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M185348/01 Version 3 GTK/BUCH

Palm Paper Limited, King's Lynn

Upgrading of the operational wastewater treatment plant by means of an anaerobic stage

Prediction of the noise caused by the planned components

Report No. M185348/01 Version 3

Client:	Palm Paper Limited Poplar Avenue Saddlebow Industrial Estate King's Lynn PE34 3AL
Consultant:	Dipl.-Ing. Armas-Christian Gottschalk
Total number of pages:	15 pages, thereof 8 pages text, 3 pages Appendix A and 4 pages Appendix B

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1 Situation and task

Palm Paper Limited (Palm) has been operating a paper mill in King's Lynn, Great Britain, since 2009.

It is now proposed to upgrade the operational wastewater treatment plant by means of an anaerobic stage. Therefore, new plant components are to be erected northwest of the Effluent Treatment Plant (ETP).

In the present report the planning values to be met regarding the sound emissions are presented. For this purpose, sound emission estimations for all relevant noise sources of the new plant components are described (current planning concept).

Furthermore, the expected noise in the vicinity is predicted by using a digital three-dimensional sound propagation calculation model.

A further acoustic assessment in accordance with the normative requirements of British Standard 4142:2014 [1] will be carried out in the course of the project by Entran Ltd. (environmental and transportation consultancy).

2 References

[1] British Standard 4142:2014. Methods for rating and assessing industrial and commercial sound. Fourth edition October 2014.

[2] ISO 9613-2: Acoustics – Attenuation of sound during propagation outdoors. Part 2: General method of calculation. 1996.

[3] Site plans, layout plans and acoustic information regarding the new plant components, sent via e-mails by the planning companys Regierungsbaumeister Schlegel GmbH & Co. KG and Eproplan GmbH.

[4] SLR Consulting Limited. SLR Ref No: 403.09898.00002, December 2020. Palm Paper Mill, Kings Lynn Paper Sorting Plant.

3 Nomenclature and reference levels

In this document, A-weighted levels are marked by the index letter "A" (as in L_A or L_{WA}, for example) and the units dB(A).

Sound pressure levels in this study are relative to the reference factor $2 \cdot 10^{-5}$ Pa. Sound power levels in this study are relative to the reference factor $1 \cdot 10^{-12}$ W.

4 Sound emission of the newly added plant components

4.1 Preliminary remarks

The new plant components are to be designed acoustically in such a way that no deterioration of the noise situation can be expected. On the basis of the current state of the planning [3], the sound emissions were determined for all significant noise sources and sound transmission paths with regard to the best available technique in noise control.

At the current stage of planning, no final details are available for individual parts of the plant, nor have any final suppliers been determined. Therefore, sound emission approaches have been taken into account based on our own measurements and experience with comparable plants, e.g. an acoustic acceptance test on comparable system components at Palm’s site in Wörth am Rhein (Germany).

To be able to comply with the acceptable sound pressure levels in the residential areas in the neighbourhood, the sound power levels given in the following sections are to be complied with.

Here, a different distribution of the sound power levels of individual parts of the plant is possible if the total calculated sound pressure levels in the residential areas caused by the newly added plant components at the noise sensitive receptors are still within their limits.

4.2 Sound emission planning values

The following Table 1 shows the sound power levels to be expected for the major noise sources located in and radiating into the open.

Table 1. A-weighted sound power levels in dB(A) of all relevant noise sources.

Description	**A-weighted sound power level** L_{WA} **in dB(A)**
Recycling pump – short loop 1	80
Recycling pump – short loop 2	80
Recycling pump – short loop 3	80
Recycling pump – short loop 4	80
Pressure release valve – biogas storage	82
Air release valve/pressure release valve – lean gas storage	82
Emergency flare	85
regenerative thermal oxidizer	92
regenerative thermal oxidizer, chimney	75
Re-cooler	84
Water chiller	83
Medium bridge with piping	85
Biogas treatment system (container & ventilation, in total)	97
Biological desulfurization (in total)	92
Newly added components in total	**100**

The positions of the noise sources in the digital three-dimensional sound propagation calculation model are shown in Figure A 1 in Appendix A.

From a technical point of view, the calculation is limited to the noise expected during operation of the stationary installations, as

- the project requires only minor construction work for the installation/erection of the plant and
- no relevant delivery or removal is required.

5 Expected operational noise

5.1 ISO 9613-2

As proposed in BS 4142:2014 [1], clause 7.3.6, the specific sound level is to be determined by calculation if the source, i.e. the new plant components, is not yet in operation.

The current calculations regarding the new plant components are carried out with a digital three-dimensional sound propagation calculation model according to a standardized international procedure described in ISO 9613-2 [2].

With the acoustic emission of a noise source or part of a plant the sound caused at a point-of-interest in the vicinity can be calculated. The calculation is performed frequency-dependent in octave bandwidth.

From the octave band spectrum L_{WA} of a sound power level of a noise source, the expected average sound pressure level in downwind direction $L_{Aeq}(DW)$[1] at a distance d of the noise source and at the octave band frequency f, can be calculated according to the following equation:

$$L_{Aeq}(DW) = L_{WA} + D_c - A_{div} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$$

with

D_c	directivity correction,
A_{div}	attenuation due to geometrical divergence,
A_{atm}	attenuation due to atmospheric absorption (at 10 °C and 70 % relative humidity),
A_{gr}	attenuation due to the ground effect (alternative method according to [2]),
A_{bar}	attenuation due to a barrier,
A_{misc}	attenuation due to miscellaneous other effects.

The calculation is carried out using the software Cadna/A, version 2025 (64 Bit). All input data and results obtained from the calculations are listed in Appendix B.

[1] $L_{Aeq}(DW)$ is the downwind average level (“downwind” means a wind direction from the source to each point-of-interest) and describes the worst-case calculation result.

5.2 Specific rating levels

In the following table the expected rating levels L_{Ar} for the new planned components at the four nearest noise sensitive receptors (NSR), as regarded for example in the last investigations by the company SLR Consulting Limited (see report [4]), are listed.

As the new components are designed for continuous operation during day and night, the calculated values for daytime and nighttime are identical.

Table 2. Calculated downwind rating levels for the new plant components at the nearest noise sensitive receptors (NSR).

Noise Sensitive Receptors	**Specific rating level L_{Ar} in dB(A)**
NSR01 – Caravan Park, Saddlebow Road	14,1
NSR02 – Hillen Road	14,5
NSR03 – Pullover Farm, Pullover Road (A47)	26,2
NSR04 – High Road	28,5

5.3 Noise contour maps

For a visualization of the results stated in the previous sections, a noise contour map was plotted which is shown in Figure A 2, Appendix A.

Please note the following remarks on the calculations and results shown in the noise contour plots.

- In the noise contour map, the grid resolution for the sound pressure field is 5 m in horizontal direction and in vertical direction. The contours shown refer to a height of 2.5 m above ground.
- It is typical for the used geometrical acoustics modeling technique, which is based on ray tracing, that gradients in the calculated sound pressure fields may be overpredicted in some places. This may lead to a strong increase/decrease of the calculated sound pressure level over a short distance whereas, in the real sound field, the level changes somewhat more smoothly. Due to the finite grid resolution and the applied interpolation schemes, the contour lines can sometimes be "zaggy" and do not always exactly follow the geometry (e.g. around fence corners etc.).

6 Conclusion and outlook

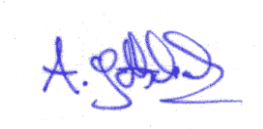
In the present document the proportionate noise expected from the new plant components planned by Palm at its paper mill site are predicted.

The specific rating levels for four noise sensitive receptors have been calculated as well as for the surrounding area by means of a noise contour map.

The expected specific rating levels are consistently well below the background levels measured on site to date (see, for example, [4]).

A further acoustic assessment in accordance with the normative requirements of British Standard 4142:2014 [1] will be carried out in the course of the project by Entran Ltd. (environmental and transportation consultancy).

Responsible for the technical contents:



Dipl.-Ing. Armas-Christian Gottschalk

Appendix A

Figures

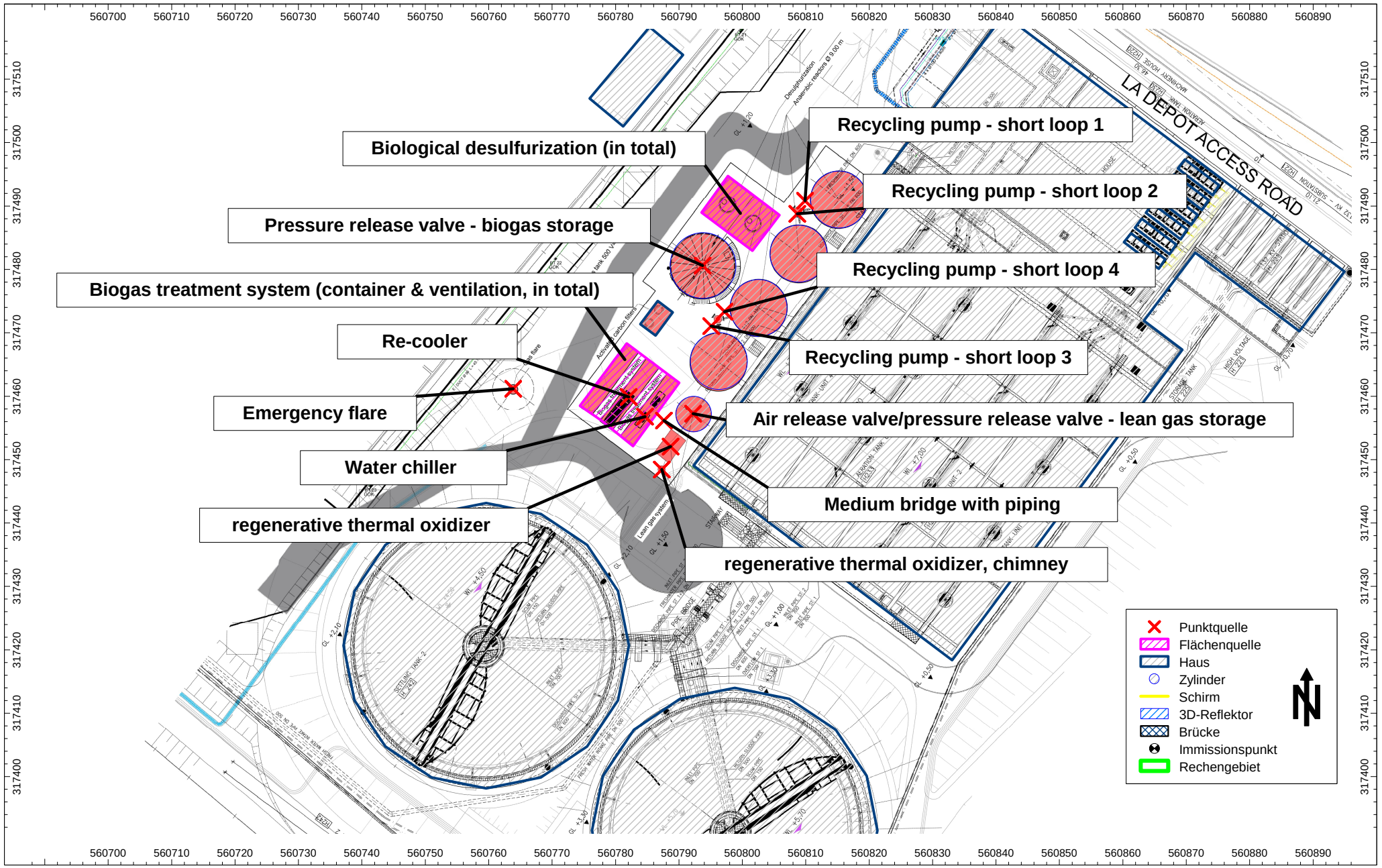
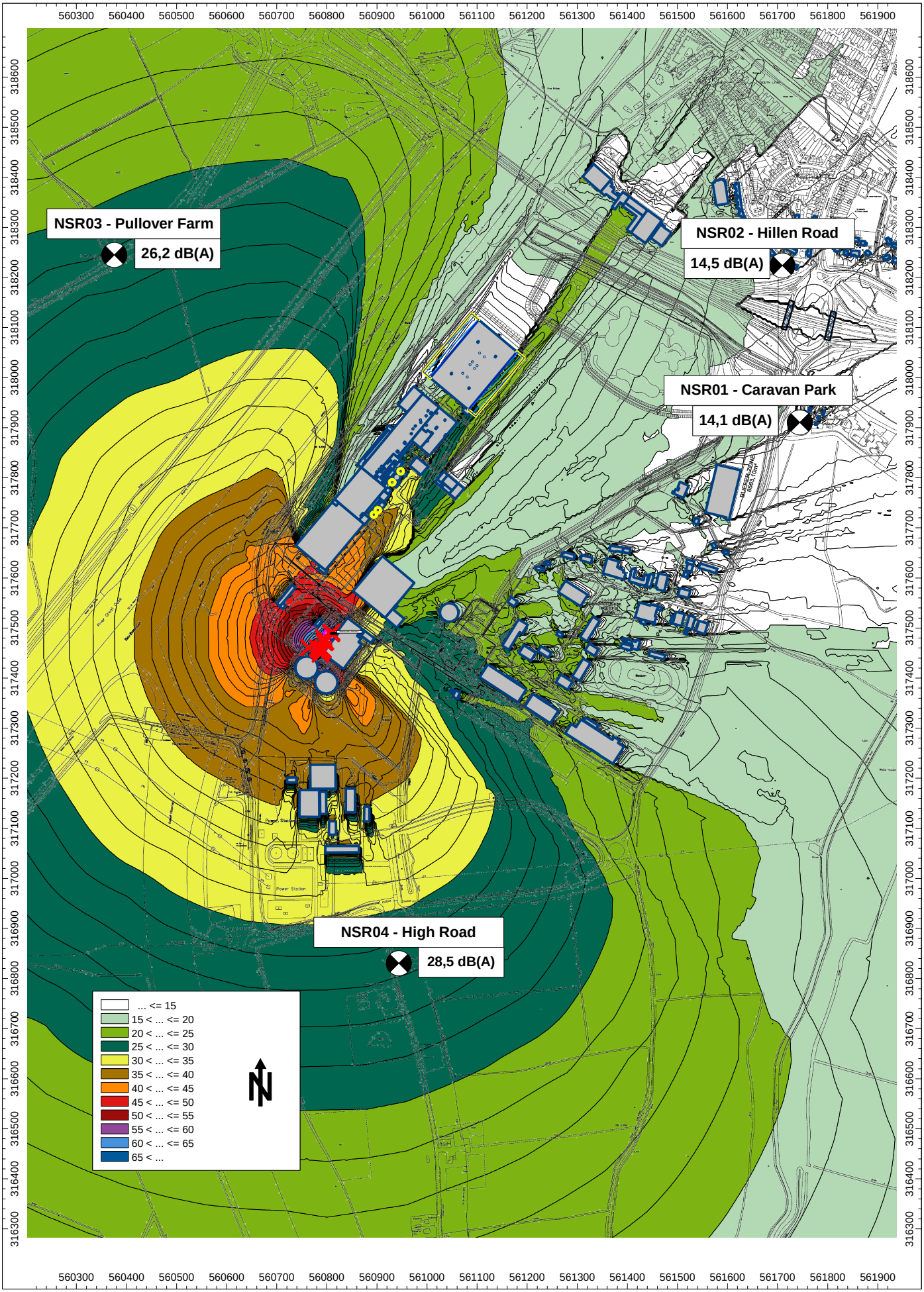


Figure A 1. Position of the main noise sources.


NSR03 - Pullover Farm
26,2 dB(A)
NSR02 - Hillen Road
14,5 dB(A)
NSR01 - Caravan Park
14,1 dB(A)
NSR04 - High Road
28,5 dB(A)
... <= 15
15 < ... <= 20
20 < ... <= 25
25 < ... <= 30
30 < ... <= 35
35 < ... <= 40
40 < ... <= 45
45 < ... <= 50
50 < ... <= 55
55 < ... <= 60
60 < ... <= 65
65 < ...
560300 560400 560500 560600 560700 560800 560900 561000 561100 561200 561300 561400 561500 561600 561700 561800 561900
316300 316400 316500 316600 316700 316800 316900 317000 317100 317200 317300 317400 317500 317600 317700 317800 317900 318000 318100 318200 318300 318400 318500 318600

Appendix B

Calculation model parameters and input data

Projektname: Palm King`s Lynn
Auftraggeber: Palm
Sachbearbeiter: Dipl.-Ing. Armas-Christian Gottschalk
Zeitpunkt der Berechnung: 09/2025
Cadna/A: Version 2025 (64 Bit)

Configuration	
Parameter	Value
General	
Max. Error (dB)	0.00
Max. Search Radius (m)	2000.00
Min. Dist Src to Rcvr	0.00
Partition	
Raster Factor	0.50
Max. Length of Section (m)	1000.00
Min. Length of Section (m)	1.00
Min. Length of Section (%)	0.00
Proj. Line Sources	On
Proj. Area Sources	On
Ref. Time	
Daytime Penalty (dB)	0.00
Recr. Time Penalty (dB)	0.00
Night-time Penalty (dB)	0.00
DTM	
Standard Height (m)	0.00
Model of Terrain	Triangulation
Reflection	
max. Order of Reflection	3
Search Radius Src	100.00
Search Radius Rcvr	100.00
Max. Distance Source - Rcvr	1500.00 1500.00
Min. Distance Rvcr - Reflector	1.00 1.00
Min. Distance Source - Reflector	0.50
Industrial (ISO 9613 (1996))	
Lateral Diffraction	some Obj
Obst. within Area Src do not shield	Off
Screening	Excl. Ground Att. over Barrier
	Dz with limit (20/25)
Barrier Coefficients C1,2,3	3.0 20.0 0.0
Temperature (°C)	10
rel. Humidity (%)	70
Wind Speed for Dir. (m/s)	3.0
SCC_C0	0.0 0.0
Roads (CRTN)	
Railways (CRN)	
Aircraft (???)	
Strictly acc. to AzB	

Emission

Point sources

Name	Sel.	M.	ID	Result. PWL			Lw / Li			Correction			Sound Reduction		Attenuation	Operating Time			K0	Freq.	Direct.	Height		Coordinates		
				Day	Evening	Night	Type	Value	norm.	Day	Evening	Night	R	Area		Day	Special	Night						X	Y	Z
				(dBA)	(dBA)	(dBA)			dB(A)	dB(A)	dB(A)	dB(A)		(m²)		(min)	(min)	(min)	(dB)	(Hz)		(m)		(m)	(m)	(m)
Recycling pump - short loop 1			!0000!	80,0	80,0	80,0	Lw	WWT_S3		0,0	0,0	0,0							0,0		(none)	1,00	r	560809,90	317490,83	7,07
Recycling pump - short loop 2			!0000!	80,0	80,0	80,0	Lw	WWT_S4		0,0	0,0	0,0							0,0		(none)	1,00	r	560808,65	317488,76	7,19
Recycling pump - short loop 3			!0000!	80,0	80,0	80,0	Lw	WWT_S5		0,0	0,0	0,0							0,0		(none)	1,00	r	560795,08	317471,05	7,03
Recycling pump - short loop 4			!0000!	80,0	80,0	80,0	Lw	WWT_S5		0,0	0,0	0,0							0,0		(none)	1,00	r	560797,17	317473,33	7,19
Pressure release valve - biogas storage			!0000!	82,0	82,0	82,0	Lw	WWT_S14		0,0	0,0	0,0							0,0		(none)	1,00	g	560793,74	317480,61	14,61
Air release valve/pressure release valve - lean gas storage			!0000!	82,0	82,0	82,0	Lw	WWT_S15		0,0	0,0	0,0							0,0		(none)	1,00	g	560792,24	317457,23	20,90
Emergency flare			!0000!	85,0	85,0	85,0	Lw	WWT_S16		0,0	0,0	0,0							0,0		(none)	7,90	r	560763,87	317461,17	9,41
regenerative thermal oxidizer			!0000!	92,0	92,0	92,0	Lw	WWT_S24		0,0	0,0	0,0							0,0		(none)	2,00	r	560788,69	317452,05	9,90
regenerative thermal oxidizer, chimney			!0000!	75,0	75,0	75,0	Lw	WWT_S25		0,0	0,0	0,0							0,0		(none)	10,00	r	560787,30	317448,45	17,90
Re-cooler			!0000!	84,0	84,0	84,0	Lw	WWT_S26		0,0	0,0	0,0							0,0		(none)	5,50	r	560782,08	317459,88	11,57
Water chiller			!0000!	83,0	83,0	83,0	Lw	WWT_S27		0,0	0,0	0,0							0,0		(none)	5,50	r	560784,67	317456,77	13,40
Medium bridge with piping			!0000!	85,0	85,0	85,0	Lw	WWT_S23		0,0	0,0	0,0							0,0		(none)	4,00	r	560787,65	317456,15	11,90

Area sources

Name	Sel.	M.	ID	Result. PWL			Result. PWL"			Lw / Li			Correction			Sound Reduction		Attenuation	Operating Time			K0	Freq.	Direct.	Moving Pt. Src		
				Day	Evening	Night	Day	Evening	Night	Type	Value	norm.	Day	Evening	Night	R	Area		Day	Special	Night				Number		
				(dBA)	(dBA)	(dBA)	(dBA)	(dBA)	(dBA)			dB(A)	dB(A)	dB(A)	dB(A)		(m²)		(min)	(min)	(min)	(dB)	(Hz)		Day	Evening	Night
Biogas treatment system (container & ventilation, in total)			!0000!	97,0	97,0	97,0	76,0	76,0	76,0	Lw	WWT_S17_S20		0,0	0,0	0,0							0,0		(none)			
Biological desulfurization (in total)			!0000!	92,0	92,0	92,0	73,4	73,4	73,4	Lw	WWT_S6_S13		0,0	0,0	0,0							0,0		(none)			

Sound power level

ID	Type	1/3 Oktave Spectrum (dB)																													
		Weight.	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000	A	lin
WWT_S3	Lw	A		40,1			50,1			65,1			71,1			74,1			75,1			72,1			68,1			65,1		80,0	86,7
WWT_S4	Lw	A		40,1			50,1			65,1			71,1			74,1			75,1			72,1			68,1			65,1		80,0	86,7
WWT_S5	Lw	A		40,1			50,1			65,1			71,1			74,1			75,1			72,1			68,1			65,1		80,0	86,7
WWT_S6_S13	Lw	A		49,9			59,9			69,9			79,9			85,9			86,9			85,9			81,9			75,9		92,0	96,2
WWT_S14	Lw	A		41,0			49,0			57,0			65,0			72,0			75,0			77,0			76,0			72,0		82,0	85,3
WWT_S15	Lw	A		41,0			49,0			57,0			65,0			72,0			75,0			77,0			76,0			72,0		82,0	85,3
WWT_S16	Lw	A		60,0			73,0			78,0			81,0			78,0			75,0			70,0			64,0			58,0		85,0	103,2
WWT_S17_S20	Lw	A		72,0			85,0			90,0			93,0			90,0			87,0			82,0			76,0			70,0		97,0	115,2
WWT_S24	Lw	A		49,9			59,9			69,9			79,9			85,9			86,9			85,9			81,9			75,9		92,0	96,2
WWT_S25	Lw	A		50,0			63,0			68,0			71,0			68,0			65,0			60,0			54,0			48,0		75,0	93,2
WWT_S26	Lw	A		41,9			51,9			61,9			71,9			77,9			78,9			77,9			73,9			67,9		84,0	88,2
WWT_S27	Lw	A		40,9			50,9			60,9			70,9			76,9			77,9			76,9			72,9			66,9		83,0	87,2
WWT_S29	Lw	A		41,9			51,9			61,9			71,9			77,9			78,9			77,9			73,9			67,9		84,0	88,2
WWT_S30	Lw	A		41,9			51,9			61,9			71,9			77,9			78,9			77,9			73,9			67,9		84,0	88,2
WWT_S23	Lw	A		42,9			52,9			62,9			72,9			78,9			79,9			78,9			74,9			68,9		85,0	89,2

Immission

Noise senstive receptors

Name	Level Lr		Height		Coordinates		
	Day	Night			X	Y	Z
	(dBA)	(dBA)	(m)		(m)	(m)	(m)
NSR01 - Caravan Park	14,1	14,1	2,50	r	561744,10	317910,67	-0,50
NSR02 - Hillen Road	14,5	14,5	5,00	r	561709,34	318223,72	2,50
NSR03 - Pullover Farm	26,2	26,2	5,00	r	560375,71	318245,08	4,78
NSR04 - High Road	28,5	28,5	5,00	r	560943,56	316830,52	5,00