



UPM

SHOTTON MILL

BAT Assessment for Noise





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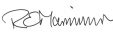
Manchester

M15 4RP

Phone: +44 161 200 5000

WSP.com

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1 INTRODUCTION

1.1 SCOPE

This report presents the methodology and findings of work carried out to inspect current processes and practices to determine whether best available techniques (BAT)¹ to control noise are currently employed, and to provide advice on further measures that could be implemented, should they be warranted.

In brief, the methodology comprises the following aspects:

- Site visits to review the current practices and processes at the site, and obtain sound level measurements of various processes and practices on the site to determine their individual noise contributions.
- Noise modelling to quantify the noise level emitted by the mill that is likely to occur at the nearest noise sensitive receptors and to identify the most significant noise sources.
- A detailed review of the current practices and processes across the site to examine whether they constitute BAT or if it would be appropriate for any alternative or additional techniques to be employed.

Quantifying noise or demonstrating that noise has been successfully restricted to certain numerical values is not strictly necessary in a review of the BAT. However, noise measurements and predictions are useful contextually and help to identify whether any potential impacts might justify a more thorough review of current practices and processes.

This report is necessarily technical in nature, and a glossary is provided in Appendix A to assist the reader.

1.2 SETTING OF THE SITE

The UPM Shotton site is located in Deeside, North Wales. The immediately adjacent land uses are industrial, and include a power station and substation, a steelworks and other large industrial plant.

The nearest residential areas are shown on the location plan in Appendix Band can be described in relation to the UPM site as follows:

- Connah's Quay – 1.8 km southwest
- Shotton – 2.3 km south-southwest
- Shotwick – 3.3 km east
- Puddington – 2.9 km northeast
- Burton – 2.9 km north-northeast
- Dwellings near Oakenholt – 3.1 km west

¹ In this report, Best Available Techniques (BAT) are as defined in '*Best Available Techniques (BAT) Reference Document for the Production of Pulp, Paper and Board*' (2015) which forms part of the Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)

The layout of the buildings on the UPM Shotton site are shown on the site plan in Appendix B. It should be noted that not all of the buildings are in use. Their operational statuses can be summarised as follows:

- Paper Mill 1 (PM1) – not operational
- Paper Mill 2 (PM2) – operational paper mill
- PM2 Winder 4 Annex – operational
- Low pressure condensing turbine – operational
- Boiler 7 – operational
- Boiler 3 – only operational in exceptional circumstances (i.e. when Boiler 7 is out of service)
- Boiler 6 – only operational in exceptional circumstances (i.e. when Boiler 7 is out of service)
- RCF1 – not operational
- RCF2 – not operational, except for a small amount of background ventilation plant on roof
- RCF3 – operational
- Waste paper storage – operational
- Paper (product) storage – operational
- Materials Recycling Facility (MRF) – operational

2 GUIDANCE AND STANDARDS

The evaluation of the application of BAT (Best Available Techniques) does not necessarily require a consideration of potential impacts on receptors. Instead, the focus of a BAT assessment is on whether or not an operator is using the best techniques available to a given process to reduce the environment impacts.

The term 'available' in BAT refers to the fact that a technique must be not just available as a product or practice, but also appropriate and proportionate to the process or plant itself. For example, a technique to reduce noise that would not physically fit on the site, would incur unacceptable financial cost, or would hinder maintenance access to processes or machinery, would not be BAT because it would not be considered to be available for that operation.

BAT is referenced extensively in the Industrial Emissions Directive 2010/75/EU (below) and the Environment Agency's *Horizontal Guidance for Noise*, both of which are discussed below.

2.1 B.R.E.F. DOCUMENT FOR THE PRODUCTION OF PULP, PAPER AND BOARD

A series of BAT Reference (BREF) documents covering different industrial processes scheduled under the Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control) are available to assist with the environmental regulation of those processes.

BREFs currently supersede any national guidance. The relevant document for UPM Shotton is '*Best Available Techniques (BAT) Reference Document for the Production of Pulp, Paper and Board*' (2015) and, as there no other BREFs referred to in this work, will be referred to herein as 'the BREF'.

The guidance in this document relevant to noise comprises two main sections, which are summarised below.

Chapter 8.1.9 '*Emissions of noise*' (BAT17) outlines a series of techniques to reduce emissions of noise from pulp and paper manufacturing and state that 'BAT is to use a combination of the techniques'. These techniques are discussed specifically in relation to the UPM Shotton site in section 4.2, so are not reproduced here.

Chapter 2.9.13 '*Reduction of noise*' provides more specific examples of sources of noise likely to be found at a paper mill and the means by which noise from those processes can be controlled. This chapter also provides examples of the cost of implementing noise control measures, based on case studies at various plants in Europe.

2.2 HORIZONTAL GUIDANCE FOR NOISE PART 2 – NOISE ASSESSMENT AND CONTROL

For permitting purposes, the UPM Shotton site is regulated by Natural Resources Wales (NRW), which continues to follow the Environment Agency's '*Horizontal Guidance for Noise Part 2 – Noise Assessment and Control*'.

*Horizontal Guidance for Noise Part 2*² sets out the requirements for the assessment and control of noise from industrial sources. The document outlines permit conditions and regulation of noise. It also describes the principles of noise measurement and prediction, and the control of noise by design, operational and management techniques and abatement technologies.

The over-riding consideration is that best available techniques (BAT) should be used to reduce the impact of the scheme. The guidance also requires that noise is assessed in accordance with BS 4142:2014.

2.3 BRITISH STANDARD 4142:2014+A1:2019

A BS 4142 assessment is not provided within this report. Furthermore, a BS 4142 assessment is not currently possible because no background sound levels have been measured at receptors. However, some of the principles and terminology are relevant, so a brief summary of the standard is therefore presented below.

BS 4142:2014+A1:2019³ provides methods for rating and assessing sound arising from commercial sources, including external plant and on-site vehicle movements and unloading, at residential receptors. It uses a relative assessment approach whereby the predicted commercial sound level (suitably penalised for annoyance character if appropriate) is compared with the prevailing background sound level. A summary of the BS 4142 approach is set out as follows:

- Establish the specific sound level of the source(s).
- Measure the representative background sound level.
- Correct the specific sound level for on-time and interferences if necessary.
- Rate the specific sound level to account for distinguishing characteristics.
- Estimate the impact by subtracting the background sound level from the rating level.
- Consider the initial impact estimate in the context of the sound and its environs.

The representative background sound level should be established from data measured at the receptor locations.

The specific sound level is rated using the following penalties:

- | | |
|-------------------------------|------------|
| ■ Tonality | up to 6 dB |
| ■ Impulsivity | up to 9 dB |
| ■ Other sound characteristics | up to 3 dB |
| ■ Intermittency | 3 dB |

An initial estimate of the impact of the specific sound is obtained by subtracting the measured background sound level from the rating level as described in section 11 of BS 4142. The results of this comparison are assessed based on the following:

² *Horizontal Guidance for Noise Part 2 – Noise Assessment and Control* (version 3, June 2004), Environment Agency

³ BS 4142:2014 +A1:2019 Methods for rating and assessing industrial and commercial sound, British Standards Institute

- Typically, the greater the difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB 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 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.

All pertinent contextual factors should then be considered and these include:

- The absolute level of the sound.
- The character and level of the residual sound compared to the character and level of the specific sound.
- The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.

The method described in BS 4142 specifically states that it is “*not intended to be applied to the derivation of indoor sound levels arising from sound levels outside, or the assessment of indoor sound levels*” (section 1.3).

2.4 ISO 9613-2:1996

ISO 9613-2:1996⁴ describes a method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. It is described in BS 4142 as “a validated method of calculating sound levels”, and its calculation procedures are implemented in most noise modelling software, including CadnaA which is discussed herein.

2.5 BRITISH STANDARD 8233:2014

BS 8233:2014⁵ provides information on the design of buildings that have internal acoustic environments appropriate to their functions. It deals with control of noise from outside the building, noise from plant and services within it, and room acoustics for non-critical situations. It is not directly applicable to industrial noise but provides typical noise levels for inside and outside residential properties. These are not adopted as criteria in this report but are useful for contextual consideration of the sound levels predicted at residential receptors. These noise levels are summarised as follows.

⁴ ISO 9613-2:1996 ‘Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation’, International Organization for Standardization

⁵ BS 8233:2014 ‘Guidance on sound insulation and noise reduction for buildings’, British Standards Institute

Table 2-1 – Summary of guideline residential noise levels from BS 8233

Description	Sound level
Outdoors – daytime (e.g. gardens, balconies)	50 – 55 dB $L_{Aeq,16hr}$
Indoors – daytime (e.g. living room)	35 – 40 dB $L_{Aeq,16hr}$
Indoors – night-time (bedroom)	30 – 35 dB $L_{Aeq,8hr}$

3 QUANTITATIVE ASSESSMENT

3.1 INTRODUCTION

The aims of the quantitative assessment are to examine the relative noise contributions from the various processes and practices employed at the site, and to consider their significance at receptor locations. This should indicate which of the sound sources on the site are the most significant, and therefore most worthy of consideration in the subsequent BAT review (see section 4 below).

3.2 METHODOLOGY OVERVIEW

Sound level measurements were made during the two site visits to quantify the sound levels and characteristics produced by those sources identified as potentially significant. These have included measurements of reverberant sound levels inside noisy buildings and measurements of sound levels close to outdoor plant.

In accordance with the principles of BAT, emphasis has been given to the sound sources that were subjectively considered to produce the highest sound levels or benefit from the least screening between the source and receptors.

Those measurements have been used to inform a noise model that predicts the sound levels emitted from the site at the site boundary and at nearby noise sensitive receptors.

The guidance in BS 4142 was taken into account during the measurement process and the prediction of noise levels drew from both BS 4142 and ISO 9613-2. However, it is not a “BS 4142 assessment” for a number of reasons including no comparisons between predicted process sound levels with background sound levels at the receiver positions.

3.3 SPECIFIC SOUND LEVEL MEASUREMENTS

SUMMARY

Sound levels were made during two visits on 15 May and 8 June 2020. Sound level measurements were made in general accordance with the method described in BS 4142, using Class 1 sound level meters as defined in BS EN 61672-1⁶, and field calibrators meeting Class 1 specifications as defined in BS EN IEC 60942:2018⁷.

MEASUREMENT EQUIPMENT

The equipment used to undertake the sound level measurements is as follows.

⁶ BS EN 61672-1:2013 *Electroacoustics. Sound level meters. Specifications*

⁷ BS EN IEC 60942:2018 *Electroacoustics. Sound calibrators*

Table 3-1 – Summary of sound level measurement equipment

Date and description	Equipment Description	Manufacturer & Type No.	Serial No.	Calibration Due Date	Accessories
B&K 2250 Used 15 May 2020	Sound Level Meter	B&K Type 2250	3023998	19 February 2022	B&K windshield
	Pre-amplifier	Brüel & Kjær Type ZC 0032	26900		
	Microphone	Brüel & Kjær 4189	3130582		
	Calibrator	Brüel & Kjær 4231 Sound Calibrator	2527490	19 February 2021	
01dB Duo Used 8 June 2020	Sound Level Meter	01 dB-Metavib DUO	10330	08 January 2021	01dB windshield + noise cone Extension lead + pole to position microphone above extract fan outlets
	Pre-amplifier	01 dB Metravib PRE 22	10219		
	Microphone	GRAS 40CD	330600		
	Calibrator	01 dB-Stell CAL 21	34924020	26 September 2020	

The sound level meters were calibrated prior to and on completion of the measurements using the field calibrators. No significant drift occurred (< 0.1 dB).

Both items of equipment were set to record A-weighted and one-third octave band spectra using the L_{eq} sound level parameter.

WEATHER CONDITIONS

Weather conditions during the two site visits can be summarised as follows (using a combination of on-site measurements and historical weather data from Wunderground.com):

- 15 May 2020
 - 6.5 m/s north-westerly wind
 - 13 °C
 - Dry
- 8 June 2020
 - 3.5 m/s south-easterly wind (measured on the roof of RCF3 during typical conditions)
 - 17 °C
 - Dry

The windshields fitted to the sound level meters are considered to be effective in wind speeds of up to 5 m/s. As wind speeds were higher than 5 m/s during the 15 May visit, outdoor measurements from the second visit have been used for most outdoor sources, including all sources at roof level.

SOUNDSCAPE DURING SPECIFIC SOURCE MEASUREMENTS

All sound level measurements were made at positions where the levels would be dominated by the sound produced by the individual sound sources. For rooftop sound sources, it was often difficult to measure the sound levels from individual sources without inadvertently including sound contributions from other nearby sources. Close-range measurements were therefore used extensively to exclude extraneous sources as much as possible.

No sound from off-site sources was audible at the measurement positions, except at ground level near the site boundary, where a small number of measurements were made to assist in subsequent calibration of the noise model.

Most of the on-site sound sources were considered to be broadband and non-tonal in nature. The exceptions to this are as follows:

- Calendar pulper exhaust fan (80V849) outlet on PM2 roof (the fan itself is below roof level) – distinct tone at 82 Hz
- Disk filter exhaust fan (80V825) at the north-east corner of PM2 roof – distinct whine from the drive belt
- Hood exhaust fans (80V845, 80V846 and 80V847) – whine from drive belts
- MRF compressor
- Fresh water pipes on tank

Spectral sound pressure levels measured at 1 m from each of these subjectively tonal sources are shown in the figure below.

Figure 3-1 – Measured spectra for tonal plant items

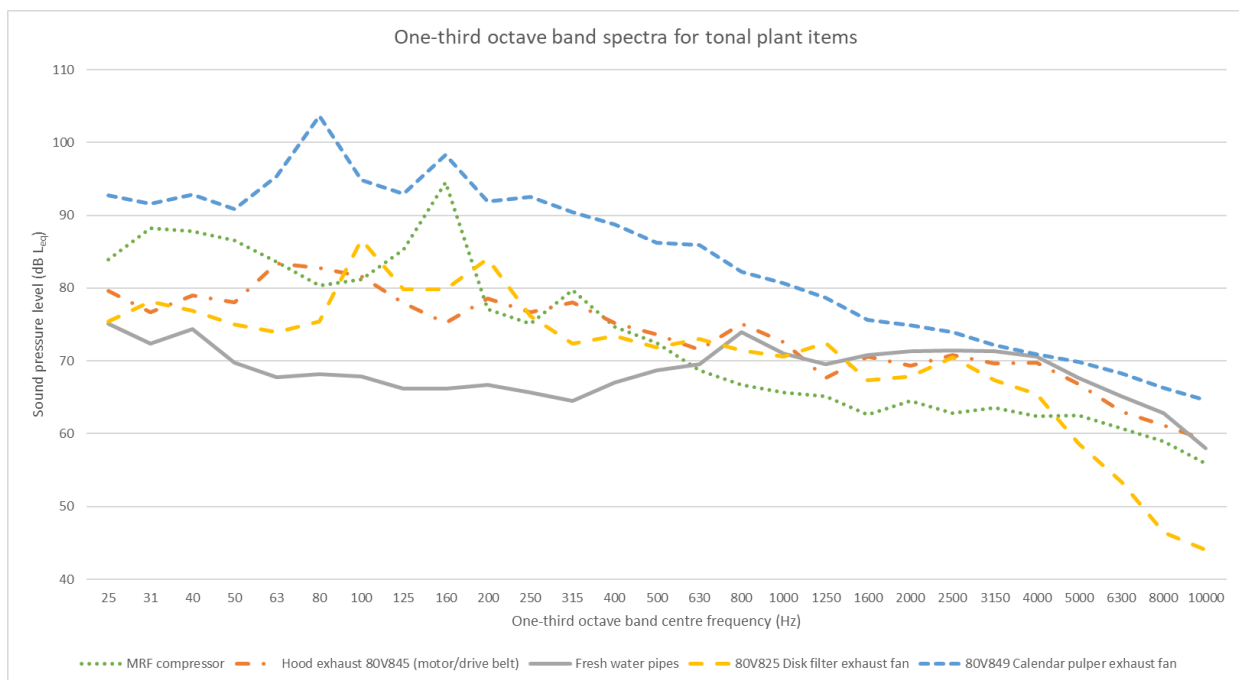


Figure 3-2 – Photographs of plant exhibiting tonal sound characteristics

Calendar pulper exhaust	Disk filter exhaust fan	Hood exhaust fans
		
Photographs of the MRF compressor and fresh water pipes can be found in Figure 3-7.		

None of the sources were considered to have impulsive or intermittent sound characteristics, except for the waste wood handling plant. This has a steady engine noise that is present at all times, and intermittent crunching noises caused when new wood is fed into the primary shredder. It is therefore considered to be intermittent but not impulsive.

It should be noted that the significance of any tonal, impulsive or intermittent sound characteristics should always be considered at the receptor location rather than close to the source.

MEASUREMENT METHODOLOGY FOR INDOOR SOUND SOURCES

Sound level measurements were made in locations where sound levels were considered high enough to have the potential to result in significant break-out via the building fabric. All measurements were spatially-averaged over a period of 30 to 120 seconds depending on the floor area of the building. For large buildings such as PM2, multiple measurements were made near each separate process, and the results were subsequently averaged before being used in the model.

Indoor sound level measurements were made in the following locations:

- PM2 – near press and wire section
- PM2 – near dryer hood
- PM2 – near winder 3
- PM2 – near wrap line
- PM2 winder 4 annex
- RCF3 – near drum pulper
- Low pressure condensing turbine hall
- Boiler 7 steam turbine hall

MEASUREMENT METHODOLOGY FOR OUTDOOR SOUND SOURCES

Measurements were made of all equipment that was subjectively considered to produce significant noise. Where a valid sound level was not obtainable (typically just for rooftop supply air units), data

have been substituted from similar equipment on the same roof. Unless otherwise stated, measurements were made at 1 m from the source in free-field conditions. All measurements were 30 seconds long as this was found to be sufficient to obtain a representative measurement, due to all of the sources emitting constant sound levels.

Specific methods adopted for each of the outdoor sound sources are described below.

Axial Extract Fans

For axial extract fans, a measurement was made at each outlet. Fan noise from the motor was not readily identifiable as a unique source and was not measurable as a separate source of noise. The measurement was made at 1 metre from the outlet, directly above the rim.

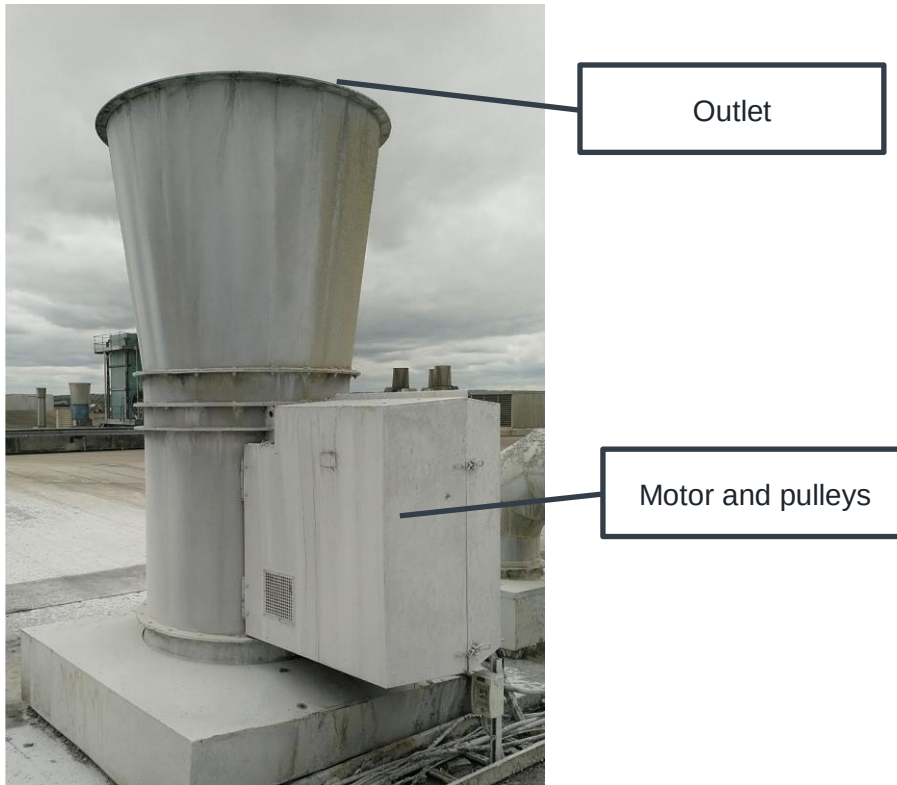
Figure 3-3 – Example axial extract fan



Centrifugal Fans

Centrifugal extract fans contain two identifiably separate sources: (a) the motor and pulleys; and (b) the outlet. These were measured as two separate sources.

Figure 3-4 – Example centrifugal fan (PM2)



Air Supply Units

Supply air fans are packaged units that house a fan with an atmosphere side attenuator. For most of these sources, only the inlet noise was audible as a unique source. For some units, sound was not clearly audible at all, particularly those units fitted with a sound-attenuating hood. For units which were audible, sound level measurements were made at 1 m from the inlet. If units were not audible and measurable, no measurement was made and data measured at another air supply unit of the same type on the same roof were adopted in the model. This is likely to over-estimate the sound emitted from those units and therefore contributes to a precautionary assessment.

Figure 3-5 – Typical air supply units

PM2 air supply unit incorporating a sound attenuator behind inlet louvre



RCF3 air supply unit fitted with a sound-attenuating inlet hood (visible on left) and inlet attenuator (behind inlet hood). This is also typical of the Winder 4 Annex units.



Cooling Towers

There are four operational cooling towers on the UPM Shotton site:

- PM2 cooling tower (on the roof of PM2)
- Low pressure condensing turbine (LPCT) cooling tower at ground level to the east of PM2
- Main mill cooling tower immediately east of PM1
- Effluent plant cooling tower in the effluent plant area towards the south of the site

It was possible to measure noise from the top and north sides of the PM2 cooling tower, but ambient sound levels on the other sides were dominated by noise from nearby extract fans. The north side measurement is considered representative of the other three sides and has therefore been used as a substitute.

For the LPCT cooling tower, residual sound levels were much lower, so it was possible to obtain representative measurements at 10 m from all sides of the unit and at 1 m above the top.

The main mill cooling tower was not operational at the times of the surveys, so it was not possible to obtain any representative measurements.

The effluent plant cooling tower was not measured, as it is understood to be a very quiet unit.

Dry Air Coolers

Spatially averaged sound level measurements were made at approximately 1 m above the four dry air coolers by walking along the walkways between them. The highest of the three measurements is to be adopted for use in the noise model.

Figure 3-6 – Dry air coolers



Other sources at ground level

Other outdoor sound sources were measured at appropriate distances to ensure (a) the safety of the engineer; and (b) that the measurement would be representative of the sound source as a whole. These sources were mostly measured at distances of more than 1 metre, and include the following items:

- Waste wood processing plant – measured at 30 metres
- Mist cannon – measured at 5 metres
- Small chillers at ground level on the north side of PM2 – measured at 1 metre, above the two units
- Compressor on east side of MRF building – measured at 7 metres
- Fresh water pipes on tank 023 – measured at 1 metre

Figure 3-7 – Ground level sound sources

Waste wood processing plant



Mist cannon



Chillers north of PM2



Fresh water pipe



MRF compressor



Lorry Movements

Lorry movements have been modelled as moving point sources along typical routes taken throughout the site. Sound power levels are based on the following spectrum adapted from data presented in Table C.6 of BS 5228-1⁸. The site speed limit is 9 mph.

Table 3-2 – Sound pressure level spectrum for lorries

Octave band centre frequencies (Hz)	63	125	250	500	2000	2000	4000	8000	dBA
Sound pressure level, dB L _{eq} at 10 m	91	77	69	68	72	67	66	59	75

Lorry movements have been assumed to all occur within a 12-hour daytime period, as a worst-case assumption. Quantities of lorry movement are based on information provided by the mill, and can be summarised as follows:

⁸ BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*, British Standards Institute

- RCP: 55 loads of inbound RCP (recovered paper) for the RCP warehouse
- RCF pulper residue: 30 empty vehicles to collect pulper residue
- MRF: 35 loads of co-mingled material destined for the MRF, plus 25 empty vehicles for MRF products leaving site
- FPW: 50 empty vehicles to Finished Paper Warehouse for loading
- Woodyard: 50 loads of waste wood delivered to woodyard
- Boiler 7: 8 empty tankers to collect boiler ash

Sources not Measured

No sound was audible from the conveyor belts at any point during the visits. As such, it was not possible to measure their specific sound level and they were deemed not to be contributing significantly to the sound levels emitted from the site.

As the boiler chimney stack is 75 m high, it was not possible to measure the noise emitted by this source. At no point across the site was the boiler chimney audible as a distinct noise source, so it has therefore been omitted from the model on the basis that (a) measurement is impractical and (b) it does not appear to contribute to the noise emissions of the site.

It is acknowledged that sound from this source is likely to be directional, with higher sound emissions vertically, and lower sound emissions at positions that are lower than the top of the chimney. As such, its sound level could be much lower at ground level close to the stack than it may be at a greater distance, particularly at elevated positions. However, specialist personnel lifting equipment would be necessary for a measurement to be undertaken so it has been omitted at present.

Figure 3-8 – Boiler 7 chimney as viewed from RCF3 roof



The site includes various transformers. However, it was not possible to obtain measurements of these that would not have been excessively affected by noise from other sources. As they were subjectively judged to be much quieter than other plant nearby, they have not been included.

The MRF building has not been included because it has very low occupancy (approximately one or two vehicles at a time) and a lot of the wall area is concrete, which has very good sound insulating properties. Noise levels inside the building were very low, so it was deemed to be not contributing significantly to the sound levels emitted from the site.

RESULTS

Individual sound level measurement results are tabulated in Appendix C.

3.4 NOISE MODEL

A computerised noise model of the site and the surrounding area was created using the CadnaA noise prediction software (version 2019 MR2), which implements calculations to predict the effects on noise propagation of geometric spreading, topography, screening, meteorological conditions and information provided regarding the sources of noise. Calculations were carried out in accordance with ISO 9613-2 which assumes a moderate downwind condition in all calculations, as recommended in section 9 of the same standard.

MODELLING SETTINGS

- Default ground absorption: $G=0$; localised areas of agricultural land/fields: $G=0.9$
- Two orders of reflection (buildings are reflective)
- ISO 9613 propagation model
- Residential receptors located at first floor (4.0m) of façade facing plant
- Predicted levels are free-field
- Ground topography based on 2 m LIDAR composite data from OS OpenMap (note: no topographic data available for the area to the west of the A548 where the road crosses the River Dee. Default model ground height = 0 m)
- Building locations derived from OpenStreetMap
- Heights of dwellings assumed to be 8m to apex;
- Heights of buildings at UPM Shotton are based on information provided by the client and by local observation
- Directivity of vertical fan exhausts modelled on German standard 'VDI Guideline 3733' assuming plume temperature of 40 °C and velocity of 7 m/s (based on site measurements)
- Breakout from buildings predicted based on measured internal noise levels and an assumed SRI spectrum of Kingspan lightweight façade (24 dB R_w) and a lightweight Kingspan roof with lining (32dB R_w). Windows are double glazed and have an assumed SRI of 24 dB R_w)

MODEL FIGURES

Figures showing the extents of the model and the sound sources incorporated within it are shown below.

Figure 3-9 – Extents of modelled area

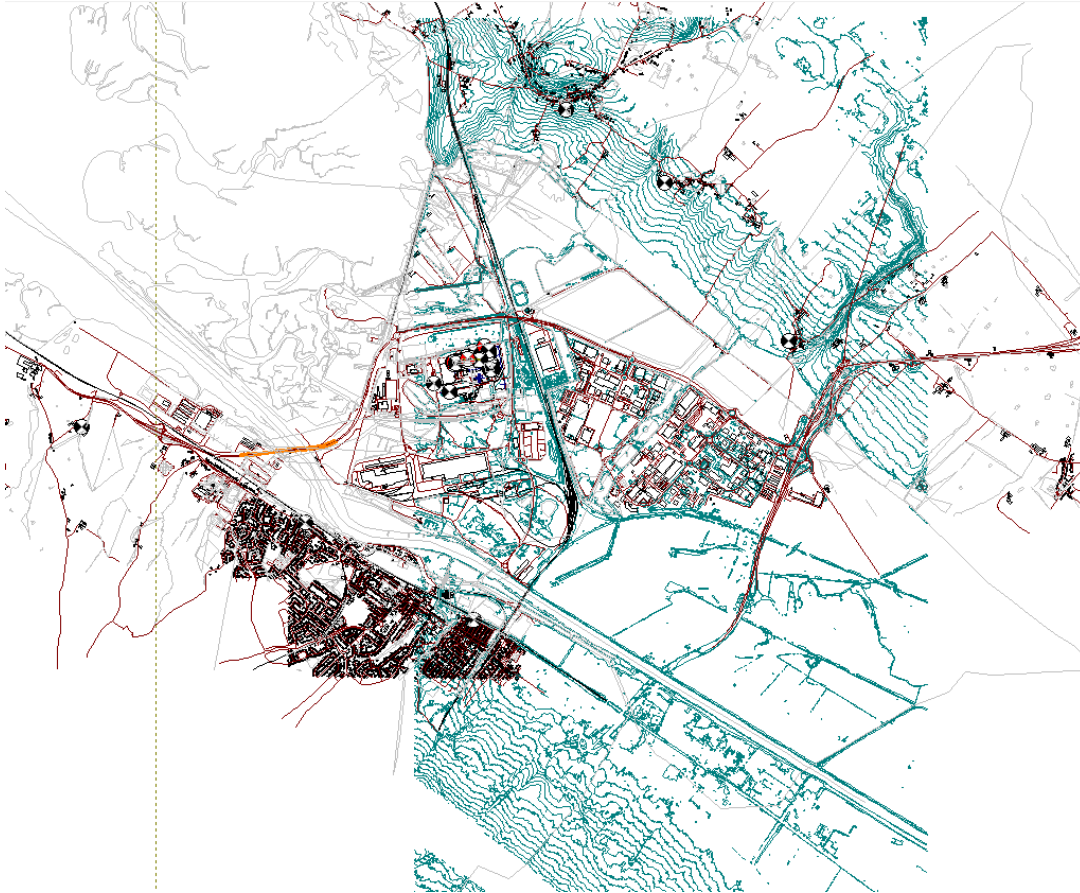


Figure 3-10 - Sound sources modelled

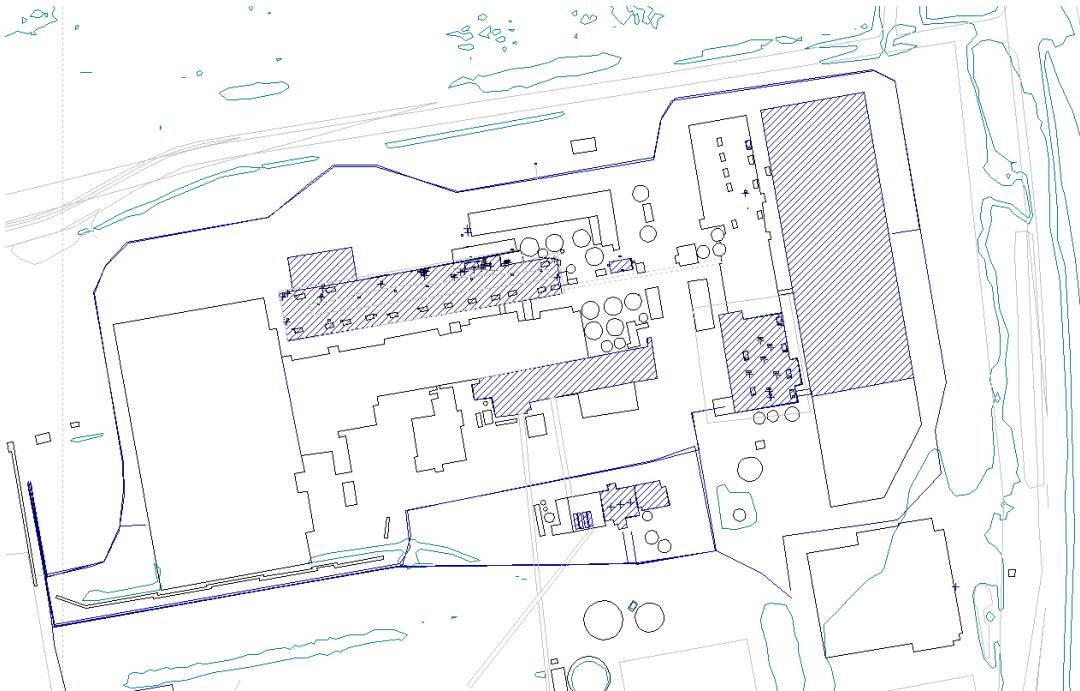
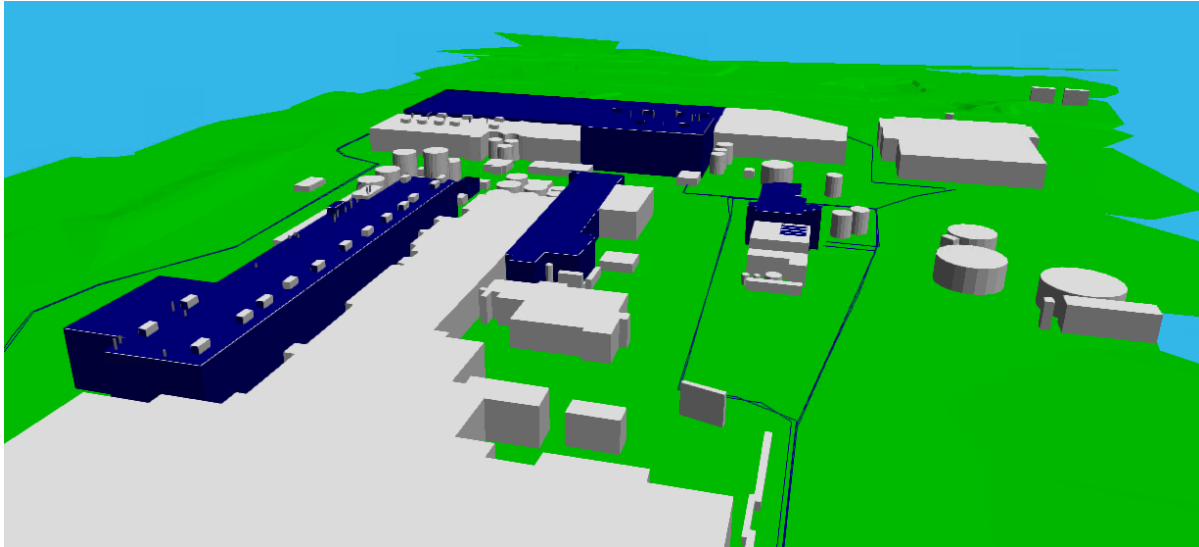


Figure 3-11 – 3-D aerial view of noise model



SOURCE, RATING AND TIME PERIOD CORRECTIONS

On-times have been assumed as follows:

- All fixed plant operates 100 % of the time – this is likely to slightly overestimate the total sound pressure levels as plant is switched off when not in use
- All plant runs continuously and is non-cyclical
- Lorry movements occur within a 12-hour period daily

3.5 PREDICTED SOUND LEVELS

The sound levels predicted at the nearest residential receptors are as follows.

Table 3-3 – Predicted sound levels at nearest residential receptors

Receptor	Coordinates (easting, northing)	Specific sound level, dB L _{Aeq}
Connah's Quay	53.22303, -3.06563	39.6
Shotton	53.21448, -3.04023	37.6
Shotwick	53.23928, -2.99549	34.5
Puddington	53.25287, -3.01287	37.6
Burton	53.25926, -3.02825	37.5
Dwellings near Oakenholt	53.23111, -3.09847	31.9

Predicted A-weighted sound levels for individual sound sources are presented in Appendix D. These have been sorted so that the highest predictions appear first in the table (with respect to Burton as the first receptor, alphabetically). From this table it is possible to identify that regardless of which receptor is used for ranking the sources, the following are the top five contributors

Table 3-4 – Predicted sound levels (dB L_{Aeq,T}) for the five most significant contributing sound sources

Sound Source	Burton	Connah's Quay	Oakenholt	Puddington	Shotton	Shotwick
80V830 Wire exhaust fan 2	29.8	32.4	20.7	30.1	26.5	23.7
Dry air coolers (total of all four)	28.7	31.8	24.0	28.6	30.8	27.2
80V831 Speed former exhaust fan	27.9	29.8	22.8	28.1	28.3	24.2
80V824 Mist syphon exhaust fan	25.7	27.6	20.5	25.9	26.0	22.7
80V829 Wire exhaust fan 1	25.0	26.8	19.6	25.2	25.3	22.6

One-third octave band results are presented in Appendix D. It can be seen from these results that the sound levels predicted at the six receptors appear to be broadband in nature, and do not exhibit any obviously significant tonal components.

The sound levels predicted for the calendar pulper exhaust fan, which was found to be a source of tonal noise (on-site, at around 82 Hz), are as follows.

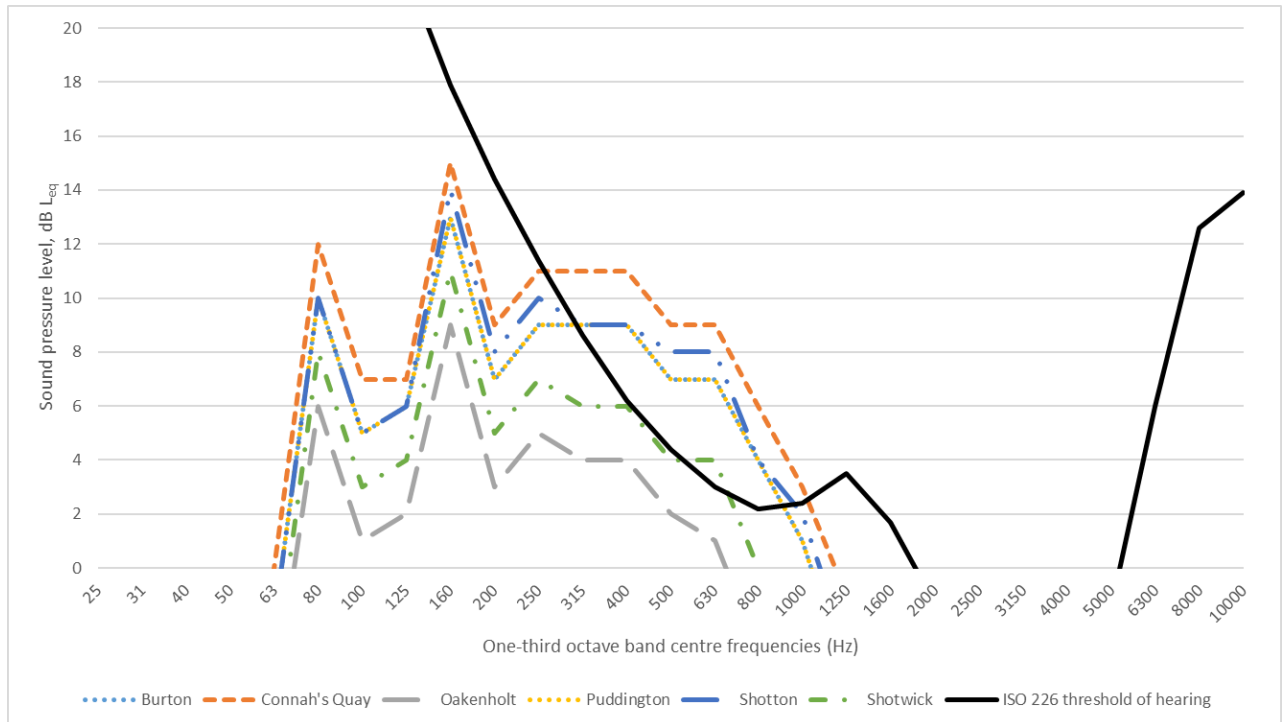
Table 3-5 – Predicted sound levels (dB L_{Aeq,T}) for the calendar pulper exhaust fan

Name	Burton	Connah's Quay	Oakenholt	Puddington	Shotton	Shotwick
80V849 Calendar pulper exhaust fan	19.1	21	14.7	19.1	19.6	16.8

Sound levels are 6 – 21 dB below the most significant sound source.

The spectral sound levels predicted for this item of plant are shown in the figure below.

Figure 3-12 – One-third octave sound levels predicted at dwellings for calendar pulper exhaust fan



3.6 UNCERTAINTY

Where it has been necessary to make assumptions in the assessment described above, these have been precautionary, to ensure a robust assessment. These are summarised as follows, along with an estimate of the likely uncertainty (positive values indicate a potential over-estimation of the total specific sound level).

Table 3-6 – Summary of uncertainty estimation

Source of uncertainty	Lower bound of impact uncertainty (under-estimation)	Upper bound of impact uncertainty (over-estimation)
ISO 9613-2 calculation method for predictions (from Table 5 of ISO 9613-2:1996)	-3 dB	+3 dB
Measuring specific sound levels of individual sources whilst in the presence of other sources	-1 dB	+2 dB
Derivation of specific source SWLs using measurements	-3 dB	+3 dB
Omission of sources not subjectively considered to be significant contributors	≤ -1 dB	0 dB
Adverse wind direction as implemented in the noise model	0 dB	< +1 dB

The principle of uncertainty estimation is not that one should assume all uncertainty deviations to occur simultaneously (in either polarity). However, it can be seen from the above that uncertainty is generally estimated to be greater in the direction that would result in an over-estimation of the specific sound's impact than an under-estimation. On this basis, and considering the overall low levels of uncertainty (all estimates are within 3 dB in either direction), it is not considered necessary to apply any uncertainty corrections to the results.

3.7 DISCUSSION

The predicted noise levels are low and indicate a low likelihood of tonal components being significant at receptor locations. It can also be seen that the A-weighted sound levels are significantly (10 – 18 dB) lower than the outdoor design criteria sound levels set out in BS 8233 (see Table 2-1).

If 15 dB attenuation is assumed for an open window (also from BS 8233), the predicted sound levels inside dwellings would be approximately 17 – 25 dB, so would, in all cases, be lower than the indoor sound levels from the same standard. With windows closed, the indoor sound levels could be assumed to be at least 5 dB lower for single glazing or 10 dB lower for double glazing.

The sound levels predicted for UPM Shotton are considered to be low. When considering the levels of predicted noise in the context of the heavily industrialised surrounding area, it is considered that the predicted noise levels are very low in relative terms.

Whilst background sound levels have not been measured at the nearest receptors, it is considered likely that the specific levels presented in Table 3-3 would be below the background sound levels.

On the basis that the quantitative assessment is indicative of a low impact at receptors (without having yet considered whether effective BAT is in use on the site) it could be tentatively concluded that the site does not require any noise-reduction programmes or that any such programmes would need to have a strongly beneficial cost/benefit ratio to be justified or considered.

The next section of this report reviews whether or not BAT is currently in use, whether it is effective, and if and/or what improvements should be made.

4 REVIEW OF BEST AVAILABLE TECHNIQUES IN USE

During the site visits on Friday 15 May and Monday 8 June 2020, inspections were made of all process buildings, outdoor processes, and major fixed plant, to determine how the BAT are applied to control noise emissions and to determine whether any further measures would be appropriate and/or necessary for the BAT to be in place.

4.1 BAT REVIEW

SUBJECTIVE IMPRESSIONS

At the site entry at the car park on the west side of the plant, the mill was audible but was subjectively judged to be quiet.

Mid-way along the north site boundary the plant was audible, but it was subjectively noted that noise from road traffic using Weighbridge Road (A548), which lies approximately 165 m to the north, was at least as loud as the mill.

SITE LOCATION

As noted in section 1.2 above, the site is located in a predominantly industrial area, with major energy infrastructure and industrial facilities adjacent to it, including:

- Power station and converter station immediately west
- Tata steelworks 400 m south-west
- Akzo Nobel factory 400 m south
- Flintshire Bridge HVDC converter station 200 m south-east
- Toyota manufacturing 500 m south-east
- Great Bear Distribution 300 m east

The choice of location is a fundamental example of BAT having been adopted from the inception of the mill use, as it means that the process is in keeping with the area and that there are no noise-sensitive receptors within 1.8 km of the site. This distance provides substantial reductions in noise due to geometric spreading.

BUILDING CONSTRUCTIONS

The processes that produces the highest levels of noise are the drum pulper, paper mill, boiler 7 steam turbine and low pressure condensing turbine. All of these are enclosed within buildings which reduces noise emissions.

Noise from the dryer hood in PM2 is further reduced by the installation of an acoustic and thermal enclosure, as shown below.

Figure 4-1 - Enclosure over dryer hood to reduce noise emissions (PM2)



The buildings in which these noise-generating processes are located are of solid construction and provide a very noticeable reduction of noise levels when entering or leaving them. This is mainly due to the large areas of opaque steel cladding, double glazed windows (where installed) and acoustically effective personnel entry doors.

The LPCT walls are mainly of concrete block construction, as shown in the photograph below, which will provide a high level of sound reduction.

Figure 4-2 – Low pressure condensing turbine hall



No significant acoustic absorption is present in the process buildings. Additional absorption could achieve some sound reductions if it were installed in large enough quantities. However, any such installation could impede access to the building fabric for maintenance and inspection and given the size of the buildings any effective installation would have to be very substantial and costly. Considering that the buildings already provide significant sound reduction of the noisiest plant, acoustic linings would not be considered necessary, appropriate or proportionate.

The existing building fabrics and containment practices are therefore considered to be the best available techniques for reducing noise from these large noise-producing processes, whilst maintaining reasonable access to the machinery and the building fabric for maintenance (which, itself is a key part of BAT for reducing noise from machinery).

OUTDOOR PLANT NOISE

The following measures to reduce noise from plant that is situated outdoors were observed during the on-site BAT review process:

- All supply air fans are fitted with attenuated enclosures and the enclosures of the newer supply air fans also have sound-attenuating hoods over the fresh air intake louvres (see Figure 3-5)
- Rooftop plant is generally low on the roof, maximising screening from the rooftop edge
- The boiler is centrally located, so that it is screened from receptors in most directions
- Noise from the Boiler 7 chimney is inaudible anywhere on the site, which indicates that it may be attenuated
- Conveyors are inaudible even at very close range, which is an indication that quiet conveyor models have been used on the site

Extract fans do not incorporate attenuators on their exhaust outlets. The BREF discusses the option of incorporating attenuators on dryer hood fans and provides an example in chapter 7. It is noted that the high humidity in the exhaust air poses a significant constraint for sound-absorbing attenuators, as the mineral wool that is used in the sound-attenuating baffles in the attenuator is not effective when it is wet. As such, regular removal of the baffles for cleaning and drying would be essential. As the extract fans at UPM Shotton do not incorporate any redundancy (i.e. all fans are required for the mill to operate), this would require the mill to be frequently stopped. The UPM site usually operates 24 hours per day and 365 days a year, so this would not be a practicable option.

Incorporating such redundancy would require extra fans to be installed as well as ductwork and dampers to redirect air between the fans. Given the proximity of the fans to the equipment below (particularly in PM2), it is unlikely that there would be space to install this.

In view of the above it is considered that attenuating the extract fans would not be an available noise control technique at the present time. Also, given the low overall noise levels predicted in the quantitative assessment above, it would not be justified.

NOISE CONTROL PRACTICES

The following practices on the site help to reduce noise emissions:

- Roller shutters are closed when not in use
- Ramdoor automatic roller shutters are installed at multiple vehicular access points of buildings . These automatically and quickly open and close when vehicles approach and depart in order to minimise the amount of time they are open for and reduce noise egress from the building. They are installed at the following locations:
 - PM1 Dry End South;
 - PM1 Dry End North;
 - PM2 Dry End South;
 - Winder 4 Annex North
- Plant is switched off when not in use

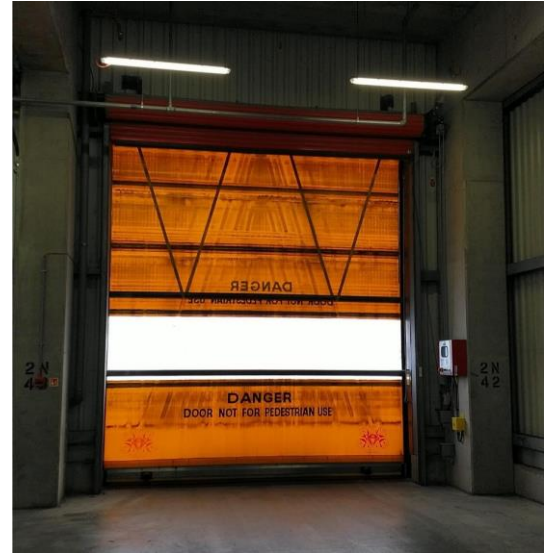
- The newest cooling tower (serving LPCT) has been positioned so that it is screened by other buildings in all directions, and at ground level where the maximum screening is achieved
- RCF3, which is the only RCF that remains in operation, is towards the middle of site where it is furthest away from receptors

Figure 4-3 – Examples of roller shutters

RCF3 roller shutters closed when not in use



PM2 Winder 4 Annex automatic roller shutter



The site contains duplicates of some processes (e.g. PM1 and PM2; RCF1, 2 & 3; and Boilers 3, 6 & 7) but not all are in operation. Those that are used – i.e. PM2, RCF3 and Boiler 7 – are the newest of their types and therefore feature the most state of the art plant. Whilst the scope of this assessment does not enable a detailed appraisal of the noise emissions from plant that is no longer in regular use, it can usually be assumed that newer plant is more efficient and quieter than older models. On that basis, one would assume that use of the newest processes wherever possible is a better available technique than to continue to use machinery that is of an older design and may have already served many more hours of duty.

4.2 SUMMARY OF B.A.T. IN RELATION TO B.R.E.F. REQUIREMENTS

Section 8.1.9 '*Emissions of noise*' in the BREF states that BAT is to use a combination of processes that reduce the emissions of noise. These are reproduced below along with comments on how those measures apply to our review described above.

Table 4-1 – Summary of BAT in use in relation to BREF Requirements

	Technique	Description	Applicability to UPM Shotton
a	Noise-reduction programme	A noise-reduction programme includes identification of sources and affected areas, calculations and measurements of noise levels in order to rank sources according to noise levels, and identification of the most cost-effective combination of techniques, their implantation and monitoring	Noise predictions have previously been carried out (by others) for all new fixed plant installed at the site, using current noise modelling prediction methods as appropriate to the significant distances between the site and its nearest sensitive receptors. Results of these assessments indicated a sufficiently low impact (after mitigation as necessary) that no further monitoring was necessary.
			The measurements and modelling presented here also indicate that noise from the plant is sufficiently low that a programme of noise reduction is not warranted, considering the availability of further noise reduction measures.
b	Strategic planning of the location of equipment, units and buildings	Noise levels can be reduced by increasing the distance between the emitter and the receiver and by using buildings as noise screens.	The UPM site is at least 1.8 km from its nearest noise-sensitive receptors, which provides substantial attenuation of sound, as is demonstrated through the quantitative assessment above.
			Plant that can be located at ground level is sited towards the middle of the site, so that its noise emissions are screened by the other buildings. Examples include the LPCT cooling tower, boiler and dry air coolers.
c	Operational and management techniques in buildings containing noisy equipment	This includes:	
		Improved inspection and maintenance of equipment to prevent failures	All equipment is subject to regular inspection and maintenance to reduce the risk of failure and minimise noise emissions.
		Closing of doors and windows of covered areas	Windows are generally not openable. Roller shutters are closed when not in use. Personnel doors are fitted with automatic fire door closers.
		Equipment operation by experienced staff	All equipment is operated and maintained by experienced and knowledgeable staff
		Avoidance of noisy activities during night-time	The site operates 24 hours per day but most deliveries are restricted to weekdays to reduce noise at weekends.
		Provisions for noise control during maintenance activities	Staff are made aware of noise sensitivities. Any noisy maintenance works are carried out during the day.

d	Enclosing noisy equipment and units	Enclosure of noisy equipment, such as wood handling, hydraulic units, and compressors in separate structures, such as buildings or soundproofed cabinets, where internal-external lining is made of impact-absorbing material.	Examples of noisy equipment being installed in acoustic enclosures and/or buildings are as follows: - Low pressure condensing turbine housed within building built from concrete blocks - Steam turbine housed within boiler 7 building - Main paper mill (including press and wire machinery) is installed in PM2 building - Dryer hood enclosed and housed within PM2 building
e	Use of low-noise equipment and noise-reducers on equipment and ducts		Supply air fans on roofs of PM2 and RCF3 are installed in acoustic enclosures (RCF3 supply air fans also include sound-attenuating inlet hoods)
f	Vibration insulation	Vibration insulation of machinery and decoupled arrangement of noise sources and potentially resonant components	For the types of plant on this site, vibration isolation (e.g. spring mountings) could marginally reduce noise levels in some buildings but would have very little effect on airborne sound. It was not possible to inspect any anti-vibration mountings due to the equipment being in use and the mountings not being visible.
g	Soundproofing of buildings	This potentially includes:	
		- Sound-absorbing materials in walls and ceilings	This could reduce reverberant noise levels in some buildings, but would require very large coverages and would restrict access to the building walls and roof for inspection and maintenance purposes And would not be practicable.
		- Sound-isolating doors	Personnel access doors to noisy areas were noted to be effective reducers of sound transmission.
		- Double-glazed windows	Double-glazed windows used in all buildings, which are predicted to provide an equivalent sound reduction index as the cladding.
h	Noise abatement	Noise propagation can be reduced by inserting barriers between emitters and receivers. Appropriate barriers include protection walls, embankments and buildings.	Much of the site is screened by other buildings, particularly the industrial buildings listed in section 1.2. LPCT cooling tower and dry air coolers are screened by buildings on site.

		Suitable noise abatement techniques include fitting silencers and attenuators to noisy equipment such as steam releases and dryer vents	Silencers are fitted to all supply air fans. The possibility of retro-fitting silencers on extract fans has been considered within this review. From an initial appraisal it appears likely that such abatement would be expensive, impractical and could require the plant to shut down frequently to allow the attenuators to be cleaned and dried. On the basis of the discussion herein, it is considered that this option is not an <i>available</i> technique at this time, although it may be considered if/when extraction plant is renewed.
i	Use of larger wood-handling machines to reduce lifting and transport times and noise from logs falling onto log piles or the feed table		The site uses recycled materials, which avoids the need for logs to be handled. Waste is handled towards the south of the site to be used as fuel for the boiler. Material brought on to the is far smaller than logs and is shredded at its first stage which reduces noise from further handling.
j	Improved ways of working, e.g. releasing logs from a lower height onto the log piles or the feed table; immediate feedback of the level of noise for the workers		The wood is reduced in size at the point that it arrives on site, reducing the need for large pieces to be handled multiple times.

4.3 SUMMARY

From the above comparison it can be seen that the UPM Shotton site meets the majority of the relevant BREF recommendations. It is concluded that where BAT processes from the BREF are not currently in use at the site, those techniques are not 'available' to the plant at the present time. In most cases, this is due to a combination of factors consisting of practicality, disruption to operations, maintenance implications and a disproportionate cost compared to the potential benefit.

5 CONCLUSIONS

A detailed technical review has been undertaken at the UPM Shotton paper mill of the techniques employed to reduce noise emitted from the site, in accordance with the principles of BAT (Best Available Techniques) as defined in the Industrial Emissions Directive 2010/75/EU and the Environment Agency's *Horizontal Guidance for Noise*.

It has been noted that the determination of BAT is not directly related to noise level measurements or predictions, but in this case both have been used in order to identify the most significant sources of noise on the site (with respect to their potential impacts on residential receptors) and to identify whether any sources of noise might justify a more thorough review of current controls.

Sound level measurements have been obtained of all processes deemed to produce significant levels of noise, and the results have been used to calibrate a noise model that predicts the total and individual noise contributions from the plant at the nearest residential receptors.

The predicted noise levels have been found to be relatively low and, by themselves, would not justify significant changes to current practices and processes.

A review of the BAT employed at the site has been undertaken, based on a thorough inspection of all practices and processes. Where potential mitigation techniques are not currently employed on the site, it has generally been found that the use of such would have significant practical implications for the site's operation or maintenance, and in many cases would also require substantial financial investment, thus rendering them not *available* (as defined in BAT) for use on this site.

Given the low noise levels predicted at receptors and the lack of additional feasible and available techniques, it concluded that the site currently demonstrates effective BAT. No justification or necessity has been identified for changing the current practices and processes.

Appendix A

TECHNICAL GLOSSARY



Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq} , L_{A90} etc, according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

An indication of the range of sound levels commonly found in the environment is given in the following table.

Typical sound levels found in the environment

Typical Sound Level	Example Location
0 dB(A)	Threshold of hearing
20 to 30 dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50 dB(A)	Typical office
50 to 60 dB(A)	Inside a car
60 to 70 dB(A)	Typical high street
70 to 90 dB(A)	Inside factory
100 to 110 dB(A)	Burglar alarm at 1m away
110 to 130 dB(A)	Jet aircraft on take off
140 dB(A)	Threshold of pain

Glossary of Terms

Term	Description
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure (2x10 ⁻⁵ Pa).
L _{Aeq,T}	L _{Aeq} is defined as the notional steady sound level which, over a stated period of time (T), would contain the same amount of acoustical energy as the A - weighted fluctuating sound measured over that period.
L _{Amax}	L _{Amax} is the maximum A - weighted sound pressure level recorded over the period stated. L _{Amax} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the overall L _{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L ₁₀ and L ₉₀	If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The L _n indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L ₁₀ is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L ₉₀ is the 'average minimum level' and is often used to describe the background noise. It is common practice to use the L ₁₀ index to describe traffic noise.
Free-field Level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other reflective surfaces. Generally as measured outside and away from buildings.
Fast	A time weighting used in the root mean square section of a sound level meter with a 125millisecond time constant.
Slow	A time weighting used in the root mean square section of a sound level meter with a 1000millisecond time constant.
Ambient Sound Level	The all-encompassing noise level measured in L _{Aeq,T} . The Ambient Sound Level incorporates background sounds as well as the industrial source noise under consideration.
Residual Sound Level	The Ambient Sound Level in the absence of the industrial source noise under consideration, measured in L _{Aeq,T} .
Specific Sound Level	The sound level measured in L _{Aeq,T} attributed to the industrial noise source under consideration alone.
Background Sound Level	The sound level in the absence of the industrial source noise under consideration, measured in L _{A90} .

Appendix B

SITE PLANS





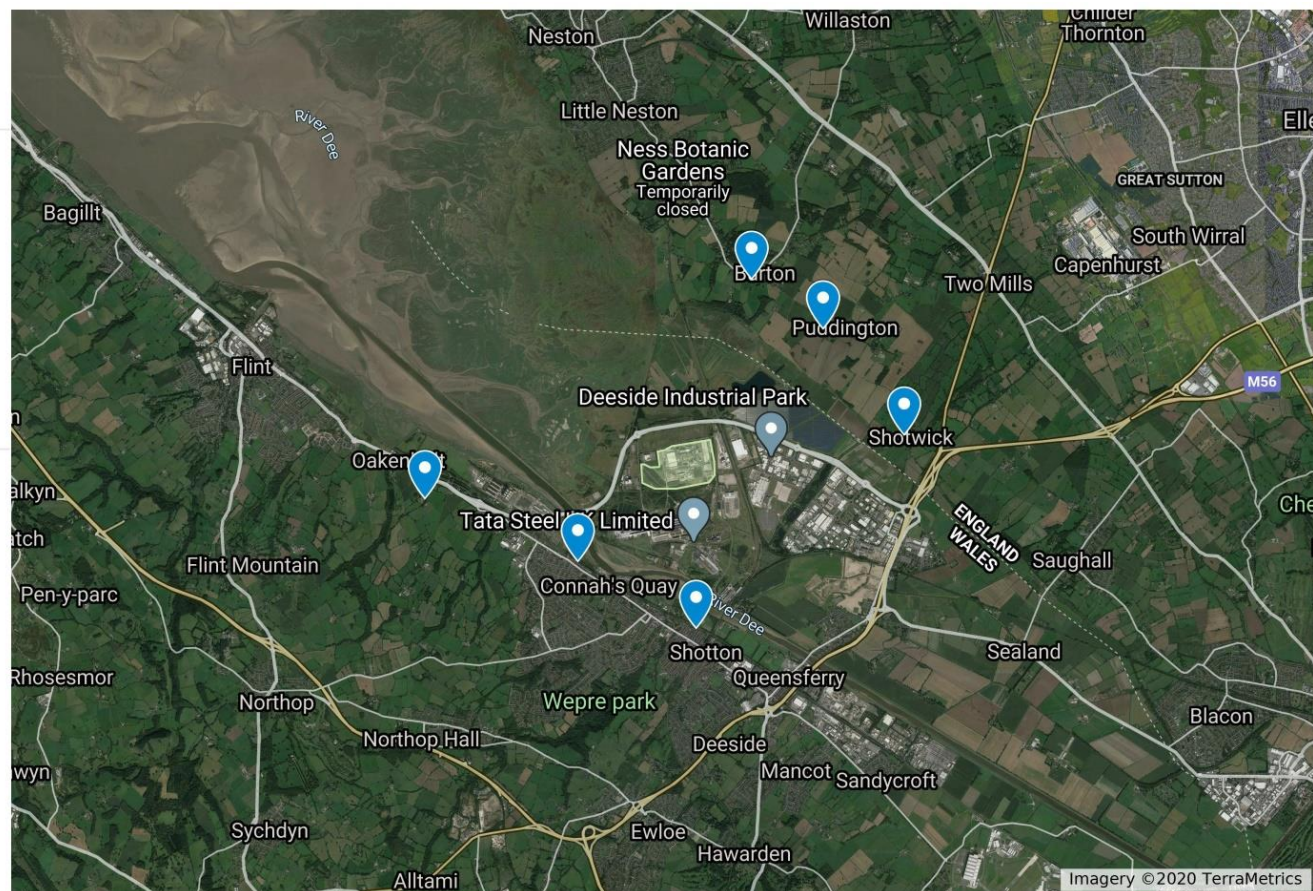
LOCATION PLAN

UPM site

 UPM Shotton site location

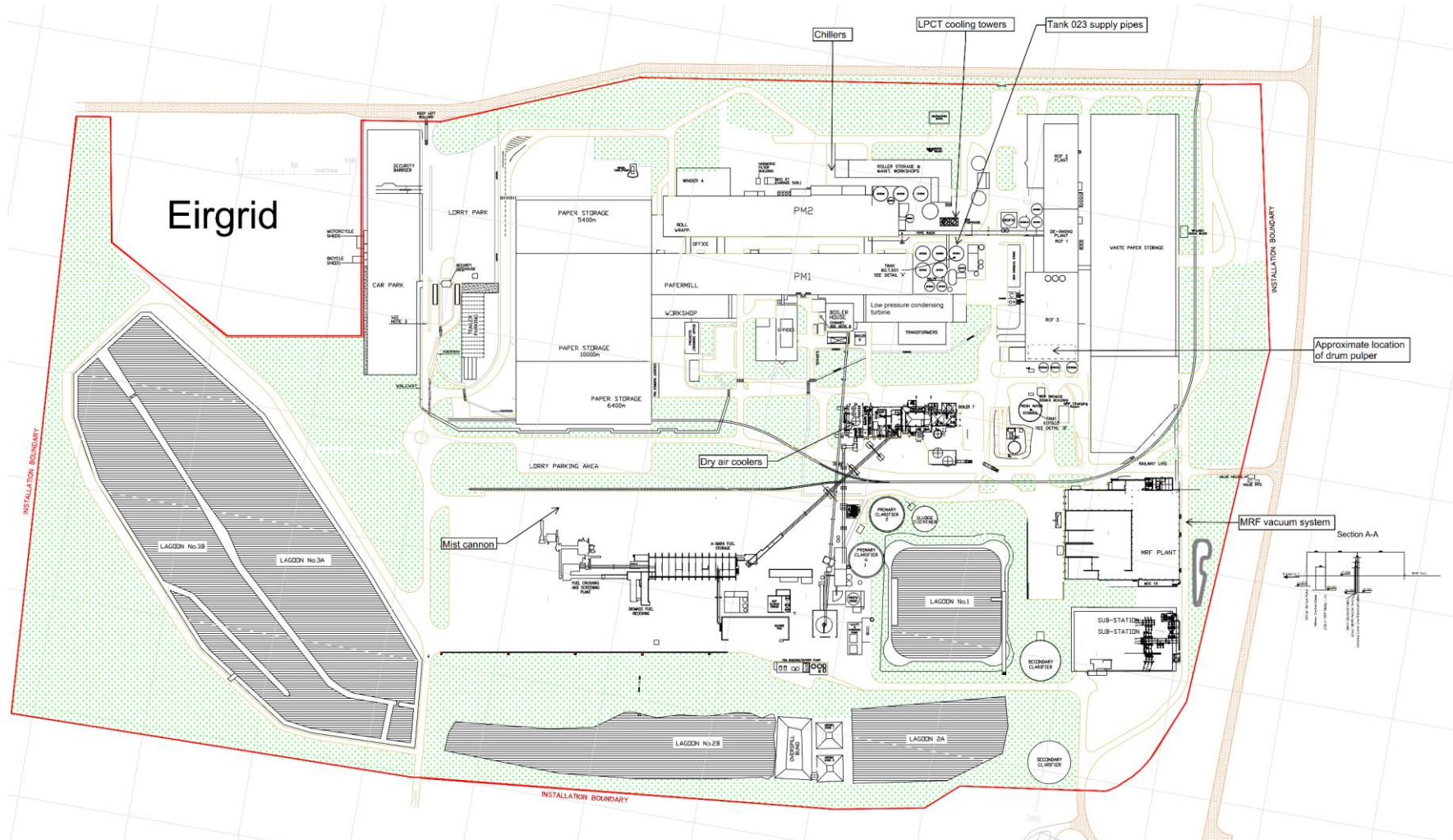
Receptors

-  Connah's Quay
-  Shotton
-  Shotwick
-  Puddington
-  Burton
-  Oakenholt





SITE PLAN



Appendix C

SURVEY DATA





Plant	Measurement description	Distance from source	25	31	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
80V020 PM2 cooling tower	Top measurement	1m from top	95.8	95.4	95.4	94.1	92.6	91.7	92.3	93.5	88.6	88.3	90.6	87.7	88.4	89.1	87.5	84.8	84.0	82.6	80.6	78.6	77.3	75.9	73.7	69.8	62.0	51.9	44.6
80V020 PM2 cooling tower	Side measurement	1m from side	78.9	78.8	81.8	80.3	80.6	80.8	83.5	84.9	78.4	80.7	86.3	84.1	82.3	80.9	79.2	77.1	74.9	72.6	69.8	67.8	67.6	68.3	69.2	68.8	63.9	55.6	47.4
80V808 Machine hall air supply unit 8	Free-field	1m from inlet	73.4	72.3	74.5	73.3	73.8	72.3	74.6	70.9	72.9	70.0	71.3	68.1	65.7	65.4	65.0	62.3	61.1	59.0	57.2	54.5	52.8	51.3	49.6	47.3	45.1	42.7	39.4
80V809 Machine hall air supply unit 0	Free-field	1m from inlet	72.0	71.6	73.1	72.6	74.2	77.3	73.5	72.5	75.8	75.1	81.3	82.9	75.2	75.2	75.2	74.4	69.7	66.3	63.7	61.2	60.0	58.1	59.1	59.4	57.9	56.0	58.2
80V810 Machine hall air supply unit 10	Free-field	1m from inlet	71.9	68.7	72.3	71.6	73.3	75.0	73.5	74.0	73.9	73.0	73.2	73.1	68.2	65.8	69.0	66.0	62.5	61.6	58.8	56.8	56.2	53.8	51.9	50.4	48.3	46.4	44.9
80V812 Machine hall air supply unit 12	Free-field	1m from inlet	71.7	68.8	71.1	68.5	68.6	75.8	72.5	69.8	70.5	67.3	68.2	67.3	66.1	69.1	69.0	66.8	64.8	62.8	61.2	59.5	57.9	56.3	59.0	59.5	58.7	56.3	57.8
80V813 - Machine hall air supply unit 13	Free-field	1m from outlet	70.4	68.7	71.6	69.6	66.7	72.0	73.3	69.2	71.7	69.0	66.8	64.8	62.5	62.6	63.6	60.4	58.7	58.1	57.0	56.4	55.2	54.3	56.7	58.4	57.1	54.6	56.5
80V813 - Machine hall air supply unit 13	Free-field	1m from side	71.6	71.6	71.9	70.3	69.9	75.5	79.1	73.2	72.7	69.0	70.1	67.6	69.8	64.3	65.8	64.2	62.4	64.1	65.3	62.4	61.1	60.9	60.6	62.9	62.9	58.3	58.7
80V814 Machine hall air supply unit 14	Free-field	1m from inlet	70.7	70.0	73.6	70.3	70.1	70.8	70.6	71.2	71.8	68.2	73.6	69.7	66.9	70.0	68.7	72.0	63.4	63.3	60.4	59.8	58.4	57.1	58.5	58.4	57.4	55.1	55.8
80V815 Machine hall air supply unit 15	Free-field	1m from inlet	68.8	67.7	70.3	68.9	69.6	72.4	69.1	72.8	72.9	69.5	73.5	67.0	63.4	76.5	69.3	60.1	58.6	59.9	57.6	55.4	54.0	51.0	49.7	46.4	45.2	42.9	39.6
80V817 MCC room 27 cooling fan	Free-field	1m from outlet	94.4	93.7	92.3	91.3	90.4	88.9	87.8	92.0	88.7	87.4	89.0	88.5	90.0	89.3	88.9	85.9	82.1	79.4	76.8	74.1	70.7	66.8	62.6	58.5	53.8	47.4	42.0
80V818 machine hall exhaust fan	Free-field	1m from outlet	106.1	105.5	104.4	103.7	102.7	101.8	101.0	100.7	99.6	99.5	98.3	96.6	95.6	94.7	93.6	92.3	89.8	87.6	84.9	83.4	82.7	83.4	84.4	84.9	82.3	74.4	65.4
80V819 machine hall exhaust fan	Free-field	1m from outlet	89.1	88.4	88.0	87.1	88.8	91.6	97.4	96.4	91.1	94.1	92.5	90.4	90.8	93.7	89.9	88.2	84.7	81.3	79.4	80.8	80.1	78.6	73.1	71.6	68.5	60.2	53.6
80V820 machine hall exhaust fan	Free-field	1m from outlet	84.0	83.0	85.1	83.6	83.6	85.1	87.9	85.3	87.0	86.8	88.2	86.3	84.9	85.6	84.3	84.1	81.3	79.9	79.2	77.7	74.8	72.0	69.7	67.9	63.6	55.1	47.1
80V821 Machine hall exhaust fan	Free-field	1m from outlet	76.1	76.1	76.3	78.7	80.6	77.1	82.1	77.9	78.3	75.4	80.1	73.4	70.0	71.1	68.5	67.6	61.9	60.0	56.4	54.7	52.4	52.4	51.9	52.0	50.8	49.4	48.3
80V822 machine hall exhaust fan	Free-field	1m from outlet	98.7	99.1	99.7	98.9	97.4	96.3	94.2	94.7	92.6	89.7	92.5	89.2	89.8	89.0	89.1	85.9	83.2	79.7	77.6	74.3	71.1	69.1	67.5	67.3	67.8	67.4	66.9
80V824 mist siphon exhaust fan	Free-field	1m from motor	80.2	80.0	81.4	81.8	80.7	80.7	85.7	85.2	86.9	86.3	91.8	88.0	84.4	84.5	81.6	79.1	75.8	72.5	70.4	69.5	71.2	69.5	67.1	68.0	68.4	62.7	53.9
80V824 mist siphon exhaust fan	Free-field	1m from outlet	109.5	108.4	107.4	106.9	105.8	105.3	103.9	103.2	102.1	101.8	101.2	103.6	99.0	96.0	98.7	95.0	92.3	91.0	88.7	87.3	86.1	85.7	85.8	84.5	79.8	70.9	62.3
80V825 disc filter exhaust fan	Free-field	1m from motor	75.4	78.2	76.9	75.0	74.0	75.4	86.6	79.8	79.8	84.0	76.2	72.4	73.4	71.8	73.0	71.4	70.6	72.5	67.3	67.9	70.5	67.3	65.5	58.6	53.4	46.5	44.0
80V825 disc filter exhaust fan	Free-field	1m from outlet	110.1	107.6	106.0	104.0	102.2	100.9	100.5	98.4	96.4	95.4	92.1	90.6	88.6	86.7	84.9	82.9	81.8	79.4	77.6	76.3	74.8	72.6	68.7	63.2	56.0	49.4	49.5
80V829 wire exhaust fan 1	Free-field	1m from motor	80.9	80.8	83.3	79.2	82.0	82.3	89.4	89.2	88.7	88.2	88.4	83.5	82.2	80.9	78.7	78.6	75.7	70.3	67.9	66.0	65.0	62.2	62.4	58.6	53.9	47.0	37.6
80V829 wire exhaust fan 1	Free-field	1m from outlet	102.0	101.3	101.4	100.0	99.3	99.3	103.2	103.1	103.5	102.5	101.1	99.3	98.9	97.0	96.3	96.1	93.1	90.7	88.9	87.0	85.7	85.4	85.6	84.4	78.9	69.0	58.2
80V830 wire exhaust fan 2	Free-field	1m from outlet	105.2	104.3	103.6	101.5	100.2	99.3	99.6	98.9	100.8	103.5	106.2	99.0	99.4	99.1	96.5	96.7	95.6	93.2	91.4	89.9	87.8	85.8	83.5	80.2	74.2	65.2	56.3
80V831 speed former exhaust fan	Free-field	1m from outlet	105.2	103.6	103.6	102.0	100.6	100.6	98.9	100.3	101.2	101.1	110.9	99.8	99.9	99.6	97.1	97.0	95.4	92.9	90.7	88.7	86.8	85.6	85.2	84.4	81.1	73.5	64.9
80V831 speed former exhaust fan	Free-field	1m from motor	82.3	82.0	86.5	84.0	83.9	81.4	86.2	85.2	88.3	87.9	88.7	86.4	84.0	86.1	80.6	79.7	77.4	71.9	68.9	68.7	68.9	66.1	66.0	65.1	64.3	57.7	48.1
80V836 Nipco flex prewss save all exhaust	Free-field	1m from outlet	86.3	88.1	87.8	87.5	89.2	88.9	91.9	87.3	87.5	87.0	87.6	82.7	80.0	79.8	77.4	75.5	74.0	72.2	70.8	68.3	66.1	64.6	62.8	61.0	57.1	49.1	41.6



Plant	Measurement description	Distance from source	25	31	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
80V837 press pulper exhaust fan	Free-field	1m from outlet	89.7	87.2	87.1	85.5	88.2	88.2	95.3	90.8	89.2	89.3	89.7	88.9	86.6	84.4	84.3	81.8	80.2	77.0	75.2	75.1	73.9	72.6	71.7	69.3	64.7	56.1	47.2
80V845 hood exhaust fan	Free-field	1m from motor	79.6	76.7	79.0	78.0	83.4	82.8	81.6	77.9	75.2	78.6	76.7	78.0	75.2	73.6	71.5	75.1	72.6	67.7	70.6	69.3	70.8	69.6	69.8	66.8	63.0	61.1	59.2
80V845 hood exhaust fan	Free-field	1m from outlet	103.7	103.4	103.1	102.4	102.2	101.9	101.4	100.4	99.8	100.1	97.8	96.8	96.4	96.1	95.5	93.9	92.7	90.6	88.3	85.2	83.1	82.5	83.4	84.1	83.2	79.6	76.3
80V846 hood exhaust fan	Free-field	1m from motor	81.2	79.2	79.6	78.0	81.6	81.3	79.6	77.5	76.7	79.3	76.7	75.3	73.8	72.4	71.1	69.0	67.7	64.7	64.4	62.8	61.5	63.4	67.1	66.4	62.8	62.4	60.8
80V846 hood exhaust fan	Free-field	1m from outlet	107.5	106.7	105.2	104.5	103.2	103.1	102.1	101.6	100.4	101.5	98.4	96.8	96.4	95.2	94.8	91.9	90.0	87.6	86.0	84.2	82.6	82.1	82.7	83.7	83.4	78.7	69.4
80V847 hood exhaust fan	Free-field	1m from motor	78.9	75.9	76.7	77.2	82.0	81.6	80.2	76.7	76.1	78.1	76.2	77.5	73.5	71.0	70.0	75.0	75.0	63.8	68.8	67.4	70.1	68.9	68.9	67.5	65.9	63.9	63.4
80V847 hood exhaust fan	Free-field	1m from outlet	103.1	102.1	101.8	101.5	101.5	101.6	101.7	101.2	100.2	100.0	98.8	98.5	97.3	96.4	95.2	92.2	90.1	87.5	85.1	82.8	81.4	80.6	80.6	80.4	79.3	74.8	69.0
80V848 waste roll exhast fan	Free-field	1m from outlet	99.2	97.7	96.6	94.9	93.1	90.5	89.5	89.7	90.5	87.5	91.3	87.8	88.8	88.2	86.5	84.1	80.6	78.3	75.5	72.3	69.1	67.0	65.7	65.4	65.8	65.5	65.5
80V849 Calendar pulper exhaust fan	Free-field	1m from outlet	92.7	91.6	92.8	90.8	95.4	103.7	94.8	92.9	98.3	91.9	92.5	90.4	88.7	86.2	85.9	82.2	80.7	78.7	75.6	74.9	73.9	72.2	70.9	69.9	68.3	66.3	64.6
80V899 winder 3 pulper exhaust fan	Free-field	1m from outlet	100.2	99.4	98.8	97.9	97.9	97.0	98.7	94.7	92.7	95.9	89.9	88.7	87.4	86.4	84.3	83.2	81.8	78.5	76.3	73.6	70.4	69.0	68.4	67.1	65.5	63.1	61.5
Boiler 7 building ventilation fan	Free-field	1m from side of fan	60.5	55.8	57.2	63.2	57.4	55.6	57.1	54.6	59.3	60.0	61.2	68.8	71.3	69.4	67.2	66.4	64.2	62.6	61.3	61.2	80.8	64.8	54.3	55.4	46.6	43.1	36.4
Boiler 7 building ventilation fan	Free-field	3m from exhaust	75.8	72.4	71.1	70.6	68.1	64.2	63.0	62.1	64.6	64.6	66.5	77.2	65.7	65.0	67.0	65.0	65.1	69.3	59.0	57.3	55.0	50.9	48.1	44.3	40.2	35.6	31.7
Chillers north of PM2	Free-field	1m above	75.4	72.5	69.9	72.8	70.5	66.4	74.3	72.9	68.8	66.7	65.6	67.8	62.8	64.4	66.2	62.3	61.5	60.9	60.8	56.8	56.1	55.9	52.4	52.6	52.5	47.5	45.6
Dry air coolers, mid walkway	Moving microphone, free-field	1m above	83.5	83.6	84.6	88.0	89.8	91.0	92.5	88.6	88.7	89.3	87.8	90.1	84.1	84.6	87.0	83.9	82.1	80.7	76.9	74.6	72.3	69.9	67.5	65.4	62.9	60.8	57.3
Dry air coolers, north walkway	Moving microphone, free-field	1m above	81.9	81.6	83.5	85.9	88.1	90.3	89.7	86.8	86.5	87.2	85.9	87.8	82.3	83.1	86.7	82.6	80.7	79.6	75.9	73.6	71.1	69.0	66.4	64.3	62.0	59.9	57.1
Dry air coolers, south walkway	Moving microphone, free-field	1m above	80.4	80.5	82.6	86.8	87.9	88.4	90.4	85.9	86.5	86.5	85.2	85.6	82.7	82.1	81.3	78.3	75.8	75.1	70.7	68.4	66.1	63.1	60.7	58.3	55.9	54.0	51.7
Fresh water pipes on tank	Free-field	1m	75.1	72.4	74.4	69.8	67.7	68.1	67.8	66.2	66.2	66.7	65.6	64.5	67.0	68.7	69.5	74.0	71.0	69.6	70.8	71.3	71.4	71.4	70.6	67.6	65.1	62.8	58.0
LPCT	Reverberant ambient	5m	71.7	69.3	68.7	69.9	68.7	74.0	82.4	71.9	71.6	75.1	69.8	75.7	76.0	73.1	73.3	73.4	70.7	71.4	71.2	73.6	71.8	70.1	66.3	64.4	61.5	58.3	54.3
LPCT - cooling tower - west	Free-field	10m	76.8	72.6	72.4	69.8	67.3	67.1	73.8	69.7	69.2	70.6	67.7	68.2	66.3	65.5	66.5	68.7	69.5	69.4	67.9	67.3	67.3	66.4	65.0	63.6	62.4	62.7	59.7
LPCT cooling tower - east	Free-field	10m	73.2	72.0	69.6	66.8	63.9	63.4	63.5	63.4	64.0	63.5	61.0	58.8	58.3	59.2	60.4	61.6	61.2	60.6	60.5	61.0	61.4	62.1	62.2	61.4	60.0	59.5	58.4
LPCT cooling tower - north	Free-field	10m	72.4	73.6	69.6	67.6	69.2	66.5	68.2	68.0	68.6	67.1	63.2	62.7	63.3	62.6	63.4	64.5	63.7	63.2	62.6	63.1	63.6	65.6	65.9	65.9	65.0	65.6	63.1
LPCT cooling tower - south	Free-field	10m	74.5	71.8	73.6	69.6	68.3	68.6	69.9	68.7	67.9	69.0	66.0	64.6	64.0	64.3	65.3	68.0	66.4	65.8	65.6	65.6	66.0	66.1	65.2	64.3	63.5	63.0	59.5
LPCT cooling tower - top	Free-field	1m	84.4	81.9	82.0	79.4	80.4	79.1	78.1	77.5	77.0	75.4	72.7	70.6	71.8	69.6	68.9	69.2	68.0	67.2	67.3	68.2	69.9	73.3	69.3	70.6	69.8	63.7	55.7
Mist cannon	Free-field	5m	73.2	74.5	78.2	76.2	75.6	78.5	84.3	84.6	80.6	85.1	82.6	83.7	86.1	82.6	80.5	82.1	80.1	79.6	77.5	76.3	74.5	72.2	70.1	68.0	65.5	63.4	60.7
MRF compressor	Free-field	7m	84.0	88.3	87.8	86.5	83.7	80.3	81.2	85.3	94.6	77.1	75.1	79.7	74.7	72.5	68.7	66.7	65.6	65.1	62.7	64.5	62.8	63.5	62.4	62.5	60.7	58.9	55.9
PM2	Reverberant ambient	10m	82.5	84.1	82.8	89.8	78.5	76.9	76.2	78.7	76.0	73.9	79.4	81.6	73.8	74.7	76.7	76.3	81.4	73.6	70.4	70.8	70.5	70.9	71.1	74.8	72.4	68.4	62.5



Plant	Measurement description	Distance from source	25	31	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
PM2 near dryer hood	Reverberant ambient	10m	81.6	78.3	78.9	89.3	77.5	76.0	74.7	76.1	74.7	73.2	76.6	78.9	75.0	75.3	78.9	75.9	78.9	74.0	72.1	74.2	76.7	75.4	70.8	72.4	69.8	66.0	59.5
PM2 near wrap line	Reverberant ambient	10m	78.7	72.3	75.8	79.9	70.7	72.3	71.8	75.1	73.9	71.3	74.8	76.1	72.4	72.8	72.7	73.9	73.8	75.8	73.7	69.5	69.4	68.4	68.6	68.0	67.0	65.9	62.2
PM2 press and wire section	Reverberant ambient	10m	83.2	80.7	79.8	80.8	79.5	80.6	79.0	80.0	80.7	80.3	81.4	81.2	80.3	81.0	82.6	82.6	83.6	82.2	81.7	86.0	90.7	88.0	81.4	81.3	80.2	81.4	80.2
PM2 winder 3	Reverberant ambient	10m	82.8	75.7	79.1	82.1	74.9	74.6	75.4	78.9	76.8	74.3	78.1	81.7	75.0	75.7	77.2	76.9	77.6	75.7	76.3	74.0	73.1	73.0	72.9	73.6	72.7	71.4	67.0
PM2 Winder 4 Annex	Reverberant ambient	10m	73.1	70.8	71.9	74.3	69.9	69.1	68.0	71.3	72.4	69.4	69.7	74.9	69.2	70.6	70.1	69.5	69.1	65.9	65.6	62.3	60.2	58.4	56.7	56.0	53.0	49.0	43.0
RCF2 - 52V8008 fresh air supply unit	Free-field	1m from inlet	65.1	64.4	62.5	62.0	58.1	57.4	62.0	52.7	53.0	55.0	61.3	52.4	49.1	47.4	43.8	42.1	43.7	43.3	42.5	41.5	41.6	46.3	45.4	47.0	47.3	40.6	33.9
RCF2 - 52V8013 extract fan	Free-field	1m from outlet	100.7	100.3	99.7	98.9	98.7	97.9	97.2	95.4	93.9	92.3	90.5	88.7	86.5	84.2	82.2	80.6	78.4	75.9	73.5	71.3	68.5	64.3	58.2	50.7	43.1	34.0	29.6
RCF3 - 53V8053	Fresh air supply unit	1m from inlet	90.6	89.8	89.7	89.8	88.6	88.3	88.1	87.9	87.5	87.5	86.6	85.7	84.2	81.6	77.8	73.5	69.5	66.7	63.6	60.6	56.0	49.9	42.5	34.8	29.6	26.2	26.5
RCF3 - 53V8054	Fresh air supply unit	1m from inlet	89.7	88.5	88.8	88.5	86.8	85.6	85.2	84.0	83.9	83.1	82.3	80.4	78.2	75.5	72.0	69.5	67.2	65.8	63.1	60.3	56.5	51.2	45.1	38.7	32.1	25.8	23.6
RCF3 - 53V8056	Fresh air supply unit	1m from inlet	82.1	81.5	83.4	84.2	79.5	77.1	76.1	73.7	76.8	71.7	71.6	69.7	69.1	65.5	62.2	60.9	61.1	60.0	54.6	55.2	54.9	52.4	52.8	50.8	48.9	43.8	33.5
RCF3 - extract fan 1	Free-field	1m from outlet	93.3	87.2	83.0	80.9	81.7	86.3	87.2	85.1	93.7	85.2	81.8	85.3	80.6	81.4	79.5	80.2	78.0	74.1	71.2	68.6	63.2	57.8	51.1	44.0	36.2	29.0	28.7
RCF3 - extract fan 2	Free-field	1m from outlet	90.2	86.0	81.8	79.6	79.8	86.7	86.3	80.6	92.7	84.4	81.6	84.8	80.9	83.0	80.3	80.8	79.3	76.2	73.1	69.9	64.8	61.4	56.7	52.4	50.8	46.9	46.6
RCF3 - extract fan 3	Free-field	1m from outlet	94.8	94.5	94.0	93.3	93.1	92.6	90.8	89.9	92.4	89.5	87.4	88.3	84.3	82.8	81.3	79.1	78.8	74.8	72.7	71.4	70.5	70.4	66.4	60.0	55.5	46.2	35.6
RCF3 - extract fan 4	Free-field	1m from outlet	76.0	80.5	78.6	75.8	77.4	76.2	73.5	74.2	80.7	75.4	74.5	74.8	74.5	78.2	76.6	72.3	71.2	72.3	72.3	70.9	61.1	61.3	67.7	63.3	56.5	54.3	53.2
RCF3 - extract fan 5	Free-field	1m from outlet	95.6	93.1	89.6	86.3	83.6	84.5	83.8	81.9	97.4	86.4	81.2	88.4	81.3	85.0	82.9	81.6	81.0	75.5	72.3	68.2	64.1	64.0	65.3	55.6	57.8	54.7	51.9
RCF3 - extract fan 6	Free-field	1m from outlet	97.8	94.7	92.8	89.6	87.7	86.5	85.8	85.1	97.4	87.5	84.1	87.1	82.4	83.5	80.5	81.1	79.1	73.7	71.2	67.7	63.1	57.2	49.8	43.2	35.5	28.0	27.8
RCF3 drum pulper	Reverberant ambient	5m	86.5	90.2	85.9	81.4	84.0	82.0	83.8	83.1	83.1	81.9	81.4	82.1	81.2	80.5	79.7	79.9	79.4	78.0	77.5	74.7	73.1	73.9	70.2	66.4	62.4	58.5	54.4
Steam turbine hall	Reverberant ambient	5m	79.9	69.7	69.6	71.0	71.2	69.3	76.6	75.3	77.8	79.4	77.7	76.0	76.7	81.8	76.8	79.2	79.7	81.3	85.6	79.4	80.0	80.2	78.3	75.2	73.3	75.4	70.3
Unknown extract fan next to 80V899	Free-field	1m from outlet	97.1	94.9	92.8	91.7	90.9	89.5	88.6	86.3	84.6	82.1	81.9	78.1	76.4	76.6	74.6	73.5	73.0	70.1	68.5	67.6	65.7	65.9	63.9	61.6	60.4	58.7	57.1
Unknown extract fan next to hood exhaust fans	Free-field	1m from outlet	110.5	108.9	108.1	106.6	105.8	105.3	104.3	103.1	102.7	100.6	102.4	96.2	94.8	94.5	91.6	90.6	89.0	87.6	86.2	85.1	83.8	82.9	82.5	82.4	79.7	71.7	62.8
Unknown extract fan on RCF3	Free-field	1m from outlet	77.6	78.0	77.7	81.0	81.4	81.2	80.1	81.0	82.7	88.0	80.6	75.0	79.7	75.7	81.1	76.7	75.0	77.1	71.6	69.6	62.8	62.4	56.6	49.6	41.6	30.3	21.4
Vac pump exhausts	Moving microphone	1m from outlets	89.5	88.4	87.1	86.1	93.9	87.9	93.5	91.2	85.4	82.8	84.1	79.9	78.0	77.6	74.5	72.8	70.2	66.0	64.0	62.8	60.4	57.3	52.8	47.0	40.4	33.5	29.5
Waste wood handling plant - active	Free-field	30m	69.0	74.7	70.7	72.5	77.2	71.8	71.8	73.6	70.2	68.4	67.2	67.9	70.4	70.0	66.4	66.7	66.3	65.3	65.1	64.2	62.5	61.6	59.2	57.0	54.9	50.9	46.7
Waste wood handling plant - idling	Free-field	20m	69.8	74.8	69.9	71.7	76.7	69.9	69.0	72.6	67.2	65.0	62.3	61.0	63.5	61.9	59.6	57.0	57.0	55.9	56.0	53.4	52.0	53.4	50.9	50.0	49.6	47.5	39.1

Appendix D

NOISE MODEL RESULTS



D-1 – Predicted Sound Levels for each Source at each Receptor (sorted highest to lowest for Burton receptor)

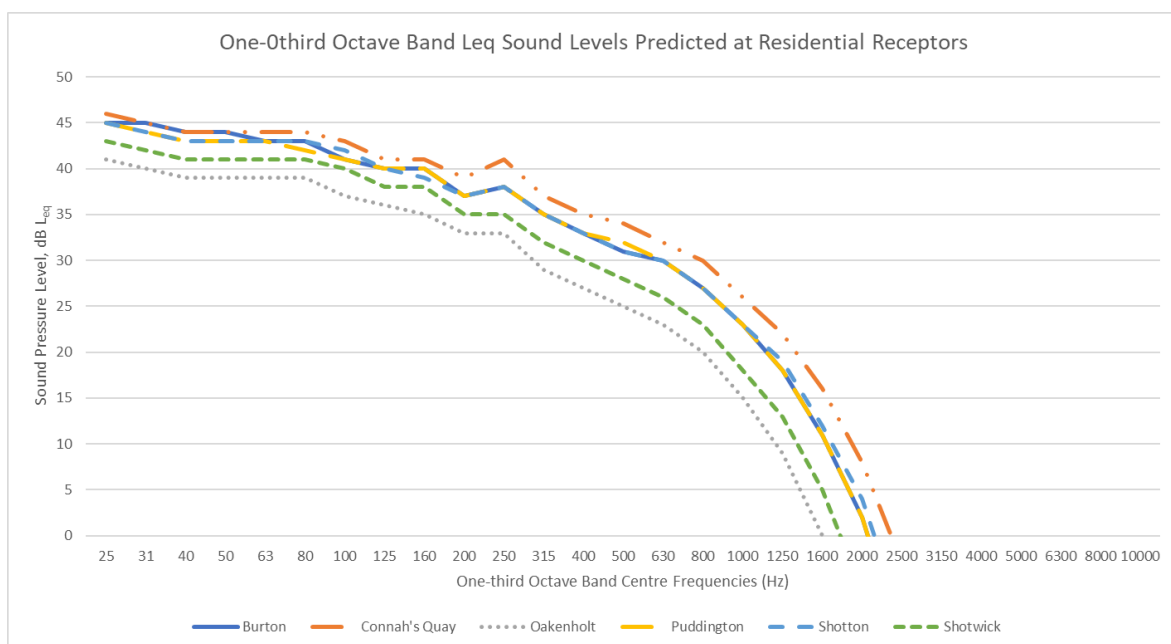
ID	Burton	Connah's Quay	Oakenholt	Puddington	Shotton	Shotwick
80V830	29.8	32.4	20.7	30.1	26.5	23.7
80V831	27.9	29.8	22.8	28.1	28.3	24.2
80V824	25.7	27.6	20.5	25.9	26	22.7
P047	25	28	20.3	25.3	27	23.5
80V829	25	26.8	19.6	25.2	25.3	22.6
P048	23.4	26.5	18.6	23.3	25.5	21.8
P048	23.3	26.4	18.6	22.5	25.4	21.7
P014	23.3	5.7	0.7	22.2	10.1	21
80V846	23	25.2	18.1	23.1	23.4	19.4
80V847	23	25.2	18	23.1	23.4	19.4
80V845	22.8	25.1	17.7	22.9	23.2	19.1
V2_022	22.8	24.7	18.1	22	23.2	20.6
80V020	21.9	24	16.7	22.1	22.3	19.5
52V8013	21.8	21.7	16.3	22.1	21	20.1
80V818	21.6	23.5	16.4	21.5	21.9	18.4
P046	21.4	24.4	17	21.8	23.4	20
P053	20.3	26.6	17.7	20.5	24.4	18.6
P053	20.3	12.5	17.6	20.6	13	18.8
80V849	19.1	21	14.7	19.1	19.6	16.8
P052	19	25.5	16.6	19.2	23.1	17.2
80V822	18.6	21.6	14.4	18.6	19.5	16
80V817	18.6	16.1	8.4	19.1	14.6	15.3
80V020	18.3	17.8	11.2	18.6	15.2	12.3
53V8053	18.1	16.4	10.9	19.1	16.7	17
52V8013	17.8	14.7	8.4	15.5	14	13.3
80V825	17.1	18.4	12.2	17.3	17.4	11.3
80V819	15.8	19.1	11.7	17.1	17.5	13.3
80V899	15	17.6	10.9	14.4	15.7	12.7
53V8054	14	11.7	6.8	15.3	12.2	12.4
80V848	13.5	16.5	9.2	13.5	14.3	10.8
HGV_MRRF 1	13.4	12.8	7.1	11.9	10.7	9.6
HGV_RCP	12.7	14.2	8.4	12.7	11.5	10.1

80V837	10.9	12	5.3	11.1	11.1	8.5
P04 to P08, Log avg inside PM2 (rev)	10.7	9.1	2	10.6	6.1	5.5
53V8053	10.6	11.6	5.2	11.3	11.3	9.3
80V820	10.4	12.7	5.1	9.8	11	7.1
P015	9.9	9.3	3	10.8	9.5	7.5
V2_043	9.3	7.8	0.3	10.2	7.3	4.8
80V836	8.6	7.6	1	5.7	6.1	3.1
80V824	8	6.5	1.5	7.9	7.7	3.7
80V829	7.7	9.3	1.8	7.9	8	5.3
80V831	7.4	8.5	1.5	7.1	7.2	4.2
V2_052	6.9	5.2	-1.8	8.4	5.7	5.8
V2_038	6.8	7.5	-1	4.9	3.7	1.6
V2_049	6.3	4.2	-2.6	8	4.5	5
P024	6.2	6	-1.3	3.1	2.4	4.1
53V8054	6	7.1	0.7	6.7	6.5	4.7
P015	5.8	7.1	0.4	6.4	6.4	4.4
V2_047	5.2	2.9	-4.1	6.3	3.1	3.5
V2_010	4.8	7.3	0.7	4.8	5.4	2.5
V2_048	4.8	2.3	-5	6	2.7	3.1
53V8056	4.6	1.8	-2.3	5.7	2.6	2.8
HGV_Woodyard	4.5	10.8	2.2	4.5	7.6	2.8
HGV_MRRF 2	4.2	12.1	2.9	5	8.4	4.6
Louvre outside PM2	3.6	-11.5	-0.8	3.8	-13.4	-12.4
V2_053	3.5	4.9	-1.9	7.9	5.3	5.8
53V8051	3.5	2.4	-2.7	5.3	3	3
53V8055	3.1	2.5	-2.2	2.1	2.7	1.5
HGV_FPW	2.4	8.1	0.3	1.7	5.3	-0.1
HGV_RCF 2	2.3	10	0.6	2.5	6.8	2.5
HGV_RCF 1	2.1	9.7	0.6	2.2	6.4	2.4
53V8052	1.9	2.5	-2.2	3	2.9	1.5
P04 to P08, Log avg inside PM2 (rev)	1.8	4.1	-2.7	1.9	2.4	-0.5
P009	0.2	-6.3	-8.4	0.1	-7.7	-7
P045	0.1	1.9	-5.7	-0.4	2.4	-1.6
80V845	0.1	-0.1	-7.2	-0.8	-2	-6.6
P022	-0.1	-1.6	-6.6	0.3	-3.7	-1.4

P020	-0.2	-1.1	-18.2	-3.2	-4.5	-3.6
P045	-0.6	-1	-9.1	-1	0.5	-2.2
80V821	-0.8	2.1	-4.7	-0.8	0.1	-3.1
P021	-1.2	-0.7	-9.3	-1.7	-4.8	-3.6
80V809	-1.4	10	-0.8	-2	4.6	-4.7
80V825	-1.5	0	-5.9	-2.9	-1.3	-3.9
80V810	-1.6	-6.9	-14.4	-2.3	-6.1	-6
80V846	-2.1	-1.7	-8.9	-2.8	-3.5	-6.3
P027	-2.4	-0.3	-6.9	-2	-1.4	-4.1
80V825	-2.4	-1.5	-6.2	-2.6	-1.6	-4.1
V2_050	-2.4	-5.2	-13.1	-1.3	-4.3	-4
80V813	-2.4	-6.6	-8	-2.6	-8.3	-9.1
HGV_Boiler 7_1	-2.5	4.5	-4.6	-1.9	1.5	-2.2
80V801	-3.2	-6.8	-14.3	-3	-5.5	-3.2
80V802	-3.2	-6.8	-12.4	-3.8	-5.5	-5.4
80V804	-3.3	-6.5	-14	-3	-5.1	-5.4
53V8056	-3.4	-2.4	-8.7	-2.7	-3	-4.8
80V807	-3.4	-6.6	-14	-3.2	-5.2	-5.6
53V8055	-3.5	-2.3	-8.7	-2.9	-2.9	-4.9
53V8052	-3.6	-2.2	-8.7	-3	-2.8	-4.9
53V8051	-3.6	-2.3	-8.7	-2.9	-2.8	-4.8
80V847	-3.8	-0.7	-8.1	-2.3	-2.7	-5.7
P023	-4.2	-22.4	-30.7	-4.5	-23.6	-17.1
HGV_Boiler7_2	-4.7	4	-5.5	-4.5	0.2	-4.1
P017	-4.9	-4.7	-10.6	-4.4	-4.6	-6.4
P027	-5	-11.6	-11.7	-4.7	-9.4	-9.5
P017	-5.1	-4	-10.6	-4.3	-4.5	-6.4
P017	-5.1	-4.1	-10.6	-4.2	-4.5	-6.6
P017	-5.2	-3.9	-10.6	-4.5	-4.2	-6.5
P017	-5.2	-4.1	-10.6	-4.3	-4.4	-6.6
P027	-5.3	0.9	-8.1	-4.7	-3.2	-6.7
P017	-5.5	-3.9	-10.6	-4.6	-4.1	-6.5
P043	-6.4	-4.3	-12.3	-6.6	-5.2	-7.6
80V815	-8.1	4.3	-6.9	-8.8	-1.6	-11.5
P042	-8.2	-5.9	-14.4	-8.5	-7	-9.5
P042	-8.2	-6	-14.5	-8.4	-7	-9.3

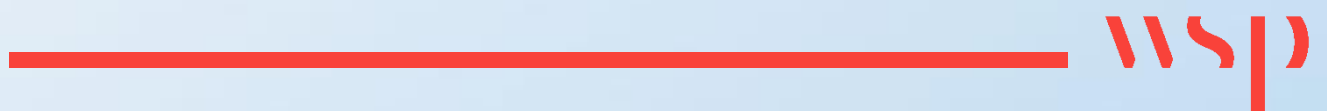
80V811	-8.3	-0.7	-7.8	-8.8	-2.8	-11.2
P025	-8.3	-9.2	-15.5	-6.4	-12.6	-10.6
80V806	-9	1.5	-8.1	-10.1	-2.7	-10.3
80V803	-9.1	1.3	-8.3	-11.4	-2.8	-10.9
P045	-9.6	-6.8	-14.2	-9	-7.7	-10.9
80V814	-9.8	2.3	-8.6	-10.5	-3.2	-13.1
80V808	-10.6	-0.8	-10.5	-13.6	-5.3	-14.5
80V805	-10.7	1.5	-8.2	-10.6	-2.8	-10.6
52V8008	-10.9	-13.9	-19.2	-10.4	-15.6	-15
P023	-10.9	-29.1	-37.4	-22.4	-30.3	-25
80V812	-11	1.1	-10.1	-11.6	-4.5	-14.2
P045	-11.5	-8.9	-16.3	-10.9	-9.7	-12.8
80V813	-12.5	-2.5	-12.6	-13.1	-7.6	-15.3
P009	-12.7	-10.3	-16.8	-12.7	-12.2	-15.2
P011	-13.1	-19.2	-16.4	-15	-22.4	-22.3
P011	-13.2	-20.5	-16.4	-15.1	-23.2	-22.4
P027	-13.4	-2.4	-9.7	-13.1	-2.1	-7.9
P013	-18.3	-25.1	-32.3	-17	-23.1	-22.9
52V8008	-19	-19	-25	-18.6	-19.8	-21.1
P013	-22.9	-24.6	-28.6	-22.2	-23.1	-24.4

Figure D-1 – Predicted One-third Octave Band Sound Levels at Receptors



Appendix E

LIMITATIONS TO THIS REPORT





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8 First Street
Manchester
M15 4RP

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