B2.8 Noise

The Immingham CHP plant is to be located adjacent to HOR. The noise radiated from the Project will naturally form an addition to that radiated from HOR. The prediction and assessment of environmental noise from the Project has therefore been considered in this regard, and use made of an acoustic model of HOR. This was developed as part of an Environmental Noise Management (ENM) system for the specific purpose of managing and assessing the noise implications of new developments associated with HOR. The acoustic model was developed in 1998, and correlated with ambient noise levels measured at that time. There have been no significant changes to noise sources on HOR since then, and the basic model is still considered valid.

There are no sources of vibration associated with the Project which are likely to have any significant environmental effects.

The following sections describe:

- the main sources of continuous noise associated with the Project;
- infrequent sources of noise;
- the nearest noise sensitive locations to the Project site, and the existing noise environment;
- details of noise modelling;
- environmental noise criteria;
- assessment of noise levels;
- BAT for noise emission.

B2.8.1 Main noise sources

The principal sources of continuous noise during normal operation of the CHP plant, in approximate order of significance with respect to resultant environmental noise levels are:

- cooling towers;
- HRSGs;
- gas turbines;
- exhaust stacks;
- electrical generators;
- gas supply system;
- water feed pumps;

- air inlets to the gas turbines;
- cooling water pumps;
- steam turbines and condensers;
- transformers;
- ducting.

The noise from these sources will be continuous and they will usually operate 24 hours per day. The sources listed above are mainly broad band in character and unlikely to have any dominant tonal characteristics. Where such characteristics might exist (eg from the transformers), these will be of a low level at the nearest noise sensitive locations and not be audible due to masking from the other noise.

B2.8.2 Infrequent sources of noise

There are several possible sources of higher intermittent noise. These are as follows:

Gas turbine trip: This would involve venting of natural gas but this will be a very infrequent event.

Steam turbine by-pass and steam turbine start-up: This could be fairly frequent, sometimes even twice per day. As a consequence noise levels will be controlled to ensure acceptable levels are not exceeded.

HRSG safety valves: These will be lifted routinely every three years at turnaround/maintenance. These could also lift if steam demand from the refinery changed quickly outside normal parameters.

Gas reception compound: Gas venting could occur in an emergency shut-down situation.

B2.8.3 Noise sensitive sites

Noise sensitive locations are usually taken to be the nearest residential properties to a development, or other facilities such as hospitals and schools if there are any in the vicinity. In the case of the proposed Project, the nearest residential is Hazeldene on Marsh Lane, which runs perpendicular to Rosper Road. This is approximately 670 m from the centre of the proposed site and 520 m to the nearest part of the site. There are other more distant properties close to the River Humber. These include a converted lighthouse (distance approximately 1.8 km) and a property in Station Road (distance approximately 1.4 km). It is understood that all these properties are located within an area designated for future industrial development. However, whilst they continue to be occupied, they have been considered potentially noise sensitive for the purposes of this assessment.

The nearest residential property in a southerly direction is East End Farm (distance approximately 1.4 km). There are greater densities of population further away. These include Immingham to the south-east (distance approximately 2.2 km), South Killingholme to the south-west (distance approximately 1.5 km), North

Killingholme to the west (distance approximately 1.9 km) and the extended village of East Halton to the north-west (distance over 2.5 km).

The OS co-ordinates of the three nearest properties are:

Hazeldene:	517325 E	417310 N
East End Farm:	516340 E	415660 N

B2.8.4 Existing noise environment

The existing noise environment at the nearest residential properties is affected by several different types of noise sources. These include the noise from traffic using Rosper Road, railway noise, and noise from HOR and LOR. The proposed CHP plant will operate 24 hours per day, and it is the night-time situation which is normally the most sensitive for a continuously operating industrial plant. At night, the ambient noise level is dominated by noise from HOR and LOR.

In 1998, Conoco commissioned a study to develop an environmental noise model of the refinery. This consisted of detailed measurements of the noise source strengths of individual plant items on the refinery, prediction of noise levels to specified community locations, measurements of night-time community noise levels under downwind conditions from the refinery, and refinement of the sound propagation model to give best fit between the measured and predicted community noise levels. Because of the proximity of LOR to HOR, the former was added into the Conoco model as an additional source. The model is part of an Environmental Noise Management (ENM) system for HOR. Two of the community locations used in the refinery noise study were Myrtle Villas and East End Farm. The predicted noise levels and measured L_{A90} and L_{Aeq} levels at these locations, both for light downwind conditions, are shown in Table B2.9.1 (to the nearest dB). Also shown are the predicted and measured noise levels for Hazeldene for similar downwind meteorological conditions.

The L_{A90} is the A-weighted sound pressure level that is exceeded for 90 per cent of the measurement time, and in the UK this is normally taken to be a measure of the background noise level. (The term A-weighting implies a measurement taken with a standardized filter which approximates to the human response to noise at different frequencies of sound). The L_{Aeq} is the equivalent continuous sound pressure level and is the energy-averaged value of the time varying noise level. Where the noise level is very steady (as is the case at night when HOR dominates the noise environment) then the different noise indices numerically become very close, as can be seen from Table B2.9.1.

TABLE B2.8.1
EXISTING DOWNWIND NOISE LEVELS AT NEARBY RESIDENTIAL LOCATIONS

Location	HOR noise model prediction dB(A)	Measured noise levels	
		dB $L_{A90, 5m}$	dB $L_{Aeq, 5m}$

East End Farm	53	53	54
Hazeldene	50	51	53

It can be seen from this table that the HOR noise model correlates well with the measured overall A-weighted sound pressure levels for East End Farm, and just slightly under-predicts for Hazeldene. The A-weighted sound pressure level results are derived from octave band sound pressure level values. These also correlate well with measured environmental noise levels (typically within ± 2 dB between 31.5 Hz and 2 kHz for East End Farm).

The HOR noise model octave band sound pressure levels at East End Farm and Hazeldene (in dB L_{eq}), are shown in Table B2.9.2:

TABLE B2.8.2
EXISTING OCTAVE BAND SOUND PRESSURE LEVELS AT NEARBY RESIDENTIAL LOCATIONS

Location	Octave band centre frequency, Hz							
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**
East End Farm	69	66	57	52	51	49	43	29
Hazeldene	67	64	55	48	47	46	37	18

The HOR noise model has been used to generate noise contours outside the boundaries of the refinery. These are shown in Figure 2.9.1 for the existing situation. These represent noise levels for night-time downwind conditions from HOR in all directions, and thus do not represent the noise levels which might be observed simultaneously at all locations around HOR on any single night. In this situation, the distribution of noise levels would be skewed, with resultant noise levels upwind of the refinery typically being some 10-15 dB(A) less than shown in Figure 2.9.1. However, in this situation, upwind noise levels from the proposed project would also be less. Therefore, from the point of view of the environmental noise impact assessment of the proposed project, it is reasonable to consider only the downwind directions from the site to the nearest residential properties.

The HOR noise model makes no allowance for any other industrial development in the area (with the exception of LOR) or for any other sources of noise, which may become significant at distant locations from the refinery.

B2.8.5 Noise model of proposed Project

To predict the environmental noise contribution from the proposed plant under normal operating conditions, use has been made of the HOR ENM system noise model. The basic data used in this model are octave band sound power levels of the individual noise sources and a three dimensional co-ordinate system based on the layout given in Figure 1.3. The majority of the sound power levels for the proposed CHP plant have been based on noise measurements at another power station where Siemens V94.3A gas turbines are installed and data from suppliers of similar plant. In addition, hydrogen cooled generator sets have been assumed and radiated noise levels from all gas turbines and generator sets limited to 80 dB(A) at 1 m through the appropriate use of acoustic enclosures and silencing measures. For the cooling towers, noise information has been obtained from a cooling tower supplier. The sound power levels used are summarized in Appendix E for reference.

The sound attenuation model is based on the calculation procedures given in EEMUA publication 140 with specific Conoco site calibration factors to improve correlation between measurement and prediction. The attenuation model is for light downwind sound propagation conditions. The propagation model takes into account:

- distance between the source and the receiver;
- in-plant screening;
- ground effects;
- sound absorption by the atmosphere.

Noise sources are entered into the model as octave band sound power levels at defined x, y and z co-ordinates. The model calculates the resultant octave band sound pressure levels at one or more defined receiver locations for each individual source, taking into account the frequency-dependent sound attenuation factors between source and receiver. For example, sound absorption by the atmosphere is predominantly a high frequency phenomenon, whereas increased attenuation due to ground effects is more prevalent in the mid frequency region of the acoustic spectrum and is also source height dependent.

Consideration has also been given to the requirements of the Noise at Work Regulations SI 1989/1790 as amended by SI 1992/2996 and SI 1996/341 to limit noise levels in work areas to reduce the risk of hearing damage. The model does not include noise emission from the auxiliary boilers. These will only run when the main gas turbines are not operating, and they will, in any case, have a significantly lower noise emission than the rest of the plant. The model also does not allow for any steam venting, which may intermittently occur, or for higher noise levels which may occur during plant start-up or shut-down.

Calculations have been performed for three residential locations viz: Hazeldene to the east of the CHP plant and East End Farm to the south of the CHP plant. The model has been used to simulate three different options for equipment and noise control treatment. These are as follows:

Case 1: Base case; consisting of high performance acoustic enclosures on gas turbines (local sound pressure levels typically 80 dB(A)), heat conservation/acoustic lagging on exhaust ductwork, generator sets not exceeding a sound pressure level of 80 dB(A) locally to the sets, gas turbine exhaust silencers, gas turbine intake silencers, thermal/acoustic lagging on steam turbines, standard acoustic lagging on exposed pipework, pipework lagging and low noise valve (or valve enclosure) on fuel gas skid, standard hybrid cooling tower design.

Case 2: As Case 1, but also assuming low noise cooling tower design utilizing oversized low speed high efficiency fans and water splash control, high performance acoustic lagging on noisy pipework and low noise pumps and motor sets.

Case 3: As Case 2, but also assuming fully ventilated buildings to enclose the two gas turbine and two steam turbine sets. Combustion air for the gas turbines would be ducted from outside although no benefit has been assumed for any potential acoustic shielding of the gas turbine air intakes by the turbine hall.

The results of the calculations at the three locations considered are given in Table B2.9.3 to the nearest dB, in terms of the overall A-weighted L_{eq} sound pressure level from the proposed CHP plant.

Table B2.8.3
PREDICTED NOISE LEVELS AT NEARBY RESIDENTIAL LOCATIONS DUE TO PROPOSED PROJECT

Noise Control Option	Predicted L_{Aeq} from proposed Project		
		Hazeldene	East End Farm
Case 1		49	38
Case 2		47	36
Case 3		45	35

In the terminology of British Standard BS 4142 “Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Users” these levels represent the “rating level” for the project for normal operating conditions in a downwind direction from the site. (The use of the term “rating level” assumes that the noise from the proposed Project will be without any distinguishable characteristics such as tonal or impulsive noise). The calculated differences between the rating levels of the proposed Project and the existing noise levels are given in Table B2.9.4 (shown to the nearest 0.1 dB for comparison purposes). This table also gives the changes in the existing noise levels that will occur as a consequence of the CHP plant, for downwind conditions.

TABLE B2.8.4
PREDICTED EXCESS OF RATING LEVEL OVER BACKGROUND LEVEL AT NEAREST RESIDENTIAL LOCATIONS AND INCREASE IN EXISTING NOISE LEVELS DUE TO PROPOSED PROJECT

Noise control option			Hazeldene		East End Farm	
			Excess of rating level	Increase on existing level	Excess of rating level	Increase on existing level
Case 1			0 dB	2.9 dB	-15 dB	0.1 dB
Case 2			-3 dB	1.8 dB	-17 dB	0.1 dB
Case 3			-5 dB	1.3 dB	-18 dB	0.1 dB

The predicted octave band sound pressure levels for Cases 1, 2 and 3 are shown in Table B2.9.5, and compared with the existing octave band sound pressure levels.

TABLE B2.8.5
PREDICTED L_{eq} OCTAVE BAND SOUND PRESSURE LEVELS AT NEARBY RESIDENTIAL LOCATIONS DUE TO PROPOSED CHP PLANT AND COMPARISON WITH EXISTING DOWNWIND LEVELS

Location	Octave band centre frequency, Hz							
	31.5	63	125	250	500	1k	2k	4k
Hazeldene								
Predicted Project noise, Case 1	60	61	59	48	46	45	37	30
Predicted Project noise, Case 2	58	59	58	45	42	42	34	26
Predicted Project noise, Case 3	58	57	56	43	40	40	32	24
Existing noise levels	**67**	**64**	**55**	**48**	**47**	**46**	**37**	**18**
East End Farm								
Predicted Project noise, Case 1	54	55	50	36	35	33	21	5
Predicted Project noise, Case 2	52	53	49	34	31	29	17	-1
Predicted Project noise, Case 3	52	51	48	32	29	28	15	-1
Existing noise levels	**69**	**66**	**57**	**52**	**51**	**49**	**43**	**29**

The predicted environmental noise contours around HOR, with the Project operational, are shown for illustrative purposes in Figure 2.9.2 (Case 1 noise control), Figure 2.9.3 (Case 2 noise control) and Figure 2.9.4 (Case 3 noise control). These contours also include the environmental noise effect of removing the existing steam raising boilers and the older power generation plant on HOR, all of which would cease to be operational following successful commissioning of the proposed plant. These items are located to the west of HOR, and their removal therefore has little impact in an easterly direction, towards Rosper Road.

The most frequent source of intermittent noise is likely to be at the start-up or shut-down of a steam turbine, when steam will by-pass the turbine and be let down through a control valve into one of the condensers. Relatively high noise levels will be generated locally to the let-down valve, downstream pipework and condenser. Based on measurements at another power station, it has been assessed that with suitable noise control treatment, overall community noise levels from the Project will increase by some 2 dB(A) for Case 2 noise control treatment, during by-pass of the steam turbine.

B2.8.6 Environmental noise criteria

In the formulation of policies on planning developments which have issues relating to noise, local Planning Authorities are advised by the Department of the Environment in Planning Policy Guidance PPG 24 “Planning and Noise”. The aim of this guidance is to provide advice on how the planning system can be used to minimize the adverse impact of noise without placing unreasonable restrictions on developments or adding unduly to the costs and administrative burdens of business. It includes some of the main considerations that should be taken into account when determining planning applications for development, which will generate noise. In the case of industrial development, PPG 24 confirms that the character of the noise should be taken into account, as well as its levels, and sudden impulses, irregular noise or noise which contains a distinguishable continuous tone will require special attention.

The policy document cites the use of British Standard BS 4142 1990 “Method for rating industrial noise affecting mixed residential and industrial areas” for assessing the noise from proposed industrial and commercial premises. This standard has since been amended and the current version is dated 1997. The prime purpose of this standard is to determine the likelihood of complaints about noise from industrial and commercial installations. It compares the ‘rating level’ of the industrial source (equivalent continuous level of the industrial activity, corrected for character where appropriate) with the pre-existing background noise level, expressed as L_{A90} dB. Both the rating level and the background noise level refer to the external noise climate in the vicinity of the sensitive area. PPG 24 quotes the standard as stating that a difference of around 10 dB or higher indicates that complaints are likely and that a difference of around 5 dB is of marginal significance. The standard itself states that if the rating level is more than 10 dB below the measured background noise level then this is a positive indication that complaints are unlikely.

Unfortunately, no absolute guidance is given in PPG 24 as to what is a reasonable limit to set for new industrial development potentially affecting sensitive areas. However, PPG 24 is intended to build on the principles established in Circular 10/73 “Planning and Noise”. This stated that where, by the standards established in BS 4142, the noise from the proposed development is “likely to give rise to complaints” it will hardly ever be right to give permission. In practice most planning authorities set a more stringent standard than this, sometimes based on the ‘marginal significance’ category, or on

allowing the noise from the proposed development to equal the pre-existing background noise level. The latter would cause the background noise level to increase by approximately 3 dB, an amount that is considered to be just detectable. For there to be no increase on background noise levels then noise from the new development would need to be some 15 dB less than the existing background noise level.

PPG 24 also makes reference to British Standard BS 8233 1987 "Code of Practice for Sound Insulation and Noise Reduction for Buildings" which gives general guidance on acceptable noise levels within buildings. In sleeping areas, the recommended maximum intrusive noise levels are 30-40 dB $L_{Aeq,T}$. This equates to an external noise level of 40-50 dB $L_{Aeq,T}$ with windows open and 45-55 dB $L_{Aeq,T}$ with windows partially open. If the noise of concern contains distinctive characteristics, then these levels may need to be lower. This standard was revised in August 1999. The standard now states that 35 dB L_{Aeq} in bedrooms represents a reasonable noise environment due to external sources.

Similar, although slightly more stringent advice is given by the World Health Organisation in a 1999 report by a WHO expert task force, entitled "Guidelines for Community Noise". This states that to avoid negative effects on sleep, the equivalent continuous sound pressure level during the sleeping period should not exceed 30 dB L_{Aeq} indoors for continuous noise indoors. If the noise is not continuous, sleep disturbance correlates best with maximum noise levels and effects have been observed at 45 dB L_{Amax} or less (indoors). It goes on to recommend that at night-time, noise levels outside of dwellings should not exceed 45 dB L_{Aeq} so that people may sleep with bedroom windows partially open. It should be noted that existing night-time noise levels at residential properties in the vicinity of HOR are already higher than this. The WHO report has not been adopted into UK legislation or formal guidance, hence it remains a source of information reflecting a high level of health care with respect to noise, rather than a standard to be rigidly applied.

With respect to the potential noise impact of the Project on other commercial or industrial properties, there are currently no developments of this type closer to the site for the proposed CHP plant than Myrtle Villas, the nearest residential property to the site. Therefore it is not anticipated that there will be any significant noise impact from the proposed Project on existing industrial or commercial developments. Similarly, it is not anticipated that any future industrial development built adjacent to the Project site would be noise sensitive. It is possible that any future industrial development may incorporate ancillary office accommodation. The main effect of relatively high external noise levels would be the potential interference with speech communication. However, any potential problems of this nature can usually be overcome by appropriate building design, in the same way that the offices for the Project would be designed, taking into account the external noise environment. BS 8233:1987 recommends 40 to 45 dB L_{Aeq} as the maximum intrusive noise levels in private offices and small conference rooms, and 45 to 50 dB L_{Aeq} in large offices. Slightly more stringent limits are suggested for executive offices in the latest version of BS 8233.

B2.8.7 Assessment of noise levels

The Project site is relatively close to an isolated residential propertie, viz Hazeldene. This property islocated in an area that is designated for industrial development. However, if the property continues to be occupied for residential purposes within the period when the proposed CHP plant will be built and operated, then any changes in existing ambient noise levels at these locations should be within acceptable guidelines and should not give rise to any significant loss of amenity.

Three cases of noise control have been considered. Within the bounds of accuracy at this stage of the project, the base case predicts a noise level from the Project, at Myrtle Villas, which is slightly greater than the

existing background noise level. Assuming that distinctive characteristics to the noise are controlled, this gives rise to an excess of rating over background level of just under 2 dB, and an increase in the background noise level of just under 4 dB(A). According to BS 4142, this is less than of marginal significance with regard to the expectation of complaints. The increase would, however, be expected to be discernible.

By utilizing a low noise design for the cooling towers, and by ensuring acoustic lagging is of a high performance and that low noise pump motor sets are purchased, the overall noise from the Project can be reduced by just over 3 dB(A), which results in a rating level from the Project some 2 dB less than the pre-existing background levels. The increase in background noise level at will then be just over 2 dB(A). In both these cases, there will be no measurable increase in background noise levels at East End Farm, which is the nearest residential property not within the designated industrial zone. The excess of rating over background levels here are -15 dB for Case 1 and -17 dB for Case 2 noise control. At Hazeldene, the Case 2 noise control option results in an increase in the background level of just under 2 dB(A), an amount which is unlikely to be discernible, as long as the noise is without distinctive characteristic.

To obtain any significant further noise reduction requires the gas turbine and steam turbine generator sets to be located within a purpose designed turbine hall. It has been estimated that a fully ventilated turbine building would reduce overall noise levels by a further 1.4 dB(A), resulting in an excess of rating over background level of -3 dB. This would result in an increase in background noise level of just under 2 dB at this residential location, an improvement of only 0.5 dB on the previous case considered. The turbine building would not benefit the noise environment at any other residential properties outside the designated industrial zone. The advantages of providing a turbine building are, therefore, marginal in view of the designation for future industrial development of the area to the east of the site.

The frequency characteristics of the predicted noise from the CHP plant generally follow the existing background noise frequency spectrum, with a slight deviation in the 125 Hz octave band. This is due to the sound power level estimate included in the model for the gas turbine exhaust noise from the stacks and from the estimated noise levels from the alternator sets. Extra care may be necessary during the design to ensure that this frequency characteristic does not become a dominant feature of the new CHP plant.

The predicted noise level from the proposed Project for Case 1 causes the total noise level (for downwind propagation conditions) to just exceed 55 dB(A) at Myrtle Cottages. For Case 2, the total noise level will be 54 dB(A). Allowing for an attenuation of 15 dB from outside to inside with partially open windows, the internal level for Case 2 would therefore be just less than the BS 8233 (PPG 24 cited version) recommended maximum limit of 40 dB L_{Aeq} in bedrooms. To achieve the revised BS 8223 “reasonable” grade within any bedrooms of Myrtle Cottages which face towards the refinery, then windows to the bedrooms would need to be kept shut even for the existing noise environment. An increase of 2 dB(A) due to noise from the CHP plant would not materially change this situation (Case 2).

At Hazeldene, the predicted total noise level with the power station operational is less than 55 dB(A) for the downwind base case condition. The recommended maximum bedroom noise levels (BS 8233) can still be achieved here with windows partially open. For the Case 2 noise control option, resultant internal noise levels will be some 36 dB(A) (assuming 15 dB(A) for partially open windows).

These predictions and assessment do not take into account the effect of the proposed screening bund parallel to Rosper Road. . It will extend from the proposed site access road to approximately 300mts South. Whilst the bund will provide an effective visual screen for the proposed Project, its benefit from an acoustical point of

view, is more limited. It will be of most benefit for calm or for upwind sound propagation conditions, together with a neutral or lapse atmospheric temperature gradient. A neutral temperature gradient will typically occur under a thick cloud layer, whilst a lapse temperature gradient will occur on a warm sunny day. Under downwind conditions and/or for an atmospheric temperature inversion (e.g. at night under a clear sky) the screen will provide very little acoustical benefit, and has therefore been excluded from the predicted noise levels.

B2.8.8 BAT for noise emission

The PPC Regulations require installations to be operated in such a way that *"all the appropriate preventative measures are taken against pollution, in particular through the application of BAT".* The IPPC General Sector Guidance (IPPC S0.01) states that the definition of pollution includes *"emissions which may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment".* It goes on to state that BAT, for noise, is therefore likely to be similar, in practice, to the requirements of the statutory nuisance legislation, which requires the use of "best practicable means" to prevent or minimize noise nuisance. In the case of noise, the Guidance states that "offence to any human senses" can normally be judged by the likelihood of complaints, but in some cases it may be possible to reduce noise emissions still further at reasonable costs, and this may exceptionally be BAT for noise emissions.

For the proposed Project, the BAT objectives for noise emission are considered to be covered by the noise attenuation measures considered for Case 2, as described in B1.1.5. These include:

- selection of low noise-generating equipment compatible with the individual plant item noise limits;
- use of low speed, high efficiency fans on the cooling towers, and the control of water splash noise;
- installation of high performance acoustic enclosures on the gas turbine generator sets with all ventilation paths adequately silenced;
- use of hydrogen cooled generators;
- installation of high performance gas turbine exhaust and air intake silencers;
- the use of acoustic cladding, in combination with heat conservation measures, on the gas turbine exhausts, steam turbines and any noisy pipework;
- the use of other acoustic enclosures, where appropriate;
- the use of silencers on steam vents in intermittent usage; and
- the erection of a screening bund along Rosper Road.

In addition, to control intermittent noise during steam turbine by-pass, the use of an in-line silencer downstream of the let-down valve prior to each condenser may need to be considered.

No specific mitigation measures are considered necessary to control ground-borne vibration, as no significant levels are anticipated at the nearest sensitive locations. Low frequency noise can cause vibration of loose fittings, windows etc. However, low frequency noise will be controlled through the use of appropriate plant selection and measures such as high performance silencers on gas turbine exhausts. There will be no significant increase in low frequency noise at the nearest noise sensitive locations due to the Project.

A formal assessment to BS 4142: 1997, for the resulting noise emission from the Project under normal operating conditions, incorporating BAT preventative measures (Case 2), is as follows (for the nearest noise sensitive development).

Predicted noise level:	L_{Aeq}	=	50 dB	
Residual noise level:	Not relevant			
Background noise level*:	$L_{A90,\ 5\ mins}$	=	52 dB	Details of instrumentation, weather conditions etc, given below
Specific noise level (night):	$L_{Aeq,\ 5\ mins}$	=	50 dB	
Acoustic feature correction:		=	0 dB	
Rating level:	(50 + 0)	=	50 dB	
Excess of rating over background level:	(50 - 52)	=	-2 dB	
Assessment:				Complaints unlikely

* *The background noise measurements were obtained on 18th December 1998 between midnight and 02:30 hours. The measurements were made in the vicinity of the previously construction at Myrtle Villas. The wind was light WSW and there was no precipitation or fog. Noise from Conoco refinery dominated the background noise environment. For the background measurements use was made of a Bruel and Kjaer Type 2260 sound level meter, serial number 1933780. The meter was field calibrated using a Bruel and Kjaer calibrator Type 4231, serial number 1934844 before and at the end of the measurements to a level of 94 dB. No significant change in calibration level was observed. The meter and calibrator had last received a verification test by the manufacturer on 19th November 1998.*

A further sound attenuation measure in the form of a fully ventilated building to encompass the two gas turbines and two steam turbines (Case 3) will only reduce the overall noise levels by 0.5 dB as compared to Case 2. This is due to the dominance of other noise sources (particularly the cooling towers and the HRSGs). In view of the likely high cost of such a building, this is not considered cost effective and is not, therefore, considered to constitute BAT.

Allowing for some tolerance in estimation, and for slightly higher noise levels during steam turbine by-pass, it is proposed that any noise condition for the proposed Project should be based on the rating level of the noise generated by the normal operation of the plant not causing the existing background noise level to be increased by more than 3 dB(A), for downwind conditions from the development site i.e. rating level equals existing background noise level. This implies a noise limit of 52 dB $L_{Aeq,\ 5\ mins}$ at Myrtle Villas (free field) for normal operating conditions. For occasional activities potentially giving rise to higher noise levels (e.g. overall plant start-up or shut-down, or non-emergency steam venting, noise levels 5 dB(A) higher than this should still be acceptable. (This represents a BS 4142 “marginal significance” situation with respect to the likelihood of

complaints). For non-emergency conditions potentially involving higher noise levels than this, written notice of the likelihood of such an event is proposed prior to the event occurring.

Acoustics and Vibration Group

Our Ref: 18917525/1 Rev 0

22nd June 2023

VPI Immingham LLP
Rosper Road
Immingham
North Lincolnshire
DN40 3DZ

For the attention of Matthew Welch

Dear Matt

Re: Environmental Noise Monitoring – Immingham CHP

Please find attached the results of the environmental noise measurements which were carried out within the vicinity of the VPI CHP facility, Immingham, on the night of 1st – 2nd June 2023.

1 Introduction

The Acoustics and Vibration Group of Bureau Veritas UK Limited has been retained by VPI Immingham LLP to carry out an environmental noise survey in the vicinity of the CHP (Combined Heat and Power) plant at Immingham, North Lincolnshire. This report presents the results and findings of the survey undertaken on the night of 1st – 2nd June 2023, conducted at a single established receptor location close to the site.

2 Measurement Procedure and Instrumentation

2.1 Noise Measurements

2.1.1 Instrumentation

The following instrumentation (which complies with BS EN 61672-1 Class 1 accuracy) was used to conduct the noise monitoring:

- Rion Sound Analyser, NL-52 (Serial No. 342835) calibrated 03/06/21 (cert. no. UCRT20/1694);
- Rion Condenser Microphone, UC-59 (Serial No. 06356) – calibrated as above;
- Rion Preamplifier, NH-25 (Serial No. 42863) – calibrated as above;
- Rion Calibrator, NC-74 (Serial No. 34857335) calibrated 11/08/21 (cert. no. UCRT21/1980).

A microphone windshield was fitted at all times. The sound level meter was pole-mounted at a representative height of 1.5 metres above ground level.

2.1.2 Calibration

The sound level meter was calibration-checked before and after the measurements. No drift in the calibration signal was noted.

2.2 Plant Operating Conditions

The plant is understood to have been running at normal operational output during the survey period. No Flaring was planned during the survey. The control room was contacted at the start of the survey and again on completion. We were advised that the average power output during the survey was 310 MW and the maximum output was 345MW.

2.3 Measurement Locations

As per the 2022 assessment, a single position has been monitored (Location 4 – Hazeldene to the east of the CHP plant).

The location numbers are as defined in the baseline environmental report (Reference 2) issued by Bureau Veritas in January 2005. These are shown on the attached layout drawing, Figure 1.

2.4 Measurement Procedure

During the night, noise monitoring was conducted at Location 4, measured in 5-minute samples. The measurements covered the period from 23:00 to 04:00 on the night of 1st – 2nd June 2023.

2.5 Meteorological Conditions

During the attended monitoring period the weather was mostly dry and warm with temperatures ranging from 9 to 12ºC, with humidity ranging between 82 – 93%. Cloud cover increased during the survey from 3/8 okta to 6/8 okta towards the end of the survey. No rain was noted during the measurement period. Wind conditions were light and measured between 3 – 5 m/s mainly in a North-East direction for the duration of the survey. There was no evidence of a temperature inversion which may have otherwise affected the environmental propagation of sound from the source to receiver. The weather conditions were therefore considered to be appropriate for the measurement of environmental noise.

3 Environmental Noise Survey Results

Appended to this report are the detailed results of the noise monitoring which are presented in full in Table A1.1.

A summary of the noise levels measured during the attended monitoring at the community location (Hazeldene) is presented in Table 1:

Table 1: Summary of Noise Levels Measured at Immingham CHP, June 2023

Location	Minimum		Maximum	
	dB $L_{A90,5min}$	dB $L_{Aeq,5min}$	dB $L_{A90,5min}$	dB $L_{Aeq,5min}$
Hazeldene	36.8	39.0	43.5	62.4

The sound measured at Hazeldene consisted primarily of a broadband noise component from the VPI Immingham CHP site, with no tonal or regular impulse noise evident.

Plant noise was the main sound source. Off-site sound sources included nearby industrial works and road traffic noise consisting of intermittent vehicle pass-bys along the A160 but this was considered low level and did not influence the noise measurements. This was further reduced due to the closure of the

southbound carriageway of Rosper Road. There was occasional vegetation rustle from nearby trees during wind gusts, but this was infrequent and intermittent.

A historical record of the noise levels measured at the receptor locations around the VPI Immingham CHP plant is presented in the Table 2 to enable comparison with the latest results. Values for L_{A90} are averaged arithmetically with L_{Aeq} averaged logarithmically.

Table 2: Comparison of Average Noise Levels Measured Close to the Immingham CHP Plant

Survey	Hazeldene		East End Farm		Station Road		Wind Direction
	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{A90}	Average dB L_{Aeq}	
February 2005	49	51	50	52	46	48	NW
March 2005	52	54	43	46	48	50	W
April 2005	53	55	38	42	48	50	W
August 2005	49	51	49	50	46	48	NW
November 2005	52	54	46	51	51	53	W
February 2006	50	51	51	53	46	48	NW
May 2006	50	52	40	44	50	51	W/SW
August 2006	52	54	46	47	50	52	W
January 2007	52	53	40	45	51	53	SW
March 2008	48	50	50	53	44	47	NW
January 2009	51	53	33	36	49	50	SW
March 2010	52	54	-	-	-	-	NW
April 2011	52	53	47	48	47	49	NW
June 2013	41	43	41	45	35	36	NE
June/July 2014	48	50	42	44	42	44	E
August 2015	44	50	-	-	-	-	S

Survey	Hazeldene		East End Farm		Station Road		Wind Direction
	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{A90}	Average dB L_{Aeq}	
September 2016	50	52	-	-	-	-	NE
July 2017	51	52	-	-	-	-	NW
July 2018	51	52	-	-	-	-	N
July 2019	49	51	-	-	-	-	SW
July 2020	52	53	-	-	-	-	SSW
June 2021	47	49	-	-	-	-	NW
June 2022	50	52	-	-	-	-	WSW
June 2023	39	50	-	-	-	-	NE

In Table 2, it can be observed that the ambient sound level results from the June 2023 survey at Hazeldene compare similarly with those made when wind directions were similar. For example, in September 2016, however the background sound level was significantly lower. Whilst other factors may have contributed, a possible reason for this is may be the speed (from the northeast, i.e., the measurement position was upwind of the VPI site). Whilst plant noise from the VPI site remained the dominant sound source at the measurement position, its contribution was significantly less than in previous years when north-easterly winds prevailed.

Please note that detailed comparisons to historic data listed in Table 2 shall be limited due to the differing wind directions during survey measurements, as well as varying plant operation conditions.

4 Conclusions

An environmental noise survey has been conducted close to the nearest residential property within the vicinity of the VPI CHP site at Immingham. Attended noise monitoring was conducted on the night of the 1st - 2nd June 2023, under dry and light wind conditions. A wind speed of around 3 - 5 m/s was measured at the monitoring location.

At the monitoring location, the residential receptor closest to the VPI CHP plant, Hazeldene, the dominant noise source was considered to have been the VPI CHP site. **No tonal or impulse noise was evident**.

Noise levels measured were found to be comparable with historic data.

The measured noise level of 50 dB L_{Aeq} over the entire measurement period (in the absence of vehicle noise on the A160) equates to being equal with the background noise level determined prior to the site's construction. Furthermore, the data in Appendix 1 indicates that the measured ambient noise levels (5-minute averages) were consistently below the pre-existing background. The permit (Section 6.6.1) requirement of not exceeding the existing background level by more than 3 dB(A) therefore **has been met**.

If you wish to discuss the findings of this report, please do not hesitate to contact me.

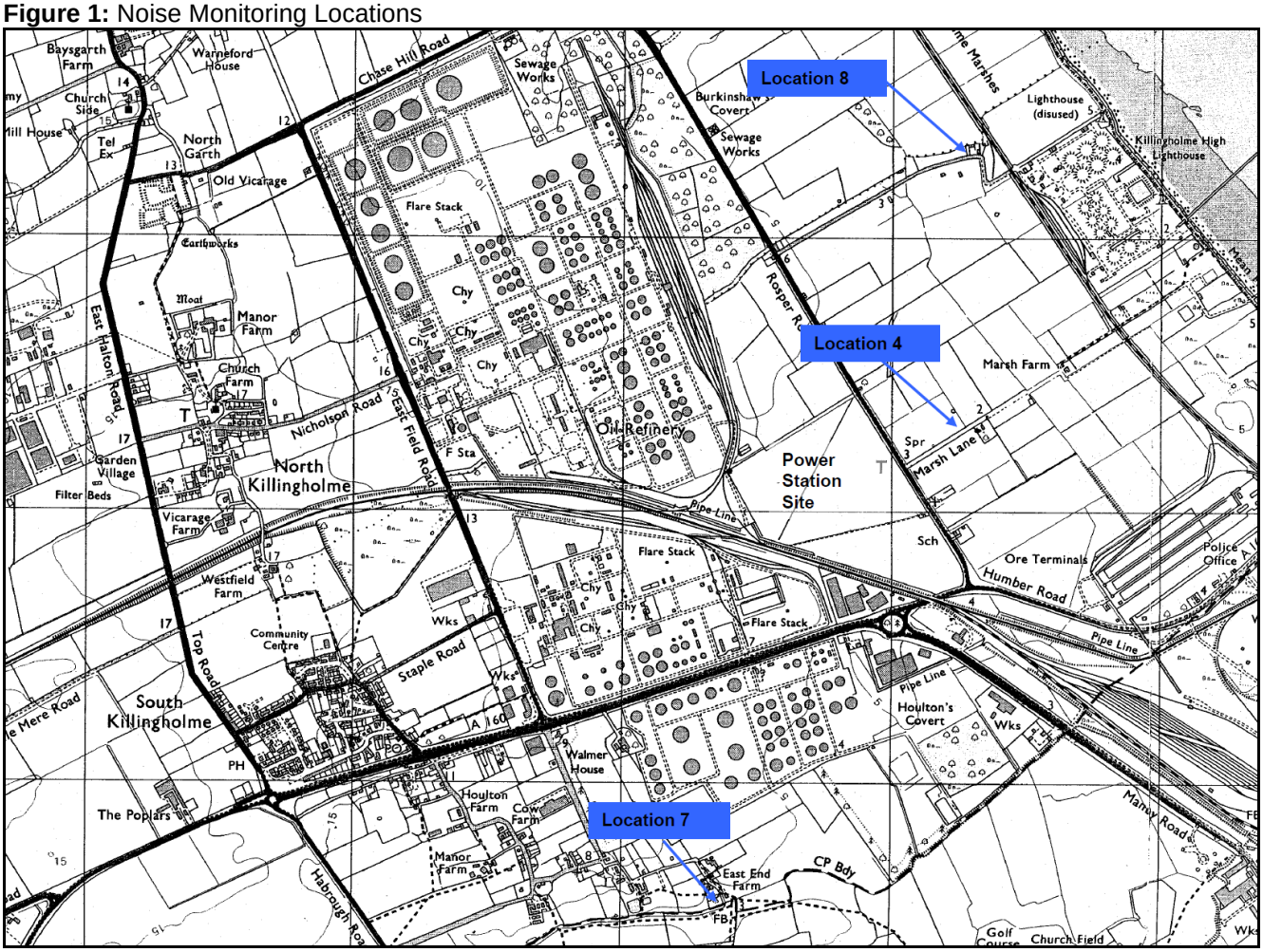
Yours sincerely

Bureau Veritas UK Ltd

Stuart Griffith, AMIOA
Senior Consultant – Acoustics, Vibration and Occupational Hygiene

Figures

Figure 1: Noise Monitoring Locations



References

1 Immingham CHP quarterly noise survey, NSOX0015/1 Rev 0, January 2007

2 Immingham Community Night-time Noise survey, BVAT Report 480361/7 Rev 0, January 2005

3 Immingham CHP Environmental Noise Survey Report 4373099 Rev 0, April 2013

4 Immingham CHP Environmental Noise Survey Report 7577394/1 Rev 0, June 2014

5 Immingham CHP Environmental Noise Survey Report 8526671/1 Rev 0, July 2015

6 Immingham CHP Environmental Noise Survey Report 6282118/2 Rev 0, August 2016

7 Immingham CHP Environmental Noise Survey Report 6380140/1 Rev 0, September 2017

8 Immingham CHP Environmental Noise Survey Report 6450625/1 Rev 0, July 2018

9 Immingham CHP Environmental Noise Survey Report 6477766/1 Rev 0, July 2019

10 Immingham CHP Environmental Noise Survey Report 9354710/1 Rev 0, July 2020

11 Immingham CHP Environmental Noise Survey Report 10824505/1 Rev 0, June 2021

12 Immingham CHP Environmental Noise Survey Report 15016838/1 Rev 0, June 2022

Appendix 1

Results of Environmental Noise Monitoring
June 2023

Table A1.1: Measured Environmental Noise Levels at Location 4, Hazeldene, Immingham, 1st – 2nd June 2023

Measurement number	Time	Measurement point weather					Noise Indicator				
		Wind Speed m/s	Wind Direction	Temperature (°C)	Humidity %	Cloud/8	L_{Aeq}	L_{Amax}	L_{A10}	L_{A50}	L_{A90}
1	23:00	4	NE	9	93	3	41.7	47.8	45.5	40.7	38.3
2	23:05	4.5	NE	9	93	3	43	51.2	49.2	41.8	39.5
3	23:10	4	NE	9	93	3	42.1	47.1	45.2	41.8	40.1
4	23:15	4	NE	10	82	3	40.3	44.5	43.1	40	38.8
5	23:20	4	NE	10	82	3	39.8	44.6	43.5	39.6	38
6	23:25	4	NE	10	82	3	39.8	46.8	43.3	39.4	38.4
7	23:30	4	NE	10	82	3	40.4	46.3	44.2	40.2	39
8	23:35	4	NE	10	82	3	40.2	46.5	44.4	40.1	38.6
9	23:40	4	NE	10	82	3	44.3	62.4	55.5	40.9	39.1
10	23:45	4	NE	10	82	3	39.2	44.9	44	38.6	37.4
11	23:50	4	NE	10	82	3	42.4	52	50	40.8	37.6
12	23:55	4	NE	10	82	3	46.5	53.8	51.4	45.2	41.4
13	00:00	4	NE	10	82	3	47.1	66.7	59.6	43	39.3
14	00:05	4	NE	10	82	3	42.9	50.5	49.3	41.5	38.7
15	00:10	4	NE	10	82	3	44.4	53.9	51.4	42.1	38.7

Measurement number	Time	Measurement point weather					Noise Indicator				
		Wind Speed m/s	Wind Direction	Temperature (°C)	Humidity %	Cloud/8	LAeq	LAmax	LA10	LA50	LA90
16	00:15	4	NE	10	76	3	45.3	54.6	50.6	44.5	42.3
17	00:20	4	NE	10	76	3	45.7	64.1	57.5	41.9	38.5
18	00:25	4.5	NE	11	76	3	45.2	52.6	50.8	44.4	41.3
19	00:30	4.5	NE	11	76	3	45.7	54.3	53.1	42.8	40.2
20	00:35	4.5	NE	11	76	3	44.4	55.7	48.7	43.8	39.6
21	00:40	4.5	NE	11	76	3	44.3	50.6	49.8	43.7	41.3
22	00:45	4.5	NE	11	76	3	45.2	50.1	49	44.8	42.3
23	00:50	4.5	NE	11	76	3	47.2	67	59.1	42.9	40
24	00:55	4	NE	11	71	3	49.6	68.6	64	43	39.5
25	01:00	4	NE	11	71	3	45.7	64.2	58.1	41.8	38.9
26	01:05	4	NE	11	71	3	40.7	53.3	47.2	39.9	37.6
27	01:10	4	NE	11	71	3	44.2	61.4	55.2	41.1	38.8
28	01:15	4	NE	11	71	3	43.8	63.7	56	39.4	37.7
29	01:20	4	NE	11	71	3	41.5	48.2	47.3	39.8	37.1
30	01:25	4	NE	11	71	3	42.6	49.1	48	41.7	37.8

Measurement number	Time	Measurement point weather	Noise Indicator

		Wind Speed m/s	Wind Direction	Temperature (°C)	Humidity %	Cloud/8	LAeq	LAmax	LA10	LA50	LA90
31	01:30	4	NE	11	71	4	42.7	50.7	48.7	41.9	39.4
32	01:35	4	NE	11	71	4	41.3	48.3	44.8	40.8	39.1
33	01:40	4	NE	11	71	4	42.8	49.6	46.9	41.9	40.1
34	01:45	4	NE	11	71	4	42	48.5	47.5	41.5	38.1
35	01:50	4	NE	11	71	4	43.7	56.7	54.2	41.7	38.7
36	01:55	4	NE	11	82	4	40	46.1	44.4	39.5	37.9
37	02:00	4	NE	11	82	4	41.3	50.3	47.6	40.5	37.6
38	02:05	4	NE	11	82	4	44.7	51.9	50.5	42.7	39.5
39	02:10	3.5	NE	11	82	4	43.8	51.6	49.3	42.7	38.6
40	02:15	3.5	NE	11	82	4	40.2	48.7	45.9	39.2	37.1
41	02:20	3.5	NE	11	82	4	41.2	49.4	45.2	40.5	38.4
42	02:25	3.5	NE	11	82	4	40.8	46.1	45.3	40.2	37.9
43	02:30	3.5	NE	10	82	5	44.5	52.4	49.6	43.7	41.2
44	02:35	3.5	NE	10	82	5	42	51.2	46.9	41.2	39.1
45	02:40	3.5	NE	10	82	5	39.3	47	43.8	38.9	36.8

Measurement number	Time	Measurement point weather	Noise Indicator

		Wind Speed m/s	Wind Direction	Temperature (°C)	Humidity %	Cloud/8	LAeq	LAmax	LA10	LA50	LA90
46	02:45	3.5	NE	10	82	5	39	46.1	43.5	38.6	37
47	02:50	3.5	NE	10	82	5	40.6	45.5	44.5	40.1	38.1
48	02:55	3.5	NE	10	82	6	41.5	59.1	48.5	40.3	38.1
49	03:00	3.5	NE	10	82	3	45.8	52.8	51.8	44.3	41.2
50	03:05	3.5	NE	10	82	3	44.6	52.8	49.9	43.8	41.1
51	03:10	3.5	NE	10	82	3	41.5	50.5	45.5	41	39.2
52	03:15	3.5	NE	10	82	3	43.1	51.6	48	42.5	40.6
53	03:20	3.5	NE	10	82	3	47	67.4	57.2	43.1	41.2
54	03:25	3.5	NE	10	82	3	42	46.7	45.4	41.7	39.9
55	03:30	4	NE	10	82	3	43.6	51.2	49.4	42.2	39.4
56	03:35	4	NE	10	82	6	43.3	50.9	48.2	42.6	39.9
57	03:40	4	NE	11	82	6	46.6	58.1	53.6	44.4	40.5
58	03:45	4	NE	11	82	6	52.8	69.9	63	46.7	43.2
59	03:50	4	NE	11	82	6	60.5	78.4	72.3	46.7	42.1
60	03:55	4	NE	11	82	6	62.4	78.2	72.6	48.2	42.8

VPI
Environmental Document for
Noise Management
IMM-ENV-7013

	Name	Job Title	Date
Owner	David Theakstone	Operations Manager	06/12/2023
Authoriser	Simon Sharpe	O&M Manager	06/12/2023
Review Date			dd/mm/yyyy

AMENDMENT RECORD		
Revision	**Issue Date**	**Purpose of Issue and Description of Amendment**
1.0	08/12/2023	First Issue

CONTENTS

1 SCOPE

This document covers the requirements for managing noise on the VPI site to minimise noise effects on the surrounding environment, including, but not limited to, local residents. It includes a Noise Management Plan (NMP) in Section 6, prepared to support an Environmental Permit variation application (Permit number EPR/BJ8022IZ) for the Immingham Combined Heat and Power (CHP) Power Plant, to include the installation of a Post-combustion Carbon Capture (PCC) plant and associated facilities.

1.1 Application

This document applies to the current and future operational footprint at the Immingham CHP site which is covered by the environmental permit EPR/BJ8022IZ. This document should be used in conjunction with the business integrated management system (IMS) and in particular the documents listed in Section 2 below.

2 RELATED DOCUMENTS

Refer to the table below where a schedule of related documents is listed in support of this Environmental document.

Where no reference is made to a specific issue or revision number of a Standard the latest published version is implied.

Document Name	Source
VPI-IMS-1006 Roles & Responsibilities	IMS
VPI-IMS-1013 Notification, Investigation, Reporting of Incidents and Near Misses	IMS
VPI-IMS-1023 Document for Handling External Queries, Complaints and Information Requests	IMS
VPI-IMS-1010 Documented Information	IMS

3 PROCEDURES

The respective Site Environmental Authority with responsibility for the procedures defined within this Environmental document and related documents shall implement and manage the following key procedures.

3.1 Document for Handling External Queries, Complaints and Information Requests

VPI-IMS-1023 Document for Handling External Queries, Complaints and Information Requests is referenced throughout the document to outline the Noise Management Plan complaints process.

3.2 Notification, Investigation, Reporting of Incidents and Near Misses

VPI-IMS-1013 Notification, Investigation, Reporting of Incidents and Near Misses is referenced throughout the document to outline the incident reporting process to record plant malfunctions or incidents which give rise to increased noise from the site.

4 ROLES AND RESPONSIBILITIES

In compliance with "VPI-IMS-1006 Roles & Responsibilities" the O&M Manager, or delegated responsible person for the management of the sites Governance process, shall appoint suitably qualified and experienced personnel with responsibility to undertake specific duties that comply with the requirements of this Environmental document and related documents.

5 IMPLEMENTATION AND REVIEW

Implementation of this Environmental document will take immediate effect from the date of issue and it is the responsibility of all personnel to ensure compliance with this Environmental document.

This Environmental document shall be reviewed every 3 years to ensure effectiveness, compliance and overall fitness for purpose. The document shall also be reviewed and re-issued in light of changes to legislation, published standards and/or good industry practice, experience, technological developments and recommendations from Audits and/or Panels of Enquiry.

6 NOISE MANAGEMENT PLAN

6.1 Site Description

The VPI Immingham Combined Heat and Power plant (CHP) is situated on Rosper Road in an industrial area of Immingham, North Lincolnshire. The site is surrounded by refineries and other industrial premises.

The gas-fired CHP operates 24 hours a day and for seven days a week. It supplies power and steam to the neighbouring refineries and electricity to the National Grid. The site consists of three gas turbines and associated heat recovery steam generators (HRSGs), exhaust stacks, cooling towers, air cooled condensers and various associated plant which emit noise to the environment.

Additional, less frequent sources of noise, such as starting up steam turbines, venting of gas, and release of steam from relief valves could give rise to higher levels of noise intermittently.

The addition of a post-combustion carbon capture (PCC) plant will reduce the carbon dioxide emissions of the CHP at Immingham by up to 3.3 million tonnes per year.

Engineering information on the proposed PCC plant equipment and corresponding sound power levels is available at this stage of the PCC plant design, however such information will be refined throughout the Engineering, Procurement, Construction (EPC) stage of the project. As such, the NMP will require revision following EPC to ensure it reflects the constructed PCC plant.

While the PCC plant is proposed to operate continuously, 24 hours a day and seven days a week, many of the items of plant will only be used subject to demand and subject to ambient weather conditions.

The site installation boundary is shown in Annex A.

6.2 Maintenance and review of the NMP

In compliance with "VPI-IMS-1006 Roles & Responsibilities" the Operations and Maintenance (O&M) manager is responsible for ensuring the NMP is complied with. The O&M manager is responsible for appointing suitably qualified and experienced personnel with responsibility to undertake specific duties, e.g. for off-site monitoring.

On-site monitoring is incorporated into the Daily Operations Routine, completed by site personnel. On-site personnel check plant and equipment daily for any abnormalities. Any obvious cases of malfunction causing increased or changes to the character of noise are reported as an incident in accordance with VPI-IMS-1013. As a minimum, anyone required to undertake the role and responsibilities of the investigation team leader shall have been trained to the internal incident investigation training module available through the VPI Human Resources / Training and Development.

Off-site monitoring is completed by an external suitably qualified and experienced body.

Complaints are recorded in the incident management system according to VPI-IMS-1023. Site O&M Managers are responsible for ensuring all complaints and queries are investigated and responded to effectively and within a reasonable timescale.

In accordance with VPI-IMS-1010 Section 3.1.5, this Environmental document shall be reviewed every 3 years to ensure effectiveness, compliance and overall fitness for purpose. The document shall also be reviewed and re-issued in light of changes to legislation, published standards and/or good industry practice, experience, technological developments and recommendations from audits and/or Panels of Enquiry.

6.3 Sector guidance for industrial noise

Relevant guidance for noise emissions from industrial plants has informed this noise management plan.

- Industrial Emissions Directive 2010/75/EU Integrated Pollution Prevention and control 2017 *Best Available Techniques (BAT) Reference Document for Large Combustion Plants* (LCP BRef)
- Commission Implementing Decision (EU) 2021/2326 of 30 November 2021 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (LCP BATc)
- Environment Agency 2021 - *Post-combustion carbon dioxide capture: Best Available Techniques (BAT)*

6.4 Receptors

Receptor reference	Land use e.g. residential, school, hospital, commercial	Direction from site (north, south, east, west)	Approximate distance to site boundary (m)
NSR 1 – Staple Road	Residential	West	1,540
NSR 2 – Clarks Road	Residential	West	1,930
NSR 3 – Church Lane	Residential	West	1,940
NSR 4 – Hazel Deane, Marsh Lane	Residential	East	340

Table 1: Receptor list

The receptors are depicted in blue in the figure attached in Annex B.

6.5 Noise sources and processes

6.5.1 Noise impact assessment for the PCC plant conclusion

A noise impact assessment (NIA) has been carried out for the PCC plant and concludes that, based on the worst-case scenario of all plant operating simultaneously at full power, the rating level at the closest noise sensitive receptors would be less than 5dB above the background sound level. The resulting significance is less than the level above which adverse impacts are likely to be indicated in accordance with BS 4142 (before context considerations). The highest predicted specific sound level from the PCC plant is at NSR4, the closest receptor. The BS4142 assessment focuses on NSR 4 as the noise climate at NSRs 1, 2 and 3 is dominated by noise from the Phillips 66 Humber Refinery and the Lindsey Oil Refinery. The assessment resulted in a worst-case increase of 3 dB over the representative background sound level at NSR 4. This was deemed to indicate a low impact due to the context of the area and the existing noise climate.

6.5.2 Noise sources

Noise from the existing CHP plant has been quantified at NSR4 through noise surveys undertaken in June 2023. Ranking of individual noise sources in approximate order of significance has been taken from the original IPPC application undertaken by PB Power in 2001.

Noise source data for the proposed PPC plant has been taken from the NIA undertaken by AECOM in November 2023. Full details of the source data and details of the modelling undertaken can be found in Appendix B of the NIA.

Plant reference	Noise Source	Quantity	Sound pressure level (SPL) @1m (dBA)	Operational conditions	Additional comments (including spectrum reference used in SoundPLAN model)
CHP plant items					
CHP continuous operation	Cooling towers	Entire CHP site	50* *individual SPL at 1m not available. This is the measured noise level at NSR4 from all plant on the existing site	24 hours a day, 7 days a week	Ranked in approximate order of significance with respect to resultant environmental noise levels from PB Power "CHP Noise Development Plan".
	Heat Recovery Steam Generator (HRSG)				
	Gas turbines				
	Exhaust stacks				
	Electrical generators				
	Gas supply system				
	Water feed pumps				
	Air inlets to the gas turbines				
	Cooling water pumps				
	Steam turbines and condensers				
	Transformers				
	Ducting				
	Gas turbine trip		50*	Infrequent	

Plant reference	Noise Source	Quantity	Sound pressure level (SPL) @1m (dBA)	Operational conditions	Additional comments (including spectrum reference used in SoundPLAN model)
CHP non-continuous noise sources	Steam turbine bypass and steam turbine start up	Entire CHP site	*individual SPL at 1m not available. This is the measured noise level at NSR4 from all plant on the existing site	Up to twice per day	Ranked in approximate order of significance with respect to resultant environmental noise levels from PB Power "CHP Noise Development Plan".
	HSRG safety valves			Once every three years	
	Gas reception compound venting			Emergency shut down only	
PCC plant items					
VPI-2	CO_2 absorber exhaust (point source)	2 (1 per train)	85	24 hours a day, 7 days a week. Trains will operate due to grid demand, based on historical operating data for the power generation, only one train will operate for a significant amount of time during the year.	SoundPLAN library ref 160 Cooling tower
VPI-5	MVR compressor	2 (1 per train)	80		BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-15	CO_2 dehydration package	2 (1 per train)	85		SoundPLAN library ref 11 Power station (boiler & coal mill room)
VPI-19	CO_2 compressor	2 (1 per train)	85		BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-20	Hydrogen generation package	2 (1 per train)	85		BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-21	CO_2 compressor 1st stage intercooler	6 fans (3 per train)	71	Cooling plant will operate continuously, however, more fans will be utilised as the	SoundPLAN library ref 90 Axial Flow Fan
VPI-22	CO_2 stripper condenser	32 fans (16 per train)	71		SoundPLAN library ref 90 Axial Flow Fan

Plant reference	Noise Source	Quantity	Sound pressure level (SPL) @1m (dBA)	Operational conditions	Additional comments (including spectrum reference used in SoundPLAN model)
VPI-23	Lean solvent cooler	72 fans (36 per train)	71	air temperature increases.	SoundPLAN library ref 90 Axial Flow Fan
VPI-24	Wash water Cooler	60 fans (30 per train)	71		SoundPLAN library ref 90 Axial Flow Fan
VPI-25	DCC water cooler	132 fans (66 per train)	71		SoundPLAN library ref 90 Axial Flow Fan
VPI-29	DCC water circulating pump	2 (1 per train)	85	24 hours a day, 7 days a week. Trains will operate due to grid demand, based on historical operating data for the power generation, only one train will operate for a significant amount of time during the year.	BS 5228 Table C2.45 Water pump
VPI-31	Wash water pump	2 (1 per train)	85		BS 5228 Table C2.45 Water pump
VPI-32	Rich solvent pump	3 (2 on one train, 1 on other train)	85		BS 5228 Table C2.45 Water pump
VPI-34	Lean solvent pump	4 (2 per train)	85		BS 5228 Table C2.45 Water pump
VPI-36	Stripper condensate pump	4 (2 per train)	85		BS 5228 Table C2.45 Water pump
VPI-39	CO_2 stripper reflux pump	2 (1 per train)	85		BS 5228 Table C2.45 Water pump
VPI-41	CO_2 compression condensate return pump	2 (1 per train)	70		BS 5228 Table C2.45 Water pump
VPI-42	Solvent drain pump	4 (2 per train)	65		BS 5228 Table C2.45 Water pump
VPI-45	Anti foam dosing package	2 (1 per train)	80		BS 5228 Table C2.45 Water pump
VPI-46	Solvent transfer pump	2	85		BS 5228 Table C2.45 Water pump
VPI-48	Solvent make up pump	1	85		BS 5228 Table C2.45 Water pump

Plant reference	Noise Source	Quantity	Sound pressure level (SPL) @1m (dBA)	Operational conditions	Additional comments (including spectrum reference used in SoundPLAN model)
VPI-49	Steam turbine	1	80		SoundPLAN library ref 10 Power Station (generator turbine hall)
VPI-54	Thermal reclaimer vacuum package	1	85		SoundPLAN ref 898 Manure trailer - vacuum pump
VPI-55	Reclaimer bottom pump	2	70		BS 5228 Table C2.45 Water pump
VPI-57	Thermal reclaimer reflux pump	1	75		BS 5228 Table C2.45 Water pump
VPI-59	Refrigeration package	1	74		BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-64	Fresh solvent container pump	1	70		BS 5228 Table C2.45 Water pump
VPI-70	IA Compressor (Instrument Air)	1	79		BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-71	CO_2 compressor 3rd stage intercooler	6 fans (3 per train)	71		SoundPLAN library ref 90 Axial Flow Fan
VPI-74	Thermal reclaimer condenser	4 fans	71		BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-75	GT Flue gas blower	2	85		SoundPLAN library ref 90 Axial Flow Fan
VPI-77	Aux boiler flue gas blower	2	82		SoundPLAN library ref 90 Axial Flow Fan
VPI-79	Thermal reclaimer degraded solvent pump	1	74		BS 5228 Table C2.45 Water pump

Plant reference	Noise Source	Quantity	Sound pressure level (SPL) @1m (dBA)	Operational conditions	Additional comments (including spectrum reference used in SoundPLAN model)
VPI-88	CO_2 compressor 4th stage intercooler	6 fans (3 per train)	71		SoundPLAN library ref 90 Axial Flow Fan
VPI-89	CO_2 compressor 5th stage intercooler	2 fans (1 per train)	71		SoundPLAN library ref 90 Axial Flow Fan
VPI-91	CO_2 compressor 2nd stage intercooler	6 fans (3 per train)	71		SoundPLAN library ref 90 Axial Flow Fan
VPI-92	CO_2 compressor after cooler	6 fans (3 per train)	71		SoundPLAN library ref 90 Axial Flow Fan
VPI-43	Recycle cooler	2 fans (1 per train)	71		SoundPLAN library ref 90 Axial Flow Fan
VPI-94	Caustic pump	1	68		BS 5228 Table C2.45 Water pump
VPI-99a	Substation-04 TR3-02	1	106		AECOM measurement
VPI-99b	Substation-04 TR4-01A/01B		96		AECOM measurement
VPI-99c	Substation-04 TR4-02A/02B		96		AECOM measurement
VPI-99d	Substation-04 TR3-01A/01B		95		AECOM measurement
VPI-100	Substation-05 TR5-01A/01B		80		AECOM measurement
VPI-101a	Substation-06 TR5-01A/01B		80		AECOM measurement
VPI-101b	Substation-06 TR5-02A/02B		80		AECOM measurement
VPI-101c	Substation-06 TR5-03A/03B		80		AECOM measurement

Plant reference	Noise Source	Quantity	Sound pressure level (SPL) @1m (dBA)	Operational conditions	Additional comments (including spectrum reference used in SoundPLAN model)
VPI-102a	Substation-07 TR5-01A/01B		80		AECOM measurement
VPI-102b	Substation-07 TR5-02A/02B		80		AECOM measurement
VPI-102c	Substation-07 TR5-03A/03B		80		AECOM measurement
VPI-112	Transformer-01	1	105		AECOM measurement
VPI-113	Transformer-02	1	105		AECOM measurement

Table 2: Description of noise emitting processes

6.5.3 Overview of noise processes and emissions

The future operation of the site will consist of the existing CHP and the new PCC plant.

The CHP operates continuously, the cooling towers, heat recovery steam generator (HRSG), gas turbines, exhaust stacks and electrical generators are the items of plant which contribute the highest noise levels from the existing site. Intermittent activities, such as gas turbine trip, steam turbine bypass and steam turbine start up, HSRG safety valves and gas reception compound venting, can also contribute to the noise climate more infrequently. The locations of these are shown in Annex C.

The new PCC plant will also operate continuously and consists of two PCC plant 'trains', each with associated air blower, direct contact cooler, absorber tower, stack, stripper/ regenerator, thermal reclaimer unit and air-cooled heat exchangers. Each train contains multiple air coolers, which the highest noise levels are attributed to, however it is unlikely that all of these will be operational at once, as more are utilised as ambient air temperature increases. The items of plant contributing to the highest noise levels at NSR 4 are the carbon dioxide compressors, The locations of these are depicted in Annex C.

An overview of the PCC process is shown in Annex D.

6.6 Control measures and process monitoring

6.6.1 Appropriate measures and Best Available Techniques (BAT)

The following attenuations have been agreed and included in the noise impact assessment.

Activity which produces noise	Operational Hours / days	Control measures (Appropriate Measure / BAT)	Contribution to overall impact	Action taken if outside optimum process parameters
VPI-19 CO_2 compressor	24 hours a day, 7 days a week	Confirmed -5dB attenuation will be achieved during the detailed design stage (see measures below)	High	Turn off individual noisy items of plant where feasible. Investigate reasons for elevated sound levels and options for mitigation.
VPI-54 Thermal reclaimer vacuum package	24 hours a day, 7 days a week	Confirmed -10dB attenuation will be achieved during the detailed design stage (see measures below)	High	Turn off individual noisy items of plant where feasible. Investigate reasons for elevated sound levels and options for mitigation.
VPI-99a-99d Substations	24 hours a day, 7 days a week	Confirmed -10dB attenuation will be achieved during the detailed design stage (see measures below)	High	Turn off individual noisy items of plant where feasible. Investigate reasons for elevated sound levels and options for mitigation.
VPI-70 Instrument air compressor	24 hours a day, 7 days a week	Confirmed -9dB attenuation will be achieved during the detailed design stage (see measures below)	High	Turn off individual noisy items of plant where feasible. Investigate reasons for elevated sound levels and options for mitigation.
VPI-23-39 Cooler and associated equipment	Air coolers - more are in operation as ambient air	Confirmed -5dB attenuation will be achieved during the detailed design stage (see measures below)	Medium	Turn off individual noisy items of plant where feasible.

Activity which produces noise	Operational Hours / days	Control measures (Appropriate Measure / BAT)	Contribution to overall impact	Action taken if outside optimum process parameters
	temperatures increase			Investigate reasons for elevated sound levels and options for mitigation.
VPI-46-48 Solvent pump	24 hours a day, 7 days a week	Confirmed -5dB attenuation will be achieved during the detailed design stage (see measures below)	Medium	Turn off individual noisy items of plant where feasible. Investigate reasons for elevated sound levels and options for mitigation.

Table 3: Activities and procedures which will be in place to achieve appropriate measures / best available techniques (BAT)

Technique	Description	Applicability
Operational measures	These include: inspection and maintenance of equipment; closing of doors and windows of buildings and enclosed areas, where possible; plant operated by experienced staff; avoidance of noisy activities at night, if possible.	These are part of good working practices at the installation.
Low-noise equipment	Select low noise equipment where possible	When equipment is new or being replaced. Where practicable low noise equipment will be procured for the PPC plant
Noise attenuation	These include: use of screening or bunding to shield receptors from noise sources; reducing the breakout noise from plant through the use of enhanced enclosures, or potentially containing them within a building; screening or enclosing the compressors or other equipment.	Consideration of screening where required and the layout of the PCC plant has incorporated consideration for the potential of noise impact to occur, within the constraints of the plot plan.

Technique	Description	Applicability
Noise control equipment	This includes: reducing air inlet noise emissions by the addition of further in-line attenuation; reducing stack outlet noise emissions by the addition of silencers or sound proofing panels; reducing fin fan cooler noise emissions by screening, re-sizing, fitting low noise fans or attenuation; use of anti-vibration supports and interconnections for equipment;	To be considered during the detailed design of the PPC plant
Appropriate location of equipment and buildings	Orientation of plant within the site to provide screening of low-level noise sources by other buildings and structures, or orientating fans and the air inlets away from sensitive receptors	This is generally applicable to new plant and has been considered during the development of the proposed PCC plant and will continue to be considered during the detailed design.

Table 4: BAT and actions to achieve stated attenuation

6.6.2 Onsite monitoring procedures

Description of procedure	Procedure	When will this be carried out?	Corrective action
Replacing old / faulty equipment	Procurement of new equipment	When equipment requires replacing	Replace with equipment that has sound levels which are equivalent to or lower than sound those of the existing equipment
Checking noise barriers	Visual inspection of barriers to ensure no gaps or holes	Monthly	Repair the barriers if holes or gaps are found.
Checking plant enclosures	Visual inspection of enclosure to ensure no rust or damage	Monthly	Repair the enclosure
Daily operations routine	Daily inspection of site to identify any malfunctioning equipment/ potential noise exceedances	Daily	Report as incident, equipment repaired / alternate equipment to be used if feasible

Table 5: Description of onsite processes which will ensure impacts do not increase on site

6.6.3 Monitoring off site sound levels

VPI will continue to monitor noise from the site at least annually. The measurement position has been established by annual measurements at NSR4, as it is the closest residential receptor. The process is robust and repeatable; and has been used since 2005 to track the sound emissions from the site. The position of NSR4 is shown in Annex B.

Measurement Location	Frequency of measurement	Minimum measurement duration	Measurement period	Operating conditions on site	Expected specific sound level
NSR 4	Annually	1 hour	Daytime (07:00 – 23:00)	Normal operation	Below 55 dB L_{Aeq}
NSR 4	Annually	15 minutes	Night time (23:00 – 07:00)	Normal operation	Below 55 dB L_{Aeq}

Table 6: Description of the sound monitoring process

6.7 Complaints reporting

Complaints will be handled according to VPI-IMS-1023.

Upon receipt of a query, information request or complaint from an external stakeholder, the reporter should record the following information in the shift log and send it to O&M Managers and the Performance Team.

- Name of the enquirer
- Organisation to which the enquirer belongs, or the fact that they are a member of the public
- Description of the query and information that is being requested
- Contact details for the enquirer, including postal address, telephone number and email address and if they require a call back.
- Any notable conditions e.g. abnormal activity, weather conditions.

Personnel must be polite and courteous when receiving complaints / queries and report the complaint / query to the O&M manager or Responsible Manager at the earliest opportunity either in person, via email or telephone.

All queries and complaints must be investigated locally to establish the root cause. If the query relates to an incident, the level and type of investigation may change depending on the severity. Key findings of the investigation should be provided to the complainant / enquirer at the earliest opportunity and by appropriate means.

Any complaint or enquiry relating to noise will initially be dealt with by the Operations Control Person and reported to the O&M Manager or Performance Team. In the event of the issue arising out of normal office hours, the Operations Control Person will immediately notify the on-call Duty Manager.

Justified complaints should be raised in the Incident Management System (IMS) and notified to the Performance Team for reporting purposes. Enquirers' personal details must not be recorded in the incident

management system or any relevant tracking sites for data protection purposes. This information should be recorded by email and submitted to the O&M Managers and Performance Team.

Justified complaints are recorded monthly in the IMS Plan and reported to the Management Team throughout the year.

The decision as to whether the complaint is considered to be justified or unjustified sits with the relevant Manager. Complaints will normally be justified where the event leading to the complaint is associated with an activity being carried out by VPI; results in a change in practice to prevent recurrence and occurred due to control measures not being put in place; best practice not being followed; operator error, or an abnormal condition.

Should the complaint be justified, an email will be sent to the Environment Agency to notify them. Should the complaint be found to correspond to a plant failure, a schedule 5 will be submitted to the Environment Agency.

Feedback from the Environment Agency and complainant should be sought after remedial action is taken.

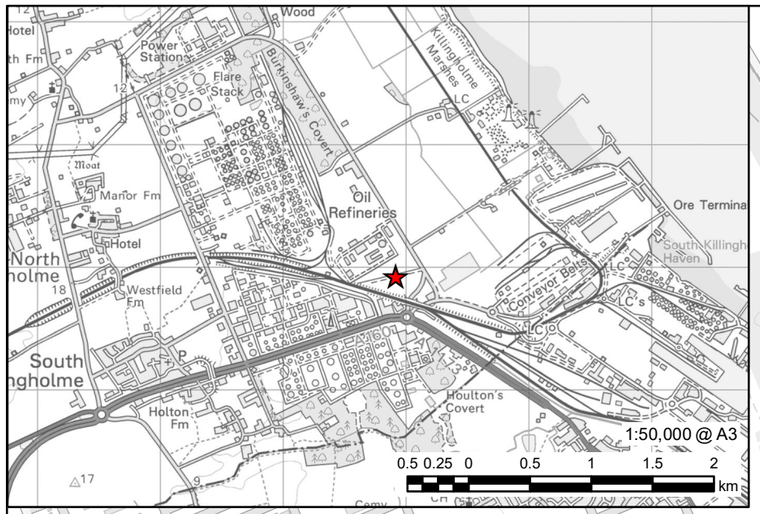
Site O&M Managers are responsible for ensuring all complaints and queries are investigated and responded to effectively and within a reasonable timescale.

Members of the public can contact the security gate house on 01469 565800. This number is for the 24-hour manned security gate house, the security guard will take the call and transfer the complainant through to the Operations Controller who will have received sufficient training in the handling of complaints.

Annex A
Site Installation Boundary

Revision: 2 Drawn: ER Checked: LC Approved: KC Date: 2023-01-11

Filename: \\na.aecomnet.com\fs\EMEA\Leeds-UKLDS2\Legacy\UKLDS2PFPSW0011\WIP\LE_Projects\Newprojet\60668866 - Humber Zero\900_CAD_GIS\02_Maps\VPI Environmental Permit Variation\HZ_EPV_Fig1_Site_Location_Plan_20230110_ER_v2.mxd



AECOM

PROJECT

Environmental Permit Variation Application

CLIENT

VPI Immingham LLP

CONSULTANT

AECOM Limited
2 City Walk
Holbeck, Leeds
LS11 9AR
www.aecom.com

LEGEND

Existing Installation Site Boundary

Site Location

NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60668866

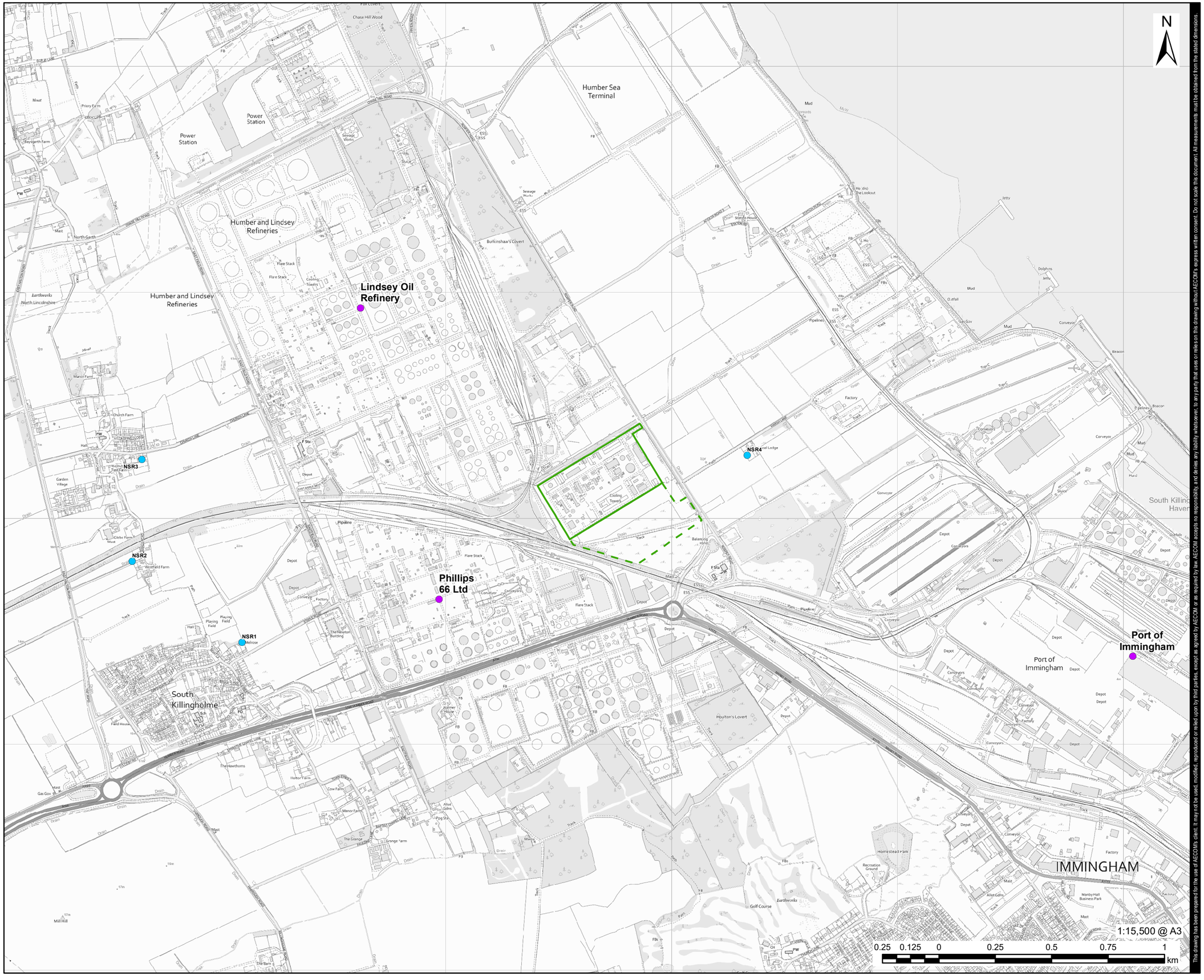
FIGURE TITLE

Site Location Plan

FIGURE NUMBER

Figure 1

Annex B
Receptor Map



Revision: 1 Drawn: ER Checked: LC Approved: DP Date: 2023-11-23

Filename: \\na.aecomnet.com\lfs\EMEA\Leeds-UKLDS2\Legacy\UKLDS2PFPSW0011\WIP\LE_Projects\Newproje\60668866 - Humber Zero\900_CAD_GIS\02_Maps\VPI Environmental Permit Variation\HZ_EPV_FigA.1_Installation_Boundary_with_Noise_Monitoring_Locations_20231123_ER_v1.mxd

AECOM

PROJECT

Humber Zero

CLIENT

VPI Immingham LLP

CONSULTANT

AECOM Limited
5th Floor
2 City Walk
Leeds, LS11 9AR
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LEGEND

- Existing Installation Site Boundary
- Extended Installation Site Boundary
- Noise Monitoring Location
- Surrounding Industry Location

NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60712174

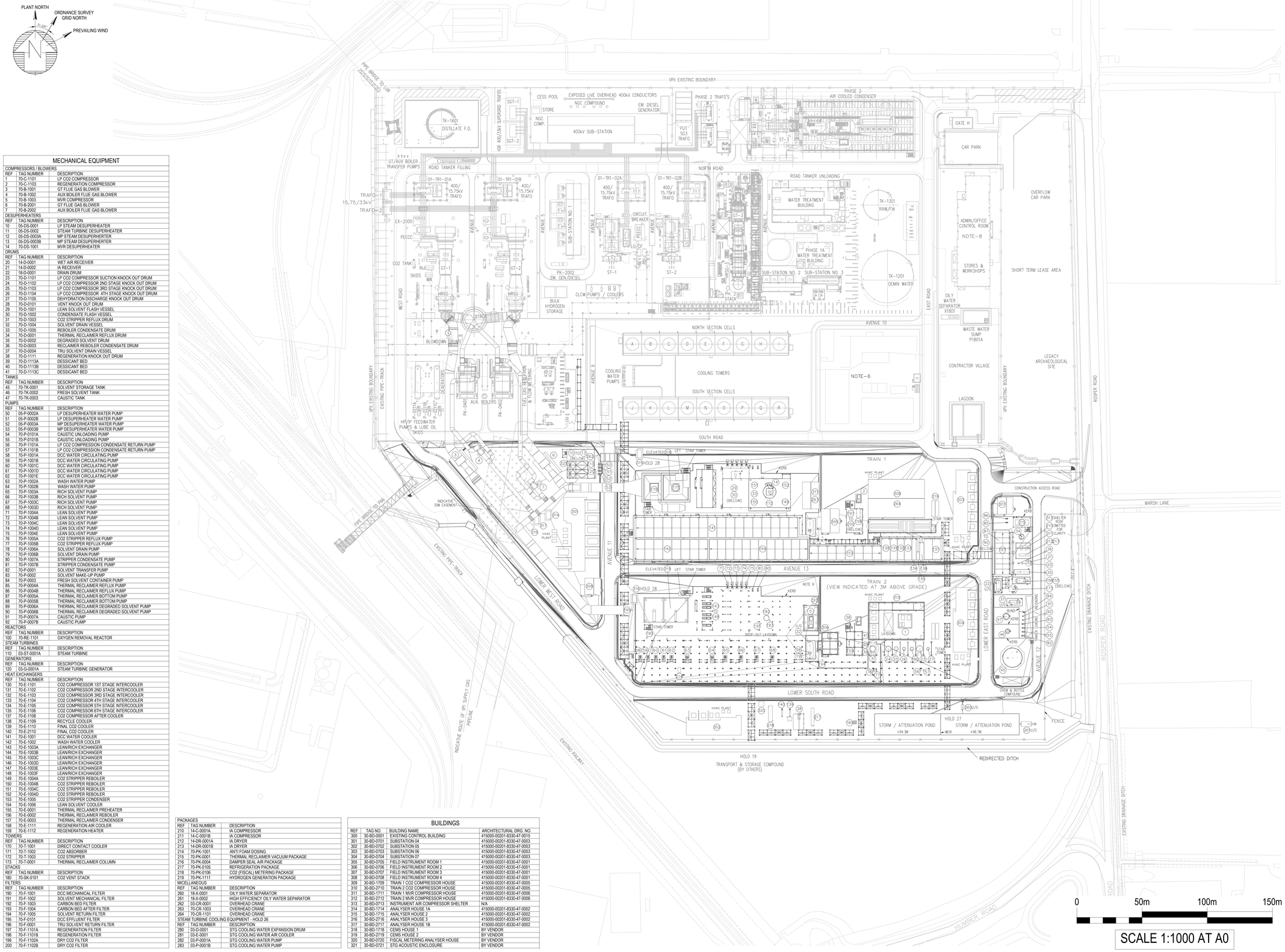
FIGURE TITLE

VPI Installation Boundary with Noise Monitoring Locations

FIGURE NUMBER

Figure A.1

Annex C
Site plan showing noise emitting sources



NOTES:

1. EXISTING SITE LAYOUT REFLECTS BEST AVAILABLE INFORMATION FROM PRE-FEED PHASE AND LEGACY DOCUMENTS FROM PHASE 1 (BY FOSTER WHEELER) AND PHASE 2 (BY BLACK & VEATCH LIMITED). THIS IS AUGMENTED BY LASER SCAN DATA CAPTURED DURING THE FEED (BY SCOPUS) FOR AREAS LOCAL TO TIE-INS.
   SEE 'REFERENCES' SECTION FOR DRAWING / DOCUMENT NUMBERS.
2. ACCURACY OF INFRASTRUCTURE (ROADS, RAILWAYS, BOUNDARIES, ETC.) IS NOT CONFIRMED.
3. DELETED.
4. DELETED.
5. THE SITE IS CENTERED AT NGR: TA 16678 17462.
6. LOCATION OF EXISTING RUBB TENT AREA IS AVAILABLE FOR OPTIONAL USE OF HZ-VPI-1 PCC PROJECT.
7. TAGS MARKED THUS * ARE DUPLICATED IN TRAINS 1 / 2.
8. CCR TO BE INTEGRATED WITH EXISTING BUILDING.
9. EXISTING PLANT NOMINAL GRADE IS +100.00M. THIS IS EQUIVALENT TO +4.90 ABOVE O/S NEWLYN.
10. NEW SCOPE IS SHOWN IN BOLD.

HOLDS:

1. CLEARED.
2. PIPE RACK GRID NUMBERS.
3. CLEARED.
4. CLEARED.
5. CLEARED.
6. CLEARED.
7. CLEARED.
8. CLEARED.
9. MAINTENANCE CRANE / LAYDOWN AREA / HARD-STANDING LOCATIONS.
10. FIRE MONITOR AND HYDRANT LOCATION.
11. CLEARED.
12. CLEARED.
13. CLEARED.
14. CLEARED.
15. CLEARED.
16. CLEARED.
17. CLEARED.
18. CLEARED.
19. TERMINAL LOCATION OF CO2 EXPORT LINE (T&S COMPOUND).
20. CLEARED.
21. CLEARED.
22. CLEARED.
23. CLEARED.
24. REQUIREMENT FOR ADDITIONAL WASTE STORAGE LAYDOWN.
25. REQUIREMENT FOR ADDITIONAL WAREHOUSE FOR CAPITAL SPARES.
26. LOCATION FOR STEAM TURBINE COOLING EQUIPMENT.
27. LOCATION / TAG NUMBERS OF STORM WATER POND WEIR PUMPS.
28. LOCATION OF ANALYSER HOUSES 30-BD-1715 / 30-BD-2716.

MECHANICAL EQUIPMENT

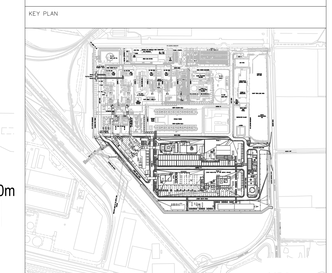
REF	TAG NUMBER	DESCRIPTION
COMPRESSORS / BLOWERS		
1	70-C-1101	LP CO2 COMPRESSOR
2	70-C-1103	REGENERATION COMPRESSOR
3	70-B-1001	GT FLUE GAS BLOWER
4	70-B-1002	AUX BOILER FLUE GAS BLOWER
5	70-B-1003	MVR COMPRESSOR
6	70-B-2001	GT FLUE GAS BLOWER
7	70-B-2002	AUX BOILER FLUE GAS BLOWER
DESUPERHEATERS		
REF	TAG NUMBER	DESCRIPTION
10	05-DS-0001	LP STEAM DESUPERHEATER
11	05-DS-0002	STEAM TURBINE DESUPERHEATER
12	05-DS-0003A	MP STEAM DESUPERHERTER
13	05-DS-0003B	MP STEAM DESUPERHERTER
14	70-DS-1001	MVR DESUPERHEATER
DRUMS		
REF	TAG NUMBER	DESCRIPTION
20	14-D-0001	WET AIR RECEIVER
21	14-D-0002	IA RECEIVER
22	18-D-0001	DRAIN DRUM
23	70-D-1101	LP CO2 COMPRESSOR SUCTION KNOCK OUT DRUM
24	70-D-1102	LP CO2 COMPRESSOR 2ND STAGE KNOCK OUT DRUM
25	70-D-1103	LP CO2 COMPRESSOR 3RD STAGE KNOCK OUT DRUM
26	70-D-1104	LP CO2 COMPRESSOR 4TH STAGE KNOCK OUT DRUM
27	70-D-1105	DEHYDRATION DISCHARGE KNOCK OUT DRUM
28	70-D-0101	VENT KNOCK OUT DRUM
29	70-D-1001	LEAN SOLVENT FLASH VESSEL
30	70-D-1002	CONDENSATE FLASH VESSEL
31	70-D-1003	CO2 STRIPPER REFLUX DRUM
32	70-D-1004	SOLVENT DRAIN VESSEL
33	70-D-1005	REBOILER CONDENSATE DRUM
34	70-D-0001	THERMAL RECLAIMER REFLUX DRUM
35	70-D-0002	DEGRADED SOLVENT DRUM
36	70-D-0003	RECLAIMER REBOILER CONDENSATE DRUM
37	70-D-0004	TRU SOLVENT DRAIN VESSEL
38	70-D-1111	REGENERATION KNOCK OUT DRUM
39	70-D-1113A	DESSICANT BED
40	70-D-1113B	DESSICANT BED
41	70-D-1113C	DESSICANT BED
TANKS		
REF	TAG NUMBER	DESCRIPTION
45	70-TK-0001	SOLVENT STORAGE TANK
46	70-TK-0002	FRESH SOLVENT TANK
47	70-TK-0003	CAUSTIC TANK
PUMPS		
REF	TAG NUMBER	DESCRIPTION
50	05-P-0002A	LP DESUPERHEATER WATER PUMP
51	05-P-0002B	LP DESUPERHEATER WATER PUMP
52	05-P-0003A	MP DESUPERHEATER WATER PUMP
53	05-P-0003B	MP DESUPERHEATER WATER PUMP
54	70-P-0101A	CAUSTIC UNLOADING PUMP
55	70-P-0101B	CAUSTIC UNLOADING PUMP
56	70-P-1101A	LP CO2 COMPRESSION CONDENSATE RETURN PUMP
57	70-P-1101B	LP CO2 COMPRESSION CONDENSATE RETURN PUMP
58	70-P-1001A	DCC WATER CIRCULATING PUMP
59	70-P-1001B	DCC WATER CIRCULATING PUMP
60	70-P-1001C	DCC WATER CIRCULATING PUMP
61	70-P-1001D	DCC WATER CIRCULATING PUMP
62	70-P-1001E	DCC WATER CIRCULATING PUMP
63	70-P-1002A	WASH WATER PUMP
64	70-P-1002B	WASH WATER PUMP
65	70-P-1003A	RICH SOLVENT PUMP
66	70-P-1003B	RICH SOLVENT PUMP
67	70-P-1003C	RICH SOLVENT PUMP
68	70-P-1003D	RICH SOLVENT PUMP
71	70-P-1004A	LEAN SOLVENT PUMP
72	70-P-1004B	LEAN SOLVENT PUMP
73	70-P-1004C	LEAN SOLVENT PUMP
74	70-P-1004D	LEAN SOLVENT PUMP
75	70-P-1004E	LEAN SOLVENT PUMP
76	70-P-1005A	CO2 STRIPPER REFLUX PUMP
77	70-P-1005B	CO2 STRIPPER REFLUX PUMP
78	70-P-1006A	SOLVENT DRAIN PUMP
79	70-P-1006B	SOLVENT DRAIN PUMP
80	70-P-1007A	STRIPPER CONDENSATE PUMP
81	70-P-1007B	STRIPPER CONDENSATE PUMP
82	70-P-0001	SOLVENT TRANSFER PUMP
83	70-P-0002	SOLVENT MAKE-UP PUMP
84	70-P-0003	FRESH SOLVENT CONTAINER PUMP
85	70-P-0004A	THERMAL RECLAIMER REFLUX PUMP
86	70-P-0004B	THERMAL RECLAIMER REFLUX PUMP
87	70-P-0005A	THERMAL RECLAIMER BOTTOM PUMP
88	70-P-0005B	THERMAL RECLAIMER BOTTOM PUMP
89	70-P-0006A	THERMAL RECLAIMER DEGRADED SOLVENT PUMP
90	70-P-0006B	THERMAL RECLAIMER DEGRADED SOLVENT PUMP
91	70-P-0007A	CAUSTIC PUMP
92	70-P-0007B	CAUSTIC PUMP
REACTORS		
REF	TAG NUMBER	DESCRIPTION
100	70-RE-1101	OXYGEN REMOVAL REACTOR
STEAM TURBINES		
REF	TAG NUMBER	DESCRIPTION
110	03-ST-0001A	STEAM TURBINE
GENERATORS		
REF	TAG NUMBER	DESCRIPTION
120	03-G-0001A	STEAM TURBINE GENERATOR
HEAT EXCHANGERS		
REF	TAG NUMBER	DESCRIPTION
130	70-E-1101	CO2 COMPRESSOR 1ST STAGE INTERCOOLER
131	70-E-1102	CO2 COMPRESSOR 2ND STAGE INTERCOOLER
132	70-E-1103	CO2 COMPRESSOR 3RD STAGE INTERCOOLER
133	70-E-1104	CO2 COMPRESSOR 4TH STAGE INTERCOOLER
134	70-E-1105	CO2 COMPRESSOR 5TH STAGE INTERCOOLER
135	70-E-1106	CO2 COMPRESSOR 6TH STAGE INTERCOOLER
137	70-E-1108	CO2 COMPRESSOR AFTER COOLER
138	70-E-1109	RECYCLE COOLER
139	70-E-1110	FINAL CO2 COOLER
140	70-E-2110	FINAL CO2 COOLER
141	70-E-1001	DCC WATER COOLER
142	70-E-1002	WASH WATER COOLER
143	70-E-1003A	LEAN/RICH EXCHANGER
144	70-E-1003B	LEAN/RICH EXCHANGER
145	70-E-1003C	LEAN/RICH EXCHANGER
146	70-E-1003D	LEAN/RICH EXCHANGER
147	70-E-1003E	LEAN/RICH EXCHANGER
148	70-E-1003F	LEAN/RICH EXCHANGER
149	70-E-1004A	CO2 STRIPPER REBOILER
150	70-E-1004B	CO2 STRIPPER REBOILER
151	70-E-1004C	CO2 STRIPPER REBOILER
152	70-E-1004D	CO2 STRIPPER REBOILER
153	70-E-1005	CO2 STRIPPER CONDENSER
154	70-E-1006	LEAN SOLVENT COOLER
155	70-E-0001	THERMAL RECLAIMER PREHEATER
156	70-E-0002	THERMAL RECLAIMER REBOILER
157	70-E-0003	THERMAL RECLAIMER CONDENSER
158	70-E-1111	REGENERATION AIR COOLER
159	70-E-1112	REGENERATION HEATER
TOWERS		
REF	TAG NUMBER	DESCRIPTION
170	70-T-1001	DIRECT CONTACT COOLER
171	70-T-1002	CO2 ABSORBER
172	70-T-1003	CO2 STRIPPER
173	70-T-0001	THERMAL RECLAIMER COLUMN
STACKS		
REF	TAG NUMBER	DESCRIPTION
180	70-SK-0101	CO2 VENT STACK
FILTERS		
REF	TAG NUMBER	DESCRIPTION
190	70-F-1001	DCC MECHANICAL FILTER
191	70-F-1002	SOLVENT MECHANICAL FILTER
192	70-F-1003	CARBON BED FILTER
193	70-F-1004	CARBON BED AFTER FILTER
194	70-F-1005	SOLVENT RETURN FILTER
195	70-F-2101	DCC EFFLUENT FILTER
196	70-F-0001	TRU SOLVENT RETURN FILTER
197	70-F-1101A	REGENERATION FILTER
198	70-F-1101B	REGENERATION FILTER
199	70-F-1102A	DRY CO2 FILTER
200	70-F-1102B	DRY CO2 FILTER

PACKAGES		
REF	TAG NUMBER	DESCRIPTION
210	14-C-0001A	IA COMPRESSOR
211	14-C-0001B	IA COMPRESSOR
212	14-DR-0001A	IA DRYER
213	14-DR-0001B	IA DRYER
214	70-PK-1001	ANTI-FOAM DOSING
215	70-PK-0001	THERMAL RECLAIMER VACUUM PACKAGE
216	70-PK-0004	DAMPER SEAL AIR PACKAGE
217	70-PK-0105	REFRIGERATION PACKAGE
218	70-PK-0106	CO2 (FISCAL) METERING PACKAGE
219	70-PK-1111	HYDROGEN GENERATION PACKAGE
MICELLANEOUS		
REF	TAG NUMBER	DESCRIPTION
260	1B-X-0001	OILY WATER SEPARATOR
261	1B-X-0002	HIGH EFFICIENCY OILY WATER SEPARATOR
262	03-CR-0001	OVERHEAD CRANE
263	70-CR-1003	OVERHEAD CRANE
264	70-CR-1101	OVERHEAD CRANE
STEAM TURBINE COOLING EQUIPMENT - HOLD 26		
REF	TAG NUMBER	DESCRIPTION
280	03-D-0001	STG COOLING WATER EXPANSION DRUM
281	03-E-0001	STG COOLING WATER AIR COOLER
282	03-P-0001A	STG COOLING WATER PUMP
283	03-P-0001B	STG COOLING WATER PUMP

BUILDINGS

REF	TAG NO.	BUILDING NAME	ARCHITECTURAL DRG. NO.
300	30-BD-0001	EXISTING CONTROL BUILDING	415000-00201-8330-47-0015
301	30-BD-0701	SUBSTATION 04	415000-00201-8330-47-0003
302	30-BD-0702	SUBSTATION 05	415000-00201-8330-47-0003
303	30-BD-0703	SUBSTATION 06	415000-00201-8330-47-0003
304	30-BD-0704	SUBSTATION 07	415000-00201-8330-47-0003
305	30-BD-0705	FIELD INSTRUMENT ROOM 1	415000-00201-8330-47-0001
306	30-BD-0706	FIELD INSTRUMENT ROOM 2	415000-00201-8330-47-0001
307	30-BD-0707	FIELD INSTRUMENT ROOM 3	415000-00201-8330-47-0001
308	30-BD-0708	FIELD INSTRUMENT ROOM 4	415000-00201-8330-47-0001
309	30-BD-1709	TRAIN 1 CO2 COMPRESSOR HOUSE	415000-00201-8330-47-0005
310	30-BD-2710	TRAIN 2 CO2 COMPRESSOR HOUSE	415000-00201-8330-47-0005
311	30-BD-1711	TRAIN 1 MVR COMPRESSOR HOUSE	415000-00201-8330-47-0006
312	30-BD-2712	TRAIN 2 MVR COMPRESSOR HOUSE	415000-00201-8330-47-0006
313	30-BD-0713	INSTRUMENT AIR COMPRESSOR SHELTER	N/A
314	30-BD-1714	ANALYSER HOUSE 1A	415000-00201-8330-47-0002
315	30-BD-1715	ANALYSER HOUSE 2	415000-00201-8330-47-0002
316	30-BD-2716	ANALYSER HOUSE 3	415000-00201-8330-47-0002
317	30-BD-2717	ANALYSER HOUSE 1B	415000-00201-8330-47-0002
318	30-BD-1718	CEMS HOUSE 1	BY VENDOR
319	30-BD-2719	CEMS HOUSE 2	BY VENDOR
320	30-BD-0720	FISCAL METERING ANALYSER HOUSE	BY VENDOR
321	30-BD-0721	STG ACOUSTIC ENCLOSURE	BY VENDOR

KEY PLAN



REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER
D	30/01/23	ISSUED FOR INFORMATION	NG		RRK	AG	NG	
C	24/11/22	ISSUED FOR REVIEW	NG		RRK	AC	AG	
B	21/10/22	ISSUED FOR REVIEW	NG		RRK	AC	AG	
A	20/07/22	ISSUED FOR DISCIPLINE CHECK	RAS	RAS	RRK	RRK	NG	

REF DRAWING No	REFERENCE DRAWING TITLE
415000-00201-8100-EL-0001	EQUIPMENT LIST
415000-00201-8820-RP-0002	BUILDINGS LIST
415000-00201-8230-01-0003	TIE-IN LOCATION PLAN
415000-00201-8230-01-0002	HZ-VPI-I PCC PROJECT - PLOT PLAN
145646-CSTA-G1000	GENERAL ARRANGEMENT - SITE OVERALL SITE PLOT PLAN
145646-3BSA-M1005	PLANT ARRANGEMENT INDEX DRAWING
9140-8230-02-0002	IMMINGHAM CHP PROJECT KEY PLAN PLOT PLANS
2180-8310-40-001	VPII CARBON CAPTURE PLANT TOPOGRAPHICAL SURVEY LAYOUT

A0 SHT SCALE: 1:1000

Worley energy|chemicals|resources

WORLEY PROJECT No. 415000-00201

ENGINEERING AND PERMIT STAMPS (As Required)

CUSTOMER: HUMBERZERO; VPIImmingham

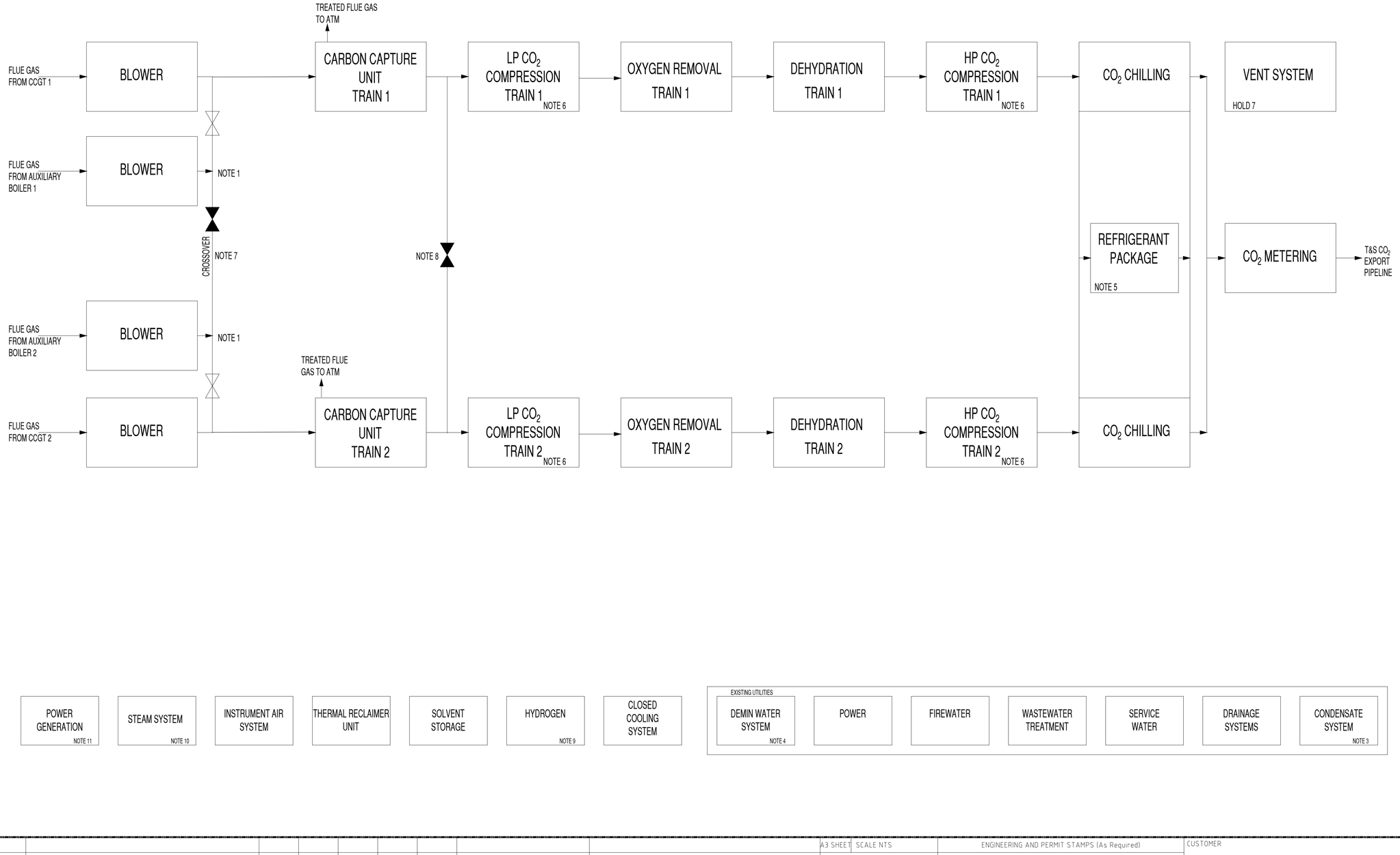
DRG TITLE: HZ-VPI-I PCC PROJECT SITE PLAN

DRG No: 415000-00201-8230-01-0001

REV: D

Worley_A0

Annex D
PCC Process



NOTES:-

1. AUXILIARY BOILER FLUE GAS DUCTING CO-MINGLING LOCATION SHALL BE DOWNSTREAM OF A BLOWER LOCATED WITHIN THE CCU TRAIN.
2. DELETED
3. RETURN MP AND LP STEAM CONDENSATE TO VPI-I CHP VIA UTILITY SYSTEM .
4. DEMIN WATER REQUIRED FOR INITIAL FILL AND THEREAFTER INTERMITTENTLY FOR FRESH SOLVENT DILUTION.
5. REFRIGERANT PACKAGE DETAILS TO BE CONFIRMED. REFRIGERANT IS REQUIRED TO COOL THE CO_2 TO 25°C.
6. LP AND HP STAGES ARE COMBINED IN ONE COMPRESSOR THERE WILL BE ONE COMPRESSOR PER TRAIN.
7. CROSSOVER LINE TO ENABLE FLUE GAS FROM AUXILIARY BOILER TO BE ROUTED TO EITHER TRAIN 1 OR TRAIN 2 (MANUAL ON/OFF SELECTION).
8. CROSSOVER LINE TO ENABLE CO_2 TO BE ROUTED TO EITHER LP COMPRESSOR TRAIN (MANUAL ON/OFF SELECTION).
9. HYDROGEN IS SUPPLIED TO REACT WITH OXYGEN IN THE OXYGEN REMOVAL REACTOR. IT IS INJECTED UPSTREAM OF THE 4TH STAGE OF THE LP COMPRESSOR TO FACILITATE MIXING.
10. STEAM DISTRIBUTED AS MP AND LP STEAM.
11. NEW STEAM TURBINE GENERATOR
12. DELETED

HOLDS:-

1. (DELETED)
2. (DELETED)
3. (DELETED)
4. (DELETED)
5. (DELETED).
6. (DELETED)
7. CO_2 VENT TO STACK LOCATIONS TO BE IDENTIFIED.
8. (DELETED)
9. (DELETED)
10. (DELETED)
11. (DELETED)

INFORMATION ONLY

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	REF DRAWING No	REFERENCE DRAWING TITLE
					pp				
0	10/05/22	ISSUED FOR DESIGN	AG	MW		SR	CV		
B	18/03/22	ISSUED FOR REVIEW	AG	MW		SR	CV		
A	25/02/22	ISSUED FOR SQUAD CHECK	MW			SR	CV		

A3 SHEET SCALE NTS

WORLEY PROJECT No. 415000-00201

ENGINEERING AND PERMIT STAMPS (As Required)

Worley energy | chemicals | resources

CUSTOMER

VPI Immingham

HUMBERZERO

"This drawing is prepared solely for the use of the contractual customer of Worley and Worley assumes no liability to any other party for any representations contained in this drawing."

DRG TITLE

HZ VPI-I PCC PROJECT FEED
BLOCK FLOW DIAGRAM

DRG No 415000-00201-8100-20-0001

REV 0

Worley_A1

B2.8 Noise

The Immingham CHP plant is to be located adjacent to HOR. The noise radiated from the Project will naturally form an addition to that radiated from HOR. The prediction and assessment of environmental noise from the Project has therefore been considered in this regard, and use made of an acoustic model of HOR. This was developed as part of an Environmental Noise Management (ENM) system for the specific purpose of managing and assessing the noise implications of new developments associated with HOR. The acoustic model was developed in 1998, and correlated with ambient noise levels measured at that time. There have been no significant changes to noise sources on HOR since then, and the basic model is still considered valid.

There are no sources of vibration associated with the Project which are likely to have any significant environmental effects.

The following sections describe:

- the main sources of continuous noise associated with the Project;
- infrequent sources of noise;
- the nearest noise sensitive locations to the Project site, and the existing noise environment;
- details of noise modelling;
- environmental noise criteria;
- assessment of noise levels;
- BAT for noise emission.

B2.8.1 Main noise sources

The principal sources of continuous noise during normal operation of the CHP plant, in approximate order of significance with respect to resultant environmental noise levels are:

- cooling towers;
- HRSGs;
- gas turbines;
- exhaust stacks;
- electrical generators;
- gas supply system;
- water feed pumps;

- air inlets to the gas turbines;
- cooling water pumps;
- steam turbines and condensers;
- transformers;
- ducting.

The noise from these sources will be continuous and they will usually operate 24 hours per day. The sources listed above are mainly broad band in character and unlikely to have any dominant tonal characteristics. Where such characteristics might exist (eg from the transformers), these will be of a low level at the nearest noise sensitive locations and not be audible due to masking from the other noise.

B2.8.2 Infrequent sources of noise

There are several possible sources of higher intermittent noise. These are as follows:

Gas turbine trip: This would involve venting of natural gas but this will be a very infrequent event.

Steam turbine by-pass and steam turbine start-up: This could be fairly frequent, sometimes even twice per day. As a consequence noise levels will be controlled to ensure acceptable levels are not exceeded.

HRSG safety valves: These will be lifted routinely every three years at turnaround/maintenance. These could also lift if steam demand from the refinery changed quickly outside normal parameters.

Gas reception compound: Gas venting could occur in an emergency shut-down situation.

B2.8.3 Noise sensitive sites

Noise sensitive locations are usually taken to be the nearest residential properties to a development, or other facilities such as hospitals and schools if there are any in the vicinity. In the case of the proposed Project, the nearest residential is Hazeldene on Marsh Lane, which runs perpendicular to Rosper Road. This is approximately 670 m from the centre of the proposed site and 520 m to the nearest part of the site. There are other more distant properties close to the River Humber. These include a converted lighthouse (distance approximately 1.8 km) and a property in Station Road (distance approximately 1.4 km). It is understood that all these properties are located within an area designated for future industrial development. However, whilst they continue to be occupied, they have been considered potentially noise sensitive for the purposes of this assessment.

The nearest residential property in a southerly direction is East End Farm (distance approximately 1.4 km). There are greater densities of population further away. These include Immingham to the south-east (distance approximately 2.2 km), South Killingholme to the south-west (distance approximately 1.5 km), North

Killingholme to the west (distance approximately 1.9 km) and the extended village of East Halton to the north-west (distance over 2.5 km).

The OS co-ordinates of the three nearest properties are:

Hazeldene:	517325 E	417310 N
East End Farm:	516340 E	415660 N

B2.8.4 Existing noise environment

The existing noise environment at the nearest residential properties is affected by several different types of noise sources. These include the noise from traffic using Rosper Road, railway noise, and noise from HOR and LOR. The proposed CHP plant will operate 24 hours per day, and it is the night-time situation which is normally the most sensitive for a continuously operating industrial plant. At night, the ambient noise level is dominated by noise from HOR and LOR.

In 1998, Conoco commissioned a study to develop an environmental noise model of the refinery. This consisted of detailed measurements of the noise source strengths of individual plant items on the refinery, prediction of noise levels to specified community locations, measurements of night-time community noise levels under downwind conditions from the refinery, and refinement of the sound propagation model to give best fit between the measured and predicted community noise levels. Because of the proximity of LOR to HOR, the former was added into the Conoco model as an additional source. The model is part of an Environmental Noise Management (ENM) system for HOR. Two of the community locations used in the refinery noise study were Myrtle Villas and East End Farm. The predicted noise levels and measured L_{A90} and L_{Aeq} levels at these locations, both for light downwind conditions, are shown in Table B2.9.1 (to the nearest dB). Also shown are the predicted and measured noise levels for Hazeldene for similar downwind meteorological conditions.

The L_{A90} is the A-weighted sound pressure level that is exceeded for 90 per cent of the measurement time, and in the UK this is normally taken to be a measure of the background noise level. (The term A-weighting implies a measurement taken with a standardized filter which approximates to the human response to noise at different frequencies of sound). The L_{Aeq} is the equivalent continuous sound pressure level and is the energy-averaged value of the time varying noise level. Where the noise level is very steady (as is the case at night when HOR dominates the noise environment) then the different noise indices numerically become very close, as can be seen from Table B2.9.1.

TABLE B2.8.1
EXISTING DOWNWIND NOISE LEVELS AT NEARBY RESIDENTIAL LOCATIONS

Location	HOR noise model prediction dB(A)	Measured noise levels	
		dB $L_{A90, 5m}$	dB $L_{Aeq, 5m}$

East End Farm	53	53	54
Hazeldene	50	51	53

It can be seen from this table that the HOR noise model correlates well with the measured overall A-weighted sound pressure levels for East End Farm, and just slightly under-predicts for Hazeldene. The A-weighted sound pressure level results are derived from octave band sound pressure level values. These also correlate well with measured environmental noise levels (typically within ± 2 dB between 31.5 Hz and 2 kHz for East End Farm).

The HOR noise model octave band sound pressure levels at East End Farm and Hazeldene (in dB L_{eq}), are shown in Table B2.9.2:

TABLE B2.8.2
EXISTING OCTAVE BAND SOUND PRESSURE LEVELS AT NEARBY RESIDENTIAL LOCATIONS

Location	Octave band centre frequency, Hz							
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**
East End Farm	69	66	57	52	51	49	43	29
Hazeldene	67	64	55	48	47	46	37	18

The HOR noise model has been used to generate noise contours outside the boundaries of the refinery. These are shown in Figure 2.9.1 for the existing situation. These represent noise levels for night-time downwind conditions from HOR in all directions, and thus do not represent the noise levels which might be observed simultaneously at all locations around HOR on any single night. In this situation, the distribution of noise levels would be skewed, with resultant noise levels upwind of the refinery typically being some 10-15 dB(A) less than shown in Figure 2.9.1. However, in this situation, upwind noise levels from the proposed project would also be less. Therefore, from the point of view of the environmental noise impact assessment of the proposed project, it is reasonable to consider only the downwind directions from the site to the nearest residential properties.

The HOR noise model makes no allowance for any other industrial development in the area (with the exception of LOR) or for any other sources of noise, which may become significant at distant locations from the refinery.

B2.8.5 Noise model of proposed Project

To predict the environmental noise contribution from the proposed plant under normal operating conditions, use has been made of the HOR ENM system noise model. The basic data used in this model are octave band sound power levels of the individual noise sources and a three dimensional co-ordinate system based on the layout given in Figure 1.3. The majority of the sound power levels for the proposed CHP plant have been based on noise measurements at another power station where Siemens V94.3A gas turbines are installed and data from suppliers of similar plant. In addition, hydrogen cooled generator sets have been assumed and radiated noise levels from all gas turbines and generator sets limited to 80 dB(A) at 1 m through the appropriate use of acoustic enclosures and silencing measures. For the cooling towers, noise information has been obtained from a cooling tower supplier. The sound power levels used are summarized in Appendix E for reference.

The sound attenuation model is based on the calculation procedures given in EEMUA publication 140 with specific Conoco site calibration factors to improve correlation between measurement and prediction. The attenuation model is for light downwind sound propagation conditions. The propagation model takes into account:

- distance between the source and the receiver;
- in-plant screening;
- ground effects;
- sound absorption by the atmosphere.

Noise sources are entered into the model as octave band sound power levels at defined x, y and z co-ordinates. The model calculates the resultant octave band sound pressure levels at one or more defined receiver locations for each individual source, taking into account the frequency-dependent sound attenuation factors between source and receiver. For example, sound absorption by the atmosphere is predominantly a high frequency phenomenon, whereas increased attenuation due to ground effects is more prevalent in the mid frequency region of the acoustic spectrum and is also source height dependent.

Consideration has also been given to the requirements of the Noise at Work Regulations SI 1989/1790 as amended by SI 1992/2996 and SI 1996/341 to limit noise levels in work areas to reduce the risk of hearing damage. The model does not include noise emission from the auxiliary boilers. These will only run when the main gas turbines are not operating, and they will, in any case, have a significantly lower noise emission than the rest of the plant. The model also does not allow for any steam venting, which may intermittently occur, or for higher noise levels which may occur during plant start-up or shut-down.

Calculations have been performed for three residential locations viz: Hazeldene to the east of the CHP plant and East End Farm to the south of the CHP plant. The model has been used to simulate three different options for equipment and noise control treatment. These are as follows:

Case 1: Base case; consisting of high performance acoustic enclosures on gas turbines (local sound pressure levels typically 80 dB(A)), heat conservation/acoustic lagging on exhaust ductwork, generator sets not exceeding a sound pressure level of 80 dB(A) locally to the sets, gas turbine exhaust silencers, gas turbine intake silencers, thermal/acoustic lagging on steam turbines, standard acoustic lagging on exposed pipework, pipework lagging and low noise valve (or valve enclosure) on fuel gas skid, standard hybrid cooling tower design.

Case 2: As Case 1, but also assuming low noise cooling tower design utilizing oversized low speed high efficiency fans and water splash control, high performance acoustic lagging on noisy pipework and low noise pumps and motor sets.

Case 3: As Case 2, but also assuming fully ventilated buildings to enclose the two gas turbine and two steam turbine sets. Combustion air for the gas turbines would be ducted from outside although no benefit has been assumed for any potential acoustic shielding of the gas turbine air intakes by the turbine hall.

The results of the calculations at the three locations considered are given in Table B2.9.3 to the nearest dB, in terms of the overall A-weighted L_{eq} sound pressure level from the proposed CHP plant.

Table B2.8.3
PREDICTED NOISE LEVELS AT NEARBY RESIDENTIAL LOCATIONS DUE TO PROPOSED PROJECT

Noise Control Option	Predicted L_{Aeq} from proposed Project		
		Hazeldene	East End Farm
Case 1		49	38
Case 2		47	36
Case 3		45	35

In the terminology of British Standard BS 4142 “Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Users” these levels represent the “rating level” for the project for normal operating conditions in a downwind direction from the site. (The use of the term “rating level” assumes that the noise from the proposed Project will be without any distinguishable characteristics such as tonal or impulsive noise). The calculated differences between the rating levels of the proposed Project and the existing noise levels are given in Table B2.9.4 (shown to the nearest 0.1 dB for comparison purposes). This table also gives the changes in the existing noise levels that will occur as a consequence of the CHP plant, for downwind conditions.

TABLE B2.8.4
PREDICTED EXCESS OF RATING LEVEL OVER BACKGROUND LEVEL AT NEAREST RESIDENTIAL LOCATIONS AND INCREASE IN EXISTING NOISE LEVELS DUE TO PROPOSED PROJECT

Noise control option			Hazeldene		East End Farm	
			Excess of rating level	Increase on existing level	Excess of rating level	Increase on existing level
Case 1			0 dB	2.9 dB	-15 dB	0.1 dB
Case 2			-3 dB	1.8 dB	-17 dB	0.1 dB
Case 3			-5 dB	1.3 dB	-18 dB	0.1 dB

The predicted octave band sound pressure levels for Cases 1, 2 and 3 are shown in Table B2.9.5, and compared with the existing octave band sound pressure levels.

TABLE B2.8.5
PREDICTED L_{eq} OCTAVE BAND SOUND PRESSURE LEVELS AT NEARBY RESIDENTIAL LOCATIONS DUE TO PROPOSED CHP PLANT AND COMPARISON WITH EXISTING DOWNWIND LEVELS

Location	Octave band centre frequency, Hz							
	31.5	63	125	250	500	1k	2k	4k
Hazeldene								
Predicted Project noise, Case 1	60	61	59	48	46	45	37	30
Predicted Project noise, Case 2	58	59	58	45	42	42	34	26
Predicted Project noise, Case 3	58	57	56	43	40	40	32	24
Existing noise levels	**67**	**64**	**55**	**48**	**47**	**46**	**37**	**18**
East End Farm								
Predicted Project noise, Case 1	54	55	50	36	35	33	21	5
Predicted Project noise, Case 2	52	53	49	34	31	29	17	-1
Predicted Project noise, Case 3	52	51	48	32	29	28	15	-1
Existing noise levels	**69**	**66**	**57**	**52**	**51**	**49**	**43**	**29**

The predicted environmental noise contours around HOR, with the Project operational, are shown for illustrative purposes in Figure 2.9.2 (Case 1 noise control), Figure 2.9.3 (Case 2 noise control) and Figure 2.9.4 (Case 3 noise control). These contours also include the environmental noise effect of removing the existing steam raising boilers and the older power generation plant on HOR, all of which would cease to be operational following successful commissioning of the proposed plant. These items are located to the west of HOR, and their removal therefore has little impact in an easterly direction, towards Rosper Road.

The most frequent source of intermittent noise is likely to be at the start-up or shut-down of a steam turbine, when steam will by-pass the turbine and be let down through a control valve into one of the condensers. Relatively high noise levels will be generated locally to the let-down valve, downstream pipework and condenser. Based on measurements at another power station, it has been assessed that with suitable noise control treatment, overall community noise levels from the Project will increase by some 2 dB(A) for Case 2 noise control treatment, during by-pass of the steam turbine.

B2.8.6 Environmental noise criteria

In the formulation of policies on planning developments which have issues relating to noise, local Planning Authorities are advised by the Department of the Environment in Planning Policy Guidance PPG 24 “Planning and Noise”. The aim of this guidance is to provide advice on how the planning system can be used to minimize the adverse impact of noise without placing unreasonable restrictions on developments or adding unduly to the costs and administrative burdens of business. It includes some of the main considerations that should be taken into account when determining planning applications for development, which will generate noise. In the case of industrial development, PPG 24 confirms that the character of the noise should be taken into account, as well as its levels, and sudden impulses, irregular noise or noise which contains a distinguishable continuous tone will require special attention.

The policy document cites the use of British Standard BS 4142 1990 “Method for rating industrial noise affecting mixed residential and industrial areas” for assessing the noise from proposed industrial and commercial premises. This standard has since been amended and the current version is dated 1997. The prime purpose of this standard is to determine the likelihood of complaints about noise from industrial and commercial installations. It compares the ‘rating level’ of the industrial source (equivalent continuous level of the industrial activity, corrected for character where appropriate) with the pre-existing background noise level, expressed as L_{A90} dB. Both the rating level and the background noise level refer to the external noise climate in the vicinity of the sensitive area. PPG 24 quotes the standard as stating that a difference of around 10 dB or higher indicates that complaints are likely and that a difference of around 5 dB is of marginal significance. The standard itself states that if the rating level is more than 10 dB below the measured background noise level then this is a positive indication that complaints are unlikely.

Unfortunately, no absolute guidance is given in PPG 24 as to what is a reasonable limit to set for new industrial development potentially affecting sensitive areas. However, PPG 24 is intended to build on the principles established in Circular 10/73 “Planning and Noise”. This stated that where, by the standards established in BS 4142, the noise from the proposed development is “likely to give rise to complaints” it will hardly ever be right to give permission. In practice most planning authorities set a more stringent standard than this, sometimes based on the ‘marginal significance’ category, or on

allowing the noise from the proposed development to equal the pre-existing background noise level. The latter would cause the background noise level to increase by approximately 3 dB, an amount that is considered to be just detectable. For there to be no increase on background noise levels then noise from the new development would need to be some 15 dB less than the existing background noise level.

PPG 24 also makes reference to British Standard BS 8233 1987 "Code of Practice for Sound Insulation and Noise Reduction for Buildings" which gives general guidance on acceptable noise levels within buildings. In sleeping areas, the recommended maximum intrusive noise levels are 30-40 dB $L_{Aeq,T}$. This equates to an external noise level of 40-50 dB $L_{Aeq,T}$ with windows open and 45-55 dB $L_{Aeq,T}$ with windows partially open. If the noise of concern contains distinctive characteristics, then these levels may need to be lower. This standard was revised in August 1999. The standard now states that 35 dB L_{Aeq} in bedrooms represents a reasonable noise environment due to external sources.

Similar, although slightly more stringent advice is given by the World Health Organisation in a 1999 report by a WHO expert task force, entitled "Guidelines for Community Noise". This states that to avoid negative effects on sleep, the equivalent continuous sound pressure level during the sleeping period should not exceed 30 dB L_{Aeq} indoors for continuous noise indoors. If the noise is not continuous, sleep disturbance correlates best with maximum noise levels and effects have been observed at 45 dB L_{Amax} or less (indoors). It goes on to recommend that at night-time, noise levels outside of dwellings should not exceed 45 dB L_{Aeq} so that people may sleep with bedroom windows partially open. It should be noted that existing night-time noise levels at residential properties in the vicinity of HOR are already higher than this. The WHO report has not been adopted into UK legislation or formal guidance, hence it remains a source of information reflecting a high level of health care with respect to noise, rather than a standard to be rigidly applied.

With respect to the potential noise impact of the Project on other commercial or industrial properties, there are currently no developments of this type closer to the site for the proposed CHP plant than Myrtle Villas, the nearest residential property to the site. Therefore it is not anticipated that there will be any significant noise impact from the proposed Project on existing industrial or commercial developments. Similarly, it is not anticipated that any future industrial development built adjacent to the Project site would be noise sensitive. It is possible that any future industrial development may incorporate ancillary office accommodation. The main effect of relatively high external noise levels would be the potential interference with speech communication. However, any potential problems of this nature can usually be overcome by appropriate building design, in the same way that the offices for the Project would be designed, taking into account the external noise environment. BS 8233:1987 recommends 40 to 45 dB L_{Aeq} as the maximum intrusive noise levels in private offices and small conference rooms, and 45 to 50 dB L_{Aeq} in large offices. Slightly more stringent limits are suggested for executive offices in the latest version of BS 8233.

B2.8.7 Assessment of noise levels

The Project site is relatively close to an isolated residential propertie, viz Hazeldene. This property islocated in an area that is designated for industrial development. However, if the property continues to be occupied for residential purposes within the period when the proposed CHP plant will be built and operated, then any changes in existing ambient noise levels at these locations should be within acceptable guidelines and should not give rise to any significant loss of amenity.

Three cases of noise control have been considered. Within the bounds of accuracy at this stage of the project, the base case predicts a noise level from the Project, at Myrtle Villas, which is slightly greater than the

existing background noise level. Assuming that distinctive characteristics to the noise are controlled, this gives rise to an excess of rating over background level of just under 2 dB, and an increase in the background noise level of just under 4 dB(A). According to BS 4142, this is less than of marginal significance with regard to the expectation of complaints. The increase would, however, be expected to be discernible.

By utilizing a low noise design for the cooling towers, and by ensuring acoustic lagging is of a high performance and that low noise pump motor sets are purchased, the overall noise from the Project can be reduced by just over 3 dB(A), which results in a rating level from the Project some 2 dB less than the pre-existing background levels. The increase in background noise level at will then be just over 2 dB(A). In both these cases, there will be no measurable increase in background noise levels at East End Farm, which is the nearest residential property not within the designated industrial zone. The excess of rating over background levels here are -15 dB for Case 1 and -17 dB for Case 2 noise control. At Hazeldene, the Case 2 noise control option results in an increase in the background level of just under 2 dB(A), an amount which is unlikely to be discernible, as long as the noise is without distinctive characteristic.

To obtain any significant further noise reduction requires the gas turbine and steam turbine generator sets to be located within a purpose designed turbine hall. It has been estimated that a fully ventilated turbine building would reduce overall noise levels by a further 1.4 dB(A), resulting in an excess of rating over background level of -3 dB. This would result in an increase in background noise level of just under 2 dB at this residential location, an improvement of only 0.5 dB on the previous case considered. The turbine building would not benefit the noise environment at any other residential properties outside the designated industrial zone. The advantages of providing a turbine building are, therefore, marginal in view of the designation for future industrial development of the area to the east of the site.

The frequency characteristics of the predicted noise from the CHP plant generally follow the existing background noise frequency spectrum, with a slight deviation in the 125 Hz octave band. This is due to the sound power level estimate included in the model for the gas turbine exhaust noise from the stacks and from the estimated noise levels from the alternator sets. Extra care may be necessary during the design to ensure that this frequency characteristic does not become a dominant feature of the new CHP plant.

The predicted noise level from the proposed Project for Case 1 causes the total noise level (for downwind propagation conditions) to just exceed 55 dB(A) at Myrtle Cottages. For Case 2, the total noise level will be 54 dB(A). Allowing for an attenuation of 15 dB from outside to inside with partially open windows, the internal level for Case 2 would therefore be just less than the BS 8233 (PPG 24 cited version) recommended maximum limit of 40 dB L_{Aeq} in bedrooms. To achieve the revised BS 8223 “reasonable” grade within any bedrooms of Myrtle Cottages which face towards the refinery, then windows to the bedrooms would need to be kept shut even for the existing noise environment. An increase of 2 dB(A) due to noise from the CHP plant would not materially change this situation (Case 2).

At Hazeldene, the predicted total noise level with the power station operational is less than 55 dB(A) for the downwind base case condition. The recommended maximum bedroom noise levels (BS 8233) can still be achieved here with windows partially open. For the Case 2 noise control option, resultant internal noise levels will be some 36 dB(A) (assuming 15 dB(A) for partially open windows).

These predictions and assessment do not take into account the effect of the proposed screening bund parallel to Rosper Road. . It will extend from the proposed site access road to approximately 300mts South. Whilst the bund will provide an effective visual screen for the proposed Project, its benefit from an acoustical point of

view, is more limited. It will be of most benefit for calm or for upwind sound propagation conditions, together with a neutral or lapse atmospheric temperature gradient. A neutral temperature gradient will typically occur under a thick cloud layer, whilst a lapse temperature gradient will occur on a warm sunny day. Under downwind conditions and/or for an atmospheric temperature inversion (e.g. at night under a clear sky) the screen will provide very little acoustical benefit, and has therefore been excluded from the predicted noise levels.

B2.8.8 BAT for noise emission

The PPC Regulations require installations to be operated in such a way that *"all the appropriate preventative measures are taken against pollution, in particular through the application of BAT".* The IPPC General Sector Guidance (IPPC S0.01) states that the definition of pollution includes *"emissions which may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment".* It goes on to state that BAT, for noise, is therefore likely to be similar, in practice, to the requirements of the statutory nuisance legislation, which requires the use of "best practicable means" to prevent or minimize noise nuisance. In the case of noise, the Guidance states that "offence to any human senses" can normally be judged by the likelihood of complaints, but in some cases it may be possible to reduce noise emissions still further at reasonable costs, and this may exceptionally be BAT for noise emissions.

For the proposed Project, the BAT objectives for noise emission are considered to be covered by the noise attenuation measures considered for Case 2, as described in B1.1.5. These include:

- selection of low noise-generating equipment compatible with the individual plant item noise limits;
- use of low speed, high efficiency fans on the cooling towers, and the control of water splash noise;
- installation of high performance acoustic enclosures on the gas turbine generator sets with all ventilation paths adequately silenced;
- use of hydrogen cooled generators;
- installation of high performance gas turbine exhaust and air intake silencers;
- the use of acoustic cladding, in combination with heat conservation measures, on the gas turbine exhausts, steam turbines and any noisy pipework;
- the use of other acoustic enclosures, where appropriate;
- the use of silencers on steam vents in intermittent usage; and
- the erection of a screening bund along Rosper Road.

In addition, to control intermittent noise during steam turbine by-pass, the use of an in-line silencer downstream of the let-down valve prior to each condenser may need to be considered.

No specific mitigation measures are considered necessary to control ground-borne vibration, as no significant levels are anticipated at the nearest sensitive locations. Low frequency noise can cause vibration of loose fittings, windows etc. However, low frequency noise will be controlled through the use of appropriate plant selection and measures such as high performance silencers on gas turbine exhausts. There will be no significant increase in low frequency noise at the nearest noise sensitive locations due to the Project.

A formal assessment to BS 4142: 1997, for the resulting noise emission from the Project under normal operating conditions, incorporating BAT preventative measures (Case 2), is as follows (for the nearest noise sensitive development).

Predicted noise level:	L_{Aeq}	=	50 dB	
Residual noise level:	Not relevant			
Background noise level*:	$L_{A90,\ 5\ mins}$	=	52 dB	Details of instrumentation, weather conditions etc, given below
Specific noise level (night):	$L_{Aeq,\ 5\ mins}$	=	50 dB	
Acoustic feature correction:		=	0 dB	
Rating level:	(50 + 0)	=	50 dB	
Excess of rating over background level:	(50 - 52)	=	-2 dB	
Assessment:				Complaints unlikely

* *The background noise measurements were obtained on 18th December 1998 between midnight and 02:30 hours. The measurements were made in the vicinity of the previously construction at Myrtle Villas. The wind was light WSW and there was no precipitation or fog. Noise from Conoco refinery dominated the background noise environment. For the background measurements use was made of a Bruel and Kjaer Type 2260 sound level meter, serial number 1933780. The meter was field calibrated using a Bruel and Kjaer calibrator Type 4231, serial number 1934844 before and at the end of the measurements to a level of 94 dB. No significant change in calibration level was observed. The meter and calibrator had last received a verification test by the manufacturer on 19th November 1998.*

A further sound attenuation measure in the form of a fully ventilated building to encompass the two gas turbines and two steam turbines (Case 3) will only reduce the overall noise levels by 0.5 dB as compared to Case 2. This is due to the dominance of other noise sources (particularly the cooling towers and the HRSGs). In view of the likely high cost of such a building, this is not considered cost effective and is not, therefore, considered to constitute BAT.

Allowing for some tolerance in estimation, and for slightly higher noise levels during steam turbine by-pass, it is proposed that any noise condition for the proposed Project should be based on the rating level of the noise generated by the normal operation of the plant not causing the existing background noise level to be increased by more than 3 dB(A), for downwind conditions from the development site i.e. rating level equals existing background noise level. This implies a noise limit of 52 dB $L_{Aeq,\ 5\ mins}$ at Myrtle Villas (free field) for normal operating conditions. For occasional activities potentially giving rise to higher noise levels (e.g. overall plant start-up or shut-down, or non-emergency steam venting, noise levels 5 dB(A) higher than this should still be acceptable. (This represents a BS 4142 “marginal significance” situation with respect to the likelihood of

complaints). For non-emergency conditions potentially involving higher noise levels than this, written notice of the likelihood of such an event is proposed prior to the event occurring.

Noise Impact Assessment

VPI

Permit Number: EPR/BJ8022IZ) Immingham Combined Heat and Power (CHP) Power Plant

Project number: 60712174
v1

November 2023

DRAFT

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Quality information

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1. Synopsis

1.1 This Noise Impact Assessment (NIA) has been prepared by AECOM on behalf of VPI Immingham LLP (VPI) to support an Environmental Permit variation application (Permit number EPR/BJ8022IZ) for the Immingham Combined Heat and Power (CHP) Power Plant, to enable the installation of a Post-combustion Carbon Capture (PCC) plant and associated facilities.

1.2 It should be noted that the Environmental Permit variation application and consequently this NIA is being carried out prior to completion of detailed design of the PCC plant, in order to fit in with the timelines for Final Investment Decision for the project to proceed. As such, some worst-case assumptions have been applied to the assessment, which may lead to an over-prediction of the potential impacts. At the detailed design stage, opportunities to reduce the predicted specific sound levels further will be explored and VPI will continue to ensure that Best Available Techniques (BAT) is applied to the PCC plant design. Following detailed design, it is proposed that this NIA assessment be reviewed and that this is provided to the Environment Agency through a Pre-operational condition to be included in the Environmental Permit.

1.3 The NIA has been prepared following the Environment Agency's Noise and Vibration Management: Environmental Permits Guidance[1].

1.4 The focus of the NIA has been on operational sound level impacts upon the nearest residential Noise Sensitive Receptors (NSRs) to the VPI Installation. Previous noise assessments and annual environmental monitoring reports have been reviewed to determine the representative background sound level without contribution of the existing noise from the VPI Installation and the specific sound level of the current CHP operations.

1.5 The assessment comprises the following:

- Review of previous noise assessments for the Installation, and annual noise monitoring reports.
- Review of baseline surveys undertaken as part of the Environmental Impact Assessment (EIA) to support the Town and Country Planning Application (TCPA) for the Proposed Development for the VPI PCC plant.
- BS 4142 (BSI, 2019), assessment of the existing CHP operations, the proposed PCC plant, and the combined existing and proposed PCC plant.
- Proposal of options to prevent or reduce noise impact, in line with Best Available Techniques (BAT) or appropriate measures.
- A report detailing baseline sound measurements, acoustic modelling, calculations and assessment work, suitable for submission to the Environment Agency as part of the Environmental Permit Variation.

1.6 A sound propagation model has been created using the noise modelling software SoundPLAN to provide a 3D representation of the proposed PCC plant.

1.7 In accordance with BS 4142 the defined representative background sound levels at the NSRs have been compared against the predicted operational rating levels (the specific sound levels with character correction).

1.8 The assessment identifies that based on the worst-case scenario 1, the rating level would be less than 5dB(A) above the defined background sound levels, i.e. below the level at which adverse effects may occur. The resulting significance of impact in accordance with BS 4142 has been determined as either "low impact" or up to "adverse impact" before context considerations.

[1] Noise and vibration management: environmental permits - GOV.UK (www.gov.uk)

1.9 The context discussion considers the predicted specific sound levels in relation to the relevant WHO Guidance indoors[2] and outdoors and the more recent Night Noise Guidelines[3]. It is concluded that the future operation of the VPI installation with the proposed PCC plant is predicted to meet with the WHO limits externally.

1.10 Considering the BS 4142 assessment outcomes in the context of the existing sound environment, noise impacts from operation of the proposed PCC plant in combination with the existing CHP plant on the nearest NSR (a single residential property) would have a low impact.as part of their Noise Management Plan (NMP) and continue to undertake annual environmental noise monitoring.

1.11 This NIA has been used to develop an Noise Management Plan (NMP) for the VPI Installation and VPI will continue to undertake annual environmental noise monitoring.

[2] World Health Organisation (1999) *Guidelines for Community Noise.* Available online: https://www.who.int/docstore/peh/noise/Comnoise-1.pdf

[3] World Health Organisation (2009) Night Noise Guidelines for Europe. Available online: https://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

2. Introduction

Background

2.1 AECOM have been commissioned by VPI to undertake a Noise Impact Assessment (NIA) to support the Environmental Permit variation application (Permit number EPR/BJ8022IZ) for the Immingham Combined Heat and Power (CHP) Power Plant to enable the installation of a Post-combustion Carbon Capture (PCC) plant and associated facilities.

2.2 This report presents the results of the NIA and a BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' (BS 4142)[4] assessment at nearest noise sensitive receptors (NSR).

2.3 VPI intend to retrofit two trains of Post-Combustion Carbon Capture (PCC) plants treating the flue gas emitted from the Installation's existing two gas turbines and the two auxiliary boilers, to remove the carbon dioxide (CO2) for subsequent compression and storage. At full power plant load, the PCC plants could capture up to 3.3 million tonnes of CO^2 per year from the flue gases from the Installation.

2.4 The VPI PCC plants comprise part of the wider Humber Zero Project (HZP), which consists of two Proposed Developments to install PCC plants and associated facilities located at the VPI Immingham CHP Power Plant and the adjacent Phillips 66's Humber Refinery.

2.5 The Humber is the largest industrial cluster in the UK in terms of existing CO2 emissions, emitting approximately 20 million tonnes of CO2 per year. The PCC plants will remove approximately 95% of CO2 from the treated emissions from the GTs and Aux Boilers during normal operation, representing a 16% reduction in the overall emissions from the Humber industrial cluster, thereby contributing towards the UK Government's legally binding target to reach net zero by 2050.

2.6 Due to the critical project timelines, long Environment Agency (EA) permit determination periods and the need to demonstrate that a permit is in place to enable the project to reach Final Investment Decision, this Environmental Permit variation is being made before detailed project design has been completed. As such, it is recognised, that further information may need to be provided to the EA following completion of the detailed design process, in order to reflect design changes that may have occurred after this variation application has been submitted. Where possible, conservative or worst-case assumptions have been used in this variation application.

Proposed PCC Plant

2.7 VPI own and operate the gas-fired CHP Plant located on Rosper Road in Immingham, North Lincolnshire. The plant operates 24 hours per day, 7 days per week, to provide the electricity and steam that is critical to the operation of the neighbouring Humber Oil Refinery and Lindsey Oil Refinery, and also to supply electricity to the National Grid.

2.8 The proposed PCC plant will prevent the emission of up to 3.3 megatonnes per annum (Mtpa) of carbon dioxide (CO_2) via the PCC retrofit to two gas turbines (GT1 and GT2) and two auxiliary gas boilers at the VPI Installation.

2.9 The PCC plant installation will include the following components:

- Ducting to connect GT1, GT2 and the auxiliary boilers to the PCC plant area;
- two PCC plants (or 'trains'), each with associated air blower, direct contact cooler, absorber tower, stack, stripper/ regenerator, and air-cooled heat exchangers;
- a common thermal reclaimer unit;
- a CO_2 vent stack for use during start up, shut down and emergencies only;

[4] British Standards Institute (2014c) BS 4142:2014+A1:2019 – Methods for rating and assessing industrial and commercial sound

- CO_2 compression facility with associated air-cooled heat exchangers;
- oxygen removal and dehydration facilities;
- CO_2 metering and a pipeline connecting the PCC plant and compression facilities to the CO_2 gathering network interface;
- on-site electrical substations;
- caustic, solvent and other chemical offloading and storage facilities;
- utilities (including chillers, steam generator, hydrogen package and air compressors).

2.10 The facilities will be designed to operate 24 hours per day, 7 days per week, with programmed offline periods for maintenance.

Existing Site Operations

2.11 The existing CHP plant is operated under an Environmental Permit (permit number EPR/BJ8022IZ) . The CHP plant was built in 2004; the original installation comprised of the existing Combined Cycle Gas Turbines (CCGT) GT1 and GT2 and two auxiliary boilers (Aux Boiler 1 and Aux Boiler 2) (known as ICHP1). In 2009 a 285 MW gas turbine (GT3) and 200 MW heat recovery steam generator were added to the operations (known as ICHP2).

2.12 VPI investigate all noise complaints received and keep a log of complaints and any actions taken, through their existing Environmental Management System (EMS). It is found that noise from day-to-day operations on the site is well controlled and gives no cause for complaint. However, exceptional events such as those that occur during maintenance activities, or release of steam from relief valves has given rise to complaints, and appropriate retrofit remedies have been applied to control these noise sources.

2.13 Once ICHP2 became operational, VPI demonstrated compliance with Condition 6.6.1 of the Variation Notice BJ8022/NP3339LK and Improvement Conditions 9.14 and 9.15 within their Environmental Permit, which stated:

Condition 6.6.1

2.14 'The rating level of the noise generated by the normal operation of the development shall not cause existing background levels, details of which shall be agreed in writing by the Environment Agency, to be exceeded by more than 3 dB (A) when assessed in accordance with BS 4142 at the nearest residential premises, for downwind conditions from the development. Such noise shall exhibit no tonal or impulse content at the nearest residential premises in any weather conditions. The limitation on noise level specified in this Condition shall be adhered to at all times unless any change has been approved in writing by the Agency or in an emergency.'

Condition 9.14

2.15 'The Operator shall report to the Environment Agency for approval, a detailed programme for monitoring noise to demonstrate compliance with Condition 6.6.1.'

Condition 9.15

2.16 *'The Operator shall report, the findings of an assessment, to address the potential for increasing noise levels in the 125 Hz 1/3 octave band.'*

2.17 It is understood that the 'agreed existing background level' as mentioned in Improvement Condition 9,14 is 58.4 dB as stated in the environmental survey report[5] which demonstrated improvement conditions 9.14 and 9.15 have been met. A copy of the report can be found in Appendix A.

2.18 The existing Immingham CHP plant has been required to undertake regular (annual) noise monitoring at locations around the site. Noise monitoring has been undertaken on behalf of VPI since 2005 and, as result, there is now a comprehensive dataset of background and ambient sound levels at the NSR measured over a period of 18 years. These measurements have been made in a variety of wind directions and show that

[5] Bureau Veritas (2010) 3952671/2 Rev 2 Immingham Environmental Survey. (Copy found in Appendix A)

in similar conditions the background and ambient levels at each monitoring location have been fairly consistent over the monitoring period.

Scope of Assessment

2.19 The assessment comprises the following items:

- Review of previous noise assessments for ICHP 1 and ICHP2, and annual noise monitoring reports.
- Review of baseline surveys undertaken as part of the Environmental Impact Assessment (EIA) to support the Town and Country Planning Application TCPA for the proposed development of the PCC plant.
- BS 4142 assessment of the existing CHP operations, the PCC plant, and the combined existing CHP and PCC plant (i.e. Future Operation).
- Proposal of options to prevent or reduce noise impact, in line with Best Available Techniques (BAT) or appropriate measures.
- Provision of a report detailing baseline sound measurements, acoustic modelling, calculations and assessment work, suitable for submission to the Environment Agency as part of the Environmental Permit Variation.

3. Assessment Locations

3.1 The VPI Installation is located approximately 1.6 km north of Immingham town and 1.5 km west of the Humber Estuary and is located within the administrative boundary of North Lincolnshire Council (NLC), in the ward of Ferry. The Installation Site boundary are shown in Figure A1 in Appendix A.

3.2 The VPI PCC plant area comprises 28.51 hectares of land to the south of the operational VPI Immingham CHP Plant site, accessed from Rosper Road and separated from the Humber Refinery by the Network Rail railway line.

3.3 VPI is situated in a heavily industrialised area with limited residential receptors nearby. The nearest residential settlements are the villages of South Killingholme (approximately 1.5 km west of the VPI Site and beyond the Humber Refinery) and North Killingholme (approximately 1.75 km north-west of the VPI Site and beyond the Lindsey Oil Refinery).

3.4 The closest NSR is a single residential property called Hazel Dene approximately 340 m east of the VPI Site (on Marsh Lane). Three other NSRs, which are located to the west of VPI (and beyond the refinery sites) have been included in this assessment. These NSRs are shown on Figure A1 in Appendix A along with details regarding the monitoring locations.

3.5 The identified NSRs are listed in Table 3.1

Table 3.1. Identified nearest NSRs

NSR ID	Location	Approx. distance to site boundary (metres)*
NSR 1	Staple Road	1,540
NSR 2	Clarks Road	1,930
NSR 3	Church Lane	1,940
NSR 4	Hazel Dene, Marsh Lane	340

* The distance from the closest point to the VPI boundary is reported

3.6 NSR 4 (Hazel Dene) is the closest NSR to VPI and therefore is the main NSR considered in this NIA. Hazel Dene is a single residential property in an industrial area. The existing noise climate at NSR4 consists of noise from the existing VPI operations, and other similar industrial operations at the Humber Refinery and Lindsey Oil Refinery, road traffic noise, and noise from operations at the Port of Immingham. The ground between NSR 4 and VPI is mainly fields, apart from Rosper Road which runs parallel to the VPI site.

3.7 The BS 4142 assessments carried out for the Environmental Permit variation require a background sound level to be established without the contributions from the existing VPI site. The VPI CHP operates continuously 24 hours a day, 7 days a week and there is no planned shutdown of the full site within the timeframes of the Environmental Permit application. Site visits were carried out by AECOM as part of the EIA works in 2022, and an additional site visit and surveys in the area were carried out in August 2023, to try to identify a suitable proxy location which had a similar sound climate to the original NSR 4 monitoring location without the presence of sound from the existing VPI operations.

3.8 The surveyor visited several possible alternative locations to the east of VPI for monitoring the background sound but no suitable location, i.e. where the existing VPI operations were not audible, could be identified and hence no additional data could be obtained for this location. Therefore, historical noise assessments and annual monitoring reports have been reviewed to determine a representative background sound level prior to VPI commencing operations.

4. Methodology

Noise Surveys

4.1 A range of noise surveys were undertaken as part of the EIA carried out to support the TCPA for the PCC plant at locations representative of the nearest NSRs.

4.2 Sound level monitoring was undertaken to the requirements of *BS 7445-1:2003 'Description and measurement of environmental noise. Guide to quantities and procedures*' (BSI, 2003) (BS 7445), in particular regarding instrumentation and monitoring methodology. This comprised unattended measurements with observations made on set up, and collection of equipment and weather data recorded using a weather station located at NSR 2.

4.3 All measurements were taken at approximately 1.5 m above ground level, and were positioned at least 3.5 m from any acoustically reflecting surface, other than the ground (i.e. free-field measurements). Each sound level meter was set to log the $L_{AF10,15mins}$, $L_{Aeq15mins}$, $L_{AF90,mins}$ and L_{AFmax} parameters. The weather conditions during the survey periods were all within the parameters set out in the relevant guidance documents including BS 7445 (BSI, 2003) and BS 4142 (BSI, 2019).

4.4 VPI also commission annual environmental noise monitoring in the vicinity of VPI CHP plant at Immingham, the most recent surveys were undertaken by a third party on the night of 1st - 2nd June 2023. Attended noise measurements were taken at a single receptor location (Hazel Dene, NSR 4) in 5-minute samples. The measurements covered the period from 23:00 to 04:00. The sound level meter was pole-mounted at a representative height of 1.5 metres above ground level. The annual environmental monitoring report stated "*The plant is understood to have been running at normal operational output during the survey period. No Flaring was planned during the survey. The control room was contacted at the start of the survey and again on completion. We were advised that the average power output during the survey was 310 MW and the maximum output was 345 MW.*"

Operational Noise Prediction and Assessment

4.5 The assessment of operational sound levels has been based upon calculations taking account of plant proposed for the PCC plant and equipment sound power levels *(L_w)* relating to the proposed plant, distance between the proposed plant and NSRs and the acoustic screening offered by existing topography and existing and proposed new buildings. The proposed plant sound power levels and the assumptions applied to the prediction methodology are detailed in Appendix B.

4.6 Three-dimensional sound propagation models have been developed using the modelling software SoundPLAN Version 8.2 to assess the current layout options for the PCC plants. SoundPLAN implements the prediction method *ISO 9613-2:1996 'Attenuation of sound during propagation outdoors'* (ISO, 1996), which has been employed to calculate sound levels at surrounding NSRs due to the proposed PPC plant at VPI.

4.7 Topographical features and buildings that may influence the transmission of sound from the PCC plant to NSRs are included in the model. A digital terrain model created using publicly available ground elevation spot height data has been used to position buildings and other noise sources at the proposed heights relative to ground. Areas of acoustically soft (e.g. vegetation) and hard (e.g. concrete) ground have been identified from the Ordnance Survey MasterMap Topographic Layer and modelled accordingly.

4.8 The following sources of information that define the PCC plant have been reviewed and form the basis of the assessment:

- Indicative Layout and Zoning Plan for the Proposed VPI Development as provided by VPI's design team;
- items of plant including sound power level data for Proposed VPI Development as provided by VPI's design team;
- Ordnance Survey (OS) MasterMap mapping, topographical data (LiDAR data) and aerial photography of the VPI site and surrounding area.

4.9 The prediction method assumes that the prevailing wind direction is always from source to receiver, which is likely to overestimate sound from the PCC plant for much of the time for NSRs 1. 2 and 3, given the predominant wind direction in the UK is from the south-west. NSR 4 is located to the west of the VPI site, therefore the predicted noise level is also likely to be slightly over-estimated the majority of the time. Based upon the predicted sound levels from the model, an assessment of potential impacts at nearby NSR has been undertaken using the guidance in BS 414: (BSI, 2019).

4.10 A key aspect of the BS 4142 (BSI, 2019) assessment procedure is a comparison between the '*background sound level*' in the vicinity of residential locations and the '*rating level*' of the sound source under consideration. The relevant parameters in this instance are as follows:

- *background sound level* – $L_{A90,T}$ – defined in the Standard as the "A-weighted sound pressure level that is exceeded by the residual sound for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels";
- *specific sound level* – *L*s ($L_{Aeq,Tr}$) – the "equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr"; and
- *rating level* – $L_{Ar,Tr}$ – the "specific sound level plus any adjustment made for the characteristic features of the sound".

4.11 BS 4142 (BSI, 2019) requires that a one-hour assessment period is considered during the day (07:00 to 23:00) and a 15-minute assessment period at night (23:00 to 07:00). It also allows for corrections to be applied based upon the presence or expected presence of the following at the receptor location:

- tonality: up to +6 dB penalty;
- impulsivity: up to +9 dB penalty (this can be summed with tonality penalty); and
- other sound characteristics (neither tonal nor impulsive but still distinctive): +3 dB penalty.

4.12 Once any adjustments have been made, the background sound level and the rating level are compared. The standard states that:

> *"Typically, the greater the difference, the greater the magnitude of 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 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."*

4.13 BS 4142 (BSI, 2019) requires that the rating level of the sound source under assessment be considered in the context of the environment when defining the overall significance of the impact.

5. Noise Monitoring Data, Equipment, Meteorology and Predictions

Noise Monitoring Data

5.1 As stated in Chapter 3, it was not possible to find a suitable proxy location for representative background sound levels where the existing VPI operations could not be heard, therefore historical noise assessment and annual noise monitoring reports have been reviewed.

5.2 The noise assessment [6]for the original Immingham CHP Plant (ICHP 1) states that the night-time background sound level prior to ICHP 1 being built was 52 dB $L_{A90,5mins.}$ A copy of this report is included in Appendix A

5.3 The noise assessment states:

> *"The background noise measurements were obtained on 19th December 1998 between midnight and 02:20 hours. The measurements were made in the vicinity of the previously construction at Myrtle Villas. The wind was light WSW and there was no precipitation or fog. Noise from Conoco refinery dominated the background noise environment. For the background measurements use was made of a Bruel and Kjaer Type 2260 sound level meter, serial number 1933780. The meter was field calibrated using a Bruel and Kjaer Calibrator Type 4231, serial number 1934844 before and at the end of the measurement to a level of 94 dB. No significant change in calibration was overserved. The meter and calibrator had last received a verification test by the manufacturer on 19th November 1998."**
>
> *Myrtle Villas was a residential property (which no longer exists) located near Hazel Dene (NSR 4) and is considered representative of NSR 4. Conoco refinery is now known as the Humber Refinery.

5.4 As stated in Chapter 2. it is understood that the 'agreed existing background level' as mentioned in Improvement Condition 9.14 was 58.4 dB based on ICHP background noise survey undertaken in August 2004.

5.5 For this assessment the representative background sound level of 52 dB $L_{A90,5mins}$ has been used, as this was based on measurements undertaken prior to ICHP being operational. Similar background sound levels were noted during the monitoring undertaken in April/ May 2022 as part of the EIA. A copy of the Noise and Vibration ES chapter and Baseline Survey Appendix is included in Appendix A.

5.6 Based on review of sound monitoring undertaken in April/May 2022 there was very little variation in the background sound levels during the day and night-time periods, therefore the representative background sound level is applicable to both day and night-time periods.

Existing Operational Noise Levels

5.7 Baseline noise surveys were undertaken by AECOM in April/ May 2022 as part of the EIA. The survey notes for Hazel Dene (NSR 4) state that the sound climate included sound from the VPI Immingham CHP Plant, together with other sources include bird song, distant road traffic, trains, industrial moving sounds e.g. cranes.

5.8 Attended surveys were undertaken during the night-time period of 1st - 2nd June 2023 by Bureau Veritas[7], as part of the annual environmental noise monitoring in the vicinity of VPI. A copy of this report can be found in Appendix A.

5.9 The Bureau Veritas report stated:

[6] CHP Noise Development Plan (copy found in Appendix A)
[7] Bureau Veritas (2023) 18917525/1 Rev 0 Immingham CHP Environmental Noise Survey June 2023 (copy found in Appendix A)

5.10 '*The following instrumentation (which complies with BS EN 61672-1 Class 1 accuracy) was used to conduct the noise monitoring:*

- *Rion Sound Analyser, NL-52 (Serial No. 342835) calibrated 03/06/21 (cert. no. UCRT20/1694);*
- *Rion Condenser Microphone, UC-59 (Serial No. 06356) – calibrated as above;*
- *Rion Preamplifier, NH-25 (Serial No. 42863) – calibrated as above;*
- *Rion Calibrator, NC-74 (Serial No. 34857335) calibrated 11/08/21 (cert. no. UCRT21/1980).*

5.11 The Bureau Veritas environmental noise monitoring report states "*A microphone windshield was fitted at all times. The sound level meter was pole-mounted at a representative height of 1.5 metres above ground level. The sound level meter was calibration-checked before and after the measurements. No drift in the calibration signal was noted. During the attended monitoring period the weather was mostly dry and warm with temperatures ranging from 9 to 12ºC, with humidity ranging between 82 - 93%. Cloud cover increased during the survey from 3 oktas to 8 oktas towards the end of the survey. No rain was noted during the measurement period. Wind conditions were light and measured between 3 - 5 m/s mainly in a North-East direction for the duration of the survey. There was no evidence of a temperature inversion which may have otherwise affected the environmental propagation of sound from the source to receiver. The weather conditions were therefore considered to be appropriate for the measurement of environmental noise.*

5.12 *The sound measured at Hazeldene consisted primarily of a broadband noise component from the VPI Immingham CHP site, with no tonal or regular impulse noise evident. Plant noise was the main sound source. Off-site sound sources included nearby industrial works and road traffic noise consisting of intermittent vehicle pass-bys along the A160 but this was considered low level and did not influence the noise measurements. This was further reduced due to the closure of the southbound carriageway of Rosper Road. There was occasional vegetation rustle from nearby trees during wind gusts, but this was infrequent and intermittent."*

5.13 The L_{Aeq} values were averaged logarithmically, with the average measured noise level of 50 dB L_{Aeq}. The Bureau Veritas environmental noise survey report states 'no tonal or impulsive noise was evident.' The measured noise level of 50 dB L_{Aeq} over the entire measurement period (in the absence of vehicle noise on the A160) were comparable with historic data.

5.14 The specific sound of the current operations used in this assessment is therefore 50 dB L_{Aeq}, based on the most recent noise survey, where VPI was the dominant sound source and with the absence of vehicle noise.

5.15 Based on review of sound monitoring undertaken by AECOM in April/May 2022 there was very little variation in the ambient sound levels during the day and night-time periods, and the current site operations are 24 hours a day, 7 days a week. Therefore, the specific level of 50 dB L_{Aeq}, is applicable to both day and night-time periods.

PCC Plant Operational Noise Levels

5.16 The predictions of operational sound from the PCC plant have been based on information provided by the VPI's engineering design team. This information has included sound power levels for the major sound sources and details of the acoustic performance of noise mitigation measures already embedded into the designs such as siting of equipment away from site boundaries and NSRs. During detailed design stage, where necessary, industrial sound will be mitigated further as discussed in Chapter 7.

5.17 In accordance with BS 4142:2014 (BSI 2019) the daytime assessment considers a 1-hour period, and the night-time assessment considers a 15-minute period. When in operation the sound produced by the PCC plant will be constant in nature. As the plant may operate at any time of day or night, the predicted specific sound levels will be the same for both day and night. No 'on-time' correction is applicable due to the continuous nature of the operation. The predicted free-field operational specific sound levels at the NSRs during the daytime have been predicted at the ground floor and the night-time levels have been predicted at the upper floor.

5.18 The potential for sound of a tonal, impulsive or intermittent nature will be designed out of the PCC plant during the detailed design phase by the selection of appropriate plant, building cladding, louvres and silencers/attenuators as necessary. It is considered that the PCC plant is very unlikely to present distinctive

sound at the NSRs due to the existing industrial and commercial sound climate in the area. Therefore, no character correction has been applied to the specific sound.

5.19 Although the proposed plant will operate 24 hours a day, 7 days a week, not all the plant will operate all the time as operation will depend on power demand and ambient temperatures. For example, the main source of noise is the large number of air coolers, which would only all be in operation in the highest anticipated ambient air temperatures. Therefore, the following scenarios have been modelled:

- Scenario 1: All proposed plant operating - worst case scenario;
- Scenario 2: All proposed plant operating apart from the air coolers in the northern PCC plant train and associated plant - a more typical operating scenario;
- Scenario 3: All proposed plant operating apart from the air coolers in the southern PCC plant train and associated plant - a more typical operating scenario.

5.20 The predicted free-field operational specific sound levels at the NSR around the VPI Installation are presented in Table 5.1.

Table 5.1. Predicted Operational Sound Levels

	Scenario 1		Scenario 2		Scenario 3	
Receptor	**Daytime *specific sound level* $L_{Aeq,Tr}$ dB**	**Night-time *specific sound level* $L_{Aeq,Tr}$ dB**	**Daytime *specific sound level* $L_{Aeq,Tr}$ dB**	**Night-time *specific sound level* $L_{Aeq,Tr}$ dB**	**Daytime *specific sound level* $L_{Aeq,Tr}$ dB**	**Night-time *specific sound level* $L_{Aeq,Tr}$ dB**
NSR 1	42	42	39	40	39	40
NSR 2	39	39	36	37	36	37
NSR 3	41	41	40	39	41	40
NSR 4	52	53	50	50	51	51

6. Noise Impact Assessment

6.1 The Environment Agency Noise and Vibration guidance requires the existing operations to be considered as well as the operations associated with the proposed variation – the existing and PPC plant operations are to be presented individually and then combined together to form an overall site sound level.

6.2 As previously discussed, the Environment Agency requires that the background sound levels do not include the existing operations from VPI for the BS 4142 assessment.

6.3 The representative background sound level without contribution from VPI, and the specific sound levels for the existing VPI operation and the PCC plant operation are stated in Chapter 5. The highest predicted specific sound level from the PCC plant is at NSR 4, which is the closest receptor. The existing sound climate at NSRs 1,2 and 3 are also dominated by the current operations at the Humber Refinery. Therefore, the BS 4142 assessment focuses on NSR 4.

6.4 The following tables present the BS 4142 assessment summary during the daytime and night-time for NSR 4. The predicted specific sound level is rounded to whole decibels. The assessment is based on the difference between the representative *background sound level* and the predicted *rating level,* $L_{Ar,Tr}$ dB (i.e. the *specific sound level* $L_{Aeq,\,Tr}$ plus any character correction) at the NSR. Positive values in the table indicate an excess of the *rating level* over the *background sound level*.

6.5 Table 6.1 shows the initial BS 4142 assessment for the existing VPI operation.

Table 6.1. Initial BS 4142 Assessment Existing Operations

	Existing Scenario	
Receptor NSR 4	**Daytime**	**Night-time**
Specific sound level L_s ($L_{Aeq,Tr}$), dB	50	50
Acoustic feature correction, dB	0	0
Rating level ($L_{Ar,Tr}$), dB	50	50
Representative *background sound level* ($L_{A90,T}$), dB	52	52
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	-2	-2
BS 4142:2014 impact category	Assessment indicates little likelihood of adverse impact	Assessment indicates little likelihood of adverse impact

6.6 Table 6.2 shows the initial BS 4142 assessment for the PCC plant operation.

Table 6.2. Initial BS 4142 Assessment for the PCC Plant

	Scenario 1		Scenario 2		Scenario 3	
Receptor NSR 4	**Daytime**	**Night-time**	**Daytime**	**Night-time**	**Daytime**	**Night-time**
Specific sound level L_s ($L_{Aeq,Tr}$), dB	52	53	50	50	51	51
Acoustic feature correction, dB	0	0	0	0	0	0
Rating level ($L_{Ar,Tr}$), dB	52	53	50	50	51	51
Representative *background sound level* ($L_{A90,T}$), dB	52	52	52	52	52	52

	Scenario 1		Scenario 2		Scenario 3	
Receptor NSR 4	**Daytime**	**Night-time**	**Daytime**	**Night-time**	**Daytime**	**Night-time**
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	0	1	-2	-2	-1	-1
BS 4142:2014 impact category	An indication of low impact depending on context	An indication of low impact depending on context	Assessment indicates little likelihood of adverse impact	Assessment indicates little likelihood of adverse impact	Assessment indicates little likelihood of adverse impact	Assessment indicates little likelihood of adverse impact

6.7 Table 6.3 shows the initial BS 4142 assessment for the future VPI operation (the existing installation and PPC plant combined).

Table 6.3. Initial BS 4142 Assessment for Existing and PCC Plant combined – Future Operation

	Scenario 1		Scenario 2		Scenario 3	
Receptor NSR 4	**Daytime**	**Night-time**	**Daytime**	**Night-time**	**Daytime**	**Night-time**
Specific sound level L_s ($L_{Aeq,Tr}$), dB	54	55	53	53	54	54
Acoustic feature correction, dB	0	0	0	0	0	0
Rating level ($L_{Ar,Tr}$), dB	54	55	53	53	54	54
Representative *background sound level* ($L_{A90,T}$), dB	52	52	52	52	52	52
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	2	3	1	1	2	2
BS 4142:2014 impact category	An indication of low impact depending on context	An indication of low impact depending on context	An indication of low impact depending on context	An indication of low impact depending on context	An indication of low impact depending on context	An indication of low impact depending on context

6.8 As stated in Chapter 4, the context of the area and existing sound climate should be taken into consideration when determining the overall impact. VPI are already a continuously operating industrial source in the study area, and there are other industrial/commercial activities around the site which are shown on Figure A1. This is likely to mean that residents at all NSR are already accustomed to noise from industrial sources. It is also noted that there is only a single residential receptor to the east of the VPI site (NSR 4).

6.9 A rating level excess over the background sound level of +5 dB is considered the level around which adverse effects may occur, depending upon context.

6.10 The results in Table 6.3 for the combined existing and proposed operations for both Scenario 1 (worst case) and Scenarios 2 and 3 (more typical operating scenarios) demonstrate that impacts from the future operation at the nearest NSR achieve rating levels at or lower than +3 dB above the representative background sound level, during both daytime and night-time.

6.11 For Scenario 1, a worst case with all plant operating at full capacity, which is unlikely to happen for the majority of the time, a rating level excess over the background sound level of +2 dB and +3 dB for day and night respectively is predicted. This is less than the level above which adverse impacts are likely to be indicated in accordance with BS 4142.

6.12 For Scenario 2, when only the southern train of air coolers and associated plant is operating a rating level excess over the background sound level of +1 dB for both day and night -time periods is predicted and close to the point at which there is an indication of the sound source having a low impact.

6.13 For Scenario 3, when only the northern train of air coolers and associated plant is operating a rating level excess over the background sound level of +2 dB for both day and night -time periods is predicted. This is less than the level above which adverse impacts are likely to be indicated in accordance with BS 4142.

6.14 In addition to BS 4142, World Health Organisation (WHO) Guidelines have also been considered. The WHO '*Guidelines for Community Noise'* (WHO, 1999) gives guideline values for external environmental daytime and evening noise of 55 dB $L_{Aeq,16h}$ or less over the 16-hour daytime period (07:00 to 23:00) "to avoid minimal serious annoyance", and 50d B $L_{Aeq,16h}$ "to avoid minimal moderate annoyance". The predicted daytime specific sound level for the existing and PCC plant combined at NSR 4 of 54 dB $L_{Aeq,16\text{-}hours}$ is below the guideline value for serious annoyance.

6.15 For night-time sources the WHO Guidelines gives a night-time guideline value of 30 dB $L_{Aeq,8hr}$ (23:00 to 07:00) inside bedrooms (for continuous sound) to avoid sleep disturbance.

6.16 The WHO external and internal guideline values are expected to be met at both NSRs, assuming a reduction through a façade with the windows partially open for ventilation of 15 dB.

6.17 The WHO Night Noise Guidelines (WHO, 2009) for Europe consider the long-term effect of night-time noise on the population. The requirement for health-based guidelines originated from the European Union Directive 2002/49/EC relating to the assessment and management of environmental noise (known as the Environmental Noise Directive).

6.18 The 2009 WHO Guidelines are intended to complement rather than replace the 1999 WHO Guidelines.

6.19 The 2009 WHO Guidelines assess the effect of noise during the night-time using the $L_{night,outside}$ parameter. This considers the external noise level averaged over a complete year for the 8-hour night time period. The Guidelines state:

"There is no sufficient evidence that the biological effects observed at the level below 40 dB $L_{night,outside}$ are harmful to health. However, adverse health effects are observed at the level above 40 dB $L_{night,outside}$, such as self-reported sleep disturbance, environmental insomnia, and increased use of somnifacient drugs and sedatives. Therefore, 40 dB $L_{night,outside}$ is equivalent to the lowest observed adverse effect level (LOAEL) for night noise."

6.20 The 2009 WHO Guidelines suggest a night-time noise guideline of 40 dB $L_{night,outside}$ and an interim target of 55 dB $L_{night,outside}$ in situations where the achievement of the night-time noise guideline is not feasible in the short-term. With regard to the suggested night time noise guideline of 40 dB $L_{night,outside}$ the guidance states:

"*The LOAEL of night noise, 40 dB $L_{night,outside}$, can be considered a health-based limit value of the night noise guidelines necessary to protect the public, including most of the vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise*."

6.21 Given that the operational sound emissions from the PCC plant could occur at any time of day/ night, provided that sound levels are acceptable during night-time hours, they will automatically be acceptable during daytime period when existing ambient sound levels are higher. The noise survey results used within this assessment confirm that existing night-time sound levels exceed the 40 dB $L_{night,outside}$ recommendation. When existing baseline night-time sound levels and predicted sound levels for the existing and proposed PCC plant are compared to the 55 dB $L_{night,outside}$, all are equal to or less than this value.

6.22 As stated in Chapter 2, the Environment Agency had previously accepted an 'agreed existing background level' as mentioned in Improvement Condition 9,14 of 58.4 dB $L_{A90,T}$ based on ICHP background noise survey undertaken in August 2004. If this background sound level was used in the above BS 4142 assessment, the rating level of the future operation would be less than the background level and meeting the requirements of Section 6.6.1 of Improvement condition 9.14, which required an exceedance of no more than 3 dB(A),

6.23 Therefore, overall, considering the BS 4142 assessment outcomes in the context of the existing sound environment, noise impacts from operation of the PCC plant in combination with the existing CHP plant on the nearest NSR (a single residential property) would have a low impact.

6.24 On this basis, no additional mitigation measures are necessarily required for the predicted sound levels. However, at the detailed design stage, opportunities to reduce the predicted specific sound levels further will be explored and are discussed in Chapter 7.

7. Noise Control

7.1 As part of the operational assessment for the EIA, AECOM modelled the PCC plant based on plant data from the project designers. The initial assessment indicated the potential for significant adverse noise impacts. Therefore, mitigation and attenuation were discussed and agreed. The proposed noise sources were ranked from highest to lowest, based on the level of impact at NSR 4. The attenuation shown in Table 7.1 were applied to the key noise emitting plant to minimise the impact. The predicted specific sound levels in Table 5.1 (Chapter 6) include these proposed reductions.

Table 7.1. Attenuation Required (dB from individual plant items).

Plant Ref (see Appendix B for plant details)	Attenuation (dB)
VPI-19	-5
VPI-54	-10
VPI-99a-99d	-10
VPI-70	-9
VPI-23-39	-5
VPI-46-48	-5

7.2 These reductions could be achieved either through reduction of sound power levels at source or by application of BAT, and general principals include, but are not limited to, the measures set out in Table 7.2.

Table 7.2. Best Available Techniques

Technique	Description	Applicability
Operational Measures	These include: • Inspection and maintenance of equipment • Closing of doors and windows of buildings and enclosed areas, where possible • Plant operated by experienced staff • Avoidance of noisy activities at night, if possible	These are part of good working practices at the installation.
Low-noise equipment	Select low noise equipment where possible	When equipment is new or being replaced. Where practicable low noise equipment will be procedure for the PPC plant
Noise Attenuation	These include: • use of screening or bunding to shield receptors from noise sources; • reducing the breakout noise from plant through the use of enhanced enclosures, or potentially containing them within a building; • screening or enclosing the compressors or other equipment;	Consideration of screening where required and the layout of the PCC plant has incorporated consideration for the potential of noise impact to occur, within the constraints of the plot plan.

Technique	Description	Applicability
Noise Control Equipment	• This includes: • reducing air inlet noise emissions by the addition of further in-line attenuation; • reducing stack outlet noise emissions by the addition of silencers or sound proofing panels; • reducing fin fan cooler noise emissions by screening, re-sizing, fitting low noise fans or attenuation; • use of anti-vibration supports and interconnections for equipment;	To be considered during the during the detailed design of the PPC plant
Appropriate Location of Equipment and buildings	orientation of plant within the Site to provide screening of low-level noise sources by other buildings and structures, or orientating fans and the air inlets away from sensitive receptors	This is generally applicable to new plant and has been considered during the development of the proposed PCC plant and will continue to be considered during the detailed design.

7.3 During the detailed design of the PCC plant it may be desirable or more practical to apply higher attenuation to some plant items/ buildings than listed in Table 7.1 in order to reduce the attenuation applied to other plant items/ buildings and still achieve the same level of overall reduction.

7.4 The operational assessment has assumed that potential sound of a tonal, impulsive or intermittent nature (according to BS4142: 2014) will be designed out of the PCC plant during the detailed design phase through the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary.

7.5 Throughout the development of the proposed PPC plant, practical measures to mitigate noise have been incorporated into the design and the implementation of further mitigation on either the existing or proposed plan may be prohibitive, and use of BAT will be taken in to account.

7.6 VPI will continue to investigate noise complaints, keeping a log of the complaint and any actions taken. In addition, a noise management plan has been prepared for the VPI site to support the Environmental Permit variation application.

7.7 VPI will continue with the annual environmental noise monitoring.

8. Assessment Uncertainty

8.1 As outlined previously, the operational noise is assessed against the background sound levels obtained during the night time surveys undertaken prior to VPI being operation and the specific sound from the existing VPI CHP plant has been taken from the 2023 environmental noise survey which is undertaken annually, as part of the ongoing noise monitoring for the existing VPI CHP Plant. There are uncertainties involved with the use of this data as there would be with any background sound measurement; other sources of noise may have changed in the intervening period. However, in view of the nature of the area these uncertainties are no greater than those which would be associated with a single occasion survey undertaken specifically for this assessment. The full set of third-party noise monitoring reports have been examined and demonstrate that the measurements have been undertaken competently and result in a robust representative background sound level.

8.2 Predictions of sound pressure levels according to ISO 9613 are based on an assumption of moderate downwind propagation, and hence could be considered as a worst-case calculation. However, the standard also indicates an estimated accuracy of ±3 dB in predicted levels at the heights and distances relevant to this assessment.

8.3 Although the proposed plant will operate 24 hours a day, 7 days a week, not all the plant will operate all the time as it is due to demand and ambient temperatures. For example, the main source of noise is the large number of air coolers, which would only all be in operation in the highest anticipated ambient air temperatures. Therefore Scenario 1 is a robust quantitative worst case scenario and operational noise levels will be lower as cooling is only required during periods of warm/ hot weather. It is considered that the assumptions made during the noise modelling and assessment of the PCC plant have led to a conservative ('worst case') assessment.

9. Conclusions

9.1 This noise assessment has been prepared by AECOM on behalf of VPI to support an Environmental Permit variation application (Permit number EPR/BJ8022IZ) for the Immingham Combined Heat and Power (CHP) Power Plant) to enable the retrofit of a Post Combustion Carbon Capture (PCC) development and associated facilities.

9.2 The focus of the assessment has been on operational sound level impacts upon the nearest residential NSR to VPI.

9.3 Previous noise assessments and annual environmental monitoring reports have been reviewed to determine the representative background sound level without contribution of the existing noise from VPI and the specific sound level of the current CHP operations.

9.4 A sound propagation model has been created using the noise modelling software SoundPLAN to provide a 3D representation of the PCC plant.

9.5 In accordance with BS 4142 (BSI, 2019), the defined representative background sound levels at the NSRs have been compared against the predicted operational rating levels (the specific sound levels with character correction).

9.6 The assessment identifies that based on the worst-case scenario 1, the rating level would be less than 5 dB above the defined background sound levels (i.e. below the level at which there is an indication that adverse impacts are likely). The resulting significance of impact in accordance with BS 4142 has been determined as either “low impact” or up to “adverse impact” (before context considerations).

9.7 The context discussion considers the predicted specific sound levels in relation to the relevant WHO Guidance indoors and outdoors and the more recent Night Noise Guidelines. It is concluded that the PCC plant is predicted to meet with the WHO guideline values externally.

9.8 Therefore, overall, considering the BS 4142 assessment outcomes in the context of the existing sound environment, noise impacts from operation of the PCC plant in combination with the existing CHP plant on the nearest NSR (a single residential property) would have a low impact.

9.9 However, at the detailed design stage, opportunities to reduce the predicted specific sound levels further will be explored and VPI will continue to follow appropriate BAT as part of the environmental management plan and undertake annual environmental noise monitoring.

Appendix A Baseline Monitoring Locations and Survey Data

Monitoring Locations.

The monitoring and assessment locations are shown on Figure A1.

Revision: 1 Drawn: ER Checked: LC Approved: DP Date: 2023-12-01

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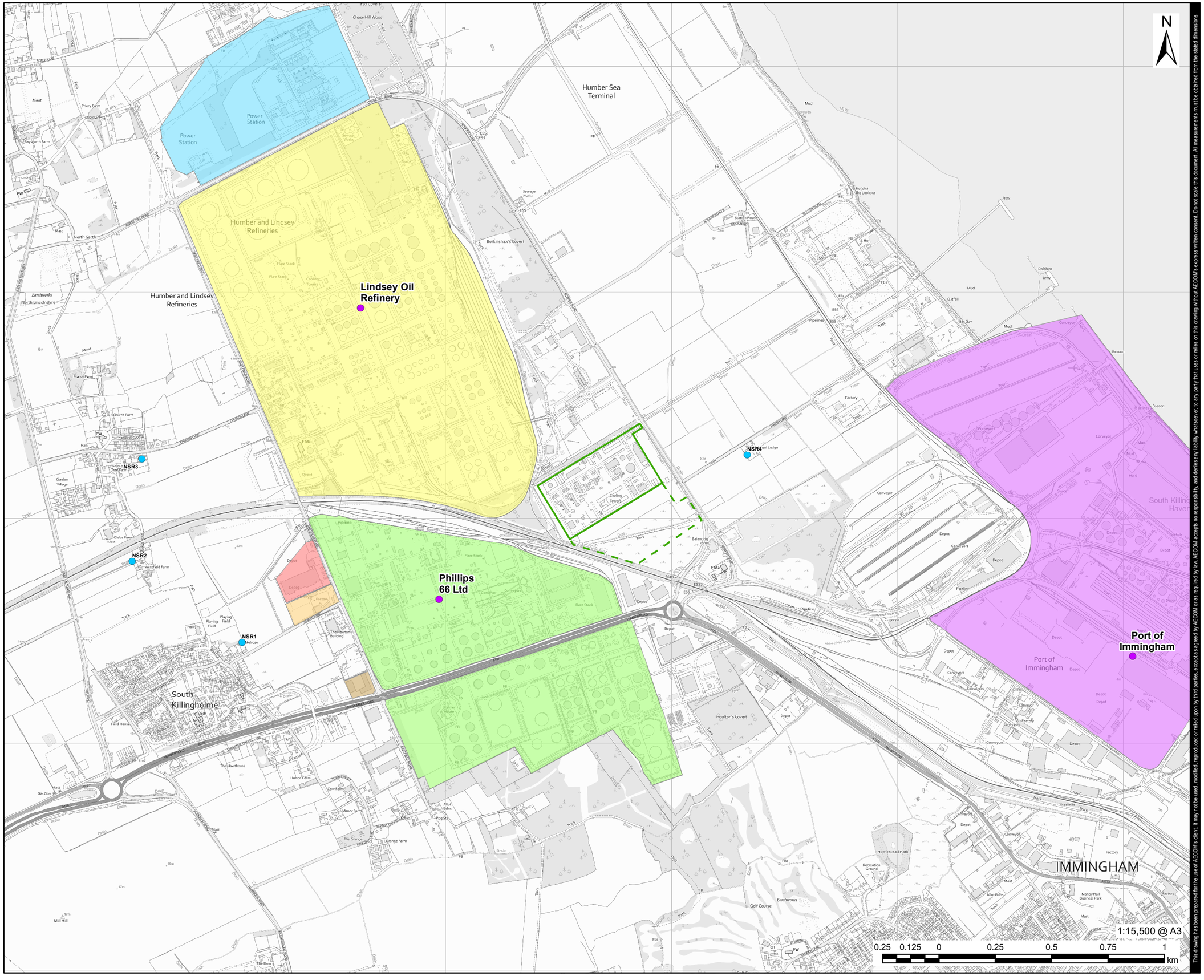

AECOM

PROJECT

Humber Zero

CLIENT

VPI Immingham LLP

CONSULTANT

AECOM Limited
5th Floor
2 City Walk
Leeds, LS11 9AR
www.aecom.com

LEGEND

- Existing Installation Site Boundary
- Extended Installation Site Boundary

Industrial Areas

- DFDS Logistics
- DSV Road
- Killingholme Power Station
- Lindsey Oil
- Phillips 66 Ltd
- Port of Immingham
- Scangrit
- Noise Monitoring Location
- Surrounding Industry Location

NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60712174

FIGURE TITLE

VPI Installation Boundary with Noise Monitoring Locations

FIGURE NUMBER

Figure A.1

Survey Data/ Reports

The following reports have been used to determine the background and existing specific sound levels.

1. Bureau Veritas (2010) 3952671/2 Rev 2 Immingham Environmental Survey. This document states the previously agreed background noise level was 58.4 dB on Page 4 of the document.
2. CHP Noise Development Plan. This document was used to determine the background sound level prior to VPI being operation. (52 dB $L_{A90,T}$ as stated on Page 57 of the document).
3. AECOM (2022) environmental Statement Chapter 7 Noise & Vibration and Appendix 7A Sound Survey Information. Baseline survey information reviewed and concluded there was very little variation in the ambient sound levels during the day and night-time periods.
4. Bureau Veritas (2023) 18917525/1 Rev 0 Immingham CHP Environmental Noise Survey June 2023. This document was used to determine the existing specific noise from VPI.

Acoustics and Vibration Group

Our Ref: 3952671/2 Rev 2

6th September 2010

David Cody
ConocoPhillips Power Operations Limited
Rosper Road
Immingham
North Lincolnshire
DN40 3DZ

Dear David,

Re: Environmental Noise Monitoring – Immingham CHP

Please find attached the results of the environmental noise measurements which were carried out within the vicinity of the Immingham CHP site on 1st and 2nd March 2010.

1. Introduction

Bureau Veritas UK Ltd (BV) has been retained by ConocoPhillips Power Operations Limited to carry out a series of environmental noise measurements at Hazel Dene, a location in the vicinity of the CHP plant at Immingham. This report presents the results and findings of the survey, conducted during March 2010 with an assessment of the impact of ICHP2 with reference to Permit Improvement Conditions 9.14 and 9.15.

2. Measurement Procedure and Instrumentation

2.1 Noise Measurements

2.1.1 Instrumentation

The following instrumentation (which complies with BS EN 61672-1 Class 1 accuracy) was used to conduct the noise monitoring:

Bruel and Kjaer Sound Analyser, Type 2260;
Bruel and Kjaer ½" Microphone, Type 4189.

A microphone windshield was fitted at all times.

2.1.2 Calibration

The equipment used was calibrated before and after the measurements using a Bruel and Kjaer Calibrator, Type 4231. No significant variation in the calibration signals was noted.

2.2 Plant Operating Conditions

The Immingham CHP plant was fully operational during the noise survey, including:

- 3 Gas Turbines
- 3 Steam Turbines
- 1 Auxiliary boiler

The Phase 2 element of the ICHP has been brought online since the previous survey.

2.3 Measurement Location

The noise monitoring location was Location 4 as defined in the baseline environmental report (Reference 1). It is a location on Marsh Lane representative of Hazel Dene. Measurements were obtained at a height of 1.5m.

2.4 Measurement Procedure

The survey was conducted between 23:00 GMT on the 1st of March and 04:00 on the 2nd of March 2010. Fifty sequential five minute measurements were obtained, pausing for local events such as passing cars.

2.5 Meteorological Conditions

During the attended monitoring period the weather was dry and clear with primarily light north-westerly winds (0 – 1 m/s) although locally this was observed to vary slightly. The temperature was in the range of 0 - 1º C. This is the classic condition for the formation of a temperature inversion.

3. Environmental Noise Survey Results

The results of the noise monitoring are presented in full in Tables A1.1 to A1.3 appended to this report. A summary of the noise levels measured during the attended monitoring at Hazel Dene is presented in the following table.

Location	Minimum		Maximum	
	dB L_{A90}	dB L_{Aeq}	dB L_{A90}	dB L_{Aeq}
Hazel Dene	50	51	55	56

Table 1: Summary of Noise Levels measured in the vicinity of Immingham CHP, March 2010.

Hazel Dene was more crosswind than downwind of the ICHP plant during much of the monitoring period. The ICHP plant was audible at this location along with other industrial sources. It is believed that the ICHP plant was the most significant of these sources. Traffic noise and railway activity were audible sporadically throughout the measurement period. Broadband noise and impacts were also barely audible from an easterly source.

A historical record of the noise levels measured at Hazel Dene is presented in the Table 2 to enable comparison with the latest results. Values for L_{A90} are averaged arithmetically with L_{Aeq} averaged logarithmically.

Survey	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{eq} at 125 Hz	Wind Direction
February 2005	49	51	-	NW
March 2005	52	54	-	W
April 2005	53	55	-	W
August 2005	49	51	51	NW
November 2005	52	54	53	W
February 2006	50	51	50	NW
May 2006	50	52	-	W/SW
August 2006	52	54	50	W
January 2007	52	53	-	SW
March 2008	48	50	48	NW
January 2009	51	53	53	SW
March 2010	**52**	**54**	**52**	**NW**

Table 2: Comparison of previous surveys at Hazel Dene.

It can be seen from Table 2 that the March 2010 average levels are higher than any previously measured under NW wind conditions. This is probably due to ICHP2 now being operational. The March 2008 survey (also with NW winds), during which a sound pressure level of 50 dB L_{Aeq} was measured, was undertaken with only 1 GT and 1 ST operating. The highest noise levels during the current survey of 55 – 56 dB L_{Aeq} occurred for about 1½ hours of the 5 hour survey. It is possible that subtle shifts in wind direction or temperature gradients may have influenced the measured levels over the course of the survey. The highest noise levels measured are compatible with those reported for normal operating conditions during the commissioning period of ICHP2 (Reference 2) which identified an average level of 55.5 dB $L_{Aeq\ 5min}$ at Hazel Dene during the reliability run under a light westerly wind.

4. Effect of ICHP2 operation on overall site noise emissions

ICHP is required to demonstrate compliance with Condition 6.6.1 of Improvement Condition 9.14, which states:

'The rating level of the noise generated by the normal operation of the development shall not cause existing background levels, details of which shall be agreed in writing by the Environment Agency, to be exceeded by more than 3 dB (A) when assessed in accordance with BS 4142 at the nearest residential premises, for downwind conditions from the development. Such noise shall exhibit no tonal or impulse content at the nearest residential premises in any weather conditions. The limitation on noise level specified in this Condition shall be adhered to at all times unless any change has been approved in writing by the Agency or in an emergency.'

In order to evaluate compliance with the above, an assessment of ICHP Phase 2 in accordance with BS 4142 has been undertaken. The interpretation adopted in this report is that the rating level shall not exceed the background level by more than 3 dB(A). The required noise data was obtained from this and previous noise surveys, as detailed below, at Hazel Dene.

Additionally, ongoing monitoring has been carried out with reference to Permit Improvement Condition 9.15, specifically

'The Operator shall report, the findings of an assessment, to address the potential for increasing noise levels in the 125 Hz ⅓ octave band.'

Of the 50 five minute integrations obtained at Hazel Dene, a subset of 9 have been selected as corresponding to a period during which conditions were most favourable for sound propagation, obtained under light downwind conditions in the presence of a probable temperature inversion.

Figure 1 presents the 1/3rd octave L_{eq} spectrum obtained by averaging this subset. It can be seen that no tone is detected in the 125 Hz band, a finding relevant to Permit Improvement Condition 9.15. The subset has an overall L_{Aeq} of 56 dB(A).

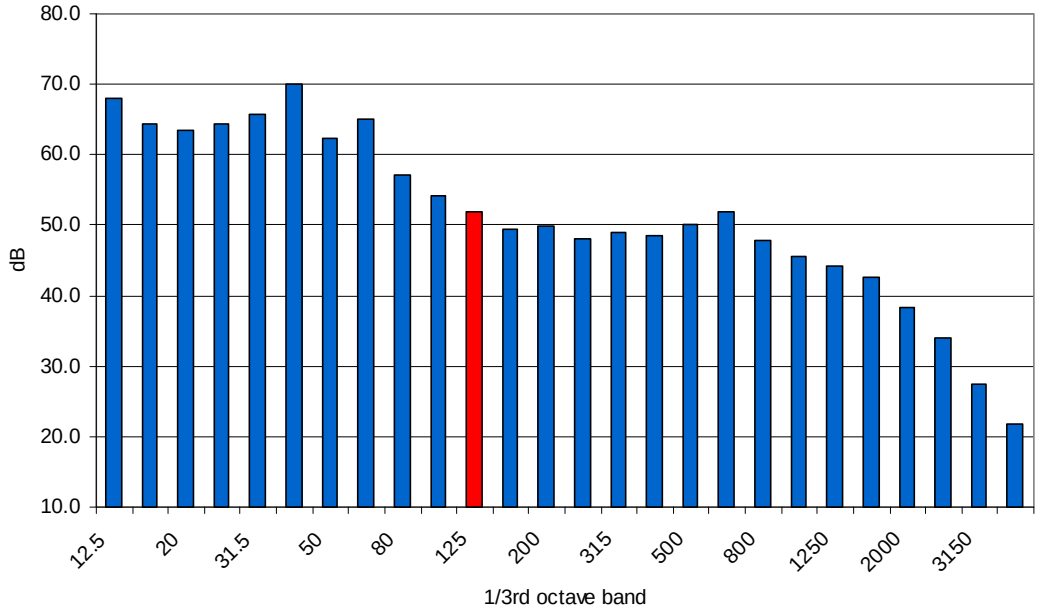

Figure 1: 1/3rd octave L_{eq} spectrum measured at Hazel Dene. The 125 Hz band is highlighted.

The noise levels required for a BS 4142 evaluation are tabulated in Table 3 below, using the terminology of BS 4142.

It is understood that the 'agreed existing background level', as mentioned in Improvement Condition 9.14 above, is 58.4 dB(A).

The residual noise level (log average L_{Aeq}) has been taken from the survey of 4 - 5th October 2009 (Reference 2), when ICHP2 was not running, and was obtained under suitable light downwind conditions and clear skies. This provides a measure of the pre-existing noise levels prior to ICHP2 commissioning.

BS 4142 Parameter	Value dB(A)	Comment
Ambient level	55.8	ICHP 1 & 2(Measured March 2010)
Residual level	52.0	ICHP 1 (Measured Oct 2009)
Specific level	53.5	ICHP 2 (Calculated)
Rating level	53.5	ICHP 2 (Calculated)
Existing Background level	58.4	ICHP 1 (ICHP communication)
Difference	**-4.9**	Rating minus background levels
Meets criterion?		**YES**

Table 3: Noise levels at Hazel Dene relevant to a BS 4142 type assessment.

The 'ambient level' is the log average L_{Aeq} of 55.8 dB measured in March 2010 at Hazel Dene, based upon the 'most favourable' dataset discussed above. It has been established using FFT analysis (Reference 2), and also by examination of Figure 1, that noise from the ICHP plant does not have a significant tonal component. This and the lack of any impulsive characteristics results in the 'rating level' being equal to the 'specific level'. A subtraction of the rating level from the background level yields a level 4.9 dB *below* the agreed existing background level.

Therefore in terms of the requirements of Section 6.6.1 of Improvement condition 9.14, which required an exceedence of no more than 3 dB(A), it is concluded that this criterion is met.

5 Summary & Conclusions

An environmental noise survey has been conducted at Hazel Dene, a residential location within the vicinity of the ConocoPhillips CHP Plant at Immingham. Attended noise monitoring was conducted on the night of the 1st to the 2nd of March 2010 under light predominantly NW wind conditions, which at times placed Hazel Dene both crosswind and downwind of the site. Temperature inversion conditions are likely to have been present.

Of all surveys undertaken at Hazel Dene by BV, the average noise levels of 54 dB $L_{Aeq\ 5mins}$ and 52 dB $L_{A90\ 5mins}$ are the highest that have been measured under this wind direction.

The increase that has occurred is in part almost certainly due to the additional power generation plant that is now operational (ICHP2).

The highest noise levels measured during the present survey were compatible with those measured during the commissioning period for ICHP2 under a light westerly wind.

No significant tonal noise is present at 125 Hz, as required by Permit Improvement Condition 9.15.

Section 6.6.1 of Improvement Condition 9.14 is found to be satisfied.

I trust this report meets your requirements, however, should you have any queries please do not hesitate to contact me.

Yours sincerely
Bureau Veritas UK Ltd

N. J. Haigh
Assistant Consultant
Acoustics and Vibration Group

References

1. Bureau Veritas Report 480361/7 Rev 0, January 2005

2. Bureau Veritas Report 1404134/1 Rev 0, February 2010.

Appendix 1

Results of Environmental Noise Monitoring

March 2010

Start Time	L_{AMaxF}	L_{Aeq}	$L_{A10\ F}$	$L_{A50\ F}$	$L_{A90\ F}$	Comments
23:19:01	60	54	55	54	53	HF and LF whine/roar from ICHP and other sources.
23:24:01	61	53	54	53	52	As above. Train hooter audible briefly and frequently.
23:31:04	57	54	55	53	52	Whine/roar as above, with blackbird occasionally audible.
23:36:42	59	54	55	53	52	Whine/roar as above. Hooter audible occasionally.
23:42:26	66	54	54	53	52	Whine/roar as above. Hooter audible occasionally. Pause for car.
23:50:54	56	52	53	52	51	Whine/roar.
23:55:54	57	52	53	52	51	Whine/roar. Hooter from west. Reversing alarm or similar from east. Impacts from east briefly audible. Pause for car.
00:01:31	58	53	54	53	52	Whine/roar (ICHP). Reversing alarm (east).
00:06:31	56	53	53	52	51	Whine/roar (ICHP). Hooter/ships horn (NE). Indeterminate source (east) just audible - possibly roads or industry.
00:11:31	59	53	53	52	51	Whine/roar (ICHP). Hooter/ships horn (NE). Indeterminate source (east) just audible - possibly roads or industry.
00:17:17	57	52	53	52	51	Whine/roar. Indeterminate source (east) as above. Pause for surveyor noise.
00:22:57	57	52	53	52	51	As above. Impacts (east). Birdcall. Prolonged pause for car.
00:30:56	60	53	54	52	51	Whine/roar. Impacts (east). Indeterminate source (east). Pause for security vehicle.
00:37:07	56	52	53	52	51	Whine/roar (ICHP). Alarm (east). Indeterminate source (east). 2 pauses for cars.
00:43:28	59	51	52	51	50	Whine/roar (ICHP). Alarm (east). Indeterminate source (east).
00:48:28	58	52	53	51	50	Whine/roar (ICHP). Alarm (east). Indeterminate source and impacts (east). Truck on Rosper Rd.
00:53:28	54	51	52	51	50	Whine/roar (ICHP). Indeterminate source (east). Single birdcall audible. Prolonged hooter (10secs) audible from NW.
01:00:02	57	53	54	52	51	Whine/roar (ICHP). Indeterminate source (east). Single birdcall audible.
01:05:02	60	53	54	53	52	Whine/roar (ICHP). Indeterminate source (east). Truck on Rosper Rd.
01:13:19	62	53	54	52	51	Slight delay to start to change batteries. Whine/roar (ICHP). Truck on Rosper Rd. Owl shriek in middle distance.Train hooter from NW.
01:18:19	56	52	53	52	51	Whine/roar. Indeterminate source from east - roads/industry.
01:24:16	60	53	54	53	51	Whine/roar. Indeterminate source from east. Hooter from ICHP direction or NW.
01:29:30	57	53	54	53	52	Whine/roar. Indeterminate source from east. Owl shrieks.
01:34:30	65	54	55	53	52	Whine/roar. Indeterminate source from east. Impacts (east). Train hooter (SW/W) and rolling noise. Hooter to W. Birdcall.
01:39:30	66	54	54	53	52	Whine/roar/ broadband noise. Indeterminate (east). Birdcall. Hooter to W (ICHP?).
01:44:30	61	54	55	54	53	Broadband noise (ICHP). Indeterminate (east). Hooters (ICHP?).
01:49:30	59	54	55	54	53	Broadband noise (ICHP). Indeterminate (east). Hooters (ICHP?).
01:54:30	59	55	56	54	53	Broadband noise (ICHP). Indeterminate (east). Hooters to NW.
01:59:30	58	56	56	55	54	Broadband noise (ICHP). Indeterminate (east).

Table A1.1: Measured sound pressure levels, Hazeldene, 1st - 2nd March 2010. Cont/…

Start Time	L_{AMaxF}	L_{Aeq}	$L_{A10\ F}$	$L_{A50\ F}$	$L_{A90\ F}$	Comments
02:04:30	61	56	57	55	54	Broadband noise (ICHP). Indeterminate (east).
02:14:30	60	55	55	54	53	ICHP broadband noise. Birdcalls. Brief siren to NW.
02:20:14	60	56	57	55	54	ICHP broadband noise. Birdcalls. Truck on Rosper Rd.
02:25:14	60	54	55	54	53	ICHP broadband noise. Birdcalls. Hooter to NW. Pause for car.
02:30:58	60	54	55	54	53	ICHP broadband noise. Hooter to NW. Pause for surveyor noise.
02:35:58	59	54	55	54	53	ICHP braodband noise. Reversing alarm to SE.
02:41:18	57	54	55	54	53	ICHP broadband noise.
02:46:18	60	55	56	54	53	ICHP broadband noise. Hooter to NW.
02:51:18	61	56	57	55	54	ICHP broadband noise. Hooter to NW.
02:56:29	61	55	57	55	53	ICHP broadband noise.
03:01:29	62	55	57	55	53	ICHP broadband noise. Hooter to NW.
03:06:29	59	55	56	54	53	ICHP broadband noise.
03:11:29	60	54	55	54	53	ICHP broadband noise.
03:16:29	60	55	56	54	53	Broadband ICHP noise. Pause for car. Hooter to NW.
03:22:58	62	56	57	55	54	Broadband ICHP noise. Pause for car. Hooter to NW.
03:28:35	64	56	57	55	54	Broadband ICHP noise.
03:33:35	61	56	57	56	55	Broadband ICHP noise. Possible train to SW. Hooter to NW.
03:38:35	63	56	57	55	54	Broadband ICHP noise. Hooter to NW.
03:43:59	65	56	58	56	54	Broadband ICHP noise. Truck on Rosper Rd.
03:48:59	62	55	57	55	53	Broadband ICHP noise. Pause for car. Hooter to NW.
03:54:54	60	55	56	54	53	Broadband ICHP noise. Truck on Rosper Rd. Pause for car

Table A1.1: Measured sound pressure levels, Hazeldene, 1st - 2nd March 2010.

Time	Overall	1/3 Octave Band Centre Frequency, Hz																												
	dB(A)	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
23:19:01	54	69	64	64	65	64	66	63	64	57	53	51	48	48	50	46	46	47	50	47	45	42	42	38	34	28	-	-	-	-	-
23:24:01	53	68	64	64	64	63	65	61	62	55	52	49	48	47	48	46	46	47	49	46	43	42	41	37	33	27	-	-	-	-	-
23:31:04	54	68	64	64	64	62	65	60	60	55	52	49	48	47	48	46	46	48	49	46	44	42	42	38	34	27	-	-	-	-	-
23:36:42	54	67	64	64	64	65	69	62	61	56	53	50	48	47	48	46	46	48	50	46	44	42	41	37	33	26	-	-	-	-	-
23:42:26	54	68	63	64	64	64	68	60	61	55	51	49	47	47	48	47	46	47	49	46	45	42	42	37	33	27	-	-	-	-	-
23:50:54	52	68	64	64	64	64	66	61	61	56	52	49	48	46	47	45	44	45	48	44	42	40	39	35	31	24	-	-	-	-	-
23:55:54	52	68	63	64	64	63	66	60	60	55	52	49	47	46	46	45	45	46	47	44	42	40	39	35	31	24	-	-	-	-	-
00:01:31	53	68	64	63	64	63	66	60	60	54	51	49	47	47	46	46	46	48	49	45	43	41	40	36	32	26	-	-	-	-	-
00:06:31	53	68	64	63	64	63	66	59	60	55	51	49	47	47	45	46	45	47	48	45	42	41	40	35	32	25	-	-	-	-	-
00:11:31	53	68	64	64	64	63	66	60	60	55	52	49	47	47	45	45	44	46	49	45	42	41	41	36	32	25	-	-	-	-	-
00:17:17	52	68	64	64	64	63	65	59	59	54	50	48	46	46	45	46	44	46	49	45	42	41	40	36	32	25	-	-	-	-	-
00:22:57	52	68	64	64	64	63	66	60	60	55	51	49	47	47	45	46	44	46	48	45	42	41	40	36	32	26	-	-	-	-	-
00:30:56	53	68	64	64	65	64	67	63	62	55	52	50	48	48	46	46	46	48	48	45	43	41	40	36	31	24	-	-	-	-	-
00:37:07	52	68	64	65	64	64	66	61	63	54	51	49	47	47	45	46	45	47	47	44	42	39	39	34	30	23	-	-	-	-	-
00:43:28	51	67	64	65	65	65	67	61	63	55	52	50	48	47	45	45	45	46	47	43	41	39	38	34	30	23	-	-	-	-	-
00:48:28	52	68	64	65	64	65	67	61	62	54	50	49	47	46	45	45	44	46	47	44	42	40	39	34	30	-	-	-	-	-	-
00:53:28	51	68	64	65	64	64	66	61	63	54	51	49	46	46	44	45	43	45	47	44	41	39	39	34	30	24	-	-	-	-	-
01:00:02	53	67	64	64	65	64	65	61	62	55	52	50	48	47	46	45	44	46	49	45	42	41	40	35	31	25	-	-	-	-	-
01:05:02	53	67	64	64	65	63	66	63	63	54	51	50	47	47	46	46	45	47	50	46	43	42	41	36	32	25	-	-	-	-	-
01:13:19	53	68	64	64	64	64	67	60	63	54	51	50	48	47	45	46	45	47	49	46	43	41	40	35	31	24	18	-	-	-	-
01:18:19	52	68	64	65	65	65	68	60	61	54	51	50	47	47	44	45	45	47	49	44	42	40	39	35	31	24	19	14	13	-	-
01:24:16	53	68	65	64	65	65	69	60	62	54	51	50	48	48	45	46	46	48	49	44	42	40	39	35	31	24	19	-	-	-	-
01:29:30	53	67	65	64	64	66	70	60	63	55	51	49	47	47	45	46	45	47	49	45	43	42	41	36	32	26	20	13	-	-	-
01:34:30	54	66	64	64	64	64	67	61	62	56	52	50	48	49	46	47	48	47	50	46	44	42	41	37	33	26	20	-	-	-	-
01:39:30	54	66	64	64	64	64	67	59	64	55	51	51	47	47	47	46	45	47	50	47	43	42	41	36	32	25	19	-	-	-	-
01:44:30	54	67	64	63	64	63	66	60	66	56	52	53	48	47	47	47	46	48	51	46	44	42	41	36	32	25	20	-	-	-	-
01:49:30	54	66	64	63	64	64	66	60	66	56	51	53	48	48	47	47	46	49	51	45	44	41	41	36	32	25	20	-	-	-	-
01:54:30	55	67	64	63	64	64	67	60	68	56	52	52	48	48	47	48	47	48	51	47	44	43	42	37	33	26	20	-	-	-	-
01:59:30	56	68	65	64	64	67	72	62	70	58	55	53	49	49	47	49	48	49	51	47	45	45	43	39	34	27	20	-	-	-	-
02:04:30	56	67	65	64	65	66	70	62	71	59	55	53	49	49	47	48	48	49	52	47	46	44	43	38	34	27	22	-	-	-	-
02:14:30	55	68	65	64	64	67	72	62	62	58	55	52	49	48	46	47	47	48	50	46	44	44	42	38	34	27	22	-	-	-	-
02:20:14	56	69	65	64	64	66	70	63	63	60	57	53	50	49	47	48	47	49	52	48	46	45	42	39	34	27	22	14	13	-	-
02:25:14	54	68	65	64	64	65	69	62	62	58	55	52	48	48	47	47	46	48	50	46	44	43	41	37	33	26	21	-	-	-	-
02:30:58	54	68	65	64	64	66	68	64	63	57	56	50	48	48	47	47	46	47	49	47	45	43	42	38	33	27	22	-	-	-	-
02:35:58	54	68	65	64	64	64	67	62	64	57	54	50	48	48	47	47	47	48	50	47	45	43	42	38	33	27	23	-	-	-	-
02:41:18	54	69	65	64	64	65	68	62	62	57	54	50	47	48	47	47	47	48	49	46	44	42	41	37	32	26	21	-	-	-	-
02:46:18	55	68	65	63	64	64	68	61	64	57	53	51	48	48	47	48	47	48	52	47	45	43	42	38	33	27	22	-	-	-	-
02:51:18	56	68	64	63	63	65	69	61	61	55	52	50	49	50	48	49	48	50	52	47	45	43	42	38	33	27	20	12	-	-	-
02:56:29	55	68	64	63	63	65	69	60	60	55	51	50	48	49	48	49	49	51	52	47	45	42	41	37	33	26	21	13	-	-	-
03:01:29	55	68	64	63	63	65	69	60	60	55	52	50	48	49	47	49	49	50	52	47	45	42	41	37	33	26	22	13	-	-	-
03:06:29	55	68	64	63	64	66	69	60	59	55	52	49	48	48	47	48	47	49	52	46	44	42	41	37	33	26	22	-	-	-	-
03:11:29	54	68	64	63	64	67	71	61	60	55	51	49	47	48	47	47	46	48	50	46	44	42	42	37	33	26	21	-	-	-	-
03:16:29	55	67	64	62	63	67	71	62	61	56	52	49	48	48	47	48	47	49	51	46	44	42	41	37	33	26	21	-	-	-	-
03:22:58	56	68	64	63	64	66	70	62	60	57	54	51	49	50	48	49	48	50	53	48	46	44	43	39	34	28	23	-	-	-	-
03:28:35	56	68	64	63	65	65	70	60	59	55	52	51	49	50	48	50	50	51	52	47	46	44	43	38	34	28	22	-	-	-	-
03:33:35	56	68	64	63	65	66	70	65	61	57	54	52	50	51	49	50	50	52	51	48	46	44	43	39	34	28	22	-	-	-	-
03:38:35	56	68	64	63	64	65	69	60	59	55	52	50	49	51	49	49	49	51	52	48	45	43	42	38	34	28	22	14	-	-	-
03:43:59	56	67	64	64	64	66	69	61	60	57	54	52	50	51	49	49	49	50	52	49	47	45	43	39	35	28	23	13	-	-	-
03:48:59	55	67	64	63	64	64	68	60	59	55	53	51	49	49	48	48	47	49	53	47	45	43	42	38	34	28	23	-	-	-	-
03:54:54	55	68	65	64	65	63	65	64	60	55	54	51	49	49	47	47	46	48	51	47	45	43	42	38	33	27	23	15	14	13	-

Table A1.2: Measured linear 1/3rd octave band L_{eq} sound pressure levels, Hazeldene, 1st - 2nd March 2010.

Time	Overall dB(A)	1/3 Octave Band Centre Frequency, Hz																													
		12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
23:19:01	53	66	62	62	62	61	62	59	60	53	50	47	46	45	47	44	44	44	46	44	42	40	40	35	32	25	-	-	-	-	-
23:24:01	52	65	61	61	61	60	61	58	58	52	48	46	45	44	46	44	43	44	46	44	42	40	39	35	31	25	-	-	-	-	-
23:31:04	52	65	61	62	61	60	62	57	57	52	48	46	45	44	45	44	43	44	46	44	42	40	40	36	32	25	-	-	-	-	-
23:36:42	52	64	61	62	61	62	64	58	58	53	49	46	45	44	46	44	43	44	46	44	42	40	39	35	31	24	-	-	-	-	-
23:42:26	52	65	61	61	61	61	63	57	58	52	48	46	45	44	45	44	43	44	46	44	42	40	39	35	31	25	-	-	-	-	-
23:50:54	51	65	61	61	61	60	63	57	57	52	47	45	44	43	44	42	42	43	45	42	40	38	37	33	29	22	-	-	-	-	-
23:55:54	51	65	61	61	61	60	63	57	58	52	48	46	44	43	44	42	42	43	44	42	40	38	37	33	29	22	-	-	-	-	-
00:01:31	52	65	61	61	61	60	62	57	57	52	47	46	44	44	43	43	43	44	45	43	41	39	38	34	30	23	-	-	-	-	-
00:06:31	51	65	62	61	61	60	62	56	57	52	48	46	44	44	43	43	42	44	45	43	41	39	39	34	30	23	-	-	-	-	-
00:11:31	51	65	61	61	61	60	62	57	57	52	48	46	44	44	43	43	42	43	45	43	40	39	39	34	30	23	-	-	-	-	-
00:17:17	51	65	61	61	61	60	61	56	56	52	47	45	44	44	43	43	42	43	45	43	40	39	38	34	30	23	-	-	-	-	-
00:22:57	51	65	62	62	61	60	62	57	57	52	48	46	44	44	42	43	42	43	45	43	40	39	38	34	30	23	-	-	-	-	-
00:30:56	51	65	62	62	62	61	63	58	58	52	48	47	45	44	43	44	43	44	45	43	41	39	38	33	29	22	-	-	-	-	-
00:37:07	51	65	62	62	61	61	63	58	60	52	48	46	45	44	43	43	43	44	45	42	40	38	37	32	28	-	-	-	-	-	-
00:43:28	50	64	62	62	62	62	63	58	60	53	48	47	45	44	43	43	42	43	44	41	39	37	37	32	28	-	-	-	-	-	-
00:48:28	50	65	62	62	61	61	63	58	59	52	47	46	44	43	42	42	42	43	44	41	39	37	37	32	28	-	-	-	-	-	-
00:53:28	50	65	61	62	61	61	62	58	59	52	48	46	43	43	42	42	41	42	44	42	39	38	37	33	29	-	-	-	-	-	-
01:00:02	51	64	61	62	62	61	62	57	60	52	48	46	44	44	43	43	42	43	45	43	40	39	38	33	29	22	-	-	-	-	-
01:05:02	52	64	61	61	62	60	62	57	59	52	48	46	44	44	43	43	42	44	47	43	41	40	39	34	30	23	-	-	-	-	-
01:13:19	51	65	62	62	61	61	62	57	60	52	48	46	45	44	42	43	42	44	46	43	40	39	38	34	29	22	15	-	-	-	-
01:18:19	51	65	62	62	62	62	63	57	58	52	47	46	44	44	42	43	42	44	45	42	40	39	37	33	29	22	15	-	-	-	-
01:24:16	51	64	62	62	62	61	63	57	59	52	48	47	45	45	42	43	43	44	45	43	40	39	38	33	29	22	15	-	-	-	-
01:29:30	52	63	62	61	61	63	66	57	60	52	48	46	45	45	43	43	43	44	45	43	41	40	39	34	30	23	16	-	-	-	-
01:34:30	52	63	62	61	61	61	63	58	59	52	48	47	45	45	43	44	43	44	47	44	41	40	39	35	30	23	16	-	-	-	-
01:39:30	52	63	62	62	61	61	63	57	60	52	48	48	45	45	44	44	43	44	46	44	41	40	39	35	30	23	16	-	-	-	-
01:44:30	53	63	62	61	61	61	63	57	63	53	48	50	46	45	44	44	43	45	47	44	42	40	39	35	31	23	16	-	-	-	-
01:49:30	53	63	61	60	61	61	63	56	63	53	48	48	45	45	44	44	44	45	47	44	42	40	39	35	30	23	15	-	-	-	-
01:54:30	53	64	62	61	61	61	63	58	62	53	48	48	45	46	45	45	44	45	48	45	42	41	40	36	31	24	16	-	-	-	-
01:59:30	54	64	62	62	61	63	67	59	66	56	51	50	46	46	45	47	45	46	48	45	43	43	41	37	32	25	17	-	-	-	-
02:04:30	54	64	62	61	61	62	65	59	67	56	52	50	46	46	45	46	45	46	48	45	43	42	40	36	32	24	17	-	-	-	-
02:14:30	53	64	62	61	61	64	68	59	59	55	52	49	46	45	44	45	44	45	47	44	43	42	40	36	32	25	18	-	-	-	-
02:20:14	54	65	62	61	61	63	65	60	60	57	53	50	47	46	44	45	45	47	48	45	44	42	40	36	31	24	17	-	-	-	-
02:25:14	53	65	62	62	61	62	65	59	59	55	52	49	46	45	44	45	44	46	47	44	42	42	39	36	31	24	16	-	-	-	-
02:30:58	53	64	62	61	60	63	65	59	59	55	53	48	45	45	44	45	44	45	46	45	43	42	40	36	31	25	18	-	-	-	-
02:35:58	53	65	63	62	60	62	64	59	61	55	51	48	45	45	44	45	45	45	46	45	43	41	40	36	31	25	19	-	-	-	-
02:41:18	53	66	63	61	60	61	63	59	59	55	51	47	45	45	44	45	45	45	46	44	43	41	39	36	31	24	17	-	-	-	-
02:46:18	53	65	62	61	61	61	63	58	60	55	50	48	45	45	45	46	45	46	47	45	43	42	40	36	31	25	18	-	-	-	-
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03:01:29	53	64	61	60	59	61	64	57	57	53	48	47	45	46	45	46	45	46	48	44	43	41	39	35	31	24	18	-	-	-	-
03:06:29	53	64	61	60	60	62	65	57	56	52	48	46	45	45	45	45	44	46	47	44	42	41	39	35	31	24	18	-	-	-	-
03:11:29	53	64	62	60	61	63	67	58	56	52	48	46	45	45	44	45	44	45	46	44	42	41	40	35	31	24	18	-	-	-	-
03:16:29	53	63	61	60	61	64	68	58	57	53	48	46	45	46	45	46	44	45	47	44	42	41	40	35	31	24	18	-	-	-	-
03:22:58	54	64	61	60	61	63	66	59	57	54	51	48	47	46	45	46	45	46	48	45	43	42	41	37	33	26	20	-	-	-	-
03:28:35	54	65	62	60	61	62	65	57	56	53	49	47	46	47	46	46	46	47	48	45	43	42	41	37	32	26	19	-	-	-	-
03:33:35	55	65	62	61	62	62	65	58	57	54	50	48	47	48	46	47	46	47	48	46	44	42	41	37	33	26	19	-	-	-	-
03:38:35	54	65	62	61	61	62	65	57	56	52	49	47	46	47	46	46	46	47	48	45	43	41	40	36	32	25	18	-	-	-	-
03:43:59	54	64	61	61	61	62	65	57	56	53	49	48	47	47	45	46	45	47	49	46	43	42	41	37	33	26	19	-	-	-	-
03:48:59	53	64	62	60	61	61	65	57	55	52	49	48	46	46	44	44	44	45	48	44	42	41	40	36	32	25	19	-	-	-	-
03:54:54	53	64	62	61	62	60	62	58	56	52	50	48	46	46	44	44	43	45	47	45	43	41	40	36	31	25	18	-	-	-	-

Table A1.3: Measured linear 1/3rd octave band L_{90} sound pressure levels, Hazeldene, 1st - 2nd March 2010.

B2.8 Noise

The Immingham CHP plant is to be located adjacent to HOR. The noise radiated from the Project will naturally form an addition to that radiated from HOR. The prediction and assessment of environmental noise from the Project has therefore been considered in this regard, and use made of an acoustic model of HOR. This was developed as part of an Environmental Noise Management (ENM) system for the specific purpose of managing and assessing the noise implications of new developments associated with HOR. The acoustic model was developed in 1998, and correlated with ambient noise levels measured at that time. There have been no significant changes to noise sources on HOR since then, and the basic model is still considered valid.

There are no sources of vibration associated with the Project which are likely to have any significant environmental effects.

The following sections describe:

- the main sources of continuous noise associated with the Project;
- infrequent sources of noise;
- the nearest noise sensitive locations to the Project site, and the existing noise environment;
- details of noise modelling;
- environmental noise criteria;
- assessment of noise levels;
- BAT for noise emission.

B2.8.1 Main noise sources

The principal sources of continuous noise during normal operation of the CHP plant, in approximate order of significance with respect to resultant environmental noise levels are:

- cooling towers;
- HRSGs;
- gas turbines;
- exhaust stacks;
- electrical generators;
- gas supply system;
- water feed pumps;

- air inlets to the gas turbines;
- cooling water pumps;
- steam turbines and condensers;
- transformers;
- ducting.

The noise from these sources will be continuous and they will usually operate 24 hours per day. The sources listed above are mainly broad band in character and unlikely to have any dominant tonal characteristics. Where such characteristics might exist (eg from the transformers), these will be of a low level at the nearest noise sensitive locations and not be audible due to masking from the other noise.

B2.8.2 Infrequent sources of noise

There are several possible sources of higher intermittent noise. These are as follows:

Gas turbine trip: This would involve venting of natural gas but this will be a very infrequent event.

Steam turbine by-pass and steam turbine start-up: This could be fairly frequent, sometimes even twice per day. As a consequence noise levels will be controlled to ensure acceptable levels are not exceeded.

HRSG safety valves: These will be lifted routinely every three years at turnaround/maintenance. These could also lift if steam demand from the refinery changed quickly outside normal parameters.

Gas reception compound: Gas venting could occur in an emergency shut-down situation.

B2.8.3 Noise sensitive sites

Noise sensitive locations are usually taken to be the nearest residential properties to a development, or other facilities such as hospitals and schools if there are any in the vicinity. In the case of the proposed Project, the nearest residential is Hazeldene on Marsh Lane, which runs perpendicular to Rosper Road. This is approximately 670 m from the centre of the proposed site and 520 m to the nearest part of the site. There are other more distant properties close to the River Humber. These include a converted lighthouse (distance approximately 1.8 km) and a property in Station Road (distance approximately 1.4 km). It is understood that all these properties are located within an area designated for future industrial development. However, whilst they continue to be occupied, they have been considered potentially noise sensitive for the purposes of this assessment.

The nearest residential property in a southerly direction is East End Farm (distance approximately 1.4 km). There are greater densities of population further away. These include Immingham to the south-east (distance approximately 2.2 km), South Killingholme to the south-west (distance approximately 1.5 km), North

Killingholme to the west (distance approximately 1.9 km) and the extended village of East Halton to the north-west (distance over 2.5 km).

The OS co-ordinates of the three nearest properties are:

Hazeldene:	517325 E	417310 N
East End Farm:	516340 E	415660 N

B2.8.4 Existing noise environment

The existing noise environment at the nearest residential properties is affected by several different types of noise sources. These include the noise from traffic using Rosper Road, railway noise, and noise from HOR and LOR. The proposed CHP plant will operate 24 hours per day, and it is the night-time situation which is normally the most sensitive for a continuously operating industrial plant. At night, the ambient noise level is dominated by noise from HOR and LOR.

In 1998, Conoco commissioned a study to develop an environmental noise model of the refinery. This consisted of detailed measurements of the noise source strengths of individual plant items on the refinery, prediction of noise levels to specified community locations, measurements of night-time community noise levels under downwind conditions from the refinery, and refinement of the sound propagation model to give best fit between the measured and predicted community noise levels. Because of the proximity of LOR to HOR, the former was added into the Conoco model as an additional source. The model is part of an Environmental Noise Management (ENM) system for HOR. Two of the community locations used in the refinery noise study were Myrtle Villas and East End Farm. The predicted noise levels and measured L_{A90} and L_{Aeq} levels at these locations, both for light downwind conditions, are shown in Table B2.9.1 (to the nearest dB). Also shown are the predicted and measured noise levels for Hazeldene for similar downwind meteorological conditions.

The L_{A90} is the A-weighted sound pressure level that is exceeded for 90 per cent of the measurement time, and in the UK this is normally taken to be a measure of the background noise level. (The term A-weighting implies a measurement taken with a standardized filter which approximates to the human response to noise at different frequencies of sound). The L_{Aeq} is the equivalent continuous sound pressure level and is the energy-averaged value of the time varying noise level. Where the noise level is very steady (as is the case at night when HOR dominates the noise environment) then the different noise indices numerically become very close, as can be seen from Table B2.9.1.

TABLE B2.8.1
EXISTING DOWNWIND NOISE LEVELS AT NEARBY RESIDENTIAL LOCATIONS

Location	HOR noise model prediction dB(A)	Measured noise levels	
		dB $L_{A90, 5m}$	dB $L_{Aeq, 5m}$

East End Farm	53	53	54
Hazeldene	50	51	53

It can be seen from this table that the HOR noise model correlates well with the measured overall A-weighted sound pressure levels for East End Farm, and just slightly under-predicts for Hazeldene. The A-weighted sound pressure level results are derived from octave band sound pressure level values. These also correlate well with measured environmental noise levels (typically within ± 2 dB between 31.5 Hz and 2 kHz for East End Farm).

The HOR noise model octave band sound pressure levels at East End Farm and Hazeldene (in dB L_{eq}), are shown in Table B2.9.2:

TABLE B2.8.2
EXISTING OCTAVE BAND SOUND PRESSURE LEVELS AT NEARBY RESIDENTIAL LOCATIONS

Location	Octave band centre frequency, Hz							
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**
East End Farm	69	66	57	52	51	49	43	29
Hazeldene	67	64	55	48	47	46	37	18

The HOR noise model has been used to generate noise contours outside the boundaries of the refinery. These are shown in Figure 2.9.1 for the existing situation. These represent noise levels for night-time downwind conditions from HOR in all directions, and thus do not represent the noise levels which might be observed simultaneously at all locations around HOR on any single night. In this situation, the distribution of noise levels would be skewed, with resultant noise levels upwind of the refinery typically being some 10-15 dB(A) less than shown in Figure 2.9.1. However, in this situation, upwind noise levels from the proposed project would also be less. Therefore, from the point of view of the environmental noise impact assessment of the proposed project, it is reasonable to consider only the downwind directions from the site to the nearest residential properties.

The HOR noise model makes no allowance for any other industrial development in the area (with the exception of LOR) or for any other sources of noise, which may become significant at distant locations from the refinery.

B2.8.5 Noise model of proposed Project

To predict the environmental noise contribution from the proposed plant under normal operating conditions, use has been made of the HOR ENM system noise model. The basic data used in this model are octave band sound power levels of the individual noise sources and a three dimensional co-ordinate system based on the layout given in Figure 1.3. The majority of the sound power levels for the proposed CHP plant have been based on noise measurements at another power station where Siemens V94.3A gas turbines are installed and data from suppliers of similar plant. In addition, hydrogen cooled generator sets have been assumed and radiated noise levels from all gas turbines and generator sets limited to 80 dB(A) at 1 m through the appropriate use of acoustic enclosures and silencing measures. For the cooling towers, noise information has been obtained from a cooling tower supplier. The sound power levels used are summarized in Appendix E for reference.

The sound attenuation model is based on the calculation procedures given in EEMUA publication 140 with specific Conoco site calibration factors to improve correlation between measurement and prediction. The attenuation model is for light downwind sound propagation conditions. The propagation model takes into account:

- distance between the source and the receiver;
- in-plant screening;
- ground effects;
- sound absorption by the atmosphere.

Noise sources are entered into the model as octave band sound power levels at defined x, y and z co-ordinates. The model calculates the resultant octave band sound pressure levels at one or more defined receiver locations for each individual source, taking into account the frequency-dependent sound attenuation factors between source and receiver. For example, sound absorption by the atmosphere is predominantly a high frequency phenomenon, whereas increased attenuation due to ground effects is more prevalent in the mid frequency region of the acoustic spectrum and is also source height dependent.

Consideration has also been given to the requirements of the Noise at Work Regulations SI 1989/1790 as amended by SI 1992/2996 and SI 1996/341 to limit noise levels in work areas to reduce the risk of hearing damage. The model does not include noise emission from the auxiliary boilers. These will only run when the main gas turbines are not operating, and they will, in any case, have a significantly lower noise emission than the rest of the plant. The model also does not allow for any steam venting, which may intermittently occur, or for higher noise levels which may occur during plant start-up or shut-down.

Calculations have been performed for three residential locations viz: Hazeldene to the east of the CHP plant and East End Farm to the south of the CHP plant. The model has been used to simulate three different options for equipment and noise control treatment. These are as follows:

Case 1: Base case; consisting of high performance acoustic enclosures on gas turbines (local sound pressure levels typically 80 dB(A)), heat conservation/acoustic lagging on exhaust ductwork, generator sets not exceeding a sound pressure level of 80 dB(A) locally to the sets, gas turbine exhaust silencers, gas turbine intake silencers, thermal/acoustic lagging on steam turbines, standard acoustic lagging on exposed pipework, pipework lagging and low noise valve (or valve enclosure) on fuel gas skid, standard hybrid cooling tower design.

Case 2: As Case 1, but also assuming low noise cooling tower design utilizing oversized low speed high efficiency fans and water splash control, high performance acoustic lagging on noisy pipework and low noise pumps and motor sets.

Case 3: As Case 2, but also assuming fully ventilated buildings to enclose the two gas turbine and two steam turbine sets. Combustion air for the gas turbines would be ducted from outside although no benefit has been assumed for any potential acoustic shielding of the gas turbine air intakes by the turbine hall.

The results of the calculations at the three locations considered are given in Table B2.9.3 to the nearest dB, in terms of the overall A-weighted L_{eq} sound pressure level from the proposed CHP plant.

Table B2.8.3
PREDICTED NOISE LEVELS AT NEARBY RESIDENTIAL LOCATIONS DUE TO PROPOSED PROJECT

Noise Control Option	Predicted L_{Aeq} from proposed Project		
		Hazeldene	East End Farm
Case 1		49	38
Case 2		47	36
Case 3		45	35

In the terminology of British Standard BS 4142 “Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Users” these levels represent the “rating level” for the project for normal operating conditions in a downwind direction from the site. (The use of the term “rating level” assumes that the noise from the proposed Project will be without any distinguishable characteristics such as tonal or impulsive noise). The calculated differences between the rating levels of the proposed Project and the existing noise levels are given in Table B2.9.4 (shown to the nearest 0.1 dB for comparison purposes). This table also gives the changes in the existing noise levels that will occur as a consequence of the CHP plant, for downwind conditions.

TABLE B2.8.4
PREDICTED EXCESS OF RATING LEVEL OVER BACKGROUND LEVEL AT NEAREST RESIDENTIAL LOCATIONS AND INCREASE IN EXISTING NOISE LEVELS DUE TO PROPOSED PROJECT

Noise control option			Hazeldene		East End Farm	
			Excess of rating level	Increase on existing level	Excess of rating level	Increase on existing level
Case 1			0 dB	2.9 dB	-15 dB	0.1 dB
Case 2			-3 dB	1.8 dB	-17 dB	0.1 dB
Case 3			-5 dB	1.3 dB	-18 dB	0.1 dB

The predicted octave band sound pressure levels for Cases 1, 2 and 3 are shown in Table B2.9.5, and compared with the existing octave band sound pressure levels.

TABLE B2.8.5
PREDICTED L_{eq} OCTAVE BAND SOUND PRESSURE LEVELS AT NEARBY RESIDENTIAL LOCATIONS DUE TO PROPOSED CHP PLANT AND COMPARISON WITH EXISTING DOWNWIND LEVELS

Location	Octave band centre frequency, Hz							
	31.5	63	125	250	500	1k	2k	4k
Hazeldene								
Predicted Project noise, Case 1	60	61	59	48	46	45	37	30
Predicted Project noise, Case 2	58	59	58	45	42	42	34	26
Predicted Project noise, Case 3	58	57	56	43	40	40	32	24
Existing noise levels	**67**	**64**	**55**	**48**	**47**	**46**	**37**	**18**
East End Farm								
Predicted Project noise, Case 1	54	55	50	36	35	33	21	5
Predicted Project noise, Case 2	52	53	49	34	31	29	17	-1
Predicted Project noise, Case 3	52	51	48	32	29	28	15	-1
Existing noise levels	**69**	**66**	**57**	**52**	**51**	**49**	**43**	**29**

The predicted environmental noise contours around HOR, with the Project operational, are shown for illustrative purposes in Figure 2.9.2 (Case 1 noise control), Figure 2.9.3 (Case 2 noise control) and Figure 2.9.4 (Case 3 noise control). These contours also include the environmental noise effect of removing the existing steam raising boilers and the older power generation plant on HOR, all of which would cease to be operational following successful commissioning of the proposed plant. These items are located to the west of HOR, and their removal therefore has little impact in an easterly direction, towards Rosper Road.

The most frequent source of intermittent noise is likely to be at the start-up or shut-down of a steam turbine, when steam will by-pass the turbine and be let down through a control valve into one of the condensers. Relatively high noise levels will be generated locally to the let-down valve, downstream pipework and condenser. Based on measurements at another power station, it has been assessed that with suitable noise control treatment, overall community noise levels from the Project will increase by some 2 dB(A) for Case 2 noise control treatment, during by-pass of the steam turbine.

B2.8.6 Environmental noise criteria

In the formulation of policies on planning developments which have issues relating to noise, local Planning Authorities are advised by the Department of the Environment in Planning Policy Guidance PPG 24 “Planning and Noise”. The aim of this guidance is to provide advice on how the planning system can be used to minimize the adverse impact of noise without placing unreasonable restrictions on developments or adding unduly to the costs and administrative burdens of business. It includes some of the main considerations that should be taken into account when determining planning applications for development, which will generate noise. In the case of industrial development, PPG 24 confirms that the character of the noise should be taken into account, as well as its levels, and sudden impulses, irregular noise or noise which contains a distinguishable continuous tone will require special attention.

The policy document cites the use of British Standard BS 4142 1990 “Method for rating industrial noise affecting mixed residential and industrial areas” for assessing the noise from proposed industrial and commercial premises. This standard has since been amended and the current version is dated 1997. The prime purpose of this standard is to determine the likelihood of complaints about noise from industrial and commercial installations. It compares the ‘rating level’ of the industrial source (equivalent continuous level of the industrial activity, corrected for character where appropriate) with the pre-existing background noise level, expressed as L_{A90} dB. Both the rating level and the background noise level refer to the external noise climate in the vicinity of the sensitive area. PPG 24 quotes the standard as stating that a difference of around 10 dB or higher indicates that complaints are likely and that a difference of around 5 dB is of marginal significance. The standard itself states that if the rating level is more than 10 dB below the measured background noise level then this is a positive indication that complaints are unlikely.

Unfortunately, no absolute guidance is given in PPG 24 as to what is a reasonable limit to set for new industrial development potentially affecting sensitive areas. However, PPG 24 is intended to build on the principles established in Circular 10/73 “Planning and Noise”. This stated that where, by the standards established in BS 4142, the noise from the proposed development is “likely to give rise to complaints” it will hardly ever be right to give permission. In practice most planning authorities set a more stringent standard than this, sometimes based on the ‘marginal significance’ category, or on

allowing the noise from the proposed development to equal the pre-existing background noise level. The latter would cause the background noise level to increase by approximately 3 dB, an amount that is considered to be just detectable. For there to be no increase on background noise levels then noise from the new development would need to be some 15 dB less than the existing background noise level.

PPG 24 also makes reference to British Standard BS 8233 1987 "Code of Practice for Sound Insulation and Noise Reduction for Buildings" which gives general guidance on acceptable noise levels within buildings. In sleeping areas, the recommended maximum intrusive noise levels are 30-40 dB $L_{Aeq,T}$. This equates to an external noise level of 40-50 dB $L_{Aeq,T}$ with windows open and 45-55 dB $L_{Aeq,T}$ with windows partially open. If the noise of concern contains distinctive characteristics, then these levels may need to be lower. This standard was revised in August 1999. The standard now states that 35 dB L_{Aeq} in bedrooms represents a reasonable noise environment due to external sources.

Similar, although slightly more stringent advice is given by the World Health Organisation in a 1999 report by a WHO expert task force, entitled "Guidelines for Community Noise". This states that to avoid negative effects on sleep, the equivalent continuous sound pressure level during the sleeping period should not exceed 30 dB L_{Aeq} indoors for continuous noise indoors. If the noise is not continuous, sleep disturbance correlates best with maximum noise levels and effects have been observed at 45 dB L_{Amax} or less (indoors). It goes on to recommend that at night-time, noise levels outside of dwellings should not exceed 45 dB L_{Aeq} so that people may sleep with bedroom windows partially open. It should be noted that existing night-time noise levels at residential properties in the vicinity of HOR are already higher than this. The WHO report has not been adopted into UK legislation or formal guidance, hence it remains a source of information reflecting a high level of health care with respect to noise, rather than a standard to be rigidly applied.

With respect to the potential noise impact of the Project on other commercial or industrial properties, there are currently no developments of this type closer to the site for the proposed CHP plant than Myrtle Villas, the nearest residential property to the site. Therefore it is not anticipated that there will be any significant noise impact from the proposed Project on existing industrial or commercial developments. Similarly, it is not anticipated that any future industrial development built adjacent to the Project site would be noise sensitive. It is possible that any future industrial development may incorporate ancillary office accommodation. The main effect of relatively high external noise levels would be the potential interference with speech communication. However, any potential problems of this nature can usually be overcome by appropriate building design, in the same way that the offices for the Project would be designed, taking into account the external noise environment. BS 8233:1987 recommends 40 to 45 dB L_{Aeq} as the maximum intrusive noise levels in private offices and small conference rooms, and 45 to 50 dB L_{Aeq} in large offices. Slightly more stringent limits are suggested for executive offices in the latest version of BS 8233.

B2.8.7 Assessment of noise levels

The Project site is relatively close to an isolated residential propertie, viz Hazeldene. This property islocated in an area that is designated for industrial development. However, if the property continues to be occupied for residential purposes within the period when the proposed CHP plant will be built and operated, then any changes in existing ambient noise levels at these locations should be within acceptable guidelines and should not give rise to any significant loss of amenity.

Three cases of noise control have been considered. Within the bounds of accuracy at this stage of the project, the base case predicts a noise level from the Project, at Myrtle Villas, which is slightly greater than the

existing background noise level. Assuming that distinctive characteristics to the noise are controlled, this gives rise to an excess of rating over background level of just under 2 dB, and an increase in the background noise level of just under 4 dB(A). According to BS 4142, this is less than of marginal significance with regard to the expectation of complaints. The increase would, however, be expected to be discernible.

By utilizing a low noise design for the cooling towers, and by ensuring acoustic lagging is of a high performance and that low noise pump motor sets are purchased, the overall noise from the Project can be reduced by just over 3 dB(A), which results in a rating level from the Project some 2 dB less than the pre-existing background levels. The increase in background noise level at will then be just over 2 dB(A). In both these cases, there will be no measurable increase in background noise levels at East End Farm, which is the nearest residential property not within the designated industrial zone. The excess of rating over background levels here are -15 dB for Case 1 and -17 dB for Case 2 noise control. At Hazeldene, the Case 2 noise control option results in an increase in the background level of just under 2 dB(A), an amount which is unlikely to be discernible, as long as the noise is without distinctive characteristic.

To obtain any significant further noise reduction requires the gas turbine and steam turbine generator sets to be located within a purpose designed turbine hall. It has been estimated that a fully ventilated turbine building would reduce overall noise levels by a further 1.4 dB(A), resulting in an excess of rating over background level of -3 dB. This would result in an increase in background noise level of just under 2 dB at this residential location, an improvement of only 0.5 dB on the previous case considered. The turbine building would not benefit the noise environment at any other residential properties outside the designated industrial zone. The advantages of providing a turbine building are, therefore, marginal in view of the designation for future industrial development of the area to the east of the site.

The frequency characteristics of the predicted noise from the CHP plant generally follow the existing background noise frequency spectrum, with a slight deviation in the 125 Hz octave band. This is due to the sound power level estimate included in the model for the gas turbine exhaust noise from the stacks and from the estimated noise levels from the alternator sets. Extra care may be necessary during the design to ensure that this frequency characteristic does not become a dominant feature of the new CHP plant.

The predicted noise level from the proposed Project for Case 1 causes the total noise level (for downwind propagation conditions) to just exceed 55 dB(A) at Myrtle Cottages. For Case 2, the total noise level will be 54 dB(A). Allowing for an attenuation of 15 dB from outside to inside with partially open windows, the internal level for Case 2 would therefore be just less than the BS 8233 (PPG 24 cited version) recommended maximum limit of 40 dB L_{Aeq} in bedrooms. To achieve the revised BS 8223 “reasonable” grade within any bedrooms of Myrtle Cottages which face towards the refinery, then windows to the bedrooms would need to be kept shut even for the existing noise environment. An increase of 2 dB(A) due to noise from the CHP plant would not materially change this situation (Case 2).

At Hazeldene, the predicted total noise level with the power station operational is less than 55 dB(A) for the downwind base case condition. The recommended maximum bedroom noise levels (BS 8233) can still be achieved here with windows partially open. For the Case 2 noise control option, resultant internal noise levels will be some 36 dB(A) (assuming 15 dB(A) for partially open windows).

These predictions and assessment do not take into account the effect of the proposed screening bund parallel to Rosper Road. . It will extend from the proposed site access road to approximately 300mts South. Whilst the bund will provide an effective visual screen for the proposed Project, its benefit from an acoustical point of

view, is more limited. It will be of most benefit for calm or for upwind sound propagation conditions, together with a neutral or lapse atmospheric temperature gradient. A neutral temperature gradient will typically occur under a thick cloud layer, whilst a lapse temperature gradient will occur on a warm sunny day. Under downwind conditions and/or for an atmospheric temperature inversion (e.g. at night under a clear sky) the screen will provide very little acoustical benefit, and has therefore been excluded from the predicted noise levels.

B2.8.8 BAT for noise emission

The PPC Regulations require installations to be operated in such a way that *"all the appropriate preventative measures are taken against pollution, in particular through the application of BAT".* The IPPC General Sector Guidance (IPPC S0.01) states that the definition of pollution includes *"emissions which may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment".* It goes on to state that BAT, for noise, is therefore likely to be similar, in practice, to the requirements of the statutory nuisance legislation, which requires the use of "best practicable means" to prevent or minimize noise nuisance. In the case of noise, the Guidance states that "offence to any human senses" can normally be judged by the likelihood of complaints, but in some cases it may be possible to reduce noise emissions still further at reasonable costs, and this may exceptionally be BAT for noise emissions.

For the proposed Project, the BAT objectives for noise emission are considered to be covered by the noise attenuation measures considered for Case 2, as described in B1.1.5. These include:

- selection of low noise-generating equipment compatible with the individual plant item noise limits;
- use of low speed, high efficiency fans on the cooling towers, and the control of water splash noise;
- installation of high performance acoustic enclosures on the gas turbine generator sets with all ventilation paths adequately silenced;
- use of hydrogen cooled generators;
- installation of high performance gas turbine exhaust and air intake silencers;
- the use of acoustic cladding, in combination with heat conservation measures, on the gas turbine exhausts, steam turbines and any noisy pipework;
- the use of other acoustic enclosures, where appropriate;
- the use of silencers on steam vents in intermittent usage; and
- the erection of a screening bund along Rosper Road.

In addition, to control intermittent noise during steam turbine by-pass, the use of an in-line silencer downstream of the let-down valve prior to each condenser may need to be considered.

No specific mitigation measures are considered necessary to control ground-borne vibration, as no significant levels are anticipated at the nearest sensitive locations. Low frequency noise can cause vibration of loose fittings, windows etc. However, low frequency noise will be controlled through the use of appropriate plant selection and measures such as high performance silencers on gas turbine exhausts. There will be no significant increase in low frequency noise at the nearest noise sensitive locations due to the Project.

A formal assessment to BS 4142: 1997, for the resulting noise emission from the Project under normal operating conditions, incorporating BAT preventative measures (Case 2), is as follows (for the nearest noise sensitive development).

Predicted noise level:	L_{Aeq}	=	50 dB	
Residual noise level:	Not relevant			
Background noise level*:	$L_{A90,\ 5\ mins}$	=	52 dB	Details of instrumentation, weather conditions etc, given below
Specific noise level (night):	$L_{Aeq,\ 5\ mins}$	=	50 dB	
Acoustic feature correction:		=	0 dB	
Rating level:	(50 + 0)	=	50 dB	
Excess of rating over background level:	(50 - 52)	=	-2 dB	
Assessment:				Complaints unlikely

* *The background noise measurements were obtained on 18th December 1998 between midnight and 02:30 hours. The measurements were made in the vicinity of the previously construction at Myrtle Villas. The wind was light WSW and there was no precipitation or fog. Noise from Conoco refinery dominated the background noise environment. For the background measurements use was made of a Bruel and Kjaer Type 2260 sound level meter, serial number 1933780. The meter was field calibrated using a Bruel and Kjaer calibrator Type 4231, serial number 1934844 before and at the end of the measurements to a level of 94 dB. No significant change in calibration level was observed. The meter and calibrator had last received a verification test by the manufacturer on 19th November 1998.*

A further sound attenuation measure in the form of a fully ventilated building to encompass the two gas turbines and two steam turbines (Case 3) will only reduce the overall noise levels by 0.5 dB as compared to Case 2. This is due to the dominance of other noise sources (particularly the cooling towers and the HRSGs). In view of the likely high cost of such a building, this is not considered cost effective and is not, therefore, considered to constitute BAT.

Allowing for some tolerance in estimation, and for slightly higher noise levels during steam turbine by-pass, it is proposed that any noise condition for the proposed Project should be based on the rating level of the noise generated by the normal operation of the plant not causing the existing background noise level to be increased by more than 3 dB(A), for downwind conditions from the development site i.e. rating level equals existing background noise level. This implies a noise limit of 52 dB $L_{Aeq,\ 5\ mins}$ at Myrtle Villas (free field) for normal operating conditions. For occasional activities potentially giving rise to higher noise levels (e.g. overall plant start-up or shut-down, or non-emergency steam venting, noise levels 5 dB(A) higher than this should still be acceptable. (This represents a BS 4142 “marginal significance” situation with respect to the likelihood of

complaints). For non-emergency conditions potentially involving higher noise levels than this, written notice of the likelihood of such an event is proposed prior to the event occurring.

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Tables

7. Noise and Vibration

7.1 Introduction

7.1.1 This chapter of the Environmental Statement (ES) addresses the potential noise and vibration impacts of Post Combustion Carbon Capture (PCC) developments at the VPI Combined Heat and Power (CHP) plant (Proposed VPI Development) and the Phillips 66 Humber Refinery (Proposed Phillips 66 Development) on local Noise Sensitive Receptors (NSRs). The impacts and effects of the Proposed VPI Development and Phillips 66 Development are considered separately and for both developments together (the Proposed Developments).

7.1.2 Impacts during the construction, operation (including maintenance) and decommissioning of the Proposed Developments are assessed. In particular, the assessment considers:

- existing and future baseline conditions;
- the effects of construction of the Proposed Developments on NSRs during the site clearance and construction works, including predicted changes in road traffic noise levels on the local road network during construction;
- the effects of noise and vibration resulting from operation of the Proposed Developments; and
- the effects of noise and vibration resulting from decommissioning of the Proposed Developments.

7.1.3 The cumulative effects of noise associated with the Proposed Developments and other committed developments in the vicinity are described in Chapter 18: Cumulative and Combined Effects (ES Volume I).

7.1.4 This chapter is supported by Figures 7.1 – 7.4, provided in ES Volume III, and Appendix 7A: Noise Surveys, Appendix 7B: Construction Sound Levels and Assumptions, and Appendix 7C: Operational Sound Levels and Assumptions, provided in ES Volume II.

7.1.5 This chapter assesses the impact of noise on residential and other human receptors. The assessment of noise impacts on relevant ecological receptors is presented in Chapter 13: Ecology and Nature Conservation (ES Volume I).

7.2 Legislation and Planning Policy Context

7.2.1 This section discusses the legislation, planning policy context and standards relevant to assessing the impacts of noise and vibration on residential and other human receptors.

Legislation

Environmental Protection Act 1990

7.2.2 The Environmental Protection Act (EPA) 1990 Part 3 identifies that noise (and vibration) emitted from premises (including land) can, at certain levels, be prejudicial to health or give rise to statutory nuisance.

7.2.3 Local Authorities are required to investigate any public complaints of noise and if they are satisfied that a statutory nuisance exists, or is likely to occur or recur, they must serve a noise abatement notice. A notice is served on the person responsible for the nuisance. It requires either the abatement of the nuisance or works to abate the nuisance to be undertaken, or it prohibits or restricts the relevant activity. Contravention of a notice without reasonable excuse is an offence. Right of appeal to the Magistrates Court exists within 21 days of the service of a noise abatement notice.

7.2.4 In determining if a noise complaint amounts to a statutory nuisance, the Local Authority can take account of various guidance documents and existing case law; however, no statutory

noise limits exist. Demonstrating the use of 'Best Practicable Means' (BPM) to minimise noise levels is an accepted defence against a noise abatement notice.

Control of Pollution Act 1974

7.2.5 Sections 60 and 61 of the Control of Pollution Act 1974 (CoPA) provide the main legislation regarding demolition and construction site noise and vibration. If noise complaints are received, a Section 60 notice may be issued by the local planning authority with instructions to cease work until specific conditions to reduce noise have been adopted.

7.2.6 Section 61 of the CoPA provides a means for applying for prior consent to undertake noise generating activities during construction. Once prior consent has been agreed under Section 61, a Section 60 notice cannot be served provided the agreed conditions are maintained on-site.

7.2.7 The CoPA requires that BPM (as defined in Section 72 of CoPA) be adopted for construction noise on any given site. CoPA makes reference to British Standard 5228 (British Standards Institute (BSI), 2014a and b) (herein referred to as 'BS 5228) which provides guidance on mitigation measures.

Environmental Permitting Regulations 2016 (as amended)

7.2.8 The Environmental Permitting (England and Wales) Regulations 2016 (EPR) require the application of Best Available Techniques (BAT) to activities performed within installations regulated by the legislation in order to manage the impact of these operations on the surrounding environment. The Environmental Permit applies only to the operational and decommissioning phase, not to the construction phase. The Proposed Developments will require variations to the existing permits.

7.2.9 In terms of noise specifically, the selection of BAT will have to be considered and balanced with releases to different environmental media (air, land and water) and to give due consideration to issues such as usage of energy and raw materials. Noise, therefore, cannot be considered in isolation from other impacts on the environment.

7.2.10 The definition of pollution in regulation 2 of the EPR includes *"emissions which may be harmful to human health or the quality of the environment, cause offence to human senses or impair or interfere with amenities and other legitimate uses of the environment"*. BAT is therefore likely to be similar, in practice, to the requirements of the Statutory Nuisance legislation which requires the use of BPM to prevent or minimise noise nuisance. In the case of noise, 'offence of any human senses' may be judged by the likelihood of complaints. However, the lack of complaint should not necessarily imply the absence of a noise problem. In some cases, it may be possible, and desirable, to reduce noise emissions still further at reasonable costs and this may therefore be BAT for the control of noise emissions from an installation. Consequently, the aim of BAT should be to ensure that there is no reasonable cause for annoyance to persons beyond the installation boundary.

7.2.11 Guidance regarding Environmental Permitting and noise is available in the Environment Agency's Integrated Pollution Prevention and Control (IPPC) H3 document 'Horizontal Guidance for Noise Part 2 - Noise assessment and Control' (Environment Agency, 2002a). However, 'Horizontal Guidance for Noise Part 1 – Regulation and Permitting' (Environment Agency, 2002b), which provided useful guidance relating to noise limits from industrial installations in terms of absolute *rating levels* and *rating levels* relative to *background sound levels* (as defined in BS 4142:1997 (now superseded)) was withdrawn in February 2016. Therefore, industry wide noise limits no longer apply.

National Policy

7.2.12 While National Policy Statements (NPS) apply to Nationally Significant Projects (NSIPs) rather than local planning applications, they can, however, have points of relevance in the determination of local planning applications.

7.2.13 Section 5.11 of the Overarching National Policy Statement (NPS) for Energy (EN-1) (Department of Energy & Climate Change (DECC) 2011) refers to the Government's policy on noise within the Noise Policy Statement for England (NPSE) (discussed further below).

7.2.14 With regards to decision making, NPS EN-1 states:

> *"The project should demonstrate good design through selection of the quietest cost-effective plant available; containment of noise within buildings wherever possible; optimisation of plant layout to minimise noise emissions; and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission.*" (paragraph 5.11.8)

7.2.15 Section 7.5 of this chapter describes the impact avoidance measures identified as relevant to the Proposed Developments.

7.2.16 The NPS for Fossil Fuel Electricity Generating Infrastructure (EN-2) (DECC, 2011b) sets out policy specific to fossil fuel power stations such as the VPI Immingham CHP Plant. In paragraph 2.7.1, specific sources of noise are identified. Those that are relevant to the Proposed VPI Development include *"the gas and steam turbines that operate continuously during normal operation"*. It then reiterates the point made in NPS EN-1, stating that:

> *"The primary mitigation for noise from fossil fuel generating stations is through good design, including enclosure of plant and machinery in noise-reducing buildings wherever possible and to minimise the potential for operations to create noise'.* It goes on to state that *"Noise from gas turbines should be mitigated by attenuation of exhausts to reduce any risk of low-frequency noise transmission."* (paragraph 2.7.5)

7.2.17 Table 7.1 provides a summary of the NPS advice regarding noise and vibration and how each has been considered in this chapter.

Table 7.1: Summary of relevant NPS advice regarding noise and vibration

Summary of NPS	Consideration within chapter
NPS EN-1	
Paragraph 5.11.4 states: *"Where noise* impacts *are likely to arise from the proposed development, the applicant should include the following in the noise assessment:* • *A description of the noise generating aspects of the development proposal leading to noise impacts, including the identification of any distinctive, tonal, impulsive or low frequency characteristics of the noise;* • *Identification of noise sensitive premises and noise sensitive areas that may be affected;* • *The characteristics of the existing noise environment;* • *A prediction of how the noise environment will change with the proposed development;* • *In the shorter term such as during the construction period;* • *In the longer term during the operating life of the infrastructure;* • *At particular times of the day, evening and night as appropriate;* • *An assessment of the effect of predicted changes in the noise; and* • *Measures to be employed in mitigation noise.*	Descriptions of noise generating aspects of the Proposed Developments, together with an assessment of construction, operational and decommissioning noise and vibration impacts are presented in Section 7.6 of this chapter. NSRs including proximity of any Noise Important Areas (NIA) are identified. Information relating to the existing noise environment is presented in Section 7.4 of this chapter. The mitigation of construction and operational noise is discussed in Section 7.5 and 7.7 of this chapter.

Summary of NPS	Consideration within chapter
NPS EN-1	
The nature and extent of the noise assessment should be proportionate to the likely noise impact."	
Paragraph 5.11.5 states: *"The noise impact of ancillary activities associated with the development, such as increased road and rail traffic movements, or other forms of transportation, should also be considered."*	Potential construction related traffic noise effects on human NSRs have been assessed in Section 7.6 of this chapter.
Paragraph 5.11.6 states: *"Operational noise, with respect to human receptors, should be assessed using the principles of the relevant British Standards and other guidance. Further information on assessment of particular noise sources may be contained in the technology-specific NPSs. In particular, for…electricity networks (EN-5) there is assessment guidance for specific features of those technologies. For the prediction, assessment and management of construction noise, reference should be made to any relevant British Standards and other guidance which also give examples of mitigation strategies."*	Potential operational noise effects on human NSRs are presented in Section 7.6 of this chapter.
Paragraph 5.11.7 states: *"The applicant should consult EA and Natural England (NE), as necessary and in particular with regard to assessment of noise on protected species or other wildlife. The results of any noise surveys and predictions may inform the ecological assessment. The seasonality of potentially affected species in nearby sites may also need to be taken into account."*	Potential effects of noise on biodiversity and nature conservation are considered in Chapter 13: Ecology and Nature Conservation (ES Volume I) and the Habitat Regulations Assessment Reports submitted with each planning application.
Paragraph 5.11.8 states *"The project should demonstrate good design through selection of the quietest cost-effective plant available; containment of noise within buildings wherever possible; optimisation of plant layout to minimise noise emissions; and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission."*	Section 7.5 of this chapter describes the impact avoidance measures identified as relevant to the Proposed Developments.
NPS-EN1	
Paragraph 2.7.2 states: *"The ES should include a noise assessment as described in Section 5.11 in EN-1."*	A noise assessment is included within this chapter.

National Planning Policy Framework

7.2.18 The National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government (MHCLG), 2021) sets out that planning should make sufficient provision for *"conservation and enhancement of the natural, built and historic environment"* (Paragraph 20d). Consequently, the aim is to prevent both new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of noise pollution.

7.2.19 Paragraph 174 of the NPPF states that:

> *"planning policies and decisions should contribute to and enhance the natural and local environment by:*

……preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans."

7.2.20 Paragraph 185 states that:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- *mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development - and avoid noise giving rise to significant adverse impacts on health and the quality of life;…* [and]
- *identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason".*

7.2.21 With regards to 'adverse effects' and 'significant adverse effects' the NPPF refers to the Noise Policy Statement for England Explanatory Note (NPSE) (Department for Environment, Food and Rural Affairs (Defra), 2010), which is described in the sub-section below.

Noise Policy Statement for England

7.2.22 The NPSE (Defra, 2010) seeks to clarify the underlying principles and aims in existing policy documents, legislation and guidance that relate to noise. The NPSE (Defra, 2010) applies to all forms of noise, including environmental noise, neighbour noise and neighbourhood noise.

7.2.23 The statement sets out the long-term vision of the government's noise policy, which is to:

"promote good health and a good quality of life through the effective management of noise within the context of policy on sustainable development".

7.2.24 This long-term vision is supported by three aims:

- *"avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvements of health and quality of life."*

7.2.25 The long-term policy vision and aims are designed to enable decisions to be made regarding what is an acceptable noise burden to place on society.

7.2.26 The 'Explanatory Note' within the NPSE (Defra, 2010) provides further guidance on defining 'significant adverse effects' and 'adverse effects' using the concepts:

- No Observed Effect Level (NOEL) - the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established;
- Lowest Observed Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.

7.2.27 The three aims can therefore be interpreted as follows:

- the first aim is to avoid noise levels above the SOAEL;
- the second aim considers situations where noise levels are between the LOAEL and SOAEL. In such circumstances, all reasonable steps should be taken to mitigate and

minimise the effects. However, this does not mean that such adverse effects cannot occur; and

- the third aim seeks, where possible, to positively improve the health and quality of life through the pro-active management of noise whilst also taking account of the guiding principles of sustainable development. It is considered that the protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim.

7.2.28 The NPSE (Defra, 2010) recognises that it is not possible to have uniform objective noise-based measures that define the SOAEL, LOAEL and NOEL that are applicable to all sources of noise in all situations. The levels are likely to be different for different noise sources, receptors and times of the day.

Planning Practice Guidance – Noise

7.2.29 The Planning Practice Guidance (PPG) (MHCLG, 2019) was first published on 6th March 2014 to provide a web-based resource with more in-depth guidance to the NPPF (MHCLG, 2021). The PPG aims to make planning guidance more accessible, and to ensure that the guidance is kept up to date. The PPG was last updated for noise in July 2021.

7.2.30 The guidance advises that local planning authorities should take account of the acoustic environment and consider:

- whether or not a significant adverse effect is occurring or likely to occur,
- whether or not an adverse effect is occurring or likely to occur, and
- whether or not a good standard of amenity can be achieved.

7.2.31 This guidance introduced the additional concepts of No Observed Adverse Effect Level (NOAEL), and Unacceptable Adverse Effect Level (UAEL). Full details of the PPG guidance on effects are provided in Table 7.2.

Table 7.2: Planning Practice Guidance noise advice

Perception	Examples of outcomes	Effect level	Action
Not present	No effect	No Observed Effect	No specific measures required
Present and not intrusive	Noise can be heard but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level (LOAEL)			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level (SOAEL)			

Perception	Examples of outcomes	Effect level	Action
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress or physiological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

7.2.32 Factors to be considered in determining if noise is a concern are identified including the absolute noise level of the source, the existing ambient noise climate, time of day, frequency of occurrence, duration, character of the noise and cumulative impacts.

Local Policy

7.2.33 The Development Plan for North Lincolnshire comprises the North Lincolnshire Local Development Framework (LDF) and the 'Saved Policies' of the North Lincolnshire Local Plan (NLC, 2007). The LDF includes the Core Strategy (adopted June 2011) (NLC, 2011).

7.2.34 North Lincolnshire Council does not have a specific policy relating to noise. However, the Council adopted its Core Strategy in June 2011 (NLC, 2011) as part of the Local Development Framework which has a Supplementary Planning Document entitled Planning for Health and Wellbeing that was published in November 2016 (NLC, 2016). It recognises that noise is an issue that can have an effect on physical and mental health.

7.2.35 Policy 3 of Planning for Health and Wellbeing - "Well Designed Places" - states:

> *"When considering the detail of development, proposals should:*
> *Seek to reduce noise and air pollution through ensuring planning applications include a Noise Impact Assessment…… in areas of concern."*

7.2.36 Paragraph 4.15 states "*the design of places also needs to take account of transport which has a direct impact on health and safety. Air pollution, noise, traffic and congestion all have a negative impact on people's ability to enjoy their environment."*

7.2.37 The 'Saved' policies of the Local Plan (NLC, 2007) that it is considered may be relevant to the determination of the planning applications include DS 1 General Requirements and DS 11.

7.2.38 Policy DS 1 General Requirements states:

> *"A high standard of design is expected in all developments in both built-up areas and the countryside and proposals for poorly designed development will be refused. All proposals will be considered against the criteria set out below:*
>
> *Amenity: iii) No acceptable loss of amenity to neighbouring land uses should result in terms of noise, smell, fumes, dust or tother nuisance, or through the effects of overlooking or overshadowing."*

7.2.39 Policy DS 11 Polluting Activities states:

> *"Planning permission for development, including extensions to existing premises and changes of use, will only be permitted where it can be demonstrated that the levels of potentially polluting emissions, including effluent, leachates, smoke, fumes, gases, dust, steam, smell or noise do not pose a danger by way of toxic release; result in land contamination; pose a threat to current and future surface or underground water resources; or create adverse environmental conditions likely to affect nearby developments and adjacent* areas*."*

Other Guidance

British Standard 7445-1:2003 and 7445-2:1991

7.2.40 BS 7445 'Description and measurement of environmental noise' (BSI, 1991 and 2003) defines parameters, procedures and instrumentation required for noise measurement and analysis.

British Standard 5228:2009+A1:2014

7.2.41 BS 5228-1 'Code of practice for noise and vibration control on construction and open sites. Noise' (BSI, 2014a) provides a 'best practice' guide for noise control and includes sound power level (L_{Aw}) data for individual plant as well as a calculation method for noise from construction activities. BS 5228-2 'Code of practice provides a 'best practice' guide for noise and vibration control on construction and open sites. Vibration' (BSI, 2014b) provides comparable 'best practice' for vibration control, including guidance on the human response to vibration.

British Standard 6472:2008

7.2.42 BS 6472-1 'Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting' (BSI, 2008), presents recommended frequency weighted vibration spectra (for continuous vibration) and vibration dose values (VDV) (for intermittent vibration), above which adverse comment is likely to occur in residential properties.

British Standard 7385:1993

7.2.43 BS 7385-2 'Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration' (BSI, 1993) presents guide values for transient and continuous vibration, above which there is a likelihood of cosmetic damage. The standard establishes the basic principles for carrying out vibration measurements and processing the data, with regard to evaluating vibration effects on buildings.

International Organization for Standardization (ISO) 4866:2010

7.2.44 ISO 4866:2010 'Mechanical Vibration and Shock – Vibration of Fixed Structures – Guidelines for the Measurement of Vibrations and Evaluation of Their Effects on Structures' (ISO, 2010) establishes the principles for carrying out vibration measurement and processing data with regard to evaluating vibration effects on structures.

British Standard 4142:2014+A1:2019

7.2.45 BS 4142 'Methods for rating and assessing industrial and commercial sound' (BSI, 2014c) can be used for assessing the effect of noise of an industrial nature, including mechanical services plant noise. The method compares the difference between '*rating level*' of the industrial sound, with the '*background sound level*' at the receptor position.

British Standard 8233:2014

7.2.46 BS 8233 'Guidance on sound insulation and noise reduction for buildings' (BSI, 2014d) defines criteria for noise levels in and around buildings.

ISO 9613-2:1996: Attenuation of Sound during Propagation Outdoors

7.2.47 ISO 9613-2:1996 'Attenuation of Sound during Propagation Outdoors, Part 2: General Method of Calculation' (ISO, 1996) specifies an engineering 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.

Calculation of Road Traffic Noise

7.2.48 Department for Transport (DfT)/ Welsh Office Memorandum 'Calculation of Road Traffic Noise' (CRTN) (DfT/ Welsh Office, 1988) describes procedures for traffic noise calculation and measurement and is suitable for environmental assessments of schemes where road traffic noise may have an effect.

Design Manual for Road and Bridges

7.2.49 The Highways England 'Design Manual for Road and Bridges LA 111 (Revision 2) Noise and Vibration' (DMRB) (Highways England, 2020) provides guidance on the appropriate approach to be taken when assessing the noise and vibration effects arising from all road projects, including new construction, improvements and maintenance. The guidance is also useful for assessing changes in traffic noise levels as a result of non-road projects such as this.

World Health Organization

7.2.50 The World Health Organization's (WHO) 'Environmental Noise Guidelines for the European Region' (WHO, 2018) provides recommendations to protect human health from noise from transportation, wind turbines and leisure. These guidelines do not cover industrial noise, however, recommend that 'Guidelines for Community Noise' (WHO, 1999) should remain valid. This recommends external daytime and evening environmental noise limits, and internal night-time limits to avoid sleep disturbance.

7.2.51 The WHO 'Night Noise Guidelines for Europe' (WHO, 2009) recommended updated guidelines on night-time noise limits to avoid sleep disturbance.

7.3 Assessment Methodology and Significance Criteria

Study Area

7.3.1 The extent of the study area has been defined to include the closest NSRs and communities in each direction from Proposed Developments. Study areas have also been informed by changes in road traffic flows predicted during the construction phase of the Proposed Developments. The extent of the study areas are shown in Figures 7.2a-c: Construction Noise Level Predictions, Figures 7.3a-c: Operational Noise Level Predictions (Daytime Unmitigated Scenario) and Figures 7.4a-c: Operational Noise Level Predictions (Night-time Unmitigated Scenario), found in ES Volume III.

Assessment Methodology

7.3.2 To facilitate the impact assessment process and ensure consistency in the terminology used, a defined assessment methodology has been applied. This methodology has been developed from a range of sources, including the guidance documents listed above in paragraphs 7.2.40 to 7.2.51.

7.3.3 An understanding of the existing sound climate in the vicinity of the Proposed Developments has been obtained through baseline sound measurement surveys, traffic count data for the local highway network and a review of details of the current uses on the Proposed Developments' sites (referred to as 'the Phillips 66 Site' and 'the VPI Site', and collectively 'the Sites'). This baseline information has been used to assess the effects of noise associated with construction, construction traffic, operational and decommissioning noise arising from the Proposed Developments.

Determining Baseline Conditions and Noise and Vibration Sensitive Receptors

7.3.4 The location of potential NSRs in proximity to the Phillips 66 Site and the VPI Site has been considered when assessing the effects associated with noise and vibration levels from the construction, operational (including maintenance) and decommissioning phases of the Proposed Developments.

7.3.5 The NSR locations selected are considered representative of the nearest and potentially most sensitive existing receptors to the Phillips 66 Site and the VPI Site. It is considered that if noise and vibration levels are suitably controlled at the selected receptors identified, then noise and vibration levels will be suitably controlled at other sensitive receptors in the surrounding area. The NSRs are shown in Table 7.3 and illustrated on Figure 7.1: Noise and Vibration Sensitive Receptors (ES Volume III).

Table 7.3: Potential noise sensitive receptors

Receptor	Sensitivity/ value of receptors	Direction from Phillips 66 Site	Distance from Phillips 66 Site boundary (m)*	Direction from VPI Site	Distance from VPI Site boundary (m)*
NSR 1 – Staple Road	High	West	519	West	1542
NSR 2 – Clarkes Road	High	North-west	790	West	1930
NSR 3 – Church Lane	High	North-west	770	North-west	1944
NSR 4 – Hazel Dene	High	North-east	1651	East	340

*Distance from the closest point to the Phillips 66 Site and VPI Site boundaries reported

7.3.6 The nearest NIA is located in Great Coates on the A1136. This is approximately 9 km away from the Sites, therefore noise impacts from the Proposed Developments at this location are unlikely and no further assessment is required.

7.3.7 A description of the study areas for ecological receptors are presented in Chapter 13: Ecology and Nature Conservation. Further assessment is provided in the Habitats Regulations Assessment Report.

Baseline Sound Surveys

7.3.8 Baseline sound monitoring to inform the assessment was undertaken at the four key residential NSRs identified in Table 7.3. This comprised unattended measurements with observations made on set up and collection of equipment and weather data recorded using a weather station located at NSR 2. Further details of the baseline sound surveys can be found in Appendix 7A (ES Volume II). The results of the baseline sound monitoring are summarised in Table 7.12 in Section 7.4 of this chapter.

Construction Phase Impacts

7.3.9 To determine the temporary noise and vibration impacts that may arise during the construction phase the following matters have been considered:

- noise and vibration caused by construction site activities; and
- noise caused by increases in traffic on existing roads as a result of construction traffic.

Assessment of Construction and Decommissioning Noise

7.3.10 At this stage in the Proposed Developments' design development, before the appointment of a construction contractor, site specific details regarding the construction activities, programme and numbers and types of construction plant are not fully available. Therefore, detailed construction noise predictions have not been undertaken. Nevertheless, indicative construction noise predictions have been undertaken using the calculation methods set out in BS 5228 (BSI, 2014a), based upon construction information from similar projects and confirmed/ updated by Phillips 66 and VPI. Further details of the proposed construction plant can be found in Appendix 7B (ES Volume II). At this stage it is assumed the decommissioning works will be similar to the construction works.

7.3.11 The assessment involves the calculation of sound emissions from the construction site based on the sound power levels associated with the plant or equipment to be used, and the propagation of sound from the source to the NSR locations. Sound power levels are taken from manufacturers data and/or archive data given in BS 5228-1. The calculated levels are then compared to nominated criteria to determine whether an adverse impact is expected.

7.3.12 The calculation method provided in BS 5228 (2014a) also takes account of factors including the number and type of equipment operating, their modes of operation (% on-times within the working period), the distance to the NSR, and the effects of any intervening ground cover or barrier/ topographical screening. This allows the prediction of the magnitude of impact.

7.3.13 The subsequent assessment of construction noise impacts at residential NSR considers the guidance in 'example method 1 – the ABC method' as defined in BS 5228 (BSI, 2014a). Table 7.4 (reproduced from BS 5228-1) provides guidance in terms of appropriate threshold values for residential NSR, based upon existing ambient noise levels.

Table 7.4: Construction noise threshold values at residential dwellings

Assessment category and threshold value period	Threshold value $L_{Aeq,T}$ dB		
	Category A (a)	Category B (b)	Category C (c)
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
Evenings and weekends (d)	55	60	65
Night-time (23:00 – 07:00)	45	50	55

NOTE 1: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

NOTE 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.

NOTE 3: Applies to residential receptors only.

(a) Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

(b) Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A value.

(c) Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.

(d) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.

7.3.14 For the appropriate period (day, evening, night etc.), the ambient noise level is determined and rounded to the nearest 5 dB and the appropriate threshold value is then derived. The predicted construction noise level is then compared with this noise threshold value.

7.3.15 Based upon the BS 5228 ABC method (BSI, 2014a), the criterion adopted in this assessment for the determination of potentially significant effects is the exceedance of the $L_{Aeq,T}$ threshold level for the category appropriate to the ambient noise level at each NSR. This is considered to be equivalent to the SOAEL, although as stated in BS 5228, other project-specific factors, such as the number of NSR affected and the duration and character of the impact, should also be considered by the assessor when determining if there is a potentially significant effect.

7.3.16 For residential receptors and other high sensitivity human receptors, the criterion for the LOAEL is a predicted construction noise level equal to the existing ambient noise level at each NSR i.e. resulting in a 3 dB increase in noise level when combined with the existing ambient noise level.

7.3.17 It is noted that the criteria for the LOAEL and SOAEL relate to residential NSR only, in line with the ABC method.

7.3.18 In accordance with the NPPF (MHCLG, 2021) and NPSE (Defra, 2010), it is important to avoid significant adverse effects (at or above the SOAEL) and also mitigate and minimise other adverse effects (above the LOAEL), where possible.

7.3.19 Based upon the above, the magnitude of the impact of construction noise is classified in accordance with the descriptors in Table 7.5.

Table 7.5: Magnitude of construction noise impacts

Magnitude of Impact	Comparison with Threshold Value $L_{Aeq,T}$ dB
High	Exceedance of ABC Threshold Value by ≥+5 dB
Medium	Exceedance of ABC Threshold Value by up to +5 dB
Low	Equal to or below the ABC Threshold Value by up to 5 dB
Negligible	Below the ABC Threshold Value by ≥-5 dB

Assessment of Construction Works Traffic on the Public Highway

7.3.20 The Proposed Developments will affect traffic flows on existing roads in the area within and surrounding the Proposed Development Sites during construction. The assessment focuses on the impact at NSRs located alongside the local road network.

7.3.21 Construction traffic noise has been assessed by considering the increase in traffic flows during the construction works, following the guidance of CRTN (DfT/ Welsh Office, 1988) and DMRB (Highways England, 2020).

7.3.22 18-hour (06:00 – 24:00) Annual Average Weekday Traffic (AAWT) data have been obtained for the year 2026 'with' and 'without' construction traffic during the peak construction period, in order to determine if any existing roads are predicted to be subject to a potentially significant change in 18-hour traffic flows. CRTN Basic Noise Level (BNL) calculations have been undertaken to predict the change in noise level between the 'with' and 'without' scenarios.

7.3.23 The criteria for the assessment of traffic noise changes arising from construction works have been taken from Table 3.17 of DMRB (Highways England, 2020) and are provided in Table 7.6 below. The magnitude descriptors in parenthesis are provided to align with the descriptors used in this assessment.

Table 7.6: Construction traffic noise criteria

Magnitude of Impact	Change in traffic noise level $L_{A10,18h}$ dB
Major (High)	≥ 5
Moderate (Medium)	3 to <5

Magnitude of Impact	Change in traffic noise level $L_{A10,18h}$ dB
Minor (Low)	1 to <3
Negligible (Very Low)	<1

7.3.24 DMRB advises that an increase in road traffic flows of 25% (where the traffic speed and composition remain consistent) equates to an approximate increase in road traffic noise of 1 dB $L_{A10,18hr}$. A doubling in traffic flow would be required for an approximate increase of 3 dB $L_{A10,18hr}$.

7.3.25 The criteria are based on the current guidance on short-term changes in traffic noise levels in DMRB. It is generally accepted that changes in noise levels of 1 dB L_A or less are imperceptible, and changes of 1 to 3 dB L_A are not widely perceptible. Therefore, the SOAEL is set at a change in traffic noise of ≥3 dB and the LOAEL at ≥1 dB.

Assessment of Construction Vibration

Impacts on Humans - Annoyance

7.3.26 Due to distances between the construction works and the NSRs, significant adverse effects are unlikely, however general information and criteria are provided below.

7.3.27 The transmission of ground-borne vibration is highly dependent on the nature of the intervening ground between the source and receptor and the activities being undertaken. BS 5228-2: 2009+A1:2014 'Code of Practice for Noise and Vibration Control on Construction and Open Sites - Vibration' (BSI, 2014b) provides data on measured levels of vibration for various construction works, with particular emphasis on piling.

7.3.28 Table 7.7 sets out Peak Particle Velocity (PPV) vibration levels and provides a semantic scale for the description of demolition and construction vibration impacts on human receptors, based on guidance contained in BS 5228-2 (BSI, 2014b).

Table 7.7: Construction vibration thresholds at residential dwellings

Peak Particle Velocity (PPV) level	Description	Magnitude of impact
>= 10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	High
1.0 to < 10 mm/s	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.	Medium
0.3 to < 1.0 mm/s	Vibration might be just perceptible in residential environments.	Low
0.14 to < 0.3 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	Very low

7.3.29 For residential receptors and other high sensitivity receptors, the LOAEL is defined as a PPV of 0.3 mm/s (millimetres per second); this being the point at which construction vibration is likely to become perceptible. The SOAEL is defined as a PPV of 1.0 mm/s, this being the level

at which construction vibration could become significant with respect to human annoyance but can be tolerated with prior warning.

7.3.30 The nearest residential NSRs are approximately 340 m from the Proposed VPI Development and 545 m from the Proposed Phillips 66 Development. Given the distance between the residential NSRs and the Proposed Developments, no significant vibration effects (i.e. those associated with a medium or high magnitude impact) are expected to result from the proposed construction (or demolition) activities and therefore further assessment on residential NSRs has been scoped out.

Impacts on Buildings/ Existing Infrastructure

7.3.31 In addition to human annoyance, building structures may be damaged by high levels of vibration. The levels of vibration that may cause building damage are far in excess of those that may cause annoyance. Consequently, if vibration levels are controlled to those relating to annoyance (i.e. 1.0 mm/s), then it is highly unlikely that buildings will be damaged by demolition and construction vibration levels.

7.3.32 Given the distance to residential receptors, no significant vibration is expected to result from the proposed construction activities on such receptors and therefore further assessment of the effects of vibration on residential buildings is scoped out. However, if piling, heavy earthworks, vibratory rollers or other significant vibration producing operations are proposed in close proximity to any existing sensitive buildings/ structures, further consideration will be given to potential impacts, once the contractor is appointed and the construction methods and requirements are known.

7.3.33 With respect to existing buildings within the Phillips 66 Site and VPI Site, as both the construction of the Proposed Developments and the existing buildings are both within the control of the respective Applicant, any identified issues can be effectively managed by the Applicants and their contractors. Potential measures to ensure that appropriate mitigation is in place during the works are discussed in Section 7.5 and Section 7.7 of this chapter.

Assessment of Operational Sound - Residential NSRs

7.3.34 The assessment of operational sound levels has been based upon calculations taking account of proposed plant and equipment (refer to Appendix 7C: Operational Noise Appendix in ES Volume II) sound power levels (L_w) relating to the proposed plant, distance between the proposed plant and NSRs and the acoustic screening offered by existing topography and existing and proposed new buildings.

7.3.35 Three-dimensional sound propagation models have been developed using the modelling software SoundPlan Version 8.2 to assess the current layout options for the Proposed Developments. SoundPlan implements the prediction method ISO 9613-2: 1996 ‘Attenuation of sound during propagation outdoors’ (ISO, 1996), which has been employed to calculate sound levels at surrounding NSR due to proposed operations at the Sites.

7.3.36 Topographical features and buildings that may influence the transmission of sound from the Proposed Developments to NSR are included in the model. A digital terrain model created using publicly available ground elevation spot height data have been used to position buildings and other noise sources at the proposed heights relative to ground. Areas of acoustically soft (e.g. vegetation) and hard (e.g. concrete) ground have been identified from the Ordnance Survey MasterMap Topographic Layer and modelled accordingly.

7.3.37 The prediction method assumes that the prevailing wind direction is always from source to receiver, which is likely to overestimate sound from the Proposed Developments for much of the time for the vast majority of NSRs, given the predominant wind direction in the UK is from the south-west.

7.3.38 Based upon the predicted sound levels from the model, an assessment of potential impacts at nearby NSR has been undertaken using the guidance in BS 4142:2014+A1:2019 ‘Methods for rating and assessing industrial and commercial sound’ (BSI, 2014c).

7.3.39 A key aspect of the BS 4142 (BSI, 2014c) assessment procedure is a comparison between the *'background sound level'* in the vicinity of residential locations and the *'rating level'* of the sound source under consideration. The relevant parameters in this instance are as follows:

- *background sound level* – $L_{A90,T}$ – defined in the Standard as the "*A-weighted sound pressure level that is exceeded by the residual sound for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels*";
- *specific sound level* – Ls ($L_{Aeq,Tr}$) – the "*equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr*"; and
- *rating level* – $L_{Ar,Tr}$ – the "*specific sound level plus any adjustment made for the characteristic features of the sound*".

7.3.40 BS 4142 (BSI, 2014c) allows for corrections to be applied based upon the presence or expected presence of the following:

- tonality: up to +6 dB penalty;
- impulsivity: up to +9 dB penalty (this can be summed with tonality penalty); and
- other sound characteristics (neither tonal nor impulsive but still distinctive): +3 dB penalty.

7.3.41 Once any adjustments have been made, the *background sound level* and the *rating level* are compared. The standard states that:

> *"Typically, the greater the difference, the greater the magnitude of 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 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."*

7.3.42 Importantly, as suggested above, BS 4142 (BSI, 2014c) requires that the *rating level* of the sound source under assessment be considered in the context of the environment when defining the overall significance of the impact.

7.3.43 BS 4142 (BSI, 2014c) suggests that a one-hour assessment period is considered during the day and a 15-minute assessment period at night.

7.3.44 Table 7.8 illustrates the adopted magnitude of impact scale used in this assessment based upon the numerical level difference. For BS 4142 (BSI, 2014c) assessment purposes, the SOAEL is set at a *rating level* above the *background sound level* of +10 dB, and the LOAEL at +5 dB, although it should be remembered that the context assessment (including the absolute level of the sound under consideration) can vary the overall classification of effects.

Table 7.8: Magnitude of impact for industrial sound

Magnitude of impact	BS 4142 descriptor	*Rating level* minus *background sound level* (dB)
High	No BS 4142 descriptor for this magnitude level	>15
Medium	Indication of a significant adverse impact, depending upon context	+10 approx.
Low	Indication of an adverse impact, depending upon context	+5 approx.

Magnitude of impact	BS 4142 descriptor	*Rating level* minus *background sound level* (dB)
Very low	Indication of low impact, depending upon context	≤ 0

7.3.45 It is intended for the Proposed Developments that the *rating level* will be limited to no greater than +5 dB above the *background sound level* in order to not exceed the LOAEL. Achieving no greater than the LOAEL would ensure that significant adverse effects are avoided, and that other adverse effects are minimised; primary and secondary aims of NPSE. However, both Phillips 66 and VPI are aiming to achieve a lower *rating level* of +3 dB above *background sound level* where practicable.

Assessment of Road Traffic Noise During the Operational Phase

7.3.46 The traffic generation associated with the operational phase of the Proposed Developments is predicted to be limited and has been scoped out of the transport assessment as stated in ES Chapter 8: Traffic and Transport (ES Volume I) and therefore is not considered further in this chapter.

Assessment of Operational Vibration Impacts

7.3.47 No significant sources of vibration are likely to be present due to the Proposed Developments and given the distances to the residential NSRs, it is not anticipated that vibration levels will be significant. Therefore, further assessment of operational vibration is scoped out of this assessment.

Receptor Sensitivity

7.3.48 Effects are classified based on the magnitude of the impact (as outlined above for the various potential impacts during construction and operation) and the sensitivity or value of the affected receptor. A scale of receptor sensitivity is presented in Table 7.9.

Table 7.9: Sensitivity/ value of receptors

Sensitivity/ value of receptor	Description	Examples of receptor usage
Very high	Receptors where noise or vibration will significantly affect the function of a receptor	Auditoria/ studios Specialist medical/ teaching centres, or laboratories with highly sensitive equipment
High	Receptors where people or operations are particularly susceptible to noise or vibration	Residential Quiet outdoor areas used for recreation Conference facilities Schools/ educational facilities in the daytime Hospitals/ residential care homes Libraries
Medium	Receptors moderately sensitive to noise or vibration where it may cause some distraction or disturbance	Offices Restaurants/ retail Sports grounds when spectators or noise is not a normal part of the event and where quiet conditions are necessary (e.g. tennis, golf)
Low	Receptors where distraction or disturbance of people	Residences and other buildings not occupied during working hours

Sensitivity/ value of receptor	Description	Examples of receptor usage
	from noise or vibration is minimal	Factories and working environments with existing high noise levels Sports grounds when spectators or noise is a normal part of the event

Classification of Effects

7.3.49 Impacts are defined as changes arising from the Proposed Developments, and consideration of the result of these impacts on environmental receptors enables the identification of associated effects, and their classification (major, moderate, minor and negligible, and adverse, neutral or beneficial). Each effect has been classified both before and after mitigation measures have been applied.

7.3.50 The following terminology has been used in the assessment to define effects:

- adverse – detrimental or negative effects to an environmental resource or receptor;
- neutral – effects to an environmental resource or receptor that are neither adverse nor beneficial; or
- beneficial – advantageous or positive effect to an environmental resource or receptor.

7.3.51 The effect resulting from each individual potential impact type above is classified according to the magnitude of the impact and the sensitivity or value of the affected receptor using the matrix presented in Table 7.10 below, but where necessary also considering the context of the acoustic environment.

Table 7.10: Significance of Effects Matrix

Magnitude of Impact	Sensitivity of Receptor			
	Low	Medium	High	Very High
High	Minor	Moderate	Major	Major
Medium	Minor	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Very Low	Negligible	Negligible	Negligible	Minor

7.3.52 Where adverse or beneficial effects have been identified, these have been assessed against the following significance scale, derived using the matrix presented in Table 7.10.

- negligible – imperceptible effect of no significant consequence;
- minor – slight, very short or highly localised effect of no significant consequence;
- moderate – limited effect (by extent, duration or magnitude), which may be considered significant; or
- major – considerable effect (by extent, duration or magnitude) of more than local significance or in breach of recognised acceptability, legislation, policy or standards.

7.3.53 For the purposes of this assessment, negligible and minor effects are considered to be not significant, whereas moderate and major effects are considered to be significant. Where necessary the context of the acoustic environment has also been considered in determining the classification of effect.

Data Sources

7.3.54 The following sources of information that define the Proposed Developments have been reviewed and form the basis of the assessment of likely significant effects of sound, noise and vibration from the Proposed Developments:

- Chapter 3: Proposed Developments Description, Need and Alternatives Considered;
- Chapter 4: Construction Programme and Management;
- Indicative Layout 3D Model and Block Plan for the Proposed Phillips 66 Development as provided by Phillips 66's design team;
- Indicative Layout and Zoning Plan for the Proposed VPI Development as provided by VPI's design team;
- items of plant including sound power level data for the Proposed Phillips 66 Development as provided by Phillips 66's design team;
- items of plant including sound power level data for Proposed VPI Development as provided by VPI's design team ;
- AAWT traffic data from the Transport Assessment (TA) (Appendix 8A ES Volume II) for the construction phase of the Proposed Developments; and
- Ordnance Survey (OS) MasterMap mapping, topographical data (LiDAR data) and aerial photography of the Proposed Developments and surrounding area.

Use of Rochdale Envelope

7.3.55 The assessment of sound, noise and vibration has been undertaken using the Rochdale Envelope approach having regard to the Planning Inspectorate (PINS) Advice Note 9 (PINS, 2018). The Rochdale Envelope is applicable where some of the details of a Proposed Developments are not able to be confirmed when an application is submitted and flexibility is needed to address design uncertainty. The three key principles an assessment should adopt are as follows:

- use a cautious worst-case approach;
- the level of information assessed should be sufficient to enable the likely significant effects of a proposed development to be assessed; and
- the allowance for flexibility should not be abused to provide inadequate descriptions of projects.

7.3.56 In line with these principles, the following approach has been taken for the construction stage:

- within each of the Sites, plant has been distributed across the development site and adjacent laydown areas;
- 24-hour construction is proposed at the Phillips 66 Site, with plant assumed to be in constant operation as a worst-case scenario (see Appendix 9A: Construction Noise Assessment Methodology (ES Volume II)); and
- construction activities and plant for the Proposed VPI Development have been assumed to be in constant operation through the 07:00 to 19:00 working day and Saturday 08:00 to 13:00 (see Appendix 9A: Construction Noise Assessment Methodology (ES Volume II)).

7.3.57 The following approach has been taken for the operational assessment:

- for each of the Sites a block/ zoning plan was used to identify approximate locations for each piece of plant. The closest location for the closest receptor in each block has been used for predicting worst-case sound levels at the NSRs.
- The free-field design criterion assumed for each piece of sound producing plant at each site is provided in Appendix 7C. There are different sound levels for equipment (e.g. fans) between the two developments due to differences in design, specification or size.

7.3.58 In relation to both construction noise and operational sound effects, mitigation, if considered necessary, would be integrated into the detailed design, in order to meet the limits to be agreed at the nearest NSR.

Consultation

7.3.59 The EIA scoping opinion stated *'the general approach to the noise and vibration assessment is supported. The noise assessment which will accompany the ES will include the following:*

- *construction and decommissioning noise and vibration impacts (including impacts related to traffic on public roads);*
- *operational noise impacts from the Proposed Developments, including the potential air-cooling infrastructure; and*
- *operational noise impacts from road traffic on public roads'*.

7.3.60 The scoping opinion confirmed that operational traffic related noise impacts can be scoped out of the assessment if justification can be provided.

7.3.61 The scoping response also states '*the methodology and details regarding the assessment will be agreed in advance with North Lincolnshire Council'.*

7.3.62 During the public consultation, concerns were raised about the noise impacts on residential properties during construction and regarding operational traffic impacts (see the Consultation Report submitted to accompany the Applications).

7.3.63 The Environmental Protection Officer at North Lincolnshire Council has been contacted to confirm the assessment methodology adopted in the assessment.

7.4 Baseline Conditions

Existing Baseline

7.4.1 The existing baseline sound climate in the vicinity of the Proposed Developments is dominated by sound from the industrial/ commercial operations at the Phillips 66 Humber Refinery and VPI Immingham CHP Plant and other nearby industrial operations as well as rail noise and road traffic noise from A160 and other local roads.

7.4.2 In order to help further define the existing sound conditions at NSRs, *ambient* and *background sound level* measurements have been undertaken at four representative residential locations (NSRs 1-4). The monitoring locations are shown on Figure 7.1 (ES Volume III).

7.4.3 Sound level monitoring was undertaken to the requirements of BS 7445 1: 2003 'Description and measurement of environmental noise. Guide to quantities and procedures' (BSI, 2003), in particular regarding instrumentation and monitoring methodology.

7.4.4 All measurements were taken at approximately 1.5 m above ground level, and were positioned at least 3.5 m from any reflecting surface, other than the ground (i.e. free-field measurements). Each sound level meter was set to log the L_{AF10}, L_{Aeq}, L_{AF90} and L_{AFmax} parameters.

7.4.5 The observations shown in Table 7.11 are the general baseline sound environment at each monitoring location recorded during the set-up and collection of the equipment.

Table 7.11: Sound climate observations at receptors

Receptor	Sound Climate Observations
NSR 1 – Staple Road	Noise from Phillips 66 Humber Refinery, wind generated noise.
NSR 2 – Clarkes Road	Noise from Phillips 66 Humber Refinery, bird song and nearby railway.

Receptor	Sound Climate Observations
NSR 3 – Church Lane	Sound from Phillips 66 Humber Refinery, together with other sources including bird song, wind generated noise, power tools and local residents.
NSR 4 – Hazel Dene	Sound from VPI Immingham CHP Plant, together with other sources include bird song, distant road traffic, trains, industrial moving sounds e.g. cranes.

7.4.6 The weather conditions during the survey periods were all within the parameters set out in the relevant guidance documents including BS 7445 (BSI, 2003) and BS 4142 (BSI, 2014c). The weather conditions are summarised for each location in Appendix 7A (ES Volume II).

7.4.7 The sound level meters and associated microphones were field calibrated at the beginning and end of their respective measurement periods in accordance with recommended practice. No significant drift in calibration was observed. The accuracy of the calibrator can be traced to the National Physical Laboratory Standards. Full details of the equipment used can be found in Appendix 7A (ES Volume II).

7.4.8 Section 8.1.1 of BS 4142 states that *background sound level* should be determined in *"weather conditions that are representative or comparable to the weather conditions when the specific sound occurs"*. The propagation of sound from outdoor sources is significantly influenced by the weather. In particular the propagation down wind of a source can be 10 to 15 dB greater than that upwind. The prediction methodology used to derive the *specific sound level* for all noise sources (based on ISO 9613 (ISO 1996)) assumes downwind conditions to the receptor. Therefore, the predicted *specific sound levels* will only occur when the receptor is downwind of the source. Representative *background sound levels* must therefore be measured in similar conditions. The dataset was therefore filtered so that only measurement sessions where the average wind direction was within a 120 degree arc (60 degrees each side) of the downwind condition were included for further analysis.

7.4.9 Section 8.1.4 of BS 4142 states that to obtain a representative value the dataset should be analysed statistically and then a judgment made. It clearly states that the lowest measured level should not be taken as representative. Therefore, after filtering for wind direction as described above the remaining levels were analysed and a representative value was selected.

7.4.10 The results from the baseline sound surveys are provided in Table 7.12. Surveys were undertaken during April and May 2022 during operational periods. The L_{Aeq} values presented in Table 7.12 combine all measurements taken in each time period (e.g. day/ night), whilst the L_{AF90} values presented are the 'representative' BS 4142 *background sound levels*, determined from analysis of the measured values.

Table 7.12: Baseline sound levels

Receptor	Time Period	$L_{Aeq,T}$ dB	$L_{AF90,\ 15min}$ dB
NSR 1 – Staple Road	Daytime	54	49
	Night-time	52	48
NSR 2 – Clarkes Road	Daytime	52	46
	Night-time	50	45
NSR 3 – Church Lane	Daytime	52	46
	Night-time	49	45
NSR 4 – Hazel Dene	Daytime	55	50
	Night-time	55	51

Future Baseline

7.4.11 In the absence of the Proposed Developments, future baseline sound levels at NSRs will continue to be influenced by traffic flows on surrounding road and rail networks, operations at Phillips 66, VPI and other industrial/ commercial premises, plus any future developments in the area.

7.5 Development Design and Impact Avoidance

Construction Noise

7.5.1 The proposed construction programme and working hours are described in Chapter 4: Construction Programme and Management (ES Volume I). However, it is likely that some construction works for the Proposed VPI Development may need to take place outside of the normal working hours and could be 24/7, although these would be limited to manage critical periods where required. Where on-site works are to be conducted outside the normal construction working hours, they will comply with any restrictions agreed with the local planning authority regarding control of noise. Normal construction working hours for the Proposed Phillips 66 Development could be 24/7 where required as per the existing Humber Refinery operating and maintenance working hours.

7.5.2 Measures to mitigate noise will be implemented during the construction phase of the Proposed Developments in order to minimise impacts at local NSRs and ecological receptors, particularly with respect to activities required outside of core working hours. Mitigation (included in the Outline CEMP) shall include, but not be limited to:

- abiding by agreed construction noise limits at locations to be agreed with NLC;
- ensuring that processes are in place to minimise noise before works begin and ensuring that BPM are being achieved throughout the construction programme, including the use of localised screening around significant noise producing plant and activities;
- ensuring that modern plant is used, complying with applicable UK noise emission requirements, and selection of inherently quiet plant where possible;
- use of hydraulic techniques for breaking, in preference to percussive techniques where reasonably practicable;
- use of lower noise piling (e.g. rotary bored or hydraulic jacking) rather than driven piling techniques, where reasonably practicable;
- off-site pre-fabrication for components of the Proposed Developments, where reasonably practicable;
- all plant and equipment being used for the works to be properly maintained, silenced where appropriate, operated to prevent excessive noise and switched off when not in use;
- all contractors to be made familiar with current legislation and the guidance in BS 5228 (Parts 1 and 2) (BSI, 2014a and b), which should form a prerequisite of their appointment;
- loading and unloading of vehicles, dismantling of site equipment such as scaffolding or moving equipment or materials within the Sites to be conducted in such a manner as to minimise noise generation, as far as reasonably practicable;
- appropriate routing of construction traffic on public roads and along access tracks, to reduce construction traffic noise, as far as reasonably practicable (see Chapter 8: Traffic and Transport ES Volume I);
- provision of information to NLC and local residents to advise of potential noisy works that are due to take place; and
- monitoring of any noise complaints and reporting to the Applicant for immediate investigation.

7.5.3 Method statements regarding construction management, traffic management, and overall site management will be prepared in accordance with best practice and relevant British Standards, to help to reduce the impacts of construction works. One of the key aims of such method statements will be to minimise noise disruption to local residents during the construction phase as far as reasonably practicable.

7.5.4 Regular communication with the local community throughout the construction period will also serve to publicise the works schedule, giving notification to residents regarding periods when higher levels of noise may occur during specific operations, and providing lines of communication where any complaints can be addressed.

7.5.5 The selected contractors for each of the Proposed Developments would be encouraged to be a member of the 'Considerate Constructors Scheme', which is an initiative open to all contractors undertaking building work.

7.5.6 As mentioned above, a Final CEMP will be prepared for each of the Proposed Developments which will set out provisions to ensure that the noise and vibration impacts relating to construction activities are reduced, as far as reasonably practicable, based on the measures outlined above. An Outline CEMP is provided as Appendix 4A (ES Volume II).

7.5.7 To assist in the preparation of the Final CEMP for each of the Proposed Developments, a detailed noise and vibration assessment will be undertaken for each of the Proposed Developments once the contractor is appointed and further details of construction methods are known, in order to identify specific mitigation measures for each of the Proposed Developments.

Carbon Dioxide and Other Venting During Commissioning and Operation

7.5.8 A CO_2 venting system will be designed to collect and safely disperse abnormal CO_2 releases generated in the Proposed Developments and needing to be discharged during start up venting, emergency venting or for safety reasons, for example due to plant over-pressurisation situations or due to maintenance activities. This venting system will comprise:

- small individual vents for minor emissions from equipment e.g. during routine maintenance;
- larger vents sized to safely dispose of larger volume emissions in an emergency scenario. The sizing of these vents is subject to ongoing work and would be confirmed at detailed design stage; and
- venting of steam lines and traps.

7.5.9 No planned operational venting of CO_2 or steam lines is expected during normal operation of the Proposed Developments and it is considered that noise associated with minor CO_2 venting from the Proposed Developments would be not significant in the context of the prevailing acoustic environment and in any event would be controlled by the Environmental Permit.

7.5.10 Measures to mitigate noise associated with any CO_2 venting during commissioning will include those listed above for construction.

7.5.11 As CO_2 venting during operation would only take place during emergency scenarios, it is not considered that any further consideration of effects or potential mitigation is required within this noise assessment for this activity.

Operational Noise

7.5.12 During the detailed design stage, potential significant residual effects of industrial sound will be mitigated by location and design. This will include appropriate stack design, use of cladding and shielding where appropriate and, where practical siting of equipment away from site boundaries and NSRs.

7.5.13 The Sites will be operated in accordance with Environmental Permits, issued and regulated by the Environment Agency. This will require operational noise to be controlled through the use of BAT, which will be determined through the Environmental Permit application.

Decommissioning Noise and Vibration

7.5.14 Appropriate best practice mitigation measures will be applied during any decommissioning works and documented in a Decommissioning Environmental Management Plan (DEMP) for each of the Proposed Developments to control noise effects. This is proposed to be secured by planning condition. No additional mitigation for decommissioning of the Proposed Developments beyond such best practice is considered necessary at this stage. The predicted noise and vibration effects of eventual decommissioning of the Proposed Developments are considered to be comparable to, or less than, those assessed for construction activities.

7.6 Likely Impacts and Effects of the Proposed Developments

Construction Phase Noise

7.6.1 Construction noise levels are likely to vary during the different construction phases, depending on the location of work sites and the proximity to NSRs.

7.6.2 Based upon the analysis and summary of the results of the free-field baseline ambient sound surveys undertaken, Table 7.13 sets out the BS 5228 'ABC' noise threshold categories and construction noise criteria (BSI, 2014a) at each NSR for the day, evening and night-time periods as set out in Table 7.4. A 3 dB correction has been added to measured free-field levels to present façade levels in the below table. These noise thresholds apply to both the Proposed Phillips 66 Development and Proposed VPI Development as well as the Proposed Developments together. Provided these construction noise criteria are not exceeded, the construction noise levels at NSRs will be below the SOAEL.

Table 7.13: Façade $L_{Aeq,\,T}$ noise levels and associated "ABC" assessment category

Receptor	Time Period	$L_{Aeq,T}$ dB	ABC Category	Indicative Construction Noise Criteria / SOAEL values
NSR 1 – Staple Road	Daytime*	57	A	65
	Evening*	54	A	55
	Weekend*	56	B	60
	Night-time*	55	C	55
NSR 2 – Clarkes Road	Daytime	55	A	65
	Evening	52	A	55
	Weekend	53	A	55
	Night-time	53	C	55
NSR 3 – Church Lane	Daytime	55	A	65
	Evening	52	A	55
	Weekend	54	A	55

Receptor	Time Period	$L_{Aeq,T}$ dB	ABC Category	Indicative Construction Noise Criteria / SOAEL values
	Night-time	52	C	55
NSR 4 – Hazel Dene	Daytime	58	A	65
	Evening	53	A	55
	Weekend	56	B	60
	Night-time	58	C	55

*Daytime is Monday to Friday 07:00 to 19:00 and Saturdays 07:00 to 13:00

Evening is Monday to Friday 19:00 to 23:00

Weekend is Saturday 13:00 to 23:00 and Sunday 07:00 to 23:00

Night is 23:00 to 07:00

Construction Noise Predictions

7.6.3 The following have been identified as the main construction phases which have the potential to affect NSRs:

- Phase 1 Enabling and Earthworks;
- Phase 2 Foundations (including CFA piling); and
- Phase 3 Mechanical and Electrical works.

7.6.4 The noise levels that will be generated by construction activities and experienced by nearby NSRs, such as residential properties, will depend upon a number of variables, including:

- the noise generated by plant or equipment used on each of the Sites, generally expressed as sound power levels;
- the periods of use of the plant on each of the Sites, known as its 'on-time';
- the distance between the noise source and the NSR;
- the attenuation due to ground absorption, air absorption and any barrier effects; and
- the existing noise environment and noise levels at the time of the works.

7.6.5 The construction noise predictions reported in this assessment have been undertaken using noise data for items of plant and calculation methodologies from BS 5228-1. Predicted noise levels for construction of the Proposed Developments have been based on construction methods used for similar developments in the UK. This gives an indication of where, at what stage, and during which construction activities construction noise is at risk of leading to potentially adverse and significant adverse effects.

7.6.6 The predicted levels apply to weekday daytime (07:00 – 19:00) working, although these could also be applied to other time periods where working at the same rate and intensity is proposed. The predictions assume constant operation of equipment throughout the 07:00 – 19:00 period which is a conservative worst-case assumption. Details regarding the noise prediction methodology, including a full list of indicative construction plant and associated sound power levels (L_{Aw}) for each construction phase, together with assumptions made during the predictions, are presented in Appendix 7B (ES Volume II).

7.6.7 Predictions have been carried out assuming all of the plant for each phase is operating at the same time, therefore presenting a worst-case scenario, as not all of the plant will be operating all of the time.

7.6.8 Predictions have also been carried out assuming that the phases occur concurrently. The worst case predicted construction noise levels at the NSRs are provided individually for both the Proposed Phillips 66 Development and the Proposed VPI Development, as well as the combined noise levels of the construction of both the Proposed Developments taking place at the same time.

7.6.9 The daytime construction noise contours (Figures 7.2a-c) are free-field construction: noise levels at ground floor level (1.5 m above ground) using 20 m x 20 m grid and are provided for illustration purposes.

Phillips 66 Construction Noise

7.6.10 For the Proposed Phillips 66 Development, 24-hour construction is proposed as work at Phillips 66 Humber Refinery already takes place 24 hours a day, 7 days per week. Therefore, the predicted façade construction noise levels during the daytime, evening, weekend and night-time periods have been included in Table 7.14.

7.6.11 The predicted daytime construction noise levels have been assumed, as a conservative approach, to be the equivalent to weekend daytime, evening and night-time levels. The daytime, evening and weekend construction noise levels have been predicted a ground floor level and the night-time construction noise levels have been predicted at first floor level (representative of bedrooms).

7.6.12 The predicted construction noise levels at NSRs are summarised in Table 7.14. The values in **bold** indicate where the construction noise threshold is exceeded.

Table 7.14: Predicted façade construction noise levels, Proposed Phillips 66 Development

Receptor	Time Period	Predicted Construction Noise Levels $L_{Aeq,T}$ dB (façade)					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
NSR 1 – Staple Road	Daytime	58	60	56	62	61	63
	Evening	**58**	**60**	**56**	**62**	**61**	**63**
	Weekend	58	60	56	**62**	**61**	**63**
	Night-time	**60**	**61**	**58**	**64**	**63**	**65**
NSR 2 – Clarkes Road	Daytime	54	56	53	59	58	60
	Evening	54	**56**	53	**59**	**58**	**60**
	Weekend	54	**56**	53	**59**	**58**	**60**
	Night-time	55	**57**	54	**59**	**58**	**60**
NSR 3 – Church Lane	Daytime	55	57	54	59	59	61
	Evening	55	**57**	54	**59**	**59**	**61**
	Weekend	55	**57**	54	**59**	**59**	**61**
	Night-time	**56**	**58**	54	**60**	**59**	**61**
NSR 4 – Hazel Dene	Daytime	48	50	47	52	52	53
	Evening	48	50	47	52	52	53

Receptor	Time Period	Predicted Construction Noise Levels $L_{Aeq,T}$, dB (façade)					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
	Weekend	48	50	47	52	52	53
	Night-time	49	51	47	53	52	54

7.6.13 The effects of the predicted daytime construction noise levels (as presented in Table 7.14) have been compared against the absolute construction noise criteria in Table 7.13, and using the semantic scale in Table 7.5, the classification of effects is summarised in Table 7.15 below.

Table 7.15: Construction noise effects – Proposed Phillips 66 Development

Receptor	Time Period	Predicted Effect					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
NSR 1 – Staple Road	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)
	Evening	**Moderate adverse (significant)**	**Major adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
	Weekend	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Moderate adverse (significant)**
	Night-time	**Major adverse (significant)**	**Major adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
NSR 2 – Clarkes Road	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)
	Evening	Minor adverse (not significant)	**Moderate adverse (significant)**	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
	Weekend	Minor adverse (not significant)	**Moderate adverse (significant)**	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
	Night-time	Minor adverse (not significant)	**Moderate adverse (significant)**	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
NSR 3 – Church Lane	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)
	Evening	Minor adverse (not significant)	**Moderate adverse (significant)**	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**

Receptor	Time Period	Predicted Effect					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
	Weekend	Minor adverse (not significant)	**Moderate adverse (significant)**	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
	Night-time	**Moderate adverse (significant)**	**Moderate adverse (significant)**	Minor adverse (not significant)	**Major adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
NSR 4 – Hazel Dene	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)
	Evening	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)
	Weekend	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)
	Night-time	Negligible adverse (not significant)	Minor adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)

7.6.14 Construction noise effects at the above NSRs during the daytime periods are predicted to be **negligible or minor adverse** (**not significant**). Phillips 66 has indicated that some construction works may take place during the evening, weekend and night-time periods.

7.6.15 At NSR 1, NSR 2 and NSR 3 there is the potential for **moderate and major adverse** (**significant**) effects during some of the phases of construction works during the evening weekend and night-time periods, especially when one or more phases may take place concurrently.

7.6.16 At NSR 4 there are no exceedances of the construction noise criteria during any assessment period, resulting in **negligible or minor adverse** (**not significant**) effects.

VPI Construction Noise

7.6.17 For the VPI development 24-hour construction may be required for some construction activities. Therefore, the predicted façade construction noise levels during the daytime, evening, weekend and night-time periods have been predicted.

7.6.18 The predicted daytime construction noise levels have been assumed, as a conservative approach, to be the equivalent to weekend daytime, evening and night-time levels. The daytime, evening and weekend construction noise levels have been predicted a ground floor level and the night-time construction noise levels have been predicted at first floor level (representative of bedrooms).

7.6.19 The predicted construction noise levels at NSRs are summarised in Table 7.16. The values in bold indicate where the construction threshold is exceeded.

Table 7.16: Predicted façade construction noise level – Proposed VPI Development

Receptor	Time Period	Predicted Construction Noise Levels $L_{Aeq,T}$, dB (façade)					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
NSR 1 – Staple Road	Daytime	49	48	48	51	51	53
	Evening	49	48	48	51	51	53
	Weekend	49	48	48	51	51	53
	Night-time	45	44	44	47	47	49
NSR 2 – Clarkes Road	Daytime	48	46	46	50	49	51
	Evening	48	46	46	50	49	51
	Weekend	48	46	46	50	49	51
	Night-time	48	47	47	50	50	52
NSR 3 – Church Lane	Daytime	48	47	48	51	50	52
	Evening	48	47	48	51	50	52
	Weekend	48	47	48	51	50	52

Receptor	Time Period	Predicted Construction Noise Levels $L_{Aeq,T}$, dB (façade)					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
	Night-time	49	47	48	51	50	52
NSR 4 – Hazel Dene	Daytime	61	59	60	**63**	**63**	**65**
	Evening	**61**	**59**	**60**	**63**	**63**	**65**
	Weekend	**61**	59	60	**63**	**63**	**65**
	Night-time	**62**	**60**	**61**	**64**	**64**	**66**

7.6.20 The effects of the predicted daytime construction noise levels (as presented in Table 7.16) have been compared against the absolute construction noise criteria in Table 7.13 and using the semantic scales in Table 7.5, the classification of effects is summarised in Table 7.17 below.

Table 7.17: Predicted construction noise effects – Proposed VPI Development

Receptor	Time Period	Predicted Effect					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
NSR 1 – Staple Road	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)
	Evening	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)
	Weekend	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)
	Night-time	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)
NSR 2 – Clarkes Road	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)
	Evening	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)
	Weekend	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)
	Night-time	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)
NSR 3 – Church Lane	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible (not significant)	Negligible adverse (not significant)
	Evening	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)
	Weekend	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)

Receptor	Time Period	Predicted Effect					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
	Night-time	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)
NSR 4 – Hazel Dene	Daytime	Minor adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)
	Evening	**Major adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
	Weekend	**Moderate adverse (significant)**	Minor adverse (not significant)	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
	Night-time	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**

7.6.21 Construction noise effects at the above NSRs during the daytime periods are predicted to be **negligible or minor** (**not significant**).

7.6.22 At NSR 4 there is the potential for **moderate and major adverse** (**significant**) effects during some of the phases of construction works during the evening, weekend and night-time periods, especially when one or more phases may take place concurrently.

7.6.23 At NSR 1, NSR 2 and NSR 3 there are no exceedances of the construction noise criteria during any assessment period, resulting in **negligible or minor adverse** (**not significant**) effects.

Combined Construction Noise of the Proposed Developments

7.6.24 The combined assessment of the construction works for both the Proposed Phillips 66 Development and the Proposed VPI Development occurring at the same time have been predicted.

7.6.25 The predicted daytime construction noise levels have been assumed, as a conservative approach, to be the equivalent to weekend daytime, evening and night-time levels. The daytime, evening and weekend construction noise levels have been predicted a ground floor level and the night-time construction noise levels have been predicted at first floor level (representative of bedrooms).

7.6.26 The predicted construction noise levels at NSRs are summarised in Table 7.18. The values in bold indicate where the construction threshold is exceeded.

Table 7.18: Predicted façade construction noise levels –Proposed Developments

Receptor	Time Period	Predicted Construction Noise Levels $L_{Aeq,T}$, dB (façade)					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
NSR 1 – Staple Road	Daytime	58	60	57	62	62	63
	Evening	**58**	**60**	**57**	**62**	**62**	**63**
	Weekend	58	60	57	**62**	**62**	**63**
	Night-time	**60**	**62**	**59**	**64**	**63**	**65**
NSR 2 – Clarkes Road	Daytime	55	57	54	59	59	60
	Evening	55	**57**	54	**59**	**59**	**60**
	Weekend	55	**57**	54	**59**	**59**	**60**
	Night-time	**56**	**57**	54	**59**	**59**	**61**
NSR 3 – Church Lane	Daytime	56	58	55	60	60	61
	Evening	**56**	**58**	55	**60**	**60**	**61**
	Weekend	**56**	**58**	55	**60**	**60**	**61**
	Night-time	**56**	**58**	55	**60**	**60**	**61**
	Daytime	61	60	60	64	63	65

Receptor	Time Period	Predicted Construction Noise Levels $L_{Aeq,T}$, dB (façade)					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
NSR 4 – Hazel Dene	Evening	**61**	**60**	**60**	**64**	**63**	**65**
	Weekend	**61**	60	60	**64**	**63**	**65**
	Night-time	**62**	**61**	**61**	**64**	**64**	**66**

7.6.27 The effects of the predicted construction noise levels (as presented in Table 7.18) have been compared against the absolute construction noise criteria in Table 7.13, and using the semantic scales in Table 7.5, the classification of effects is summarised in Table 7.19 below.

Table 7.19: Predicted Construction noise effects – Proposed Developments

Receptor	Time Period	Predicted Effect					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
NSR 1 – Staple Road	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)
	Evening	**Moderate adverse (significant)**	**Major adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
	Weekend	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Moderate adverse (significant)**
	Night-time	**Major adverse (significant)**	**Major adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
NSR 2 – Clarkes Road	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)
	Evening	Minor adverse (not significant)	**Moderate adverse (significant)**	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
	Weekend	Minor adverse (not significant)	**Moderate adverse (significant)**	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
	Night-time	**Moderate adverse (significant)**	**Moderate adverse (significant)**	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**

Receptor	Time Period	Predicted Effect					
		Phase 1 Enabling & Earthworks	Phase 2 Foundations	Phase 3 Mechanical & Electrical	Phase 1 & 2	Phase 2 & 3	All Phases
NSR 3 – Church Lane	Daytime	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)
	Evening	**Moderate adverse (significant)**	**Moderate adverse (significant)**	Minor adverse (not significant)	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
	Weekend	**Moderate adverse (significant)**	**Moderate adverse (significant)**	Minor adverse (not significant)	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
	Night-time	**Moderate adverse (significant)**	**Moderate adverse (significant)**	Minor adverse (not significant)	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
NSR 4 – Hazel Dene	Daytime	Minor adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)
	Evening	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**
	Weekend	**Moderate adverse (significant)**	Minor adverse (not significant)	Minor adverse (not significant)	**Moderate adverse (significant)**	**Moderate adverse (significant)**	**Major adverse (significant)**
	Night-time	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**	**Major adverse (significant)**

7.6.28 Construction noise effects at the above NSRs during the daytime periods are predicted to be **negligible or minor adverse** (**not significant**).

7.6.29 At all NSRs there is the potential for **moderate** and **major adverse** (**significant**) effects during some of the phases of construction works during the evening, weekend and night-time periods, especially when one or more phases may take place concurrently.

Construction Traffic Noise for the Proposed Developments

7.6.30 As reported in Chapter 8 Traffic and Transport, the peak period for construction traffic is expected in 2025. The CRTN traffic noise BNL on nine local roads has been calculated 'with' and 'without' construction traffic, using 18 AAWT traffic data provide by the Transport Consultant from traffic models reported in Chapter 8: Traffic and Transport (ES Volume I).

7.6.31 It has been assumed as a worst-case approach that the traffic speeds will remain the same 'with' and 'without' the construction traffic. The difference between the 'with' and 'without' construction traffic BNL has been compared to the short-term change criteria in noise levels as shown in Table 7.6.

7.6.32 The potential changes in road traffic noise as result of the construction traffic from the Proposed Developments as a whole is presented in Table 7.20. The change in road traffic noise levels due to each development individually would be smaller, therefore the results presented are a worst case.

Table 7.20: Changes in road traffic noise as a result of construction of the Proposed Developments

Link	'Without' the Proposed Developments construction flows (2025)			'With' the Proposed Developments construction flows (2025)			Change in BNL, dB ('with'- 'without')	Magnitude of Impact
	AAWT	% HGV	Speed (km/h)	AAWT	% HGV	Speed (km/h)		
Ropser Road	4,657	30	64	4,801	29	64	0.1	Negligible
Eastfield Road	8,201	12	45	10,011	12	45	0.9	Negligible
A160 Humber Road (near Killingholme Primary School)	15,112	51	75	16,910	46	75	0.5	Negligible
A180 (near Ulceby Skitter)	31,190	37	99	32,727	36	99	0.2	Negligible
A180 (near Immingham)	13,203	16	87	13,427	16	87	0.1	Negligible
A1173 Manby Road	9,394	13	65	9,473	13	65	0.0	Negligible
A160 Humber Road (south of Phillips 66 Site)	12,569	52	83	12,812	52	83	0.1	Negligible
Humber Road	11,473	21	49	11,550	21	49	0.0	Negligible
A15	25,284	9	88	26,031	9	88	0.1	Negligible

7.6.33 Table 7.20 shows that there is very small increase in road traffic noise due to construction traffic along the construction routes of the Proposed Developments during the peak construction phase. These will result in **negligible adverse** effects (**not significant**) at local residential NSRs. Based upon the above, no specific mitigation measures are required beyond those listed in Section 7.5.

Construction Phase Vibration

7.6.34 There are no residential receptors in close proximity to the Proposed Developments which have the potential to be affected by construction vibration. However, there is the potential for some vibration impacts upon buildings/ structures within the existing Phillips 66 or VPI Sites. It is considered unlikely that most typical construction working routines would generate levels of vibration above which building damage, as set out in Section 7.3, would be a possibility.

7.6.35 If piling, heavy earthworks, vibratory rollers or other significant vibration producing operations are proposed in close proximity to any existing sensitive buildings, further consideration will be given to potential impacts, once the contractors are appointed and the construction methods and requirements are developed. As the construction of the Proposed Developments and the use of many of the existing buildings and structures within the Phillips 66 and VPI Sites are both within the control of the Applicants, any identified issues can be effectively managed by the Applicants and their contractor. Potential measures to ensure that appropriate mitigation is in place during the works are discussed in Section 7.5 and Section 7.7.

Operation Phase

Operational Sound Criteria

7.6.36 Using the representative *background sound levels* presented in Table 7.12 and following the approach proposed by the Applicants, operational sound criteria are set as the *rating level* at the NSRs. As stated in paragraph 7.3.45, *rating level* will be limited to no greater than +5 dB above the *background sound level* in order to not exceed the LOAEL.

7.6.37 Table 7.21 presents the operational sound criteria, in the form of a *rating level*, for each of the Proposed Developments.

Table 7.21: Operational Sound Criteria (*Rating Levels*, $L_{Ar,Tr}$ dB)

Receptor	Time Period	Phillips 66: *Background Sound Level* + 5 dB	VPI: *Background Sound Level* + 5 dB
NSR 1 – Staple Road	Daytime	54	54
	Night-time	53	53
NSR 2 – Clarkes Road	Daytime	51	51
	Night-time	50	50
NSR 3 – Church Lane	Daytime	51	51
	Night-time	50	50
NSR 4 – Hazel Dene	Daytime	55	55
	Night-time	56	56

BS 4142 Assessment

7.6.38 The predictions of operational sound from the Proposed Developments have been based on information provided by the Applicants' engineering design teams. This information has included sound power levels for the major sound sources and details of the acoustic performance of noise mitigation measures already embedded into the designs. Using the Rochdale Envelope principle, reasonable worst-case operational sound impacts and effects are presented. The data are summarised in Appendix 7C (ES Volume II) which also lists the assumptions applied to the prediction methodology.

7.6.39 In accordance with BS 4142:2014 (BSI 2014c) the daytime assessment considers a 1-hour period, and the night-time assessment considers a 15-minute period. When in operation the sound produced by the plant will be constant in nature. As the plant may operate at any time of day or night the predicted *specific sound levels* will be the same for both day and night. No on-time correction is applicable due to the continuous nature of the operation. The predicted free-field operational *specific sound levels* at the NSRs during the daytime have been predicted at the ground floor and the night-time levels have been predicted at the upper floor.

7.6.40 The assessment has assumed that the potential sound of a tonal, impulsive or intermittent nature will be designed out of the Proposed Developments during the detailed design phase by the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary. However, a +3 dB correction for has been included at this stage to account for the potential, as a conservative approach, that NSRs might identify 'other distinctive character' in the new sound source in the future acoustic environment.

7.6.41 The daytime operational noise contours (Figures 7.3 a-c) present free-field operational sound levels at ground floor level (1.5 m above ground), and the night-time operational noise contours (Figures 7.4 a-c) present free-field operational sound levels at first floor (4 m above ground). All Figures use 20 m x 20 m grids and are provided for illustration purposes.

Proposed Phillips 66 Development

7.6.42 In the absence of additional mitigation, the predicted free-field operational *specific sound levels* at the NSRs around the Proposed Phillips 66 Development are presented in Table 7.22 below.

Table 7.22: Predicted Operational Sound Levels – Proposed Phillips 66 Development

Receptor	Daytime *specific sound level* $L_{Aeq,Tr}$ dB	Night-time *specific sound level* $L_{Aeq,Tr}$ dB
NSR 1 – Staple Road	57	57
NSR 2 – Clarkes Road	53	54
NSR 3 – Church Lane	55	55
NSR 4 – Hazel Dene	42	45

The daytime BS 4142 assessments are presented in Table 7.23 and the night-time BS 4142 assessments are presented in

7.6.43 Table 7.24. The magnitude of impact and significance of effect classifications have been included in the tables, to provide context for the BS 4142 assessment outcomes, with reference to the semantic scales in Table 7.8, Table 7.9 and Table 7.10.

7.6.44 The values presented are the difference between the representative *background sound level* at each NSR (Table 7.12) and the predicted *rating level* (the *specific sound level* $L_{Aeq,Tr}$ presented in Table 7.22 plus the character correction). Positive values in the table indicate an excess of the *rating level* over the *background sound level*.

Table 7.23: Daytime BS4142 assessment without additional mitigation – Proposed Phillips 66 Development

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	57	53	55	42
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	60	56	58	45
Representative *background sound level* ($L_{A90,T}$), dB	49	46	46	50
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+11	+10	+12	-5
BS 4142:2014 impact category (assigned from Table 7.8)	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, depending upon context	Indication of low impact
Magnitude of impact (assigned from Table 7.8)	Medium	Medium	Medium	Very low
Initial classification of effect (assigned from Table 7.10)	**Moderate adverse** (significant)	**Moderate adverse** (significant)	**Moderate adverse** (significant)	Negligible adverse (not significant)

Table 7.24: Night-time BS4142 assessment without additional mitigation – Proposed Phillips 66 Development

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	57	54	55	45
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	60	57	58	48
Representative *background sound level* ($L_{A90,T}$), dB	48	45	45	51
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+12	+12	+13	-3
BS 4142:2014 impact category (assigned from Table 7.8)	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, depending upon context	Indication of low impact

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Magnitude of impact (assigned from Table 7.8)	Medium	Medium	Medium	Very low
Initial classification of effect (assigned from Table 7.10)	**Moderate adverse** (significant)	**Moderate adverse** (significant)	**Moderate adverse** (significant)	Negligible adverse (not significant)

7.6.45 In accordance with Table 7.10, the values in Table 7.23 and

7.6.46 Table 7.24 for the worst-case scenario produce a range of impact magnitudes from very low to medium adverse at the NSRs. This would result in effects between **negligible adverse (not significant)** to **moderate adverse (significant)**, subject to consideration of context.

7.6.47 Phillips 66 and VPI are already a continuously operating industrial source in the study area, and there are other industrial/ commercial activities around the Sites. This is likely to mean that residents at all NSR are already accustomed to industrial sources. Nevertheless, based upon the desire to reduce *rating levels* to +3 dB, or where not possible no greater than +5 dB, above the *background sound level* to achieve the operational sound criteria in Table 7.21, potential mitigation options to reduce sound levels have been considered and are discussed in Section 7.7.

Proposed VPI Development

7.6.48 In the absence of additional mitigation, the predicted free-field operational *specific sound levels* at the NSR around the Proposed VPI Development are presented in Table 7.25 below.

Table 7.25: Predicted Operational Sound Levels – Proposed VPI Development

Receptor	Daytime *specific sound level* $L_{Aeq,Tr}$ dB	Night-time *specific sound level* $L_{Aeq,Tr}$ dB
NSR 1 – Staple Road	44	44
NSR 2 – Clarkes Road	41	41
NSR 3 – Church Lane	43	43
NSR 4 – Hazel Dene	56	56

7.6.49 The daytime BS 4142 assessments are presented in Table 7.26 and the night-time BS 4142 assessments are presented in Table 7.27. The magnitude of impact and significance of effect classifications have been included in the tables, to provide context for the BS 4142 assessment outcomes, with reference to the semantic scales in Table 7.8, Table 7.9 and Table 7.10.

7.6.50 The values presented are the difference between the representative *background sound level* at each NSR (Table 7.12) and the predicted *rating level* (the *specific sound level* $L_{Aeq,T}$ presented in Table 7.25 plus the character correction). Positive values in the table indicate an excess of the *rating level* over the *background sound level*.

Table 7.26: Daytime BS4142 assessment without additional mitigation – Proposed VPI Development

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	44	41	43	56

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	47	44	46	59
Representative *background sound level* ($L_{A90,T}$), dB	49	46	46	50
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	-2	-2	+0	+9
BS 4142:2014 impact category (assigned from Table 7.8)	Indication of low impact	Indication of low impact	Indication of low impact	Indication of a significant adverse impact
Magnitude of impact (assigned from Table 7.8)	Very low	Very low	Very low	Medium
Initial classification of effect (assigned from Table 7.10)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	**Moderate adverse** (significant)

Table 7.27: Night-time BS4142 assessment without additional mitigation – Proposed VPI Development

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	44	41	43	56
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	47	44	46	59
Representative *background sound level* ($L_{A90,T}$), dB	48	45	45	51
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	-1	-1	+1	+8
BS 4142:2014 impact category (assigned from Table 7.8)	Indication of low impact	Indication of low impact	Indication of a low to adverse impact, depending upon context	Indication of an adverse to significant adverse impact, depending upon context
Magnitude of impact (assigned from Table 7.8)	Very low	Very low	Very Low/Low	Low/Medium
Initial classification of effect (assigned from Table 7.10)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible/ Minor adverse (not significant)	**Minor/ Moderate adverse** (significant)

7.6.51 In accordance with Table 7.10, the values in Table 7.26 and Table 7.27 for the worst-case scenario produce a range of impact magnitudes from very low to medium adverse at the NSRs. This would result in effects between **negligible adverse (not significant)** to **moderate adverse** (significant), subject to consideration of context.

7.6.52 Phillips 66 and VPI are already a continuously operating industrial source in the study area, and there are other industrial/ commercial activities around the Sites. This is likely to mean that residents at all NSR are already accustomed to industrial sources. Nevertheless, to achieve the operational noise criteria in Table 7.21, potential mitigation options to reduce sound levels have been considered and are discussed in Section 7.7.

Combined Operational Sound from the Proposed Developments

7.6.53 In the absence of additional mitigation, the predicted free-field operational *specific sound levels* at the NSRs around the Proposed Developments as a whole are presented in Table 7.28 below.

Table 7.28: Predicted Operational Sound Levels – Both Proposed Developments – Unmitigated

Receptor	Daytime *specific sound level* L_{Aeq} dB	Night-time *specific sound level* L_{Aeq} dB
NSR 1 – Staple Road	57	57
NSR 2 – Clarkes Road	53	54
NSR 3 – Church Lane	55	55
NSR 4 – Hazel Dene	56	56

7.6.54 The daytime BS 4142 assessments are presented in Table 7.29 and the night-time BS 4142 assessments are presented in Table 7.30. The magnitude of impact and effect classification has been included in the tables, to provide context for the BS 4142 assessment outcomes, with reference to the semantic scales in Table 7.8, Table 7.9 and Table 7.10.

7.6.55 The values presented are the differences between the representative *background sound level* at each NSR (Table 7.12) and the predicted *rating level* (the *specific sound level* $L_{Aeq,T}$ presented in Table 7.25 plus the character correction). Positive values in the table indicate an excess of the *rating level* over the *background sound level*.

Table 7.29: Daytime BS4142 assessment without additional mitigation – Both Proposed Developments

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	57	53	55	56
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	60	56	58	59
Representative *background sound level* ($L_{A90,T}$), dB	49	46	46	50
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+11	+10	+12	+9

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
BS 4142:2014 impact category (assigned from Table 7.8)	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, , depending upon context
Magnitude of impact (assigned from Table 7.8)	Medium	Medium	Medium	Medium
Initial classification of effect (assigned from Table 7.10)	**Moderate adverse** (significant)	**Moderate adverse** (significant)	**Moderate adverse** (significant)	**Moderate adverse** (significant)

Table 7.30: Night-time BS4142 assessment without additional mitigation – Both Proposed Developments

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	57	54	55	56
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	60	57	58	59
Representative *background sound level* ($L_{A90,T}$), dB	48	45	45	51
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+12	+12	+13	+8
BS 4142:2014 impact category (assigned from Table 7.8)	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, depending upon context	Indication of a significant adverse impact, depending upon context	Indication of an adverse to significant adverse impact, depending upon context
Magnitude of impact (assigned from Table 7.8)	Medium	Medium	Medium	Low/Medium
Initial classification of effect (assigned from Table 7.10)	**Moderate adverse** (significant)	**Moderate adverse** (significant)	**Moderate adverse** (significant)	**Minor/ Moderate adverse** (significant)

7.6.56 In accordance with Table 7.10, the values in Table 7.29 and Table 7.30 for the worst-case scenario produces an impact magnitude of low/medium or medium at the NSRs. This would result in minor/moderate adverse or moderate adverse (significant) effects, subject to consideration of context.

7.6.57 Phillips 66 and VPI are already a continuously operating industrial source in the study area, and there are other industrial/ commercial activities around the Sites. This is likely to mean that residents at all NSR are already accustomed to industrial sources. Nevertheless, to

achieve the operational noise criteria in Table 7.21, potential mitigation options to reduce sound levels have been considered and are discussed in Section 7.7.

Decommissioning Phase

7.6.58 The potential impacts and effects would require further consideration at the decommissioning stage of the Proposed Developments, but potential measures to ensure that appropriate mitigation is in place during such works are detailed in Section 7.5.

7.6.59 The effects of eventual decommissioning are considered to be comparable to, or less than, those assessed for construction activities.

7.6.60 Decommissioning would require submission of a DEMP to the relevant planning authority for its approval, secured by a planning condition. Appropriate best practice mitigation measures will be applied during any decommissioning works, as described in section 7.5, and documented in a DEMP; no additional mitigation for decommissioning of the Proposed Developments beyond such best practice specified in BS 5228 and section 7.5 is considered necessary to specify at this stage.

7.7 Mitigation and Enhancement Measures

Construction Phase

7.7.1 This assessment has identified no greater than negligible/ minor adverse (not significant) noise effects during construction works during core daytime and Saturday morning working hours, and up to moderate/ major adverse (significant) noise effects if Phillips 66 and/or VPI construction work were to take place at the same intensity during evenings/ night-time and/or weekend periods.

7.7.2 In the event that Phillips 66 and VPI construction activities are required during evening/ night-time periods, levels in excess of the SOAEL for night-time works could occur (depending on the nature of activities undertaken and the intensity of working). This could result in a moderate/ major adverse (significant) noise effect at NSRs in the absence of additional mitigation. Measures would therefore be put in place to control or restrict activities during evenings/ night-times so as to not exceed the SOAEL or relevant noise criteria at locations to be agreed with NLC. Control of construction noise and vibration, for example construction noise and vibration limits, is proposed to be secured by a planning condition. By timing construction works and avoiding noisier activities being undertaken during the evening, weekend and night, significant adverse effects can therefore be avoided.

7.7.3 The list of noise control measures presented within Section 7.5 of this chapter provides a detailed but not exhaustive list of construction noise management measures. The measures listed will be implemented and supplemented as necessary with further bespoke measures identified through further detailed assessment as part of the Final CEMP. With respect to reduction of noise levels, this may include, but is not limited to, use of temporary acoustic barriers and use of a partial enclosures around items of plant. The need for monitoring of noise and vibration levels during construction will also be determined through the detailed assessment to be undertaken.

7.7.4 Residual effects after mitigation is implemented are described in Section 7.8.

Operation Phase

7.7.5 The operational assessment has assumed that potential sound of a tonal, impulsive or intermittent nature (according to BS4142: 2014) will be designed out of the Proposed Developments during the detailed design phase through the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary. However, a +3 dB correction for has been included at this stage to account for the potential, as a conservative approach, that NSRs might identify ‘other distinctive character’ in the new sound source in the future acoustic environment.

7.7.6 Based on the worst-case results presented in Section 7.6, further mitigation would be required to achieve the operational daytime and night-time LOAEL criterion of a *rating level* no greater than +5 dB above the defined representative *background sound level* at each NSR.

7.7.7 The potential mitigation measures and general principles to achieve this may include, but are not limited to, the following measures, depending upon the potential benefits achieved from such measures:

- reducing the breakout noise from plant through the use of enhanced enclosures, or potentially containing them within a building;
- reducing air inlet noise emissions by the addition of further in-line attenuation;
- reducing stack outlet noise emissions by the addition of silencers or sound proofing panels;
- reducing fin fan cooler noise emissions by screening, re-sizing, fitting low noise fans or attenuation;
- screening or enclosing the compressors or other equipment;
- use of screening or bunding to shield receptors from noise sources; or
- orientation of plant within the Site to provide screening of low-level noise sources by other buildings and structures, or orientating fans and the air inlets away from sensitive receptors.

Proposed Phillips 66 Development

7.7.8 Table 7.31 outlines the overall attenuation required to achieve the daytime and night-time operational sound criteria i.e. the *rating level* to be no greater than +5 dB above the defined representative *background sound level* at each NSR.

Table 7.31: Overall attenuation (dB) required to achieve operational sound criteria

Receptor	Required attenuation to achieve daytime +5 dB criterion	Required attenuation to achieve night-time +5 dB criterion
NSR 1 – Staple Road	6	7
NSR 2 – Clarkes Road	5	7
NSR 3 – Church Lane	7	8
NSR 4 – Hazel Dene	-	-

7.7.9 The sound contribution at each NSR from each modelled sound source across the Proposed Phillips 66 Development has been ranked. The potential attenuation required from the source sound power levels of the key noise emitting plant in order to meet a *rating level* of no greater than +5 dB above the defined representative *background sound level* at each NSR is listed in Table 7.32. These reductions could be achieved either through reduction of sound power level at source or by application of the mitigation measures listed in paragraph 7.7.7 above.

Table 7.32: Attenuation required (dB) from individual plant items – Proposed Phillips 66 Development

Plant Ref. (see Appendix 7C for plant details)	Attenuation required to achieve a *rating level* no greater than +5 dB above the defined *background sound level*
P66-33, P66-34, P66-35, P66-36, P66-37	-11
P66-13, P66-51, P66-52, P66-55, P66-58	-10

Plant Ref. (see Appendix 7C for plant details)	Attenuation required to achieve a *rating level* no greater than +5 dB above the defined *background sound level*
P66-39, P66-56, P66-57	-9

7.7.10 During the detailed design of the Proposed Phillips 66 Development it may be desirable or more practical to apply higher attenuation to some plant items/ buildings than listed in Table 7.32 in order to reduce the attenuation applied to other plant items/ buildings and still achieve the +5 dB criterion.

7.7.11 The daytime and night-time BS 4142 assessment results for these mitigated predictions are presented in Table 7.33 and Table 7.34.

Table 7.33: Daytime BS4142 assessment with additional mitigation (to achieve up to +5dB above the *background sound level*) – Proposed Phillips 66 Development

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	50	45	47	36
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	53	48	50	39
Representative *background sound level* ($L_{A90,T}$), dB	49	46	46	50
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+4	+2	+4	-11
BS 4142:2014 effect category (assigned from Table 7.8)	Indication of an adverse impact, depending upon context	Indication of a low to adverse impact, depending upon context	Indication of an adverse impact, depending upon context	Indication of a low impact
Magnitude of impact (assigned from Table 7.8)	Low	Very Low/ Low	Low	Very low
Initial classification of effect (assigned from Table 7.10)	Minor adverse (not significant)	Negligible/ minor adverse (not significant)	Minor adverse (not significant)	Negligible adverse (not significant)

Table 7.34: Night-time BS4142 assessment with additional mitigation (to achieve up to +5 dB above the *background sound level*) – Proposed Phillips 66 Development

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	50	46	47	37
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	53	49	50	40
Representative *background sound level* ($L_{A90,T}$), dB	48	45	45	51
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+5	+4	+5	-11
BS 4142:2014 impact category (assigned from Table 7.8)	Indication of an adverse impact, depending upon context	Indication of an adverse impact, depending upon context	Indication of an adverse impact, depending upon context	Indication of low impact
Magnitude of impact (assigned from Table 7.8)	Low	Low	Low	Very low
Initial classification of effect (assigned from Table 7.10)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Negligible adverse (not significant)

7.7.12 Residual effects after mitigation has been implemented are described in Section 7.8.

Proposed VPI Development

7.7.13 Based on the worst-case results presented in Table 7.26 and Table 7.27 mitigation would be required to achieve operational sound levels equal to the LOAEL, or lower, at each NSR. Table 7.35 outlines the overall attenuation required to achieve the daytime and night-time operational sound criteria i.e. the *rating level* to be no greater than +5 dB, above the defined representative *background sound level* at each NSR.

Table 7.35: Overall attenuation (dB) required to achieve operational sound criteria – Proposed VPI Development

Receptor	Required attenuation to achieve daytime +5 dB criterion	Required attenuation to achieve night-time +5 dB criterion
NSR 1 – Staple Road	-	-
NSR 2 – Clarkes Road	-	-
NSR 3 – Church Lane	-	-
NSR 4 – Hazel Dene	-4	-3

7.7.14 The sound contribution at each receptor from each modelled sound source across the Proposed VPI Development has been ranked. The potential attenuation required from the

source sound power levels of the key noise emitting plant in order to meet the operational sound criteria of +5 dB above the *background sound level* is listed in Table 7.36. These reductions could be achieved either through reduction of sound power levels at source or by application of the mitigation measures listed in paragraph 7.7.7 above.

Table 7.36: Attenuation required (dB) from individual plant items – Proposed VPI Development

Plant Ref. (See Appendix 7C for plant details)	Attenuation required to achieve a *rating level* no greater than +5 dB above the *background sound level*
VPI-19	-5
VPI-54	-10
VPI 99a-99d	-10
VPI 70	-9
VPI-29-39	-5
VPI-46-48	-5

7.7.15 During detailed design of the Proposed VPI Development it may be desirable or more practical to apply higher attenuation to some plant items/ buildings than listed in Table 7.32 in order to reduce the attenuation applied to other plant items/ buildings and still achieve the +5 dB.

7.7.16 The daytime and night-time BS 4142 assessment results for these mitigated predictions are presented in Table 7.37 and Table 7.38.

Table 7.37: Daytime BS4142 assessment with additional mitigation to achieve +5dB above background – Proposed VPI Development

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	42	39	41	52
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	45	42	44	55
Representative *background sound level* ($L_{A90,T}$), dB	49	46	46	50
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	-4	-4	-2	+5
BS 4142:2014 impact category (assigned from Table 7.8)	Indication of low impact	Indication of low impact	Indication of low impact	Indication of an adverse impact, depending upon context
Magnitude of impact (assigned from Table 7.8)	Very low	Very low	Very low	Low

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Initial classification of effect (assigned from Table 7.10)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)

Table 7.38: Night-time BS4142 assessment with additional mitigation to achieve +3/+5dB above background – Proposed VPI Development

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	42	39	41	53
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	45	42	44	56
Representative background sound level ($L_{A90,T}$), dB	48	45	45	51
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	-3	-3	-1	+5
BS 4142:2014 effect category (assigned from Table 7.8)	Indication of low effect	Indication of low effect	Indication of low effect	Indication of an adverse impact, depending upon context
Magnitude of impact (assigned from Table 7.8)	Very low	Very low	Very low	Low
Initial classification of effect (assigned from Table 7.10)	Negligible adverse (not significant)	Negligible adverse (not significant)	Negligible adverse (not significant)	Minor adverse (not significant)

7.7.17 Residual effects after mitigation has been implemented are described in Section 7.8.

Combined Proposed Developments

7.7.18 Based on the worst-case results presented in Table 7.29 and Table 7.30, mitigation would be required to achieve operational sound levels equal to the LOAEL at each NSR. Table 7.39 outlines the overall attenuation required to achieve the daytime and night-time operational sound criteria i.e. the *rating level* to be no greater than +5 dB, above the defined representative *background sound level* at each NSR.

Table 7.39: Overall attenuation (dB) required to achieve operational sound criteria

Receptor	Required attenuation to achieve daytime (+5 dB) criterion	Required attenuation to achieve night-time (+5 dB) criterion
NSR 1 – Staple Road	6	7
NSR 2 – Clarkes Road	5	7
NSR 3 – Church Lane	7	8

Receptor	Required attenuation to achieve daytime (+5 dB) criterion	Required attenuation to achieve night-time (+5 dB) criterion
NSR 4 – Hazel Dene	4	3

7.7.19 The sound contribution at each receptor from each modelled sound source across the Proposed Developments have been ranked. The potential attenuation required from the source sound power levels of the key noise emitting plant in order to meet the operational noise criterion of *rating level* +5 dB above the *background sound level* is listed in Table 7.40. These reductions could be achieved either through reduction of sound power level at source or by application of the mitigation measures listed in paragraph 7.7.7 above.

Table 7.40: Attenuation required (dB) from individual plant items – Both Proposed Developments

Plant Item	Attenuation required to achieve a *rating level* no greater than +5 dB above the defined *background sound level*
P66-13, P66-33, P66-34, P66-35, P66-36, P66-37, P66-51, P66-52, P66-55, P66-58, P66-67	-11
P66-39, P66-56, P66-57	-10
P66-32	-8
VPI-19	-5
VPI-54	-10
VPI-99a-99d	-10
VPI-70	-9
VPI-29-39	-5
VPI 46-48	-5

7.7.20 During detailed design of the Proposed Developments it may be desirable or more practical to apply higher attenuation to some plant items/ buildings than listed in Table 7.32 in order to reduce the attenuation applied to other plant items/ buildings and still achieve the +5 dB criteria.

7.7.21 The daytime and night-time BS 4142 assessment results for these mitigated predictions are presented in Table 7.41 and Table 7.42.

Table 7.41: Daytime BS4142 assessment with additional mitigation to achieve +5dB above the *background sound level* – Combined Proposed Developments

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	50	45	47	52
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	53	48	50	55

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Representative *background sound level* ($L_{A90,T}$), dB	49	46	46	50
Excess of *rating level* over background sound level ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+4	+2	+4	+5
BS 4142:2014 effect category (assigned from Table 7.8)	Indication of an adverse impact, depending upon context	Indication of a low to adverse impact, depending upon context	Indication of an adverse impact, depending upon context	Indication of an adverse impact, depending upon context
Magnitude of impact (assigned from Table 7.8)	Low	Very Low/Low	Low	Low
Initial classification of effect (assigned from Table 7.10)	Minor adverse (not significant)	Negligible/ minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)

Table 7.42: Night-time BS4142 assessment with additional mitigation to achieve +5dB above the *background sound level* – Combined Proposed Developments

Receptor	NSR 1 – Staple Road	NSR 2 – Clarkes Road	NSR 3 – Church Lane	NSR 4 – Hazel Dene
Specific sound level L_s ($L_{Aeq,Tr}$), dB	50	46	47	53
Acoustic feature correction, dB	+3	+3	+3	+3
Rating level ($L_{Ar,Tr}$), dB	53	49	50	56
Representative *background sound level* ($L_{A90,T}$), dB	48	45	45	51
Excess of *rating level* over *background sound level* ($L_{Ar,Tr}$ - $L_{A90,T}$), dB	+5	+4	+5	+5
BS 4142:2014 effect category (assigned from Table 7.8)	Indication of an adverse impact, depending upon context	Indication of an adverse impact, depending upon context	Indication of an adverse impact, depending upon context	Indication of an adverse impact, depending upon context
Magnitude of impact (assigned from Table 7.8)	Low	Low	Low	Low
Initial classification of effect (assigned from Table 7.10)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)	Minor adverse (not significant)

7.7.22 Residual effects after mitigation has been implemented are described in Section 7.8.

Decommissioning Phase

7.7.23 Consistent with construction mitigation, it has been assumed that relevant best practice mitigation measures would be in place during any decommissioning works. No additional

mitigation has been identified as necessary for the decommissioning phase of the Proposed Developments.

7.8 Residual Effects and Conclusions

A summary of the likely residual effects, following the implementation of appropriate mitigation to reduce sound, noise and vibration during construction, operation and decommissioning phases, is presented in Table 7.43 below.

Table 7.43: Summary of effects

Phase	Description of Effect	Time Period	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
Construction	Noise effects on residential NSRs during construction of the Proposed Phillips 66 Development	Daytime	**Negligible/ minor adverse** (not significant)	Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed	**Up to minor adverse** (not significant)	Short term, reversible
		Evening, Weekend, Night-time	**Negligible up to major adverse** (significant)	Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed	**Up to minor adverse** (not significant)	Short term, reversible
	Noise effects on residential NSRs during construction of the Proposed VPI Development	Daytime	**Negligible/ minor adverse** (not significant)	Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed	**Up to minor adverse** (not significant)	Short term, reversible
		Evening, Weekend, Night-time	**Negligible up to major adverse** (significant)	Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed	**Up to minor adverse** (not significant)	Short term, reversible

Phase	Description of Effect	Time Period	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
	Combined noise effects on residential NSR during construction of both Proposed Developments simultaneously	Daytime	**Negligible/ minor adverse** (not significant)	Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed	**Up to minor adverse** (not significant)	Short term, reversible
		Evening, Weekend, Night-time	**Minor up to major adverse** (significant)	Further detailed assessment and implementation of a CEMP once a contractor appointed and appropriate mitigation is employed such that the BS 5228 ABC noise criteria are met and the section 7.5 mitigation guidance is followed	**Up to minor adverse** (not significant)	Short term, reversible
	Noise effects due to construction traffic	All time periods	**Negligible adverse** (not significant)	No further mitigation considered necessary, unless number of proposed construction vehicle movements changes.	**Negligible adverse** (not significant)	Short term, reversible
	Vibration effects on existing structures on site	All time periods	**Minor adverse or less** (not significant)	Further assessment once construction methods confirmed and appropriate mitigation implemented so as not to exceed the vibration SOAEL	**Minor adverse or less** (not significant)	Short term, reversible
Operation	Effects of operational sound on residential NSRs – Proposed Phillips 66 Development	Daytime and Night-time	**Negligible adverse** (not significant) to **moderate adverse** (significant)	Application of practical mitigation to reduce relevant sound at source to meet the operational sound criteria in Table 7.21	**Negligible to minor adverse** (not significant)	Long-term, reversible
	Effects of operational sound on residential NSRs – Proposed VPI Development	Daytime and Night-time	**Negligible adverse** (not significant) to **moderate adverse** (significant)	Application of practical mitigation to reduce relevant sound at source to meet the operational sound criteria in Table 7.21	**Negligible to minor adverse** (not significant)	Long-term, reversible

Phase	Description of Effect	Time Period	Significance of Effect (Before Mitigation)	Mitigation Measures	Significance of Effect (After Mitigation)	Duration (short/ medium/ long term) and Reversibility
	Combined effects of operational sound on residential NSRs – Both Proposed Developments	Daytime and Night-time	**Minor/ moderate to Moderate adverse** (significant)	Application of practical mitigation to reduce relevant sound at source to meet the operational sound criterion in Table 7.21	**Minor adverse** (not significant)	Long-term, reversible
Decommissioning	Noise effects during decommissioning of the Proposed Phillips 66 Development	All time periods	As detailed above for construction effects.	Further detailed assessment and Decommissioning Environmental Management Plan (DEMP), particularly regarding working outside of daytime working hours.	Further assessment would need to confirm the potential level of effects at NSRs, although they would be expected to be similar or less than those during construction.	Short-term, reversible
	Noise effects during decommissioning of the Proposed VPI Development	All time periods	As detailed above for construction effects.	Further detailed assessment and Decommissioning Environmental Management Plan (DEMP), particularly regarding working outside of daytime working hours.	Further assessment would need to confirm the potential level of effects at NSRs, although they would be expected to be similar or less than those during construction.	Short-term, reversible
	Combined noise effects during decommissioning of the Both Proposed Developments simultaneously	All time periods	As detailed above for construction effects.	Further detailed assessment and Decommissioning Environmental Management Plan (DEMP), particularly regarding working outside of daytime working hours.	Further assessment would need to confirm the potential level of effects at NSRs, although they would be expected to be similar or less than those during construction.	Short-term, reversible

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Contents

7A. Noise Survey Information

7A.1 Monitoring Location 1 (M1) Staple Road

7A.1.1 Table 7A.1 below provides information on the survey location and conditions for M1.

Table 7A.1: Location M1 survey location details

Location M1	Description
Location description and OS grid reference (Easting/Northing)	Melrose, Staple Road, South Killingholme ///squaring.nips.rocker 515099, 416451
Monitoring date and time	22/04/2022 13:45 - 03/05/2022 10:56
Monitoring height above ground	1.5 m
Distance to nearest building facade	Greater than 3.5 m
Average wind speeds (m/s)	19 mph on set up
Wind direction	NE on set up
Temperature (°C)	14°C on set up
Cloud coverage	0/8 on set up
Sound Level Meter and Serial No.	Rion NL-52 386766 calibrated 03 June 2020
Field Calibrator and Serial No.	B&K 4321 2217877 calibrated 15 July 2021
Description of the sound climate	Dominated by Phillips 66 refinery noise and wind

7A.1.2 Plate 7A.1 below shows a photograph of the monitoring location.

Plate 7A.1: Location M1 at Staple Road looking towards the receptor

7A.2 Monitoring Location 2 (M2) Clarkes Road

7A.2.1 Table 7A.2 below provides information on the survey location and conditions for M2. A weather monitoring station recording the wind speed, wind direction and rainfall was also set up at M2 for the duration of the monitoring period.

Table 7A.2: Location M2 survey location details

Location M2	Description
Location description and OS grid reference (Easting/Northing)	Westfield Farm, Clarkes Road, North Killingholme ///pages.visions.arise 514612, 416811
Monitoring date and time	22/04/2022 15:45 – 03/05/2022 13:30
Monitoring height above ground	1.5 m
Distance to nearest building facade	Greater than 3.5 m
Average wind speeds (m/s)	19 mph on set up
Wind direction	NE on set up
Temperature (°C)	14°C on set up
Cloud coverage	0/8 on set up
Sound Level Meter and Serial No.	Rion NL-52 386762 calibrated 14 July 2020
Field Calibrator and Serial No.	B&K 4321 2217877 calibrated 15 July 2021
Weather station and Serial No.	RS Hydro Vaisala Weather Transmitter WXT533 Serial no. P1540170 and Outpost COBRA2 Series 3G logger Serial no. OP46548
Description of the sound climate	Dominated by Phillips 66 refinery noise. Other sound from nearby railway and birdsong

7A.2.2 Plate 7A.2 below shows a photograph of the monitoring location.

Plate 7A.2: Location M2 at Clarkes Road looking towards the receptor

7A.3 Monitoring Location 3 (M3) Church Lane

7A.3.1 Table 7A.3 below provides information on the survey location and conditions for M3.

Table 7A.3: Location M3 survey location details

Location M3	Description
Location description and OS grid reference (Easting/Northing)	Church Lane, North Killingholme ///grocers.nips.influencing 514655, 417262
Monitoring date and time	22/04/2022 14:45-03/05/2022 13:55
Monitoring height above ground	1.5 m
Distance to nearest building facade	Greater than 3.5 m
Average wind speeds (m/s)	19 mph on set up
Wind direction	NE on set up
Temperature (°C)	14°C on set up
Cloud coverage	0/8 on set up
Sound Level Meter and Serial No.	Rion NL-52 1021280 calibrated 13 April 2021
Field Calibrator and Serial No.	B&K 4321 2217877 calibrated 15 July 2021
Description of the sound climate	Dominated by Phillips 66 refinery. Other sound from power tools at nearby residential properties, birds and wind.

7A.3.2 Plate 7A.3 below shows a photograph of the monitoring location.

Plate 7A.3: Location M3 Church Lane looking away from receptor

7A.4 Monitoring Location 4 (M4) Hazeldene

7A.4.1 Table 7A.4 below provides information on the survey location and conditions for M4.

Table 7A.4: Location M4 survey location details

Location M4	Description
Location description and OS grid reference (Easting/Northing)	Hazel Dene, Marsh Lane, South Killingholme ///sands.inert.shave 517336, 417280
Monitoring date and time	22/04/2022 16:32 – 03/05/2022 14:02
Monitoring height above ground	1.5 m
Distance to nearest building facade	Greater than 3.5 m
Average wind speeds (m/s)	19 mph on set up
Wind direction	NE on set up
Temperature (°C)	14°C on set up
Cloud coverage	0/8 on set up
Sound Level Meter and Serial No.	Rion NL-52 1021278 Calibrated 20 May 2021
Field Calibrator and Serial No.	B&K 4321 2217877 calibrated 15 July 2021
Description of the sound climate	Dominated by industrial noise (unable to distinguish between VPI and Phillips 66 industrial noise). Other sources include birdsong, railway traffic, distant road traffic.

7A.4.2 Plate 7A.4 below shows a photograph of the monitoring location.

Plate 7.4: Location M4 Hazel Dene looking away from receptor

Acoustics and Vibration Group

Our Ref: 18917525/1 Rev 0

22nd June 2023

VPI Immingham LLP
Rosper Road
Immingham
North Lincolnshire
DN40 3DZ

For the attention of Matthew Welch

Dear Matt

Re: Environmental Noise Monitoring – Immingham CHP

Please find attached the results of the environmental noise measurements which were carried out within the vicinity of the VPI CHP facility, Immingham, on the night of 1st – 2nd June 2023.

1 Introduction

The Acoustics and Vibration Group of Bureau Veritas UK Limited has been retained by VPI Immingham LLP to carry out an environmental noise survey in the vicinity of the CHP (Combined Heat and Power) plant at Immingham, North Lincolnshire. This report presents the results and findings of the survey undertaken on the night of 1st – 2nd June 2023, conducted at a single established receptor location close to the site.

2 Measurement Procedure and Instrumentation

2.1 Noise Measurements

2.1.1 Instrumentation

The following instrumentation (which complies with BS EN 61672-1 Class 1 accuracy) was used to conduct the noise monitoring:

- Rion Sound Analyser, NL-52 (Serial No. 342835) calibrated 03/06/21 (cert. no. UCRT20/1694);
- Rion Condenser Microphone, UC-59 (Serial No. 06356) – calibrated as above;
- Rion Preamplifier, NH-25 (Serial No. 42863) – calibrated as above;
- Rion Calibrator, NC-74 (Serial No. 34857335) calibrated 11/08/21 (cert. no. UCRT21/1980).

A microphone windshield was fitted at all times. The sound level meter was pole-mounted at a representative height of 1.5 metres above ground level.

2.1.2 Calibration

The sound level meter was calibration-checked before and after the measurements. No drift in the calibration signal was noted.

2.2 Plant Operating Conditions

The plant is understood to have been running at normal operational output during the survey period. No Flaring was planned during the survey. The control room was contacted at the start of the survey and again on completion. We were advised that the average power output during the survey was 310 MW and the maximum output was 345MW.

2.3 Measurement Locations

As per the 2022 assessment, a single position has been monitored (Location 4 – Hazeldene to the east of the CHP plant).

The location numbers are as defined in the baseline environmental report (Reference 2) issued by Bureau Veritas in January 2005. These are shown on the attached layout drawing, Figure 1.

2.4 Measurement Procedure

During the night, noise monitoring was conducted at Location 4, measured in 5-minute samples. The measurements covered the period from 23:00 to 04:00 on the night of 1st – 2nd June 2023.

2.5 Meteorological Conditions

During the attended monitoring period the weather was mostly dry and warm with temperatures ranging from 9 to 12ºC, with humidity ranging between 82 – 93%. Cloud cover increased during the survey from 3/8 okta to 6/8 okta towards the end of the survey. No rain was noted during the measurement period. Wind conditions were light and measured between 3 – 5 m/s mainly in a North-East direction for the duration of the survey. There was no evidence of a temperature inversion which may have otherwise affected the environmental propagation of sound from the source to receiver. The weather conditions were therefore considered to be appropriate for the measurement of environmental noise.

3 Environmental Noise Survey Results

Appended to this report are the detailed results of the noise monitoring which are presented in full in Table A1.1.

A summary of the noise levels measured during the attended monitoring at the community location (Hazeldene) is presented in Table 1:

Table 1: Summary of Noise Levels Measured at Immingham CHP, June 2023

Location	Minimum		Maximum	
	dB $L_{A90,5min}$	dB $L_{Aeq,5min}$	dB $L_{A90,5min}$	dB $L_{Aeq,5min}$
Hazeldene	36.8	39.0	43.5	62.4

The sound measured at Hazeldene consisted primarily of a broadband noise component from the VPI Immingham CHP site, with no tonal or regular impulse noise evident.

Plant noise was the main sound source. Off-site sound sources included nearby industrial works and road traffic noise consisting of intermittent vehicle pass-bys along the A160 but this was considered low level and did not influence the noise measurements. This was further reduced due to the closure of the

southbound carriageway of Rosper Road. There was occasional vegetation rustle from nearby trees during wind gusts, but this was infrequent and intermittent.

A historical record of the noise levels measured at the receptor locations around the VPI Immingham CHP plant is presented in the Table 2 to enable comparison with the latest results. Values for L_{A90} are averaged arithmetically with L_{Aeq} averaged logarithmically.

Table 2: Comparison of Average Noise Levels Measured Close to the Immingham CHP Plant

Survey	Hazeldene		East End Farm		Station Road		Wind Direction
	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{A90}	Average dB L_{Aeq}	
February 2005	49	51	50	52	46	48	NW
March 2005	52	54	43	46	48	50	W
April 2005	53	55	38	42	48	50	W
August 2005	49	51	49	50	46	48	NW
November 2005	52	54	46	51	51	53	W
February 2006	50	51	51	53	46	48	NW
May 2006	50	52	40	44	50	51	W/SW
August 2006	52	54	46	47	50	52	W
January 2007	52	53	40	45	51	53	SW
March 2008	48	50	50	53	44	47	NW
January 2009	51	53	33	36	49	50	SW
March 2010	52	54	-	-	-	-	NW
April 2011	52	53	47	48	47	49	NW
June 2013	41	43	41	45	35	36	NE
June/July 2014	48	50	42	44	42	44	E
August 2015	44	50	-	-	-	-	S

Survey	Hazeldene		East End Farm		Station Road		Wind Direction
	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{A90}	Average dB L_{Aeq}	Average dB L_{A90}	Average dB L_{Aeq}	
September 2016	50	52	-	-	-	-	NE
July 2017	51	52	-	-	-	-	NW
July 2018	51	52	-	-	-	-	N
July 2019	49	51	-	-	-	-	SW
July 2020	52	53	-	-	-	-	SSW
June 2021	47	49	-	-	-	-	NW
June 2022	50	52	-	-	-	-	WSW
June 2023	39	50	-	-	-	-	NE

In Table 2, it can be observed that the ambient sound level results from the June 2023 survey at Hazeldene compare similarly with those made when wind directions were similar. For example, in September 2016, however the background sound level was significantly lower. Whilst other factors may have contributed, a possible reason for this is may be the speed (from the northeast, i.e., the measurement position was upwind of the VPI site). Whilst plant noise from the VPI site remained the dominant sound source at the measurement position, its contribution was significantly less than in previous years when north-easterly winds prevailed.

Please note that detailed comparisons to historic data listed in Table 2 shall be limited due to the differing wind directions during survey measurements, as well as varying plant operation conditions.

4 Conclusions

An environmental noise survey has been conducted close to the nearest residential property within the vicinity of the VPI CHP site at Immingham. Attended noise monitoring was conducted on the night of the 1st - 2nd June 2023, under dry and light wind conditions. A wind speed of around 3 - 5 m/s was measured at the monitoring location.

At the monitoring location, the residential receptor closest to the VPI CHP plant, Hazeldene, the dominant noise source was considered to have been the VPI CHP site. **No tonal or impulse noise was evident**.

Noise levels measured were found to be comparable with historic data.

The measured noise level of 50 dB L_{Aeq} over the entire measurement period (in the absence of vehicle noise on the A160) equates to being equal with the background noise level determined prior to the site's construction. Furthermore, the data in Appendix 1 indicates that the measured ambient noise levels (5-minute averages) were consistently below the pre-existing background. The permit (Section 6.6.1) requirement of not exceeding the existing background level by more than 3 dB(A) therefore **has been met**.

If you wish to discuss the findings of this report, please do not hesitate to contact me.

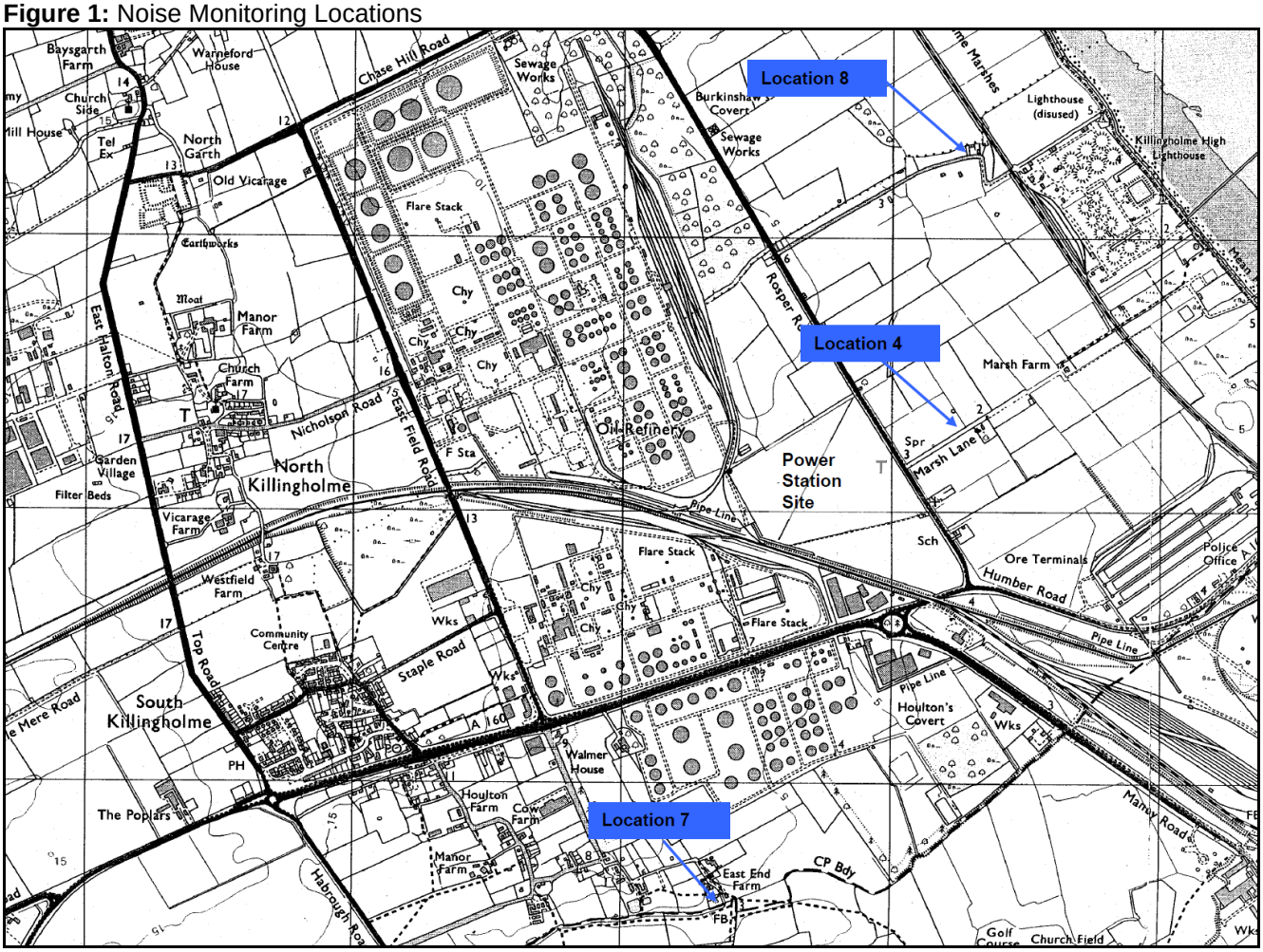
Yours sincerely

Bureau Veritas UK Ltd

Stuart Griffith, AMIOA
Senior Consultant – Acoustics, Vibration and Occupational Hygiene

Figures

Figure 1: Noise Monitoring Locations



References

1 Immingham CHP quarterly noise survey, NSOX0015/1 Rev 0, January 2007

2 Immingham Community Night-time Noise survey, BVAT Report 480361/7 Rev 0, January 2005

3 Immingham CHP Environmental Noise Survey Report 4373099 Rev 0, April 2013

4 Immingham CHP Environmental Noise Survey Report 7577394/1 Rev 0, June 2014

5 Immingham CHP Environmental Noise Survey Report 8526671/1 Rev 0, July 2015

6 Immingham CHP Environmental Noise Survey Report 6282118/2 Rev 0, August 2016

7 Immingham CHP Environmental Noise Survey Report 6380140/1 Rev 0, September 2017

8 Immingham CHP Environmental Noise Survey Report 6450625/1 Rev 0, July 2018

9 Immingham CHP Environmental Noise Survey Report 6477766/1 Rev 0, July 2019

10 Immingham CHP Environmental Noise Survey Report 9354710/1 Rev 0, July 2020

11 Immingham CHP Environmental Noise Survey Report 10824505/1 Rev 0, June 2021

12 Immingham CHP Environmental Noise Survey Report 15016838/1 Rev 0, June 2022

Appendix 1

Results of Environmental Noise Monitoring
June 2023

Table A1.1: Measured Environmental Noise Levels at Location 4, Hazeldene, Immingham, 1st – 2nd June 2023

Measurement number	Time	Measurement point weather					Noise Indicator				
		Wind Speed m/s	Wind Direction	Temperature (°C)	Humidity %	Cloud/8	L_{Aeq}	L_{Amax}	L_{A10}	L_{A50}	L_{A90}
1	23:00	4	NE	9	93	3	41.7	47.8	45.5	40.7	38.3
2	23:05	4.5	NE	9	93	3	43	51.2	49.2	41.8	39.5
3	23:10	4	NE	9	93	3	42.1	47.1	45.2	41.8	40.1
4	23:15	4	NE	10	82	3	40.3	44.5	43.1	40	38.8
5	23:20	4	NE	10	82	3	39.8	44.6	43.5	39.6	38
6	23:25	4	NE	10	82	3	39.8	46.8	43.3	39.4	38.4
7	23:30	4	NE	10	82	3	40.4	46.3	44.2	40.2	39
8	23:35	4	NE	10	82	3	40.2	46.5	44.4	40.1	38.6
9	23:40	4	NE	10	82	3	44.3	62.4	55.5	40.9	39.1
10	23:45	4	NE	10	82	3	39.2	44.9	44	38.6	37.4
11	23:50	4	NE	10	82	3	42.4	52	50	40.8	37.6
12	23:55	4	NE	10	82	3	46.5	53.8	51.4	45.2	41.4
13	00:00	4	NE	10	82	3	47.1	66.7	59.6	43	39.3
14	00:05	4	NE	10	82	3	42.9	50.5	49.3	41.5	38.7
15	00:10	4	NE	10	82	3	44.4	53.9	51.4	42.1	38.7

Measurement number	Time	Measurement point weather					Noise Indicator				
		Wind Speed m/s	Wind Direction	Temperature (°C)	Humidity %	Cloud/8	LAeq	LAmax	LA10	LA50	LA90
16	00:15	4	NE	10	76	3	45.3	54.6	50.6	44.5	42.3
17	00:20	4	NE	10	76	3	45.7	64.1	57.5	41.9	38.5
18	00:25	4.5	NE	11	76	3	45.2	52.6	50.8	44.4	41.3
19	00:30	4.5	NE	11	76	3	45.7	54.3	53.1	42.8	40.2
20	00:35	4.5	NE	11	76	3	44.4	55.7	48.7	43.8	39.6
21	00:40	4.5	NE	11	76	3	44.3	50.6	49.8	43.7	41.3
22	00:45	4.5	NE	11	76	3	45.2	50.1	49	44.8	42.3
23	00:50	4.5	NE	11	76	3	47.2	67	59.1	42.9	40
24	00:55	4	NE	11	71	3	49.6	68.6	64	43	39.5
25	01:00	4	NE	11	71	3	45.7	64.2	58.1	41.8	38.9
26	01:05	4	NE	11	71	3	40.7	53.3	47.2	39.9	37.6
27	01:10	4	NE	11	71	3	44.2	61.4	55.2	41.1	38.8
28	01:15	4	NE	11	71	3	43.8	63.7	56	39.4	37.7
29	01:20	4	NE	11	71	3	41.5	48.2	47.3	39.8	37.1
30	01:25	4	NE	11	71	3	42.6	49.1	48	41.7	37.8

Measurement number	Time	Measurement point weather	Noise Indicator

		Wind Speed m/s	Wind Direction	Temperature (°C)	Humidity %	Cloud/8	LAeq	LAmax	LA10	LA50	LA90
31	01:30	4	NE	11	71	4	42.7	50.7	48.7	41.9	39.4
32	01:35	4	NE	11	71	4	41.3	48.3	44.8	40.8	39.1
33	01:40	4	NE	11	71	4	42.8	49.6	46.9	41.9	40.1
34	01:45	4	NE	11	71	4	42	48.5	47.5	41.5	38.1
35	01:50	4	NE	11	71	4	43.7	56.7	54.2	41.7	38.7
36	01:55	4	NE	11	82	4	40	46.1	44.4	39.5	37.9
37	02:00	4	NE	11	82	4	41.3	50.3	47.6	40.5	37.6
38	02:05	4	NE	11	82	4	44.7	51.9	50.5	42.7	39.5
39	02:10	3.5	NE	11	82	4	43.8	51.6	49.3	42.7	38.6
40	02:15	3.5	NE	11	82	4	40.2	48.7	45.9	39.2	37.1
41	02:20	3.5	NE	11	82	4	41.2	49.4	45.2	40.5	38.4
42	02:25	3.5	NE	11	82	4	40.8	46.1	45.3	40.2	37.9
43	02:30	3.5	NE	10	82	5	44.5	52.4	49.6	43.7	41.2
44	02:35	3.5	NE	10	82	5	42	51.2	46.9	41.2	39.1
45	02:40	3.5	NE	10	82	5	39.3	47	43.8	38.9	36.8

Measurement number	Time	Measurement point weather	Noise Indicator

		Wind Speed m/s	Wind Direction	Temperature (°C)	Humidity %	Cloud/8	LAeq	LAmax	LA10	LA50	LA90
46	02:45	3.5	NE	10	82	5	39	46.1	43.5	38.6	37
47	02:50	3.5	NE	10	82	5	40.6	45.5	44.5	40.1	38.1
48	02:55	3.5	NE	10	82	6	41.5	59.1	48.5	40.3	38.1
49	03:00	3.5	NE	10	82	3	45.8	52.8	51.8	44.3	41.2
50	03:05	3.5	NE	10	82	3	44.6	52.8	49.9	43.8	41.1
51	03:10	3.5	NE	10	82	3	41.5	50.5	45.5	41	39.2
52	03:15	3.5	NE	10	82	3	43.1	51.6	48	42.5	40.6
53	03:20	3.5	NE	10	82	3	47	67.4	57.2	43.1	41.2
54	03:25	3.5	NE	10	82	3	42	46.7	45.4	41.7	39.9
55	03:30	4	NE	10	82	3	43.6	51.2	49.4	42.2	39.4
56	03:35	4	NE	10	82	6	43.3	50.9	48.2	42.6	39.9
57	03:40	4	NE	11	82	6	46.6	58.1	53.6	44.4	40.5
58	03:45	4	NE	11	82	6	52.8	69.9	63	46.7	43.2
59	03:50	4	NE	11	82	6	60.5	78.4	72.3	46.7	42.1
60	03:55	4	NE	11	82	6	62.4	78.2	72.6	48.2	42.8

Appendix B Noise Modelling Data and Assumptions.

Noise Model Settings

SoundPLAN (version 8.2) 3-dimensional acoustic modelling software has been used to predict the LAeq noise levels from the on-site operational activities of the PCC plant. Operational noise is predicted using the method described in ISO 9613-2:1996 'Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation'.

The following noise modelling parameters, data and assumptions have been used for the assessment:

- The 3D digital terrain model (DTM) has been created using LiDAR data from www.environment.data.gov.uk [Downloaded 27/05/22].
- Acoustically hard ground which includes roads, other areas of hardstanding and water have been modelled to reflect sound. Acoustically soft ground which includes areas covered in vegetation have been modelled to absorb sound.
- All existing building outlines were taken from the OS MasterMap provided by the client. Existing building heights have been determined using a combination of the OS MasterMap Building Height Attribute dataset and a survey of images from Google Earth and Google 'Streetview'.
- The noise levels at the NSRs were predicted at 1.5 m above the ground during the day. For night-time, levels were predicted at 4.0 m above ground, representative of first floor level, at Church Lane and Clarkes Road. Night-time predicted noise levels at Hazeldene were at 6.5 m, representative of third floor level.
- Operational noise from site activities has been modelled using spectral data to allow more accurate prediction of sound propagation. Spectral data have been estimated from the in-built SoundPLAN library, BS 5228 measured levels and measured levels from other AECOM projects. The overall sound pressure level at 1 m for each source has been provided by the client for each item of plant.
- Where the location of equipment is unknown or uncertain, a worst-case position on the closest boundary of each "block" or "zone" to the closest receptor has been used.
- The PCC plant stack exhausts have been modelled as individual point sources, located 0.1 m above the top of each stack.
- The different noise levels for same/ similar equipment (e.g. fans and pumps) are due to differences in design, specification or size.

Proposed VPI Development Noise Modelling

The following noise modelling parameters, data and assumptions have been used for the PCC plant:

- The layout of the Proposed VPI Development is based upon the following drawings:

  415000-00201-8530-79-0001_B.pdf;

  415000-00201-8530-79-0002_B.pdf;

  415000-00201-8530-79-0003_B.pdf;

  415000-00201-8530-79-0004_B.pdf;

  415000-00201-8820-01-0001.pdf;

  415000-00201-8820-01-0002.pdf;

  415000-00201-8820-01-0003.pdf;

  415000-00201-8820-01-0004.pdf;

  415000-00201-8820-01-0005.pdf;

  415000-00201-8820-01-0006.pdf;

  415000-00201-8820-01-0007.pdf;

415000-00201-8820-01-0008.pdf;

415000-00201-8820-01-0009.pdf;

415000-00201-8820-01-0010.pdf;

415000-00201-8820-01-0011.pdf;

415000-00201-8820-01-0012.pdf;

415000-00201-8820-01-0013.pdf;

415000-00201-8820-01-0014.pdf;

415000-00201-8820-01-0015.pdf;

415000-00201-8820-01-0016.pdf;

415000-00201-8820-01-0017.pdf; and

415000-00201-8820-01-0018.pdf.

- The heights of the proposed sources have been taken from the 3d CAD model *3D_OUTPUT2.nwd* provided by the project engineers.

Details of source assumptions for the VPI Site are provided in Table 9.1

Table 9.1. Noise Data input for the Proposed VPI PCC Plant

Plant ref.	Equipment Description	Quantity	Noise Level at 1 m $L_{Aeq,T}$ dB	Dimensions of Source (width x length x height)	Source type	Spectrum reference
VPI-2	CO_2 absorber exhaust (point source)	2 (1 per train)	85	Point at 110.1 m	Point Source	SoundPLAN library ref 160 Cooling tower
VPI-5	MVR compressor	2 (1 per train)	80	10 m x 19.35 m x 12.4 m	Industrial Building	BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-15	CO_2 dehydration package	2 (1 per train)	85	7 m x 8 m x 6 m	Industrial Building	SoundPLAN library ref 11 Power station (boiler & coal mill room)
VPI-19	CO_2 compressor	2 (1 per train)	85	42 m x 27.89 m x 24 m	Industrial Building	BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-20	Hydrogen generation package	2 (1 per train)	85	2.45 m x 12.2 m x 2.6 m	Industrial Building	BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-21	CO_2 compressor 1st stage intercooler	6 fans (3 per train)	71	4.267 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-22	CO_2 stripper condenser	32 fans (16 per train)	71	3.353 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-23	Lean solvent cooler	72 fans (36 per train)	71	4.877 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-24	Wash water Cooler	60 fans (30 per train)	71	4.267 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-25	DCC water cooler	132 fans (66 per train)	71	4.267 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-29	DCC water circulating pump	2 (1 per train)	85	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-31	Wash water pump	2 (1 per train)	85	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-32	Rich solvent pump	3 (2 on one train, 1 on other train)	85	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-34	Lean solvent pump	4 (2 per train)	85	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-36	Stripper condensate pump	4 (2 per train)	85	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-39	CO_2 stripper reflux pump	2 (1 per train)	85	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump

Plant ref.	Equipment Description	Quantity	Noise Level at 1 m $L_{Aeq,T}$ dB	Dimensions of Source (width x length x height)	Source type	Spectrum reference
VPI-41	CO_2 compression condensate return pump	2 (1 per train)	70	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-42	Solvent drain pump	4 (2 per train)	65	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-45	Anti foam dosing package	2 (1 per train)	80	1.95 m x 1.8 m x 0.9 m	Industrial Building	BS 5228 Table C2.45 Water pump
VPI-46	Solvent transfer pump	2	85	1.2 m x 2 m x 1.2 m	Industrial Building	BS 5228 Table C2.45 Water pump
VPI-48	Solvent make up pump	1	85	1.2 m x 2 m x 1.2 m	Industrial Building	BS 5228 Table C2.45 Water pump
VPI-49	Steam turbine	1	80	5.6 m x 20 m x 9.8 m	Industrial Building	SoundPLAN library ref 10 Power Station (generator turbine hall)
VPI-54	Thermal reclaimer vacuum package	1	85	10 m x 4 m x 3 m	Industrial Building	SoundPLAN ref 898 Manure trailer - vacuum pump
VPI-55	Reclaimer bottom pump	2	70	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-57	Thermal reclaimer reflux pump	1	75	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-59	Refrigeration package	1	74	2.2 m x 13.518 m x 2.562 m	Industrial Building	BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-64	Fresh solvent container pump	1	70	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-70	IA Compressor (Instrument Air)	1	79	12 m x 11 m x 6 m	Industrial Building	BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-71	CO_2 compressor 3rd stage intercooler	6 fans (3 per train)	71	4.267 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-74	Thermal reclaimer condenser	4 fans	71	3.353 m diameter	Point Source	BS 5228 Table C5.5 Compressor for hand-held pneumatic breaker
VPI-75	GT Flue gas blower	2	85	3.8 m x 7.4 m x 7 m	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-77	Aux boiler flue gas blower	2	82	3.9 m x 2.9 m x 4 m	Point Source	SoundPLAN library ref 90 Axial Flow Fan

Plant ref.	Equipment Description	Quantity	Noise Level at 1 m $L_{Aeq,T}$ dB	Dimensions of Source (width x length x height)	Source type	Spectrum reference
VPI-79	Thermal reclaimer degraded solvent pump	1	74	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-88	CO_2 compressor 4th stage intercooler	6 fans (3 per train)	71	2.743 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-89	CO_2 compressor 5th stage intercooler	2 fans (1 per train)	71	1.585 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-91	CO_2 compressor 2nd stage intercooler	6 fans (3 per train)	71	4.267 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-92	CO_2 compressor after cooler	6 fans (3 per train)	71	4.267 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-43	Recycle cooler	2 fans (1 per train)	71	2.743 m diameter	Point Source	SoundPLAN library ref 90 Axial Flow Fan
VPI-94	Caustic pump	1	68	1.2 m x 2 m x 1.2 m	Point Source	BS 5228 Table C2.45 Water pump
VPI-99a	Substation-04 TR3-02	1	102.5	8 m x 6 m x 6m	Industrial Building	AECOM measurement
VPI-99b	Substation-04 TR4-01A/01B		95.6	8 m x 4.6 m x 5 m	Industrial Building	AECOM measurement
VPI-99c	Substation-04 TR4-02A/02B		95.6	8 m x 4.6 m x 5 m	Industrial Building	AECOM measurement
VPI-99d	Substation-04 TR3-01A/01B		94.5	8 m x 4.6 m x 5 m	Industrial Building	AECOM measurement
VPI-100	Substation-05 TR5-01A/01B		80.4	3.5 m x 3.5 m x 3.5 m	Industrial Building	AECOM measurement
VPI-101a	Substation-06 TR5-01A/01B		80.4	3.5 m x 3.5 m x 3.5 m	Industrial Building	AECOM measurement
VPI-101b	Substation-06 TR5-02A/02B		80.4	3.5 m x 3.5 m x 3.5 m	Industrial Building	AECOM measurement
VPI-101c	Substation-06 TR5-03A/03B		80.4	3.5 m x 3.5 m x 3.5 m	Industrial Building	AECOM measurement
VPI-102a	Substation-07 TR5-01A/01B		80.4	3.5 m x 3.5 m x 3.5 m	Industrial Building	AECOM measurement

Plant ref.	Equipment Description	Quantity	Noise Level at 1 m $L_{Aeq,T}$ dB	Dimensions of Source (width x length x height)	Source type	Spectrum reference
VPI-102b	Substation-07 TR5-02A/02B		80.4	3.5 m x 3.5 m x 3.5 m	Industrial Building	AECOM measurement
VPI-102c	Substation-07 TR5-03A/03B		80.4	3.5 m x 3.5 m x 3.5 m	Industrial Building	AECOM measurement
VPI-112	Transformer-01	1	104.9	9.97 m x 14.6 m x 5 m	Industrial Building	AECOM measurement
VPI-113	Transformer-02	1	104.9	9.97 m x 14.6 m x 5 m	Industrial Building	AECOM measurement

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