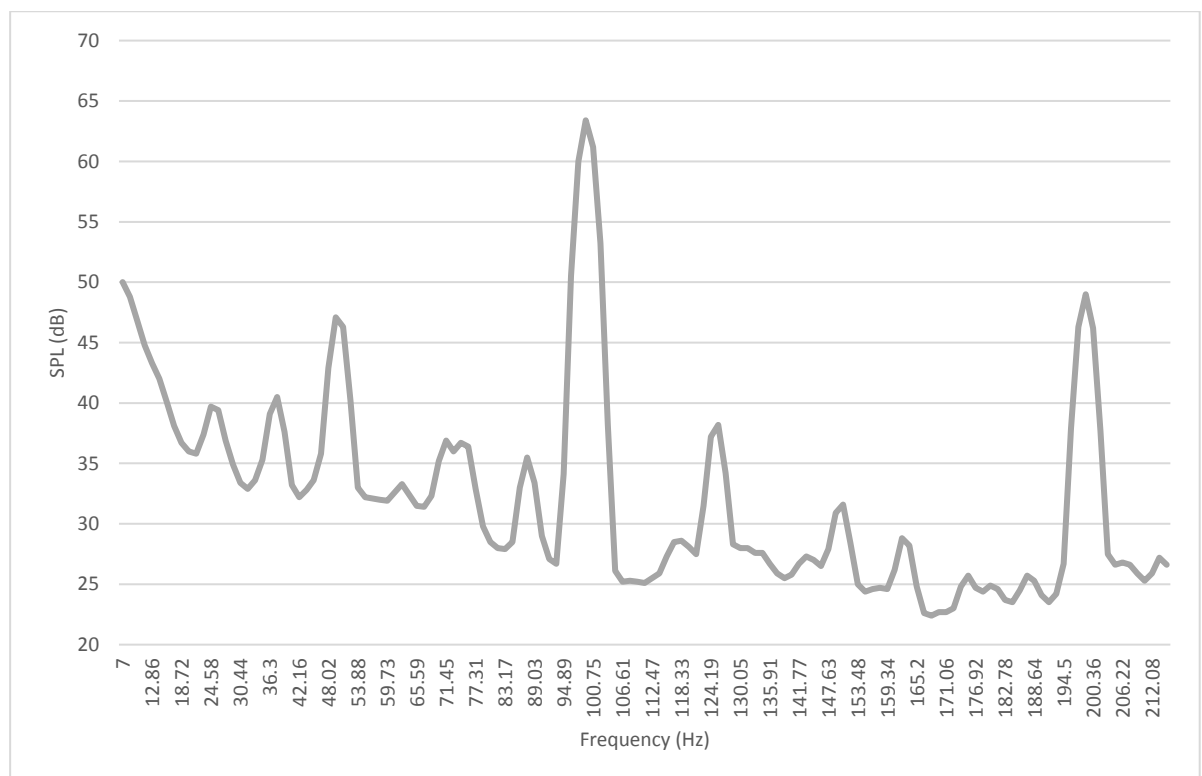
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|--------------------|-------------|---------------------------------|
| • Claerwen (Pos B) | Measured | 31dB L_{Aeq} (not audible) |
| | Assume max. | 21dB L_{Aeq} from plant noise |
- | | | |
|---------------------------|-------------|--|
| • Llancaiach Farm (Pos C) | Measured | 36dB L_{Aeq} (not audible, stream noise) |
| | Assume max. | 26dB L_{Aeq} from plant noise |

Referring back to section 2.1, the limits set at these receivers were 25dB L_{Aeq} at Claerwen and 26dB L_{Aeq} at Llancaiach Farm. Therefore the night-time limits are indicated to be met at these receivers.

Plant noise was audible at the Greenacres Bungalow during the night-time period. A low hum at around 100Hz was audible. Overall noise levels were around 46dB L_{Aeq} , which exceeds the 28dB L_{Aeq} limit.

There was a distinct tone present at this location so an FFT measurement was undertaken, as well as the third octave band data recorded.

3781/G1 – FFT Spectrum Recorded at Position A at 2341hrs on 09/03/2017



Results show the presence of prominent tones around 100Hz and 200Hz.

Investigative measurements undertaken on site the following morning indicate the bank of compressors adjacent to the secondary digester tank were the source of the tone audible at Green Acres during the night-time.

3781/P1 – Photo Showing the Banks of Compressors between Digester Tanks



The bank of compressors were then switched off whilst stood at Green Acres (Pos A) during the daytime and the hum dropped in level significantly (from 63dB at 100Hz to 52dB at 100Hz).

A significant amount of vibration was noted in the metal frame on which the compressors were mounted and also in the connected pipework.

Neoprene isolation pads appear to be included under units however vibration may also be transferring via the pipework into the tank wall and drumming? Suitable anti-vibration mounts, with flexible pipe connectors and oversized pipe brackets with neoprene inserts should be used to ensure the units remain isolated from pipework/mounting frame.

The above represents good practice as structure-borne noise getting into the tanks may be part of the issue.

3781/P2 – Photo Showing the Compressors on Hollow Metal Box Frame

Based on the night-time spectra measured at the bungalow, noise levels may still exceed the limits set at this receiver with the problem compressors switched off. We would recommend undertaking further night-time measurements with an AD facility engineer in attendance to switch plant on/off to assess the impact with the minimum amount of night-time plant running.

6.2 Daytime Assessment

Due to the amount of ambient noise in the area daytime, source noise data measured on site is put back into the noisemap model used at the design stage to predict noise levels back to the receivers.

The following scenario is modelled in line with that modelled at the design stage, except there are only 2no gas holder air fans and half the associated pumps as only 1 primary and secondary digester have been built to date. Also, there is a second CHP on site, so this is included in the model;

Daytime – worst case 1 hour assessment period

- 1no Telehandler / Loader externally for 30mins in the 1hr period
- 1no Hammer Mill Macerator for whole 1hr internally with doors closed
- 2no CHP externally for whole 1hr
- 1no Drying Unit for whole 1hr
- 2no Gas Booster externally for whole 1hr
- 2no Gas Holder Airfans externally for whole 1hr
- 1no Trioliet externally for 20mins in the 1hr period
- All pumps externally for 20mins in the 1hr period
- All compressors externally for 20mins in the 1hr period

Our analysis has used the proprietary NoiseMap Five computer modelling software, in conjunction with procedures of;

BS 5228: Parts 1 & 2 2009 'Code of Practice for assessing noise and vibration on construction and open sites'.

This model allows noise levels from major industrial sources to be predicted over large distances and varying terrain. Attenuation is included accounting for distance, air absorption, ground absorption, and screening losses from site topography and local structures.

The analysis predicts resultant noise levels at the agreed NSPs.

6.2.1 Source Plant Noise Data

Data from sample measurements detailed above has been used in our assessment. Details of the data used for the model can be seen in table 3781/T4 below;

3781/T5 - Plant Noise Data Used in Prediction Model

Plant Item	Qty	Location	Make/Model	SPL / Lw (dBA)	Hours of Operation
Loader	1	Internal and External	Hyundai HL760-9A	105 Lw	Daytime only (50% on-time)
Macerator	1	Internal	Wackerbauer	65 @10m	Daytime only (1hr)
Flare	1	External	Uniflare	65 @1m	Only runs if CHP is down
Gas Booster for Flare	1	External	Unknown	79 @1m	Only runs if CHP is down
CHP 1	1	External	Jenbacher	65 @10m	24/7
Gas Booster for CHP1	1	External	-	83 @1m	24/7
CHP 2	1	External	Edina	65 @10m	Daytime only
Gas Booster for CHP2	1	External	-	74 @1m	Daytime only
Mixer/Feeder	1	External	Trioliet	69 @10m	15-20mins per hour
Drying Unit	1	External	ALLin DRYer	65 @10m	24/7
Pump	5	External	ETO-11	73 @1m	20mins per hour
Pump	4	External	Vogelsang VX136-105Q	67 @1m	20mins per hour
Pump	5	External	Vogelsang VX136-105Q	67 @1m	20mins per hour
Pump	3	External	Vogelsang RCW-43G	79 @1m	20mins per hour
Pump	1	External	Vogelsang A-RCX-48G	78 @1m	20mins per hour
Pump	1	External	Vogelsang VX186-130QD	78 @1m	20mins per hour
Compressor	22	External	Busch Mink MM 1102 BP	76 @1m	20mins per hour, max of 6 units
Gas Holder Air Fan	1	External (High Level on Primary Digestor)	CADFAN	56 @10m	24/7
Gas Holder Air Fan	1	External (Low Level on Secondary Digestor)	CADFAN	54 @10m	24/7

6.2.2 Results

Predicted $L_{Aeq,1hr}$ daytime levels are shown below;

3781/T6 - Daytime Noisemap Predictions

Daytime	Level Above Ground	Predicted $L_{Aeq,1hr}$ (dB)	Criteria $L_{Aeq,1hr}$ (dB)
1 Top Hill Farm	4.5	39	39
2 Green Acres	4.5	41	39
3 Claerwen	4.5	33	41
4 Llanciach Farm	4.5	28	37

Results confirm that daytime noise criteria are met at all NSPs with a marginal exceedance at Green Acres (which is in the operators' ownership).

However, when night-time noise levels are investigated and additional noise control measures introduced, noise levels at Green Acres may well reduce further.

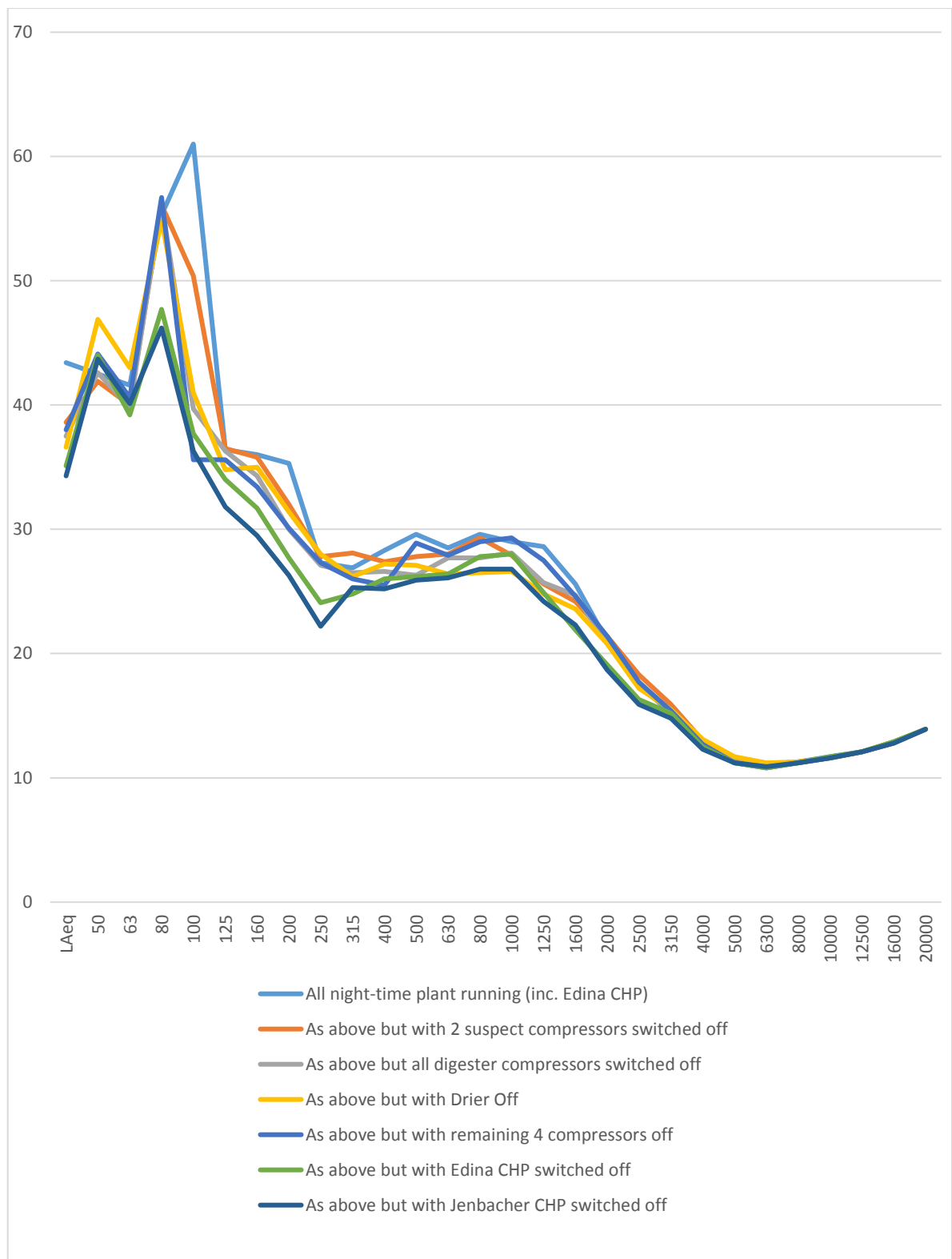
The hum at 100Hz which was prominent during the night-time period was also audible during lulls in traffic daytime.

7.0 Further Investigations

Further investigative measurements were undertaken during the night-time of Wednesday 22/03/2017 with Jen Morgan (AD plant manager) in attendance to isolate individual items of plant where possible.

Weather conditions were cold, dry and calm. Measurements were undertaken between 2300-0200hrs.

The effect of switching plant off during the night-time measured outside Green Acres bungalow is shown in graph 3781/G2 below;

3781/G2 – Impact of Turning off Individual Items of Plant South of Green Acres

Note: A stream located at the southern boundary of the field just north of the AD facility was measured at 55dB(A) at 1m, which would result in around 28dB(A) at Green Acres Bungalow, in line with the original background sound level measured during original surveys prior to development. Therefore, if plant noise contributes at 28dB L_{Aeq} , the overall measured level would be around 31dB L_{Aeq} .

Measurements were undertaken;

- i. With all night time plant running (including Edina CHP – does not normally run during night).
- ii. With the two problematic compressors switched off, which resulted in levels of around 34dB L_{Aeq} outside Top Hill Farm and 37dB L_{Aeq} outside Green Acres bungalow. There was a significant reduction in tonal low frequency content (up to 10dB reduction at 100Hz). Both CHPs were running during these measurements.
- iii. All remaining digester compressors switched off, 1dB reduction.
- iv. Dryer switched off, again not much impact 1dB further reduction.
- v. Remaining 4 compressors switched off – no effect on the current overall level
- vi. Edina CHP switched off. A significant reduction in low frequency noise (10dB reduction at 80Hz) and a 3dB overall reduction in noise levels was noted. The 80Hz tone was noted in the source daytime measurement of the Edina CHP. At the moment the Edina CHP does not run at night but the site would like the option.
- vii. Jenbacher CHP switched off: further 1.7dB reduction.

8.0 Recommendations

Noise criteria are indicated to be met at Claerwen and Llanciach Farm during both daytime and night-time operations. However the noise criteria are not indicated to be met at receivers to the north (Green Acres & Top Hill Farm).

8.1 Plant Attenuation

The following recommendations should be implemented and the plant then re-measured at source and at receivers to the north (Green Acres / Top Hill Farm);

- Use the minimum amount of plant required during the critical night-time period – confirm in a marked up plan, with approximate durations plant runs during the night.
- The two noisier compressors on the bank of 4 compressors nearest the secondary digester should be kept off during the critical night-time period until they can be assessed/serviced by the supplier/manufacturer.
- According to technical data from Busch, the Mink MM 1102 compressors are rated at 78dB(A) at 1m. In order to achieve design criteria of 50dB(A) at 10m, these should be rated at 70dB(A) at 1m. We would advise contacting the manufacturer to discuss attenuation options or look at installing a proprietary acoustic enclosure.
- Gas holder air fans are relatively noisy at 74-76dB at 1m, Attenuation measures should be installed to reduce noise levels to 50dB(A) at 10m. Seek advice from supplier.
- The Trioliet was measured at 79dB(A) at 10m. The original design aim of 50dB(A) at 10m is therefore exceeded. Further attenuation measures are therefore required.

- The Dryer exhaust requires attenuation to achieve the original limits set at 60dB at 10m (currently 65dB at 10m).
- The ABP pumps and Digestate TT pumps are indicated to exceed the 50dB at 10m design criterion and therefore require further attenuation. Seek advice from manufacturer to discuss attenuation options or look at installing proprietary acoustic enclosures.
- The Edina CHP should not be run during the night-time until additional sound attenuation measures have been installed to reduce the 80Hz tone and reduce the overall level to within original limits set at 60dB at 10m (currently 65dB at 10m).
- The Jenbacher CHP requires attenuation to achieve the original limits set at 60dB at 10m (currently 65dB at 10m).
- Gas booster fans were originally quoted at 46dB(A) @ 1m casing sound pressure level. These appear to be a lot higher on site; Jenbacher CHP gas booster measured at 83dB at 1m and Edina CHP gas booster measured at 74dB at 1m. Seek advice from supplier.
- Ensure line of sight is removed from top of dryer and CHPs to first floor level of receivers to the north. The dryer exhaust appears to have a screen erected next to it, however CHP exhausts are approaching the top of the adjacent banking and may require an additional screen either at source or at the top of the bank to remove line of sight.

3781/P3 – Photo Showing Dryer with Local Screen next to Exhaust



8.2 Proprietary Acoustic Enclosures

In order to control heat build-up, attenuated louvres or mechanical ventilation is likely to be required to allow airflow around the pumps whilst maintaining sound insulation requirements of the enclosure.

Final design options should be confirmed acceptable with pump/compressor manufacturers to ensure warranties remain valid.

Acoustic enclosure manufacturers include;

- ☐ Caice <http://www.caice.co.uk>
- ☐ EMTEC <http://www.emtecproducts.co.uk>
- ☐ IAC Acoustics <https://www.iac-acoustics.com/uk>

Care should be taken to ensure suitable vibration isolation is included between plant and the tanks/pipework to avoid drumming at high level.

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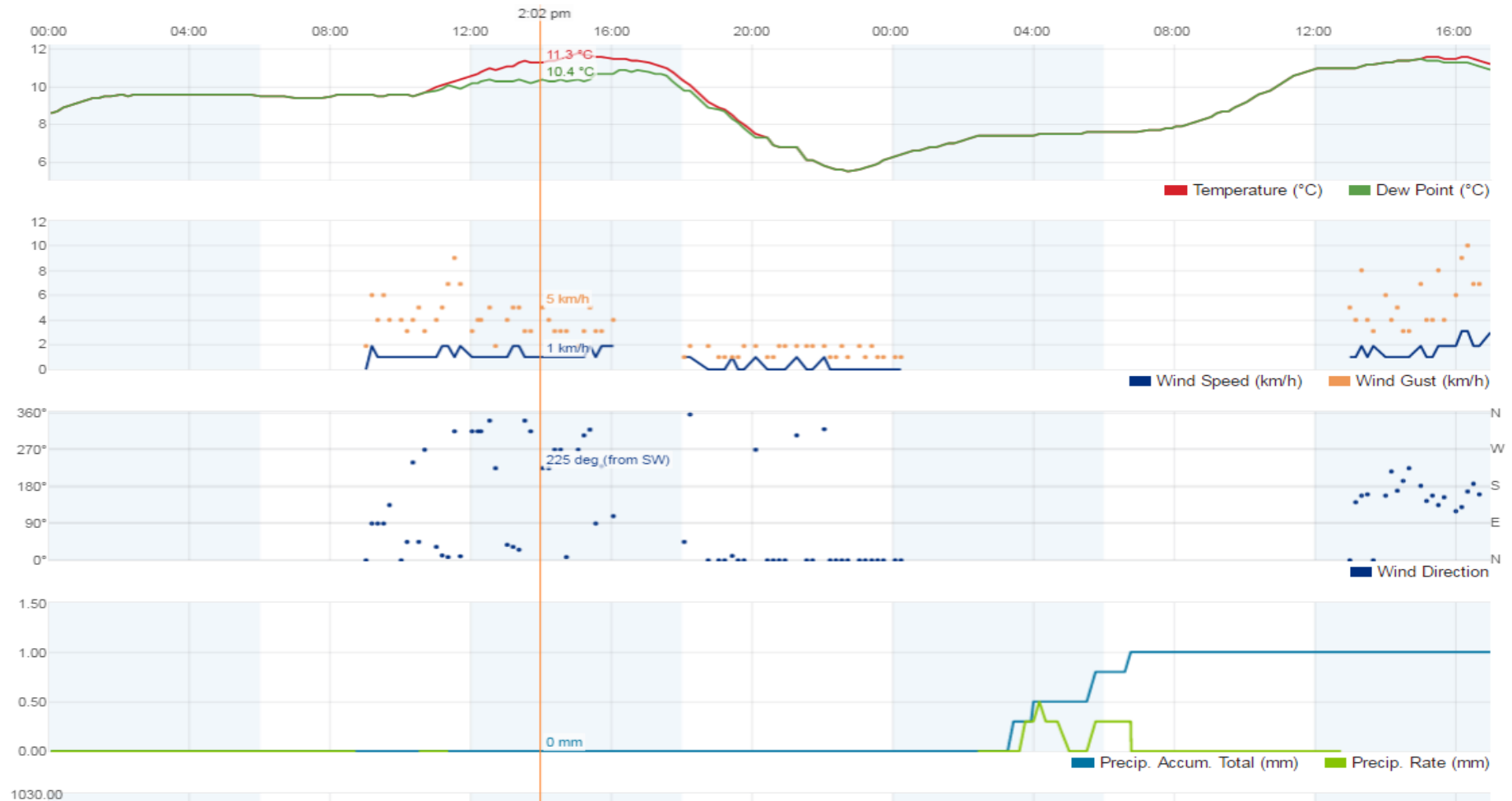
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Hunter Acoustics

Appendix A – Graphs, Tables and Diagrams

3781/WH1 – Approximate Weather History for 09/03/2017-10/03/2017



Data taken from www.wunderground.com. Weather Station: IGELLIGA2, located in Gelligaer [N 51 ° 40 ' 11 " , W 3 ° 14 ' 53 "]

3781/T3b – Source Sample Measurement Results (including octave band data)

Description	Distance	Duration	L _{Aeq}	L _{Amax}	Leq at Octave Band Centre Frequencies, Hz (dB)							
	(m)	(secs)	(dB)	(dB)	63	125	250	500	1k	2k	4k	8k
Macerator in shed start up	3	6	75.7	76.5	63.0	62.3	65.7	77.3	60.1	56.2	49.6	47.1
Macerator pump	1	5	75.5	76.1	64.5	62.2	64.2	75.7	66.4	66.7	55.7	56.9
Macerator running inside (daytime 2-4pm) start up at start of measurement	2	106	78.2	90.6	73.7	70.4	71.0	75.4	74.3	70.0	66.7	59.9
Macerator running loading shovel idling general level in building	3	84	76.1	86.1	75.4	78.1	74.8	73.0	70.6	68.0	66.5	56.1
Macerator shutting down (whine during shut down)	2	34	77.6	87.1	74.3	70.4	71.6	71.2	74.5	70.4	67.0	59.0
Drier exhaust (whine audible from gas engines)	5	15	71.4	72.2	77.6	77.3	68.3	68.0	67.6	62.8	49.0	42.7
Looking down at drier exhaust from high level 3-5m	3	7	70.4	71.3	74.4	77.5	68.7	66.7	66.1	61.2	53.0	43.8
Start up of conveyor 1m from motor and 4m from belt	1	16	65.5	79.4	69.9	63.4	62.3	65.6	60.5	53.0	49.4	42.0
Conveyor belt (squeaking)	1	9	67	71.6	70.7	65.4	64.1	68.6	58.1	52.8	48.8	41.5
Next to slurry tank general noise from drier, gas engines and compressors (background for next measurement)	-	6	55	56.4	61.4	61.4	56.3	52.1	48.3	48.5	37.7	31.2
Slurry tank - pump in tank - measure outside tank at pump location	1	9	61.8	62.8	67.9	63.5	58.4	61.7	51.9	53.1	50.5	44.5
Slurry tank - 1/4 way round tank from where pump is located - drier audible	1	5	62.6	63.5	68.3	61.2	57.3	64.2	50.5	49.9	47.4	41.7
Trioliet fan	0.5	4	72	72.8	73.8	69.7	66.5	72.0	66.6	62.9	56.4	47.9
Trioliet fan with some noise from pump system next to measurement position	1	7	70.1	71.9	67.9	67.6	64.5	71.1	62.7	58.2	53.0	46.5
Temporary recirc pump next to Trioliet	1	8	77.6	78.4	66.6	63.6	63.9	68.5	69.8	70.9	72.5	67.5
Quick background level with just slurry tank running - pump below in drain cover, everything else off	-	4	63.4	64.4	72.9	63.9	57.6	62.2	58.0	54.2	49.1	41.7

Trioliet and macerator running	3	280	79.2	86.1	70.6	68.1	66.1	70.1	75.4	71.6	71.5	68.0
Trioliet mixer which cycles in and out for trioliet period of 5mins	1	14	81.5	83.5	68.3	66.2	65.5	69.1	75.9	73.6	77.1	63.1
End two Trioliet mixers running at same time - only happens when loading Trioliet in morning for around 5mins	3	35	81.8	89.2	68.5	68.4	63.1	70.0	77.8	76.8	72.2	53.3
Background measurement at ABP feed system with engines opposite running	-	4	60.4	60.9	71.9	60.0	60.7	59.5	51.9	52.6	47.6	47.4
ABP feed	1	37	78.8	82.1	72.2	65.2	65.2	78.7	73.9	65.6	59.8	56.0
ABP feed pump	1	7	79.2	81.1	81.2	67.1	68.3	79.9	70.5	66.1	60.2	57.2
ABP feed pumps	5	6	68.3	70	71.4	63.4	61.6	67.2	62.1	60.4	52.6	50.9
ABP tank compressor 1 running on its own at 1m	1	6	75.8	76.4	73.3	68.1	69.5	74.3	71.4	68.5	60.8	58.6
ABP tank compressor 1 and 2 running together at 1m	1	8	77.6	78.5	73.0	67.3	72.7	74.6	72.8	71.5	63.1	60.2
Digestate TT pump	1	6	72.7	73.5	69.5	65.4	64.9	68.3	70.7	63.2	58.5	56.8
Digestate discharge pump	1	6	66.9	67.7	58.8	55.2	57.1	62.1	58.2	56.8	49.4	65.4
Tank air fan	1	9	74	74.6	57.9	59.2	59.0	67.4	70.5	68.1	63.3	57.2
Air fan on top of the primary digester	1	13	75.6	76.4	70.3	61.4	62.5	66.9	72.0	69.9	65.0	56.7
Measurement up on gantry between secondary and primary digesters with pumps running below	-	10	64.3	67.1	67.9	59.5	59.2	61.4	60.1	56.4	51.7	51.1
3 out of 5 biogas compressors running	1	6	77.7	78.4	68.7	66.2	72.6	73.0	72.8	72.5	65.0	59.6
Gas booster associated with flare at base approx. All kit running (flare off)	1	10	78.8	80.5	68.5	60.2	61.8	72.6	68.9	75.6	68.6	59.2
Measurement taken in yard near cabin, water falling behind, gas engine doors open	-	8	56.6	57.7	64.9	60.1	54.8	52.8	50.4	50.0	45.9	39.9
Loader drive by	5	7	71.6	76.2	77.3	74.5	71.4	68.4	66.0	63.7	56.2	48.1
Loader working and moving rotten material about	5	49	72.8	84.7	78.8	77.4	70.0	68.5	70.3	59.8	54.2	48.8

End louvre on Jenbacher gas engine facing AD Reception Building	1	10	73.7	74.6	75.7	77.1	69.4	66.4	65.9	69.1	64.4	61.2
CHP Biogas Booster on Jenbacher gas engine	1	10	82.8	83.5	81.0	76.0	73.6	76.1	75.5	79.5	70.8	65.8
End louvre on Jenbacher gas engine running	5	13	70.8	71.4	76.4	73.1	64.1	62.4	62.2	67.8	57.3	52.9
Side of Jenbacher engine, just below rad/cooling fans and side louvre	1	12	70.6	71.4	75.8	74.0	70.0	69.7	64.6	61.4	57.0	48.5
Rad/side louvre on Jenbacher engine	5	12	67.6	68.5	74.6	70.3	67.8	65.6	61.8	59.1	54.1	46.4
End facing north of Jenbacher engine	3	10	69.5	70.3	71.7	72.8	66.5	66.6	63.1	63.6	56.9	49.6
Between two gas engines, only Jenbacher running	-	12	76.2	76.8	77.3	79.4	74.8	73.3	69.9	69.7	65.2	55.4
Between two gas engines, only Jenbacher running - about 3m from CHP Biogas Booster near AD Reception end	-	10	78.8	79.5	71.2	80.4	76.1	71.2	72.0	74.9	67.0	59.1
30m north of the gas engine, just Jenbacher running - 10m from orange pump Pasteurisation Recirc Pump	-	20	67.2	68.2	65.5	64.2	63.2	61.5	65.4	55.7	50.4	41.9
Side of Jenbacher engine near rads	5	9	67	67.9	74.2	72.1	67.4	65.3	61.5	57.5	53.4	45.4
North of Jenbacher but hearing the compressors at this position	10	8	64.6	65.3	65.8	66.6	62.5	63.1	59.0	56.7	50.8	41.8
10m from Jenbacher (north)	10	10	65	66.2	73.8	70.5	59.2	60.3	57.5	60.1	53.5	48.8
Southern end of engines with both running	10	10	65.2	65.8	80.2	70.9	62.0	60.3	57.2	58.8	54.4	47.5
End of Edina engine (south)	1	8	63	63.6	73.7	63.4	66.9	57.5	53.6	54.2	54.7	44.9
End of Edina engine (south)	3	7	60.9	61.5	73.3	62.6	58.7	55.8	53.9	53.5	53.0	44.3
End of Edina engine (south)	10	10	60.1	60.7	77.0	60.4	57.4	56.1	51.3	51.5	51.0	42.4
Gas booster fan on side of Edina	1	9	74	74.7	77.3	69.0	64.9	72.0	69.8	66.3	60.3	57.6
Side of Edina, gas booster fan running	5	8	68	68.5	65.9	70.2	67.5	64.6	61.4	60.1	58.4	57.4
Side of Edina	10	10	65.1	65.5	74.6	66.2	67.8	62.4	56.0	56.2	54.3	53.0
Between containers north end, just Edina running	-	7	72.7	73.4	80.9	75.9	78.5	65.9	58.4	62.5	60.5	61.3
Between containers central, just Edina running	-	6	74.8	75.4	85.6	76.5	80.2	69.6	61.8	64.6	63.2	64.6

Between containers southern end, just Edina running	-	4	71.4	72.1	79.1	72.2	70.7	67.2	58.9	64.5	62.9	63.6
50m north of engines - tone from compressors dominant	50	27	67.3	70.2	72.0	68.0	65.7	63.0	64.1	57.8	53.2	43.6

3781/T4b – Night-time Sample Measurements (including octave band data)

Description	Time (hh:mm:ss)	Duration (secs)	L _{Aeq} (dB)	L _{Amax} (dB)	Leq at Octave Band Centre Frequencies, Hz (dB)							
					63	125	250	500	1k	2k	4k	8k
Pos A - just south of bungalow - hum dominant	22:49:02	1885	46.4	57.9	52.4	63.8	46.4	34.9	37.6	32.3	24.6	20.8
Pos A - just north of bungalow near main road - hum dominant	23:24:36	15	41.1	45.7	48.4	52.1	48.5	33.8	34.4	27.4	18.5	14.9
Pos B - back of Claerwen estate, no plant audible	23:29:14	60	31.2	42.4	49.3	35.4	29.0	27.8	27.6	18.8	17.5	15.3
Pos A – south of bungalow, check hum still present	23:38:30	10	43.2	47.5	46.7	59.6	47.8	34.2	34.4	27.0	18.8	15.3
Pos C - stream noise, no plant audible	23:46:28	90	35.6	44.4	50.8	41.0	36.6	29.3	31.3	26.8	23.7	19.3

Appendix B – Acoustic Terminology

Human response to noise depends on a number of factors including; Loudness, Frequency content, and variations in level with time. Various frequency weightings and statistical indices have been developed in order to objectively quantify 'annoyance'. The following units have been used in this report:

dB(A):	The sound pressure level weighted to correspond with the frequency response of the human ear, and therefore a persons' subjective response to frequency content.
L_{eq} :	The equivalent continuous sound level is a notional steady state level which over a quoted time period would have the same acoustic energy content as the actual fluctuating noise measured over that period.
L_{90} :	The sound level which is exceeded for 90% of the measurement period. i.e. The level exceeded for 54 minutes of a 1-hour measurement. It is often used to define the background noise level.
L_{10} :	The sound level which is exceeded for 10% of the measurement period. i.e. The level exceeded for 6 minutes of a 1-hour measurement
L_{max} :	The highest instantaneous sound level recorded during the measurement period.
$L_{Ar,Tr}$:	The specific noise level plus any adjustment for the characteristic features of the noise