Summary of Chemical Analysis
Water Samples

Our Ref	17-15582-1
Client Ref	4159
Contract Title	Lundwood WwTW

Lab No	1257729	1257732
Sample ID	BH03	BH09
Depth	5.00	7.00
Other ID	44	35
Sample Type	EW	EW
Sampling Date	31/10/17	01/11/17
Sampling Time	n/s	n/s

Test	**Method**	**LOD**	**Units**		
Fluoranthene	DETSC 3304	0.01	ug/l	0.01	< 0.01
Pyrene	DETSC 3304	0.01	ug/l	0.02	< 0.01
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01
Chrysene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	< 0.01	< 0.01
PAH Total	DETSC 3304	0.04	ug/l	0.11	< 0.04
Phenols					
Phenol - Monohydric	DETSC 2130	100	ug/l	< 100	< 100

Key: * -not accredited. n/s -not supplied.

WASTE ACCEPTANCE CRITERIA TESTING ANALYTICAL REPORT

Our Ref 17-15582-1
Client Ref 4159
Contract Title Lundwood WwTW
Sample Id BH02 6 0.50

Sample Numbers 1257722 1257733 1257734
Date Analysed 17/11/2017

Test Results On Waste

Determinand and Method Reference	Units	Result	WAC Limit Values		
			Inert Waste	SNRHW	Hazardous Waste
DETSC 2084* Total Organic Carbon	%	1.2	3	5	6
DETSC 2003# Loss On Ignition	%	3.9	n/a	n/a	10
DETSC 3321# BTEX	mg/kg	< 0.04	6	n/a	n/a
DETSC 3401# PCBs (7 congeners)	mg/kg	< 0.01	1	n/a	n/a
DETSC 3311# TPH (C10 - C40)	mg/kg	< 10	500	n/a	n/a
DETSC 3301 PAHs	mg/kg	2.1	100	n/a	n/a
DETSC 2008# pH	pH Units	8.0	n/a	>6	n/a
DETSC 2073* Acid Neutralisation Capacity (pH4)	mol/kg	< 1	n/a	TBE	TBE
DETSC 2073* Acid Neutralisation Capacity (pH7)	mol/kg	< 1	n/a	TBE	TBE

Test Results On Leachate

Determinand and Method Reference	Conc in Eluate ug/l		Amount Leached mg/kg		WAC Limit Values Limit values for LS10 Leachate		
	2:1	8:1	LS2	LS10	Inert Waste	SNRHW	Hazardous Waste
DETSC 2306 Arsenic as As	2.2	1.4	0.004	0.015	0.5	2	25
DETSC 2306 Barium as Ba	9.4	4.4	< 0.02	< 0.1	20	100	300
DETSC 2306 Cadmium as Cd	< 0.03	< 0.03	< 0.004	< 0.02	0.04	1	5
DETSC 2306 Chromium as Cr	1.3	0.5	< 0.02	< 0.1	0.5	10	70
DETSC 2306 Copper as Cu	4.7	2.2	0.009	0.026	2	50	100
DETSC 2306 Mercury as Hg	0.04	0.02	< 0.0004	< 0.002	0.01	0.2	2
DETSC 2306 Molybdenum as Mo	< 1.1	< 1.1	< 0.02	< 0.1	0.5	10	30
DETSC 2306 Nickel as Ni	1.2	< 0.5	< 0.02	< 0.1	0.4	10	40
DETSC 2306 Lead as Pb	2.3	0.79	< 0.01	< 0.05	0.5	10	50
DETSC 2306 Antimony as Sb	0.74	0.33	< 0.01	< 0.05	0.06	0.7	5
DETSC 2306 Selenium as Se	0.41	< 0.25	< 0.006	< 0.03	0.1	0.5	7
DETSC 2306 Zinc as Zn	4.9	1.4	0.01	0.02	4	50	200
DETSC 2055 Chloride as Cl	3900	2500	< 20	< 100	800	15,000	25,000
DETSC 2055* Fluoride as F	550	270	1.1	3.15	10	150	500
DETSC 2055 Sulphate as SO4	6600	2300	< 20	< 100	1000	20,000	50,000
DETSC 2009* Total Dissolved Solids	47000	22000	94	260.1	4000	60,000	100,000
DETSC 2130 Phenol Index	< 100	< 100	< 0.2	< 1	1	n/a	n/a
* Dissolved Organic Carbon	12000	5000	24	61.2	500	800	1000

TBE - To Be Evaluated
SNRHW - Stable Non-Reactive Hazardous Waste

Additional Information

DETSC 2008 pH	6.8	7.7
DETSC 2009 Conductivity uS/cm	67.1	31.2
* Temperature*	16	19

Mass of Sample Kg	0.140
Mass of dry Sample Kg	0.123

Stage 1

Volume of Leachant L2	0.23
Volume of Eluate VE1	0.198

Stage 2

Volume of Leachant L8	0.987
Volume of Eluate VE2	0.92

Disclaimer: *The WAC limit values are provided for guidance only. DETS does not accept responsibility for errors or omissions. Values are correct at time of issue.*

WASTE ACCEPTANCE CRITERIA TESTING ANALYTICAL REPORT

Our Ref 17-15582-1
Client Ref 4159
Contract Title Lundwood WwTW
Sample Id TH06 6 0.60
Sample Numbers 1257727 1257735 1257736
Date Analysed 17/11/2017

Test Results On Waste			**WAC Limit Values**		
Determinand and Method Reference	**Units**	**Result**	**Inert Waste**	**SNRHW**	**Hazardous Waste**
DETSC 2084* Total Organic Carbon	%	1.1	3	5	6
DETSC 2003# Loss On Ignition	%	3.1	n/a	n/a	10
DETSC 3321# BTEX	mg/kg	< 0.04	6	n/a	n/a
DETSC 3401# PCBs (7 congeners)	mg/kg	< 0.01	1	n/a	n/a
DETSC 3311# TPH (C10 - C40)	mg/kg	140	500	n/a	n/a
DETSC 3301 PAHs	mg/kg	< 1.6	100	n/a	n/a
DETSC 2008# pH	pH Units	9.8	n/a	>6	n/a
DETSC 2073* Acid Neutralisation Capacity (pH4)	mol/kg	< 1	n/a	TBE	TBE
DETSC 2073* Acid Neutralisation Capacity (pH7)	mol/kg	< 1	n/a	TBE	TBE

Test Results On Leachate					**WAC Limit Values** Limit values for LS10 Leachate		
Determinand and Method Reference	**Conc in Eluate ug/l**		**Amount Leached mg/kg**		**Inert Waste**	**SNRHW**	**Hazardous Waste**
	2:1	**8:1**	**LS2**	**LS10**			
DETSC 2306 Arsenic as As	2.2	1	0.004	0.012	0.5	2	25
DETSC 2306 Barium as Ba	36	5.8	0.07	0.11	20	100	300
DETSC 2306 Cadmium as Cd	< 0.03	< 0.03	< 0.004	< 0.02	0.04	1	5
DETSC 2306 Chromium as Cr	0.88	< 0.25	< 0.02	< 0.1	0.5	10	70
DETSC 2306 Copper as Cu	6	2.1	0.012	0.027	2	50	100
DETSC 2306 Mercury as Hg	0.02	< 0.01	< 0.0004	< 0.002	0.01	0.2	2
DETSC 2306 Molybdenum as Mo	< 1.1	< 1.1	< 0.02	< 0.1	0.5	10	30
DETSC 2306 Nickel as Ni	2.8	0.7	< 0.02	< 0.1	0.4	10	40
DETSC 2306 Lead as Pb	1.3	0.38	< 0.01	< 0.05	0.5	10	50
DETSC 2306 Antimony as Sb	1.3	0.64	< 0.01	< 0.05	0.06	0.7	5
DETSC 2306 Selenium as Se	0.75	< 0.25	< 0.006	< 0.03	0.1	0.5	7
DETSC 2306 Zinc as Zn	5.4	1.9	0.011	0.025	4	50	200
DETSC 2055 Chloride as Cl	4800	2600	< 20	< 100	800	15,000	25,000
DETSC 2055* Fluoride as F	260	< 100	0.52	0.43	10	150	500
DETSC 2055 Sulphate as SO4	19000	4500	38	< 100	1000	20,000	50,000
DETSC 2009* Total Dissolved Solids	120000	30000	240	447.2	4000	60,000	100,000
DETSC 2130 Phenol Index	< 100	< 100	< 0.2	< 1	1	n/a	n/a
* Dissolved Organic Carbon	11000	4200	22	53.1	500	800	1000

Additional Information

DETSC 2008 pH	6.6	7.3
DETSC 2009 Conductivity uS/cm	168	42.6
* Temperature*	16	19

TBE - To Be Evaluated
SNRHW - Stable Non-Reactive Hazardous Waste

Mass of Sample Kg	0.140
Mass of dry Sample Kg	0.124

Stage 1

Volume of Leachant L2	0.231
Volume of Eluate VE1	0.202

Stage 2

Volume of Leachant L8	0.988
Volume of Eluate VE2	0.92

Disclaimer: *The WAC limit values are provided for guidance only. DETS does not accept responsibility for errors or omissions. Values are correct at time of issue.*

Summary of Asbestos Analysis
Soil Samples

Our Ref 17-15582-1
Client Ref 4159
Contract Title Lundwood WwTW

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1257723	BH02 9 0.80	SOIL	NAD	none	D Wilkinson
1257727	TH06 6 0.60	SOIL	NAD	none	D Wilkinson
1258038	TH03 8 1.00	SOIL	NAD	none	D Wilkinson

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 17-15582-1
Client Ref 4159
Contract Lundwood WwTW

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1257718	BH01 0.20 SOIL	31/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1257719	BH01 0.40 SOIL	31/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1257720	BH01 0.70 SOIL	31/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1257721	BH02 0.20 SOIL	30/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1257722	BH02 0.50 SOIL	30/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1257723	BH02 0.80 SOIL	30/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1257724	BH02 1.50 SOIL	30/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1257725	BH02 2.50 SOIL	30/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1257726	BH03 3.50 SOIL	31/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1257727	TH06 0.60 SOIL	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1257728	TH06 1.20 SOIL	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1257729	BH03 5.00 WATER	31/10/17	GB 1L x2	Cyanide/Mono pHoh (7 days)	
1257730	BH07 1.10 SOIL	02/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1257731	BH09 1.50 SOIL	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1257732	BH09 7.00 WATER	01/11/17	GB 1L x2	Cyanide/Mono pHoh (7 days)	
1257733	BH02 0.50 LEACHATE	30/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1257734	BH02 0.50 LEACHATE	30/10/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1257735	TH06 0.60 LEACHATE		GJ 250ml x2, GJ 60ml x2, PT 1L x2	Sample date not supplied	
1257736	TH06 0.60 LEACHATE		GJ 250ml x2, GJ 60ml x2, PT 1L x2	Sample date not supplied	
1258038	TH03 1.00 SOIL	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2	pH + Conductivity (7 days)	
1258039	TH03 1.70 SOIL	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1258040	TH-05 0.50 SOIL	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1258041	TH03 1.00 LEACHATE	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1258042	TH03 1.00 LEACHATE	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		
1258095	TH05 1.20 SOIL	01/11/17	GJ 250ml x2, GJ 60ml x2, PT 1L x2		

Information in Support of the Analytical Results

Our Ref 17-15582-1
Client Ref 4159
Contract Lundwood WwTW

Key: G-Glass P-Plastic J-Jar T-Tub B-Bottle

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

dets
Derwentside Environmental Testing Services

Quality Control

Quality Systems.

Derwentside Environmental Testing Services employs numerous measures to ensure high levels of confidence in the results produced. Our laboratory has been accredited by the United Kingdom Accreditation Service (UKAS) since its inception and operates in full compliance with the internationally recognised standard ISO17025 and the Environment Agency's MCERTS (Monitoring & Certification Scheme) standard for soils and waters, which provides greater assurance to all parties of the reliability of data from chemical analysis.

To obtain a copy of our full UKAS schedule visit the UKAS website at www.ukas.org and search for our laboratory number 2139.

MCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
2139

Proficiency Testing Schemes.

DETS participates in nine external proficiency testing schemes in order to monitor and ensure the continuing quality of analysis. These schemes are:

Aquacheck
LGC Setting standards in analytical science Contest
RTC
AIMS
AISS
RICE
WEPAL
DCC
pt:a proficiency testing australia

Internal Quality Control.

DETS runs a strict internal quality control system. A minimum of 5% of all samples that undergo analysis in our laboratories are quality control samples. This way we can ensure a high level of confidence in all of the analytical data produced. In addition, MCERTS accredited tests must meet strict, ongoing limits for precision and bias in order to maintain their accreditation status.

DETS INFO 001 – ANALYTICAL METHOD SUMMARY

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETS 036	**Leachate Preparation** **(NRA Method and BS EN 12457 Parts 1-3)**	Leachates are prepared as per the NRA (1994) method and as per BS EN 12457 Parts 1 - 3 one and two stage leachate preparation.	Leaching Test Method for the Assessment of Contaminated Land, Interim Guidance, NRA(1994) BS EN 12457 Part 1,2 & 3	n/a	Not Accredited
DETS 073	**Acid Neutralisation Capacity of Soils and Other Solids**	ANC is a measure of the buffering capacity of soils and other waste materials. The analysis measures the amount of acid required to bring the sample to a fixed pH. The initial pH of the sample extract must be measured before analysis begins. Analysis is performed by the addition of acid in conjunction with pH measurement by pH meter until the specified pH has been reached as indicated by the meter. The result is expressed in mol/kg (dry wt).	Annex B (Preliminary determination of the acid/base consumption) – CEN/TC 292 – WI 292046 – Characterization of waste – Leaching behaviour tests – Acid and Base neutralization capacity test	1.0 mol/kg	Not Accredited
DETS 074	**Low Level PAH by HPLC Fluorescence**	PAH is extracted from one litre of filtered water sample by solid phase extraction. PAH is eluted from the SPE column with DCM evaporated to dryness under nitrogen and redissolved in acetonitrile. Analysis of samples is carried out by HPLC fluorescence.	EPA Method 550 The Analyst 2001, 126:1336-1331 Phenomonex Strata X Application Note for PAH by SPE	0.01ug/L each 5.0 ug/L Total	Not Accredited

DETS INFO 001 – ANALYTICAL METHOD SUMMARY

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 1001	**Sample Pre-Treatment and Preparation of Solids**	Solid samples are classified and identified. Samples requiring analysis for unstable or volatile determinands are analysed as received. Samples requiring analysis for stable and non-volatile determinands are dried at <30°C or 50°C, depending on requirements, for a minimum of 16hrs (overnight). Dried samples are crushed in a jaw crusher, if necessary, and then ground using a mechanical mixer mill and sieved through a 250µm sieve to ensure they are homogenous.	BS1377:1990 – Soils for Civil Engineering Purposes The preparation and pre-treatment of potentially contaminated soils prior to chemical analysis – MEWAM – 2006 – Environment Agency (Updated procedure under preparation)	n/a	Not Accredited
DETSC 1002	**Description of Soil Sample Type**	This method outlines the procedure used to describe soil samples with respect to basic type, predominant colour and inclusions. The procedure is carried out during the sample preparation stage.	BS 5930:Section 6:1999	n/a	Not Accredited
DETSC 1003	**Stone and Glass / Metal / Plastic Content of Soil**	This method outlines the procedure used to determine the Stone and Glass/Metal/Plastic content of soil samples. The procedure is carried out during the sample preparation stage.	BS 3882:2007 BS 1377:1990	0.1%	Not Accredited
DETSC 1004	**Moisture Content/Loss on Drying of Soil**	Loss on drying is determined by loss of mass on drying in an oven set at 28°C or 50°C. Moisture content is determined by loss of mass on drying in an oven set at 105°C. The procedure is carried out during the sample preparation stage.	Practical Environmental Analysis. Radojevic & Bashkin. RSC 1999 BS 1377: Part 2:1990 DETS drying time study	0.1%	Not Accredited
DETSC 1101	**Asbestos - Bulk Analysis**	Samples are examined visually for the presence of asbestos containing materials or asbestos fibres. Suspect fibres are removed from the sample and examined using polarised light microscopy to determine whether they are asbestos fibres. If no asbestos fibres are identified by the method after an adequate length of examination time, and after at least two small pinch samples have been examined, then the sample may be reported as 'NAD' (no asbestos detected).	HSG 248 Asbestos: The Analysis Guide for Sampling, Analysis and Clearance Procedures. 2005 McCrone W.C., Asbestos Identification (Second Edition), The McCrone Research Institute, 1987 LAB 30, Application of ISO/IEC17025 for Asbestos Sampling and Testing, UKAS, Edition 2, April 2008	n/a	UKAS

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 1102	**Quantification of asbestos in soils, loose aggregates and ballast**	The method of quantification is divided into three procedures: Gravimetric analysis, detailed gravimetric analysis and PCOM analysis. The analysis may be affected by the client's requirements as determined by contract review, and by the nature of the asbestos found in the sample, e.g. whether ACMs are present, and whether fibre bundles large enough to pick out using tweezers are have been found in the sample.	HSG 248 Asbestos: The Analysis Guide for Sampling, Analysis and Clearance Procedures. 2005 HSG264 Asbestos: The survey guide. HSE Books, 2010. Davies, L. S.T., Wetherill, G. Z., McIntosh, C., McGonagle, C., Addison, J. 1996. Development and validation of an analytical method to determine the amount of asbestos in soils and loose aggregates. HSE Contract Research Report N0. 83/1996. HSE Books	Gravimetric Analysis: 0.01% for 1kg sample Detailed Gravimetric Analysis: 0.001% for 50g sample PCOM Analysis: 0.001%	UKAS
DETSC 1103	**Asbestos Water Absorption Test**	This test involves a sample of the asbestos product being dried and weighed before being immersed in water for a period of time. The sample is then removed from the water and re-weighed. If the amount of water absorbed is <30% by weight, then the sample should be reported as 'Not Licensed'. If ≥30% water is absorbed then the sample should be reported as being 'Licensed', i.e. an asbestos material for which a licence is required to work on.	Work with Materials Containing Asbestos: Approved Code of Practice and Guidance. HSE Books, 2006.	n/a	UKAS
DETSC 2002	**Organic matter content of soil**	The procedure is based upon Walkley and Black's method. Organic matter in soil is oxidised with potassium dichromate in the presence of concentrated sulphuric acid. The excess dichromate is titrated with ferrous sulphate using diphenylamine as an external indicator. The organic matter content is calculated from the amount of dichromate used during the oxidation process based on an empirical relationship.	BS1377 : Part 3 : 1990 Method 3 BS1377 : Part 1 : 1990 BS 3882:2007	0.1%	UKAS MCERTS(Soils)

DETS INFO 001 – ANALYTICAL METHOD SUMMARY

DETSC 2003	**Loss On Ignition**	Soil is ignited at 440C and the amount of sample lost on ignition is determined gravimetrically. Other specified temperatures may be used but are not accredited.	BS1377 : Part 3 : 1990 Method 4 BS1377 : Part 1 : 1990	0.01%	UKAS MCERTS(Soils)
Method Number	**Title**	**Description**	**Reference**	**LOD**	**Accreditation Status**
DETSC 2004	**Sulphate Content of Soil and Water**	The sulphate in the soil is dissolved in dilute hydrochloric acid, or in an aqueous extract having a water:soil ratio of 2:1 and the insoluble residue is removed by filtration. Waters are also filtered prior to analysis. The sulphate in the filtrate is precipitated as barium sulphate which is then filtered, ignited and weighed.	BS1377 : Part 3 : 1990 Method 5 BS1377 : Part 1 : 1990 BRE SD1: 2005 Concrete in Aggressive Ground	**Acid Soluble:** 0.01% **Water Soluble** 100mg/l **Waters** 10mg/l	UKAS MCERTS(Soils)
DETSC 2005	**Carbonate content of soil by Rapid Titration**	The carbonate present in the soil reacts with a known excess of hydrochloric acid liberating carbon dioxide. The acid remaining after the reaction is determined by titration against sodium hydroxide. The result is calculated in terms of the equivalent proportion of carbon dioxide.	BS 1377: Part 1: 1990. BS 1377: Part 3: 1990: Method 5	1%	UKAS
DETSC 2006	**Water Soluble Chloride Content of Soil & Chloride Content of Water**	The chloride in the soil is dissolved in water and the insoluble material is removed by filtration. Waters are filtered before analysis. The chloride is analysed by Mohr's method. The chloride in a neutral solution is titrated against standard silver nitrate using potassium chromate as an indicator. The colour change is from yellow to brick red.	BS1377 : Part 3 : 1990 Method 7.2 BS1377: Part 1: 1990	**Soil:** 0.01% **Water:** 10mg/l	UKAS MCERTS(Soils)
DETSC 2007	**Acid Soluble Chloride Content of Soil and Concrete**	The chloride in the sample is dissolved in nitric acid and the insoluble material is removed by filtration. The dissolved chloride is analysed by Volhard's method. The chloride in solution is precipitated with a known excess of standard silver nitrate. The excess silver nitrate is titrated against standard ammonium thiocyanate using ferric alum as an indicator. The colour change is white to red.	BS1377 : Part 3 : 1990 Method 7.3 BS1377: Part 1: 1990 BS 1881-124:1988	0.01%	UKAS

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2008	**pH Value of Soil and Water**	The pH value of a soil suspension in water or a groundwater sample is determined electrometrically using a glass electrode.	BS1377: Part 3: 1990 – Soils for Civil Engineering Purposes – Chemical and Electrochemical Methods	n/a	UKAS (Soils + Waters) MCERTS (Soils + Waters-Trade Effluent only)
DETSC 2009	**Electrical Conductivity of Soil & Water**	The electrical conductance of a soil suspension in water or of a water sample is determined by voltammetry using a conductivity meter. In some cases, the soil may need to be extracted with an aqueous solution of an inorganic salt e.g. the conductivity of topsoil is determined by preparing a suspension of the soil in saturated calcium sulphate.	Standard Methods for the Examination of water and Wastewater Part 2510B 21st Edition 2005 APHA, AWWA, WEF BS3882:2007 Specification for Topsoil	1uS/cm	UKAS
DETSC 2019	**Loose Packed Dry Soil Density**	Dried, ground soil is transferred to a dry, tared measuring cylinder and the volume recorded. The cylinder and its contents are then weighed and the density of the soil calculated.	BS3882:2007 Specification for Topsoil	n/a	Not Accredited

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2024	**Sulphide in Soil and Water by Iodometry**	Hydrogen sulphide is liberated by acidification of the sample with hydrochloric acid in a steam distillation unit. The hydrogen sulphide produced is carried over with the steam and is absorbed in alkaline zinc acetate. The zinc sulphide produced reacts with iodine formed when iodate-iodide is acidified and the excess iodine titrated with standard thiosulphate.	In House Method based on: Environment Agency The determination of easily liberated sulphide in soils and similar matrices (2010) - Blue Book 228 Method D - The determination of easily liberated sulphide in as received or air-dried samples following acid steam distillation with iodometric titration. Environment Agency The determination of sulphide in waters and associated materials (2007) Draft Method D - The determination of easily liberated sulphide in as received or air-dried samples following phosphoric acid steam distillation with iodometric titration.	**Soils:** 10mg/kg **Waters:** 250ug/l	**Soils:** UKAS MCERTS(Soils) **Waters:** Not Accredited
DETSC 2030	**Alkalinity in Water**	Alkalinity of a water sample is determined by indicator end point titration with a strong acid from sample pH to pH8.3 (where applicable) and then to pH4.5. From the titres obtained the total alkalinity and concentrations and types of alkalinity present can be calculated.	SCA Method ISBN 0 11 751601 5 The Determination of Alkalinity and Acidity in Water 1981 Instruction Manual for Skalar SP50 Robotic Analyser	20mg/l as CaCO3	UKAS MCERTS(Waters) Trade Effluent only
DETSC 2031	**5 Day Biochemical Oxygen Demand**	The sample, either diluted or undiluted, is placed in a BOD bottle and the initial dissolved oxygen content of the sample is measured using a dissolved oxygen meter. The bottle is placed in an incubator at 20°C in the dark for 5 days. After this time the bottle is removed and the residual dissolved oxygen content of the sample is measured. The BOD of the sample is calculated from the reduction in the concentration of dissolved oxygen over 5 days.	SCA Method ISBN 0 117522120 5 Day Biochemical Oxygen Demand (BOD5) Second Edition 1988	1 mg/l	UKAS MCERTS(Waters)-Trade Effluent only

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2032	**Chemical Oxygen Demand**	Oxidisable substances react with sulphuric acid – potassium dichromate solution in the presence of silver sulphate as a catalyst. Chloride is masked by mercury sulphate. The reduction in the yellow colouration of Cr6+ is evaluated using a spectrophotometer for the low range tubes (LCK 314) whilst the green colouration of Cr3+ is evaluated for the medium and high range tubes (LCK 014 and LCK 114).	Environment Agency The determination of chemical oxygen demand in waters and effluents (2007) Methods for the Examination of Waters and Associated Materials	10 mg/l	UKAS MCERTS(Waters)-Trade Effluent only
DETSC 2033	**Total and Dissolved Organic Carbon in Water**	The term TOC (Total Organic Carbon) is used to describe the total content of organically bound carbon in dissolved and undissolved compounds. The TOC content is expressed in mg/l. If DOC (Dissolved Organic Carbon) is required, samples are filtered through a 0.45µm filter paper prior to analysis. Inorganic carbon is expelled by acidification of the sample. TOC is then determined by digestion of the sample with sulphuric acid and peroxodisulphate. Carbon containing compounds are transformed into carbon dioxide. The carbon dioxide evolves and reacts with an indicator solution. The colour change is measured using a spectrophotometer.	Hach-Lange Technical Instructions: LCK 385, LCK 386, LCK 387	2 mg/l	UKAS
DETSC 2034	**Suspended and Settleable Solids in Water**	Suspended matter is removed from a measured volume of sample by filtration under reduced pressure through a pre-treated, pre-weighed glass fibre filter paper. The paper is washed with deionised water to remove dissolved salts and the total suspended matter is determined gravimetrically after drying at 105 ±5°C Settleable solids are determined by subtracting the solids left in suspension after settlement for 1 hour (or other agreed time) from the total suspended matter in the sample.	SCA Method ISBN 011 751957 X Suspended, Settleable and Total Dissolved Solids in Waters and Effluents 1980	5 mg/l	**Suspended Solids:** UKAS MCERTS(Waters)-Trade Effluent only **Settleable Solids:** Not Accredited

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2035	**Total Dissolved Solids in Water**	Water samples are pre-filtered to remove any suspended solids and evaporated in an oven at 180°C. The amount of residual dissolved solids is determined gravimetrically. An estimate of the total dissolved solids can be obtained by measuring the conductivity of the sample. This method is not accredited.	SCA Method ISBN 011 751957 X Suspended, Settleable and Total Dissolved Solids in Waters and Effluents 1980 BS1377: Part 3 : 1990 Section 8	5 mg/l	UKAS
DETSC 2047	**Formaldehyde in Water**	Formaldehyde in soil is extracted in water, with a water to soil ratio of 10:1. The insoluble residue is removed by filtration prior to analysis. Waters are filtered prior to analysis to remove any particulates in suspension. Formaldehyde in the extract or water sample reacts with chromatropic acid-sulphuric acid solution to form a purple coloured complex. The absorbance of the coloured solution is read at 580nm using a suitable visible spectrophotometer.	Formaldehyde by visible absorption spectrophotometry – Method 3500, Issue 2 – NIOSH Manual of Analytical Methods, Fourth edition, August 1994	**Soil:** 0.2mg/kg **Water:** 20µg/l	Not Accredited
DETSC 2048	**Dissolved Oxygen Content of Water**	The dissolved oxygen content of the sample is measured using a dissolved oxygen meter either electrochemically or by fluorescence, or by the titrimetric method developed by Winkler.	SCA Method ISBN 0.11 751442X Dissolved Oxygen in Natural and Waste Waters 1979	0.1 mg/l	Not Accredited
DETSC 2055	**Anions in Water and Aqueous Soil Extracts by Ion Chromatography**	Liquid samples and aqueous soil extracts are filtered through a 0.22µm syringe filter prior to analysis. The filtered samples are injected into an Ion Chromatograph. The anions of interest are separated on the basis of their affinity for the active sites of the column packing material. The separated anions are converted into their highly conductive acid forms and measured by conductivity. The anions are identified on the basis of retention time as compared to standards and quantisation is by measurement of peak area.	Standard Methods for the Examination of Water and Wastewater Section 4110 21st Edition 2005 APHA, AWWA, WEF	**Soil:** 1.0 mg/kg **Water:** 0.1 mg/L	UKAS

DETS INFO 001 – ANALYTICAL METHOD SUMMARY

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2076	**Sulphate and Magnesium Content of 2:1 Aqueous Extract of Soil by ICP-OES**	The sulphate and magnesium in the soil are extracted in an aqueous extract having water: soil ratio of 2:1 and the insoluble material is removed by filtration. The concentrations of sulphate and magnesium in the filtrate are determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The wavelengths used for identification and quantification are 181.972nm for sulphate and 285.213nm for magnesium.	BS1377 : Part 3: 1990 Method 5 BS1377 : Part 1: 1990 TRL 447 Sulphate Specification for Structural Backfills 2005 BRE SD1:2005 Concrete in Aggressive Ground 2005	10mg/L	**Sulphate:** UKAS MCERTS(Soils) **Magnesium:** Not Accredited
DETSC 2084	**Total Organic Carbon by PrimacATC Analyser**	Soil samples are treated with phosphoric acid to expel any inorganic carbonates. The samples are then heated at high temperature in a continuous flow of air so that any organic carbon is oxidised to carbon dioxide. The gas is then allowed to cool and analysed by an infra-red detector.	PrimacsATC Analyser – User Manual, Skalar	0.47%	MCERTS(Soils)
DETSC 2085	**Total and Dissolved Organic Carbon in Water**	**Direct TOC Analysis** The sample is acidified, stirred and purged to remove the IC before the sample is injected and handled as in the TC Analysis. The sample is filtered before acidification for DOC. **TC Analysis** The sample is injected by an automated septum less rotary port into a high temperature reactor. In the reactor, at a temperature of 750 - 950°C all organic and inorganic carbon is oxidized to the gaseous carbon dioxide (CO2). The catalyst that is present in the reactor catalysis the oxidation to completion. A flow of air transports these oxidation products to the detectors. The oxygen required for reaction is taken from the airflow. The products are led into the non-dispersive infrared detector where the carbon dioxide is determined. The carbon dioxide is measured at a wavelength of 4.2 µm by NDIR detection.	Standard Methods for the Examination of Water and Wastewater Section 5310 B 21st Edition 2005 APHA, AWWA, WEF HMSO Methods for the Examination of Waters and Associated Materials – The Instrumental Determination of Total Organic Carbon and Related Determinands 1995	lmg/l as C	UKAS

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2119	**Exchangeable Ammonia in Soil**	An intense blue-green complex, related to indophenol blue, is formed by the reaction of ammonia with hypochlorite and sodium salicylate, with sodium nitroprusside acting as a catalyst. The complex is measured at 655nm and is related to the ammonia concentration by means of a calibration curve. Sodium citrate is added to overcome interfering ions.	MAFF/ADAS Reference Book 427 – the Analysis of Agricultural Materials – Method 53, Ammonium, Nitrate and Nitrite-Nitrogen, Potassium Chloride Extractable	0.5mg/kg	UKAS MCERTS(Soils)
DETSC 2120	**Ammonia in Water by Spectrophotometry**	An intense blue-green complex, related to indophenol blue, is formed by the reaction of ammonia with hypochlorite and sodium salicylate, with sodium nitroprusside acting as a catalyst. The complex is measured at 655nm and is related to the ammonia concentration by means of a calibration curve. Sodium citrate is added to overcome interfering ions.	Environment Agency Ammonia in Waters 1981 ISBN 0117516139 Methods for the Examination of Waters and Associated Materials	20µg/l	UKAS
DETSC 2121	**Total Kjeldahl Nitrogen Content of Soils and Waters**	The sample is digested with sulphuric acid and a mixture of catalysts to convert organic nitrogen to ammonia. The sample is then distilled under alkaline conditions, and the distilled ammonia is absorbed in sulphuric acid. The ammonia content of the distillate is then determined colorimetrically either using the UV/vis spectrophotometer or the Konelab 60i. Ammonia reacts with hypochlorite ions generated by the alkaline hydrolysis of sodium dichloroisocyanurate to form monochloramine. Monochloramine reacts with salicylate ions in the presence of sodium nitroprusside at around pH 12.6 to form a blue compound. The absorbance of this compound is measured spectrophotometrically at wavelength 660nm	The Analysis of Agricultural Materials – MAFF/ADAS Reference Book 427 – HMSO BS 3882: 2007 Specification for topsoil Standard Methods for the Examination of Water and Wastewater Part 4500-N. 21st Edition 2005 APHA, WWA, WEF	**Soil:** 0.01% **Water:** 2mg/l	Not Accredited
DETSC 2123	**Water Soluble Boron in Soil & Boron in Water**	Boron in soil is extracted in boiling saline water. Waters are filtered prior to analysis to remove any particulates in suspension. The water soluble boron in the extract or filtrate reacts with azomethine–H to produce a yellow coloured complex. The resulting colour absorbance is measured at 420nm using a suitable visible spectrophotometer.	SecondSite Property (now National Grid Property Holdings) - Guidance for assessing and managing potential contamination on former gasworks and associated sites (Part I) (Version 3) Method 17.12 The analysis of Agricultural materials MAFF/ADAS – reference book 427	**Soil:** 0.2mg/kg **Water:** 100ug/L	UKAS MCERTS(Soils)

			HMSO		

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2130	**Cyanides & Monohydric Phenols by Skalar**	Water samples are filtered through a 0.45µm syringe filter and solid samples are extracted with 1M caustic soda prior to analysis on the automated flow analyser. The method determines total cyanide, easily liberated cyanide, complex cyanide, thiocyanate and monohydric phenols	Skalar methods: I295-001 w/r+P7 I295-002 w/r+P7 293-902 w/r+P7 497-001	**Soils mg/kg:** Total & Free CN=0.1, Thio=0.6, Phenol=0.3 **Waters ug/L:** Total CN=40, Free CN=20, Thio=20, Phenol=100	UKAS MCERTS(Soils)
DETSC 2140	**Sugar in Mixing Water for Cement**	Waters are filtered prior to analysis to remove any particulates in suspension. The sugar in the filtrate reacts with phenol and sulphuric acid to produce a yellow-orange coloured complex. The resulting colour absorbance is measured at 490nm using a suitable visible spectrophotometer.	Colorimetric Method for Determination of Sugars and Related Substances MICHEL DUBOIS, K. A. GILLES, J. K. HAMILTON, P. A. REBERS, and FRED SMITH - Division of Biochemistry, University of Minnesota, St. Paul, Minnesota.	10mg/l	Not Accredited
DETSC 2201	**Nitrite in Waters and Leachates by Konelab 60i**	Nitrite is determined colorimetrically using the Konelab60i autoanalyser. The nitrite colour reaction occurs at pH 2.0 to 2.5 by coupling diazotized Sulphanilamide with N-1-naphthyl-ethylenediamine. The absorbance of this compound is measured spectrophotometrically at 520nm.	Standard Methods for the Examination of Water and Wastewater Part 4500-NO2 B – 21st Edition 2005 APHA, AWWA, WEF Aquakem Method Nitrite in Waters Iss No 2 Methods for the Examination of Water and Associated Materials Oxidised Nitrogen in Waters 1981.	0.04mg/l (as N)	UKAS

			EPA Method 354.1 Nitrite, spectrophotometric (Approved at 40 CFR Part 136, not approved at Part 141)		

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2202	**Total Oxidised Nitrogen in Waters and Leachates by Konelab 60i**	Nitrate is reduced to nitrite by hydrazine under alkaline conditions. The total nitrite ions are then reacted with sulphanilamide and N-1-naphthylethylenediamine dihydrochloride under acidic conditions to form a reddish purple azo-dye. The absorbance of this compound is measured spectrophotometrically at 540 nm using the Konelab 60i autoanalyser.	Standard Methods for the Examination of Water and Wastewater Part 4500-NO2 B and Part 4500-NO3 H – 21st Edition 2005 APHA, AWWA, WEF Aquakem Method Total Oxidised Nitrogen. Methods for the Examination of Water and Associated Materials Oxidised Nitrogen in Waters 1981. EPA Method 353.1 Nitrate, Nitrite Colorimetric Automated Hydrazine Reduction (Approved at 40 CFR Part 136, Not approved at Part 141)	0.7mg/l (as N)	UKAS
DETSC 2203	**Hexavalent Chromium in Waters and Leachates by Konelab 60i**	Hexavalent Chromium is determined colorimetrically using the Konelab 60i autoanalyser. Hexavalent chromium reacts with diphenylcarbizide in acid solution and produces a red-violet colour. The absorbance of this compound is measured spectrophotometrically at 540nm.	Standard Methods for the Examination of Water and Wastewater Part 3500-Cr – 21st Edition 2005 APHA, AWWA, WEF USEPA 7196-A Aquakem Method. Hexavalent Chromium	10µg/l	UKAS
DETSC 2204	**Hexavalent Chromium in Soil by Konelab 60i**	Hexavalent Chromium is determined colorimetrically using the Konelab 60i autoanalyser. Hexavalent chromium reacts with diphenylcarbizide in acid solution and produces a red-violet colour. The absorbance of this compound is measured spectrophotometrically at 540nm.	Aquakem Method. Hexavalent Chromium	1mg/kg	Not Accredited

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2205	**Reactive & Total Phosphorus in Waters and Leachates by Konelab 60i**	Phosphate is determined colorimetrically using the Konelab60i autoanalyser. The orthophosphate ion reacts with ammonium molybdate and antimony potassium tartrate under acidic conditions to form a 12-molybdophosphoric acid complex. The complex is then reduced with ascorbic acid to form a blue heteropoly compound. The absorbance of this compound is measured spectrophotometrically at wavelength 880nm.	Standard Methods for the Examination of Water and Wastewater Part 4500-P E– 21st Edition 2005 APHA, AWWA, WEF Aquakem Method. Phosphate in Waters Issue 2	0.01mg/l	**Reactive Phosphorus:** UKAS MCERTS (Waters-Trade Effluent only) **Total Phosphorus:** Not Accredited
DETSC 2206	**High Level Ammonia in Waters and Leachates by Konelab 60i**	Ammonia is determined colorimetrically using the Konelab60i autoanalyser. Ammonia reacts with hypochlorite ions generated by the alkaline hydrolysis of sodium dichloroisocyanurate to form monochloramine. Monochloramine reacts with salicylate ions in the presence of sodium nitroprusside at around pH 12.6 to form a blue compound. The absorbance of this compound is measured spectrophotometrically at wavelength 660nm.	Methods for the Examination of Waters and Associated Materials Ammonia in Waters 1981 ISBN 0117516139. Aquakem Method. Ammonia in Waters Issue 2	0.8mg/l	UKAS
DETSC 2207	**Low Level Ammonia in Waters and Leachates by Konelab 60i**	Ammonia is determined colorimetrically using the Konelab60i autoanalyser. Ammonia reacts with hypochlorite ions generated by the alkaline hydrolysis of sodium dichloroisocyanurate to form monochloramine. Monochloramine reacts with salicylate ions in the presence of sodium nitroprusside at around pH 12.6 to form a blue compound. The absorbance of this compound is measured spectrophotometrically at wavelength 660nm.	Methods for the Examination of Waters and Associated Materials Ammonia in Waters 1981 ISBN 0117516139. Aquakem Method. Ammonia in Waters Issue 2	0.015mg/l	UKAS

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2208	**Sulphide in Waters and Leachates by Konelab 60i**	Sulphide is determined colorimetrically using the Konelab60i autoanalyser. Potassium Dichromate converts N-N-Diethyl-p-phenylenediamine to the free radical which reacts rapidly with sulphide to produce the coloured 'DPD Blue' or 'Ethylene Blue'. The absorbance can then be measured at wavelength 660nm.	The determination of sulphide in waters and associated materials (2007) - SCA - Draft (March 2007) Aquakem Method. Sulphide SP001 Issue 2 Standard Methods for the Examination of Water and Wastewater, 21st Edition 2005, Part 4500. ISBN0-87553-223-3	10µg/l	UKAS
DETSC 2210	**Ferrous Iron in Waters and Leachates by Konelab 60i**	Three molecules of phenanthroline chelate with each atom of ferrous iron to form an orange/red complex. The intensity of the coloured solution is stable between pH3 to pH9. Rapid colour development occurs between pH2.9 and pH3.5 in the presence of excess phenanthroline. The resulting colour absorbance is measured at 510nm	Aquakem Method Ferrous Iron FIR001 Issue 2	0.1mg/l	Not Accredited
DETSC 2211	**Silicate in Waters and Leachates by Konelab 60i**	Reactive forms of silicon in acid solution, below pH2, react with ammonium molybdate ions to form a yellow silicomolybdate. Ascorbic acid reduces the yellow silicomolybdate to produce a blue silicomolybdate complex. Oxalic acid is added to destroy any molybdophosphoric acid formed.	ASTM D7126 - 10 Standard Test Method for On-Line Colorimetric Measurement of Silica Aquakem Method Silica SIL Issue 2	0.1mg/l	Not Accredited
DETSC 2301	**Metals in Soil by ICP-OES** As, Ba, Be, Cd, Cr, Co, Cu, Fe, Mn, Mo, Ni, Pb, Se, V, Zn	Metals in soil are extracted using aqua regia and their concentrations are determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Any metals not listed can be determined but are not accredited under UKAS or MCERTS for soils.	Standard Methods for the Examination of Water and Wastewater Part 3120 B – 21st Edition 2005, AWWA, WEF	**mg/kg:** As, Be Cu, Ni =0.2, Ba=1.5, Cd=0.1, Cr=0.15, Co=0.7, Mn=20, Mo=0.4, Pb=0.3, Fe=1200, Se=0.5, V=0.8, Zn=1.0	UKAS (all listed) MCERTS (All soils listed except Fe)

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2302	**Metals in Waters by ICP-OES** Al, As, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Se, Zn	Concentrations of metals in water are determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Any metals not listed can be determined but are not accredited under UKAS or MCERTS for waters	Standard Methods for the Examination of Water and Wastewater Part 3120 B – 21st Edition 2005 APHA, AWWA, WEF	**µg/l:** Al=6.5, As= 7.1, Ca=100, Cd=0.3, Cr=0.75, Cu=0.75, Fe=70, K=20, Mg=5, Na=12, Ni=2.7, Pb=4, Se=11.3, Zn=3.8	**Dissolved:** UKAS (all listed) MCERTS(Waters)- Trade Effluent only (Al, Cd, Cr, Cu, Ni, Pb, Zn) **Total:** Not Accredited
DETSC 2303	**Total Hardness (By Calculation)**	The concentrations of calcium and magnesium are determined using the appropriate methodologies. The hardness is a measure of the sum of the calcium and magnesium concentration expressed as calcium carbonate.	Standard Methods for the Examination of Water and Wastewater Part 3120 B – 21st Edition 2005 APHA, AWWA, WEF	n/a	UKAS
DETSC 2304	**Zinc Equivalent in Soil (By Calculation)**	The concentrations of copper, nickel and zinc concentrations are determined using the appropriate methodologies. The zinc equivalent is a measure of the combined toxicity of the three metals, relative to the toxicity of zinc.	n/a	n/a	Not Accredited
DETSC 2306	**Metals in Waters by ICP-MS** Ag, Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Sn, V, Zn	Concentrations of metals in water are determined by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). Any metals not listed can be determined but are not accredited under UKAS.	Standard Methods for the Examination of Water and Wastewater Part 3125 B – 21st Edition 2005 APHA, AWWA, WEF	**µg/l:** Ag=0.13, Al=10.0, As=0.16, Ba=0.26, Ca=90, Cd=0.03, Co=0.16, Cr=0.25, Cu=0.40, Fe=5.50, Hg=0.01, K=80, Mg=20, Mn=0.22, Mo=1.1, Na=70, Ni=0.50, P=18.0, Pb=0.09, Sb=0.17, Se=0.25, Sn=0.40, V=0.60, Zn=1.3	**Dissolved:** UKAS (all listed) **Total:** Not Accredited

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2320	**Total Sulphur in Soil by ICP**	Sulphur compounds in soil are extracted using aqua regia and the insoluble residue is removed by filtration. The concentration of sulphur in the filtrate is determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Loss of sulphur as H2S is prevented by oxidation of the sulphur compounds to sulphate by the aqua regia.	TRL 447 Sulphate Specification for Structural Backfills 2005 BRE SD1 Concrete in Aggressive Ground 2005	0.01%	UKAS
DETSC 2321	**Total Sulphate content of Soil by ICP-OES**	The sulphate in the soil is extracted in dilute hydrochloric acid and the insoluble residue is removed by filtration. The filtrate is made up to volume and the concentration of sulphate in the filtrate is determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES).	BS1377 : Part 3: 1990 Method 5 BS1377 : Part 1 : 1990	0.01%	UKAS MCERTS(Soils)
DETSC 2322	**Total Potential Sulfate and Total Oxidisable Sulphur (By Calculation)**	Sulphur compounds in soil are extracted using aqua regia and the insoluble residue is removed by filtration. The concentration of sulphur in the filtrate is determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Loss of sulphur as H2S is prevented by oxidation of the sulphur compounds to sulphate by the aqua regia. The wavelength used for identification and quantification of sulphate is 181.972nm. The sulphate in the soil is extracted in dilute hydrochloric acid and the insoluble residue is removed by filtration. The filtrate is made up to volume and the concentration of sulphate in the filtrate is determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The wavelength used for identification and quantification of sulphate is 181.972nm. The two results obtained from the above tests may then be combined to calculate the Total Potential Sulphate and Total Oxidisable Sulphur content	BS1377 : Part 3: 1990 Method 5 BS1377 : Part 1 : 1990	0.01%	Not Accredited

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2324	**Mercury in Waters by Atomic Fluorescence Spectroscopy**	Waters and aqueous samples are preserved by fixing with concentrated nitric acid. Treatment with tin (II) chloride reduces mercury (II) to mercury (0) vapour which is detected using atomic fluorescence spectrometry.	Standard Methods for the Examination of Water and Wastewater Part 3112 B – 21st Edition 2005 APHA, AWWA, WEF PSA Method – Millennium Merlin Method for Total Mercury in Drinking, Surface, Ground, Industrial and Domestic Wastewaters and Saline Waters	0.05µg/l	UKAS
DETSC 2325	**Mercury in Soil Atomic Fluorescence Spectroscopy**	The mercury is extracted from soil in aqua regia with gentle refluxing. The extract is filtered to remove particulates and diluted to volume. Treatment with tin (II) chloride reduces mercury (II) to mercury (0) vapour which is detected using atomic fluorescence spectrometry.	PSA Method – Millennium Merlin Method for Mercury in Sludge, Soils and Sediments	0.05 mg/kg	UKAS MCERTS(Soils)
DETSC 2332	**Inorganic and Methyl Mercury Speciation**	Soils are air-dried and crushed before being subjected to a two-stage microwave extraction procedure for Inorganic (Hg(II)) and Methyl (MeHg) mercury. Waters and aqueous samples are filtered to remove particulates. An aliquot is separated via HPLC before treatment with bromate-bromide and tin (II) chloride to generate mercury and the mercury is determined by atomic fluorescence spectroscopy.	USEPA Method 3200 – Mercury Species Fractionation and Quantification by Microwave Assisted Extraction. PSA Application Note 053 – Mercury Speciation Using The Millenium Merlin Speciation System	**Soil:** 100µg/kg **Water:** 1µg/l	Not Accredited
DETSC 2333	**Elemental Mercury Speciation**	Soils, waters and aqueous samples are tested on an as-received bases. A known quantity of sample is extracted using argon and the released elemental mercury is trapped. The trapped mercury is released upon heating in a scarifier module and determined by atomic fluorescence spectroscopy.		**Soil:** 0.6µg/kg **Water:** 1µg/l	Not Accredited

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 2400	**Unified Barge Bioaccessible Metals in Soils**	The Unified BARGE Method (UBM) is a an in vitro method for simulating the human digestive system. Synthetic digestive fluids are used to simulate the fluids present in the body. Both inorganic solutions (Containing inorganic salts such as KCl, NaCletc), and organic solutions (Containing organic compounds such as Urea, Glucose etc) are mixed with enzymes to produce 4 Synthetic digestive fluids saliva (S), Gastric fluid (G), duodenal fluid (D) and bile (B). These solutions are then used to mimic the effect of a sample passing through a human gastro intestinal tract by shaking portions of the sample at 37^0C, human body temperature (17.4).	EPA 9200.2-86 April 2012- Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead in Soil BGS Chemical& Biological Hazards Programme Open Report OR/07/027 - Inter-laboratory Trial of a Unified Bioaccessibility Procedure	V = 1.0mg/kg Cr = 5.0mg/kg Co = 1.0mg/kg Ni = 5.0mg/kg As = 0.5mg/kg Se = 0.5mg/kg Cd = 0.5mg/kg Pb = 1.0mg/kg	Not Accredited
DETSC 3001	**Solvent Extractable Matter in Soil**	Soil samples are extracted with a water-immiscible solvent and filtered to remove the water. The solvent is evaporated and the amount of extractable matter in the sample is determined gravimetrically.	In-house method based on:- Problems Arising from the Redevelopment of Gas Works and Similar Sites - AERE Harwell Laboratory 1981. Environmental Agency The Determination of Material Extractable by Carbon Tetrachloride and of Certain Hydrocarbon Oil and Grease Components in sewage Sludge – 1978	40mg/kg	**Toluene & Cyclohexane:** UKAS **Other Solvents:** Not Accredited
DETSC 3002	**Oil & Grease/Solvent Extractable Matter in Waters**	A known volume of sample is acidified to pH<2 and extracted three times with an organic solvent, such as n-Hexane, in a separating funnel. The solvent is removed by evaporation and the amount of extractable matter in the sample is determined gravimetrically.	APHA 21st Edition, 2005 – Method 5520 B. Oil & Grease - Partition Gravimetric Method USEPA Method 1664, Revision A: n-Hexane Extractable Material (HEM: Oil & Grease) and Silica Treated N-Hexane Extractable Material (SGT-HEM; Non Polar Material) by Extraction and Gravimetry.	1mg/l for 500ml sample	UKAS

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 3049	**Elemental Sulphur in Soils and Waters by HPLC**	Soils are extracted in dichloromethane (DCM) by sonication. The elemental sulphur concentration is determined by high performance liquid chromatography (HPLC) with UV detection using a C_{18} (e.g. 250mm x 4.6mm) column and a mobile phase composed of 95% methanol and 5% water. Waters and aqueous extracts of soils are extracted using DCM in a separating funnel, filtered, and the concentration determined using HPLC.	National Grid Property Holdings Limited, Methods for the Collection and Analysis of Samples from National Grid Sites, Version 1, September 2006. Section 3.12 Soil Analysis: Elemental Sulphur.	**Soil:** 0.75mg/kg **Waters:** 90ug/l	**Soil:** UKAS MCERTS(Soils) **Water:** UKAS
DETSC 3072	**Aliphatic / Aromatic TPH by GC-FID**	Aliphatic and aromatic petroleum hydrocarbons (C_{10}-C_{35}) are extracted from soil and water using n-Hexane. The fractions are separated by solid phase extraction using silica columns, whereby the aliphatic fraction is eluted first with n-Hexane and the aromatic portion is eluted second with dichloromethane. The total, aliphatic, and aromatic concentrations are determined by gas chromatography flame ionisation detection (GC-FID) using a capillary column and hydrogen as the carrier gas. The chromatographic data is further characterized by subdivision into approximate boiling point/carbon number ranges with respect to n-alkane retention time markers.	National Grid Property Holdings Limited, Methods for the Collection and Analysis of Samples from National Grid Sites, Version 1, September 2006. Section 3.12 Soil Analysis: Draft TNRCC Method 1006	**Soil mg/kg:** AL10-12 =1.5 AL12-16 =1.2 AL16-21 =1.5 AL21-35 =3.4 AR10-12 =0.9 AR12-16 =0.5 AR16-21 =0.6 AR21-35 =1.4 **Water:** 1ug/l	**Soil:** UKAS MCERTS(Soils) (C10-C35 only) **Water:** Not Accredited
DETSC 3301	**PAH in Soil by GC-FID**	Soils and associated materials are extracted in dichloromethane (DCM) using sonication. The PAH concentration is recorded both as "Total PAH" and as "Speciated PAH", specified in terms of the 16 US EPA "Priority Pollutant" Polycyclic Aromatic Hydrocarbons. Concentrations are determined by gas chromatography using a BPX 50 (30m; 0.25µm ID; 0.25µm film) capillary column (or equivalent).	In-house method based on US EPA Method 8100, Polynuclear Aromatic Hydrocarbons	0.5 mg/kg each 1.6 mg/kg Total PAH	UKAS (16 PAH's only)
DETSC 3302	**Hexane / Acetone Extracted PAH in Soil by GC-FID**	Soils are extracted into hexane: acetone by shaking. The PAH concentration is recorded both as "Total PAH" and as "Speciated PAH", specified in terms of the 16 US EPA "Priority Pollutant" Polycyclic Aromatic Hydrocarbons. Concentrations are determined by gas chromatography using a BPX 50 (30m; 0.25µm ID; 0.25µm film) capillary column (or equivalent).	In-house method based on US EPA Method 8100, Polynuclear Aromatic Hydrocarbons	0.1 mg/kg each 1.6 mg/kg Total PAH	Not Accredited

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 3303	**Polyaromatic Hydrocarbons in Soils by GC-MS**	The PAHs in the soil sample are extracted into hexane: acetone by shaking. The PAHs in the extract are separated by gas chromatography and identified by the mass selective detector. The concentration of each PAH is determined by referencing individual mass peak areas to the appropriate internal standard mass peak area. Quantification is carried out within the instrument software.	In-house method based on EPA Method 8270- US EPA Method 8270, Revision C, Semivolatile Organic Compounds by Gas Chromatography – Mass Spectrometry (GC/MS)	0.03 mg/kg each 0.10 mg/kg Total PAH	UKAS (All 16 PAH's) MCERTS (not Fluorene, Anthracene, Chrysene or Total)
DETSC 3304	**Polyaromatic Hydrocarbons in Waters by GC-MS**	The PAHs in the water sample are extracted into dichloromethane by shaking. The PAHs in the extract are separated by gas chromatography and identified by the mass selective detector. The concentration of each PAH is determined by referencing individual mass peak areas to the appropriate internal standard mass peak area. Quantification is carried out within the Instrument software.	In-house method based on EPA Method 8270- US EPA Method 8270, Revision 3, Semivolatile Organic Compounds by Gas Chromatography – Mass Spectrometry (GC/MS) In-house method based on EPA Method 3510C- EPA Method 3510C, Revision 3, Separatory Funnel Liquid-Liquid Extraction	10 ng/l each	UKAS (16 PAH's only)
DETSC 3311	**Extractable Petroleum Hydrocarbons (EPH) in Soil, Ballast and Water**	This method is designed to determine total concentrations of extractable petroleum hydrocarbons (EPH) in solid and aqueous matrices. This method uses a dichloromethane (DCM) extraction followed by quantification using gas chromatography/flame ionisation detection (GC-FID) analysis using a 1:1 mixture of diesel and mineral oil as calibration standards and n-alkane markers to establish the boiling point ranges. This method is used for the quantitative analysis of “Total EPH” (C10-C40) and as “Speciated EPH”, specified in terms of the “diesel range” (C10-C24), and “mineral oil range” (C24-C40).	USEPA Method 3550C – Ultrasonic Extraction USEPA Method 8015B – Non-Halogenated Organics Using GC/FID	**Soil:** 10 mg/kg **Ballast:** 10mg/kg **Water:** 10µg/l	**Soil:** UKAS MCERTS(Soils) **Water:** UKAS

DETS INFO 001 – ANALYTICAL METHOD SUMMARY

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 3312	**Hexane Extractable Petroleum Hydrocarbons (HPH)**	This method is designed to determine total concentrations of extractable petroleum hydrocarbons (EPH) in solid matrices. This method uses a hexane: acetone (9.4) extraction followed by quantification using gas chromatography/flame ionisation detection (GC-FID) analysis using a 1:1 mixture of diesel and mineral oil as calibration standards and n-alkane markers to establish the boiling point ranges. This method is used for the quantitative analysis of "Total EPH" (C10-C40) and as "Speciated EPH", specified in terms of the "diesel range" (C10- C24) and "mineral oil range" (C24-C40).	USEPA Method 8015B – Non-Halogenated Organics Using GC/FID	**Soil:** 5 mg/kg	Not Accredited
DETSC 3321	**BTEX, MTBE & PRO in Soils by Headspace GC-FID**	BTEX, MTBE and PRO in soils are determined via Headspace GC-FID. Individual aromatic compounds are quantified by external calibration against known standards. PRO range is banded using alkane markers to define retention time windows.	EPA Methods 5021 and 8015D	0.01 mg/kg	UKAS MCERTS(Soils) Not accredited for PRO range (C5-10)
DETSC 3322	**BTEX, MTBE & PRO in Waters & Leachates by Headspace GC-FID**	BTEX, MTBE and PRO in soils are determined via Headspace GC-FID. Individual aromatic compounds are quantified by external calibration against known standards. PRO range is banded using alkane markers to define retention time windows.	EPA Methods 5021 and 8015D	1 µg/l	UKAS
DETSC 3401	**PCBs in Soils by GC-MS**	An as-received soil sample is extracted in Hexane:Acetone (1:2) using sonication methodology. The sample is separated by gas chromatography and identified by mass selective detector. Quantification is carried out within the instrument software.	EPA Method 8082 - Polychlorinated Biphenyls (PCBs) by Gas Chromatography.	**µg/kg** PCB 28=1.25 PCB 52=1.12 PCB 101=1.32 PCB 118=1.43 PCB 153=2.08 PCB 138=1.35 PCB 180=1.42	UKAS MCERTS(Soils)

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 3402	**Polychlorinated Biphenols in Waters by GC/MS**	The water sample is extracted in DCM on a reciprocal shaker. The sample is separated by gas chromatography and identified by mass selective detector. Quantification is carried out within the GC-MS software using an internal standard.	EPA Method 8082 - Polychlorinated Biphenyls (PCBs) by Gas Chromatography.	**ng/l** PCB 28=208 PCB 52=161 PCB 101=211 PCB 118+123=513 PCB 153=163 PCB 138=107 PCB 180=132 PCB 105=133 PCB 114=253 PCB 126=399 PCB 156=253 PCB 157=119 PCB 167=248 PCB 169=181 PCB 189=271 PCB 77=202 PCB 81=186	UKAS
DETSC 3432	**Volatile Organic Compounds in Waters by Headspace GC-MS**	The method covers the range of volatile organic compounds with boiling points up to 220°C. Water samples are heated and agitated in a crimp cap vial. This drives the volatile components in to the headspace. An aliquot of the headspace is taken and injected in to a gas chromatograph with mass selective detection (GC-MS).The detector operates in full scan mode and is calibrated with standards containing known concentrations of the compounds of interest.	USEPA Method 8260B Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 2, December 1996	1 ug/l except: DCM (27), 2,2-Dichloropropane (2), Bromochloromethane (4), Bromodichloromethane (4), m+p-Xylene (2), 1,3-Dichlorobenzene (2)	UKAS except: Trichlorofluoromethane, Methylene Chloride, 1,1,1-Trichloroethane,

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 3433	**Semi-Volatile Organic Compounds in Soils by GCMS**	The SVOCs in the soil sample are extracted into DCM: Acetone by shaking. The SVOCs in the extract are separated by gas chromatography and identified by the mass selective detector. The concentration of each SVOC is determined by referencing individual mass peak areas to the appropriate internal standard mass peak area. Quantification is carried out within the instrument software.	In-house method based on EPA Method 8270- US EPA Method 8270, Revision 3, Semi volatile Organic Compounds by Gas Chromatography – Mass Spectrometry (GC/MS)	Individual SVOCs 0.1 mg/kg	UKAS
DETSC 5001	**Ash Content of Coal**	The ash content of the sample is determined gravimetrically. A known weight of the sample is placed in a prepared ash crucible and placed in a furnace. The furnace is heated to 750°C ±10°C where the temperature is maintained. Following combustion the crucible and sample are removed, cooled and reweighed.	ASTM D3174-11 BS 1016-104.4 1998 ISO 1171: 2010	0.1%	UKAS
DETSC 5002	**Ash & LOI Content of Solid Biomass & Solid Recovered Fuels**	The ash and LOI content of the sample is determined gravimetrically. A known weight of the sample is placed in a prepared ash crucible and placed in a furnace. The furnace is heated to 550°C ±10°C where the temperature is maintained. Following combustion the crucible and sample are removed, cooled and reweighed.	BS EN 14775:2009 BS EN 15403:2011	0.1%	UKAS
DETSC 5003	**Volatile Matter Content of Solid Biomass, Solid Recovered Fuels and Coal**	A known weight of the sample produced for volatile matter determination is placed in a suitable crucible fitted with a lid. The crucible and sample is weighed and heated in a furnace with a limited air through put at a temperature of 900°C ±10°C for 7 minutes. The sample and crucible are re-weighed and the volatile matter content determined by difference.	BSEN15148:2009 – Solid Biofuels Determination of the Content of Volatile Matter BS EN 15402:2011 - Solid Recovered Fuels - Determination of the Content of Volatile Matter	0.1%	UKAS

DETS INFO 001 – ANALYTICAL METHOD SUMMARY

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 5004	**Total Moisture / Dry Solids Content of Solid Biomass & Solid Recovered Fuels & Coal**	The sample produced for general analysis is placed into a suitable prepared and weighed tray and reweighed. The sample is dried at 105°C to constant weight and the total moisture / dry solids content is calculated from the reduction in weight.	BSEN 14774 Parts 1 & 2 2009 DD CEN/TS 15414 Parts 1 & 2: 2010	0.1%	UKAS
DETSC 5005	**Analysis Moisture Content of Solid Biomass, Solid Recovered Fuels & Coal**	The sample produced for total moisture determination in accordance with DETSC 5009 or DETSC 5010 is placed in a suitable pre-weighed tray and reweighed. The sample is then dried at 105°C ±2°C to constant weight and then weighed again. The analysis moisture content is calculated from the reduction in weight.	BS EN 14774-3 2009 BS EN 15414-3 2011 BS 1016-104.1 -1999 ISO 11722 – 1999	n/a	UKAS
DETSC 5007	**Calorific Value of Solid Biomass, Solid Recovered Fuels & Coal**	Calorific value of a material is determined in an Isoperbol calorimeter by burning it in pure oxygen in a combustion bomb. A known amount of sample is placed in a combustion bomb which is then pressurised to 30bar with oxygen. A calorimeter bucket is filled with a known amount of deionised water which is placed in the calorimeter and the bomb placed in the bucket. The system is allowed to equilibrate and the bomb fired by electrical connection. The difference in temperature of the water in the calorimeter bucket caused by the ignition of the material in the bomb is measured and the calorific value calculated	BS EN 14918: Solid biofuels – Determination of calorific value BS EN 15400: Solid recovered fuels - Determination of calorific value	1MJ/kg	UKAS
DETSC 5008	**Calorific Value of Soil**	A known amount of sample material is burnt in a combustion bomb that is immersed in water in a calorimeter and the difference in the water temperature before and after ignition measured. The calorific value of the sample material is calculated making any necessary corrections for heat generation not associated with the combusting sample. A gelatine capsule will be required to assist combustion which is also corrected for in the final calculations.	BS 1016-105 1992 ISO 19208 ASTM 5865	1MJ/kg	UKAS

DETS INFO 001 – ANALYTICAL METHOD SUMMARY

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 5009	**Sample Preparation of Solid Biomass & Solid Recovered Fuels**	If analysis is required on the original material (i.e. Bulk Density) a sub-sample will be taken after initial mixing after which the sample is then reduced by cutting/chopping oversized pieces of material. The material is then mixed and subdivided by manual means during which process representative samples are taken for analysis i.e. total moisture. The remainder of the sample is dried and then reduced to <1mm and again mixed and subdivided to produce the sample for laboratory analysis.	BS EN 14780:2011 BS EN 15413:2011	n/a	Not Accredited
DETSC 5010	**Sample Preparation of Coal**	If required the sample received is first mixed and a sample taken for bulk density or bulk density is carried out on the whole initial sample. The remaining sample or the whole sample used for bulk density is then reduced to <10mm preferably by jaw crushing. The material is then mixed and subdivided by mechanical or manual means during which process representative samples are taken for any analysis required at this stage i.e. total moisture, The remainder of the sample is again mixed and subdivided to produce the sample for laboratory analysis which may require drying prior to crushing to <212 microns. If there is excessive water content a pre- drying stage of the whole sample may have to be carried out before sample blending and subdivision commences.	BS ISO 13909-4: 2001	n/a	Not Accredited
DETSC 5011	**Calculation of Fixed Carbon Content of Coal, SRF and Solid Biomass Fuels**	The total moisture, analysis moisture, ash and volatile matter content are determined by approved methods. The values obtained are deducted from 100 and this gives the fixed carbon value of the fuel.	DD CENT/S 15296:2006 BS 1016.100:1994 BS ISO 17246:2005	0.1%	Not Accredited

DETS INFO 001 – ANALYTICAL METHOD SUMMARY

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 5012	**Determination of Biomass Content of SRF**	Approximately 5g of the sample is dissolved in 150ml of 78% Sulphuric Acid for 16 hours ±2 hours after which 35ml of 30% Hydrogen Peroxide is added and the sample left for an additional 5 hours ±1 hour. At the end of this period 300ml of deionised water is added to the sample and the residue remaining filtered off using a glass fibre filter paper, washing the residue with an additional 300ml of deionised water. The filter paper and residue are placed in a pre-weighed crucible and dried at 1500C until completely dry. The filter paper is reweighed after drying and the non biomass residue determined. Corrections for carbonates content is made by determining the ash content of the original sample and the non biomass residue remaining. The result can also be expressed by percentage calorific value by performing a calorific valve on the solid captured on the filter paper.	BS EN 15440 Solid recovered fuels - Methods for the determination of biomass content	n/a	UKAS
DETSC 5013	**Determination Of Carbon, Hydrogen, Nitrogen & Oxygen In Solid Biomass, Solid Recovered Fuels & Coal**	A known mass of fuel is weighed into tin capsules which are dropped sequentially into the combustion reactor prior to the arrival of oxygen. The sample and tin capsule react with oxygen and combust at temperatures of 1700-1800 °C and the sample is broken down into its elemental components N2, CO2, and H2O. High performance copper wires absorb the excess oxygen not used for sample combustion. The gases flow through the gas chromatographic (GC) separation column which is kept at a constant temperature. As they pass through the GC column, the gases are separated and are detected sequentially by the thermal conductivity detector (TCD). The TCD generates a signal, which is proportional to the amount of element in the sample. The instrument software compares the elemental peak to a known standard material (after calibration) and generates a report for each element on a weight basis. The oxygen is calculated by deducting these quantities from 100 along with the moisture, ash, sulphur & chlorine contents determined by other methods.	BS EN 15104:2011 Solid biofuels - Determination of total content of carbon, hydrogen and nitrogen - Instrumental methods BS EN 15407:2011 Solid recovered fuels - Methods for the determination of carbon (C), hydrogen (H) and nitrogen(N) content BS EN 15296:2011 Solid biofuels - Conversion of analytical results from one basis to another	Carbon 0.10% Nitrogen 0.30% Hydrogen 0.30% Oxygen 3.55%	UKAS

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 5014	**Metals in Coal, SRF and Biomass by ICP**	Metals in coal, solid recovered fuel (SRF) and biomass samples are extracted by microwave using Hydrogen Peroxide (to oxidise and break down organic matter) and Aqua Regia (to dissolve the matrix and hold the metals in solution). Their concentrations are determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES).	BS EN 15410 - Solid recovered fuels - Methods for the determination of the content of major elements (Al, Ca, Fe, K, Mg, Na, P, Si, Ti) BS EN 15411 - Solid recovered fuels - Methods for the determination of the content of trace elements (As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mo, Mn, Ni, Pb, Sb, Se, Tl, V and Zn) BS EN 15290 - Solid biofuels - Determination of major elements - Al, Ca, Fe, Mg, P, K, Si, Na and Ti BS EN 15297 - Solid biofuels - Determination of minor elements - As, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Sb, V and Zn	**0.1 mg/kg:** As, Be, Cd, Co, Mn, Ni, P, Pb, Sb, Se, Sn, Ti, V, Zn **0.2mg/kg:** Cr, Cu, Tl **0.5mg/kg:** Mo **1mg/kg:** Al, Fe, K, Mg **5mg/kg:** Ca **10mg/kg:** Ag, Ba, Rh, Sr, Te	UKAS: Al, As (SRF only), Ca, Cd, Co, Cr, Cu, K, Mg, Mn, Na (SRF only), Ni, P, Pb, Se, Sn, Tl, V, Zn All other metals not accredited
DETSC 5015	**Mercury in Coal, SRF and Biomass by Atomic Fluorescence Spectroscopy**	The mercury is extracted from coal, SRF and biomass in aqua regia with gentle refluxing. The extract is filtered to remove particulates and diluted to volume. Treatment of the resulting solution with tin (II) chloride reduces mercury (II) to mercury (0) vapour which is then quantitatively detected using atomic fluorescence spectrometry.	PSA Method – Millennium Merlin Method for Mercury in Sludge, Soils and Sediments.	0.055mg/kg	UKAS

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 5016	**Total Sulphur Content Of Coal, SRF And Biomass**	Sulphur compounds in SRF and biomass are extracted using aqua regia / hydrogen peroxide and the insoluble residue is removed by filtration. The concentration of sulphur in the filtrate is determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Loss of sulphur as H2S is prevented by oxidation of the sulphur compounds to sulphate by the aqua regia. The use of hydrogen peroxide enhances the oxidation properties of nitric acid especially in the digestion of organics. Sulphur compounds in coal are determined by ICP-OES from the aqueous washings of the combustion products after firing in a bomb calorimeter.	TRL Report TRL447 (Updated) - Sulphate specification for structural backfills 2005	0.001mg/kg	UKAS
DETSC 5017	**Sulphur, Chlorine, Fluorine & Bromine Content of Solid Biomass, Solid Recovered Fuels and Coal by IC**	A known weight of fuel is burnt in a pressurised bomb in pure oxygen. After firing of the bomb, it is stood for a minimum of five minutes to allow the combustion products to settle then the oxygen is slowly released over a period of at least three minutes. The bomb is then taken apart and the bomb electrodes rinsed with deionised water into the inside of the bomb. These washings are then decanted into a 50ml volumetric flask. The inside of the bomb is rinsed with deionised water and the washings added to those in the volumetric flask. The contents of the volumetric flask are made up to volume with deionised water and stored for the analysis of sulphur, chloride, fluoride and bromide by ion chromatography.	Operating Instruction Manual No. 442M 6200 Parr Oxygen Bomb Calorimeter Operating Instruction Manual No. 205M 1108 Oxygen Combustion Bomb Operating Instruction Manual No. 454M 6510 Water Handling System	0.01% Chlorine 0.01% Fluorine 0.01% Bromine 0.04% Sulphur (Coal only)	UKAS

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 5018	**XRF Analysis of Coal, Biomass, SRF and Cement**	When X-rays are targeted at a material they will cause electrons to be ejected from the component atoms (Ionisation). The ejection of electrons will cause the electronic structure of the component atoms to become unstable resulting in electrons from the higher energy outer orbitals "falling" into the inner orbitals to compensate. This causes a release of energy in the form of a photon equal to the energy difference between the two orbitals involved. Thus the material emits radiation which has energy characteristics of the atoms present. In energy dispersive X-ray fluorescence the fluorescent X-rays emitted are directed to a detector from which the data is processed by a multichannel analyser, producing a digital spectrum which is processed to obtain analytical data. The instrument analytical parameters are set up for the matrix type. A sample cell is prepared by placing a piece of prolene film over the outer cell and then inserting the inner cell. This gives a complete cell with a clear prolene base. A portion of the sample is placed into the cell and then analysed.	Rigaku NEX CG EDXRF instruction manual	**Cement:** 0.01% BaO, Cr_2O_3, CuO, PbO, Rb_2O, SrO, ZnO 0.02% Cl, V_2O_5 0.05% TiO_2 0.1% Mn_2O_3, P_2O_5, SO_3 0.5% K_2O 1% Al_2O_3, CaO, CdO, Co_2O_3, Fe_2O_3, MgO, Na_2O, NiO, SiO_2, Y_2O_3 **Fuel:** 0.01% Co, Cr, Cu, I, Li, Mn, Ni, P, Pb, Sn, Ti, V, Zn 0.02% Al, Ba, S, Si 0.1% Mg 0.2% Ca 0.5% As, Cd, Hg, Mo, Na, Sb, Se, Th, Tl 1% Ag	UKAS Al, As, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, P, Sb, Si, Sn, Tl, Ti, V, Zn Al2O3, BaO, CaO, Cl, Cr2O3, CuO, Fe2O3, K2O, MgO, Mn2O3, Na2O, P2O5, PbO, Rb2O, SiO2, SO3, SrO, TiO2, V2O5, ZnO All other testing not accredited
DETSC 5019	**Determination of Biodegradable Municipal Waste Content (Compositional Analysis)**	The method is based on handpicking the BMW fraction from the municipal waste sample, and then weighing the amount of BMW sorted and expressing this as a percentage on a wet weight basis of the weight of the whole municipal waste sample.	ENVIRONMENT AGENCY: Guidance on monitoring of MBT and other treatment processes for the landfill allowances schemes (LATS and LAS) for England and Wales	n/a	Not Accredited
DETSC 5020	**Determination of Bulk Density in Solid Biomass and Solid Recovered Fuels**	The test portion is filled into a standard container of a given size and shape and weighed afterwards. Bulk density is calculated from the net weight per standard volume and reported for the moisture content.	BS EN 15103:2009 Solid Biofuels- Determination of bulk density BS EN 15401:2010 Solid Recovered Fuels- Determination of bulk density	0.5kg/m^3	Not Accredited

Method Number	Title	Description	Reference	LOD	Accreditation Status
DETSC 5021	**Auto Ignition Temperature**	A quantity of the sample is placed into a metal tray or crucible and placed into an oven or furnace. The temperature of the oven / furnace is increased in predefined increments and the temperature in which the sample ignites is noted.	None	25°C	Not Accredited

DETS INFO 008 – Sample Holding Time Information

Soil

Analyte	Container type	Minimum sample required	Reference	Maximum holding time from sampling	
				pre drying/extraction[1]	post drying/extraction[2]
Aliphatic/Aromatic	Glass	20g	EPA Victoria	14 days	-
Ammonium	Glass or plastic	20g	E DIN 19746	3 days	30 days
Anions	Glass or plastic	20g	BS ISO18512:2007	1 month	3 years
Boron	Glass or plastic	50g	BS ISO18512:2007	6 months	30 years
BTEX	60ml glass jar	Full container	EPA SW-846 Chapter 4	14 days	-
Carbonate	Glass or plastic	20g	Lab Validation	4 weeks	1 year
Chloride	Glass or plastic	20g	BS ISO18512:2007	1 month	3 years
Conductivity	Glass or plastic	20g	BS ISO18512:2007	1 week	3 years
Cyanide	Glass or plastic	20g	EPA SW-846 Chapter 3	14 days	-
Heavy metals	Glass or plastic	10g	BS ISO18512:2007	6 months	30 years
Hexavalent chromium	Glass or plastic	20g	BS ISO18512:2007	30 days	
Loss on ignition	Glass or plastic	10g	EPA SW-846 Chapter 3	28 days	-
Mercury	Glass or plastic	10g	EPA SW-846 Chapter 3	28 days	-
OCP	Glass	20g	BS ISO18512:2007	1 month	
Oil & grease	Glass	20g	EPA SW-846 Chapter 3	28 days	-
Organic matter/TOC	Glass or plastic	20g	EPA SW-846 Chapter 3	28 days	-
PAH	Glass	20g	EPA Victoria	14 days	-
PCB	Glass	20g	BS ISO18512:2007	1 month	
pH	Glass or plastic	20g	BS ISO18512:2007	1 week	3 years
Phenols	Glass	20g	EPA Victoria	14 days	-
PRO	60ml glass jar	Full container	EPA SW-846 Chapter 4	14 days	-
Sulphate	Glass or plastic	50g	BS ISO18512:2007	1 month	3 years
Sulphide	Glass or plastic	20g	EPA SW-846 Chapter 3	7 days	-
SVOC	Glass	20g	EPA SW-846 Chapter 4	14 days	40 days
TEM/CEM	Glass	20g	EPA Victoria	14 days	-
Total sulphur	Glass or plastic	20g	EPA Victoria	7 days	-
TPH (C10-C40)	Glass	20g	EPA Victoria	14 days	-
VOC	60ml glass jar	Full container	EPA SW-846 Chapter 4	7 days	-

Sample storage environment 5 ± 3°C

[1] From sampling to extraction

[2] Once extracted

DETS INFO 008 – Sample Holding Time Information

Water

Analyte	Container type	Minimum sample required	Reference	Maximum holding time from sampling	
				pre drying/extraction[1]	post drying/extraction[2]
Alkalinity	Glass or plastic	100	ISO 5667 3:2012	none	2 weeks
Aluminium (Reactive)			CIP 2 Tech Spec	none	5 days
Ammonium	Glass or plastic	20	ISO 5667 3:2012	Sulphuric acid	3 weeks
BOD	Glass or plastic	500	CIP 2 Tech Spec	none	5 days
Boron			ISO 5667 3:2012	HNO3	6 months
Bromide	Glass or plastic	20	ISO 5667 3:2012	none	1 month
BTEX	Glass vial	Full container	ISO 5667 3:2012	HCl / HNO3	7 days
Chloride	Glass or plastic	20	ISO 5667 3:2012	none	1 month
COD	Glass or plastic	20	ISO 5667 3:2012	Sulphuric acid	1 month
Conductivity/TDS	Glass or plastic	100	ISO 5667 3:2012	none	1 day
Cyanide	Glass or Plastic	50	EPA SW-846 Chapter 3	NaOH	14 days
Fluoride	Glass or plastic	20	ISO 5667 3:2012	none	1 month
Hexavalent chromium	Glass or plastic	20	ISO 5667 3:2012	none	4 days
Metals	Glass or plastic	20	CIP 2 Tech Spec	HNO3	6 months
Mercury	Glass or plastic	20	CIP 2 Tech Spec	Acid / dichromate	28 days
Nitrate	Glass or plastic	20	EPA SW-846 Chapter 3	none	28 days
Nitrite	Glass or plastic	20	EPA Victoria	none	48 hours
OCP	Glass	500	ISO 5667 3:2012	Dark Glass	7 days
Oil & grease	Glass	500 (Separate bottle)	ISO 5667 3:2012	HCl / HNO3 / H2SO4	1 month
PAH	Glass	500	CIP 2 Tech Spec	none	5 days
pH	Glass or plastic	50	CIP 2 Tech Spec	none	2 days
PCB	Glass	500	EPA Victoria	none	7 days
Phenols	Glass	500	ISO 5667 3:2012	H3PO4 / H2SO4	21 days
Phosphate	Glass or plastic	20	CIP 2 Tech Spec	none	6 days
Phosphorus	Glass or plastic	20	CIP 2 Tech Spec	none	6 days
PRO	Glass vial	Full container	ISO 5667 3:2012	HCl / HNO3 / H2SO4	7 days
Sulphate	Glass or plastic	20	ISO 5667 3:2012	none	1 month
Sulphide	Plastic	50	CIP 2 Tech Spec	Zinc acetate / Na2CO3	5 days
Suspended solids	Glass or plastic	100	CIP 2 Tech Spec	none	5 days
SVOC	Glass	500	EPA SW-846 Chapter 4	none	7 days
TOC/DOC	Glass or plastic	20	CIP 2 Tech Spec	none	5 days
TON	Glass or plastic	20	CIP 2 Tech Spec	none	5 days
TPH/EPH	Glass	500 (Separate bottle)	ISO 5667 3:2012	none (HCl / HNO3)	4 days (1 Month)
VOC	Glass vial	Full container	ISO 5667 3:2012	HCl / HNO3 / H2SO4	7 days

Sample Transport environment 5 ± 3°C

Sample Storage environment 3 ± 2°C

DETS INFO 008 – Sample Holding Time Information

Fuel

Due to the nature of fuel samples, no sample holding time is appropriate.

Asbestos

Due to the nature of asbestos samples, no sample holding time is appropriate.

Unaccredited Methods

As unaccredited methods may not have undertaken a full validation programme, no sample holding time study has been undertaken. A study will be conducted (if required) during the process of accreditation of the method.

Appendix 6 BAT Assessment

BAT No.	Topic	Brief Description	BAT	Applicable BAT- AEL	Compliant now?	Derogation needed?	Provide brief comments on how compliance with BAT is (or will be) achieved Where "N/A" or "other" is given, please explain why
General BAT conclusions							
1	Overall performance	EMS *Applicability* The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have (determined also by the type and amount of wastes processed).	In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:				
			i) commitment of the management, including senior management;		Yes	No	Yes, this is an integral part of the ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems
			ii) definition, by the management, of an environmental policy that includes the continuous improvement of the environmental performance of the installation;		Yes	No	Yes, this is an integral part of the ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems
			iii) planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;		Yes	No	Yes, this is an integral part of the ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems
			iv) implementation of procedures paying particular attention to: (a) structure and responsibility, (b) recruitment, training, awareness and competence (c) communication, (d) employee involvement, (e) documentation, (f) effective process control, (g) maintenance programmes, (h) emergency preparedness and response, (i) safeguarding compliance with environmental legislation;		Yes	No	Yes, this is an integral part of the ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems
			v) checking performance and taking corrective action, paying particular attention to: (a) monitoring and measurement (see also the JRC Reference Report on Monitoring of emissions to air and water from IED installations – ROM), (b) corrective and preventive action, (c) maintenance of records, (d) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;		Yes	No	Yes, this is an integral part of the ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems
			vi) review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;		Yes	No	Yes, this is an integral part of the ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems
			vii) following the development of cleaner technologies;		Yes	No	The Innovations Team at YW undertakes regular monitoring and review of new and innovative technologies and equipment to ensure the business continually improves its operations and activities. This includes consideration of cleaner technologies and improved environmental performance. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems
			viii) consideration for the environmental impacts from the eventual decommissioning of the plant at the stage of designing a new plant, and throughout its operating life;		Yes	No	Yes, this is an integral part of the ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems. See also see Section V: Appendix 5 Site Condition Report.
			ix) application of sectoral benchmarking on a regular basis;		Yes	No	Yes, sectoral and cross-sector benchmarking also takes place as required. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems
			x) waste stream management (see BAT 2);		Yes	No	ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems. See also BAT 2 below.
			xi) an inventory of waste water and waste gas streams (see BAT 3);		Yes	No	Refer to Section III: Supporting Information, Form C3, Question 2 Point source emissions to air, water and land. See also BAT 3 below. YW is committed to undertake a period of monitoring to further characterise process liquors returned to Lundwood WwTW and therefore no long term derogation is required.
			xii) residues management plan (see description in Section 6.5);		Yes	No	Yes, this is an integral part of the ISO 14001 system. Refer to Section III: Supporting Information, Form C2, Question 3d Management systems and also information provided in response to Form C3, Question 6.
			xiii) accident management plan (see description in Section 6.5);		Yes	No	This is provided in response to Section III: Supporting Information, Form C2, Question 6-8.
2	Overall performance	Improvement of overall environmental performance	In order to improve the overall environmental performance of the plant, BAT is to use all of the techniques given below.				
			a) Set up and implement waste characterisation and pre-acceptance procedures		Yes	No	Refer to Appendix 12 Waste pre-acceptance, acceptance and rejection Procedure. All sludges arriving at Lundwood STF are either indigenous primary and secondary sludges from Lundwood WwTW or imported sludge from other YW sites. The volume, % dry solids and source of imports to the site is recorded by WaSP loggers.
			b) Set up and implement waste acceptance procedures		Yes	No	Refer to Appendix 12 Waste pre-acceptance, acceptance and rejection Procedure. All sludges arriving at Lundwood STF are either indigenous primary and secondary sludges from Lundwood WwTW or imported sludge from other YW sites. The volume, % dry solids and source of imports to the site is recorded by WaSP loggers.
			c) Set up and implement a waste tracking system and inventory		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C2, Question 3d Management systems and comments noted above. The volume and source of imports to the site is recorded by WaSP loggers.
			d) Set up and implement an output quality management system		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C2, Question 3d Management systems. HACCP processes are in place to manage and maintain the quality of digested sludge to ensure its suitability for land spreading.
			e) Ensure waste segregation		N/A (explain)	No	Waste received on site comprises only sewage sludge. Waste segregation, sorting and waste compatibility considerations are not relevant
			f) Ensure waste compatibility prior to mixing or blending of waste		N/A (explain)	No	Waste received on site comprises only sewage sludge. Waste segregation, sorting and waste compatibility considerations are not relevant
			g) Sort incoming solid waste		N/A (explain)	No	Waste received on site comprises only sewage sludge. Waste segregation, sorting and waste compatibility considerations are not relevant
3	Overall performance	Inventory *Applicability* The scope (e.g. level of detail) and nature of the inventory will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have (determined also by the	In order to facilitate the reduction of emissions to water and air, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system (see BAT 1), that incorporates all of the following features:				
			(i) information about the characteristics of the waste to be treated and the waste treatment processes, including: (a) simplified process flow sheets that show the origin of the emissions; (b) descriptions of process-integrated techniques and waste water/waste gas treatment at source including their performances;		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C3, Question 2 Point source emissions to air, water and land.

BAT No.	Topic	Brief Description	BAT	Applicable BAT- AEL	Compliant now?	Derogation needed?	Provide brief comments on how compliance with BAT is (or will be) achieved Where "N/A" or "other" is given, please explain why
		type and amount of wastes processed).	(ii) information about the characteristics of the waste water streams, such as: (a) average values and variability of flow, pH, temperature, and conductivity; (b) average concentration and load values of relevant substances and their variability (e.g. COD/TOC, nitrogen species, phosphorus, metals, priority substances/micropollutants); (c) data on bioeliminability (e.g. BOD, BOD to COD ratio, Zahn-Wellens test, biological inhibition potential (e.g. inhibition of activated sludge)) (see BAT 52);		Other (explain)	No	All liquor from sludge thickening and dewatering processes, condensate (e.g. from biogas handling), cleaning / washdown effluent and some surface water runoff (other than roofwater from two buildings which is discharged to soakaway) is collected and discharged via underground drainage systems to Lundwood WwTW for full treatment prior to discharge to the River Dearne. As both Lundwood STF and Lundwood WwTW are owned and operated by YW, separate monitoring of Lundwood STF discharges has not been necessary or required under any permitting regime. YW do not currently undertake any routine monitoring of these discharges (other than checks for process control purposes). YW recognises that there is a change in permitting regime and therefore commits to undertake initially a one-off programme of monitoring return liquors from the emission points in order to obtain further information about the characteristics of the waste streams. The monitoring programme will comprise collection of wastewater samples from each emission point over a 12 month period. Further information is provided in response to Form C2, Question 6-9.
			(iii) information about the characteristics of the waste gas streams, such as: (a) average values and variability of flow and temperature; (b) average concentration and load values of relevant substances and their variability (e.g. organic compounds, POPs such as PCBs); (c) flammability, lower and higher explosive limits, reactivity; (d) presence of other substances that may affect the waste gas treatment system or plant safety (e.g. oxygen, nitrogen, water vapour, dust).		Other (explain)	No	Refer to Section III: Supporting Information, Form C3, Question 2 Point source emissions to air, water and land.
4	Overall performance	Techniques for storage of waste	In order to reduce the environmental risk associated with the storage of waste, BAT is to use all of the techniques given below.				
			a) Optimised storage location		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C3, Question 6e Describe how you avoid producing waste in line with Council Directive 2008/98/EC on waste. Waste materials are stored on site for the minimum period of time, in suitable, fit for purpose containers located on areas of hardstanding and away from sensitive receptors.
			b) Adequate storage capacity		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C3, Question 6e Describe how you avoid producing waste in line with Council Directive 2008/98/EC on waste. Waste materials are stored on site for the minimum period of time, in suitable, fit for purpose containers located on areas of hardstanding and away from sensitive receptors.
			c) Safe storage operation		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C3, Question 6e Describe how you avoid producing waste in line with Council Directive 2008/98/EC on waste. Waste materials are stored on site for the minimum period of time, in suitable, fit for purpose containers located on areas of hardstanding and away from sensitive receptors.
			d) Separate area for storage and handling of packaged hazardous waste		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C3, Question 6e Describe how you avoid producing waste in line with Council Directive 2008/98/EC on waste. Very limited quantities of hazardous waste are generated by site activities. These are segregated and stored in suitable, fit for purpose containers.
5	Overall performance	Techniques for handling and transfer of waste	In order to reduce the environmental risk associated with the handling and transfer of waste, BAT is to set up and implement handling and transfer procedures.		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C3, Question 6e Describe how you avoid producing waste in line with Council Directive 2008/98/EC on waste and Section III: Supporting Information, Form C2, Question 3d Management systems. Waste procedures are included within the YW management system and training is provided to staff as required.
6	Monitoring	Waste water - Monitor key parameters	For relevant emissions to water as identified by the inventory of waste water streams (see BAT 3), BAT is to monitor key process parameters (e.g. waste water flow, pH, temperature, conductivity, BOD) at key locations (e.g. at the inlet and/or outlet of the pre-treatment, at the inlet to the final treatment, at the point where the emission leaves the installation).		Other (explain)	No	There are no direct emissions to water other than roofwater from two buildings which is discharged to soakaway. No wastewater treatment is undertaken within the installation boundary. Wastewater is returned to Lundwood WwTW for full treatment prior to discharge. In respect of characterisation monitoring for return liquors refer to commitments made in BAT 3 above and Section III: Supporting Information, Form C2, Question 6-9.
7	Monitoring	Waste water - Monitoring frequencies and standards	BAT is to monitor emissions to water with at least the frequency given below, and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	See 'Water emissions tables' tab	Other (explain)	No	All liquor from sludge thickening and dewatering processes, condensate (e.g. from biogas handling), cleaning / washdown effluent and some surface water runoff (other than roofwater from two buildings which is discharged to soakaway) is collected and discharged via underground drainage systems to Lundwood WwTW for full treatment prior to discharge to the River Dearne. As both Lundwood STF and Lundwood WwTW are owned and operated by YW, separate monitoring of Lundwood STF discharges has not been necessary or required under any permitting regime. YW do not currently undertake any routine monitoring of these discharges (other than checks for process control purposes). YW recognises that the inventory of emissions to sewer is currently incomplete and commits to undertake the sampling and analysis of effluent discharged to Lundwood WwTW in line with BAT3 requirements. This emissions characterisation programme will be carried out by sampling every month for a 12-month period in order to fully characterise wastewater emissions. Further information is provided in response to Form C2, Question 6-9. The data will be used to undertake an environmental impact assessment in accordance with Environment Agency guidance. The findings of the monitoring, analysis and impact assessment will be provided to the Environment Agency within 18 months of permit issue. Requirements for ongoing monitoring will be established after this has been completed.
8	Monitoring	Channelled air emissions - Monitoring frequencies and standards	BAT is to monitor channelled emissions to air with at least the frequency given below, and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	See 'Air emissions tables' tab	Yes	No	Refer to Appendix 10 - Odour Management Plan in respect of monitoring provisions (olfactometric and process). A programme of ongoing monitoring of the OCU will be undertaken in accordance with BAT 8 requirements and will include emissions monitoring at the OCU stack on a 6-monthly basis.
9	Monitoring	Diffuse emissions - Monitor organic compounds	BAT is to monitor diffuse emissions of organic compounds to air from the regeneration of spent solvents, the decontamination of equipment containing POPs with solvents, and the physico-chemical treatment of solvents for the recovery of their calorific value, at least once per year using one or a combination of the techniques given below.		N/A (explain)	NA	Relevant activities are not carried out at this site.
			a) Measurement		N/A (explain)	NA	Relevant activities are not carried out at this site.
			b) Emissions factors		N/A (explain)	NA	Relevant activities are not carried out at this site.
			c) Mass balance		N/A (explain)	NA	Relevant activities are not carried out at this site.
10	Monitoring	Odour - Monitor emissions *Applicability* The applicability is restricted to cases where an odour nuisance at sensitive receptors is expected and/or has been substantiated.	BAT is to periodically monitor odour emissions. (The monitoring frequency is determined in the odour management plan (see BAT 12).)		Other (explain)	No	Refer to Appendix 10 Odour Management Plan which provides details of the proposed programme of sniff testing.
11	Monitoring	Monitor annual consumption and generation of waste outputs	BAT is to monitor the annual consumption of water, energy and raw materials as well as the annual generation of residues and waste water, with a frequency of at least once per year.		Yes	No	Refer to Section II: Technical Description and Section III: Supporting Information, Form C2, Question 3d Management systems (sub-section 'Monitoring') and Form C3, Questions 6a, b, c, d and e

BAT No.	Topic	Brief Description	BAT	Applicable BAT- AEL	Compliant now?	Derogation needed?	Provide brief comments on how compliance with BAT is (or will be) achieved Where "N/A" or "other" is given, please explain why
12	Emissions to air	Odour Management Plan *Applicability* The applicability is restricted to cases where an odour nuisance at sensitive receptors is expected and/or has been substantiated.	In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements: — a protocol containing actions and timelines; — a protocol for conducting odour monitoring as set out in BAT 10; — a protocol for response to identified odour incidents, e.g. complaints; —an odour prevention and reduction programme designed to identify the source(s); to characterise the contributions of the sources; and to implement prevention and/or reduction measures.		Yes	No	Refer to Appendix 10 Odour Management Plan
13	Emissions to air	Odour reduction techniques	In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to use one or a combination of the techniques given below.		Yes	No	Refer to Appendix 10 Odour Management Plan
			a) Minimising residence times		Yes	No	Refer to Appendix 10 Odour Management Plan
			b) Using chemical treatment		Yes	No	Refer to Appendix 10 Odour Management Plan. Chemical treatment is not routinely used but could be considered in order to respond to an abnormal / significant odour issue.
			c) Optimising aerobic treatment		N/A (explain)	NA	Relevant activities are not carried out at this site.
14	Emissions to air	Diffuse emission reduction techniques	In order to prevent or, where that is not practicable, to reduce diffuse emissions to air, in particular of dust, organic compounds and odour, BAT is to use an appropriate combination of the techniques given below. Depending on the risk posed by the waste in terms of diffuse emissions to air, BAT 14d is especially relevant.				
			a) Minimising the number of potential diffuse emission sources		Other (explain)	No	Refer to Section III: Supporting Information, Form C2, Question 6-5 review of diffuse and point source emissions, Appendix 13 LDAR procedure and also Section II: Technical Description, Section III Supporting Information, Form C3, Question 3b General Requirements – LDAR programme, Section V: Appendix 8 Odour Risk Assessment, and Section V: Appendix 10 Odour Management Plan. Refer to Proposed Improvement Programme for commitments to tank covering - no long term derogation is required.
			b) Selection and use of high- integrity equipment		Yes	No	Plant is compliant with YW engineering standards and subject to ongoing formal inspection and maintenance regimes.
			c) Corrosion prevention		Yes	No	Plant is compliant with YW engineering standards and subject to ongoing formal inspection and maintenance regimes.
			d) Containment, collection and treatment of diffuse emissions		Other (explain)	No	Some, but not all, odour sources on site are covered and contained and meet the requirements of BAT 14d. The use of enclosed equipment or buildings for control of diffuse odour emissions from secondary maturation of digested cake on the cake pad is constrained by the volume of waste. YW commits to a series of improvements to meet BAT 14d requirements; these are listed in Proposed Improvement Programme section of the main application document.
			e) Dampening		N/A (explain)	NA	Materials are already wet or liquid
			f) Maintenance		Yes	No	Planned maintenance systems in place. Refer to Appendix 13 LDAR procedure and also Section II: Technical Description and Section III: Supporting Information, Form C2, Question 3d Management systems.
			g) Cleaning of waste treatment and storage areas		Yes	No	Regular cleaning is undertaken, where required and appropriate
			h) Leak detection and repair (LDAR) programme		Yes	No	Refer to Appendix 13 LDAR procedure and also Form C3, Question 3b General Requirements – LDAR programme
15	Emissions to air	Flare use minimisation techniques	BAT is to use flaring only for safety reasons or for non-routine operating conditions (e.g. start-ups, shutdowns) by using both of the techniques given below.				
			a) correct plant design		Yes	No	Refer to Section II: Technical Description (sub-section Biogas Storage and Use)
			b) Plant management		Yes	No	Refer to Section II: Technical Description (sub-section Biogas Storage and Use)
16	Emissions to air	Flare emissions minimisation techniques	In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use both of the techniques given below.				
			a) Correct design of flaring devices		Yes	No	Refer to Section II: Technical Description (sub-section Biogas Storage and Use)
			b) Monitoring and recording as part of flare management		Yes	No	Refer to Form C3, Question 4 Monitoring, Table C3: 4a-1 and 4a-2 .
17	Noise and vibrations	Noise management plan *Applicability* The applicability is restricted to cases where a noise or vibration nuisance at sensitive receptors is expected and/or has been substantiated.	In order to prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to set up, implement and regularly review a noise and vibration management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:		N/A (explain)	NA	Noise or vibration nuisance at sensitive receptors is not expected and no substantiated noise and vibration nuisance complaints have been received. Noise and vibration management plan not required. Refer to Section V: Appendix 9 - Noise impact assessment. Complaints handling and response procedures are in place – refer to Section III: Supporting Information, Form C2, Question 3d Management systems.
			i) a protocol containing appropriate actions and timelines;		N/A (explain)	NA	See above
			ii) a protocol for conducting noise and vibration monitoring;		N/A (explain)	NA	See above
			iii) a protocol for response to identified noise and vibration events, e.g. complaints;		N/A (explain)	NA	See above
			iv) a noise and vibration reduction programme designed to identify the source(s), to measure/estimate noise and vibration exposure, to characterise the contributions of the sources and to implement prevention and/or reduction measures.		N/A (explain)	NA	See above
18	Noise and vibrations	Noise and vibration reduction techniques	In order to prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to use one or a combination of the techniques given below.		Yes	No	Noise is minimised using a combination of techniques appropriate to the nature of installation activities and the risk of noise nuisance. Refer to Section V: Appendix 9 Noise impact assessment.
			a) Appropriate location of equipment and buildings		Yes	No	See above.
			b) Operational measures		Yes	No	See above
			c) Low-noise equipment		Yes	No	See above
			d) Noise and vibration control equipment		Yes	No	See above
			e) noise attenuation		Yes	No	See above
19	Emissions to water	Water management techniques	In order to optimise water consumption, to reduce the volume of waste water generated and to prevent or, where that is not practicable, to reduce emissions to soil and water, BAT is to use an appropriate combination of the techniques given below.				
			a) water management		Yes	No	Measures are in place to ensure that water is used only where necessary, and preference is given to the use of final treated effluent rather than mains water. Refer to Section III: Supporting Information, Form C3, Question 6d Explain and justify the raw and other materials, other substances and water that you will use.
			b) water recirculation		N/A (explain)	No	Relevant activities are not carried out at this site. Measures are in place to ensure that water is used only where necessary, and preference is given to the use of final treated effluent rather than mains water.
			c) impermeable surface		Yes	No	For details of techniques to minimise accidental/unplanned discharges to the environment from surfacing, storage areas, tanks, vessels, drainage systems etc refer to the Accident Management Plan (Form C2, Q 6-7), Appendix 5: Site Condition Report and Appendix 11: Secondary Containment Risk Assessment.

BAT No.	Topic	Brief Description	BAT	Applicable BAT- AEL	Compliant now?	Derogation needed?	Provide brief comments on how compliance with BAT is (or will be) achieved Where "N/A" or "other" is given, please explain why
			d) Techniques to reduce the likelihood and impact of overflows and failures from tanks and vessels		Other (explain)	No	Refer to Appendix 11 Secondary Containment Risk Assessment. A secondary containment risk assessment has been undertaken to assess whether existing measures to protect the environment in the event of a failure of containment of primary storage tanks are adequate. This study has identified that some additional mitigation measures are required in order to enhance environmental protection for the identified sensitive receptors. YW will implement the required improvements in order to meet BAT 19d requirements, and therefore no long term derogation is necessary.
			e) Roofing of waste storage and treatment areas		Other (explain)	No	Digested sludge cake is transferred from the centrifuges onto the cake pad. The cake pad is not covered, but engineered to direct run-off generated (during periods of rainfall), via return liquor flows, to the Lundwood WwTW for full treatment. This treatment provision is considered adequate and negates the need to cover the cake pad for the purpose of run-off reduction.
			f) Segregation of water streams		Other (explain)	No	In order to reduce pollution risks most rainwater runoff is collected and returned to Lundwood WwTW for treatment in addition to process liquors and cleaning washwater etc. Clean roofwater runoff from two buildings is discharged to soakaway. Refer to Section II: Technical Description, Section III: Supporting Information, Form C3, Question 2 Point source emissions to air, water and land and Figure 4 Drainage Plan.
			g) Adequate drainage infrastructure		Other (explain)	No	All process liquors, cleaning washwater and most surface water runoff (other than roofwater from two buildings which is discharged to soakaway) from the site are returned to Lundwood WwTW for treatment. It is has been identified that there are two areas of uncertainty in respect of the drainage system. YW is committed to investigating the drainage uncertainties and taking any improvement actions necessary and therefore no long term derogation is necessary - refer to proposed improvement programme. Refer also to Section III: Supporting Information, Form C3, Question 2 Point source emissions to air, water and land and Figure 4 Drainage Plan.
			h) Design and maintenance provisions to allow detection and repair of leaks		Yes	No	Measures are in place for the protection of land and groundwater during operation of the permit - refer to Appendix 11 Secondary Containment Risk Assessment. This study has identified that some additional mitigation measures are required in order to enhance environmental protection for the identified sensitive receptors. YW will implement the required improvements in order to meet BAT 19h requirements, and therefore no long term derogation is necessary.
			i) Appropriate buffer storage capacity		Yes	No	Wastewater is returned for treatment at the co-located Lundwood WwTW where there is adequate buffer storage capacity.
20	Emissions to water	Water emission reduction techniques	In order to reduce emissions to water, BAT is to treat waste water using an appropriate combination of the techniques given below.	See 'Water emissions tables' tab			Process liquor, including most surface water runoff is directed to Lundwood WwTW for full treatment. Refer to Section II: Technical Description and Section III: Supporting Information, Form C3, Question 2 Point source emissions to air, water and land
			a) equalisation		Yes	No	Wastewater flow from the STF is mixed with UWwTD wastewater (outside of the installation in the wider WwTW), providing adequate balancing of flow and composition.
			b) neutralisation		Yes	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			c) Physical separation, e.g. screens, sieves, grit separators, grease separators, oil- water separation or primary settlement tanks		Yes	No	Sludge screens are located within the STF. UWWTD flow is screened at Lundwood WwTW.
			d) adsorption		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			e) distillation/rectification		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			f) precipitation		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			g) chemical oxidation		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			h) chemical reduction		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			i) evaporation		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			j) ion exchange		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			k) stripping		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			l) activated sludge process		Yes	No	Undertaken at Lundwood WwTW
			m) membrane bioreactor		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			n) Nitrification/denitrification when the treatment includes a biological treatment		Yes	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			o) coagulation and flocculation		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			p) sedimentation		Yes	No	Primary settlement tanks at Lundwood WwTW enable solids settlement to occur.
			q) Filtration (e.g. sand filtration, microfiltration, ultrafiltration)		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
			r) floatation		N/A (explain)	No	Not applicable - treatment processes in place ensure that discharge permit conditions are met.
21	Emissions from accidents and incidents	Prevention and limitation techniques	In order to prevent or limit the environmental consequences of accidents and incidents, BAT is to use all of the techniques given below, as part of the accident management plan (see BAT 1).		Yes	No	Refer to Accident Management Plan Table C2: 6-8.
			a) protection measures		Yes	No	Refer to Accident Management Plan Table C2: 6-8.
			b) Management of incidental/accidental emissions		Yes	No	Refer to Accident Management Plan Table C2: 6-8.
			c) Incident/accident registration and assessment system		Yes	No	Refer to Accident Management Plan Table C2: 6-8.
22	Material efficiency	Material efficiency *Applicability* Some applicability limitations derive from the risk of contamination posed by the presence of impurities (e.g. heavy metals, POPs, salts, pathogens) in the waste that substitutes other materials. Another limitation is the compatibility of the waste substituting other materials with the waste input (see BAT 2).	In order to use materials efficiently, BAT is to substitute materials with waste.		Yes	No	Opportunities to substitute materials with waste are very limited. However, treated final effluent is used in preference to mains water supply wherever feasible. Refer also to Section III: Supporting Information, Form C3, Question 6e.
23	Energy efficiency	Energy efficiency techniques	In order to use energy efficiently, BAT is to use both of the techniques given below.		Yes	No	Refer to Section III: Supporting Information, Form C3, Question 6a and 6b
			a) energy efficient plant		Yes	No	Refer to Section III: Supporting Information, Form C3, Question 6a and 6b
			b) energy balance record		Yes	No	Refer to Section III: Supporting Information, Form C3, Question 6a and 6b
24	Reuse of packaging	Reuse of packaging *Applicability* Some applicability restrictions derive from the risk of contamination of the waste posed by the reused packaging.	In order to reduce the quantity of waste sent for disposal, BAT is to maximise the reuse of packaging, as part of the residues management plan (see BAT 1).		Yes	No	Limited opportunities exist as packaging waste arisings are very low. Refer to Section III: Supporting Information, Form C3, Question 6e for further information about residues management
General BAT conclusions for the biological treatment of waste							
33	Overall performance		In order to reduce odour emissions and to improve the overall environmental performance, BAT is to select the waste input.		Yes	No	Waste is only received from YW WwTW sites. Refer to Section II: Technical Description and Section III: Supporting Information, Form C2, Question 3d Management systems. Refer also to BAT 2 above.

BAT No.	Topic	Brief Description	BAT	Applicable BAT- AEL	Compliant now?	Derogation needed?	Provide brief comments on how compliance with BAT is (or will be) achieved Where "N/A" or "other" is given, please explain why
34	Emissions to air		In order to reduce channelled emissions to air of dust, organic compounds and odorous compounds, including H2S and NH3, BAT is to use one or a combination of the techniques given below.	See 'Air emissions tables' tab	Other (explain)	No	YW operates an OCUs at Lundwood STF comprising a 2-stage biofilter and activated carbon polishing unit. The OCU on site will be managed and monitored in accordance with BAT 8 requirements - see Appendix 10: Odour Management Plan.
			a) adsorption - see table 6.1		Yes	No	See above
			b) biofilter - see table 6.1		Yes		See above
			c) fabric filter - see table 6.1		N/A (explain)		See above
			d) thermal oxidation - see table 6.1		N/A (explain)		See above
			e) wet scrubbing - see table 6.1		N/A (explain)		See above
35	Emissions to water and usage		In order to reduce the generation of waste water and to reduce water usage, BAT is to use all of the techniques given below.				
			a) segregation of water streams		Yes	No	Treated final effluent is used in preference to mains water supply wherever feasible. Most surface water runoff (other than roofwater from two buildings which is discharged to soakaway) is limited and is directed to Lundwood WwTW for full treatment prior to discharge.
			b) water recirculation		Yes	No	Wastewater is minimised within the constraints of existing plant. Treated final effluent is used in preference to mains water supply wherever feasible.
			c) minimisation of the generation of leachate		Yes	No	Digested sludge is dewatered using centrifuges in order to minimise leachate generation from digested sludge cake. Sludge is contained within tanks and pipework at all other times.
BAT conclusions for the aerobic treatment of waste							
36	Overall environmental performance	control key waste and process parameters	In order to reduce emissions to air and to improve the overall environmental performance, BAT is to monitor and/or control the key waste and process parameters.		N/A (explain)	NA	Relevant activities are not carried out at this site.
37	Odour and diffuse emissions to air	reduce diffuse emissions to air of dust, odour and bioaerosols	In order to reduce diffuse emissions to air of dust, odour and bioaerosols from open-air treatment steps, BAT is to use one or both of the techniques given below.		N/A (explain)	NA	Relevant activities are not carried out at this site.
			a) use of semipermeable membrane covers		N/A (explain)	NA	Relevant activities are not carried out at this site.
			b) adaptation of operations to the meteorological conditions		N/A (explain)	NA	Relevant activities are not carried out at this site.
BAT conclusions for the anaerobic treatment of waste							
38	Emissions to air	Monitor and control key waste and process parameters	In order to reduce emissions to air and to improve the overall environmental performance, BAT is to monitor and/or control the key waste and process parameters.		Yes	No	YW carries out an extensive level of process monitoring (Refer to Section II: Technical Description and Section III: Form C3, Question 4a: Monitoring Table C3: 4a-2 Key process monitoring provision). Digester process operation is controlled, including control of foaming (refer to Section II: Technical Description, 'sludge digestion' sub-section). Process monitoring parameters for the OCU are established in the Odour Management Plan.
BAT conclusions for the mechanical biological treatment (MBT) of waste							
39	Emissions to air	Segregation and recirculation of waste gas streams	In order to reduce emissions to air, BAT is to use both of the techniques given below.		N/A (explain)	NA	Relevant activities are not carried out at this site.
			a) segregation of the waste gas streams		N/A (explain)	NA	Relevant activities are not carried out at this site.
			b) recirculation of waste gas		N/A (explain)	NA	Relevant activities are not carried out at this site.
BAT conclusions for the physico-chemical treatment of solid and/or pasty waste							
40	Monitor waste input	Monitoring of content of wastes during pre-acceptance and acceptance	In order to improve the overall environmental performance, BAT is to monitor the waste input as part of the waste pre-acceptance and acceptance procedures (see BAT 2).		N/A (explain)	NA	Relevant activities are not carried out at this site.
41	Emissions to air	Abatement systems and BAT-AELS	In order to reduce emissions of dust, organic compounds and NH3 to air, BAT is to apply BAT 14d and to use one or a combination of the techniques given below.	See 'Air emissions tables' tab	N/A (explain)	NA	Relevant activities are not carried out at this site.
			a) adsorption - see section 6.1				
			b) biofilter - see section 6.1				
			c) fabric filter - see section 6.1				
			d) wet scrubbing - see section 6.1				

Appendix 7 Air Emissions Risk Assessment

Lundwood Sludge Treatment Facility

Air Emissions Risk Assessment

On behalf of

Project Ref:331001762/100.2301 | Rev: Rev.02 | Date: December 2023

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Document Control Sheet

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	Name	**Position**	**Signature**	**Date**
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For and on behalf of Stantec UK Limited				

Revision	**Date**	**Description**	**Prepared**	**Reviewed**	**Approved**
Draft	December 2021	Draft for client comment	SB	LS	PB
Draft_Rev01	December 2021	Revised to measured CHP NOx emission	SB	LS	PB
Issued_Rev01	December 2021	With client comments included	SB	LS	PB
Draft_ Rev.02	December 2023	Additional mitigation scenarios included	LS	PB	PB

This report has been prepared by Stantec UK Limited ('Stantec') on behalf of its client to whom this report is addressed ('Client') in connection with the project described in this report and takes into account the Client's particular instructions and requirements. This report was prepared in accordance with the professional services appointment under which Stantec was appointed by its Client. This report is not intended for and should not be relied on by any third party (i.e. parties other than the Client). Stantec accepts no duty or responsibility (including in negligence) to any party other than the Client and disclaims all liability of any nature whatsoever to any such party in respect of this report.

Contents

Tables

Appendices

1 Introduction

1.1 Background

1.1.1 Yorkshire Water Services Ltd has commissioned Stantec UK Ltd (Stantec) to undertake an Air Emission Risk Assessment (AERA) to support the Environmental Permit (EP) application for Anaerobic Digestion (AD) activities at Lundwood Sludge Treatment Facility (STF).

1.1.2 The Installation is located within the administrative boundary of Barnsley Metropolitan Borough Council (BMBC). The location of the Installation is shown in **Figure 1, Appendix E**.

1.1.3 The Installation includes existing biogas combustion plant comprising a gas-fired Combined Heat and Power (CHP) plant, gas-fired boiler and a biogas flare.

1.2 Report Scope

1.2.1 The scope of the assessment is limited to the point source combustion emissions to air at the Installation (as defined above). Consistent with Environment Agency guidance (Environment Agency, 2023), for a gas engine fired on biogas, the principal release of oxides of nitrogen (NOx) have been assessed alongside sulphur dioxide (SO_2) due to the potential sulphur content of biogas.

1.2.2 Emissions of NOx (in the form of nitrogen dioxide (NO_2)) and SO_2 have been assessed against the relevant Air Quality Standards for NO_2 and SO_2 for the protection of human health. An assessment has also been carried out against the relevant Critical Levels (C_{Le}) for NOx and SO_2, and Critical Loads (C_{Lo}) for nitrogen and acid deposition which are designed for the protection of designated ecological sites.

1.2.3 This report outlines the approach, methodology and results of the AERA that has been undertaken, utilising atmospheric dispersion modelling, to support the EP application.

1.2.4 The results of the assessment have been interpreted in accordance with the requirements of the Environment Agency to identify if impacts represent 'significant pollution' as required by the Environment Agency to determine an EP application.

1.2.5 To present a worst-case baseline scenario, all sources have initially been modelled as operating simultaneously at the maximum emission rates for 24 hours a day. In reality plant (such as the flare and second boiler) would be used far less frequently, or not at all, and there would not be sufficient biogas available for such a scenario.

1.2.6 Additional scenarios have also been assessed in order to determine the impact of mitigation measures (i.e. operating hour limits and increased stack height) on air quality impacts at ecological receptors.

1.2.7 The AERA has been undertaken in accordance with relevant legislation, policy and guidance.

2 Legislation and Relevant Guidance

2.1 Environmental Permitting Guidance

2.1.1 Guidance Notes produced by DEFRA provide a framework for regulation of installations and additional technical guidance produced by the Environment Agency are used to provide the basis for permit conditions.

2.1.2 Of particular relevance to the assessment is the '*Air emissions risk assessment for your environmental permit*', also known as the AERA Guidance (Environment Agency, 2023). The purpose of the AERA Guidance is to assist operators to assess risks to the environment and human health when applying for a permit under the EP Regulations. Included in the AERA guidance are:

- an approach to screening assessment;
- guidance on when detailed atmospheric dispersion modelling is required; and
- Environmental Assessment Levels (EALs) for a range of pollutants not covered by other regulations, against which impact may be assessed.

2.2 National Air Quality Legislation and Guidance

Air Quality Standards

2.2.1 The Air Quality Standards Regulations 2010 (the AQSR) transposed the Air Quality Directive (2008/50/EC) and Fourth Daughter Directive (2004/107/EC). The Regulations include Limit Values, Target Values, Objectives, Critical Levels and Exposure Reduction Targets for the protection of human health and the environment.

2.2.2 Following the Transition Period after the UK's departure from the EU in January 2020, the Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019 (and subsequent amendments for the devolved administrations) have amended the AQ Standards Regulations 2010 to reflect the fact that the UK has left the EU, but do not change the pollutants assessed or the numerical thresholds.

National Air Pollution Plan for NO_2 in the UK

2.2.3 The national Air Quality Plan for NO_2 (DEFRA, 2018) sets out how the Government plans to deliver reductions in NO_2 throughout the UK, with a focus on reducing concentrations to below the EU Limit Values throughout the UK within the 'shortest possible time'.

2.2.4 The plan requires all Local Authorities (LAs) in England which DEFRA identified as having exceedances of the Limit Values in their areas past 2020 to develop local plans to improve air quality and identify measures to deliver reduced emissions, with the aim of meeting the Limit Values within their area within "*the shortest time possible*". Potential measures include changing road layouts, encouraging public and private ultra-low emission vehicle (ULEV) uptake, the use of retrofitting technologies and new fuels and encouraging public transport. In cases where these measures are not sufficient to bring about the required change within 'the shortest time possible' then LAs may consider implementing access restrictions on more polluting vehicles (e.g. Clean Air Zones (CAZs)). A CAZ is defined within the plan as being "*an area where targeted action is taken to improve air quality and resources are prioritised and coordinated in a way that delivers improved health benefits and supports economic growth*" and may be charging or non-charging.

Air Quality Strategy

2.2.5 The Air Quality Strategy (AQS) 2007 for England, Scotland, Wales and Northern Ireland sets out a comprehensive strategic framework within which air quality policy will be taken forward in the short to medium term, and the roles that Government, industry, the Environment Agency, local government, business, individuals and transport have in protecting and improving air quality (DEFRA, 2007). The AQS contains Air Quality Objectives (AQOs) based on the protection of both human health and vegetation (ecosystems). The AQOs are maximum ambient pollutant concentrations that are not to be exceeded, either without exception or with a permitted number of exceedances allowable over a specified timescale. The AQOs are generally in accordance with the Limit Values specified in the AQSRs, however requirements for compliance differ slightly.

2.2.6 The Environment Act 2021 required an updated Air Quality Strategy (DEFRA, 2023) which sets out priorities including focusing on enforcement of industrial activities in close proximity to residential areas, and closer alignment between Local Air Quality Management (LAQM) and permitting regimes. The Air Quality Strategy sets out the Government policy on achieving the AQOs, including new targets for $PM_{2.5}$.

2.2.7 The Clean Air Strategy (2019) aims to lower national emissions of pollutants, thereby reducing background pollution and minimising human exposure to harmful concentrations of pollution. The Strategy aims to create a stronger and more coherent framework for action to tackle air pollution (DEFRA, 2019).

2.2.8 The Environment Agency's role in relation to the AQS is as follows:

> *"The Environment Agency is committed to ensuring that any industrial installation or waste operation we regulate will not contribute significantly to breaches of an AQS objective.*
>
> *It is a mandatory requirement of EPR legislation that we ensure that no single industrial installation or waste operation we regulate will be the sole cause of a breach of an EU air quality limit value. Additionally, we have committed that no installation or waste operation will contribute significantly to a breach of an EU air quality limit value."* (Environment Agency, 2008)

2.3 Standards for Air Quality

2.3.1 The standards applied in this assessment are taken from the AERA Guidance (Environment Agency, 2023) which are in accordance with the AQS and AQSR. The EALs that have been applied in this assessment are provided in **Table 2-1**.

Table 2-1 Applied EALs

Pollutant	Averaging Period	EAL (µg/m^3)	Source
Nitrogen dioxide (NO_2)	Annual Mean	40	AQS and AQSR
	1-hour Mean	200 (1-hour) not to be exceeded more than 18 times per year	AQS and AQSR
Sulphur Dioxide (SO_2)	15 minutes	266 µg/m^3 not to be exceed more than 35 times a year	AQS
	1-hour	350 µg/m^3 not to be exceeded more than 24 times a year	AQS and AQSR
	24-hour	125 µg/m^3 not to be exceeded more than 3 times a year	AQS and AQSR

2.3.2 DEFRA has published technical guidance for use in Local Air Quality Management (LAQM) (DEFRA, 2022). According to LAQM.TG (22), air quality strategy objectives should only apply to locations where "*members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective*". Authorities should not consider exceedances of the objectives at any location where relevant public exposure would not be realistic. Thus, short term objectives such as the 1-hour objective should apply to footpaths and other areas which may be regularly frequented by the public even for a short period of time. Longer term objectives such as annual means, should apply at houses or other locations which the public can be expected to occupy on a continuous basis. These objectives do not apply to exposure at the workplace.

Table 2-2 Relevant Public Exposure

Averaging Period	Air quality objectives should apply at:	Air quality objectives don't apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour and 8-hour mean	All locations where the annual mean NAQO would apply, together with hotels and gardens of residences.	Kerbside sites Any other location where public exposure is expected to be short term.
1-hour mean	Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where public would not be expected to have regular access
15-minute mean	All locations where members of the public might reasonably be regularly exposed for a period of 15 minutes or longer.	Locations where members of the public would not reasonably be expected to be regularly exposed for a period of 15 minutes or longer.

2.4 Protection of Ecological Receptors

2.4.1 Sites of nature conservation importance at a national and local level, are provided environmental protection from developments, including from atmospheric emissions. EALs for the protection of ecological receptors are known as Critical Levels (C_{Le}) for airborne concentrations and Critical Loads (C_{Lo}) for deposition to land from air.

2.4.2 The AERA Guidance requires that ecological habitats should be screened against relevant standards if they are located within the following set distances from the facility:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10km of the Installation; and

- Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNR), Local Nature Reserves (LNR), Local Wildlife Sites (LWS) and Ancient Woodland (AW) within 2km of the Installation.

Critical Levels (C_{Le})

2.4.3 C_{Le} are a quantitative estimate of exposure to one or more airborne pollutants in gaseous form, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. The relevant C_{Le} for the protection of vegetation and ecosystems are specified within the UK Air Quality Regulations and AERA Guidance (see **Table 2-3**).

Table 2-3 Relevant C_{Le} for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m^3)	Habitat and Averaging Period	Source
Nitrogen Oxides (NOx)	30	Annual mean (all ecosystems)	AQSR
	75[a]	Daily mean (all ecosystems)	AERA
Sulphur Dioxide (SO_2)	10	Annual Mean (lichens and bryophytes)	AERA
	20	Annual Mean	AQSR

[a] 200 µg/m^3 where ozone (O_3) is below the AOT40 critical level of 6000 µg/m^3 and SO_2 is below the lower critical level of 10 µg/m^3.

Critical Loads (C_{Lo})

2.4.4 C_{Lo} are a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. Critical loads are set for the deposition of various substances to sensitive ecosystems. In relation to combustion emissions critical loads for eutrophication and acidification are relevant which can occur via both wet and dry deposition; however, on a local scale only dry (direct deposition) is considered significant.

2.4.5 Empirical C_{Lo} for eutrophication (derived from a range of experimental studies) are assigned based for different habitats, including grassland ecosystems, mire, bog and fen habitats, freshwaters, heathland ecosystems, coastal and marine habitats, and forest habitats and can be obtained from the UK Air Pollution Information System (APIS) website (UK CEH, 2023).

2.4.6 C_{Lo} for acidification have been set in the UK using an empirical approach for non-woodland habitats on a 1km grid square based upon the mineralogy and chemistry of the dominant soil series present in the grid square, and the simple mass balance (SMB) equation for both managed and unmanaged woodland habitats.

3 Assessment Methodology

3.1 Model Setup

3.1.1 Detailed atmospheric dispersion modelling has been undertaken using version 19191 of the AERMOD dispersion model which has been developed in conjunction with, and approved for use by, the US EPA. The dispersion modelling has been undertaken with due consideration to relevant guidance. The modelling approach is based upon the following stages:

- identification of sensitive receptors;
- review of process design and emission sources;
- compilation of the existing air quality baseline and review of LAQM status; and
- calculation of process contribution to ground level concentrations and evaluation against relevant environmental standards for both human and ecological receptors.

3.1.2 The AERMOD model calculates time-averaged ground level concentrations over any set of distances from the source. A 4km x 4km Cartesian grid with 25m spacing was used to predict the maximum predicted contribution to ground level (1.5m flagpole) concentrations. The pollutant concentrations were also predicted at specific human and ecological receptor locations.

3.1.3 The model requires inputs for:

- building effects;
- nature of the surface;
- physical characteristics of the emissions; and
- meteorology.

Building Effects

3.1.4 Buildings can influence the dispersion of pollutants from sources and can increase the maximum predicted ground level concentrations. The main effect of a building is to entrain pollutants into the cavity region in the immediate leeward side of the building, bringing them rapidly down to ground level. Therefore, concentrations near the building are increased but further away concentrations are decreased.

3.1.5 The buildings that are nearest (or attached) to the sources have been considered in the model. Buildings located horizontally within the distance equivalent to five stack heights of the stack and taller than approximately a third of the stack height have been included, in accordance with advice from the software provider. Details of buildings input to the model are provided in **Table 3-1** and **Table 3-2** below and shown in **Figure 2, Appendix E**. Building heights were obtained from OS Mastermap and LiDAR data where OS Mastermap heights were unavailable.

Table 3-1 Building Parameters – Rectangular Buildings

Building ID	X	Y	X Length (m)	Y Length (m)	Height above Ground (m)
B05	438056.4	406990.6	3.9	6.9	2.4
B06	438044.6	407059.7	17.9	11.9	7.1
B07	438024.2	407024.6	8.4	22.2	3.1
B08	438045.2	407010.1	3.6	4.3	2.2
B09	438043.6	407005.7	2.5	5.3	3.4
B10	438053.0	406995.0	6.3	2.7	2.6

Table 3-2 Building Parameters – Circular Buildings

Building ID	X	Y	Radius (m)	Height above Ground (m)
B01	438059.3	407008.4	4.1	6.4
B02	438075.7	407023.0	9.6	8.7
B03	438067.4	406995.9	5.4	6.4
B04	438087.4	407004.2	9.6	8.6

Table 3-3 Building Parameters – Polygon Buildings

Building ID	X	Y	Height above Ground (m)
B11	438060.4	406984.7	1.5

Terrain

3.1.6 Topographical data covering the extent of the receptor grid and specific receptor locations has been included in the model and was obtained from the OS LandForm Panorama dataset.

Meteorology

3.1.7 The model utilises a meteorological dataset that contains hourly values for wind speed, wind direction, and atmospheric stability to compute the dispersion of the emissions.

3.1.8 The assessment has used the five-year (2016 to 2020) sequential Numerical Weather Prediction (NWP) meteorological dataset for the Site which is considered to be appropriate for use in the assessment due to a lack of representative meteorological stations in the area. The 2016 to 2020 NWP windroses are provided in **Appendix A**.

3.2 Emissions to Atmosphere

3.2.1 The technical specifications of the combustion plant are:

- One MAN ROLLO SE2842E CHP (165 kWe output, 413 kW thermal input).
- One Hoval boiler (833 kW thermal input) (Boiler 1).
- One Strebel boiler (900 kW thermal input, 557 kW thermal output) (Boiler 2). This boiler is no longer in use and has been removed from some of the modelling scenarios.
- One 575 Nm/hr^3 biogas combustion flare.

3.2.2 The quantification of the flue gas flow rates for the CHP plant and Boiler 1 has been based on physical discharge characteristics and stack emissions testing data (Element, 2021a, Element, 2021b). The quantification of gas flow rates for Boiler 2 has been based on physical discharge characteristics and standard operating parameters included within AEA's 'Biomass Unit Conversion and Screening Assessment Tool' (AEA, 2008).

3.2.3 The emission release rates for the CHP plant, boilers and flare have been calculated from the 'normalised' flue gas flow rates (see **Table 3-3**) and the relevant ELVs (and measured NOx emission concentration for the CHP as a worst-case). The use of ELV values represents a worst-case assessment assumption as the levels below these values have been recorded during CHP and boiler emission testing (Element, 2021a, Element, 2021b).

3.2.4 The source parameters and emission rates used for the assessment of emissions are provided in **Table 3-3**. Emissions from the CHP plant, boilers and flare are discharged via individual stacks (i.e. four stacks in total). The CHP plant flue has been modelled as a horizontal point source, Boiler 1 has been modelled as a capped point source, and Boiler 2 and the flare have been modelled as regular point sources in AERMOD.

Table 3-3 Applied Physical Discharge Characteristics to Estimate Emissions and Estimated Emission Rates

Parameter / Source	CHP Flue	Boiler1 Flue	Boiler2 Flue	Flare
Stack Locations (x, y)	438038.1, 407021.4	438034.9, 407022.7	438049.3, 407008.3	438111.2, 406962.3
Stack Release Height (m AGL)	4	3.5	3.5	5.5
Emission Temperature (ºC)	260	150	120	1,000
Stack Internal Diameter (m)	0.34	0.3	0.25	1.6
Emission Velocity (m/s)	20.17 (horizontal)	7.69 (capped point source)	8.48	5.16
Actual flow rate (Am^3/s)	1.83	0.54	0.42	10.37
Normalised flow rate, dry, 15% oxygen (Nm^3/s)	2.13	-	-	-
Normalised flow rate, dry, 3% oxygen (Nm^3/s)	-	0.23	0.17	1.00
NOx Emission Rate (g/s)	0.682[a]	0.056[c]	0.044[c]	0.150[e]
Emission Rate (g/s)	0.128[b]	0.045[d]	0.035[d]	0.075[f]

a The NOx emission rate has been calculated using the measured emission concentration of 321 mg/Nm^3 (@STP, dry, 15% O_2).
b TSO_2 SO_2 emission rate has been calculated using the MCPD ELV of 60 mg/Nm^3 (@STP, dry, 15% O_2).
c The NOx emission rate has been calculated using the MCPD ELV of 250 mg/Nm^3 (@STP, dry, 3% O_2).

d The SO_2 emission rate has been calculated using the MCPD ELV of 200 mg/Nm^3 (@STP, dry, 3% O_2).
e The NOx emission rate has been calculated using an ELV of 150 mg/Nm^3 (@STP, dry, 3% O_2).
f The SO_2 emission rate has been calculated basem^3 on 575 m^3/hr biogas wm^3 h 250 mg/m^3 H_2S.

3.2.5 As an initial ‘worst-case’ baseline scenario (Scenario A), the CHP plant, boilers and flare have been assumed to operate throughout the year for 24-hours a day (8,760 hours per annum). This assumption is considered conservative; ‘real-world’ boiler and flare usage in particular are substantially below this level of utilisation. All plant is periodically taken off-line for servicing which would also reduce total available annual operating hours.

3.2.6 Additional scenarios (Scenarios B – C) have also been modelled to test the impact of mitigation options on reducing the process contribution at ecological receptor locations. The mitigation options include limits to operating hours (using ‘real-world’ operating hours for all plant) and changes to the CHP stack configuration. The ‘real-world’ operating hours are based on run-hour data for the plant (CHP and boiler 1) from previous years and existing limits (for the flare) and are assumed to be 95% (8,322 hours per year) for the CHP, 50% (4,380 hours per year) for boiler 1 and 10% (876 hours per year) for the flare.

3.2.7 Since Scenario A was modelled, Boiler 2 is now non-functional and is due to be disconnected. Boiler 2 has therefore not been included in Scenarios B and C.

3.2.8 The assessment scenarios are summarised below:

- Scenario A: ‘worst-case’ baseline scenario – existing stacks as per **Table 3-3** and 'worst-case’ 100% operation of all plant throughout the year.
- Scenario B (ecological receptors only): boiler 2 removed, 9m high vertical CHP stack, ‘real-world’ operation of all plant.
- Scenario C (ecological receptors only): boiler 2 removed, 14m high vertical CHP stack, 100% operation of all plant throughout the year.

3.3 Assessment of Impacts on Air Quality

NOx to NO_2 Conversion

3.3.1 Emissions of NOx from combustion sources include both NO_2 and NO, with the majority being in the form of NO. In ambient air, NO is oxidised to form NO_2, and it is NO_2 which has the greater potential health impacts. For this assessment, the conversion of NO to NO_2 has been estimated using the worst-case assumptions set out in Environment Agency AERA guidance, namely that:

- For the assessment of long term (annual mean) impacts at receptors, 70% of NOx is NO_2; and
- For the assessment of short term (hourly mean) impacts at receptors, 35% of NOx is NO_2.

3.3.2 The oxidation of NO to NO_2 is not, however, an instantaneous process and where the maximum impacts occur within close proximity to the stacks, the EA AERA guidance assumptions lead to a conservative assessment.

15-minute SO_2 Concentrations

3.3.3 In this assessment, the 99.9th percentiles of 1-hour mean SO_2 concentrations have been converted into 99.9th percentiles of 15-minute mean concentrations using a conversion factor 1.34, as recommended in the Environment Agency AERA guidance.

Assessment of Impact and Significance

3.3.4 To assess the potential impact on air quality, the predicted exposure is compared to the EALs, and the results of the dispersion modelling have been presented in the form of:

- tabulated concentrations at discrete receptor locations to facilitate the discussion of results; and
- illustrations of the impact as isopleths (contours of concentration) for the criteria selected enabling determination of impact at any locations within the study area.

3.3.5 In accordance with the Environment Agency's AERA guidance, the impact is considered to be insignificant or negligible if:

- the long-term process contribution is <1% of the long term EAL; and
- the short-term process contribution is <10% of the short term EAL.

3.3.6 For process contributions that cannot be considered insignificant further assessment has been undertaken and the Predicted Environmental Concentration (PEC: PC + existing background pollutant concentration) determined for comparison as a percentage of the relevant EAL. DEFRA 2018-based background maps for 2021 (DEFRA, 2021) have been applied to calculate the NO_2 PECs at receptor locations, whilst background monitoring data from DEFRA's Barnsley Gawber Automatic Urban and Rural Network (AURN) monitoring site has been applied to calculate the SO_2 PECs at receptor locations.

3.3.7 The Environment Agency's AERA guidance indicates that no further assessment is required, and impacts do not constitute 'significant pollution' if the resulting PEC is below the EAL, and the applied emission levels comply with the BAT requirements.

3.4 Assessment of Impacts on Vegetation and Ecosystems

Calculation of Deposition Rates

3.4.1 Deposition rates were calculated using empirical methods recommended by the EA AQTAG06 (EA, 2014). Dry deposition flux was calculated using the following equation:

Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m^3) x deposition velocity (m/s)

3.4.2 Wet deposition occurs via the incorporation of the pollutant into water droplets which are then removed in rain or snow and is not considered significant over short distances (AQTAG06) compared with dry deposition. Therefore, for the purposes of this assessment, wet deposition has not been considered.

3.4.3 The dry deposition velocities and conversion factors for NO_2 and SO_2 were taken from the EA's guidance document AQTAG 06 (EA, 2014) and are set out in **Table 3-4**.

Table 3-4 Applied Deposition Velocities

Chemical Species	Habitat	Recommended deposition velocity (m/s)	Conversion µg/m^2/s to kgN/ha/yr	Conversion µg/m^2/s to keq/ha/yr
NO_2	Grassland	0.0015	96.0	6.84
	Woodland	0.003		
SO_2	Grassland	0.012	-	9.84
	Woodland	0.024		

Assessment of Impact and Significance

3.4.4 In addition to the AERA guidance, the Environment Agency's Operational Instruction 66_12 (Environment Agency, 2012a) details how the air quality impacts on ecological sites should be assessed. This guidance provides risk-based screening criteria to determine whether impacts will have 'no likely significant effects (alone and in-combination)' for European sites, 'no likely damage' for SSSI's and 'no significant pollution' for other sites, as follows:

- PC <1% long-term C_{Le} and/or C_{Lo} or that the PEC <70% long-term C_{Le} and/or C_{Lo} for European sites and SSSIs;
- PC <10% short-term C_{Le} for NOx for European sites and SSSIs;
- PC <100% long-term C_{Le} and/or C_{Lo} other conservation sites; and
- PC <100% short-term C_{Le} for NOx (if applicable) for other conservation sites.

3.4.5 Where impacts cannot be classified as resulting in 'no likely significant effect', more detailed assessment may be required depending on the sensitivity of the feature in accordance with Environment Agency's Operational Instruction 67_12 (Environment Agency, 2012b). This can require the consideration of the potential for in-combination effects, the actual distribution of sensitive features within the site, and local factors (such as the water table).

3.4.6 The guidance provides the following further criteria:

- if the PEC <100% of the appropriate limit, it can be assumed there will be no adverse effect;
- if the background is below the limit, but a small PC leads to an exceedance – decision based on local considerations;
- if the background is currently above the limit and the additional PC will cause a small increase – decision based on local considerations;
- if the background is below the limit, but a significant PC leads to an exceedance – cannot conclude no adverse effect; and
- if the background is currently above the limit and the additional PC is large - cannot conclude no adverse effect.

4 Baseline Environment

4.1 Site Setting and Sensitive Receptors

4.1.1 The Site location is shown in **Figure 1, Appendix E**. Sunny Bank, Horse Carr and Storrs Wood LWS / Ancient Woodland lies directly to the east of the Installation. The area immediately surrounding the Installation predominantly consists of farmland, industrial and residential uses. The modelled sensitive human and ecological receptor locations in proximity to the Installation are detailed in the following sections.

Human Receptors

4.1.2 According to LAQM.TG (22), air quality standards should apply to locations where members of the public may be reasonably likely to be exposed to air pollution for the duration of the relevant limit value. The dispersion modelling has been completed using a receptor grid which allows the maximum ground level impact to be assessed including potential short-term exposure locations. As such, the impact concentration has been assessed at all potential exposure locations surrounding the Site. In addition, sensitive existing residential properties and a school have been modelled, details of which are shown in **Table B-1, Appendix B** and their locations are shown in **Figure 3, Appendix E**.

Ecological Receptors

4.1.3 Locally and nationally designated sites within the relevant AERA guidance screening distances are presented in **Table B-2, Appendix B** and shown in **Figure 4, Appendix E**. There are no internationally designated sites within the AERA guidance screening distance of 10km.

4.2 Ambient Air Quality

Local Air Quality Management

4.2.1 BMBC has investigated air quality within its area as part of its responsibilities under the LAQM regime. The Council currently has seven Air Quality Management Areas (AQMAs) which have all been declared due to exceedances of the annual mean NO_2 AQO.

4.2.2 The closest AQMA is the Barnsley AQMA No.5 on Burton Road, located approximately 1.6km west of the Installation boundary.

Local Air Quality Monitoring Data

4.2.3 BMBC carries out monitoring of NO_2 concentrations at a number of locations across the borough. The closest and most representative locations are shown in **Figure 1, Appendix E**. 2016 to 2020 monitoring data for these sites are presented in **Table 4-1**.

4.2.4 **Table 4-1** shows that there were exceedances of the annual mean NO_2 AQO in recent years at three of the six closest monitoring locations to the Installation. Of the three sites that exceeded the AQO, DT40 is the closest and is located adjacent to Grange Lane, approximately 850m from the Installation. DT49 and DT55, both located adjacent to Doncaster Road, are approximately 1.3km and 1.6km from the Installation, respectively. Whilst concentrations were lower at all monitoring locations presented in **Table 4-1** in 2020, it should be noted that these concentrations are not considered to be representative of ‘normal’ conditions due to the impact of COVID-19 restrictions.

Table 4-1 Measured NO_2 concentrations 2016 - 2020

Site ID	Site Type	Annual Mean (µg/m^3)				
		2016	2017	2018	2019	2020
BMBC Diffusion Tubes						
DT40 – Grange Lane, nr Cundy Cross junc.	Roadside	-	-	-	42.2	30
DT46 – Nr supermarket site, Wombwell Lane	Kerbside	**46.7**	**48.1**	38.4	**42.2**	29.0
DT49 – Doncaster Road, Ardsley	Kerbside	**48.7**	**46.4**	39.0	**41.9**	30.2
DT55 – Wombwell Lane, adj. Keel Inn	Roadside	-	-	-	**42.6**	27
DT57 – Grange Lane, Stairfoot, northbound	Roadside	-	-	-	38.9	29.1
DT58 – Grange Lane, Stairfoot, southbound	Roadside	-	-	-	37.4	26.1
AQO		**40**				

BMBC data obtained from the BMBC 2021 Air Quality Annual Status Report (BMBC, 2021).

4.3 Predicted Background Concentrations

4.3.1 Modelled background pollutant concentration data on a 1km x 1km spatial resolution is provided by DEFRA through the UK AIR website (DEFRA, 2020). These data are routinely used to support LAQM and Air Quality Assessments.

4.3.2 The latest available background pollutant concentrations for NO_2 are based upon a 2018 base year and projected to future years. The projected 2021 background concentrations for the grid squares containing the Installation and modelled receptor locations have been applied in this AERA and are provided in **Table 4-2**. Background NO_2 concentrations are well below the AQO.

Table 4-2 Estimated Annual Mean NO_2 Background Concentrations 2023 (µg/m^3)

Location (x_y)	Annual Mean (µg/m^3)	
	NOx	NO_2
436_407	13.1	10.0
437_405	13.6	10.4
437_406	12.6	9.6
437_407	12.8	9.8
438_405	11.8	9.1
438_406	10.8	8.4
438_407	10.8	8.4
438_408	12.5	9.6
439_405	10.9	8.4
439_407	10.6	8.2

4.3.3 The latest available modelled background pollutant data for SO_2 available from DEFRA is for 2001. Therefore, it has been considered more appropriate to use more recent SO_2 background monitoring data available from DEFRA's AURN.

4.3.4 The 2022 annual mean SO_2 concentration from the Barnsley Gawber background AURN monitoring site is provided in **Table 4-3**. The Barnsley Gawber AURN site is the closest and most representative SO_2 monitoring site to the Installation with sufficient data capture in 2022. The measured annual mean SO_2 background concentration from the Barnsley Gawber monitoring site has been applied to all modelled human receptor locations in this AERA.

Table 4-3 Annual Mean SO_2 Measured Background Concentration

Site Name	**Location (x,y)**	**2022 Annual Mean SO_2 Concentration (µg/m^3)**
Barnsley Gawber AURN	432524,407478	1.01

4.4 Baseline Air Quality at Ecological Receptors

4.4.1 The APIS website, a support tool for assessment of potential effects of air pollutants on habitats and species developed in partnership by the UK conservation agencies and regulatory agencies and the Centre for Ecology and Hydrology (CEH), has been used to provide information on relevant C_{Lo} and current deposition rates for nutrient nitrogen and for acidity. These are provided in **Table 4-4** and have been obtained from the APIS website (UK CEH, 2023).

Table 4-4 Nitrogen and Acid Deposition Critical Loads, Background Concentrations and Deposition

Receptor	Designated Site	Applied Critical Load Habitat	Critical Loads		Background Concentrations and Deposition				
			Nitrogen Deposition (kgN/ha/yr)	**Acid Deposition - MinCLMaxN (keqN/ha/yr)**	**Nitrogen Deposition (kgN/ha/yr**	**Nitrogen (keq N/ha/yr)**	**Sulphur (keq S/ha/yr)**	**NOx Concentration (µg/m^3)**	**SO_2 Concentration (µg/m^3)**
AW1	Pearson's Wood	Broadleaved, mixed and yew woodland	10	1.395	28.4	2.0	0.2	11.8	1.5
AW2	Storrs Wood	Broadleaved, mixed and yew woodland	10	1.395	28.4	2.0	0.2	11.8	1.5
LWS1a	Sunny Bank, Horse Carr and Storrs Wood	Broadleaved, mixed and yew woodland	10	1.394	28.3	2.0	0.2	12.5	1.6
LWS1b	Sunny Bank, Horse Carr and Storrs Wood	Broadleaved, mixed and yew woodland	10	1.399	28.3	2.0	0.2	12.4	1.5
LWS1c	Sunny Bank, Horse Carr and Storrs Wood	Broadleaved, mixed and yew woodland	10	1.399	28.3	2.0	0.2	12.4	1.5
LWS1d	Sunny Bank, Horse Carr and Storrs Wood	Broadleaved, mixed and yew woodland	10	1.399	28.3	2.0	0.2	12.4	1.5
LWS1e	Sunny Bank, Horse Carr and Storrs Wood	Broadleaved, mixed and yew woodland	10	1.399	28.3	2.0	0.2	12.4	1.5
LWS1f	Sunny Bank, Horse Carr and Storrs Wood	Broadleaved, mixed and yew woodland	10	1.399	28.3	2.0	0.2	12.4	1.5
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	Broadleaved, mixed and yew woodland	10	1.395	28.4	2.0	0.2	11.8	1.5
LWS2	Stairfoot Disused	Broadleaved, mixed	10	3.138	28.3	2.0	0.2	14.4	1.7

Receptor	Designated Site	Applied Critical Load Habitat	Critical Loads		Background Concentrations and Deposition				
			Nitrogen Deposition (kgN/ha/yr)	Acid Deposition - MinCLMaxN (keqN/ha/yr)	Nitrogen Deposition (kgN/ha/yr	Nitrogen (keq N/ha/yr)	Sulphur (keq S/ha/yr)	NOx Concentration (µg/m^3)	SO$_2$ Concentration (µg/m^3)
	Railway	and yew woodland							
LWS3	Cliff Wood	Broadleaved, mixed and yew woodland	10	3.142	28.6	2.0	0.3	14.8	1.7
LWS4	Carlton Marsh	Broadleaved, mixed and yew woodland	10	3.131	29.0	2.1	0.2	13.8	1.8
SSSI1	Dearn Valley Wetlands SSSI	Rich Fens	15	No species sensitive to acidity	17.1	2.0	0.2	14.4	1.8

5 Assessment Results

5.1.1 Dispersion modelling has been undertaken using the input data specified in this report. **Figure 5** to **Figure 9, Appendix E** should be referred to for graphical visualisations of modelling results. The impacts at modelled human and ecological receptor locations are described in the following sections.

5.2 Impacts on Sensitive Human Receptors

Scenario A - 'worst-case' baseline scenario – existing stacks and 'worst-case' 100% operation of all plant throughout the year.

5.2.1 Impact predictions have been based on a worst-case assessment scenario of the boilers, CHP plant and flare operating constantly throughout the year and emitting the maximum permitted NOx concentration. Therefore, the predicted concentrations presented in this report for this scenario are likely to be significant overestimations of the actual impacts of the Installation.

Nitrogen Dioxide (NO_2)

5.2.2 **Figure 5, Appendix E** illustrates the predicted annual mean NO_2 PC contour whilst **Figure 6, Appendix E** shows the 1-hour mean NO_2 PC contour. Contours are presented for the year of the maximum PC which is 2017 for annual mean NO_2 and 2019 for 1-hour mean NO_2. Predicted annual mean NO_2 concentrations at sensitive receptor locations are summarised in **Table C-1, Appendix C,** whilst predicted 1-hour mean NO_2 concentrations are provided in **Table C-2, Appendix C**. Results for the worst-case meteorological year (i.e. maximum impact at each receptor) of the five years assessed (2016 - 2020) are presented.

5.2.3 The predicted annual mean NO_2 PCs exceed 1% of the EAL at sensitive receptors R01 – R12, R14 and R33, R34 and R35, however the PECs are all less than 50% of the EAL. At all remaining receptors, including R15 within the Barnsley AQMA No.5 on Burton Road, the predicted annual mean NO_2 PCs are less than 1% of the EAL and are therefore considered to be 'insignificant' in accordance with Environment Agency guidance.

5.2.4 The predicted 1-hour mean NO_2 PCs exceed 10% of the EAL at sensitive receptors R02 – R07 and R35, however the PECs are less than 40% of the EAL. For all remaining receptors, the predicted annual mean NO_2 PCs are less than 10% of the EAL and are therefore considered to be 'insignificant' in accordance with Environment Agency guidance.

5.2.5 As both the predicted annual mean and 1-hour mean NO_2 PECs are well below the relevant EALs at all sensitive human receptor locations, the predicted NO_2 impacts do not constitute 'significant pollution'.

Sulphur Dioxide (SO_2)

5.2.6 **Figures 7, Appendix E** illustrates the predicted 24-hour mean SO_2 PC contour, **Figure 8, Appendix E** shows the 1-hour mean SO_2 PC contour and **Figure 9, Appendix E** shows the 15-minute mean SO_2 contour. Contours are presented for the year of the maximum PC which is 2019 for 24-hour mean $SO_{2,}$ 2017 for 1-hour mean SO_2 and 2016 for 15-minute mean SO_2. Predicted SO_2 concentrations at sensitive receptor locations are summarised in **Table C-3 – C-6, Appendix C**. Results for the worst-case meteorological year of the five years assessed (2016 - 2020) are presented.

5.2.7 The predicted 24-hour mean SO_2 PCs exceed 10% of the EAL at sensitive receptors R03, R04 and R35, however the PECs are less than 30% of the EAL. For all remaining receptors, the PCs are less than 10% of the EAL and are therefore considered to be 'insignificant' in accordance with Environment Agency guidance.

5.2.8 The predicted 1-hour mean SO_2 PC exceed 10% of the EAL at sensitive receptor R35, however the PEC is less than 20% of the EAL. For all remaining receptors, the PCs are less than 10% of the EAL and are therefore considered to be 'insignificant' in accordance with Environment Agency guidance.

5.2.9 The predicted 15-minute mean SO_2 PCs exceed 10% of the EAL at sensitive receptors R02 – R08 and R35, however the PECs are less than 35% of the EAL. For all remaining receptors, the PCs are less than 10% of the EAL and are therefore considered to be 'insignificant' in accordance with Environment Agency guidance.

5.2.10 The predicted 24-hour, 1-hour and 15-minute mean SO_2 PECs are well below the relevant EALs and therefore do not constitute 'significant pollution'.

5.3 Impacts on Ecological Receptors

Scenario A: 'worst-case' baseline scenario – existing stacks and 'worst-case' 100% operation of all plant throughout the year.

5.3.1 Impact predictions have initially been based on a worst-case assessment scenario assuming the two boilers, CHP plant and flare are operating constantly throughout the year and emitting at the maximum NOx and SO_2 emission concentrations defined previously.

Nitrogen Oxides (NO_x)

5.3.2 Predicted annual and 24-hour mean NO_x concentrations at sensitive ecological receptor locations are summarised in **Table D-1** and **Table D-2, Appendix D.** Results for the worst-case meteorological year of the five years assessed (2016 – 2020) are presented.

5.3.3 The predicted annual mean NOx PCs are less than 100% of the C_{Le} and can therefore be considered 'insignificant' at all locally designated ecological receptor locations, except for LWS1a (Sunny Bank, Horse Carr and Storrs Wood LWS). At LWS1a, the predicted annual mean NOx PC exceeds 100% of the C_{Le}, as does the PEC.

5.3.4 Within the Dearne Valley Wetlands SSSI, the predicted annual mean NOx PC exceeds 1% of the C_{Le}. However, the PEC is well below the C_{Le} (49.4%) and therefore adverse effects relating to annual mean NOx concentrations are unlikely to occur within the SSSI as a result of the Installation.

5.3.5 The predicted 24-hr NOx PCs are less than 100% of the C_{Le} at receptor locations within locally designated sites (and less than 1% at Dearne Valley Wetlands SSSI), except for at receptors LWS1a and LWS1b (Sunny Bank, Horse Carr and Storrs Wood LWS) where the 24-hour NOx PC exceeds the C_{Le}, as does the PEC.

5.3.6 The effects of nitrogen on vegetation are additive over long periods of time and therefore vegetation is affected by long-term changes in nitrogen deposition (and NOx concentrations) (Institute of Air Quality Management, 2020). Vegetation is much less likely to be affected by short-term (i.e. 24-hour) changes in NOx concentrations, and resulting nitrogen deposition. In addition, the C_{Le} for short-term NOx concentrations was reduced from 200 $\mu g/m^3$ to 75 $\mu g/m^3$ in 2000 to reflect the fact that elevated short-term NOx concentrations often coincide with elevated SO_2 and O_3 concentrations globally, however, this is not the case in the study area or the UK in general where SO_2 and O_3 concentrations generally remain low. Therefore, it is considered that the predicted 24-hour NOx PC is unlikely to result in a significant effect on the Sunny Bank, Horse Carr and Storrs Wood LWS.

Sulphur Dioxide (SO_2)

5.3.7 Predicted annual mean SO_2 concentrations at sensitive ecological receptor locations are summarised in **Table D-3, Appendix D.**

5.3.8 The predicted annual mean SO_2 PCs are less than 100% of the C_{Le} at all of the locally designated ecological receptor locations, and less than 1% at Dearne Valley Wetlands SSSI, and can therefore be considered 'insignificant'.

Nitrogen and Acid Deposition

5.3.9 Predicted annual mean nitrogen and acid deposition rates at sensitive ecological receptor locations are summarised in **Table D-4** and **Table D-5, Appendix D.**

5.3.10 The predicted annual nitrogen deposition PCs are less than 100% of the C_{Lo} at all locally designated ecological receptor locations, and less than 1% at Dearne Valley Wetlands SSSI, and can therefore be considered 'insignificant'.

5.3.11 The predicted annual acid deposition PCs are less than 100% of the C_{Lo} at all locally designated ecological receptor locations, except for two receptors, LWS1a and LWS1b (both within Sunny Bank, Horse Carr and Storrs Wood LWS), where the maximum predicted PCs are 219% and 123% of the $C_{Lo,}$ respectively.

5.3.12 Species within Dearne Valley Wetlands SSSI are not sensitive to acid deposition according to APIS (UK CEH, 2023).

Scenario B: boiler 2 removed, 9m high vertical CHP stack, 'real-world' operation of all plant.

5.3.13 Scenario B assumes boiler 2 is removed, a 9m high vertical CHP stack, 'real-world' operation of all remaining plant. The 'real-world' operation hours are based on run hour data for previous years and existing limits (i.e. for the flare) and are assumed to be 95% (8,322 hours per year) for the CHP, 50% (4,380 hours per year) for boiler 1 and 10% (876 hours per year) for the flare.

5.3.14 Predicted annual and 24-hour mean NO_x concentrations, annual SO_2 concentrations, nitrogen deposition and acid deposition at sensitive ecological receptor locations are summarised in **Table D-6** and **Table D-10, Appendix D.** Results for the worst-case meteorological year of the five years assessed (2016 – 2020) are presented.

5.3.15 In Scenario B, the predicted annual mean NOx, SO_2, nitrogen deposition and acid deposition PCs are reduced such that they are less than 100% of the C_{Le} or C_{Lo} at all locally designated ecological receptor locations, including Sunny Bank, Horse Carr and Storrs Wood LWS. In addition, the predicted PCs do not exceed 1% of the C_{Le} and C_{Lo} at ecological receptor locations within the Dearne Valley Wetlands SSSI. Therefore, with the Scenario B mitigation in place, the annual mean NOx and SO_2 PCs, as well as the nitrogen and acid deposition PCs are considered to be 'insignificant' at ecological receptor locations, in accordance with Environment Agency guidance.

5.3.16 The predicted 24-hour mean NOx PC exceeds 100% of the C_{Le} at one ecological receptor location (LWS1b), where the PC is predicted to be 105.3% of the C_{Le}. However, as discussed in the previous section, a conservative C_{Le} of 75 $\mu g/m^3$ has been used for 24-hour NOx impacts, and therefore, it is considered that the predicted 24-hour NOx PC is unlikely to result in a significant effect on the Sunny Bank, Horse Carr and Storrs Wood LWS in this scenario.

Scenario C: boiler 2 removed, 14m high vertical CHP stack, 100% operation of all plant.

5.3.17 Scenario C assumes boiler 2 is removed, a 14m high vertical CHP stack, and 100% operation year-round of all remaining plant.

5.3.18 Predicted annual and 24-hour mean NO_x concentrations, annual SO_2 concentrations, nitrogen deposition and acid deposition at sensitive ecological receptor locations are summarised in **Table D-11** and **Table D-15, Appendix D.** Results for the worst-case meteorological year of the five years assessed (2016 – 2020) are presented.

5.3.19 In Scenario C, the predicted annual mean NOx, SO_2, nitrogen deposition and acid deposition PCs are reduced such that they are less than 100% of the C_{Le} or C_{Lo} at all locally designated ecological receptor locations, including Sunny Bank, Horse Carr and Storrs Wood LWS. In addition, the predicted PCs do not exceed 1% of the C_{Le} and C_{Lo} at ecological receptor locations within the Dearne Valley Wetlands SSSI. Therefore, with the Scenario C mitigation in place, the annual mean NOx and SO_2 PCs, as well as the nitrogen and acid deposition PCs are considered to be ‘insignificant’ at ecological receptor locations, in accordance with Environment Agency guidance.

5.3.20 In addition, the 24-hour mean NOx PCs are less than 100% of the C_{Le} at all ecological receptor locations within locally designated sites, and less than 10% of the C_{Le} within the Dearn Valley Wetlands SSSI, and are therefore considered to be ‘insignificant’ in accordance with Environment Agency guidance.

6 Summary and Conclusions

6.1.1 An Air Emission Risk Assessment (AERA) utilising atmospheric dispersion modelling has been undertaken to support the EP application for Anaerobic Digestion activities at Lundwood STF. The Installation includes biogas combustion plant comprising a CHP plant unit, one boiler and a flare.

6.1.2 In relation to human receptors, in Scenario A (‘worst-case baseline scenario) where impacts are not classified as ‘insignificant’ (i.e. PC less than 1% of the EAL for long-term concentrations or 10% for short-term) the predicted impacts of the Installation do not lead to any exceedances of EALs and do not constitute ‘significant pollution’.

6.1.3 In relation to the impact of the Installation on designated ecological sites, in Scenario A (‘worst-case’ baseline scenario), the predicted PCs from the Installation are less than 100% of the applicable annual or 24-hour C_{Le} or C_{Lo} at locally designated ecological receptor locations, except for within the Sunny Bank, Horse Carr and Storrs Wood LWS where the 24-hour mean NOx, annual mean NOx and annual acid deposition PCs exceed 100% of the C_{Le}/C_{Lo}, as do the PECs.

6.1.4 Additional scenarios have been modelled to test the impact of mitigation options such as increasing the height of the CHP stack and applying limits to the operating hours of the combustion plant. The results of the additional scenarios (Scenarios B and C) indicate that either a 9m high vertical CHP stack with limits to annual operating hours (95% for the CHP, 50% for boiler 1, removal of boiler 2 and 10% for the flare) or a 14m high vertical CHP stack with no limits to operating hours (but including removal of boiler 2), would be sufficient to reduce the PCs for annual mean NOx and SO_2 concentrations, as well as nitrogen and acid deposition at ecological receptor locations such that they would be considered ‘insignificant’ in accordance with Environment Agency guidance. In Scenario B, the predicted 24-hour mean NOx PC exceeds 100% of the C_{Le} at one ecological receptor location in the Sunny Bank, Horse Carr and Storrs Wood LWS, however, a conservative C_{Le} of 75 µg/m^3 has been used for 24-hour NOx impacts, and therefore, it is considered that the predicted 24-hour NOx PC is unlikely to result in a significant effect on the LWS in this scenario. In Scenario C, the 24-hour NOx PCs are considered to be ‘insignificant’ at all ecological sites.

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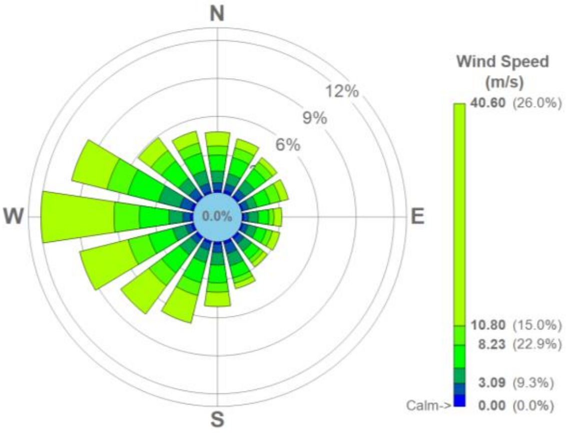
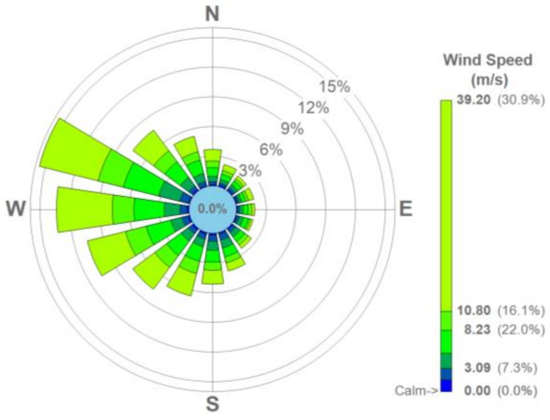
Appendix A Lundwood NWP 2016 – 2020 Windroses



2016



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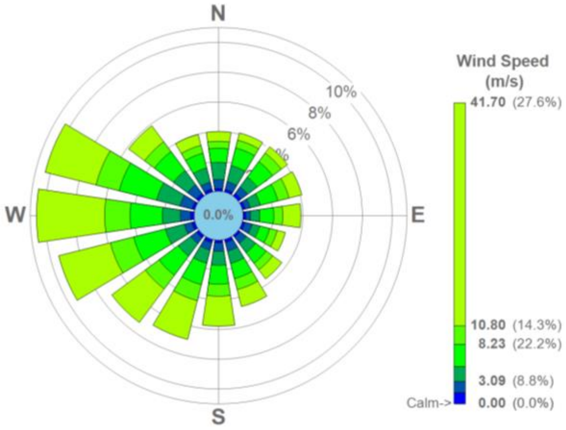

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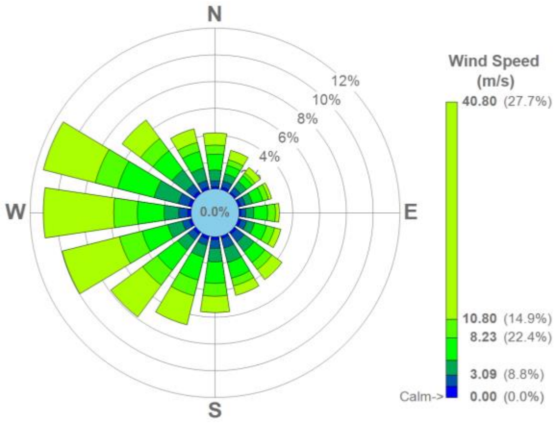
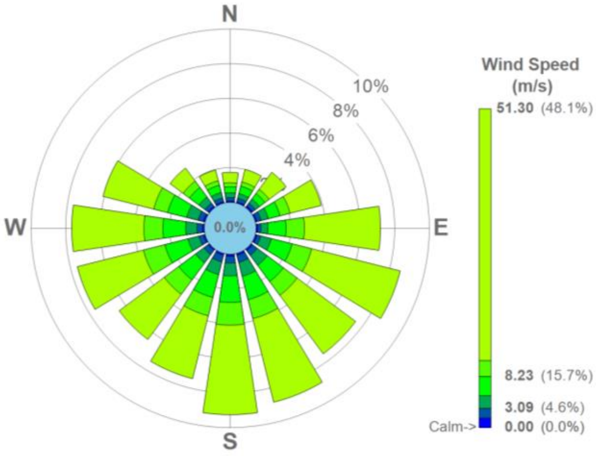


2019



2020

Appendix B Modelled Receptor Locations

Table B-1 Modelled Human Receptor Locations

Receptor	Description	X Coordinate	Y Coordinate	Height (m)	Approximate Distance from Installation Boundary (m)
R01	Sunny Bank, Lund Lane	438442.7	406903.6	1.5	81
R02	Hilcrest, Lund Lane	438059.8	407265.1	1.5	224
R03	Woodcote, Lund Lane	437962.8	407216.2	1.5	190
R04	77, Lund Lane	437902.4	407137.4	1.5	112
R05	Fernbank, Lund Lane	437865.3	407196.9	1.5	172
R06	Priory Gardens, Lund Lane	437813.6	407177.0	1.5	155
R07	46, Lund Lane	437766.5	407143.5	1.5	141
R08	40, Lund Lane	437705.8	407141.4	1.5	180
R09	37, Lang Avenue	437609.5	407110.6	1.5	249
R10	13, Lang Avenue	437608.1	407065.6	1.5	238
R11	45, Lang Avenue	437608.1	406961.7	1.5	243
R12	103, Lang Avenue	437433.5	406830.9	1.5	453
R13	2, Meadow View	437141.3	406991.4	1.5	702
R14	9, Lang Crescent	437384.4	406704.6	1.5	559
R15	158, Burton Road	436154.6	407305.7	1.5	1,712
R16	12, Abbey Lane	437266.5	406466.8	1.5	789
R17	80, Grange Lane	437159.6	406502.6	1.5	849
R18	4, Carrwood Road	437201.5	406043.1	1.5	1,152
R19	39, Grange Lane	437234.9	405811.7	1.5	1,317
R20	20, Pinfold Close	437469.1	405752.8	1.5	1,258
R21	585, Doncaster Road	437524.4	405677.9	1.5	1,308
R22	Oakhill Primary School, Doncaster Road	437534.6	405645.1	1.5	1,336
R23	22, Scarfield Close	437638.0	405970.2	1.5	995
R24	34, Horse Carr View	438088.6	405971.6	1.5	877
R25	25, Hawkwell Bank	438271.8	405922.8	1.5	885
R26	27, Penrhyn Walk	438461.3	405981.9	1.5	800

Receptor	Description	X Coordinate	Y Coordinate	Height (m)	Approximate Distance from Installation Boundary (m)
R27	Tylers Hill Cottages, Watering Lane	439580.4	405975.3	1.5	1,327
R28	Rifle Range Farm, Carrs Lane	438815.9	407472.4	1.5	728
R29	Burton Abbey Farm, Carrs Lane	438843.5	407770.1	1.5	1,016
R30	129, Birkwood Avenue	439221.5	407775.3	1.5	1,194
R31	11, Ring Farm Hollow	438687.2	408028.4	1.5	1,146
R32	106, Newland Avenue	438376.9	408229.9	1.5	1,217
R33	12, Station Road	438029.5	408133.2	1.5	1,091
R34	Low Range Cottage, Moor Lane	437932.4	407895.4	1.5	867
R35	Arunden, Lund Lane	437995.5	407135.0	1.5	117

Table B-2 Modelled Ecological Sites

Receptor	Grid Reference		Site Name (Designation)	Interest Status	Approximate Distance from Installation Boundary (m)
	X	Y			
AW1	439271.7	406403.8	Pearsons Wood Ancient Woodland	Local	836
AW2	439796.7	406796.6	Storrs Wood Ancient Woodland	Local	1,273
LWS1a	438126.9	407017.7	Sunny Bank, Horse Carr and Storrs Wood Local Wildlife Site and Ancient Woodland	Local	3
LWS1b	438160.4	406977.6	Sunny Bank, Horse Carr and Storrs Wood Local Wildlife Site and Ancient Woodland	Local	15
LWS1c	438203.9	406935.6	Sunny Bank, Horse Carr and Storrs Wood Local Wildlife Site and Ancient Woodland	Local	20
LWS1d	438660	406777.1	Sunny Bank, Horse Carr and Storrs Wood Local Wildlife Site and Ancient Woodland	Local	136
LWS1e	438594.1	406620.8	Sunny Bank, Horse Carr and Storrs Wood Local Wildlife Site and Ancient Woodland	Local	173
LWS1f	438653.3	406130.5	Sunny Bank, Horse Carr and Storrs Wood Local Wildlife Site and Ancient Woodland	Local	661
LWS1g	439889.9	406775.2	Sunny Bank, Horse Carr and Storrs Wood Local Wildlife Site and Ancient Woodland	Local	1,366
LWS2	437666.5	406593.4	Stairfoot Disused Railway Local Wildlife Site	Local	432
LWS3	436947.2	406537.7	Cliff Wood Local Wildlife Site	Local	1,013
LWS4	437960.6	409000	Carlton Marsh Local Wildlife Site	Local	1,960
SSSI1	438027.9	408697.7	Dearne Valley Wetlands Site of Special Scientific Interest	Local	1,655

Appendix C Modelled Human Receptor Results

Table C-1 Scenario A Predicted Annual Mean NO_2 Concentrations

Receptor	Scenario A - Annual Mean NO_2 Concentration (µg/m^3)			
	PC	PC as % of EAL	PEC	PEC as % of EAL
R01	1.3	**3.3%**	9.7	24.2%
R02	3.3	**8.2%**	11.6	29.1%
R03	4.1	**10.2%**	13.9	34.7%
R04	4.3	**10.7%**	14.1	35.2%
R05	2.6	**6.6%**	12.4	31.1%
R06	2.3	**5.8%**	12.1	30.3%
R07	2.2	**5.4%**	12.0	29.9%
R08	1.6	**4.1%**	11.4	28.6%
R09	1.1	**2.7%**	10.9	27.1%
R10	1.1	**2.7%**	10.9	27.1%
R11	1.1	**2.8%**	10.7	26.8%
R12	0.6	**1.4%**	10.2	25.5%
R13	0.3	0.8%	10.0	24.9%
R14	0.4	**1.1%**	10.1	25.1%
R15	0.1	0.2%	10.1	25.2%
R16	0.3	0.7%	9.9	24.7%
R17	0.3	0.6%	9.9	24.7%
R18	0.2	0.6%	9.8	24.6%
R19	0.2	0.5%	10.6	26.4%
R20	0.2	0.4%	10.5	26.4%
R21	0.1	0.3%	10.5	26.3%
R22	0.1	0.3%	10.5	26.3%
R23	0.2	0.5%	10.6	26.4%
R24	0.2	0.4%	9.2	23.0%
R25	0.1	0.4%	9.2	23.0%
R26	0.2	0.4%	9.2	23.0%
R27	0.1	0.3%	8.5	21.3%
R28	0.2	0.6%	8.6	21.5%
R29	0.2	0.5%	8.6	21.4%

Receptor	Scenario A - Annual Mean NO_2 Concentration (µg/m^3)			
	PC	**PC as % of EAL**	**PEC**	**PEC as % of EAL**
R30	0.2	0.4%	8.3	20.9%
R31	0.3	0.6%	9.8	24.5%
R32	0.4	0.9%	9.9	24.8%
R33	0.5	**1.2%**	10.0	25.1%
R34	0.7	**1.6%**	10.4	26.1%
R35	9.5	**23.8%**	19.3	48.3%

PCs exceeding 1% of the EAL are highlighted in bold.

Table C-2 Scenario A Predicted 1-hour Mean NO_2 Concentrations

Receptor	Scenario A - 99.79%ile 1-Hour Mean NO_2 Concentration (µg/m^3)			
	PC	**PC as % of EAL**	**PEC**	**PEC as % of EAL**
R01	12.8	6.4%	29.5	14.8%
R02	32.6	**16.3%**	49.3	24.6%
R03	27.2	**13.6%**	46.8	23.4%
R04	29.2	**14.6%**	48.8	24.4%
R05	22.0	**11.0%**	41.6	20.8%
R06	22.9	**11.4%**	42.4	21.2%
R07	22.7	**11.3%**	42.3	21.1%
R08	19.1	9.5%	38.6	19.3%
R09	12.9	6.5%	32.5	16.3%
R10	13.0	6.5%	32.6	16.3%
R11	11.4	5.7%	30.6	15.3%
R12	8.8	4.4%	28.1	14.0%
R13	8.1	4.1%	27.4	13.7%
R14	7.9	4.0%	27.2	13.6%
R15	3.3	1.7%	23.3	11.7%
R16	6.9	3.5%	26.2	13.1%
R17	6.9	3.4%	26.1	13.1%
R18	5.8	2.9%	25.1	12.5%
R19	5.3	2.7%	26.1	13.1%
R20	5.0	2.5%	25.8	12.9%
R21	4.5	2.2%	25.2	12.6%
R22	4.5	2.3%	25.3	12.6%
R23	6.3	3.1%	27.0	13.5%
R24	3.7	1.9%	21.8	10.9%
R25	3.5	1.7%	21.6	10.8%
R26	3.6	1.8%	21.7	10.8%
R27	2.6	1.3%	19.5	9.7%
R28	4.5	2.2%	21.2	10.6%
R29	4.0	2.0%	20.7	10.3%
R30	3.8	1.9%	20.2	10.1%

Receptor	Scenario A - 99.79%ile 1-Hour Mean NO_2 Concentration (µg/m^3)			
	PC	**PC as % of EAL**	**PEC**	**PEC as % of EAL**
R31	5.2	2.6%	24.3	12.1%
R32	6.6	3.3%	25.7	12.9%
R33	7.0	3.5%	26.1	13.1%
R34	9.5	4.7%	29.0	14.5%
R35	52.6	**26.3%**	72.2	36.1%

PCs exceeding 10% of the EAL are highlighted in bold.

Table C-3 Scenario A Predicted 24-hour Mean SO_2 Concentrations

Receptor	**Scenario A - 99.19%ile 24-Hour Mean SO_2 Concentration (µg/m^3)**			
	PC	**PC as % of EAL**	**PEC**	**PEC as % of EAL**
R01	4.7	3.8%	5.9	4.8%
R02	10.6	8.5%	11.8	9.4%
R03	15.3	**12.3%**	16.5	13.2%
R04	16.1	**12.8%**	17.3	13.8%
R05	11.7	9.4%	12.9	10.3%
R06	8.3	6.6%	9.5	7.6%
R07	7.6	6.1%	8.8	7.1%
R08	6.3	5.0%	7.5	6.0%
R09	5.0	4.0%	6.2	4.9%
R10	3.9	3.1%	5.1	4.1%
R11	3.5	2.8%	4.7	3.8%
R12	2.1	1.7%	3.3	2.6%
R13	1.4	1.1%	2.6	2.1%
R14	2.2	1.7%	3.3	2.7%
R15	0.6	0.5%	1.8	1.4%
R16	1.7	1.4%	2.9	2.4%
R17	1.6	1.3%	2.8	2.2%
R18	1.0	0.8%	2.2	1.8%
R19	0.9	0.7%	2.1	1.7%
R20	0.8	0.6%	2.0	1.6%
R21	0.7	0.5%	1.8	1.5%
R22	0.6	0.5%	1.8	1.5%
R23	0.8	0.7%	2.0	1.6%
R24	0.5	0.4%	1.7	1.3%
R25	0.6	0.4%	1.7	1.4%
R26	0.6	0.5%	1.8	1.4%
R27	0.5	0.4%	1.7	1.3%
R28	0.8	0.7%	2.0	1.6%
R29	0.7	0.6%	1.9	1.5%
R30	0.6	0.5%	1.8	1.5%

Receptor	**Scenario A - 99.19%ile 24-Hour Mean SO_2 Concentration (µg/m^3)**			
	PC	**PC as % of EAL**	**PEC**	**PEC as % of EAL**
R31	0.8	0.7%	2.0	1.6%
R32	1.3	1.0%	2.5	2.0%
R33	1.9	1.5%	3.1	2.5%
R34	3.4	2.7%	4.6	3.6%
R35	30.1	**24.1%**	31.3	25.0%

PCs exceeding 10% of the EAL are highlighted in bold.

Table C-4 Scenario A Predicted 1-Hour Mean SO_2 Concentrations

Receptor	Scenario A - 99.73%ile 1-Hour Mean SO_2 Concentration ($\mu g/m^3$)			
	PC	PC as % of EAL	PEC	PEC as % of EAL
R01	14.5	4.1%	16.5	4.7%
R02	32.9	9.4%	34.9	10.0%
R03	32.2	9.2%	34.3	9.8%
R04	32.5	9.3%	34.5	9.9%
R05	25.5	7.3%	27.5	7.9%
R06	24.5	7.0%	26.6	7.6%
R07	23.1	6.6%	25.2	7.2%
R08	20.5	5.8%	22.5	6.4%
R09	13.0	3.7%	15.1	4.3%
R10	12.5	3.6%	14.5	4.1%
R11	13.0	3.7%	15.0	4.3%
R12	9.2	2.6%	11.2	3.2%
R13	6.9	2.0%	8.9	2.6%
R14	8.4	2.4%	10.4	3.0%
R15	2.4	0.7%	4.4	1.3%
R16	7.0	2.0%	9.0	2.6%
R17	6.4	1.8%	8.4	2.4%
R18	5.1	1.5%	7.1	2.0%
R19	4.9	1.4%	7.0	2.0%
R20	4.2	1.2%	6.2	1.8%
R21	3.6	1.0%	5.6	1.6%
R22	3.7	1.1%	5.8	1.6%
R23	4.7	1.3%	6.7	1.9%
R24	3.0	0.9%	5.0	1.4%
R25	2.8	0.8%	4.8	1.4%
R26	2.7	0.8%	4.7	1.4%
R27	1.8	0.5%	3.9	1.1%
R28	4.2	1.2%	6.2	1.8%
R29	3.6	1.0%	5.6	1.6%
R30	3.5	1.0%	5.6	1.6%

Receptor	Scenario A - 99.73%ile 1-Hour Mean SO_2 Concentration (µg/m^3)			
	PC	**PC as % of EAL**	**PEC**	**PEC as % of EAL**
R31	4.9	1.4%	7.0	2.0%
R32	6.6	1.9%	8.6	2.5%
R33	7.1	2.0%	9.1	2.6%
R34	10.0	2.9%	12.0	3.4%
R35	56.7	**16.2%**	58.7	16.8%

PCs exceeding 10% of the EAL are highlighted in bold.

Table C-5 Scenario A Predicted 15-minute Mean SO_2 Concentrations

Receptor	**Scenario A - 99.9%ile 15-Minute Mean SO_2 Concentration ($\mu g/m^3$)**			
	PC	**PC as % of EAL**	**PEC**	**PEC as % of EAL**
R01	25.6	9.6%	28.3	10.6%
R02	48.1	**18.1%**	50.9	19.1%
R03	47.6	**17.9%**	50.3	18.9%
R04	50.0	**18.8%**	52.7	19.8%
R05	38.1	**14.3%**	40.8	15.3%
R06	40.0	**15.1%**	42.8	16.1%
R07	41.7	**15.7%**	44.4	16.7%
R08	34.2	**12.8%**	36.9	13.9%
R09	22.3	8.4%	25.0	9.4%
R10	24.2	9.1%	26.9	10.1%
R11	22.3	8.4%	25.0	9.4%
R12	14.9	5.6%	17.6	6.6%
R13	14.0	5.3%	16.7	6.3%
R14	14.5	5.5%	17.2	6.5%
R15	5.1	1.9%	7.8	2.9%
R16	11.2	4.2%	13.9	5.2%
R17	11.0	4.1%	13.7	5.1%
R18	8.5	3.2%	11.2	4.2%
R19	9.1	3.4%	11.8	4.5%
R20	8.3	3.1%	11.0	4.1%
R21	7.8	2.9%	10.5	3.9%
R22	7.6	2.8%	10.3	3.9%
R23	9.8	3.7%	12.5	4.7%
R24	4.9	1.8%	7.6	2.9%
R25	5.0	1.9%	7.7	2.9%
R26	5.1	1.9%	7.8	2.9%
R27	4.0	1.5%	6.7	2.5%
R28	7.7	2.9%	10.4	3.9%
R29	6.7	2.5%	9.4	3.5%
R30	6.9	2.6%	9.6	3.6%

Receptor	Scenario A - 99.9%ile 15-Minute Mean SO_2 Concentration (µg/m^3)			
	PC	PC as % of EAL	PEC	PEC as % of EAL
R31	8.8	3.3%	11.5	4.3%
R32	10.9	4.1%	13.6	5.1%
R33	11.1	4.2%	13.8	5.2%
R34	15.5	5.8%	18.2	6.8%
R35	85.5	**32.2%**	88.2	33.2%

PCs exceeding 10% of the EAL are highlighted in bold.

Appendix D Modelled Ecological Receptor Results

Scenario A Results

Table D-1 Scenario A Predicted Annual Mean NO_x Concentrations

Receptor	**Designated Site**	**Scenario A - Annual Mean NOx**			
		PC (µg/m³)	**PC as % of C_{Le}**	**PEC (µg/m³)**	**PEC as % of C_{Le}**
AW1	Pearsons Wood AW	0.3	1.0%	12.1	40.2%
AW2	Storrs Wood AW	0.2	0.7%	12.0	39.9%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	32.2	**107.3%**	44.6	**148.8%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	16.7	55.7%	29.1	97.1%
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	6.4	21.2%	18.8	62.6%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.6	2.0%	13.0	43.4%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.5	1.6%	12.9	43.0%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.2	0.7%	12.6	42.1%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.2	0.7%	12.0	39.9%
LWS2	Stairfoot Disused Railway LWS	0.9	2.9%	15.3	50.9%
LWS3	Cliff Wood LWS	0.3	1.0%	15.1	50.4%
LWS4	Carlton Marsh LWS	0.4	1.2%	14.2	47.2%
SSSI1	Dearne Valley Wetlands SSSI	0.4	**1.4%**	14.8	49.4%

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Le} criteria, and PECs exceeding 100% of the C_{Le}, are highlighted in bold.

Table D-2 Scenario A Predicted 24-hour Mean NOx Concentrations

Receptor	Designated Site	Scenario A - 24-Hour Mean NOx			
		PC (µg/m^3)	PC as % of C_{Le}	PEC (µg/m^3)	PEC as % of C_{Le}
AW1	Pearsons Wood AW	3.7	4.9%	27.2	36.3%
AW2	Storrs Wood AW	3.5	4.7%	27.1	36.1%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	165.6	**220.8%**	190.5	**254.0%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	101.7	**135.6%**	126.6	**168.8%**
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	36.7	48.9%	61.5	82.0%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	6.5	8.6%	31.3	41.7%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	7.4	9.9%	32.2	43.0%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	3.8	5.0%	28.6	38.1%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	3.3	4.4%	26.9	35.8%
LWS2	Stairfoot Disused Railway LWS	10.0	13.4%	38.8	51.8%
LWS3	Cliff Wood LWS	5.5	7.4%	35.1	46.9%
LWS4	Carlton Marsh LWS	4.4	5.9%	32.0	42.6%
SSSI1	Dearne Valley Wetlands SSSI	4.6	6.1%	33.3	44.5%

PCs exceeding 100% (locally designated sites) or the 10% (nationally designated sites) C_{Le} criteria, and PECs exceeding 100% of the C_{Le}, are highlighted in bold.

Table D-3 Scenario A Predicted Annual Mean SO_2 Concentrations

Receptor	Designated Site	Scenario A - Annual Mean SO_2			
		PC (µg/m³)	PC as % of C_{Le}	PEC (µg/m³)	PEC as % of C_{Le}
AW1	Pearsons Wood AW	0.1	0.5%	1.6	8.1%
AW2	Storrs Wood AW	0.1	0.3%	1.6	7.9%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	10.9	54.7%	12.5	62.5%
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	6.2	31.2%	7.8	38.8%
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	2.4	12.2%	4.0	19.8%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.2	1.0%	1.7	8.7%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.2	0.8%	1.7	8.5%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.1	0.3%	1.6	8.0%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.1	0.3%	1.6	7.9%
LWS2	Stairfoot Disused Railway LWS	0.3	1.5%	2.0	9.9%
LWS3	Cliff Wood LWS	0.1	0.5%	1.8	8.9%
LWS4	Carlton Marsh LWS	0.1	0.6%	1.9	9.4%
SSSI1	Dearne Valley Wetlands SSSI	0.1	0.7%	2.0	9.9%

Table D-4 Scenario A Predicted Annual Nitrogen Deposition Rates

Receptor	**Designated Site**	**Scenario A - Nitrogen Deposition**			
		PC (kgN/ha/yr)	**PC as % of C_{Lo}**	**PEC (kgN/ha/yr)**	**PEC as % of C_{Lo}**
AW1	Pearsons Wood AW	0.06	0.6%	28.4	**284.2%**
AW2	Storrs Wood AW	0.04	0.4%	28.4	**284.0%**
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	6.49	64.9%	34.8	**348.2%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	3.37	33.7%	31.7	**317.0%**
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.28	12.8%	29.6	**296.1%**
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.12	1.2%	28.5	**284.5%**
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.10	1.0%	28.4	**284.3%**
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.04	0.4%	28.4	**283.7%**
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.04	0.4%	28.4	**284.0%**
LWS2	Stairfoot Disused Railway LWS	0.18	1.8%	28.5	**284.7%**
LWS3	Cliff Wood LWS	0.06	0.6%	28.6	**286.4%**
LWS4	Carlton Marsh LWS	0.07	0.7%	29.1	**290.9%**
SSSI1	Dearne Valley Wetlands SSSI	0.08	0.6%	17.1	**114.2%**

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Lo} criteria, and PECs exceeding 100% of the C_{Lo}, are highlighted in bold.

Table D-5 Scenario A Predicted Annual Acid Deposition Rates

Receptor	Designated Site	Scenario A – Acid Deposition			
		PC (ke/ha/yr)	PC as % of C_{Lo}	PEC (keq/ha/yr)	PEC as % of C_{Lo}
AW1	Pearsons Wood AW	0.03	1.9%	2.3	164.6%
AW2	Storrs Wood AW	0.02	1.3%	2.3	164.0%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	3.05	**219.0%**	5.3	**380.4%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.72	**122.6%**	4.0	**284.1%**
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.67	47.8%	2.9	209.3%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.06	4.1%	2.3	165.6%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.05	3.2%	2.3	164.8%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.02	1.3%	2.3	162.9%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.02	1.2%	2.3	164.0%
LWS2	Stairfoot Disused Railway LWS	0.08	2.7%	2.3	74.7%
LWS3	Cliff Wood LWS	0.03	0.9%	2.3	73.8%
LWS4	Carlton Marsh LWS	0.03	1.0%	2.3	74.8%
SSSI1	Dearne Valley Wetlands SSSI	Not sensitive to acidity			

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Lo} criteria, and PECs exceeding 100% of the C_{Lo}, are highlighted in bold.

Scenario B Results

Table D-6 Scenario B Predicted Annual Mean NO_x Concentrations

Receptor	Designated Site	Scenario B - Annual Mean NOx			
		PC ($\mu g/m^3$)	PC as % of C_{Le}	PEC ($\mu g/m^3$)	PEC as % of C_{Le}
AW1	Pearsons Wood AW	0.2	0.8%	12.0	40.0%
AW2	Storrs Wood AW	0.2	0.5%	11.9	39.8%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	14.3	47.5%	26.7	89.0%
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	7.2	23.9%	19.6	65.3%
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	3.5	11.8%	15.9	53.2%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.5	1.6%	12.9	43.0%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.4	1.3%	12.8	42.7%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.2	0.6%	12.6	42.0%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.2	0.5%	11.9	39.7%
LWS2	Stairfoot Disused Railway LWS	0.6	1.9%	15.0	49.9%
LWS3	Cliff Wood LWS	0.2	0.7%	15.0	50.1%
LWS4	Carlton Marsh LWS	0.3	0.8%	14.0	46.8%
SSSI1	Dearne Valley Wetlands SSSI	0.3	1.0%	14.7	48.9%

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Le} criteria, and PECs exceeding 100% of the C_{Le}, are highlighted in bold.

Table D-7 Scenario B Predicted 24-hour Mean NOx Concentrations

Receptor	Designated Site	Scenario B - 24-Hour Mean NOx			
		PC (µg/m^3)	PC as % of C_{Le}	PEC (µg/m^3)	PEC as % of C_{Le}
AW1	Pearsons Wood AW	3.4	4.6%	27.0	35.9%
AW2	Storrs Wood AW	3.0	4.0%	26.5	35.4%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	78.9	**105.3%**	103.9	**138.5%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	47.9	63.8%	72.7	97.0%
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	28.2	37.6%	53.0	70.7%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	7.2	9.6%	32.0	42.7%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	5.4	7.1%	30.2	40.3%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	3.5	4.6%	28.3	37.8%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	2.8	3.8%	26.4	35.2%
LWS2	Stairfoot Disused Railway LWS	7.7	10.3%	36.6	48.7%
LWS3	Cliff Wood LWS	4.4	5.9%	34.1	45.4%
LWS4	Carlton Marsh LWS	3.8	5.1%	31.4	41.9%
SSSI1	Dearne Valley Wetlands SSSI	4.1	5.4%	32.9	43.8%

PCs exceeding 100% (locally designated sites) or the 10% (nationally designated sites) C_{Le} criteria, and PECs exceeding 100% of the C_{Le}, are highlighted in bold.

Table D-8 Scenario B Predicted Annual Mean SO_2 Concentrations

Receptor	Designated Site	Scenario b - Annual Mean SO_2			
		PC (µg/m^3)	PC as % of C_{Le}	PEC (µg/m^3)	PEC as % of C_{Le}
AW1	Pearsons Wood AW	0.0	0.2%	1.6	7.8%
AW2	Storrs Wood AW	0.0	0.2%	1.6	7.8%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	3.5	17.4%	5.0	25.2%
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.8	8.8%	3.3	16.4%
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.8	4.1%	2.3	11.7%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.1	0.5%	1.6	8.2%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.1	0.4%	1.6	8.1%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.0	0.2%	1.6	7.8%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.0	0.2%	1.6	7.8%
LWS2	Stairfoot Disused Railway LWS	0.1	0.7%	1.8	9.1%
LWS3	Cliff Wood LWS	0.1	0.3%	1.7	8.7%
LWS4	Carlton Marsh LWS	0.1	0.3%	1.8	9.1%
SSSI1	Dearne Valley Wetlands SSSI	0.1	0.3%	1.9	9.5%

Table D-9 Scenario B Predicted Annual Nitrogen Deposition Rates

Receptor	**Designated Site**	**Scenario B - Nitrogen Deposition**			
		PC (kgN/ha/yr)	**PC as % of C_{Lo}**	**PEC (kgN/ha/yr)**	**PEC as % of C_{Lo}**
AW1	Pearsons Wood AW	0.05	0.5%	28.4	**284.1%**
AW2	Storrs Wood AW	0.03	0.3%	28.4	**283.9%**
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	2.87	28.7%	31.2	**312.0%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.45	14.5%	29.8	**297.8%**
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.71	7.1%	29.0	**290.4%**
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.10	1.0%	28.4	**284.3%**
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.08	0.8%	28.4	**284.1%**
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.04	0.4%	28.4	**283.7%**
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.03	0.3%	28.4	**283.9%**
LWS2	Stairfoot Disused Railway LWS	0.11	1.1%	28.4	**284.0%**
LWS3	Cliff Wood LWS	0.04	0.4%	28.6	**286.2%**
LWS4	Carlton Marsh LWS	0.05	0.5%	29.1	**290.7%**
SSSI1	Dearne Valley Wetlands SSSI	0.06	0.4%	17.1	**114.1%**

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Lo} criteria, and PECs exceeding 100% of the C_{Lo}, are highlighted in bold.

Table D-10 Scenario B Predicted Annual Acid Deposition Rates

Receptor	Designated Site	Scenario B – Acid Deposition			
		PC (ke/ha/yr)	PC as % of C_{Lo}	PEC (keq/ha/yr)	PEC as % of C_{Lo}
AW1	Pearsons Wood AW	0.02	1.1%	2.3	**163.8%**
AW2	Storrs Wood AW	0.01	0.8%	2.3	**163.5%**
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.03	73.8%	3.3	**235.2%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.52	37.0%	2.8	**198.6%**
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.24	17.5%	2.5	**179.0%**
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.03	2.3%	2.3	**163.8%**
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.03	1.9%	2.3	**163.4%**
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.01	0.8%	2.3	**162.4%**
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.01	0.7%	2.3	**163.4%**
LWS2	Stairfoot Disused Railway LWS	0.04	1.3%	2.3	73.3%
LWS3	Cliff Wood LWS	0.02	0.5%	2.3	73.4%
LWS4	Carlton Marsh LWS	0.02	0.6%	2.3	74.3%
SSSI1	Dearne Valley Wetlands SSSI	Not sensitive to acidity			

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Lo} criteria, and PECs exceeding 100% of the C_{Lo}, are highlighted in bold.

Scenario C Results

Table D-11 Scenario C Predicted Annual Mean NO_x Concentrations

Receptor	**Designated Site**	**Scenario C - Annual Mean NOx**			
		PC ($\mu g/m^3$)	**PC as % of C_{Le}**	**PEC ($\mu g/m^3$)**	**PEC as % of C_{Le}**
AW1	Pearsons Wood AW	0.3	0.9%	12.1	40.2%
AW2	Storrs Wood AW	0.2	0.6%	12.0	39.9%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	13.4	44.7%	25.9	86.2%
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	9.4	31.4%	21.9	72.8%
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	5.1	17.1%	17.5	58.5%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.7	2.3%	13.1	43.7%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.5	1.8%	13.0	43.2%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.2	0.7%	12.6	42.1%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.2	0.6%	11.9	39.8%
LWS2	Stairfoot Disused Railway LWS	0.5	1.8%	15.0	49.8%
LWS3	Cliff Wood LWS	0.2	0.8%	15.1	50.2%
LWS4	Carlton Marsh LWS	0.3	0.9%	14.0	46.8%
SSSI1	Dearne Valley Wetlands SSSI	0.3	1.0%	14.7	49.0%

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Le} criteria, and PECs exceeding 100% of the C_{Le}, are highlighted in bold.

Table D-12 Scenario C Predicted 24-hour Mean NOx Concentrations

Receptor	**Designated Site**	**Scenario C - 24-Hour Mean NOx**			
		PC (µg/m^3)	**PC as % of C_{Le}**	**PEC (µg/m^3)**	**PEC as % of C_{Le}**
AW1	Pearsons Wood AW	3.3	4.4%	26.9	35.8%
AW2	Storrs Wood AW	2.7	3.6%	26.3	35.0%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	64.5	86.1%	89.5	**119.3%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	45.3	60.3%	70.1	93.5%
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	30.4	40.5%	55.2	73.6%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	7.3	9.7%	32.1	42.8%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	5.8	7.7%	30.6	40.8%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	3.1	4.1%	27.9	37.2%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	2.6	3.5%	26.1	34.9%
LWS2	Stairfoot Disused Railway LWS	6.1	8.1%	34.9	46.5%
LWS3	Cliff Wood LWS	3.6	4.8%	33.2	44.3%
LWS4	Carlton Marsh LWS	3.5	4.7%	31.1	41.5%
SSSI1	Dearne Valley Wetlands SSSI	3.7	4.9%	32.5	43.3%

PCs exceeding 100% (locally designated sites) or the 10% (nationally designated sites) C_{Le} criteria, and PECs exceeding 100% of the C_{Le}, are highlighted in bold.

Table D-13 Scenario C Predicted Annual Mean SO_2 Concentrations

Receptor	**Designated Site**	**Scenario C - Annual Mean SO_2**			
		PC ($\mu g/m^3$)	**PC as % of C_{Le}**	**PEC ($\mu g/m^3$)**	**PEC as % of C_{Le}**
AW1	Pearsons Wood AW	0.1	0.4%	1.6	8.0%
AW2	Storrs Wood AW	0.1	0.3%	1.6	7.9%
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	4.4	21.8%	5.9	29.6%
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	2.9	14.6%	4.5	22.3%
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.5	7.7%	3.1	15.3%
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.2	0.9%	1.7	8.6%
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.1	0.7%	1.7	8.4%
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.1	0.3%	1.6	7.9%
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.0	0.2%	1.6	7.8%
LWS2	Stairfoot Disused Railway LWS	0.2	0.9%	1.9	9.3%
LWS3	Cliff Wood LWS	0.1	0.4%	1.8	8.8%
LWS4	Carlton Marsh LWS	0.1	0.4%	1.8	9.2%
SSSI1	Dearne Valley Wetlands SSSI	0.1	0.4%	1.9	9.6%

Table D-14 Scenario C Predicted Annual Nitrogen Deposition Rates

Receptor	Designated Site	Scenario C - Nitrogen Deposition			
		PC (kgN/ha/yr)	PC as % of C_{Lo}	PEC (kgN/ha/yr)	PEC as % of C_{Lo}
AW1	Pearsons Wood AW	0.06	0.6%	28.4	**284.2%**
AW2	Storrs Wood AW	0.04	0.4%	28.4	**284.0%**
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	2.70	27.0%	31.0	**310.3%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.90	19.0%	30.2	**302.3%**
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.03	10.3%	29.4	**293.6%**
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.14	1.4%	28.5	**284.7%**
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.11	1.1%	28.4	**284.4%**
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.04	0.4%	28.4	**283.7%**
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.04	0.4%	28.4	**284.0%**
LWS2	Stairfoot Disused Railway LWS	0.11	1.1%	28.4	**284.0%**
LWS3	Cliff Wood LWS	0.05	0.5%	28.6	**286.3%**
LWS4	Carlton Marsh LWS	0.05	0.5%	29.1	**290.7%**
SSSI1	Dearne Valley Wetlands SSSI	0.06	0.4%	17.1	**114.1%**

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Lo} criteria, and PECs exceeding 100% of the C_{Lo}, are highlighted in bold.

Table D-15 Scenario C Predicted Annual Acid Deposition Rates

Receptor	Designated Site	Scenario C – Acid Deposition			
		PC (ke/ha/yr)	PC as % of C_{Lo}	PEC (keq/ha/yr)	PEC as % of C_{Lo}
AW1	Pearsons Wood AW	0.02	1.6%	2.3	**164.4%**
AW2	Storrs Wood AW	0.01	1.1%	2.3	**163.8%**
LWS1a	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	1.23	87.9%	3.5	**249.3%**
LWS1b	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.83	59.2%	3.1	**220.8%**
LWS1c	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.44	31.1%	2.7	**192.7%**
LWS1d	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.05	3.9%	2.3	**165.4%**
LWS1e	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.04	3.1%	2.3	**164.6%**
LWS1f	Sunny Bank, Horse Carr and Storrs Wood LWS/AW	0.02	1.2%	2.3	**162.8%**
LWS1g	Sunny Bank, Horse Carr and Storrs Wood	0.01	1.0%	2.3	**163.7%**
LWS2	Stairfoot Disused Railway LWS	0.05	1.6%	2.3	73.6%
LWS3	Cliff Wood LWS	0.02	0.6%	2.3	73.5%
LWS4	Carlton Marsh LWS	0.02	0.7%	2.3	74.5%
SSSI1	Dearne Valley Wetlands SSSI	Not sensitive to acidity			

PCs exceeding 100% (locally designated sites) or the 1% (nationally designated sites) C_{Lo} criteria, and PECs exceeding 100% of the C_{Lo}, are highlighted in bold.

Appendix E Figures

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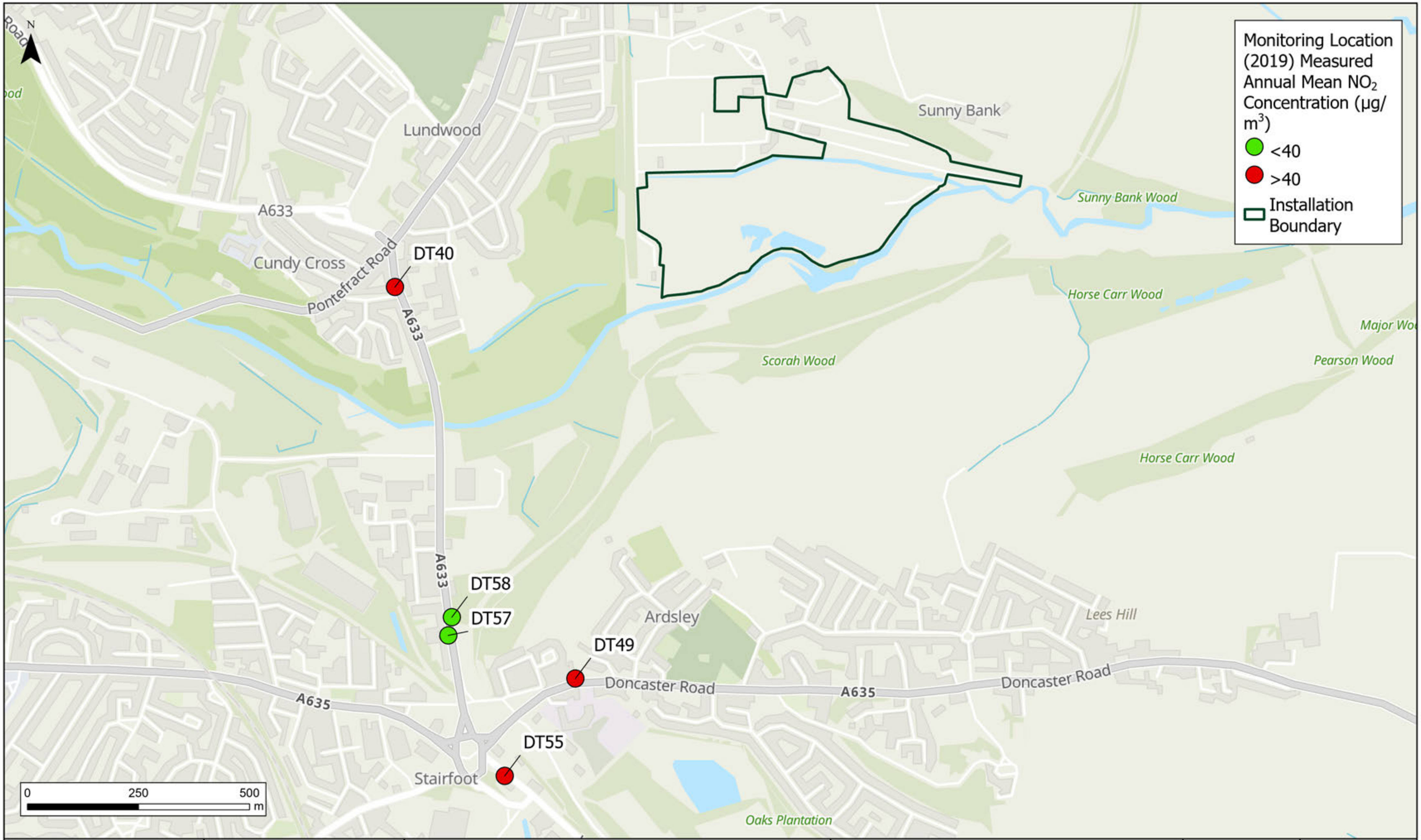

Stantec

Client

YorkshireWater

Lundwood Sludge Treatment Centre

Barnsley Metropolitan Borough Council Monitoring Locations

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Rev B

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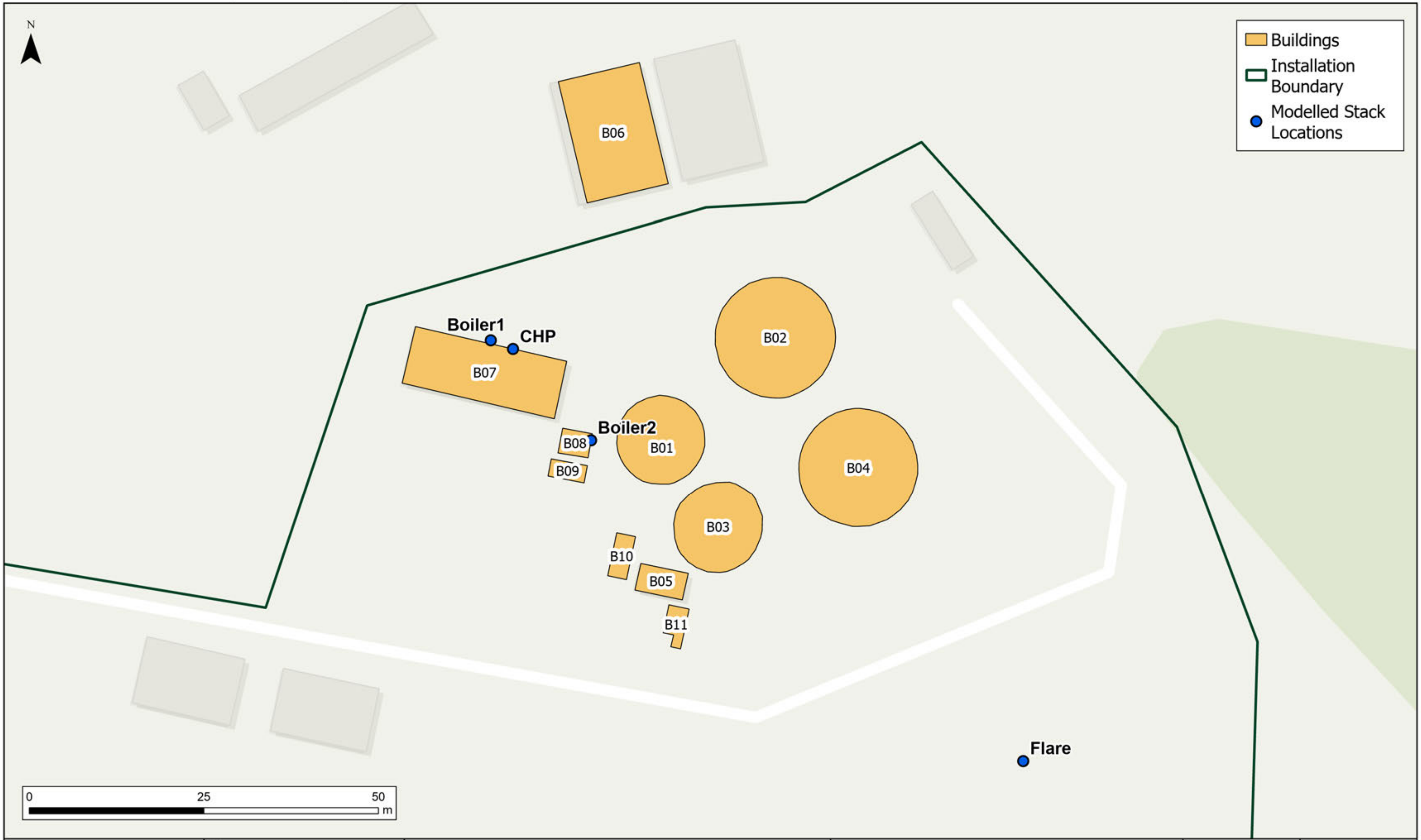

Client

YorkshireWater

Lundwood Sludge Treatment Centre

Modelled Buildings and Stack Locations

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Rev B

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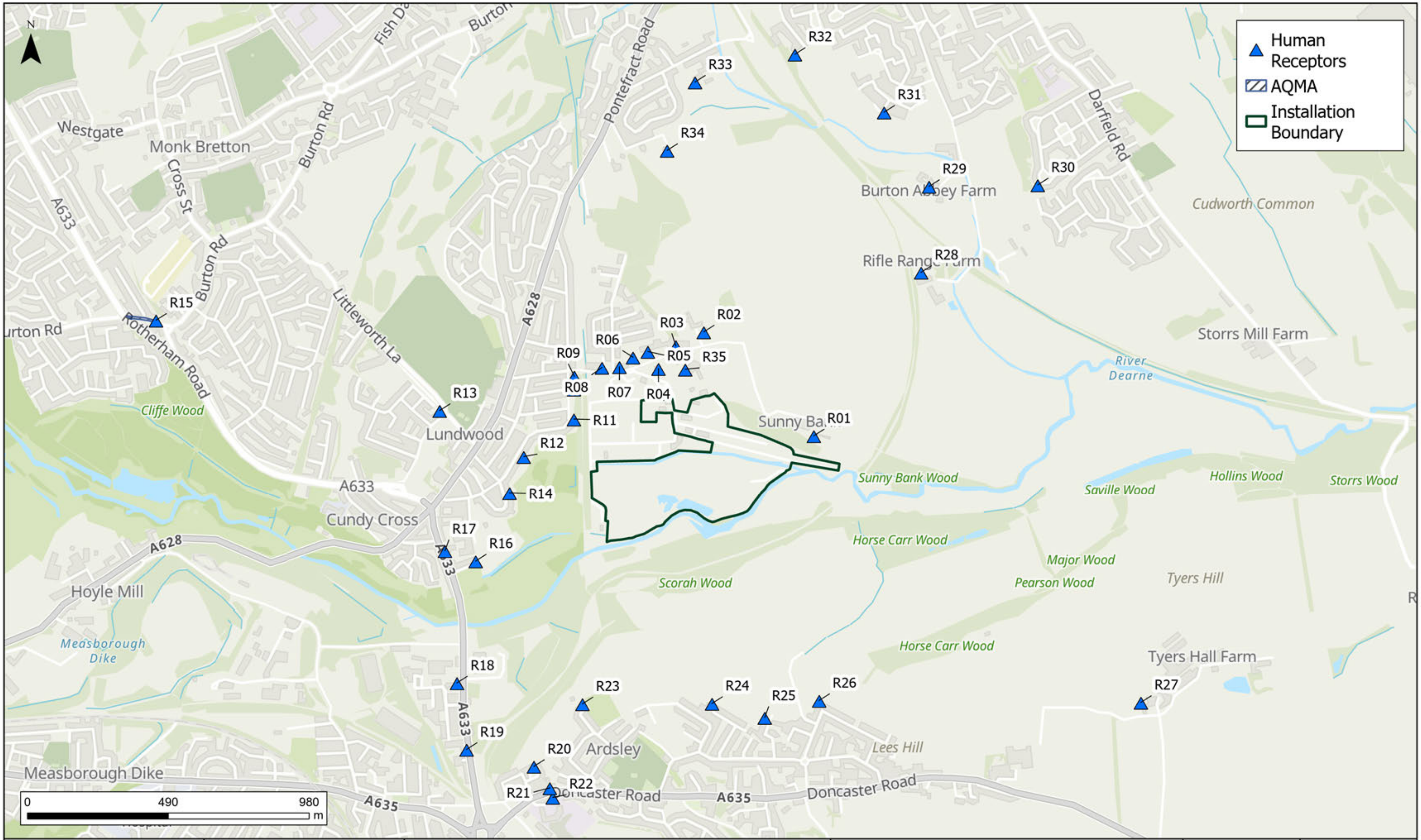

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Stantec

YorkshireWater

Lundwood Sludge Treatment Centre

Modelled Discrete Human Receptor Locations

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Figure 03	Rev B

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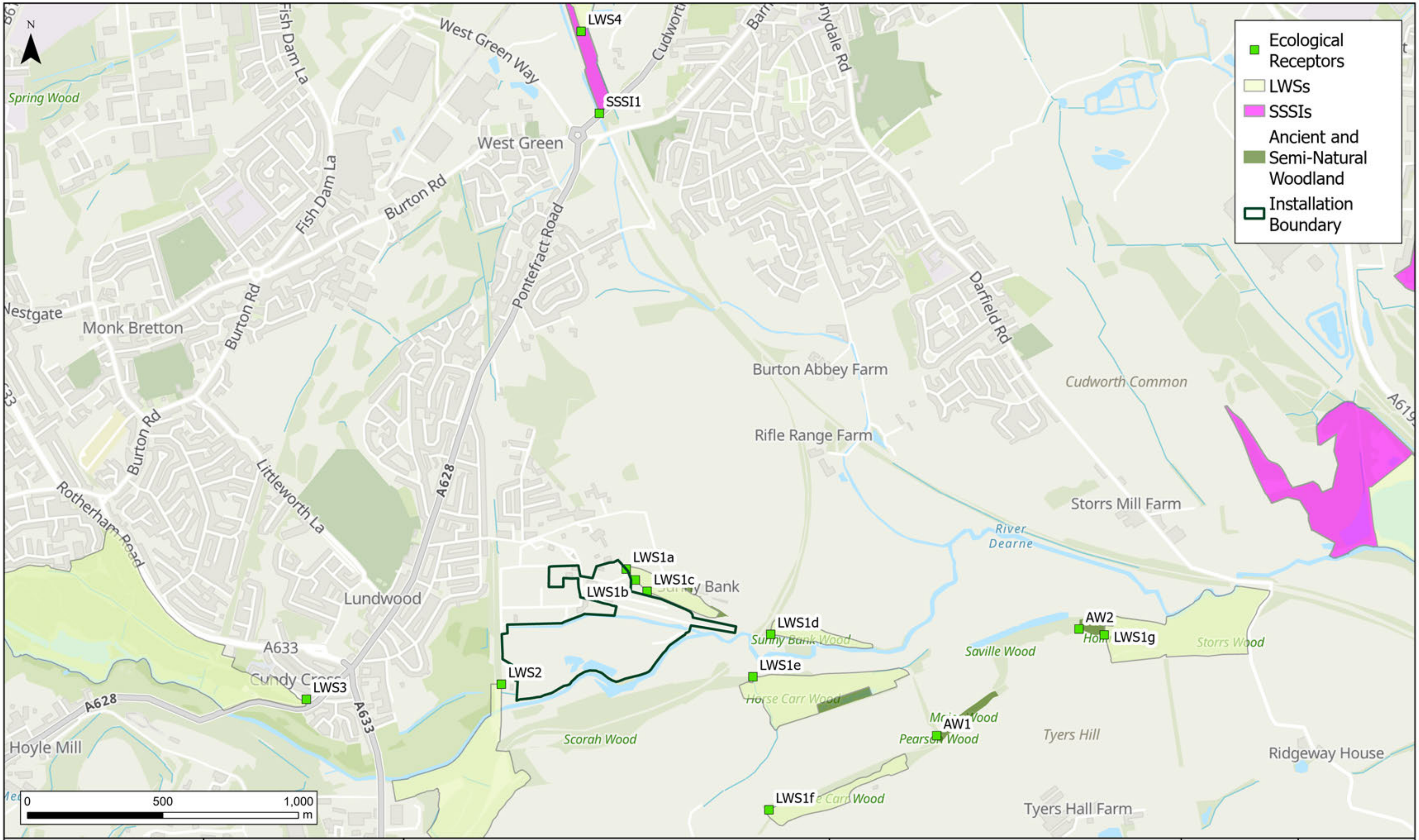

Stantec

Client

YorkshireWater

Lundwood Sludge Treatment Centre

Ecological Receptors within 2 km of the Modelled Stack Locations

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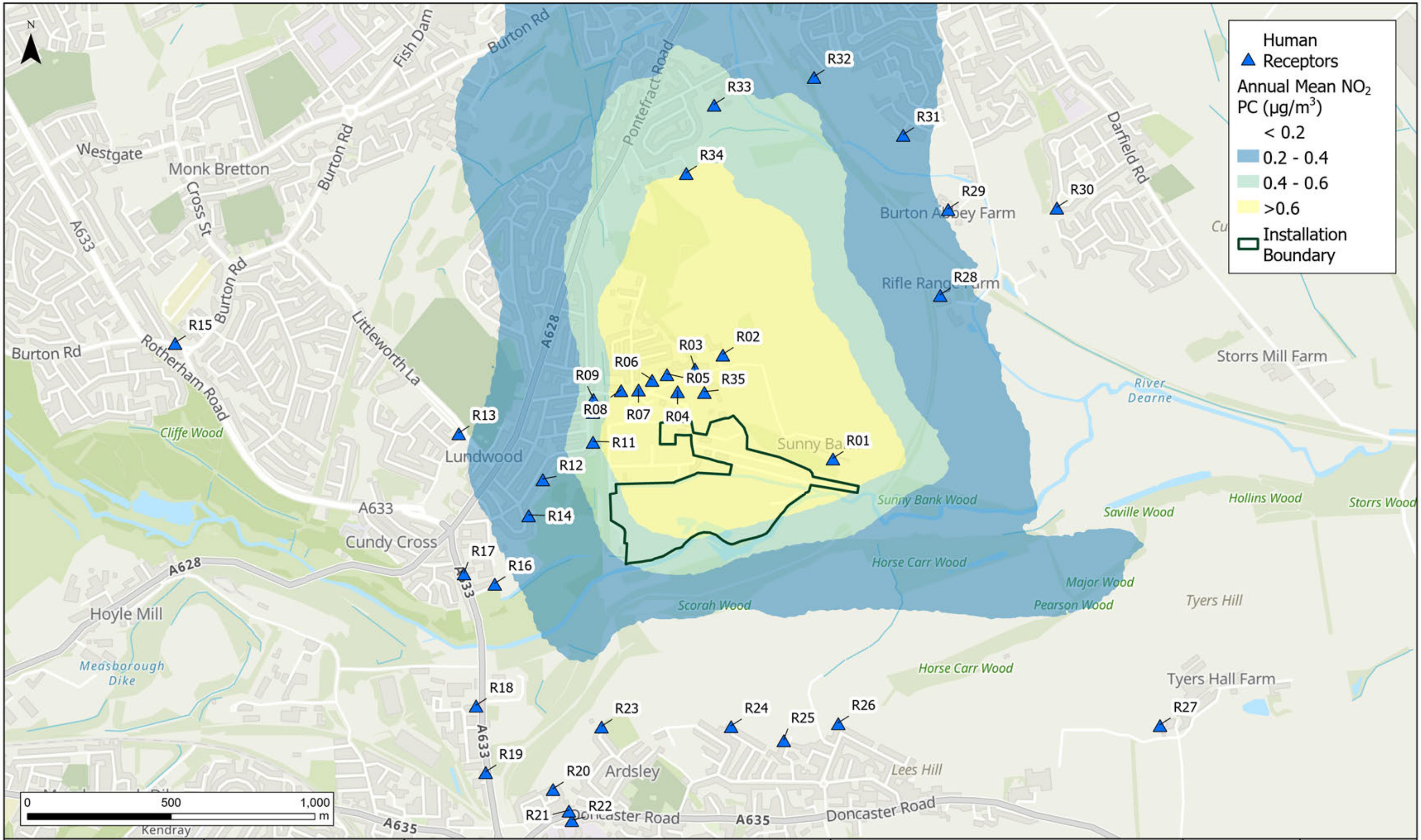
Figure 04	Rev B



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Lundwood Sludge Treatment Centre

2017 Predicted Annual Mean NO$_2$ Process Contribution (PC) Contours - Scenario A

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Figure 05
Rev B

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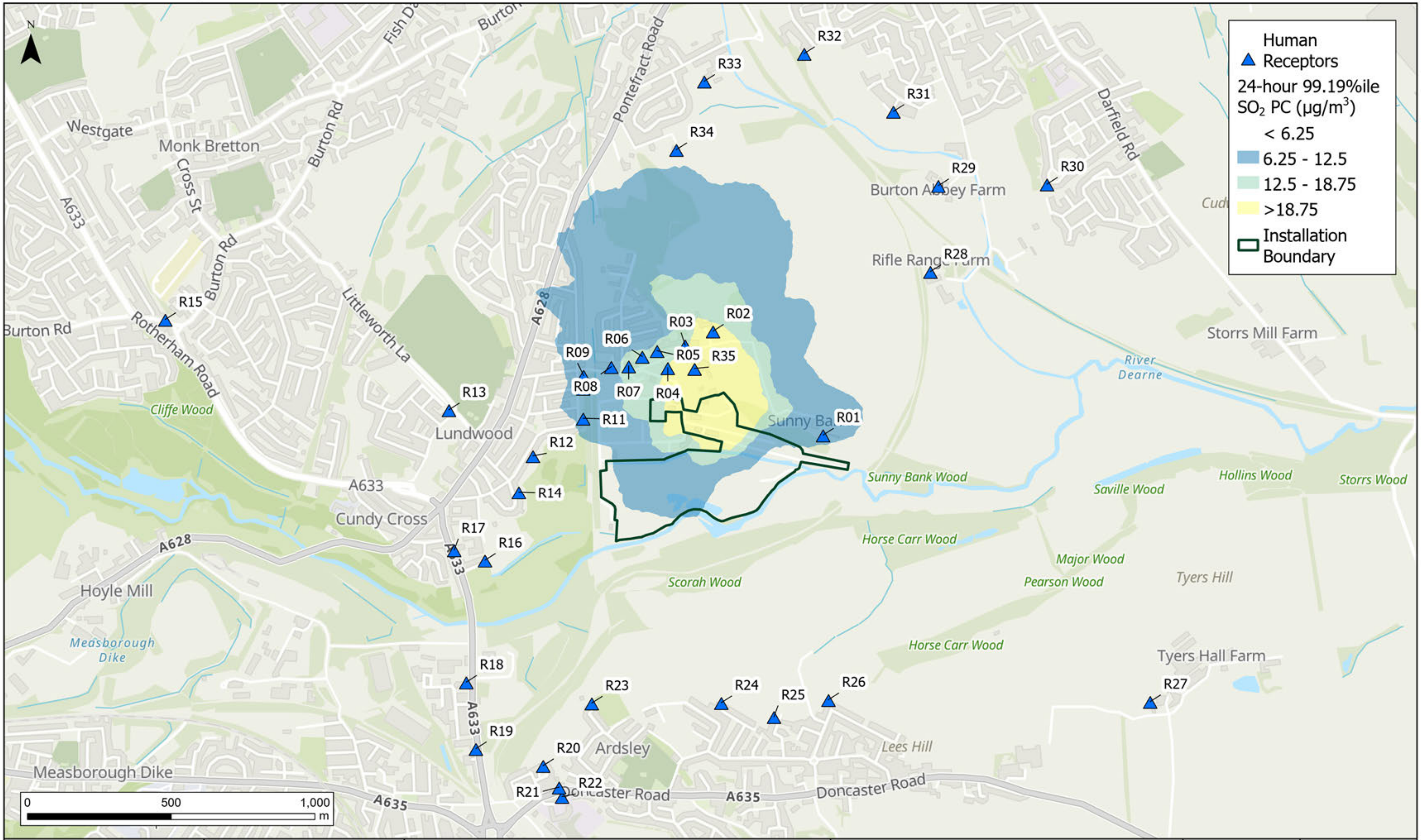

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2019 Predicted 1-hour Mean NO_2 (99.79%ile) Process Contribution (PC) Contours - Scenario A

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Figure 06	Rev B

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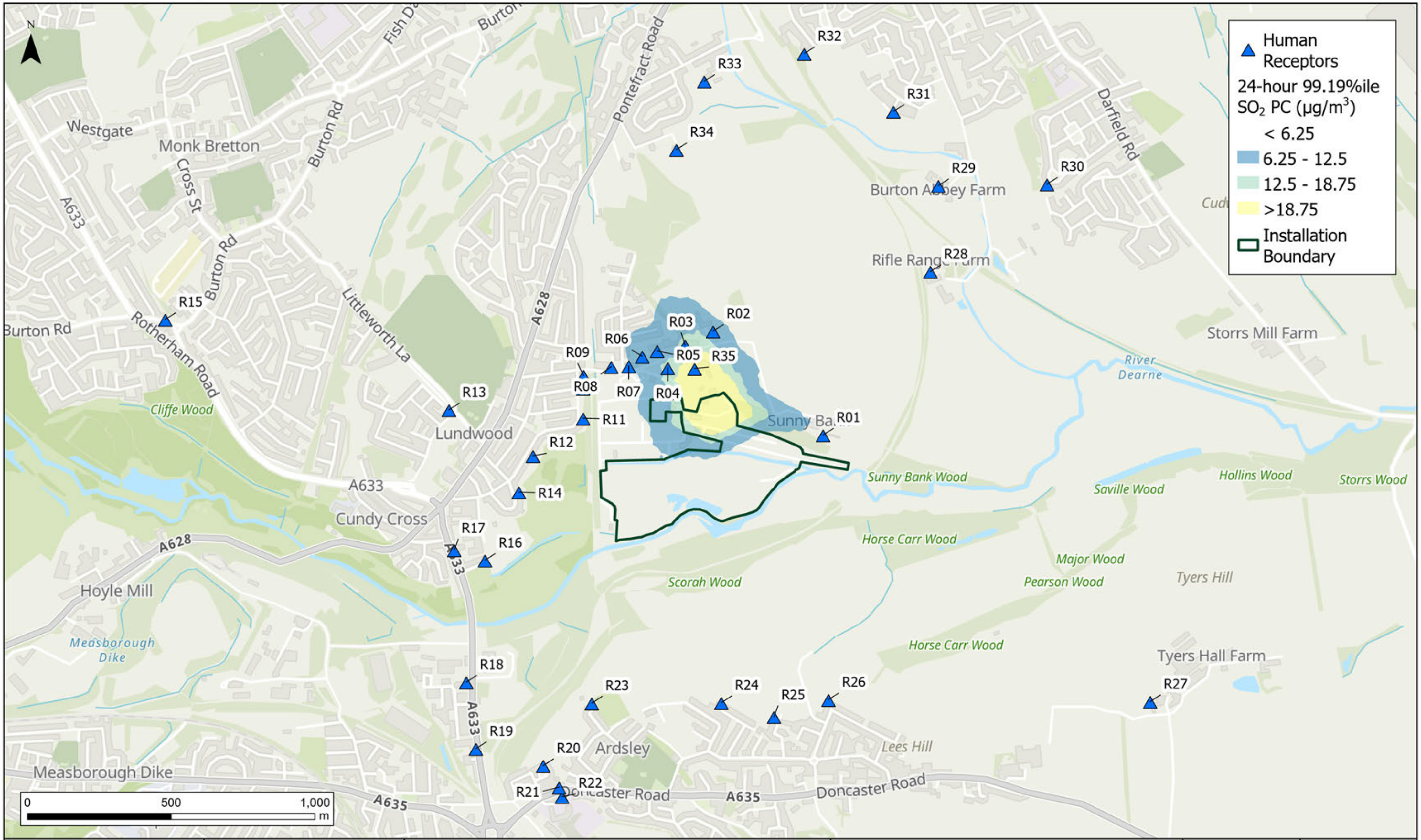

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Lundwood Sludge Treatment Centre

2019 Predicted 24-hour Mean SO_2 (99.19%ile) Process Contribution (PC) Contours - Scenario A

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Figure 07	Rev B

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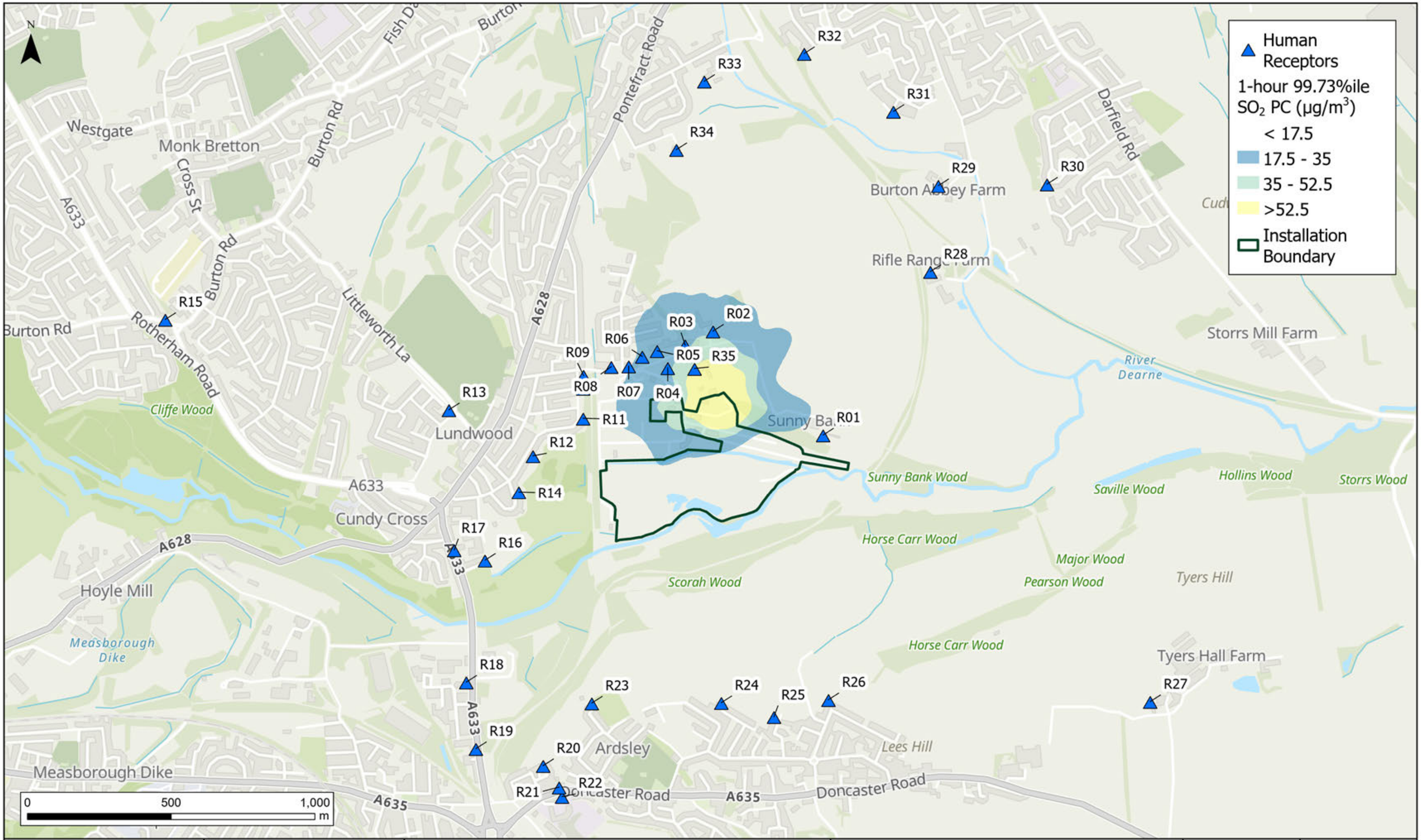

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2017 Predicted 1-hour Mean SO_2 (99.73%ile) Process Contribution (PC) Contours - Scenario A

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Figure 08	Rev B

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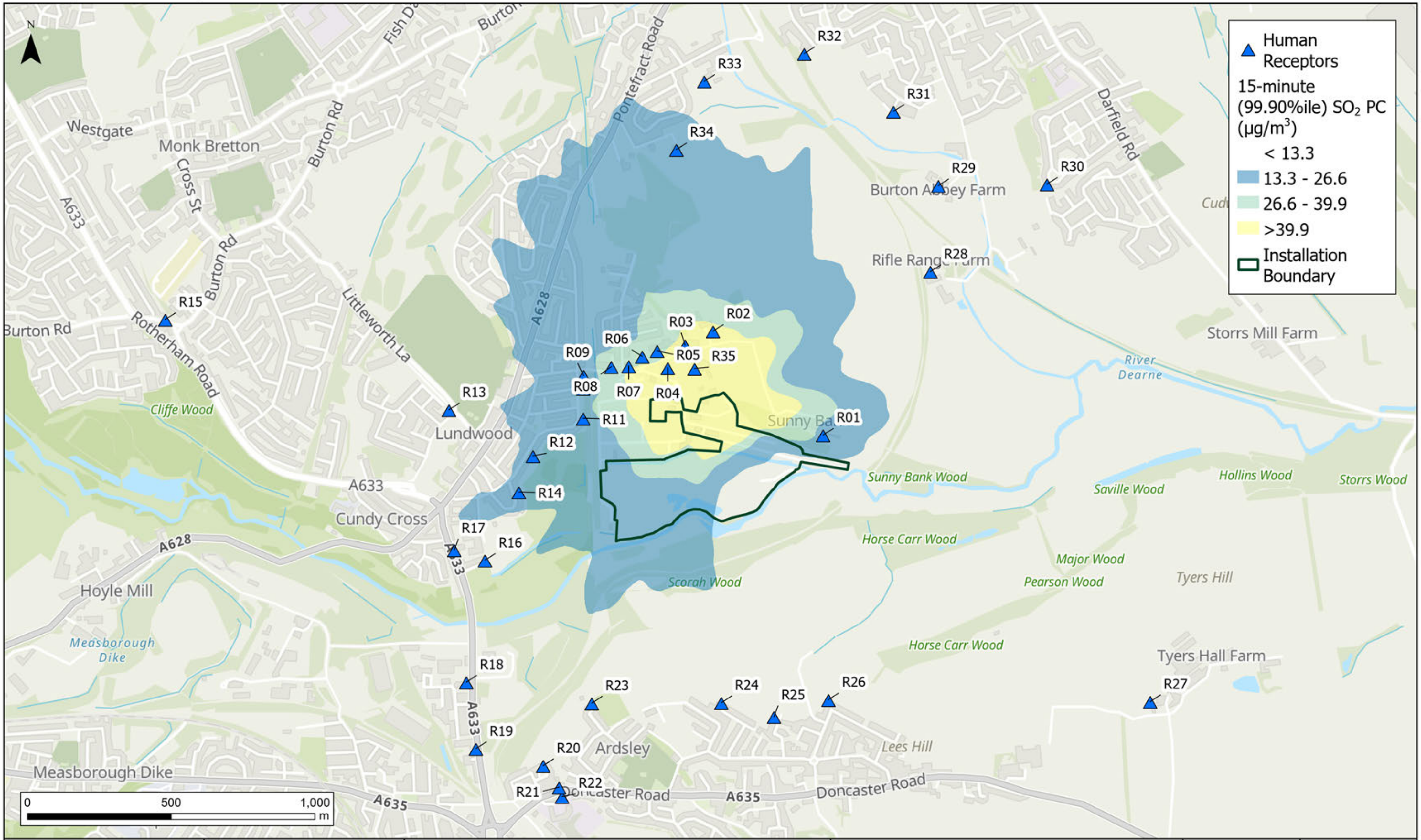

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2016 Predicted 15-minute Mean SO_2 (99.9%ile) Process Contribution (PC) Contours - Scenario A

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Figure 09	Rev B

Appendix 8 Odour Risk Assessment

Lundwood STF Qualitative Odour Risk Assessment

Project reference: 331001762

Prepared for:
Yorkshire Water

Prepared by:
Stantec

Document reference number:
331001762-100.2401-5

Report Date

23rd November 2021

Revision	Description	Author		Quality Check		Review	
1.0	First Issue	A Saunders	15/11/21	A Shaikh	22/11/21	G Baichoo	23/11/21
	FINAL	A Saunders	15/11/21	A Shaikh	22/11/21	G Baichoo	23/11/21

Table of Contents

1.0 EXECUTIVE SUMMARY

An environmental permit application is being developed for Lundwood Sludge Treatment Facility (STF) due to changes to the Environment Agency (EA) interpretation of the environmental permitting exclusion for Urban Wastewater Activities (under Environmental Permitting (England and Wales) Regulations 2016 (EPR) Schedule 1, Part 2, Chapter 5, Section 5.4). The EA interpretation now requires that anaerobic digestion (AD) plants treating over 100 tonnes/day (t/d) are classified as installations for the purposes of EPR. Furthermore, it has been determined that, in calculating digester capacity, there shall be no distinction between imported or indigenous sludges. Therefore, the Yorkshire Water (YW) Lundwood STF exceeds the 100t/d throughput limit and therefore it has been agreed that a new permit application is required in respect of Schedule 5.4 Part A(1)(b)(i) AD treatment activities currently operated on site.

As part of the permit application, an odour assessment is required to assess the risk of odours from Lundwood STF on the surrounding area. This has been developed in the form of a qualitative odour risk assessment.

The qualitative odour risk assessment for Lundwood STF has indicated that all considered sensitive receptors are exposed to either a negligible or slight adverse odour effect indicating no receptors is exposed to a moderately adverse odour effect or worse.

The STF complaints log recorded only five complaints over the last five years for the site. The odour complaints are reported to be from receptors located to the north and west of the site. The inconsistent and infrequent nature of these complaints coupled with irregularity of timing throughout the year, suggests the complaints are likely to be attributed to ad hoc events and are not associated with “normal” operation of the site.

Of the considered BAT Conclusions associated with emissions to air, specifically 14d and 34, a number of sources have been identified as not complying with the stated BAT conclusions. The OCU (biotrickling and carbon OCU) has been assessed to be achieving the stack outlet odour concentration of 1,000 ou_E/m^3.

Some of the processes are open to atmosphere, such as the digested sludge balance tanks and the cake pad. Whilst these processes do not utilise the techniques specifically described in the BAT conclusions; the assessment has not identified a significant risk of odour impact at surrounding receptors from the works. This is supported by the infrequent nature of odour complaints and no “strong” or “unpleasant” odours associated with the uncovered processes detectable at the STF operational area during the odour survey sniff testing. It is considered that although these processes do not adopt the specified measures in BAT 14d, they do not have an odour impact on surrounding receptors to the level to warrant odour mitigation; as such the alternatives measures in place are adequate.

For the overall site, it is considered that Lundwood STF does not have an adverse odour effect on its surrounding receptors. As such, no additional odour mitigation is required above the existing measures already observed on site.

2.0 INTRODUCTION

A permit application is being developed for Lundwood Sludge Treatment Facility (STF) due to changes to the Environment Agency (EA) interpretation of the environmental permitting exclusion for Urban Wastewater Activities (under Environmental Permitting (England and Wales) Regulations 2016 (EPR) Schedule 1, Part 2, Chapter 5, Section 5.4). The EA interpretation now requires that anaerobic digestion (AD) plants treating over 100 tonnes/day (t/d) are classified as installations for the purposes of EPR. Furthermore, it has been determined that, in calculating digester capacity, there shall be no distinction between imported or indigenous sludges. Therefore, the Yorkshire Water (YW) Lundwood STF exceeds the 100t/d throughput limit therefore it has been agreed that a new permit application is required in respect of Schedule 5.4 Part A(1)(b)(i) AD treatment activities currently operated on site.

As part of the permit application, an odour assessment is required to assess the risk of odours from Lundwood STF on the surrounding area. This has been developed in the form of a qualitative odour risk assessment.

3.0 SITE BACKGROUND

Lundwood STF is located adjacent to Lundwood WwTW. The site is located to the east of Lundwood village and to the north of the River Dearne. This site is located approximately 3.5 km east of Barnsley. The site is bordered grassland and farmland to the east and south, and residential and industrial areas to the north and west. The works location is highlighted in Figure 1.

Figure 1: Lundwood STF Site Location

4.0 PROCESS OVERVIEW

Sewage sludges treated within the STF originates from two sources:

- Indigenous primary sludges and surplus activated sludge (SAS) arising from sewage treatment processes operating within the wider Lundwood WwTW that are piped directly to the STF.
- Liquid sludges generated by other YW WwTW (with lower capacity or capability for treating sludges on-site) are imported to Lundwood STF for additional treatment.

Imported liquid sludge is delivered to site by tanker. The tanker unloads at the dedicated sludge import area and sludge is pumped (using vehicle mounted pumps) into the sludge import tank. The sludge is then screened using two Huber ROTAMAT enclosed rotating screens. Screenings drop into a skip and are disposed off-site.

After screening, liquid sludge is pumped via a sub-surface concrete sump, initially above ground and then underground to the thickener feed tanks. At the thickener feed tanks, imported liquid sludge is mixed with indigenous sludge and SAS, which is piped directly from the wider Lundwood WwTW.

Liquid sludge from the thickener feed tanks is transferred to the drum thickeners located within the adjacent drum thickener building. There are 4 no. drum thickeners operating on a duty/standby basis to serve two thickener process streams.

The thickened sludge is then transferred to the digester feed tank. This tank is mixed and covered.

Thickened sludges are pumped from the digester feed tank to the anaerobic digesters. The anaerobic digesters operate as a continuous process with sludge being added via a feed pump and treated sludge extracted. The digesters have a typical combined feed rate of around 120 m^3 / day; the maximum feed rate is 308 m^3 / day giving a 12-day retention time as required by Hazard Analysis and Critical Control Points (HACCP) controls. The digesters are mixed by gas mixing systems, which utilise biogas from the headspace of each digester; the gas is compressed and then reintroduced using an array of mixing nozzles on the floor of the digester.

Digested sludge is gravity fed from the digesters to the adjacent digested sludge balance tanks. These uncovered tanks are periodically mixed to prevent settlement and anoxic conditions. From these tanks, the digestate is transferred to the centrifuge building (containing one centrifuge) where the digested sludge is dewatered. Dewatering liquor is transferred to 2 no. liquor balancing tanks prior to transfer to the WwTW for full treatment.

The final digested and dewatered sludge cake is transferred via a centreless screw conveyer from the centrifuge and onto the cake pad. The whole area under the conveyer and adjacent sludge cake pads are an engineered impermeable surface, with water runoff collected in drains running along the eastern edge of the pad. These liquids are pumped back to the WwTW for full treatment.

There is 1 no. odour control unit (OCU) present on site. The OCU is a two-stage biotrickling filter and activated carbon polishing OCU that extracts and treats odours from the following sources and discharged to atmosphere via a 15m tall stack:

- Thickener Feed Tanks
- Drum Thickeners

Air from the thickener building is extracted directly to the second stage of the OCU (the carbon polishing unit) where it is treated prior to discharge via the stack.

5.0 METHODOLOGY

This qualitative odour risk assessment relies on subjective judgement but uses the generic guidance methodologies provided and referenced in documents such as the Institute of Air Quality Management (IAQM) Guidance on the Assessment of Odour for Planning, the Scottish Environmental Protection Agency (SEPA) Odour Guidance 2010, the Environment Agency's Horizontal Guidance Note 1 H1 Environmental Risk Assessments for Permits, and Annex A of H1 – Amenity & accident risk from installations and waste activities.

These guidelines use the Source-Pathway-Receptor concept in which it evaluates the relationship between source(s) of odour, the pathway or transmission route by which exposure may occur at a given receptor(s) who may be affected/impacted.

How well a qualitative odour risk assessment predicts the odour impact for a scenario is dependent on how well the Source-Pathway-Receptor approach can be assessed and scored. This type of assessment is based on subjective judgement and therefore, robust assessment criteria are required. Where subjective judgement for a criterion could be considered broad, sub-criteria have been determined to provide a more detailed judgement.

The below sections outline the assessment criteria for each key area and how it will be applied.

5.1 SOURCE ODOUR POTENTIAL

The odour potential of a source can be broken down into three key considerations:

- How inherently odorous the compounds present are.
- The unpleasantness of the odour.
- The magnitude of the odour release

When trying to determine the offensiveness of an odour source, site-specific odour sampling should be considered in the first instance. In the absence of source odour emission data, the assessment criteria will consider the Environment Agency's Horizontal Guidance Note (H4). H4 looks to categorise how offensive odours are with sources/processes/activities that are considered 'most offensive' odours include septic effluent or sludge and biological landfill odours. All raw sludge treatment processes would be considered to have a high odour offensiveness unless source-specific odour sampling is undertaken demonstrating a low level of odorous compounds. Processes containing the below material are considered to represent a high odour offensiveness:

- Indigenous sludge
- Sludge imports (liquid and solid)
- Sludge liquors

Processes containing the below material are considered to represent a medium odour offensiveness:

- Rags and screenings
- Digested sludge
- Digested sludge liquors
- Digested sludge cake (stored)

No processes on a STF are considered to store material that represents a low odour offensiveness.

The unpleasantness of an odour can be used in defining the source odour offensiveness. This is typically achieved through source material hedonic tone assessments, however; these types of assessments are not typically available for a site. As no source material hedonic tone has been undertaken for Lundwood STF, it has not been included in the assessment criteria.

The magnitude of the odour release considers the operation of the asset and how likely odours will be released. Whilst the magnitude of odour release is dependent on a number of factors such as source surface area, turbulence of source material, age of source material; the source odour mitigation and control measures have been determined as the defining criteria for magnitude of odour release. For conservatism, all open sources are considered to have a high magnitude of odour release regardless of process operation. Processes with good cover containment that have the headspace odours extracted via a fan are considered to have a low magnitude of odour release. Processes that are covered without fan extraction will have a magnitude of odour release dependant on the source odour offensiveness. This could vary between a low and high odour magnitude of odour release however, for this assessment, it would be considered to represent a medium risk.

Table 1 includes the criteria risk scoring for determining the source odour potential.

Table 1: Source Odour Potential Criteria Risk Scoring

Criteria	Risk Ratings		
	High	**Medium**	**Low**
Odour Offensiveness	Very odorous compounds (H2S, Mercaptans) with low odour threshold. Unpleasant odour - "Most Offensive". Unpleasant hedonic tone. Large permitted process / Surface Area.	Compounds involved are moderately odorous. Unpleasantness - process classed in H4 as "Moderately Offensive" or where odours have neutral or slightly unpleasant hedonic tone. Smaller permitted process / Surface Area.	Compounds involved are only mildly offensive. Unpleasantness - process classed in H4 as "Less Offensive". Neutral to positive hedonic tone.
Mitigation / Control	Open air operation with no containment. Reliance solely on good management techniques and best practice.	Some mitigation measures in place but significant residual odour remains.	Effective mitigation measures in place (e.g. BAT, BPM) leading to little or no residual odour.

5.2 PATHWAY EFFECTIVENESS

When considering the effectiveness of the odour pathway as a source transport mechanism through the air to a receptor, a number of factors need to be considered. Any factor that increases the source dilution or dispersion into atmosphere from source to receptor will reduce the odour concentration at the receptor, and hence reduce odour exposure. Several factors need to be considered including:

- The distance from source to receptor
- Wind direction and frequency
- Source release effectiveness of dispersion to atmosphere
- Topography and terrain between source and receptor

The highest likelihood of impact for a given source will be present when the predominant wind direction is present, the sensitive receptor is close to the emission source, the emission source is located at ground level with limited dispersion and there are no emission mitigation measures in place.

Table 2 includes the criteria risk scoring for determining the source pathway effectiveness.

Table 2: Source Pathway Effectiveness Criteria Risk Scoring

	Risk Ratings		
	High	Medium	Low
Distance from Site	< 50m	50 - 300m	> 300 m
Wind Direction Frequency	> 10%	5 - 10%	< 5%
Source Dispersion	Open processes with low level releases	Releases are elevated but compromised by building effects.	Releases are elevated and dispersed via stack/vent and not compromised by surrounding buildings.

When determining the odour risk criteria for a site, consideration should be given to any past studies that identify an odour impact boundary or any sensitive locations of odour complaints. Due to the infrequent nature of the small number of complaints (5 complaints) in the last 5 years (2017 to 2021) associated with the YW Lundwood site as a whole (i.e. the Lundwood WwTW and Lundwood STF), generic risk values have been used for the receptors distance from site. It has been considered that any receptor within a 50 m radius from the STF permit application boundary would be considered in a higher risk location whereby any receptor beyond a 300 m radius would be considered in a lower risk location. Whilst it is recognised that receptors far enough away from site will not be subject to odour impact associated to the works, no maximum distance cap has been included. However, it has been loosely considered that any receptor more than 1 km away from the works will not be considered in the assessment.

When considering pathway effectiveness, consideration is given to whether the receptors are downwind of the source and what the predominant prevailing wind direction is. Whilst the main consideration is typically for the predominant prevailing wind direction, odour impact tends to occur with low wind speeds or stable atmospheric conditions. When conditions are not stable, it will be the downwind receptors that are affected. When considering prevailing wind conditions, annual meteorological data sets from representative meteorological stations local to the site containing wind direction and frequency should be considered.

When considering the source dispersion risk, consideration is given to whether there will be sufficient dilution in reducing the odours as they transverse towards the sensitive receptors. A source at ground level that is open to atmosphere would likely have poor dispersion of odours and be reliant on other factors such as distance from receptor or low odour offensiveness to manage the risk of likely odour effect at receptors. Sources at height would be considered to have an increased dispersion but could still present a risk. Sources that are either fully contained or fan extracted through an emission stack are considered to have a low dispersion risk.

The topography and terrain surrounding a site can influent the air movement and create an increased risk of odour effect at receptors. The presence of topographical features such as hills and valleys, or urban terrain features such as buildings can affect air flow and therefore increase or inhibit dispersion and dilution. The topography at Lundwood STF is sloped with a noticeable rising gradient towards the north whereby the elevated sources can appear to be at ground level. The topography of the site has been considered in the individual source dispersion risk.

5.3 RECEPTOR SENSITIVITY

Within the IAQM guidance document, receptors are placed into one of three categories depending on land use, duration of exposure, and the anticipated level of amenity.

- High Sensitivity – High level of amenity expected, prolonged or continuously present within the area, examples include residential dwellings, schools, hospitals and tourist/cultural.

- Medium Sensitivity – Reasonable level of amenity expected, no prolonged or continuously presence within the area, examples include a place of work, commercial/retail, playing recreational fields.

- Low Sensitivity – No reasonable level of amenity expected or transient exposure, example include farms, industrial, footpaths/roads.

5.4 ASSESSMENT OUTPUT

For the above qualitative odour risk assessment, the risk of odour exposure at a receptor can be determined and used to determine a receptor's sensitivity risk of 'likely odour effect'. The risk of odour exposure is summarised in the below expressions:

- Negligible Effect
- Slight Adverse Effect
- Moderate Adverse Effect
- Substantial Adverse Effect

As referenced by the IAQM, "Guidance on the assessment of odour for planning" Version 1.1 – July 2018, when discussing qualitative odour risk assessments, "the EIA regulations require that an assessment reaches a conclusion on the likely significance of the effects. Where the overall effect is greater than "slight adverse", the effect is likely to be considered significant. Whilst this assessment will consider the risk of odour exposure for each receptor in the assessment, an overall judgement will be made for the whole site. As such, the result of the assessment will be considered binary on whether the site has significant or no significant risk of odour effect at surrounding receptors. The risk matrix approach outlined by the IAQM and adopted for this assessment is outlined in Table 3 and Table 4.

Table 3: Risk of odour exposure at specified receptor locations

		Source Odour Potential		
		Low	Medium	High
Pathway Effectiveness	Highly Effective Pathway	Low Risk	Medium Risk	High Risk
	Moderately Effective Pathway	Negligible Risk	Low Risk	Medium Risk
	Ineffective Pathway	Negligible Risk	Negligible Risk	Low Risk

Table 4: Likely magnitude of odour effect at the specific receptor location

Risk of Odour Exposure	Source Odour Potential		
	Low	Medium	High
High Risk of Odour Exposure	Slight Adverse Effect	Moderate Adverse Effect	Substantial Adverse Risk
Medium Risk of Odour Exposure	Negligible Risk	Slight Adverse Effect	Moderate Adverse Effect
Low Risk of Odour Exposure	Negligible Effect	Negligible Effect	Slight Adverse Effect
Negligible Risk of Odour Exposure	Negligible Effect	Negligible Effect	Negligible Effect

6.0 ASSESSMENT

6.1 SOURCE ODOUR POTENTIAL RESULTS

6.1.1 Site Operation

An odour survey has been undertaken providing some indicative information on odorous compounds present on uncovered and channelled emission sources. Where there is no source odour emission data available, the Environment Agency's Horizontal Guidance Note (H4) has been adopted. H4 considers sources/processes/activities that are considered 'most offensive' odours including septic effluent or sludge and biological landfill odours.

As a number of sources are adjacent to each other, it is not realistic to consider the odour effect at a receptor based on individual sources. This assessment has considered all sources as a combined single area. The pathway effectiveness has been determined based on the receptor being closest in distance to the permitted boundary / nearest source. Figure 2 shows the permit application boundary for the STF.

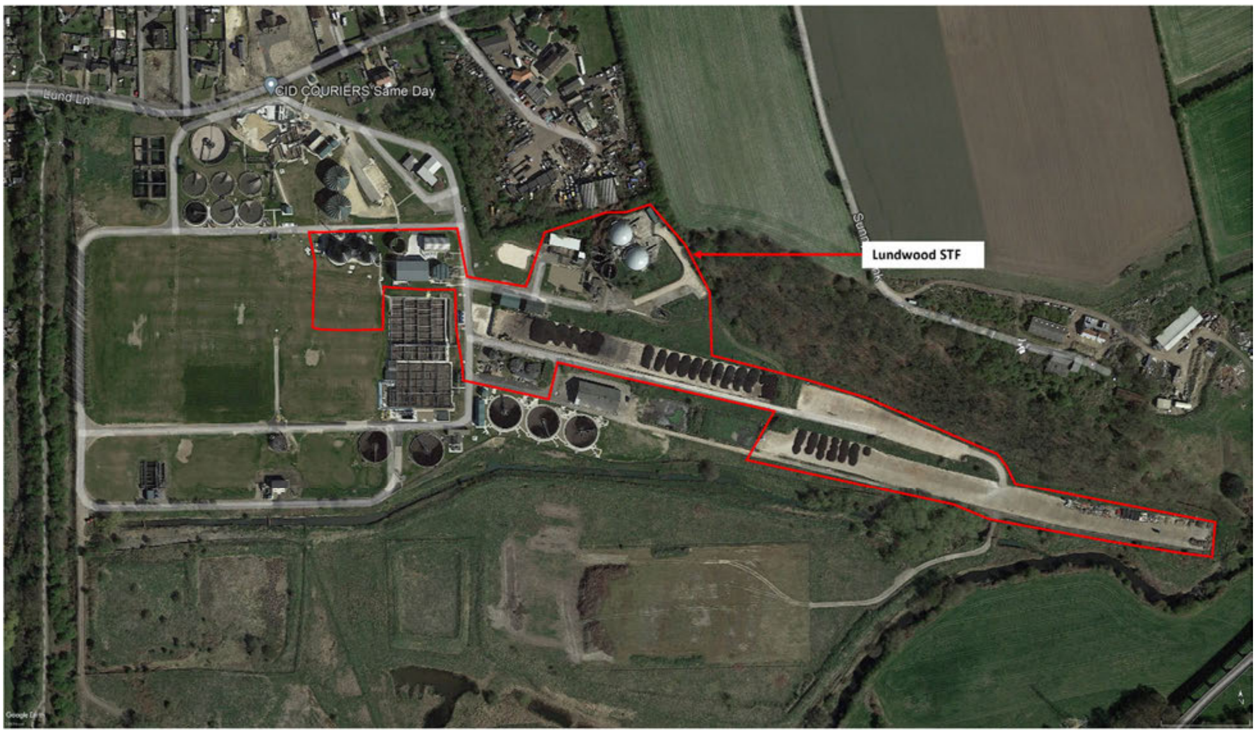


Figure 2: Lundwood STF Odour Source Areas

There is 1 no. OCU present on site. The OCU is a two-stage biotrickling filter and activated carbon polishing OCU that extracts and treats odours from the thickener feed tanks and drum thickeners with treated emissions discharged to atmosphere via a 15m tall stack.

All processes utilising the odour control units are considered to hold a negative pressure to mitigate fugitive emissions. The sludge import tank, sludge screens, digester feed tank, liquor balance tanks and dewatering centrifuge are covered without extraction presenting only partial mitigation of odours. The sludge screenings skip, thickener liquor wet well, digested sludge balance tanks and cake pad are all open to atmosphere with no mitigation of odours.

6.1.2 Odour Survey Results

The results of an odour survey considering source odour potential are presented below for both fresh digested cake, stored digested cake and other uncovered sources. The odour survey consisted of two samples per day taken on two different days in July 2021. The results indicate that the sludge cake had low odour emission rates and was comparable to typical emissions expected for sludge cakes. Sampling has been undertaken on other Yorkshire Water STFs and digested sludge cake has been observed to be between 1 and 10 $ou_E/m^2/s$, (based on data from Blackburn Meadows and Esholt).

The survey results indicate that the imported sludge tank odours were comparable to those of typical raw sludge odours however, the thickener liquor wet well is highly odorous.

The survey results for the sludge screening skip and digested sludge balance tank indicated that these processes were low odour sources and not likely to contribute to off-site odours.

A summary of the survey results is included in Table 5.

Table 5: Odour Survey Averaged Results

Source	Odour Concentration	Odour Emission Rate	Hydrogen Sulphide	Ammonia	Volatile Organic Compounds	Mercaptan	Dimethyl Sulphide
	(ou_E/m^3)	$(ou_E/m^2/s)$	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Fresh Digested Cake	551	5.7	0.006	18.0	0.1	< 0.1	< 0.1
Stored Digested Cake	89	0.9	0.005	3.3	0.1	< 0.1	< 0.1
Imported Sludge Tank	4,168	43.3	0.440	< 0.1	0.1	< 0.1	< 0.1
Sludge Screen Skip	301	3.1	0.020	< 0.1	< 0.1	< 0.1	< 0.1
Thickener liquor wet well	63,404	658.7	10.5	< 0.1	4.0	1.5	0.2
Digested Sludge Balance Tanks	105	1.1	0.005	3.0	0.1	< 0.1	< 0.1

Contaminant sampling was undertaken for hydrogen sulphide, ammonia, volatile organic compounds, mercaptans, and dimethyl sulphide. Hydrogen sulphide is considered to be the main contaminant in sludge emissions with high source odour potential. Depending on the source material, the detection threshold for hydrogen sulphide is highly variable. For the purpose of this report, Environment Agency's "Review of odour character and threshold" is used to define a compound hydrogen sulphide detection threshold of 0.0005 ppm with a recognition concentration of 0.0047 ppm. The odour survey results indicate that under all operating conditions, hydrogen sulphide concentrations from each form of sludge asset are within the detection range.

The results indicate that hydrogen sulphide concentrations are far higher than other contaminants in the survey for the raw sludges. The thickener liquor wet well has high levels of hydrogen sulphide and is the only open source where other contaminants (VOCs, mercaptans, di-methyl sulphide) have been detected above a “trace” level.

The results indicate that ammonia concentrations are far higher than any other contaminant in the survey for the digested sludge, with the fresh cake five times greater in ammonia concentration than stored digested cake. Whilst the results indicate a higher ammonia concentration for digested cake when compared to other contaminants, it does not indicate an increased odour risk when compared to other contaminants as the measured ammonia concentrations for fresh digested cake are only slightly higher than the limit of detection of 17 ppm set in the Environment Agency’s “Review of odour character and threshold” The measured ammonia concentrations for stored digested cake is considerably below this limit.

Each type of stored sludge cake exhibits concentrations of odorous compounds low enough to not cause nuisance or adverse effects local to the source and as such, would not be considered to cause adverse effects to local receptors. Whilst this means the sludge cake could potentially be considered as an asset with low odour offensiveness, for the purpose of this assessment, and to add a level of conservatism, the digested sludge and cake storage are considered to have a medium odour offensiveness.

As part of the odour survey, monitoring and sniff tests have been undertaken local to the STF operational area. The STF operational area monitoring has identified that one location on the STF detected hydrogen sulphide (the main compound in sludge odours) above the detection threshold (0.009 ppm hydrogen sulphide, north of imported cake storage). The odour description for the majority of the samples range between no odour or faint, with only one location (north of the imported cake storage) observing “strong” odours. It is understood that the strong odour detected at this location was due to the temporary storage of limed raw cake on the cake pad at the time of the survey. This cake had been produced at another YW site; storage of limed raw cake is not part of normal operation at Lundwood STF and is used as a contingency only.

Odour monitoring at the permit boundary or at nearby sensitive receptors was not included as part of the odour survey. It is envisaged that the hydrogen sulphide concentrations would be diluted between the STF operational area and the site boundary/receptors to below the recognition concentration threshold of 0.0047 ppm.

The STF operational area survey results are located in Appendix A.

6.1.3 Source Odour Potential Assessment Results

Table 6 includes a summary of the likely source odour potential with the detailed assessment in Appendix B. This assessment has been based on the approach outlined in section 5.1

Table 6: Likely magnitude of odour effect at the specific receptor location

Source	Odour Offensiveness	Mitigation/Control	Source Odour Potential
Main Treatment Area			
Sludge import tank	High risk – Imported sludge	Medium risk - covered without extraction process	High
Sludge screens	High risk – Imported sludge	Medium risk - covered without extraction process	Medium
Screening skip	Medium Risk - Screenings	High risk – open to atmosphere	Medium
Thickener feed tanks	High risk - Indigenous sludge, Imported sludge	Low risk - covered and extracted processes	Low
Drum thickeners	High risk - Indigenous sludge, Imported sludge	Low risk - covered and extracted processes within a building	Low
Thickener liquor wet well	High risk - Indigenous sludge, Imported sludge	High risk - open to atmosphere	High
Digester feed tank	High risk - Indigenous sludge, Imported sludge	Medium risk - covered without extraction process	Medium
Digested sludge balance tanks	Medium risk - digested sludge	High risk - open to atmosphere	Medium
Dewatering centrifuge	Medium risk - digested sludge	Medium risk - covered within a building	Medium
Liquor balance tanks	Medium risk - digested sludge liquors	Low risk - covered without extraction processes	Low
Cake pad	Medium risk - digested sludge	High risk - open to atmosphere	Medium

Of the twelve processes on site, three are considered to have a low source odour potential, six are considered to have a medium source odour potential and two are considered to have a high source odour potential.

The OCU is a treated air stream with good dispersion and would not give rise to adverse odour effects at receptors under normal operating conditions. The odour emissions from the OCU are considered to represent BAT for management of these type of odour sources and as such, have not been considered any further in the assessment.

Of the eleven processes within the STF, it is considered that this area is best represented with an odour source potential of a medium risk.

6.1.4 BAT Compliance

As part of the IED permit application, there are several BAT conclusions that are specifically associated with emissions to air. Whilst the outcome of this odour risk assessment is not directly influenced by the site's performance against the BAT conclusions, consideration is required if the STF is not BAT compliant and at risk of adverse odour effects on surrounding receptors.

6.1.4.1 BAT Conclusion 14

BAT Conclusion 14 is associated with the appropriate combination of techniques to prevent or reduce diffuse emissions to air. BAT Section 14d is associated with the "containment, collection and treatment of diffuse emissions" and includes techniques such as:

- Storing, treating, and handling waste and materials that may generate diffuse emissions in enclosed buildings and/or enclosed equipment (e.g., conveyor belts);

- Maintaining the enclosed equipment or buildings under adequate negative pressure;

- Collecting and directing emissions to an appropriate abatement system via an air extraction system and/or air suction systems close to the emission sources.

An assessment of STF processes has been undertaken against BAT 14d in Table 7 to review current site measures and compliance.

Table 7: BAT 14d Containment, Collection and Treatment of Diffuse Emissions

Source	Containment, Collection and Diffuse Emissions	BAT Compliance	Compliance Restrictions
Sludge import tank	Tank covered processes without foul air extraction. Tank will not hold a negative pressure.	Odour management techniques in use rather than specific BAT containment measures	None
Sludge screens	Screens a contained processes without foul air extraction. Screens will not hold a negative pressure.	Screens contained.	None
Screening skip	Skip open to atmosphere with no containment or treatment of emissions.	Odour management techniques in use rather than specific BAT containment measures	None
Thickener feed tanks	Tank covered with foul air mechanically extracted. Odour emissions treated by odour control unit and dispersed to atmosphere. Thickener feed tanks negative differential pressure measured between -34 to -55 Pa, indicating full containment of emissions with limited risk of fugitive emissions under current operation.	Yes - covered and extracted	N/A

Source	Containment, Collection and Diffuse Emissions	BAT Compliance	Compliance Restrictions
Drum thickeners	Thickeners covered with foul air mechanically extracted. Odour emissions treated by odour control unit and dispersed to atmosphere. Drum thickeners negative differential pressure measured at -1 Pa to -2 Pa, indicating average containment of emissions with limited risk of fugitive emissions under current operation.	Yes – covered and extracted	N/A
Thickener room	Building fully contained with foul air mechanically extracted. Thickener room negative differential pressure measured at -4 Pa, indicating good containment of emissions with limited risk of fugitive emissions under current operation.	Yes – building is contained and extracted	The building ventilation system extracts ambient air from the building to the outside. The ambient air is not odorous under normal operating conditions because of localised extraction from the drum thickeners.
Thickener liquor wet well	Wet well open to atmosphere with no containment or treatment of emissions.	Odour management techniques in use rather than specific BAT containment measures	None

Source	Containment, Collection and Diffuse Emissions	BAT Compliance	Compliance Restrictions
Digester feed tank	Tank covered processes without foul air extraction. Tank will not hold a negative pressure.	Partial – covered only	None
Digested sludge balance tanks	Tank open to atmosphere with no containment or treatment of emissions.	Odour management techniques in use rather than specific BAT containment measures	None
Dewatering centrifuge	Centrifuge a contained processes without foul air extraction. Centrifuges, although of a proprietary enclosed design, do not facilitate creating a negative pressure.	Area subject to regular inspection and management, source not considered to contribute to off-site odour nuisance potential. Adequate measures considered to be in operation.	None
Liquor balance tanks	Tank covered processes without foul air extraction. Tank will not hold a negative pressure.	Odour management techniques in use rather than specific BAT containment measures	None
Cake pad	Cake pad open to atmosphere with no containment or treatment of emissions.	Odour management techniques in use rather than specific BAT containment measures	The use of enclosed equipment or building is constrained by the volume of cake stored.

Of the sources on site, the screening skip, thickener liquor wet well, digested sludge balance tanks and cake pad do not adopt the specific conclusions outlined in BAT 14d. The sludge import tank, sludge screens, digester feed tank, liquor balance tanks and dewatering centrifuge would be considered to be partially compliant due to being a contained process. Whilst these processes are only partially compliant, the sludge screens and dewatering centrifuge occupy a small source footprint and are not likely to contribute to significant odour emissions or impact on surrounding receptors.

Specific BAT measures within 14d are not in use on the digested sludge balance tanks. However, the odour survey indicates that the digested sludge emissions have a low emission rate, more akin to secondary treated wastewater than raw sludge emissions. As activated sludge plants and final tanks are typically uncovered wastewater treatment processes, argument could be made that as the dewater feed tanks are more akin to these process emissions, that these tanks could remain uncovered, presenting a low risk of odour impact on surrounding receptors.

The cake pad is not covered and does not utilise specific measures outlined in BAT 14d. The cake pad odour emissions are more akin to secondary treated wastewater than raw sludge emissions. Covering the cake pad would require a significantly sized building with air extraction / ventilation, odour treatment and dispersion to atmosphere. Given the infrequent nature of odour complaints, the risk of odour impact from this area would be limited and does not warrant additional mitigation measures beyond adherence to measures, established in the odour management plan and limiting cake double handling. These measures are considered adequate and equivalent to the specified provisions in BAT 14d.

6.1.4.2 BAT Conclusion 34

BAT 34 is associated with the treatment of channelled emissions to air and identifies the accepted techniques and associated emission levels (BAT-AELs). The BAT-AELs for channelled emissions are included in Table 8.

Table 8: BAT 34 BAT Associated Emission Levels for Channelled Emissions

Parameter	Unit	BAT-AEL (Average over the sampling period)	Waste Treatment Process
Ammonia (NH_3)	Mg/Nm³	0.3 - 20	All biological treatments of waste
Odour Concentration	ou$_E$/m³	200 – 1,000	

To note, whilst the BAT-AEL for odour concentration is reported as a range, clarification has been provided that the upper range of 1,000 ou$_E$/m³ is an accepted performance limit. As part of the odour survey, OCU was sampled and identified to be treating odours and meeting BAT 34 odour concentration.

6.2 RECEPTOR SENSITIVITY RESULTS

For the assessment, before the pathway effectiveness can be determined, the discrete receptors need to be identified. Discrete receptors should typically consider complaint locations and areas of specific interest. The YW Lundwood site as a whole (i.e. the WwTW and STF combined) has received some odour complaints from the north and west of the site.

Infrequent odour complaints have been received at site level (5 complaints in the last 5 years – from 2017 to 2021), from different receptors and at different times of the year. This would suggest they are more likely to be attributed to an event occurring on site (failure of asset, maintenance work etc.) as opposed to continuous complaints associated with normal operation.

As the complaints are infrequent, all discrete receptors considered in this assessment are based on distance from the site and then categorised on sensitivity. Where a number of discrete receptors are in the same location, a single receptor has been selected, considering the likely highest sensitivity receptor, to represent the area. Table 9 and Figure 3 highlight the receptors sensitivity and location. This assessment has been based on the approach outlined in section 5.3.

Table 9: Receptor Type and Sensitivity

Receptor Name	Receptor Map Reference	Receptor Type	Receptor Sensitivity
Lund Lane - Industrial 1	D01	Industry	Low
Lund Lane - Residential 1	D02	Residential	High
Lund Lane - Residential 2	D03	Residential	High
Lund Lane - Residential 3	D04	Residential	High
Lund Lane - Residential 4	D05	Residential	High
Lund Lane - Residential 5	D06	Residential	High
Loxley Road	D07	Residential	High
Lund Crescent	D08	Residential	High
Abbots Road - Residential 1	D09	Residential	High
Lang Avenue - Residential 1	D10	Residential	High
Lang Avenue - Residential 2	D11	Residential	High
Lang Avenue - Residential 3	D12	Residential	High
Lang Crescent	D13	Residential	High
Meadow View	D14	Residential	High
Wike Road	D15	Residential	High
Priory Road	D16	Residential	High
Abbots Road - Residential 2	D17	Residential	High

Receptor Name	Receptor Map Reference	Receptor Type	Receptor Sensitivity
Scarfield Close	D18	Residential	High
Penrhyn Walk	D19	Residential	High
Watering Lane - Cottage/Residential	D20	Residential	High
Sunny Bank - Farm	D21	Farm	Low
Carrs Lane - Farm	D22	Farm	Low

Figure 3: Location of Sensitive Receptors

Of the twenty-two discrete receptors included, nineteen are considered to be highly sensitive, attributed to residential and educational centre receptors. Residential receptors can be found towards the north, south and west of the STF. The main residential areas of consideration are to the north and west of the site due to their volume and proximity to the STF.

There are no receptors which are considered to be medium sensitivity receptors.

Three receptors are considered to be of low sensitivity and represent industrial areas and farmland. A large industrial business is located adjacent to the north-east of the STF boundary. Farmland is located to the north-east of the STF boundary, adjacent to the cake pads.

6.3 PATHWAY EFFECTIVENESS RESULTS

6.3.1 Wind Direction

When considering the pathway effectiveness from source odours to an identified receptor, a number of factors have to be determined. Numerical weather predicted (NWP) meteorological data (met. year 2018) for Lundwood STF has been used to predict the wind direction frequency for this location. NWP meteorological data has been adopted for this assessment due to the complexity of the topography on site and is likely to give more accurate wind directions and frequencies. The distance between source and receptor is shown in Appendix B. The breakdown of the wind direction frequency and risk for Lundwood STF met. year 2018 are summarised in Table 10.

Table 10: Meteorological Data Wind Direction Frequency

Wind Direction	Sample Count	Frequency (%)	Wind Direction Frequency Risk
North to South	9,448	9.8%	Medium
North-East to South-West	3,688	3.8%	Low
East to West	4,246	4.4%	Low
South-East to North-West	4,382	4.5%	Low
South to North	11,572	12.0%	High
South-West to North-East	14,086	14.6%	High
West to East	30,844	32.0%	High
North-West to South-East	18,094	18.8%	High

6.3.2 Source Dispersion

When considering the source dispersion risk, a dispersion risk needs to be defined for the STF as a whole. Table 11 considers the dispersion risk from each individual process.

Table 11: Source Dispersion Risk

Source Dispersion Risk		
Sludge import tank	Covered, elevated	Medium*
Sludge screens	Covered, ground level	Medium
Screening skip	Open to atmosphere, ground level	High
Thickener feed tanks	Covered and extracted	Low
Drum Thickeners	Covered and extracted	Low
Thickener liquor wet well	Open to atmosphere, ground level	High
Digester feed tank	Covered, elevated	Medium*
Digested sludge balance tanks	Open to atmosphere, elevated	High*
Dewatering Centrifuge	Covered, ground level	Medium
Liquor balance tanks	Covered, elevated	Medium*
Cake pad	Open to atmosphere, ground level	High

*Whilst the sludge import tank, digester feed tank, liquor balance tanks and digested sludge balance tanks are elevated, due to the topography of the site, with a southernly wind, these sources would effectively be dispersed at ground level. Therefore, to add a level of conservatism to the assessment, these sources have been considered to have a medium and high source dispersion risk, respectively.

It is considered that a medium dispersion risk would be most applicable for the STF.

6.3.3 Pathway Effectiveness Assessment Results

The pathway effectiveness for each defined sensitive receptor is summarised in Table 12 with detailed assessment in Appendix B.

Table 12 Pathway Effectiveness Assessment

Receptor Name	Distance Risk	Direction From Installation	Wind Direction Frequency	Source Dispersion Risk	Pathway Effectiveness
Lund Lane - Industrial 1	High	N	High	Medium	Highly Effective Pathway
Lund Lane - Residential 1	Medium	N	High	Medium	Moderately Effective Pathway
Lund Lane - Residential 2	Medium	N	High	Medium	Moderately Effective Pathway
Lund Lane - Residential 3	Medium	N	High	Medium	Moderately Effective Pathway
Lund Lane - Residential 4	Medium	NW	Low	Medium	Moderately Effective Pathway
Lund Lane - Residential 5	Medium	NW	Low	Medium	Moderately Effective Pathway
Loxley Road	Medium	N	High	Medium	Moderately Effective Pathway
Lund Crescent	Medium	NW	Low	Medium	Moderately Effective Pathway
Abbots Road - Residential 1	Low	NW	Low	Medium	Ineffective Pathway
Lang Avenue - Residential 1	Medium	W	Low	Medium	Moderately Effective Pathway
Lang Avenue - Residential 2	Medium	W	Low	Medium	Moderately Effective Pathway

Receptor Name	Distance Risk	Direction From Installation	Wind Direction Frequency	Source Dispersion Risk	Pathway Effectiveness
Lang Avenue - Residential 3	Low	SW	Low	Medium	Ineffective Pathway
Lang Crescent	Low	SW	Low	Medium	Ineffective Pathway
Meadow View	Low	W	Low	Medium	Ineffective Pathway
Wike Road	Low	W	Low	Medium	Ineffective Pathway
Priory Road	Low	NW	Low	Medium	Ineffective Pathway
Abbots Road - Residential 2	Low	NW	Low	Medium	Ineffective Pathway
Scarfield Close	Low	S	Medium	Medium	Ineffective Pathway
Penrhyn Walk	Low	S	Medium	Medium	Ineffective Pathway
Watering Lane - Cottage/Residential	Low	SE	High	Medium	Ineffective Pathway
Sunny Bank - Farm	Medium	E	High	Medium	Highly Effective Pathway
Carrs Lane - Farm	Low	NE	High	Medium	Ineffective Pathway

7.0 ASSESSMENT RESULTS

The results of the qualitative odour risk assessment are summarised in Table 13 and based on section 5,4.

Table 13: Qualitative Odour Risk Assessment Results

Receptor	Source Odour Potential	Pathway Effectiveness	Odour Exposure	Receptor Sensitivity	Likely Odour Effect
Lund Lane - Industrial 1	Medium	Highly Effective Pathway	Medium Risk	Low	Negligible Effect
Lund Lane - Residential 1	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Lund Lane - Residential 2	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Lund Lane - Residential 3	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Lund Lane - Residential 4	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Lund Lane - Residential 5	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Loxley Road	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Lund Crescent	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Abbots Road - Residential 1	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect

Receptor	Source Odour Potential	Pathway Effectiveness	Odour Exposure	Receptor Sensitivity	Likely Odour Effect
Lang Avenue - Residential 1	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Lang Avenue - Residential 2	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
Lang Avenue - Residential 3	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Lang Crescent	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Meadow View	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Wike Road	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Priory Road	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Abbots Road - Residential 2	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Scarfield Close	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Penrhyn Walk	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Watering Lane - Cottage/Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
Sunny Bank - Farm	Medium	Highly Effective Pathway	Medium Risk	Low	Negligible Effect
Carrs Lane - Farm	Medium	Ineffective Pathway	Negligible Risk	Low	Negligible Effect

8.0 SUMMARY

A qualitative odour risk assessment has been undertaken for Lundwood STF considering eleven process activities across the STF and potential odour effect on twenty-two receptors. The assessment has been based on a Source-Pathway-Receptor approach and is primarily based upon professional judgement.

As the sludge assets are within the same area of the Lundwood site, the assessment has considered all sources as a combined single area. Consideration has been given to existing site operation for odour mitigation and source dispersion, and combined with receptor location and meteorological conditions, a pathway effectiveness has been determined for each sensitive receptor. This has allowed, with the use of risk matrices, a receptor specific likely odour effect to be determined.

The qualitative odour risk assessment for Lundwood STF has indicated that all considered sensitive receptors are exposed to either a negligible or slight adverse odour effect indicating no receptor is exposed to a moderately adverse odour effect or worse.

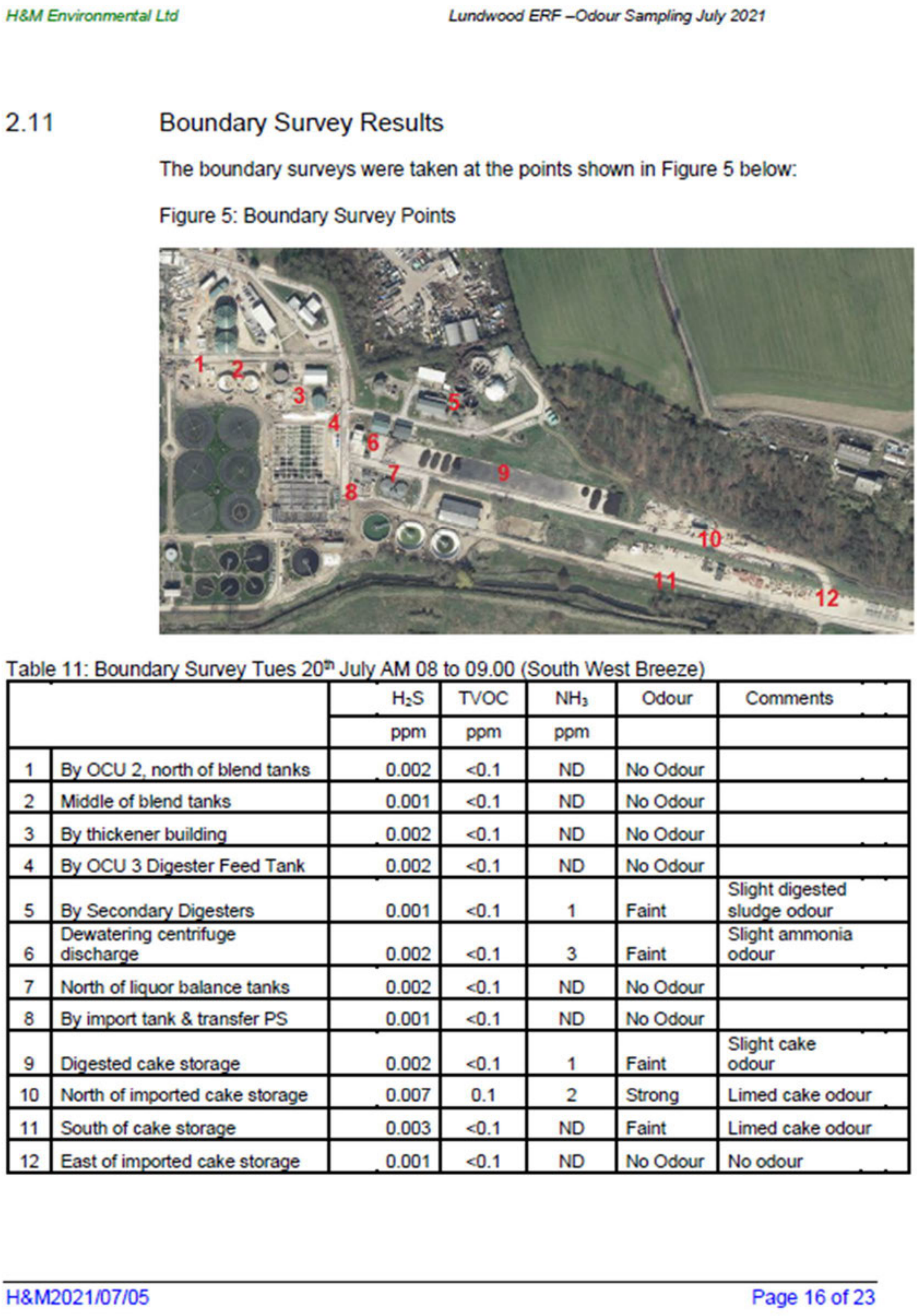
The YW complaints log recorded only five complaints over the last five years for the site as a whole (i.e. the YW Lundwood WwTW and STF). The odour complaints are reported to be from receptors located to the north and west of the site. The inconsistent and infrequent nature of these complaints coupled with irregularity of timing throughout the year, suggests the complaints are likely to be attributed to ad hoc events and are not associated with “normal” operation of the site.

Of the considered BAT Conclusions associated with emissions to air, specifically 14d and 34, a number of sources have been identified as not complying with certain BAT conclusions. The OCU (biotrickling and carbon OCU) has been assessed to be achieving the stack outlet odour concentration of 1,000 ou_E/m^3.

Some of the processes are open to atmosphere, such as the digested sludge balance tanks and the cake pad. Whilst these processes do not utilise the techniques specifically described in the BAT conclusions; the assessment has not identified a significant risk of odour impact at surrounding receptors from the works. This is supported by the infrequent nature of odour complaints and no “strong” or “unpleasant” odours associated with the uncovered processes detectable at the STF operational area during the odour survey sniff testing. It is considered that although these processes do not adopt the specified measures in BAT 14d, they do not have an odour impact on surrounding receptors to the level to warrant odour mitigation; as such the alternatives measures in place are adequate.

For the overall site, it is considered that Lundwood STF does not have an adverse odour effect on its surrounding receptors. As such, no additional odour mitigation is required above the existing measures already observed on site.

8.1 APPENDIX A – STF AREA SURVEY



2.11 Boundary Survey Results

The boundary surveys were taken at the points shown in Figure 5 below:

Figure 5: Boundary Survey Points

Table 11: Boundary Survey Tues 20th July AM 08 to 09.00 (South West Breeze)

		H_2S	TVOC	NH_3	Odour	Comments
		ppm	ppm	ppm		
1	By OCU 2, north of blend tanks	0.002	<0.1	ND	No Odour	
2	Middle of blend tanks	0.001	<0.1	ND	No Odour	
3	By thickener building	0.002	<0.1	ND	No Odour	
4	By OCU 3 Digester Feed Tank	0.002	<0.1	ND	No Odour	
5	By Secondary Digesters	0.001	<0.1	1	Faint	Slight digested sludge odour
6	Dewatering centrifuge discharge	0.002	<0.1	3	Faint	Slight ammonia odour
7	North of liquor balance tanks	0.002	<0.1	ND	No Odour	
8	By import tank & transfer PS	0.001	<0.1	ND	No Odour	
9	Digested cake storage	0.002	<0.1	1	Faint	Slight cake odour
10	North of imported cake storage	0.007	0.1	2	Strong	Limed cake odour
11	South of cake storage	0.003	<0.1	ND	Faint	Limed cake odour
12	East of imported cake storage	0.001	<0.1	ND	No Odour	No odour

Table 12: Boundary Survey Tues 20th July PM 13.00 to 14.00 (South West Breeze)

		H_2S	TVOC	NH_3	Odour	Comments
		ppm	ppm	ppm		
1	By OCU 2, north of blend tanks	0.003	<0.1	ND	No Odour	
2	Middle of blend tanks	0.002	<0.1	ND	No Odour	
3	By thickener building	0.002	<0.1	ND	No Odour	
4	By OCU 3 Digester Feed Tank	0.002	<0.1	ND	No Odour	
5	By Secondary Digesters	0.002	<0.1	1	Faint	Slight digested sludge odour
6	Dewatering centrifuge discharge	0.002	<0.1	2	Faint	Slight ammonia odour
7	North of liquor balance tanks	0.002	<0.1	ND	No Odour	
8	By import tank & transfer PS	0.001	<0.1	ND	No Odour	
9	Digested cake storage	0.002	<0.1	0.5	Faint	Slight cake odour
10	North of imported cake storage	0.008	0.1	2	Strong	Limed cake odour
11	South of cake storage	0.003	<0.1	ND	Faint	Limed cake odour
12	East of imported cake storage	0.001	<0.1	1	Faint	Limed cake odour

Table 13: Boundary Survey Weds 21st July AM 07.45 to 08.45 (Slight south West Breeze)

		H_2S	TVOC	NH_3	Odour	Comments
		ppm	ppm	ppm		
1	By OCU 2, north of blend tanks	0.002	<0.1	ND	No Odour	
2	Middle of blend tanks	0.001	<0.1	ND	No Odour	
3	By thickener building	0.002	<0.1	ND	No Odour	
4	By OCU 3 Digester Feed Tank	0.002	<0.1	ND	No Odour	
5	By Secondary Digesters	0.001	<0.1	1	Faint	Slight digested sludge odour
6	Dewatering centrifuge discharge	0.002	<0.1	4	Faint	Slight ammonia odour
7	North of liquor balance tanks	0.002	<0.1	ND	No Odour	
8	By import tank & transfer PS	0.001	<0.1	ND	No Odour	
9	Digested cake storage	0.002	<0.1	1	Faint	Slight cake odour
10	North of imported cake storage	0.009	0.1	3	Strong	Limed cake odour
11	South of cake storage	0.003	<0.1	ND	Faint	Limed cake odour
12	East of imported cake storage	0.001	<0.1	1	Faint	Limed cake odour

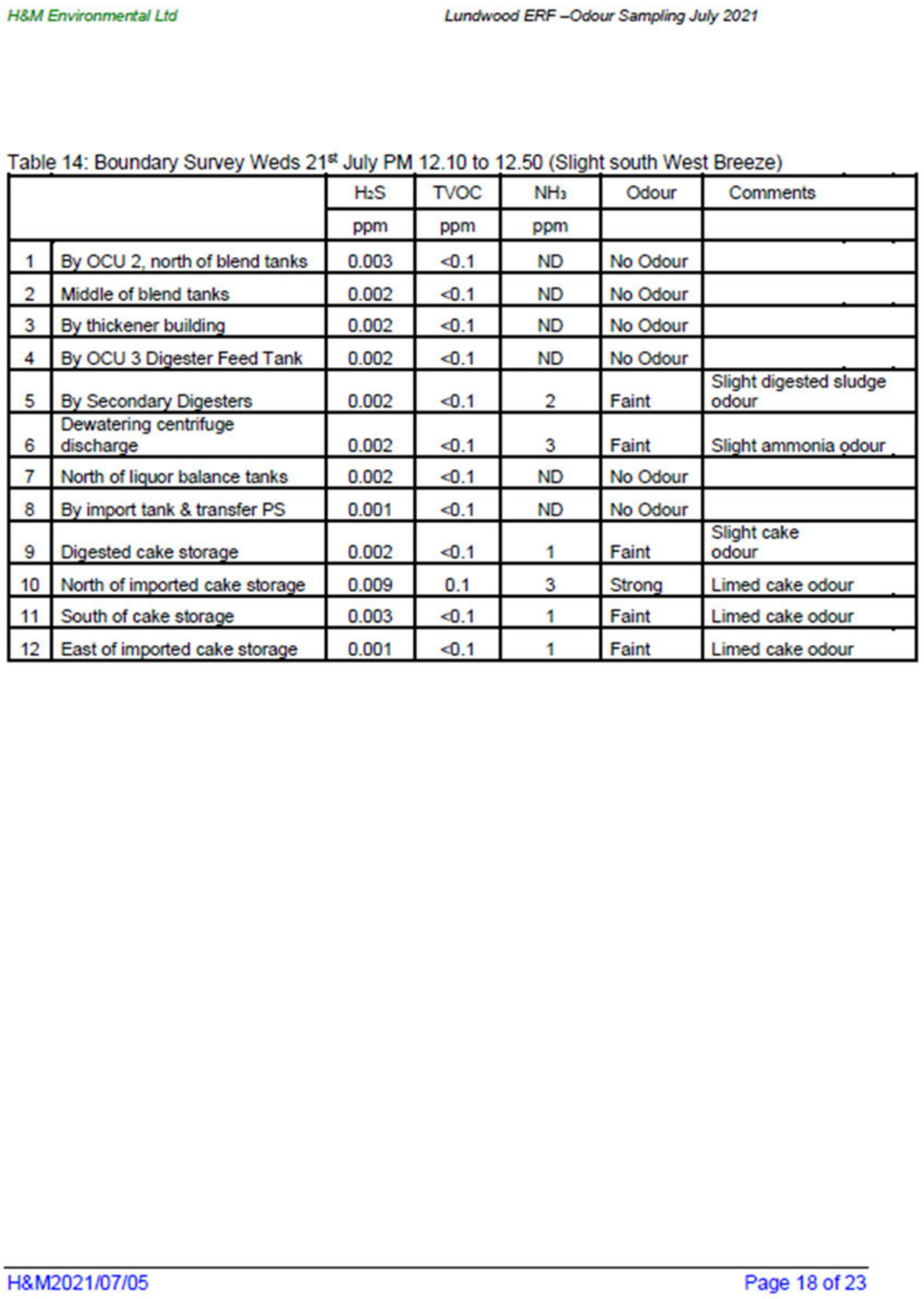


Table 14: Boundary Survey Weds 21st July PM 12.10 to 12.50 (Slight south West Breeze)

		H_2S	TVOC	NH_3	Odour	Comments
		ppm	ppm	ppm		
1	By OCU 2, north of blend tanks	0.003	<0.1	ND	No Odour	
2	Middle of blend tanks	0.002	<0.1	ND	No Odour	
3	By thickener building	0.002	<0.1	ND	No Odour	
4	By OCU 3 Digester Feed Tank	0.002	<0.1	ND	No Odour	
5	By Secondary Digesters	0.002	<0.1	2	Faint	Slight digested sludge odour
6	Dewatering centrifuge discharge	0.002	<0.1	3	Faint	Slight ammonia odour
7	North of liquor balance tanks	0.002	<0.1	ND	No Odour	
8	By import tank & transfer PS	0.001	<0.1	ND	No Odour	
9	Digested cake storage	0.002	<0.1	1	Faint	Slight cake odour
10	North of imported cake storage	0.009	0.1	3	Strong	Limed cake odour
11	South of cake storage	0.003	<0.1	1	Faint	Limed cake odour
12	East of imported cake storage	0.001	<0.1	1	Faint	Limed cake odour

8.2 APPENDIX B – DETAILED ASSESSMENT

Table 14: Likely magnitude of odour effect at the specific receptor location

Source	Odour Offensiveness	Mitigation/Control	Source Odour Potential
Sludge import tank	High risk - Import sludge	Medium risk - covered without extraction process	High
2 No. Huber screens	High risk - Import sludge	Medium risk - covered without extraction process	Medium
Screening skip	Medium risk - Screenings	High risk - open to atmosphere	Medium
2 No. Thickener feed tanks	High risk - Indigenous sludge, Imported sludge	Low risk - covered and extracted processes	Low
4 No. Drum thickeners	High risk - Indigenous sludge, Imported sludge	Low risk - covered and extracted processes	Low
Thickener liquor wet well	High risk - Indigenous sludge, Imported sludge liquors	High risk - open to atmosphere	High
Digester feed tank	High risk - Indigenous sludge, Imported sludge	Medium risk - covered without extraction process	Medium
2 No. Digested sludge balance tanks	Medium risk - Digested sludges	High risk - open to atmosphere	Medium
Dewatering Centrifuge	Medium risk - Digested sludges	Medium risk - covered without extraction process	Medium
2 No. Liquor balance tanks	Medium risk - Digested sludges	Low risk - covered and extracted processes	Low
Cake pad	Medium risk - Digested sludges	High risk - open to atmosphere	Medium

Table 15 Pathway Effectiveness Assessment

Receptor Name	Distance from Site (m)	Distance Risk	Direction From Installation	Wind Direction Frequency	Source Dispersion Risk	Pathway Effectiveness	Notes
Lund Lane - Industrial 1	15	High	N	12.0%	Medium	Highly Effective Pathway	Highly Effective due to distance and wind direction frequency risk.
Lund Lane - Residential 1	107	Medium	N	12.0%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk
Lund Lane - Residential 2	103	Medium	N	12.0%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk
Lund Lane - Residential 3	159	Medium	N	12.0%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk
Lund Lane - Residential 4	182	Medium	NW	4.5%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk

Receptor Name	Distance from Site (m)	Distance Risk	Direction From Installation	Wind Direction Frequency	Source Dispersion Risk	Pathway Effectiveness	Notes
Lund Lane - Residential 5	276	Medium	NW	4.5%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk
Loxley Road	208	Medium	N	12.0%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk
Lund Crescent	226	Medium	NW	4.5%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk
Abbots Road - Residential 1	332	Low	NW	4.5%	Medium	Ineffective Pathway	Ineffective due to low distance and wind direction frequency risk
Lang Avenue - Residential 1	253	Medium	W	4.4%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk
Lang Avenue - Residential 2	264	Medium	W	4.4%	Medium	Moderately Effective Pathway	Moderately effective pathway due to distance and source dispersion risk

Receptor Name	Distance from Site (m)	Distance Risk	Direction From Installation	Wind Direction Frequency	Source Dispersion Risk	Pathway Effectiveness	Notes
Lang Avenue - Residential 3	449	Low	SW	3.8%	Medium	Ineffective Pathway	Ineffective due to low distance and wind direction frequency risk
Lang Crescent	638	Low	SW	3.8%	Medium	Ineffective Pathway	Ineffective due to distance >500m from site
Meadow View	683	Low	W	4.4%	Medium	Ineffective Pathway	Ineffective due to distance >500m from site
Wike Road	420	Low	W	4.4%	Medium	Ineffective Pathway	Ineffective due to low distance and wind direction frequency risk
Priory Road	612	Low	NW	4.5%	Medium	Ineffective Pathway	Ineffective due to distance >500m from site

Receptor Name	Distance from Site (m)	Distance Risk	Direction From Installation	Wind Direction Frequency	Source Dispersion Risk	Pathway Effectiveness	Notes
Abbots Road - Residential 2	599	Low	NW	4.5%	Medium	Ineffective Pathway	Ineffective due to distance >500m from site
Scarfield Close	959	Low	S	9.8%	Medium	Ineffective Pathway	Ineffective due to distance >500m from site
Penrhyn Walk	1070	Low	S	9.8%	Medium	Ineffective Pathway	Ineffective due to distance >500m from site
Watering Lane - Cottage/Residential	1369	Low	SE	18.8%	Medium	Ineffective Pathway	Ineffective due to distance >500m from site
Sunny Bank - Farm	91	Medium	E	32.0%	High	Highly Effective Pathway	Highly Effective due to distance and wind direction frequency risk.
Carrs Lane - Farm	729	Low	NE	14.6%	High	Ineffective Pathway	Ineffective due to distance >500m from site

Appendix 9 Noise Impact Assessment

TECHNICAL NOTE

Job Name: Yorkshire Water Environmental Permitting, Lundwood

Job No: 331001762 (doc ref no. 331001762-100.2401-8)

Note No: 100.1501/ACO01

Date: November 2021

Prepared By: Janec Lillis-James

Subject: **Lundwood – Noise and Vibration Risk Assessment**

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1. Introduction

1.1. Stantec (UK) has been commissioned by Yorkshire Water (YW) to undertake a noise and vibration risk assessment to support a permit application for the Lundwood Sludge Treatment Facility (STF).

1.2. This application is being made due to changes to the Environment Agency (EA) interpretation of the environmental permitting exclusion for Urban Wastewater Activities. The EA interpretation now requires that anaerobic digestion (AD) plants treating over 100 tonnes/day (t/d) are classified as installations for the purposes of EPR.

1.3. The Yorkshire Water (YW) Lundwood Sludge Treatment Facility (STF), part of the wider Lundwood Wastewater Treatment Works (WwTW), exceeds the 100t/d throughput limit and therefore it has been agreed that a new permit application is required in respect of the AD activities currently operated on site (Schedule 5.4 Part A(1)(b)(i)).

1.4. The site has been operating until now within the scope of a registered T21 permit exemption (reference: WEX259926) and Regulatory Position Statement (RPS) 109 in respect of Combined Heat and Power (CHP) operations burning biogas.

1.5. This technical note summarises the results of our review of the activities associated with the STF having regard to statutory guidance relating to noise and vibration.

2. EA Permitting Requirements – Noise

2.1. The Environment Agency requires that operators (or permit applicants) must consider the potential noise impact of their site. They may need to carry out noise impact assessments:

- at the permit application stage
- when applying to vary a permit
- to comply with specific permit conditions

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2.2. The environment agencies will treat noise in the same way as any other polluting emission. If noise is audible at any of the following types of locations, they will regard it as 'possibly causing an impact':

- residential properties
- schools
- hospitals
- offices
- public recreation areas
- other noise sensitive receptors (NSRs)
- noise sensitive habitats

2.3. Where noise is possibly causing an impact, the operator must carry out an assessment to determine:

- the level of impact
- how much work needs to be done to prevent or minimise noise pollution

2.4. Operators must prevent significant pollution and also comply with the requirements to use 'appropriate measures' (Waste Framework Directive 2018/851) or 'best available techniques' (BAT) to prevent or minimise noise pollution.

2.5. Guidance on the noise assessment process for permit applications is detailed in Noise and vibration management: environmental permits.[1]

Guidance on Risk Assessments

2.6. Risk assessments for permitting purposes should be undertaken in accordance with the Guidance on the preparation of risk assessments[2].

Requirements for Quantitative Noise Impact Assessments

2.7. The information requirements of the EA with regards to what must be submitted if an assessment uses computer modelling or spreadsheet calculations are detailed in guidance 'Noise impact assessments involving calculations or modelling'[3]. This requirement is not applicable in this instance as a qualitative review methodology has been selected.

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[1] https://www.gov.uk/government/publications/noise-and-vibration-management-environmental-permits/noise-and-vibration-management-environmental-permits

[2] https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit

[3] https://www.gov.uk/guidance/noise-impact-assessments-involving-calculations-or-modelling

Basic Pre-Application Advice Note (v1)

2.8. A basic pre-application advice note[4] relating to Industrial Emission Directive (IED) permits for water and sewage companies has been provided by the Environment Agency.

2.9. With respect to noise, the note states that if the risk assessment indicates the operation is likely to cause noise or vibration beyond the site boundary then a noise impact assessment based on BS4142:2014+A1:2019 should be provided.

2.10. The assessment should be accompanied by a noise and vibration management plan informed by the results of the assessment.

3. Best Applicable Techniques (BAT)

3.1. Information on BAT is detailed in the 'Commission Implementing Decision (EU) 2018/1147 of 10 August 2018'[5]. With respect to noise, section 1.4 states:

> ***BAT 17***. *In order to prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to set up, implement and regularly review a noise and vibration management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:*
>
> *1. A protocol containing appropriate actions and timelines;*
>
> *2. A protocol for conducting noise and vibration monitoring;*
>
> *3. A protocol for response to identified noise and vibration events, e.g. complaints;*
>
> *4. A noise and vibration reduction programme designed to identify the source(s), to measure/estimate noise and vibration exposure, to characterise the contributions of the sources and to implement prevention and/or reduction measures.*
>
> *Applicability*
>
> *The applicability is restricted to cases where a noise or vibration nuisance at sensitive receptors is expected and/or has been substantiated*

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[4] Water and sewage companies IED permits: Basic pre-application advice – supporting information (v1, March 2021)

[5] https://www.legislation.gov.uk/eudn/2018/1147

BAT 18. *In order to prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to use one or a combination of the techniques given below.*

Technique		***Description***	***Applicability***
a.	*Appropriate location of equipment and buildings*	*Noise levels can be reduced by increasing the distance between the emitter and the receiver, by using buildings as noise screens and by relocating building exits or entrances.*	*For existing plans, the relocation of equipment and building exits or entrances may be restricted by a lack of space or excessive costs.*
b.	*Operational measures*	*This includes techniques such as:* *(i) inspection and maintenance of equipment;* *(ii) closing of doors and windows of enclosed areas, if possible;* *(iii) equipment operation by experienced staff;* *(iv) avoidance of noisy activities at night, if possible;* *(v) provisions for noise control during maintenance, traffic, handling and treatment activities.*	*Generally applicable.*
c.	*Low-noise equipment*	*This may include direct drive motors, compressors, pumps and flares.*	
d.	*Noise and vibration control equipment*	*This includes techniques such as:* *(i) noise reducers;* *(ii) acoustic and vibrational insulation of equipment;* *(iii) enclosure of noisy equipment;* *(iv) soundproofing of buildings.*	*Applicability may be restricted by a lack of space (for existing plants).*
e.	*Noise attenuation*	*Noise propagation can be reduced by inserting obstacles between emitters and receivers (e.g. protection walls, embankments and buildings).*	*Applicable only to existing plants, as the design of new plants should make this technique unnecessary. For existing plans, the insertion of obstacles may be restricted by a lack of space.* *For mechanical treatment in shredders of metal wastes, it is applicable within the constraints associated with the risk of deflagration in shredders.*

4. Project Proposals

4.1. Reference should be made to Section II of the full permit application for a technical description of the site activities covered by the permit variation application. A site layout and plan of the current STF assets is included as part of the application.

5. Noise and Vibration Risk Assessment

5.1. A preliminary noise risk assessment has been undertaken based on information provided by YW.

5.2. In considering the risks associated with the operations covered by the permit application, the following site-specific factors have been considered:

- The proximity and sensitivity of nearby receptors
- The existing environmental sound climate at the receptors
- The operational characteristics of the source
- The historical lack of noise complaints arising in respect of the operations carried out under the scope of the permit variation.

Noise and Vibration Sensitive Receptors

5.3. The sensitivity of a particular receptor depends on a variety of factors, but the following table provides examples of the types of receptors likely to be considered either high, medium or low sensitivity.

Table 1: Summary of Receptor Sensitivity

Sensitivity to Noise and Vibration	Description	Example Receptor
High	Receptors where people or operations are particularly sensitive to noise or vibration	Residential, including private gardens Quiet outdoor areas used for recreation Theatres/Auditoria/Studios Schools and Nurseries during the daytime Hospitals/residential care homes Places of worship
Medium	Receptors where noise or vibration may cause some distraction or disturbance	Offices Retail areas and other commercial developments Bars/Cafes/Restaurants where external noise may be intrusive Sports ground where quiet conditions are necessary (e.g. tennis, golf, bowls)
Low	Receptors where distraction or disturbance from noise and vibration is minimal	Industrial areas Sports ground with no specific requirement for quiet conditions Night clubs

5.4. For the purposes of this assessment, noise and vibration sensitive receptors are considered to be any existing occupied premises within 300m of the site which may be adversely affected by noise or vibration and has a high sensitivity. Due to shielding by other dwellings and buildings, receptors beyond this distance are less likely to be affected and by assessing those closest to the site and confirming no impacts will imply no impacts for receptors further away.

5.5. In this instance the following receptors have been identified. Where appropriate, receptors have been grouped where they are within the same area. Due to the large number of receptors within 300 m of the site, we have only identified those closest to the site boundary.

5.6. The identified noise sensitive receptors are presented in Table 2 and the location plan presented in Appendix A.

Table 2: Noise and Vibration Sensitive Receptors

Receptor Reference	Receptor Description	Receptor Type	Approximate Distance/Direction from Site Boundary (m)
A	75 – 77 Lund Lane	Residential	110 N
B	Dwellings along Lund Lane	Residential	190 N
C	Dwellings along Lang Avenue	Residential	230 W
D	Dwellings along Michael Road	Residential	290 W
E	Dwellings along Martin Road	Residential	290 W

5.7. Due to the nature of the sources present on site, the distance between the identified receptors and the site boundary, vibration from the operations at the site is unlikely to have an impact and is considered to be low risk. Vibration is therefore not considered further.

Existing Environmental Sound Climate

5.8. The site lies in a predominantly suburban area approximately 3 km to the east of Barnsley.

5.9. The site lies close to a number of sources of noise including the A628 and the A633 to the west. Strategic noise mapping data provided by Defra[6] does not cover this area, and there are no planning applications in the immediate vicinity which include environmental sound survey data.

5.10. In the absence of detailed environmental sound surveys, the existing environmental sound climate is assumed to be low.

Operational Characteristics

5.11. The sources of noise associated with the permit include:

- The movement of vehicles (tankers) to and from the sludge import area.
- The operation of plant items including the CHP engine, induced draft fans associated with odour extraction, rotating screens, compressors, waste gas burner and air-cooled radiators.

5.12. Typically, the main sources of noise would be the operation of the CHP (engine and exhaust), air-cooled radiators, centrifuge/thickening processes, sludge pumping/screening processes and the waste gas burner.

5.13. All of the activities described within the permit variation application are existing and will continue to operate in the same manner as their established use (e.g. hours of operation and load). There are no changes to activities or additional plant or equipment included as part of the permit variation.

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[6] https://www.gov.uk/government/publications/strategic-noise-mapping-2019

Risk Matrix

5.14. Based on the Preliminary Noise Risk Assessment set out in Section 5, Table 3 details a risk matrix setting out overall risk levels associated with the STF operations with regards to noise.

5.15. The combined assessment of the proposals in noise and vibration terms is that the probability of exposure is unlikely and the consequence is minor/negligible, with the overall risk level being low.

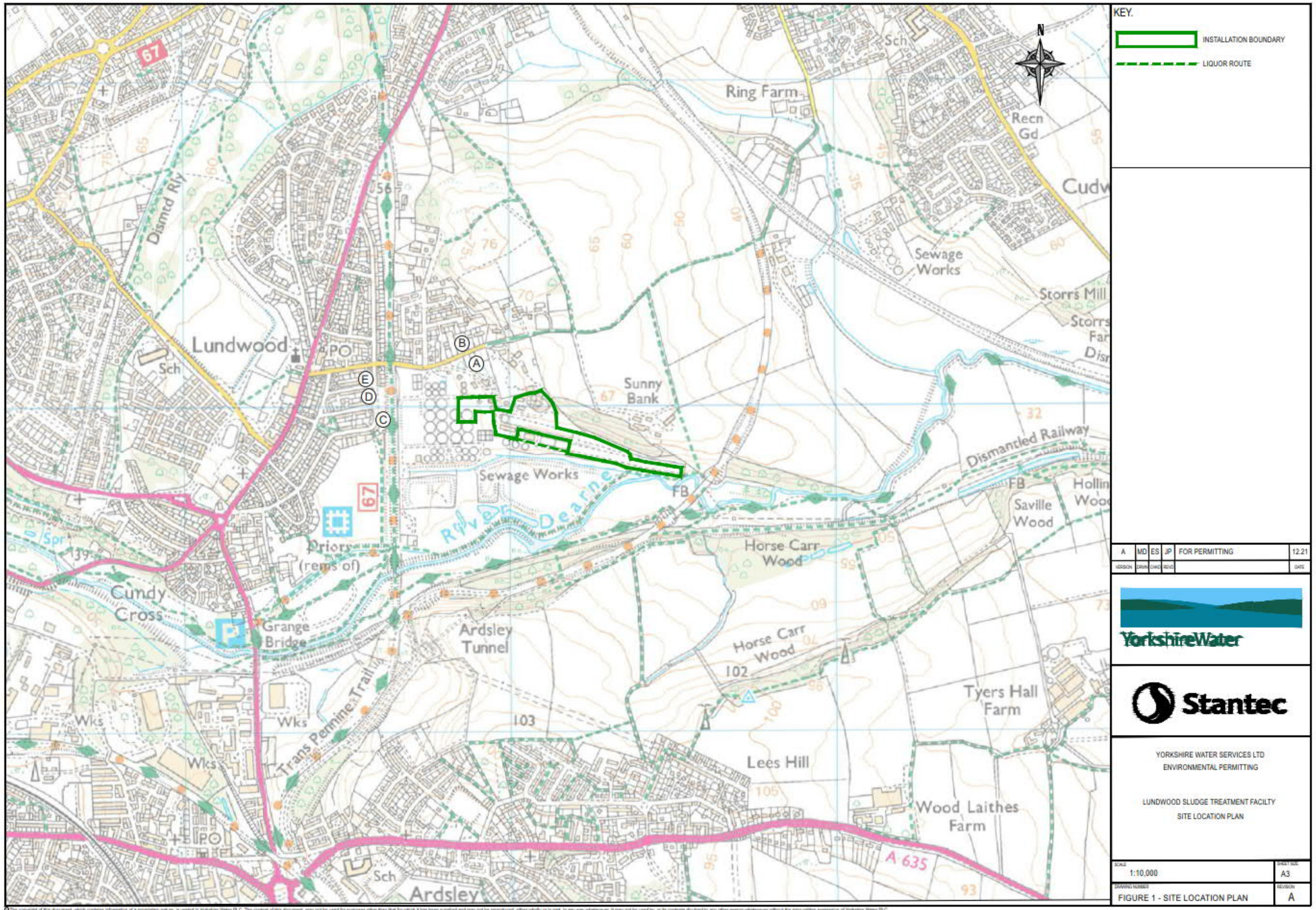
5.16. As there have been no noise complaints associated with STF, and there are no significant changes proposed to the existing installation, BAT 17 as defined in 'Commission Implementing Decision (EU) 2018/1147 of 10 August 2018', i.e. the requirement to set up, implement and regularly review a noise and vibration management plan, is not considered to be applicable.

5.17. On the basis of the qualitative risk assessment carried out above and reported in Table 3, and in light of the operating history of the plant, no further controls are considered necessary in respect of the permitted operations. Site management practices included within YW's Environmental Management Systems (EMS), which include provisions for noise control and plant maintenance, will continue to be applied.

5.18. With reference to the EA guidance on the assessment of noise and vibration, no specific permit Noise Management Plan is considered necessary at this time. In the event of material changes to the local noise environment, or location or sensitivity of nearby receptors, or should substantiated complaints arise, this position should be reviewed as part of normal site management reviews and controls.

Table 3: Risk Matrix

Hazard	Receptor	Pathway	Risk Management Techniques	Probability of Exposure	Consequence	Overall Risk
Noise: CHP	Residential	Airborne	Equipment is enclosed within dedicated housing and located within a building. This location on site would be partly shielded from receptors by higher land to the north and west of the building Good maintenance of plant to ensure that excessive noise levels are not generated, under Operations & Maintenance contract Regular checks of noise mitigation measures fitted to items of plant. Where repair or replacement is required, the plant will, where possible, be taken out of service until repair or replacement of parts has been undertaken.	Unlikely	Mild	Low
Noise: CHP Exhaust	Residential	Airborne	This location on site would be partly shielded from receptors by higher land to the north and west of the building Regular checks of noise mitigation measures fitted to items of plant. Where repair or replacement is required, the plant will, where possible, be taken out of service until repair or replacement of parts has been undertaken.	Unlikely	Mild	Low
Noise: Fans on air cooled radiators	Residential	Airborne	Fans subject to regular checks and maintenance. Plant is located such that surrounding structures partly shield potential receptors from the noise source. Good maintenance of plant to ensure that excessive noise levels are not generated from equipment breakdown or wear and tear (e.g. fan motor bearing failure), under Operations & Maintenance contract.	Unlikely	Mild	Low
Noise: Waste Gas Burner	Residential	Airborne	Waste gas burner operates only when there is excess biogas. Good maintenance of plant to ensure that excessive noise levels are not generated from equipment breakdown or wear and tear (e.g. fan motor bearing failure), under Operations & Maintenance contract.	Unlikely	Mild	Low
Noise: Vehicular movements around site	Residential	Airborne	Deliveries would take place during the daytime hours only when background sound levels are higher.	Unlikely	Mild	Low
Noise: Sludge Delivery / Pumping / screening	Residential	Airborne	Sludge import area is located such that site structures / topography provide some degree of shielding to potential receptors Deliveries would take place during the daytime hours only when background sound levels are higher.	Unlikely	Mild	Low
Noise: Centrifuge / thickening process	Residential	Airborne	Centrifuge and Thickener plant are located inside dedicated buildings. Good maintenance of plant to ensure that excessive noise levels are not generated from equipment breakdown or wear and tear under Operations & Maintenance contract.	Unlikely	Mild	Low


KEY.
INSTALLATION BOUNDARY
LIQUOR ROUTE
N
Lundwood
Ring Farm
Sewage Works
Sunny Bank
River Dearne
Dismantled Railway
Priory (rems of)
Cundy Cross
Grange Bridge
Ardsley Tunnel
Horse Carr Wood
Saville Wood
Storrs Mill
Tyers Hall Farm
Lees Hill
Wood Laithes Farm
Trans Pennine Trail
Ardsley
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VERSION | DRWN | CHKD | REVD | DATE
YorkshireWater
Stantec
YORKSHIRE WATER SERVICES LTD
ENVIRONMENTAL PERMITTING
LUNDWOOD SLUDGE TREATMENT FACILTY
SITE LOCATION PLAN
SCALE
1:10,000
SHEET SIZE
A3
DRAWING NUMBER
FIGURE 1 - SITE LOCATION PLAN
REVISION
A

Appendix 10 Odour Management Plan

Lundwood Sludge Treatment Facility Odour Management Plan

December 2023

Document Control

Document Control Ref:	Version 2
Document Location:	IMS > Level 3 Site Specific Manuals > Energy & recycling Assets > Lundwood > Sludge Treatment Facility
Document Custodian:	IMS Team
Review Period:	This OMP will be updated following completion of the abatement review as detailed in the proposed improvement programme. It will then be reviewed every year, and in the event of operational changes or persistent odour events or complaints.

Document Revision History

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1	Dec 2021	Antony Saunders (Stantec)	Ed Sutherland	Version 1
2	Dec 23	Antony Saunders (Stantec)	Hazel Morgan	Various additions made as detailed in the EA's Schedule 5

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Report reviewed by	
Report approved by	
Report by	Stantec Stantec House Kelburn Court Birchwood Warrington WA3 6UT

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Contents

1 Introduction

This Odour Management Plan (OMP) for Lundwood sludge treatment facility (STF) has been developed by Stantec on behalf of Yorkshire Water Services Ltd (YW). YW have developed this OMP as a live working document that forms part of the operational management system of the site. The OMP demonstrates how odours shall be managed and controlled to prevent odour impacts from activities during normal operation and also during abnormal events.

The OMP has been developed to meet the Environment Agency’s (EA) H4 Odour Management Guidance.

The OMP has been prepared in support of the permit variation for Lundwood STF.

These activities fall under Environmental Permit reference VP3392ZB.

The OMP provides sufficient detail to allow operators and maintenance staff to understand clearly the operational procedures for both normal and abnormal conditions. It is intended to be used as a reference document by operational staff on a day-to-day basis. The OMP includes the following:

- A description of the site and catchment, including sources of odour on the site, and location of sensitive receptors;
- A brief history of received complaints and measures taken to date;
- YW Operation and Management (O and M) procedures for the site, including good housekeeping measures to minimise odour generation and release;
- The mitigation procedures which should be implemented when foreseeable situations that may compromise the ability to prevent and minimise odorous releases occur. These can include both breakdowns and external conditions such as extreme weather;
- An Action Procedure for complaints;
- An odour risk assessment identifying any odorous or potentially odorous areas of the works and immediate and longer-term actions required to eliminate odour complaints; and
- The management and operator training requirements and records with respect to odour.

1.1 Yorkshire Water Odour Management

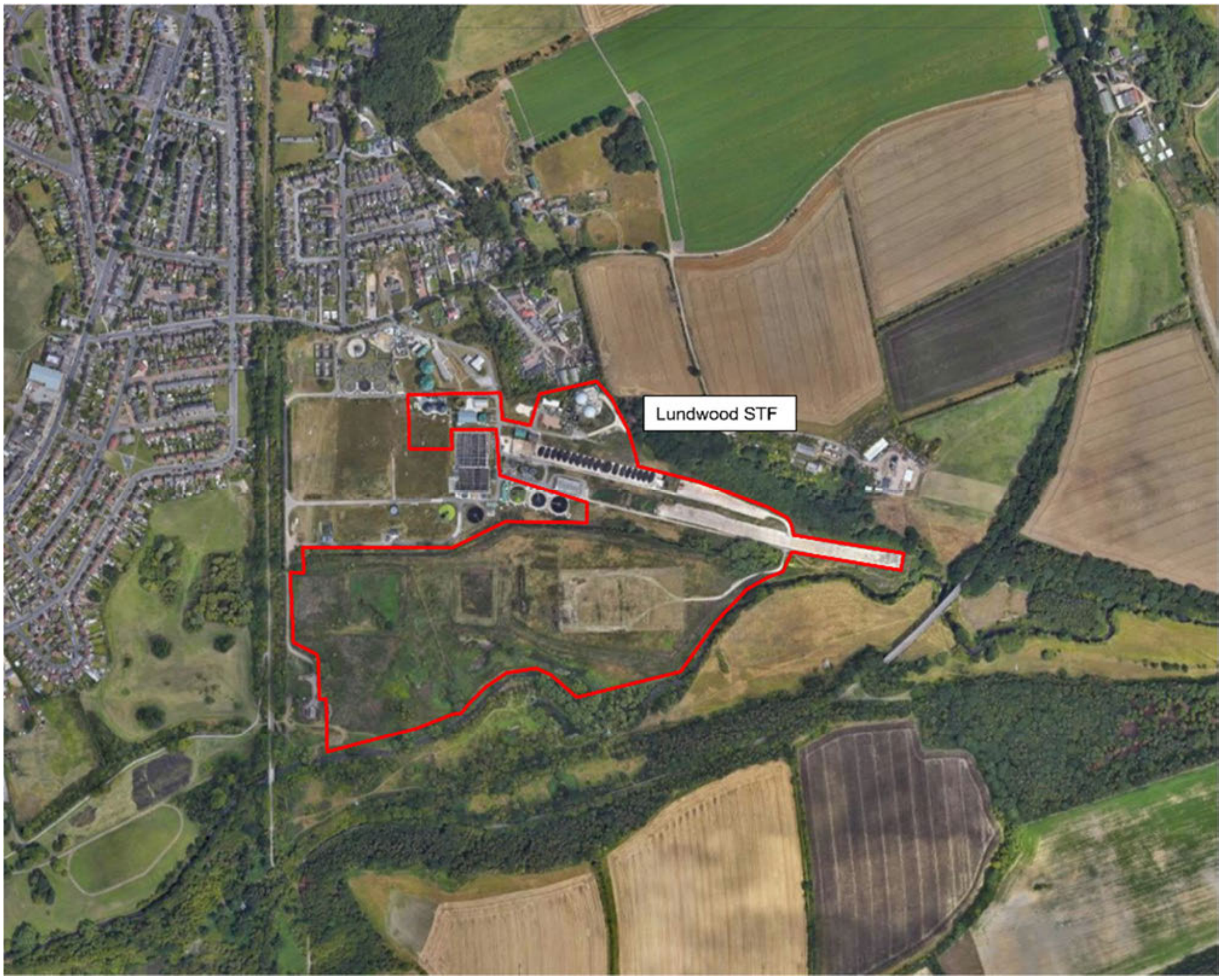
YW acknowledges that high levels of odour arising from wastewater and sludge treatment are not acceptable and that reasonable measures must be taken to minimise any inconvenience to the general public. YW does not operate under a single defined odour exposure standard. Each site is considered individually taking into account the relevant legislation and local authority’s conditions. Site specific factors such as site history with regard to odour complaints, potential future encroachment by residential or business developments, and the presence of particularly odour sensitive receptors within the vicinity of the works / facility are also taken into consideration.

2 Site Information

2.1 Site Location

Lundwood STF is located adjacent to Lundwood WwTW. The site is located to the east of Lundwood village and to the north of the River Dearne. This site is located approximately 3.5 km east of Barnsley. The site is bordered grassland and farmland to the east and south, and residential and industrial areas to the north and west. The works location is highlighted in Figure 1.

Figure 1 Lundwood STF Site Location



2.2 Site Receptors

Lundwood STF is located adjacent to Lundwood WwTW. The site is bordered to the north and west by industrial and residential areas. Towards the east and south are open grassland and farms with residential and industrial receptors beyond this initial boundary area.

The YW Lundwood site (which includes both the STF and the WwTW) has received 5 odour complaints in the last 5 years. The complaints are of an infrequent nature and relate to the site as a whole; it is not known whether these complaints are attributed to the STF or to the WwTW operations.

A summary of the areas of interest and receptors local to the site are highlighted in Figures 2-4, complete with receptor description and sensitivity in Table 1.

Figure 2 Location of Sensitive Receptors (Residential)

Figure 3 Location of Sensitive Receptors (Commercial / Industrial)

Figure 4 Location of Sensitive Receptors (Education / Leisure)

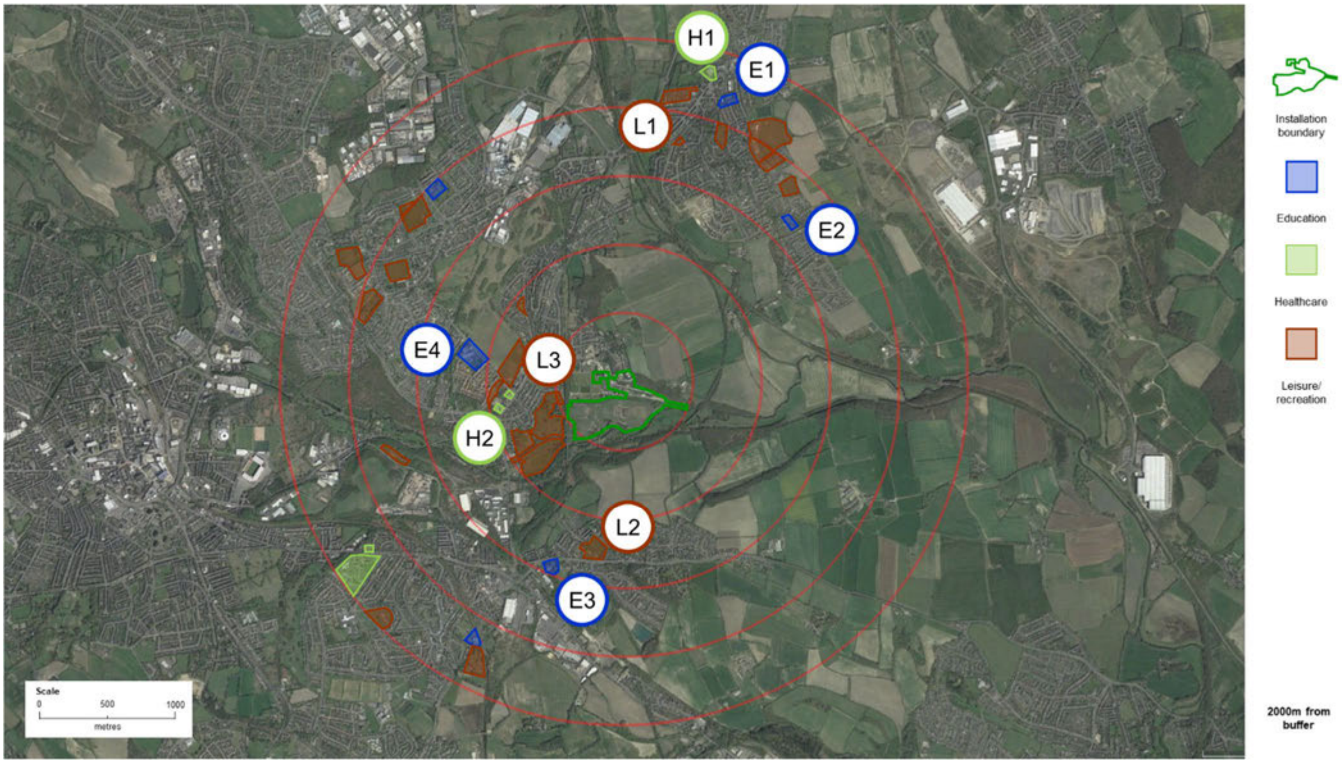


Table 1 Lundwood Receptor sensitivities

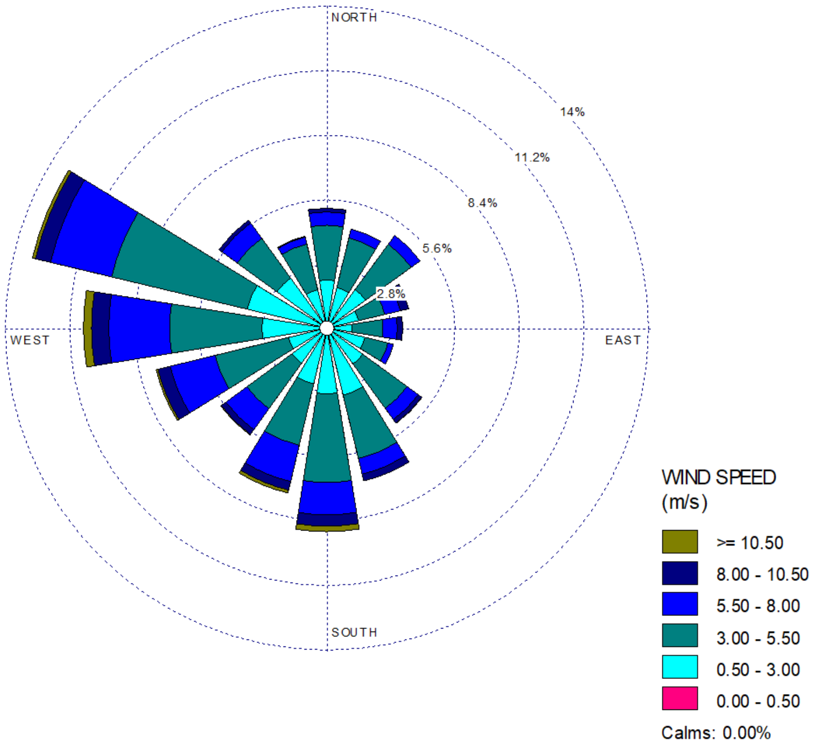
Receptor Name	Receptor Map Reference	Distance from STF operational area (m)	Receptor Type	Receptor Sensitivity
Residential properties to north	R1	100	Residential	High
Residential properties to east	R2	1,420	Residential	High
Residential properties to south	R3	800	Residential	High
Residential properties to west	R4	210	Residential	High
Commercial businesses to north	C1	1,760	Commercial	Medium
Commercial businesses to south	C2	1,150	Commercial	Medium
Commercial businesses to west	C3	415	Commercial	Medium
Industry to north	I1	0	Industrial	Low
Industry to east	I2	1,220	Industrial	Low
Industry to south	I3	910	Industrial	Low
Industry to west	I4	340	Industrial	Low
Schools to the north	E1	2,040	Education	High
Schools to the east	E2	1,450	Education	High
Schools to the south	E3	1,310	Education	High
Schools to the west	E4	800	Education	High
Leisure/recreation to the north	L1	1,800	Leisure/recreation	Medium
Leisure/recreation to the south	L2	1,080	Leisure/recreation	Medium
Leisure/recreation to the west	L3	250	Leisure/recreation	Medium
Healthcare to the north	H1	2,220	Healthcare	Medium
Healthcare to the west	H2	580	Healthcare	Medium

2.3 Meteorological Conditions

In the UK, the prevailing wind directions are commonly from the west and south-west. The wind direction and speed will impact the dispersion of odour emissions from site. There is currently no wind station on site to measure meteorological conditions.

As there are no representative meteorological stations for Lundwood STF, numerical weather predicted (NWP) meteorological data for Lundwood STF has been used to predict the wind direction frequency for Lundwood STF. NWP meteorological data has been adopted for this assessment due to the complexity of the topography on site and is likely to give more accurate wind directions and frequencies. The wind rose plot for Lundwood STF is included in Figure 5.

Figure 5 Lundwood STF NWP Windrose Plot



2.4 Process Description

Lundwood STF treats the following sewage sludges:

- Indigenous primary sludges and surplus activated sludge (SAS) arising from sewage treatment processes operating within the wider Lundwood WwTW that are piped directly to the STF.
- Liquid sludges generated by other YW Wastewater Treatment Works (WwTW) (with lower capacity or capability for treating sludges on-site) that are imported to Lundwood STF for additional treatment.

Imported liquid sludge is delivered to site by tanker. The tanker unloads at the dedicated sludge import area and sludge is pumped (using vehicle mounted pumps) into the sludge screen feed tank (150 m^3 covered steel tank). The maximum load is typically 28 tonnes with unloading taking up to 30 minutes. Only appropriately authorised vehicles can discharge at the site. This is controlled using a ‘WaSP’ logger; valves on the discharge pipework will only open when a driver presents appropriate authentication to the system. The WaSP logger records the source of the sludge, the time and date of delivery, the total volume discharged and average percentage dry solids of the load.

There are waste acceptance procedures that deal with the trade waste that is being treated through the WwTW. Some traders may also be subject to trade effluent consents. With regard to the potential for septic sludge imports to be received into the STF, a pre-acceptance process is in place to ensure that it is only received at sites that are capable of processing it without impacting the process.

The sludge is then screened using two Huber ROTAMAT enclosed rotating screens. Screenings drop into a skip and are disposed of off-site.

After screening, imported liquid sludge is pumped via a sub-surface concrete sump, in pipework (largely underground) to the thickener feed tanks (2 no. 1,589 m^3 covered steel tanks). These tanks are air mixed and operate in fill / draw mode with tanks changing over every 24 hours. The tanks are covered with headspace air extracted and routed to a two-stage odour control unit (see below for further details of odour control).

Indigenous SAS and primary sludge from the wider Lundwood WwTW is piped directly to the thickener feed tanks and mixed with the imported screened liquid sludge prior to onward transfer to the drum thickener building.

Sludge from the thickener feed tanks is then transferred to the thickener building via above and below ground pipework serving two thickening process streams, which operate on a duty/standby basis. Each sludge stream comprises a dedicated thickener feed pump drawing blended sludge, a polymer dosing pump drawing made-up polymer, a flocculation tank and a pair of drum thickeners (thus there are four thickeners in total). Concentrated liquid polymer is diluted with potable water, then mixed with treated final effluent as a carrier and mixed with the sludge in the flocculation tank. Each flocculation tank feeds two drum thickeners at an equal rate. The polymer encourages separation of water and sludge as the sludge is rotated in the drum to remove excess liquid. The resulting liquor is transferred to a wet well located to the west of the thickener feed tanks and from there is pumped back to the WwTW for full treatment. Each sludge stream has been sized with sufficient capacity to process site daily throughput requirements over a 16 hour period i.e. there is adequate redundant capacity in the event of plant failure.

The drum thickeners are equipped with automatic spray bars which provide continual self-cleaning. In addition, an automatic hot wash system is run periodically in accordance with the planned maintenance regime. The hot wash is designed to break down any fats that would blind the drum filter material. The automatic spray bars operate using treated final effluent and the hot wash system utilises mains potable water.

The liquid polymer delivery point is located in the roadway outside the thickener building; liquid polymer is delivered in 1m^3 IBCs and pumped from these to a 10 m^3 bulk storage tank located within the thickener building. Located above the same concrete sump bund within the thickener building as the bulk storage tank is the 5 m^3 capacity polymer solution storage tank containing the diluted polymer solution.

The thickened sludge is transferred to the 712 m^3 digester feed tank. This tank is of concrete construction, mixed and covered. Sludge is passed forward continually from this tank to the anaerobic digesters (2 no. 2,056 m^3 concrete tanks). The digesters are located on steeply sloping ground and therefore are partly buried below ground on one side. The anaerobic digesters operate as a continuous process with sludge being added and treated sludge extracted. The two digesters have a typical feed rate of around 120 m^3/day combined; the combined maximum feed rate is 308m^3/day (at 6% dry solids) giving a 12-day retention time as required by Hazard Analysis and Critical Control Points (HACCP) controls. The digesters are mixed by gas mixing systems, which utilise biogas from the headspace of each digester; the gas is compressed and then reintroduced using an array of mixing nozzles on the floor of the digester.

A hot water circuit provides heating to ensure optimum conditions for digester microbial activity. Potable water is heated to around 70°C by the CHP and/or boiler. This hot water then heats the digester using tube-in-tube, counter-current heat exchangers. Sludge from the digesters is continually recirculated around the heat exchangers using 2 no. (duty/standby) recirculation pumps per digester. A 3-way modulating valve on the water side moderates the amount of hot water that passes into the heat exchanger, depending on the heat demand of the digesters.

Grit build up within digesters is a normal feature of operation; the digesters are cleaned out (including accumulated grit) every 10 years as part of the planned periodic inspection which also includes an internal and external inspection of tank integrity and replacement of instrumentation and gas mixing equipment as required.

An automatic anti-foam dosing system is in place to control digester foaming. This system uses a radar level probe in the digester headspace and compares this to the pressure level sensor at the bottom of the digester to determine the depth of foam. Upon detection of foam, treated final effluent is sprayed into the digester head space through nozzles in the digester roof. If this is not effective in breaking up the foam, a chemical anti-foam is mixed with treated final effluent and dosed into the headspace of the digester via the same spray nozzles. This system includes operator-adjustable dosing setpoints and failsafe systems; if the foam level continues to increase mixing systems are inhibited and if this continues the digester feed will be inhibited. Antifoam is stored in 20 litre plastic containers on a drip tray located within the digester compound prior to transfer to the integrally bunded antifoam dosing tank (approximate capacity of 0.5m^3).

Biogas generated by the digestion process is collected and stored within the digesters. Each of the digester tanks is equipped with a membrane gas holder (700 m^3 capacity each) located over the tank providing biogas storage continuous with the tank headspace. The gas holders allow capacity to store and balance the biogas produced from the digestion process. Each roof gas holder is kept inflated by duty/standby air blowers, blowing into the inter-membrane air space, in conjunction with a pressure sustaining valve. Biogas is withdrawn, conveyed by a pipeline through the tank wall, from the gas space of each tank. Pressure relief valves (PRVs) are fitted to each pipeline. The pipelines combine into a manifold which branches to the CHP/boiler and to the flare. Condensate removal pots are installed at low points in the gas pipelines. The collected condensate is drained to Lundwood WwTW for treatment.

Biogas is used as the sole fuel source for the site CHP. The CHP facility comprises a single reciprocating engine generator set with a thermal input of approximately 413 kW and generates electricity which is used to power essential site processes. Heat from the combustion process is used to maintain the required temperature in the anaerobic digesters, with any excess being discharged using air cooled radiators.

The CHP set is located within a building with engine combustion products discharged via a 3m high (approximately) stack located to the rear of the building.

A boiler is available for use as an alternative heat source for the digesters. The boiler can be fired by either biogas or fuel oil and has a thermal input of approximately 833 kW. This is located within the same building as the CHP (in an adjacent room) and combustion products are discharged via a 3.5m high (approximately) stack located to the rear of the building. In normal operations boiler use is limited as heat recovery from the CHP engine meets the digester heat demand.

Fuel oil used as back up supply for the boiler is stored within a 35,000 litre integrally bunded steel tank.

In periods where the CHP engines and boiler are unavailable or biogas generation exceeds combustion capacity, biogas is directed to the waste gas burner (575 m3/hr capacity). This burner, although a purpose-built closed flare system, is not capable of achieving a minimum of 1,000°C with 0.3 seconds retention time at this temperature. The flare facility is located at a safe distance from the digesters and other biogas handling and treatment activities. Flare stack operation is automated based on gas level within the biogas holder. If the gas level is high then the flare will operate, however utilisation of the gas is preferred over flaring.

Digested sludge is gravity fed from the digesters to the adjacent digested sludge balance tanks (2 no. concrete open topped tank with capacity of 880m^3). These tanks are periodically mixed to prevent settlement and anoxic conditions. Powdered polymer stored in 750kg bags is dispensed via a hopper dosing system which feeds a polymer ‘ageing’ tank where the powdered polymer is mixed with potable water and transferred to a stock tank (approximate capacities of 6m^3). The polymer solution is injected into the sludge stream and taken to the digested sludge dewatering centrifuge where the sludge coagulates and supernatant liquor is removed by centrifugal forces. Dewatering liquor is transferred to two liquor balancing tanks (covered steel tanks, each with a capacity of 250 m^3) prior to transfer to the WwTW for full treatment.

The final digested and dewatered sludge cake is transferred via a conveyer from the centrifuge up over a push-wall and onto the cake pad. The area under the conveyer and adjacent sludge cake pads are an engineered impermeable surface, with water runoff collected in drains running along the bottom edge of the pad. These liquids are pumped back to the WwTW for full treatment.

Once on the cake pad, sludge cake is moved by mechanical loaders into storage rows. There is no lime addition at Lundwood STF; instead, cake is stored in piles according to age and is left to mature for a minimum of six weeks in accordance with HACCP requirements. Approximately 3,000 tonnes sludge cake will normally be held on site at any one time. However, the maximum storage capacity of the cake pad is significantly greater than this, up to 12,750 tonnes; greater volumes may be stored on site in emergency/abnormal conditions such as following processing problems at other YW sites or in extreme weather conditions when landspreading operations are temporarily paused. Once maturation is complete, sludge cake is removed from site and landspread in accordance with legislative requirements. Samples of digested, matured cake are taken every 3 months, or whenever a Critical Control Point (CCP) (e.g. digestion retention time or temperature) is not within specification, and analysed for metals and pathogens to ensure HACCP standards are being met.

The cake pad may also be used to serve certain contingency functions, for both operations at Lundwood and to wider strategic regional sewage infrastructure operated by YW. The cake pad may, under exceptional circumstances (such as the failure of assets or non-availability of normal disposal routes on a temporary basis) be used for the interim storage of treated or untreated thickened or dewatered sludge on the cake pad, where that sludge originates from another YW site (or from Lundwood operations), before that material then undergoes AD treatment in the STF at Lundwood. It is recognised that such operations are abnormal and would require initiation of site contingency operating procedures, with the intention of minimising any potential short term adverse environmental effects and returning to normal operations as soon as practicable.

There is 1 no. odour control unit (OCU) present on site. The OCU is a two-stage biotrickling filter and activated carbon polishing OCU that extracts and treats odours from the following sources and discharges to atmosphere via a 15m tall stack:

- Thickener Feed Tanks
- Drum Thickeners

Air from the thickener building is extracted directly to the second stage of the OCU (the carbon polishing unit) where it is treated prior to discharge via the stack. The process flow diagram for the site is highlighted in Figure 6. The location of key site activities are shown in Figure 7.

Figure 6 Lundwood STF Process Flow Diagram

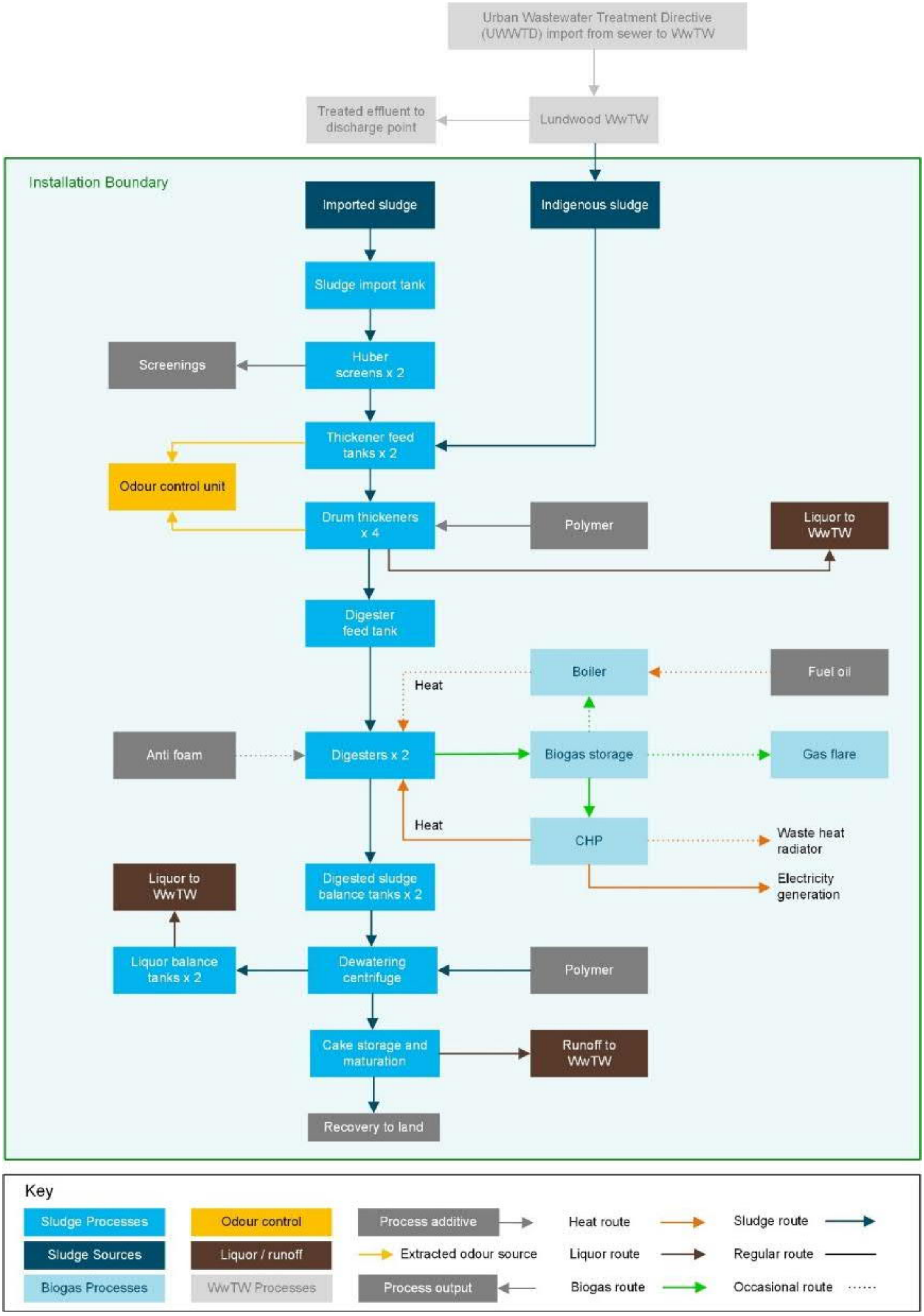


Figure 7 Lundwood STF Source Locations

Odour sources

Sludge Import Tank	1
Sludge screens	2
Screenings Skip	3
Thickener Feed Tanks	4
Drum Thickeners	5
Thickener Liquor Wet Well	6
Digester Feed Tanks	7
Digesters	8
Biogas Relief Valves	9
OCU stack	10
Biogas Holder	11
Flare	12
Digested Sludge Balance Tanks	13
Dewatering Centrifuges	14
Liquor Balance Tanks	15
Cake Storage Pad	16
Screened sludge PS	17

Type of waste accepted at Lundwood STF are provided in the environmental permit.

2.5 Process Odour Sources

The odour potential of a source can be broken down into three key considerations:

- How inherently odorous the compounds present are.
- The unpleasantness of the odour.
- The magnitude of the odour release.

When trying to determine the offensiveness of an odour source, site-specific odour sampling should be considered in the first instance. In the absence of source odour emission data, the assessment criteria will consider the Environment Agency's Horizontal Guidance Note (H4). H4 looks to categorise how offensive odours are with sources/processes/activities that are considered 'most offensive' odours include septic effluent or sludge and biological landfill odours. All raw sludge treatment processes would be considered to have a high odour offensiveness unless source-specific odour sampling is undertaken demonstrating a low level of odorous compounds. Processes containing the below material are considered to represent a high odour offensiveness:

- Indigenous sludge
- Sludge imports (liquid and solid)
- Sludge liquors

Processes containing the below material are considered to represent a medium odour offensiveness:

- Rags and screenings
- Digested sludge
- Digested sludge liquors
- Digested sludge cake (stored)

No processes on an STF are considered to store material that represents a low odour offensiveness unless supported by source-specific odour sampling.

The unpleasantness of an odour can be used in defining the source odour offensiveness. This is typically achieved through source material hedonic tone assessments, however; these types of assessments are not typically available for a site without source-specific sampling.

The risk source odour potential critical risk scoring for odour offensiveness and mitigation / control adopted is summarised in Table 2.

Table 2 Source Odour Potential Risk Scoring

Source	Risk Rating		
	High	Medium	Low
Odour Offensiveness	Very odorous compounds (H2S, Mercaptans) with low odour threshold. Unpleasant odour - "Most Offensive". Unpleasant hedonic tone. Large, permitted process / Surface Area.	Compounds involved are moderately odorous. Unpleasantness - process classed in H4 as "Moderately Offensive" or where odours have neutral or slightly unpleasant hedonic tone. Smaller permitted process / Surface Area.	Compounds involved are only mildly offensive. Unpleasantness - process classed in H4 as "Less Offensive". Neutral to positive hedonic tone.
Mitigation / Control	Open air operation with no containment. Reliance solely on good management techniques and best practice.	Some mitigation measures in place but significant residual odour remains.	Effective mitigation measures in place (e.g. BAT, BPM) leading to little or no residual odour.

Table 3 displays the site sludge odour sources, with an inventory of material, quality, and storage capacity, and goes on to explore the odour offensiveness and emission risk. The location of each odour source (asset ID) is shown in Figure 7 above.

Table 3 Lundwood STF Sludge Inventory of odorous materials

Source	Asset ID	Source Type	Storage Capacity (m^3)	Average retention time	Frequency of Operation	Odour Description	Hedonic Tone	Odour Offensiveness	Mitigation Measures	Emission Release Type	Emission Risk
Sludge Import Tank	1	Indigenous, Imports	150	30 minutes	Continuous	Septic sludge, sulphide	Unpleasant	High	Covered	Fugitive	Medium
Sludge screens	2	Indigenous, Imports	N/A	N/A	Continuous	Septic sludge, sulphide	Unpleasant	High	Covered	Fugitive	Medium
Screenings Skip	3	Sludge Screenings	N/A	N/A	Continuous	Septic sludge, sulphide	Unpleasant	Medium	Open to atmosphere	Diffuse	Medium
Thickener Feed Tanks	4	Indigenous, Imports	2 x 1,589	24 hours per tank	Continuous	Septic sludge, sulphide	Unpleasant	High	Covered and extracted to OCU	Abnormal - fugitive only as off-gases ducted to OCU in normal operation	Low
Drum Thickeners	5	Indigenous, Imports	N/A	N/A	Intermittent Daily	Septic sludge, sulphide	Unpleasant	High	Covered and extracted to OCU	Abnormal - fugitive only as off-gases ducted to OCU in normal operation	Low
Thickener Liquor Wet Well	6	Indigenous Liquors	N/A	N/A	Intermittent Daily	Septic sludge, sulphide	Unpleasant	High	Open to atmosphere	Diffuse	High
Digester Feed Tanks	7	Indigenous, Imports	712	24 hours	Continuous	Septic sludge, sulphide	Unpleasant	High	Covered	Fugitive	Medium
Digesters	8	Indigenous, Imports	2 x 2,056	12 days	Continuous	Biogas, Methane/ sulphide	Unpleasant	High	Covered and extracted to biogas storage Full containment of biogas is a critical safety consideration	Abnormal - fugitive only as biogas is collected for use on site.	Low

Source	Asset ID	Source Type	Storage Capacity (m^3)	Average retention time	Frequency of Operation	Odour Description	Hedonic Tone	Odour Offensiveness	Mitigation Measures	Emission Release Type	Emission Risk
Biogas Relief Valves	9	Digested Sludge	N/A	N/A	Emergency operation	Biogas, Methane/ sulphide	Unpleasant	High	Critical process safety requirement. Operates only as required under abnormal process conditions	Point	Low
OCU stack	10	Treated gases	N/A	N/A	Continuous	Treated off gases	Acceptable	Low	Enclosed system with 2-stage treatment	Point	Low
Biogas Holder	11	Biogas	1,580	2 days	Continuous	Biogas	Unpleasant	High	Enclosed vessel. Full containment of biogas is a critical safety consideration	Abnormal - fugitive only as biogas is collected for use on site.	Low
Flare	12	Combusted biogas	N/A	N/A	Emergency Operation	Combustion	Acceptable	Low	Biogas is combusted	Point	Low
Digested Sludge Balance Tanks	13	Digested	2 x 880	36 hours per tank	Continuous	Digested sludge / Earthy	Acceptable	Medium	Open to atmosphere	Diffuse	High
Dewatering Centrifuges	14	Digested	N/A	N/A	Intermittent Daily	Digested sludge / Earthy	Acceptable	Medium	Covered and within a building	Diffuse	Medium
Liquor Balance Tanks	15	Digested Liquors	2 x 250	24 hours	Continuous	Digested sludge / Earthy	Acceptable	Medium	Covered	Diffuse	Medium
Cake Storage Pad	16	Digested	12,750 tonnes	6 weeks minimum	Continuous	Digested sludge / Earthy	Acceptable	Medium	Open to atmosphere	Diffuse	High
Screened sludge pumping station	17	Indigenous, Imports	N/A	N/A	Intermittent Daily	Septic sludge, sulphide	Unpleasant	High	Open to atmosphere	Diffuse	High

2.6 Odour Control Units

There is 1 no. odour control unit (OCU) present on site. The OCU is a two-stage biotrickling filter and activated carbon polishing OCU that extracts and treats odours from the following sources and discharges to atmosphere via a 15m tall stack:

- Thickener Feed Tanks
- Drum Thickeners

Air from the thickener building is extracted directly to the second stage of the OCU (the carbon polishing unit) where it is treated prior to discharge via the stack.

The key OCU performance parameters are summarised in Table 4 below. OCU emissions monitoring is provided in Section 5.1 and OCU performance checklist is provided in Appendix 3:

Table 4 Lundwood STF OCU Performance Parameters

Parameter	Biological Filter	Carbon Filter
Media Type	Pumice	Activated Carbon
Media Life (Yrs)	Variable – replace media once saturated	1 year approximately, depending on inlet loading
Inlet Parameters		
Airflow (m^3/hr)	9,156	
Hydrogen Sulphide	34.75**	
Stack Outlet Performance		
Stack Height	15m	
Stack Efflux Velocity (m/s)	15	
Permitted Odour Concentration (ou_E/m^3)	1,000	
Measured Odour Concentration (ou_E/m^3)	339*	
Measured Hydrogen Sulphide (ppm)	0.020**	

*Direct air samples were collected by lung method in accordance with BS EN 13725:2003

** Sampling methodology using Jerome Hydrogen Sulphide analyser

3 Odour Critical Plant Operation

3.1 Odour Critical Sources

Given the control measures that are in place during operation of the facility, these contributions (if any) are unlikely to increase the odour impact on the receptors outside of the site boundary.

Management of releases includes reducing turbulence, containment and abatement. Where odorous gasses are finally released, controlling the height of release through a stack or the timing of releases through management of activities can influence dispersion before there is an impact on people. Potential on site odour releases associated with Lundwood STF are given in Table 5 below.

Table 5 Lundwood STF Odour Critical Sources (operational controls)

Asset	Asset ID	Potential Odour Source	Odour Control Measures	Odour Risk	Mitigation Trigger	Mitigation Measures	Timescale	Responsible Person
Sludge Import Tank	1	Liquid sludge	Tank covered without extraction. Inspection hatches kept closed. Sludge is mixed and regular throughput is maintained	Unlikely given control measures in place	Increase in complaint frequency / odour sniff test identifies sludge odours off-site	Dose sludge with odour control chemical	Within 5 working days of incident	Product and Process Engineer
Sludge Screens	2	Liquid sludge	Sludge screen is contained asset	Unlikely given control measures in place	Screenings spill local to skip. Increase in complaint frequency / odour sniff test identifies sludge screenings off-site.	Early removal / replacement of skip	Within 5 working days of incident	Product and Process Engineer
Screenings Skip	3	Sludge screenings	Minimal handling and stockpiling of screenings.	Unlikely given control measures in place	Screenings spill local to skip. Increase in complaint frequency / odour sniff test identifies sludge screenings off-site.	Early removal / replacement of skip	Within 5 working days of incident	Product and Process Engineer
Thickener Feed Tanks	4	Liquid sludge	Tank covered and odour controlled. Inspection hatches kept closed. Sludge is mixed and regular throughput is maintained	Unlikely given control measures in place	Failure of extraction fans & increase in complaint frequency / odour sniff test identifies sludge odours off-site.	Dose sludge with odour control chemical	Within 5 working days of incident	Product and Process Engineer
Drum Thickeners	5	Liquid sludge	Sludge thickeners are enclosed, and air extracted to OCU. Building doors are kept closed, except when access is required.	Unlikely given the control measures in place	Failure of OCU extraction fans & increase in complaint frequency / odour sniff test identifies sludge odours off-site.	Dose sludge with odour control chemical	Within 5 working days of incident	Product and Process Engineer
Thickener Liquor Wet Well	6	Sludge liquors	Wet well is uncovered.	Likely given lack of control measures in place	Increase in complaint frequency / odour sniff test identifies sludge liquor odours off-site	Investigate thickener performance and schedule reactive maintenance	Same day as incident	Product and Process Engineer

Asset	Asset ID	Potential Odour Source	Odour Control Measures	Odour Risk	Mitigation Trigger	Mitigation Measures	Timescale	Responsible Person
						Dose sludge with odour control chemical	Within 5 working days of incident	Product and Process Engineer
Digester Feed Tanks	7	Liquid sludge	Tank covered without extraction. Inspection hatches kept closed. Sludge is mixed and regular throughput is maintained	Unlikely given control measures in place	Increase in complaint frequency / odour sniff test identifies sludge odours off-site	Dose sludge with odour control chemical	Within 5 working days of incident	Product and Process Engineer
Digesters	8	Liquid sludge / biogas	Tank is covered and biogas extracted. Risk assessment and odour plan in place before cleaning of any tank.	Unlikely given control measures in place	Loss of digester performance (see table 14 for monitoring parameters)	Investigate digester performance and schedule reactive maintenance.	Same day as incident	Product and Process Engineer
Biogas Relief Valves	9	Biogas	Planned maintenance on equipment. Monitoring of digester pressures. Flare available to burn excess gas.	Unlikely given the control measures in place. Critical safety system.	Prolonged / frequent use of safety valve.	Failures are investigated and reactive maintenance undertaken.	Same day as incident	Product and Process Engineer
OCU stack (mechanical extraction)	10	Liquid sludge	Duty / Standby extraction fan to be available. Prevent increase of fugitive emissions risk from covered processes.	Unlikely given control measures in place	Standby Fan Failure	Standby extraction fan to be in service. Investigate cause of limited extraction.	Support from OCU supplier to be arranged next availability	Product and Process Engineer
OCU stack (media)	10	Liquid sludge	2-stage process to prevent early exhaustion of carbon media. OCU performance is monitored.	Unlikely given control measures in place emissions from OCU outlet	0.5 ppm Hydrogen Sulphide at outlet	Performance monitoring of OCU. Investigate cause of reduced performance	Support from OCU supplier to be arranged next availability	Product and Process Engineer
Biogas Holder	11	Biogas	Planned maintenance on equipment. Monitoring of digester pressures. Flare available to burn excess gas.	Unlikely given the control measures in place. Critical safety system.	Prolonged / frequent use of safety valves.	Failures are investigated and reactive maintenance undertaken.	Same day as incident	Product and Process Engineer

Asset	Asset ID	Potential Odour Source	Odour Control Measures	Odour Risk	Mitigation Trigger	Mitigation Measures	Timescale	Responsible Person
Flare	12	Biogas	Planned maintenance on equipment.	Unlikely given the control measures in place. Critical safety system.	Prolonged / frequent use of flare.	Failures are investigated and reactive	Same day as incident	Product and Process Engineer
Digested Sludge Balance Tanks	13	Liquid digested sludge	Risk assessment and odour plan in place before cleaning of any tank.	Reduced risk due to lower odour potential from digested sludge	Increase in complaint frequency / odour sniff test identifies digested sludge odours off-site.	Review the digester performance	Same week as incident	Product and Process Manager / Process Engineer
Dewatering centrifuge	14	Digested sludge cake	Centrifuge is contained asset	Unlikely given control measures in place	Increase in complaint frequency / odour sniff test identifies sludge cake storage odours off-site.	Review the digester performance	Same week as incident	Product and Process Engineer
Liquor Balance Tanks	15	Digested sludge liquors	Tank covered without extraction. Inspection hatches kept closed. Liquors are mixed and regular throughput is maintained	Unlikely given control measures in place	Increase in complaint frequency / odour sniff test identifies digested sludge liquor odours off-site.	Review the digester performance	Same week as incident	Product and Process Engineer
Sludge cake storage	16	Digested sludge cake	Cake to be handled by the loader only twice (once to move from conveyor to pad, and once to load into the export wagon) to minimise disturbance and odour release.	Unlikely given control measures in place	Increase in complaint frequency / odour sniff test identifies sludge cake storage odours off-site.	Restrict process and reduce storage volumes.	Same week as incident	Centrifuge unit operator
						Ensure cake is removed from site for disposal at the earliest opportunity.	Arrange for compliant cake to be removed from site same week	Centrifuge unit operator
						Root cause analysis and resolution.	Immediately	Product and Process Engineer
Sludge cake export	16	Digested sludge cake	Cover the wagon before leaving site.	Unlikely given control measures in place	Wagon uncovered when leaving site	Ensure wagon is covered before leaving site	Immediately	Centrifuge unit operator
Screened sludge pumping station	17	Liquid sludge	Wet well is uncovered.	Likely given lack of control measures in place	Increase in complaint frequency / odour sniff test identifies sludge liquor odours off-site	Dose sludge with odour control chemical	Within 5 working days of incident	Product and Process Engineer

3.2 OCU Performance Investigation

OCUs installed on site shall be monitored and maintained by site operations and the product and process engineer. Whereby there is an issue with an OCU's operability or treatability that cannot be resolved by site operations, a 3rd party specialist shall be engaged as a priority to arrange for support. In the event that the 3rd party specialist cannot directly mobilise to site, the product and process engineer shall manage the OCU's operation to reduce the risk of compromised performance.

The 3rd party specialist shall be commissioned to undertake an asset condition and performance assessment. The assessment shall include as a minimum the tasks outlined in Appendix 3 but shall extended to any additional tasks to include the highlighted issues by operations.

As part of the assessment, the 3rd party specialist with support from YW operational staff shall work to resolve any issues to ensure the OCU is returned to normal operating conditions. Any issues that cannot be resolved on the day or requires additional parts shall be raised as an action to be manged by the product and process engineer.

At the end of the asset condition and performance assessment the 3rd party specialist shall provide a summary report that documents findings and associated actions / recommendations to return the OCU to normal operating conditions.

3.3 Protocol for Dosing Odour Control Chemical

In the event that there is failure of process mitigation measures that could lead to increased risk of elevated odours, chemical can be dosed directly into the sludge to mitigate this risk.

4 Odour Impact

4.1 Odour Dispersion Model

An odour dispersion model has not been developed for Lundwood STF as part of this OMP due to infrequent odour complaints associated with the WwTW / STF.

Odour dispersion modelling including site specific olfactometric surveys shall be undertaken in the event of increased frequency of odour complaints or operational changes with a perceived increase in odour impact risk.

Any odour sampling shall be undertaken in accordance with EN standards (e.g. dynamic olfactometry according to EN 13725 in order to determine the odour concentration or EN 16841-1 or -2 in order to determine the odour exposure).

4.2 Odour Survey Results

Table 6 An odour survey has been undertaken on selected processes as part of the qualitative odour risk assessment. The odour survey was undertaken during July 2021 to assess the odour emissions from the uncovered and treated emission source. Table 6 includes a summary of the survey results.Lundwood STF Odour Survey Results

Source	Odour Concentration	Odour Emission Rate	Hydrogen Sulphide	Ammonia
	(ou_E/m^3)	($ou_E/m^2/s$)	(ppm)	(ppm)
Fresh Digested Cake	551	5.7	0.006	18.0
Stored Digested Cake	89	0.9	0.005	3.3
Imported Sludge Tank	4,168	43.3	0.440	< 0.1
Sludge Screen Skip	301	3.1	0.020	< 0.1
Thickener Liquor Wet Well	63,404	658.7	10.5	< 0.1
Digested Sludge Balance Tanks	105	1.1	0.005	3.0

As part of the odour survey, monitoring and sniff tests have been undertaken local to the STF operational area. The STF operational area monitoring has identified that one location on the STF detected hydrogen sulphide (the main compound in sludge odours) above the detection threshold (0.009 ppm hydrogen sulphide, north of imported cake storage). The odour description for the majority of the samples range between no odour or faint, with only one location (north of the imported cake storage) observing “strong” odours. It is understood that the strong odour detected at this location was due to the temporary storage of limed raw cake on the cake pad at the time of the survey. This cake had been produced at another YW site; storage of limed raw cake is not part of normal operation at Lundwood STF and is used as a contingency only.

4.3 Qualitative Odour Risk Assessment

A qualitative odour risk assessment of Lundwood STF has been undertaken by Stantec to determine the odour impact risk at sensitive receptors local to the works. The assessment relies on subjective professional judgement but uses the generic guidance methodologies provided and referenced in documents such as the Institute of Air Quality Managements (IAQM) Guidance on the Assessment of Odour for Planning, the Scottish Environmental Protection Agency (SEPA) Odour Guidance 2010, the Environment Agency's Horizontal Guidance Note H1 Environmental Risk Assessments for Permits, and Annex A of H1 – Amenity & accident risk from installations and waste activities.

These guidelines use the Source-Pathway-Receptor concept in which it evaluates the relationship between source(s) of odour, the pathway or transmission route by which exposure may occur at a given receptor(s) who may be affected/impacted.

How well a qualitative odour risk assessment predicts the odour impact for a scenario is dependent on how well the Source-Pathway-Receptor approach can be assessed and scored. This type of assessment is based on subjective judgement and therefore, robust assessment criteria are required. Where subjective judgement for a criterion could be considered broad, sub-criteria have been determined to provide a more detailed judgement.

The odour offensiveness of the have adopted the risk ratings included in Table 4. The pathway from source to receptor considers the distance, local terrain and meteorological conditions, as highlighted in Section 2.3.

The sensitive receptors considered in the assessment are documented in Figure 8 and Table 7.

Figure 8 Lundwood STF Odour Risk Assessment Sensitive Receptor Locations

Table 7 Lundwood STF Odour Risk Assessment Sensitive Receptors

Receptor ID	Receptor Type	Distance from STF operational area (m)	Receptor Sensitivity
D01	Industry	15	Low
D02	Residential	107	High
D03	Residential	103	High
D04	Residential	159	High
D05	Residential	182	High
D06	Residential	276	High
D07	Residential	208	High
D08	Residential	226	High
D09	Residential	332	High
D10	Residential	253	High
D11	Residential	264	High
D12	Residential	449	High
D13	Residential	638	High
D14	Residential	683	High
D15	Residential	420	High
D16	Residential	612	High
D17	Residential	599	High
D18	Residential	959	High
D19	Residential	1070	High
D20	Residential	1369	High
D21	Farm	91	Low
D22	Farm	729	Low

4.4 Results

The results of the qualitative odour risk assessment are summarised in Table 8.

Table 8 Lundwood STF Odour Risk Assessment Results

Receptor ID	Receptor Type	Source Odour Potential	Pathway Effectiveness	Odour Exposure	Receptor Sensitivity	Likely Odour Effect
D01	Industry	Medium	Highly Effective Pathway	Medium Risk	Low	Negligible Effect
D02	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
D03	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
D04	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect

Receptor ID	Receptor Type	Source Odour Potential	Pathway Effectiveness	Odour Exposure	Receptor Sensitivity	Likely Odour Effect
D05	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
D06	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
D07	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
D08	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
D09	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D10	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
D11	Residential	Medium	Moderately Effective Pathway	Low Risk	High	Slight Adverse Effect
D12	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D13	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D14	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D15	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D16	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D17	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D18	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D19	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D20	Residential	Medium	Ineffective Pathway	Negligible Risk	High	Negligible Effect
D21	Farm	Medium	Highly Effective Pathway	Medium Risk	Low	Negligible Effect
D22	Farm	Medium	Ineffective Pathway	Negligible Risk	Low	Negligible Effect

The qualitative odour risk assessment for Lundwood STF has indicated that all considered sensitive receptors are exposed to either a negligible or slight adverse odour effect indicating no receptors are exposed to a moderately adverse odour effect or worse.

The YW complaints log recorded only five complaints over the last five years for the site as a whole (i.e. the YW Lundwood WwTW and STF). The odour complaints are reported to be from receptors located to the north and west of the site. The inconsistent and infrequent nature of these complaints coupled with irregularity of timing throughout the year, suggests the complaints are likely to be attributed to ad hoc events and are not associated with "normal" operation of the site.

Of the considered BAT Conclusions associated with emissions to air, specifically 14d and 34, a number of sources have been identified as not complying with certain BAT conclusions. The OCU (biotrickling and carbon OCU) has been assessed to be achieving the stack outlet odour concentration of 1,000 ouE/m3.

Some of the processes are open to atmosphere, such as the digested sludge balance tanks and the cake pad. Whilst these processes do not utilise the techniques specifically described in the BAT conclusions; the assessment has not identified a significant risk of odour impact at surrounding receptors from the works. This is supported by the infrequent nature of odour complaints and no "strong" or "unpleasant" odours associated with the uncovered processes detectable at the STF operational area during the odour survey sniff testing.

For the overall site, it is considered that Lundwood STF does not have an adverse odour effect on its surrounding receptors. As such, no additional odour mitigation is required above the existing measures already observed on site.

4.5 BAT Conclusions

BAT Conclusion 14 describes specific measures which may be appropriate for the prevention or reduction of diffuse emissions to air. BAT Section 14d is associated with the "containment, collection and treatment of diffuse emissions" and includes techniques such as:

- Storing, treating, and handling waste and materials that may generate diffuse emissions in enclosed buildings and/or enclosed equipment (e.g., conveyor belts);
- Maintaining the enclosed equipment or buildings under adequate negative pressure;
- Collecting and directing emissions to an appropriate abatement system via an air extraction system and/or air suction systems close to the emission sources.

In terms of the applicability of this technique it is noted that: "The use of enclosed equipment or buildings may be restricted by safety considerations such as the risk of explosion or oxygen depletion. The use of enclosed equipment or buildings may also be constrained by the volume of waste."

An assessment of STF processes carried out at Lundwood has been undertaken against BAT 14d. Table 9 provides a summary of compliance for site odour sources.

Table 9 BAT Compliance / Alternative Techniques

Source	Source ID	BAT Compliance Review	Alternative Techniques	Compliance Restrictions
Sludge import tank	1	Tank is covered without foul air extraction. Tank will not hold a negative pressure.	BAT partially in place. YW commits to improvements – refer to proposed improvement programme for further details.	None
Sludge screens	2	Sludge screens contained process without foul air extraction. Sludge screens, although of a proprietary enclosed design, do not facilitate creating a negative pressure environment.	Enclosed process, but without extraction and abatement of process air. Small size of source, intermittent use. No sensitive receptors in close proximity. Skip will be covered.	None
Screenings skip	3	Skips open to atmosphere with no containment or treatment of emissions.	BAT not in place – YW commits to cover screenings skip.	None
Thickener feed tanks	4	Tank is covered and headspace air is extracted and treated.	BAT in place	N/A
Drum thickeners	5	Thickener units are enclosed and located within a building. Air from thickener units is extracted and treated in OCU.	BAT in place	N/A
Thickener liquor wet well	6	Sump open to atmosphere with no containment or treatment of emissions.	Small source footprint. No sensitive receptors in close proximity. YW commits to improvements – refer to proposed improvement programme for further details.	None
Digester feed tank	7	Tank is covered without foul air extraction. Tank will not hold a negative pressure.	Odour management techniques in use rather than specific BAT containment measures. YW commits to improvements – refer to proposed improvement programme for further details.	None
Digesters	8	Tank is covered and biogas captured and utilised. LDAR in place.	BAT in place	N/A
Biogas relief valves	9	N/A – emergency use only	N/A	N/A
OCU stack	10	OCU treats headspace air from tanks and thickener. OCU is operated in accordance with this OMP.	BAT in place	N/A

Source	Source ID	BAT Compliance Review	Alternative Techniques	Compliance Restrictions
Biogas holder	11	Biogas is fully contained. LDAR in place.	N/A	N/A
Flare	12	Used only as required. Biogas is combusted.	N/A	N/A
Digested sludge balance tanks	13	Tank open to atmosphere with no containment or treatment of emissions.	Tank contains digested sludge only which is inherently less odorous. No sensitive receptors in close proximity. YW commits to improvements – refer to proposed improvement programme for further details.	None
Dewatering centrifuge	14	Centrifuges, although of a proprietary enclosed design, do not facilitate creating a negative pressure environment.	Source is enclosed. Area subject to regular inspection and management, source not considered to contribute to off-site odour nuisance potential. No sensitive receptors in close proximity. Adequate measures considered to be in operation.	None
Liquor balance tank	15	Tanks are covered with no containment or treatment of emissions.	BAT partially in place. Odour management techniques in use rather than specific BAT containment measures Liquors arise from digested sludge only which is inherently less odorous. No sensitive receptors in close proximity.	None
Cake Pad	16	Cake Pad open to atmosphere with no containment or treatment of emissions.	Odour management techniques in use rather than specific BAT containment measures. Digested sludge only, which is inherently less odorous, during normal operating conditions. Adequate measures considered to be in operation, as supported by odour measurements and impact assessment.	The use of enclosed equipment or buildings is constrained by the volume of cake stored.
Screened sludge pumping station	17	Sump open to atmosphere with no containment or treatment of emissions.	Small source footprint. No sensitive receptors in close proximity. YW commits to improvements – refer to proposed improvement programme for further details.	None

A number of sources on site do not adopt the specific conclusions outlined in BAT 14d. The sludge import tank, sludge screens, digester feed tank, dewatering centrifuge and liquor balance tanks would be considered to be partially compliant due to being contained processes. Whilst these processes are only partially compliant, the sludge screens, screenings skips and dewatering centrifuge occupy a small source footprint and are not likely to contribute to significant odour emissions or impact on surrounding receptors.

The cake pad is currently uncovered and does not utilise specific measures outlined in BAT 14d. The cake pad odour emissions are more akin to secondary treated wastewater than indigenous sludge emissions. Covering the cake pad would require a large building with air extraction / ventilation, odour treatment and dispersion to atmosphere. The ongoing operation of this building would be associated with significant electrical consumption and use of consumable carbon media. Given that the risk assessment showed that cake storage is low risk and the large volume of waste being handled, it is considered reasonable that the applicability guidance previously mentioned justifies the uncovered storage of cake.

As part of the odour survey, the OCU was sampled and identified to be treating odours and meeting BAT 34 odour concentration.

5 Monitoring and Control of Odours

All monitoring should clearly relate to the assessment of odour control and complete records must be kept in an auditable format. The only way to determine whether the processes on site are under control, and to keep them under control, is to do appropriate monitoring.

As far as possible, Lundwood STF is operated to minimise odour generation and release. As long as the treatment process satisfies the normal design criteria, odour should be minimal. To minimise odour nuisance, it is important to ensure that Lundwood STF is operating at its optimum. Covers and hatches should always be replaced to maintain the integrity of enclosures provided to collect odorous air.

5.1 Sniff Testing

Sniff testing is recognised by Yorkshire Water as a useful technique to build up a picture of the impact the odour has on the surrounding environment over time. Sniff testing shall be used to support profiling site odour impact, investigate odour complaints and to introduce temporary odour mitigation measures.

Sniff testing shall be undertaken on site on a weekly basis by site operational staff. It is accepted that operational staff may not be ideal for sniff testing of site odours as they have adapted to odours from the site. However, this will provide a baseline for routine observations. The weekly operator sniff tests shall assess the site boundary and focus on the detection of any odours that could potentially be leaving site.

Monthly sniff tests shall be carried out by non-site-based staff (Technically Competent Manager) who are not adapted to site odours. The monthly sniff test shall be carried out at additional test locations local to source to profile the location of any fugitive emission sources. For Lundwood STF, due to a low frequency of odour complaints and the majority of assets having odour mitigation, the routine sniff-testing shall be site based only.

In the event of odour complaints being received, site operators shall undertake a sniff test including off-site sniff testing local to the complaint location(s). In the occurrence of a significant odour event or repeated complaints, a third-party shall be engaged for an additional odour investigation including on and off-site sniff testing.

A third-party odour sniff test is scheduled to be undertaken twice a year for comparison with Yorkshire Water (operator and monthly tester) observations. The third-party sniff test shall include both on and off-site locations based on surrounding sensitive receptors and complaint locations. The off-site locations shall be reviewed prior to any third-party testing to ensure any recent changes to sensitive receptors are considered.

The location of weekly and monthly on-site sniff testing locations has been included in Figures 9 and 10, respectively. Routine off-site locations have not been included due to a lack of odour contacts. In the event that odour complaint frequency increase, off-site locations shall be incorporated into the routine sniff testing.

Figure 9 Lundwood STF Weekly On-Site Sniff Testing Locations

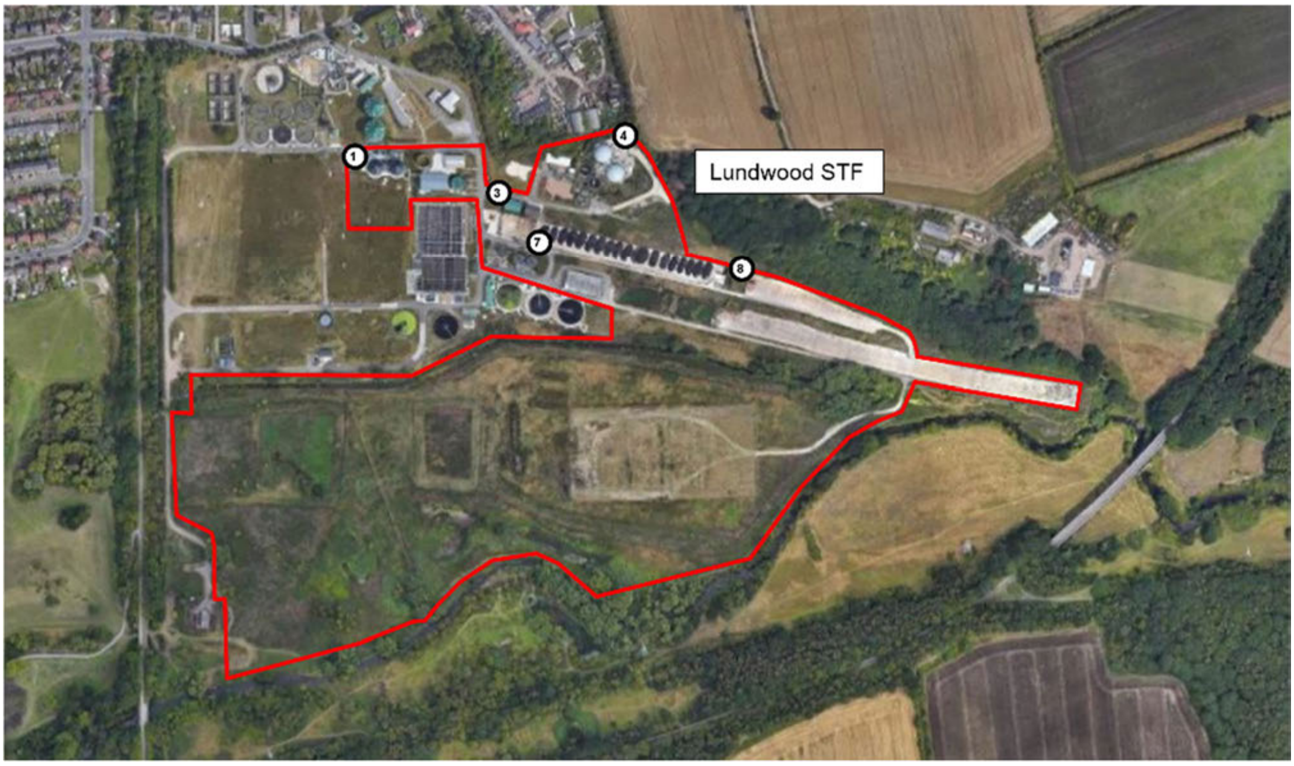
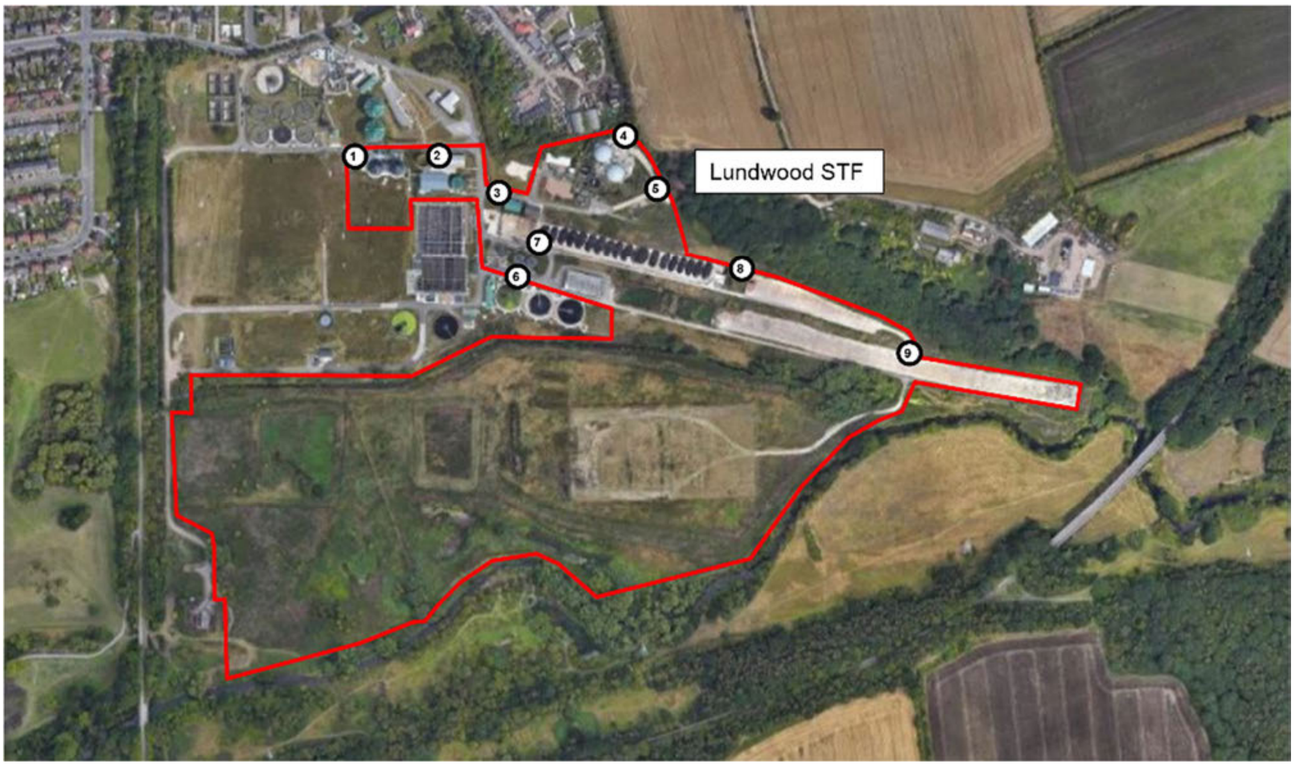


Figure 10 Lundwood STF Monthly On-Site Sniff Testing Locations



5.2 Channelled Emissions

The odour control unit outlet emissions shall be monitored once every six months for H_2S and NH_3. The sampling shall be undertaken by a third-party Assessor. OCU performance shall be monitored in accordance with the OCU performance checklist provided in Appendix 3.

5.3 Imports/Exports

The Site Operating Procedures include instructions on how sludge must be imported. The YW Safe Loading & Discharging of Sludge Road Tankers is available in Appendix 6. Tankers shall be filled and emptied in a way that minimises odour discharge.

5.4 Sludge Treatment and Disposal

Raw or co-settled sludges always smell objectionable, but the odour becomes stronger during storage, as anaerobic decomposition occurs, leading to high concentrations of malodorous compounds in sludges and sludge liquors. Digested sludges are less odorous, particularly after they have cooled. To minimise the generation of odours, where possible, fresh sludge shall be processed and sent to digestion as quickly as possible before further treatment and removal from site. Raw sludges stored upstream of digestion would never be stored for more than 2 days in normal plant operation.

5.5 Sludge Thickening and Storage

Accumulation of sludge in the system can cause increased odour release in storage tanks, as well as from sludges and liquors when thickening takes place. To minimise odours from the Lundwood STF, the works should be operated as follows:

- Minimise retention prior to thickening, dewatering or digestion;
- Prevention of sludge accumulation in off-line tanks; and
- Proactive identification of potential problems and tankering of sludges to other sites with odour abatement.

5.6 Anaerobic Digestion

The digestion process breaks down a wide range of odorous compounds, which may be released if care is not taken to avoid turbulence of the sludge after digestion. Odour problems may be caused by:

- Saline intrusion (or industrial wastes) leading to elevated sulphate concentrations of raw sludge, giving a greater sulphide potential;
- Emissions of biogas resulting in significant odour problems; and
- Incomplete digestion leading to odour release from secondary digestion tanks.

Suggested remedial measures include:

- Check seals and valves to prevent the release of biogas;
- Ensure gas handling system is balanced and that pressure relief valves do not operate prematurely;
- Ensure all excess gas is flared and that flare stack ignition is immediate and reliable;
- Addition of iron salts or other chemicals to precipitate or inhibit the formation of sulphide.

There are odour checklists for both YW Operators and Team Leaders in Appendix 2.

5.7 Site Operation and Management Procedures

All operating practices should be compliant with the site O&M manuals. The Integrated Management System (IMS) developed by YW to cover Environmental, Health & Safety and Quality elements of all aspects of YW activities will also apply.

The IMS identifies the environmental aspects and impacts of all YW plants, including the facility at Lundwood. The facility will operate under the IMS which shall include:

- Quality management procedures for operational aspects, for example: preventative electrical and mechanical maintenance, safe working procedures, accident / incident response and emergencies;
- Specialist contractors shall be employed by YW to undertake any non-routine or specialised maintenance tasks;
- Use of only YW approved contractors. YW maintain an approved contractors list which is used for appointment of all YW contractors. This requires contractors to achieve a high level of environmental competence / performance. YWS Framework Contractors are required to operate an EMS in accordance with ISO 14001;
- Preparation/issue of risk assessments and method statements by all contractors before starting work. These risk assessments and method statements will include consideration of odour and measures in place to control odour releases. These are prepared as part of the 'hand - over' and 'hand – back' certificate or 'permit to work'; and
- Regular environmental and quality audits to be carried out. These shall include a review of potential odour and identify any additional control measures which may be required.

5.7.1 Procedures for Operation Plant

All operating practices should be compliant with the site O&M manuals, YW company practice and the OMP.

5.7.2 Routine Inspection and Recording

Visual inspection of facility processes will be carried out on regular basis as part of staff duties. In addition, regular checks of the OCU performance as described in Appendix 3 shall be carried out. If abnormal odour is witnessed, YW staff shall record details in the Odour Log Spreadsheet of the observation and immediately investigate. During any such recording carried out as part of this OMP, it is important to document any potential contribution from other off-site sources of potential odour nuisance located outside of the facility boundary. An odour monitoring record sheet to be used in the event of site odours is included in Appendix 4.

5.7.3 Maintenance by Engineering Reliability Staff

Engineering Reliability staff (Mechanical Fitters, Electricians and ICA Technicians) carry out routine maintenance of plant and equipment. There is also proactive maintenance of the OCU. This includes odour abatement equipment.

Routine maintenance requirements are included within YW's Work Management System (WMS) task lists for the site and are forwarded to members of this team via their Toughbook. Feedback on planned maintenance carried out is recorded in WMS by the Engineering Reliability staff member via their Toughbook and transferred to SAP for storage.

5.7.4 Reporting Faults and Identifying Maintenance Needs

For faults requiring immediate attention, the Product and Process Engineer raises a SAP notification and calls it through to the Scheduling & Planning Team. If it meets a high priority according to the Risk Assessment Matrix (RAM), it will be attended as a scheduling buster for the relevant YW Engineer to attend site.

For less urgent faults the Product and Process Engineer raises a SAP notification. It will be converted into a SAP job and picked up by the Scheduling & Planning Team and progressed accordingly. If at any time the situation changes, and the job becomes more urgent, the Product and Process Engineer (PPE) would re-prioritise the SAP job in line with the RAM and call through to the Scheduling & Planning Team.

Routine maintenance requirements are fed to YW's maintenance team via SAP.

5.7.5 Replenishing Chemicals / Consumables

The OCU performs an important function for the overall control of odour across the site. When consumables in the OCU need to be replenished they are ordered via YW's ordering system. An order is set up for each chemical and stocks are replenished via a one-off Order. Delivery notes must be kept in a folder on site.

5.7.6 Initiating OCU Media Replacement

Before 12 months of operation carbon samples from the OCUs are manually taken on a given schedule in the Operator's task list and sent for laboratory analysis to determine the lifespan of the media. Once at around 70% spent an order is raised for replacement of the media.

5.8 Changing Dispersion Conditions

Site activities that could lead to increased site emissions will be avoided when there are poor dispersion conditions or during sensitive periods (hot days, when people are more around). If not possible to be avoided, additional monitoring in the form of sniff testing and monitoring of site performance shall be undertaken. In the event that site activities are resulting in increased off-site odours or customer complaints, the activity shall be rescheduled / undertaken during low-risk times / weather conditions.

Table 10 Lundwood STF Changing Dispersion Risk

Asset	Changing Dispersion Condition	Mitigation Trigger	Mitigation Action	Time scale	Responsible Person
Screening skip	Hot Days, School Holidays (summer)	Temperature - >26°C and significant odour complaints	Increase frequency of skip export from site	Forecast in advance – 5-day weather forecast	Product and Process Engineer
Sludge cake export	Hot Days, School Holidays (summer)	Temperature - >26°C and significant odour complaints	Cake export between 8am to 6pm only	Forecast in advance – 5-day weather forecast	Product and Process Engineer

6 Emergency and Incident Response

This section addresses the issue of appropriate response to odour incidents caused by process failure or equipment breakdown. These emergency procedures include the:

- Foreseeable situation that may compromise the ability to prevent and minimise odorous releases from the process;
- Actions to be taken to minimise the impact; and
- Person responsible for initiating the action.

Where abnormally high odour levels are observed – indicating odour pollution a PPE will be required to take appropriate contingency measures. These measures should include:

- Investigating the odour incident and its cause(s);
- Bringing the process back under control; and
- Minimising exposure or annoyance effects.

Table 11 below summarises incident / emergency control measures in place. The YW odour emergency contact details for Lundwood STF are available in Appendix 1.

Table 11 Lundwood STF Incident/Emergency Control Measures

Failure/Abnormal Situation	Potential Odour Source	Potential Impact	Mitigation Measures	Actions to be Taken	Timescale for Rectification	Responsible Person
Failure of the odour control unit	Untreated air	High – OCUs provide treatment for odorous air from the Permitted site. Failure of OCU would result in release of abnormal operational fugitive odours direct to atmosphere	Routine maintenance. Regular monitoring of equipment performance. Duty standby functionality. Standby capacity in the media beds.	For plant failure - investigate and repair.	Site operator to investigate on same working day. Support from OCU supplier to be arranged for next availability	Site Operator
Liquid sludge import spillage	Liquid sludge	Medium – low volume spillage likely to go directly to drain which returns to the WwTW for treatment.	Pipework and tanks undergo regular inspections. Planned maintenance on equipment	Stop source of spill and immediately wash down area.	Immediate	Tanker Driver
				Arrange repair.	Job to be raised and promoted on same working day or next	Site Operator
				Record spillage and actions taken in site diary.	Same day as incident	Site Operator
Sludge cake spillage	Sludge Cake	Medium to High depending on volume of spill	Regular inspection and planned maintenance	Stop source of spill and immediately wash down area.	Immediate	Tanker Driver
				Arrange repair.	Job to be raised and promoted on same working day or next	Site Operator
				Record spillage and actions taken in site diary.	Same day as incident	Site Operator
				If there is likely to be any offsite impact inform manager and technically competent manager immediately.	Same day as incident	Site Operator
Contingency storage of	Raw/Indigenous sludge cake	High	Regular inspection and planned maintenance	Arrange repair	Job to be raised and promoted on same	Site Operator

Failure/Abnormal Situation	Potential Odour Source	Potential Impact	Mitigation Measures	Actions to be Taken	Timescale for Rectification	Responsible Person
raw/indigenous sludge on cake pad					working day or next. Work to be prioritised. Raw sludge cake to be processed through the digester as priority.	
High pressure conditions in digesters	Release from Pressure Relief Valve	Medium - Biogas would be vented at high pressure to aid dispersion	Gas pressure is regulated and monitored	Diversion of biogas to Waste Gas Burner	Immediate	Site Operator
				Investigate likely sources of high pressure in the digester and resolve (e.g. blocked outlet)	Immediate	Site Operator
Loss of Biogas containment	Leaks from gas holder membrane	Medium	Double gas holder membrane system with gas pressure between the membranes regulated and monitored. Methane detectors operated with alarms to alert operators of any leakage between membranes.	Diversion of biogas to CHP plant or Waste Gas Burner. Inspection maintenance and repairs of gas holder as appropriate	Immediate	Site Operator
				Record details and Actions taken in site diary	Immediate	Site Operator
Staff unavailability	Risk of increase to site odours due to limited operational resources	Low	Staff replacement	Operator replacement from another site Remote monitoring from Control Room / off-site / another site	Same day / For next working day	Product and Process Engineer / Site Manager
Asset Fire	Risk of increase to site odours due to limited	Medium	Regular inspection and planned maintenance	Remote monitoring from Control Room / off-site / another site	Immediate	Product and Process Engineer

Failure/Abnormal Situation	Potential Odour Source	Potential Impact	Mitigation Measures	Actions to be Taken	Timescale for Rectification	Responsible Person
	access and inability to operate assets					
Very high rainfall	Flooding	Low	Increased monitoring of media and sludge storage	Check the performance of the Odour Control Unit when water levels drop and replace media as required (if media has been flooded it may need replacing)	Site operator to investigate on same working day. Support from OCU supplier to be arranged for next availability	Product and Process Engineer

7 Inspection/Monitoring/Maintenance Schedules and Records

7.1 Inspection/Monitoring/Maintenance Schedules for Odour Abatement Equipment

A list of routine monitoring and maintenance tasks for the odour control units is included in Appendix 2. Reference should also be made to the OCU specific O&M manuals.

Proactive maintenance tasks are included within SAP task lists for each site and are forwarded to the Product and Process Engineer and Operator via their Toughbook for completion.

Monitoring results from the inlet and outlet of the odour control units will be recorded as appropriate. Refer to Appendix 3 monitoring schedule.

Feedback on maintenance of odour abatement equipment and pipework is recorded in SAP by the Product and Process Engineer or Operator via their Toughbook. YW maintenance staff also provide feedback on work carried out by them.

A review of the OCU plant effectiveness, including measurement of inlet and outlet process and emissions parameters. Any improvements required will be identified and timescales for implementation proposed. This odour management plan will be updated with details of this planned improvement work.

7.2 Key Process Monitoring

Records of site deliveries for the odour control system are stored on site.

The site is operated under a full PLC SCADA control with data logging and interrogation of key parameters to maintain safe, efficient, and low emissions operation. Table 12 includes the key process monitoring provisions for processes associated with emissions to air.

Table 12 Key Process Monitoring Provisions

Emission point / description	Parameter	Monitoring approach	Monitoring frequency
Sludge intake	Intake volume	SCADA	Continuous during unloading operations
	% dry solids	SCADA	Continuous during unloading operations
CHP (A1)	Operating hours	SCADA	Continuous data logging
	Electricity generated	SCADA	Continuous data logging
	Load required / actual (%)	SCADA	Continuous data logging
	Biogas flow / pressure to CHP	SCADA	Continuous data logging
	Heat circuit temperatures (deg. C)	SCADA	Continuous data logging
Boiler (A2 and A3)	Load required / actual (%)	SCADA	Continuous data logging
	Biogas / natural gas flow / pressure to boiler	SCADA	Continuous data logging
	Heat circuit temperatures (deg. C)	SCADA	Continuous data logging
	Heat circuit flow	SCADA	Continuous data logging
Flare compound (A4)	Biogas to flare (m^3)	SCADA	Continuous data logging
	Run hours	SCADA	Continuous data logging
Odour control unit stack (A5)	Operational status	SCADA	Indication
Biogas storage	Gas level (%)	SCADA	Continuous data logging
	Gas pressure (mb)	SCADA	Continuous data logging
	Methane %	SCADA	Continuous data logging
Digesters	Volume	SCADA	Continuous data logging
	Volatile Fatty Acids (VFAs)	Manual	Periodic
	Alkalinity	Manual	Periodic
	Process temperature	SCADA	Continuous data logging
	% solids (intake)	SCADA	Continuous data logging
	Retention (hours)	SCADA	Continuous data logging
	Temperature	SCADA	Continuous data logging
	H_2S (ppm)	SCADA	Continuous data logging
	Foam level	SCADA	Continuous data logging
Centrifuges	Dry solids (%)	Manual	Periodic
	Flow	SCADA	Continuous data logging

8 Customer Communications

8.1 External Complaints

External odour complaints are received by Loop, which is the external company YW uses for all customer contacts. The call handler will work with the caller to understand the source of the issue. They will explore where the caller experienced the odour, whether it is a repeat or a singular issue, when and where it's most noticeable, what site the odour may be coming from, a description of the smell and if it's the first time it's been noticed. Loop record all complaints on the ICE system and contact the appropriate site owner, via the YW Control Room, to manage the complaint. The complaint will be passed to the Site Manager within 30 minutes or next working day if out of hours. The issue will be dealt with as a matter of priority. ICE is a computer program used to record and manage customer contact. The complainant may or may not request feedback of the cause and resolution of the issue. The odour contact form is included in Appendix 8.

When a complaint has been received, Site will undertake an investigation using the Site Checklist and record details of the investigation in the Odour Investigation Form (Appendix 9).

Odour complaints will be investigated at this site on the same working day (where practicable) and ideally within 2 working days of being aware of the issue. The investigation must not be carried out any later than 5 working days after being aware of the issue.

The Technical Optimiser should then put a note in the site diary and odour diary to record the complaint and inform the TCM and Site Manager of their findings.

Any actions will be resolved as a matter of priority. If immediate resolution of the odour issue can't be carried out, and where reasonably practicable, mitigation measures will be undertaken. Actions will be recorded on the investigation form. Feedback of the issue and the actions undertaken will be sent to the Customer Case Manager to communicate to the Complainant (if requested).

In the event of multiple complaints, and / or the potential for multiple complaints to occur, the Duty Manager will be informed and an incident response will be instigated.

8.2 Internal Complaints

If the PPE or any YW staff identify an abnormal odour release, the PPE will undertake an investigation using the Operator Site Checklist and complete any actions the investigation suggests. The PPE should then put a note in the site diary and the odour site dairy and inform the Technical Optimiser and Site Manager of their findings.

The odour complaint process is included in Appendix 7.

8.3 Community Engagement

Customers are at the heart of what we do at Yorkshire Water. In the event of an odour issue affecting multiple customers within the community, Yorkshire Water's communication team will decide the level of response that is required. This could include, but not be restricted to, stakeholder liaison (communication through local councillors, MPs and affected businesses), local media liaison and/or community meetings to discuss the issues and actions that will be undertaken to rectify the issue. Customer engagement events would be held if the odour severity dictated this level of response. Customers may be encouraged to keep an odour diary to record when odour is perceived to be a greater issue.

9 Training

9.1 Training Requirement

All staff receive training to cover operation of the site, assessment of odour and monitoring and maintenance of the OCU on the site. The training requirements for key staff at Lundwood STF are displayed in Table 13 below.

Table 13 Lundwood STF Training Requirements

Post	Training Requirement
Product and Process Site Manager	• Awareness of the responsibilities for avoiding odour nuisance. • Monitoring / maintenance of odour abatement equipment. • Odour control procedures during start-up / shut down. • Procedures for abnormal conditions. • Requirements of the OMP and Environmental Permit.
Product and Process Engineer / Operator	• Awareness of the responsibilities for avoiding odour nuisance. • Monitoring / maintenance of odour abatement equipment. • Odour control procedures during start-up / shut down. • Procedures for abnormal conditions. • Requirements of the OMP and Environmental Permit.
Sampler	• Awareness of responsibilities for avoiding odour nuisance and reporting. • Monitoring of odour abatement equipment.

9.2 Training Received

YW maintains processes to ensure that all those working for or on behalf of YW are suitably trained to fulfil their roles efficiently. Assessment of competence and identification of individual training needs is carried out through mutual discussion between the individual and their manager as part of the company performance management process, a fundamental part of which is the competency framework and progression plans which are available for every role in the organisation.

All YW employees receive IMS awareness training, delivered online at induction and periodically thereafter. This includes awareness of the environmental policy and understanding key environmental hazards and risks and the need to comply with IMS requirements.

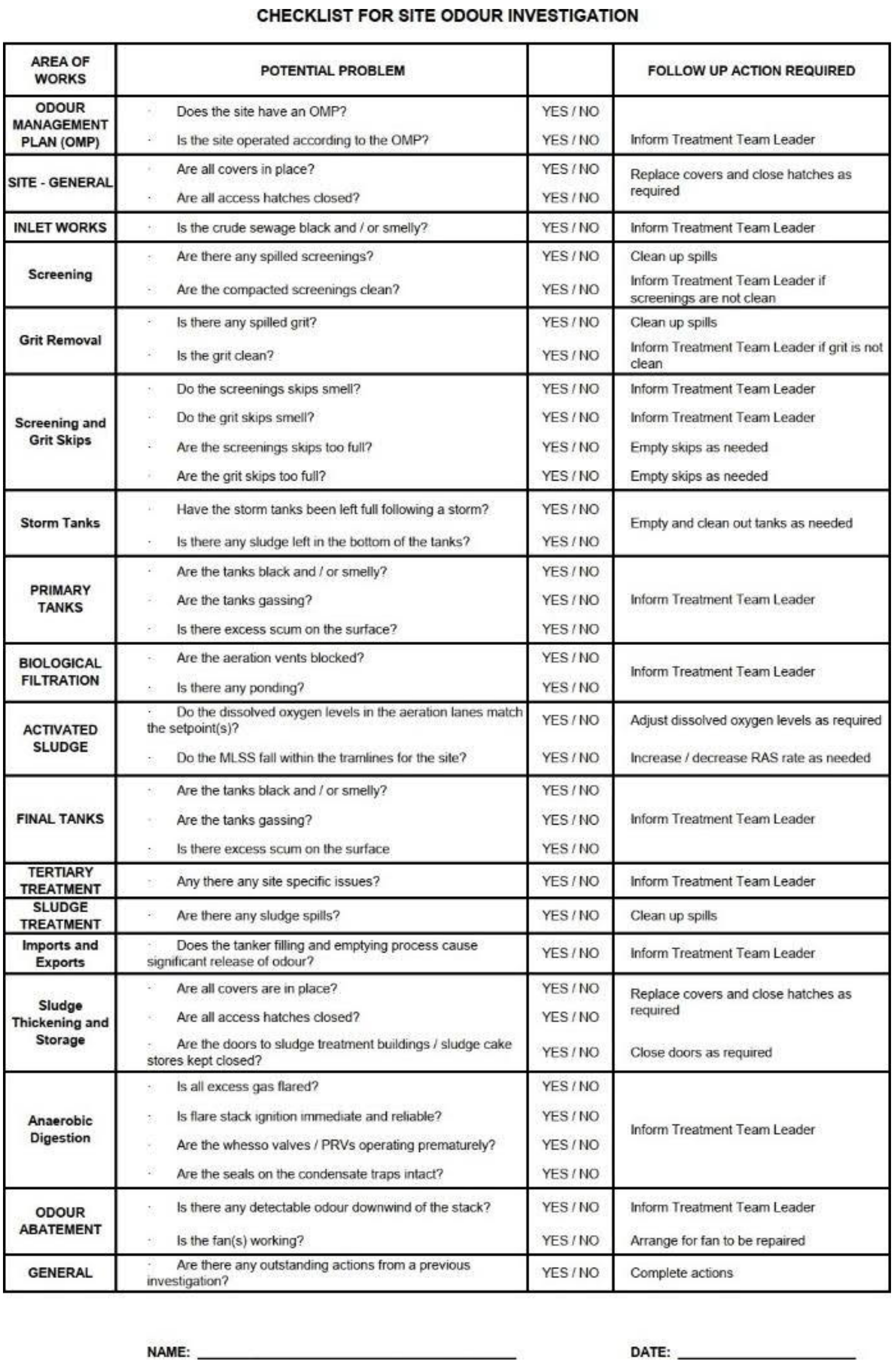
Staff who work at the Lundwood STF receive specific training in the plant's operation and the potential environmental impact of the process as well as health and safety. Plant operators have a detailed understanding of the operational procedures for the site for both normal and abnormal operation. As part of the training, operators will receive specific instructions relating to those aspects of plant operation that have the potential for a negative impact on the environment. Toolbox talks are used to provide information and training to site staff, including information about environmental requirements/activities and legislative and compliance requirements. Training records for programmes and courses managed centrally are held on the company Learning Management System. Records for specific training managed locally at the Lundwood site is held by individual managers and/or on the Leaning Management System.

Appendix 1 Emergency Contacts

Table 14 Lundwood STF Contacts

Area	Contact
Barnsley Council	01226 787787
Odour Abatement Systems Suppliers	ERG Odour Control
OCU Maintenance Provider	Greenacre Environmental Systems Limited
Lundwood STF Odour related Yorkshire Water Contacts	Site Manager: Mick Flanaghan Site Optimiser: John Bullivant

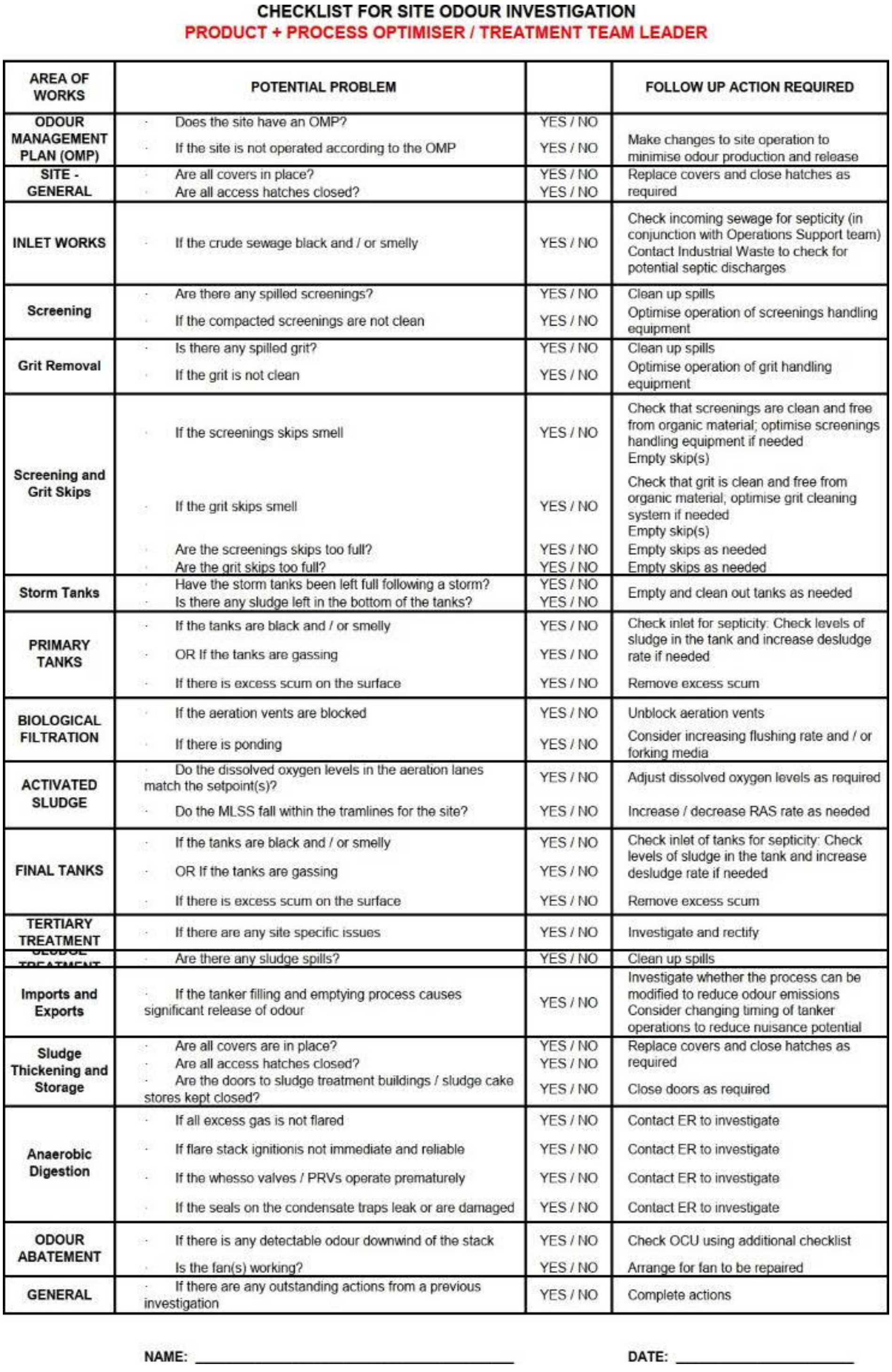
Appendix 2 Odour Checklist



CHECKLIST FOR SITE ODOUR INVESTIGATION

AREA OF WORKS	POTENTIAL PROBLEM		FOLLOW UP ACTION REQUIRED
ODOUR MANAGEMENT PLAN (OMP)	· Does the site have an OMP? · Is the site operated according to the OMP?	YES / NO YES / NO	Inform Treatment Team Leader
SITE - GENERAL	· Are all covers in place? · Are all access hatches closed?	YES / NO YES / NO	Replace covers and close hatches as required
INLET WORKS	· Is the crude sewage black and / or smelly?	YES / NO	Inform Treatment Team Leader
Screening	· Are there any spilled screenings? · Are the compacted screenings clean?	YES / NO YES / NO	Clean up spills Inform Treatment Team Leader if screenings are not clean
Grit Removal	· Is there any spilled grit? · Is the grit clean?	YES / NO YES / NO	Clean up spills Inform Treatment Team Leader if grit is not clean
Screening and Grit Skips	· Do the screenings skips smell? · Do the grit skips smell? · Are the screenings skips too full? · Are the grit skips too full?	YES / NO YES / NO YES / NO YES / NO	Inform Treatment Team Leader Inform Treatment Team Leader Empty skips as needed Empty skips as needed
Storm Tanks	· Have the storm tanks been left full following a storm? · Is there any sludge left in the bottom of the tanks?	YES / NO YES / NO	Empty and clean out tanks as needed
PRIMARY TANKS	· Are the tanks black and / or smelly? · Are the tanks gassing? · Is there excess scum on the surface?	YES / NO YES / NO YES / NO	Inform Treatment Team Leader
BIOLOGICAL FILTRATION	· Are the aeration vents blocked? · Is there any ponding?	YES / NO YES / NO	Inform Treatment Team Leader
ACTIVATED SLUDGE	· Do the dissolved oxygen levels in the aeration lanes match the setpoint(s)? · Do the MLSS fall within the tramlines for the site?	YES / NO YES / NO	Adjust dissolved oxygen levels as required Increase / decrease RAS rate as needed
FINAL TANKS	· Are the tanks black and / or smelly? · Are the tanks gassing? · Is there excess scum on the surface	YES / NO YES / NO YES / NO	Inform Treatment Team Leader
TERTIARY TREATMENT	· Any there any site specific issues?	YES / NO	Inform Treatment Team Leader
SLUDGE TREATMENT	· Are there any sludge spills?	YES / NO	Clean up spills
Imports and Exports	· Does the tanker filling and emptying process cause significant release of odour?	YES / NO	Inform Treatment Team Leader
Sludge Thickening and Storage	· Are all covers are in place? · Are all access hatches closed? · Are the doors to sludge treatment buildings / sludge cake stores kept closed?	YES / NO YES / NO YES / NO	Replace covers and close hatches as required Close doors as required
Anaerobic Digestion	· Is all excess gas flared? · Is flare stack ignition immediate and reliable? · Are the whesso valves / PRVs operating prematurely? · Are the seals on the condensate traps intact?	YES / NO YES / NO YES / NO YES / NO	Inform Treatment Team Leader
ODOUR ABATEMENT	· Is there any detectable odour downwind of the stack? · Is the fan(s) working?	YES / NO YES / NO	Inform Treatment Team Leader Arrange for fan to be repaired
GENERAL	· Are there any outstanding actions from a previous investigation?	YES / NO	Complete actions

NAME: ____________________________ **DATE:** __________________



CHECKLIST FOR SITE ODOUR INVESTIGATION

PRODUCT + PROCESS OPTIMISER / TREATMENT TEAM LEADER

AREA OF WORKS	POTENTIAL PROBLEM		FOLLOW UP ACTION REQUIRED
ODOUR MANAGEMENT PLAN (OMP)	Does the site have an OMP?	YES / NO	
	If the site is not operated according to the OMP	YES / NO	Make changes to site operation to minimise odour production and release
SITE - GENERAL	Are all covers in place?	YES / NO	Replace covers and close hatches as required
	Are all access hatches closed?	YES / NO	
INLET WORKS	If the crude sewage black and / or smelly	YES / NO	Check incoming sewage for septicity (in conjunction with Operations Support team) Contact Industrial Waste to check for potential septic discharges
Screening	Are there any spilled screenings?	YES / NO	Clean up spills
	If the compacted screenings are not clean	YES / NO	Optimise operation of screenings handling equipment
Grit Removal	Is there any spilled grit?	YES / NO	Clean up spills
	If the grit is not clean	YES / NO	Optimise operation of grit handling equipment
Screening and Grit Skips	If the screenings skips smell	YES / NO	Check that screenings are clean and free from organic material; optimise screenings handling equipment if needed Empty skip(s)
	If the grit skips smell	YES / NO	Check that grit is clean and free from organic material, optimise grit cleaning system if needed Empty skip(s)
	Are the screenings skips too full?	YES / NO	Empty skips as needed
	Are the grit skips too full?	YES / NO	Empty skips as needed
Storm Tanks	Have the storm tanks been left full following a storm?	YES / NO	Empty and clean out tanks as needed
	Is there any sludge left in the bottom of the tanks?	YES / NO	
PRIMARY TANKS	If the tanks are black and / or smelly	YES / NO	Check inlet for septicity: Check levels of sludge in the tank and increase desludge rate if needed
	OR If the tanks are gassing	YES / NO	
	If there is excess scum on the surface	YES / NO	Remove excess scum
BIOLOGICAL FILTRATION	If the aeration vents are blocked	YES / NO	Unblock aeration vents
	If there is ponding	YES / NO	Consider increasing flushing rate and / or forking media
ACTIVATED SLUDGE	Do the dissolved oxygen levels in the aeration lanes match the setpoint(s)?	YES / NO	Adjust dissolved oxygen levels as required
	Do the MLSS fall within the tramlines for the site?	YES / NO	Increase / decrease RAS rate as needed
FINAL TANKS	If the tanks are black and / or smelly	YES / NO	Check inlet of tanks for septicity: Check levels of sludge in the tank and increase desludge rate if needed
	OR If the tanks are gassing	YES / NO	
	If there is excess scum on the surface	YES / NO	Remove excess scum
TERTIARY TREATMENT	If there are any site specific issues	YES / NO	Investigate and rectify
SLUDGE TREATMENT	Are there any sludge spills?	YES / NO	Clean up spills
Imports and Exports	If the tanker filling and emptying process causes significant release of odour	YES / NO	Investigate whether the process can be modified to reduce odour emissions Consider changing timing of tanker operations to reduce nuisance potential
Sludge Thickening and Storage	Are all covers are in place?	YES / NO	Replace covers and close hatches as required
	Are all access hatches closed?	YES / NO	
	Are the doors to sludge treatment buildings / sludge cake stores kept closed?	YES / NO	Close doors as required
Anaerobic Digestion	If all excess gas is not flared	YES / NO	Contact ER to investigate
	If flare stack ignitionis not immediate and reliable	YES / NO	Contact ER to investigate
	If the whesso valves / PRVs operate prematurely	YES / NO	Contact ER to investigate
	If the seals on the condensate traps leak or are damaged	YES / NO	Contact ER to investigate
ODOUR ABATEMENT	If there is any detectable odour downwind of the stack	YES / NO	Check OCU using additional checklist
	Is the fan(s) working?	YES / NO	Arrange for fan to be repaired
GENERAL	If there are any outstanding actions from a previous investigation	YES / NO	Complete actions

NAME: ______________________________ **DATE:** ____________________

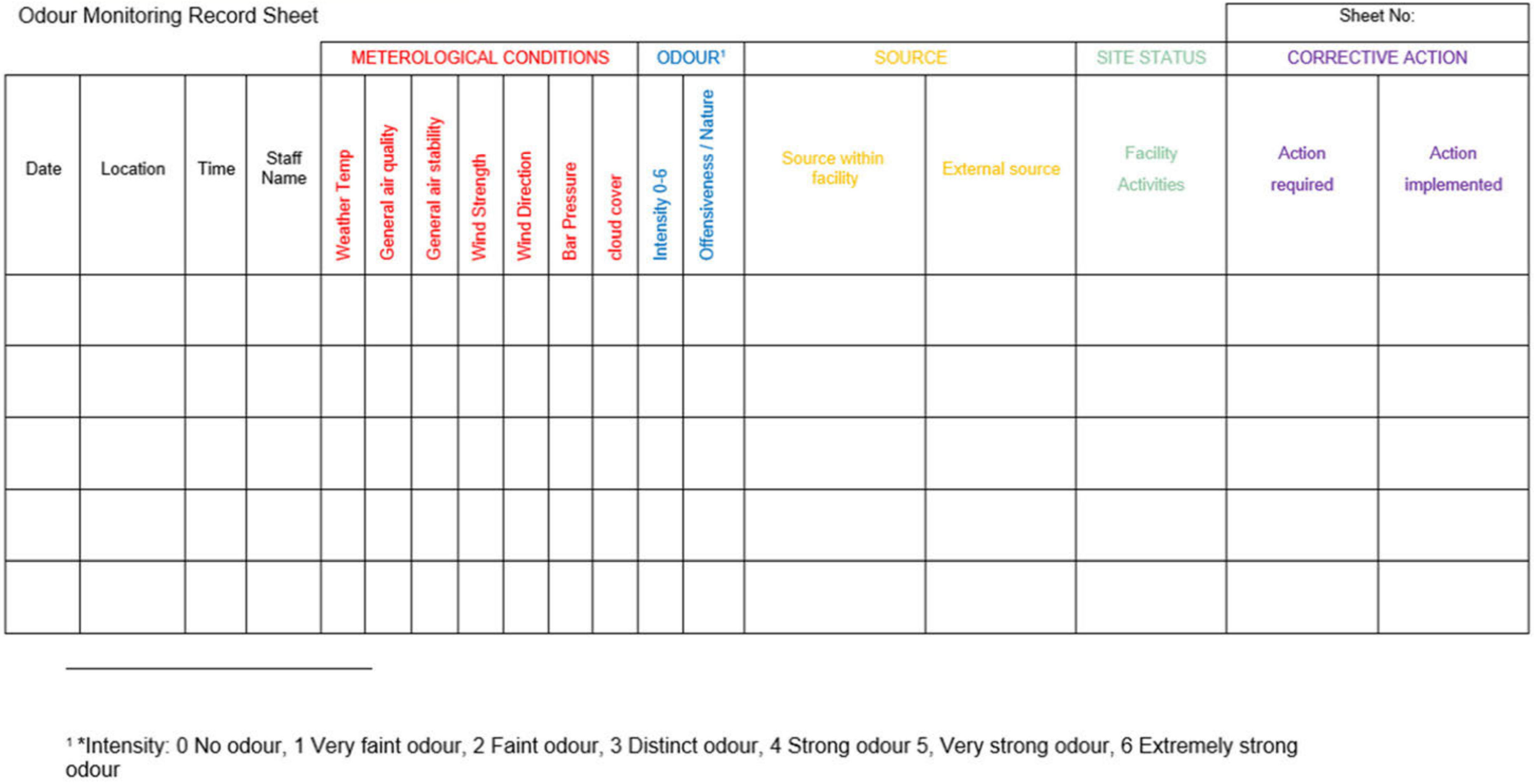
Appendix 3 OCU Performance Check List

Task	Frequency	Performance Indicators	Method	Actions to be Taken	Responsible Person
Odour Abatement Plant – Biofilter					
Gas flow rate	Continuous	+/- 15% design value (21,260 m^3/hr)	Gas flow meter / EN 16911-1 and MID for EN 16911-1	Odour abatement plant shall be regularly checked and maintained to ensure appropriate performance. Odour abatement plant shall be managed in accordance with permit conditions, the odour management plan and manufacturer's recommendations. Carbon filter(s) to be replaced in accordance with manufacturers recommendations. Equipment shall be regularly calibrated.	Operations
Temperature (inlet)	Daily	For information only	Temperature probe /Traceable to national standards		Operations
Thatching / compacting	Weekly	As per O&M	Back pressure		Operations
Hydrogen sulphide	Continuous	Max 172 ppm	Electrochemical monitor		Operations
pH (biofilter drainage effluent)	Continuous	pH 6 – 8	pH metre		Operations
Differential pressure	Continuous	+/- 15% design value (-224 Pa)	Recognised industry method		Operations
Check irrigation rates of biological OCU	As per O&M	As per O&M	Monitor flow on the unit.	Adjust wetting rate as required.	Operations
Check and clean the irrigation nozzles on the biological OCU	As per O&M	As per O&M	As per O&M	Clean as required	Operations
Efficiency assessment	Every 6 months	Hydrogen Sulphide – 98% removal rate Ammonia – 90% removal rate Mercaptans – 95% removal rate Dimethyl Sulphide – 20% removal rate VOCs – 50% removal rate	Media health, air-flow distribution and emission removal efficiency (BS EN 13725 for odour removal)	Third party survey to assess performance of the OCU including contaminant removal rates, media health, channelling of media.	3rd Party Specialist
Odour Abatement Plant – Carbon Filters					
Moisture / humidity	Daily	For information only	Moisture meter	Odour abatement plant shall be managed in accordance with permit conditions, the odour management plan and manufacturer's recommendations. Carbon filter(s) to be replaced in accordance with manufacturers recommendations. Equipment shall be regularly calibrated.	Operations
Differential pressure	Continuous	+/- 15% design value (-1,278 Pa)	Recognised industry method		Operations
Efficiency assessment	Annual	99% removal of contaminants	Emission removal efficiency (BS EN 13725 for odour removal)		3rd Party Specialist

Task	Frequency	Performance Indicators	Method	Actions to be Taken	Responsible Person
Odour Abatement Plant – Outlet Stack					
Temperature	Continuous	For information only	Temperature probe /Traceable to national standards	N/A	Operations
Hydrogen sulphide	Continuous	0.5 ppm	Electrochemical monitor	Investigate OCU performance. Arrange third party specialist support. Replace OCU media	Operations
Hydrogen sulphide	Every 6 months or as agreed in writing by the Environment Agency.	As per BAT 8 / BAT 34	CEN TS 13649 for sampling NIOSH 6013 for analysis	Action levels to be achieved in accordance with permit conditions and the odour management plan.	3rd Party Specialist
Ammonia	Every 6 months or as agreed in writing by the Environment Agency.	As per BAT 8 / BAT 34 (0.3 – 20 mg/Nm^3)	EN ISO 21877	Action levels to be achieved in accordance with permit conditions and the odour management plan.	3rd Party Specialist
Containment and Extraction System					
Extraction fan visual inspection	Monthly	No damage / leakage/ signs of corrosion	Visual inspection	If fans are damaged raise a job with ER	Operations
Extraction fan noise	Monthly	Increase noise or vibration from the fan motor	Listen	If fan is in fault or running noisy raise a job with ER	Operations
Check fan drive belt condition and tension	Annually	As per O&M	As per O&M	Check / Repair. Raise a job with ER	Operations
Check fan motors	Annually	As per O&M	As per O&M	Check / Repair. Raise a job with ER	Operations
Check physical integrity of ducting	Monthly	No signs of degradation or other damage and no holes	Visual Inspection	Raise a job with ER	Operations
Check duct supports	Monthly	No damage or corrosion	Visual Inspection	Raise a job with ER	Operations

Task	Frequency	Performance Indicators	Method	Actions to be Taken	Responsible Person
Process covers visual inspection	Monthly	Good cover integrity. No damage / gaps allowing for fugitive emission leakage.	Visual inspection	If process covers are damaged raise a job with ER	Operations

Appendix 4 Odour Monitoring Record Sheet



Odour Monitoring Record Sheet

Sheet No:

				METEROLOGICAL CONDITIONS							ODOUR[1]		SOURCE		SITE STATUS	CORRECTIVE ACTION	
Date	Location	Time	Staff Name	Weather Temp	General air quality	General air stability	Wind Strength	Wind Direction	Bar Pressure	cloud cover	Intensity 0-6	Offensiveness / Nature	Source within facility	External source	Facility Activities	Action required	Action implemented

---

[1] *Intensity: 0 No odour, 1 Very faint odour, 2 Faint odour, 3 Distinct odour, 4 Strong odour 5, Very strong odour, 6 Extremely strong odour

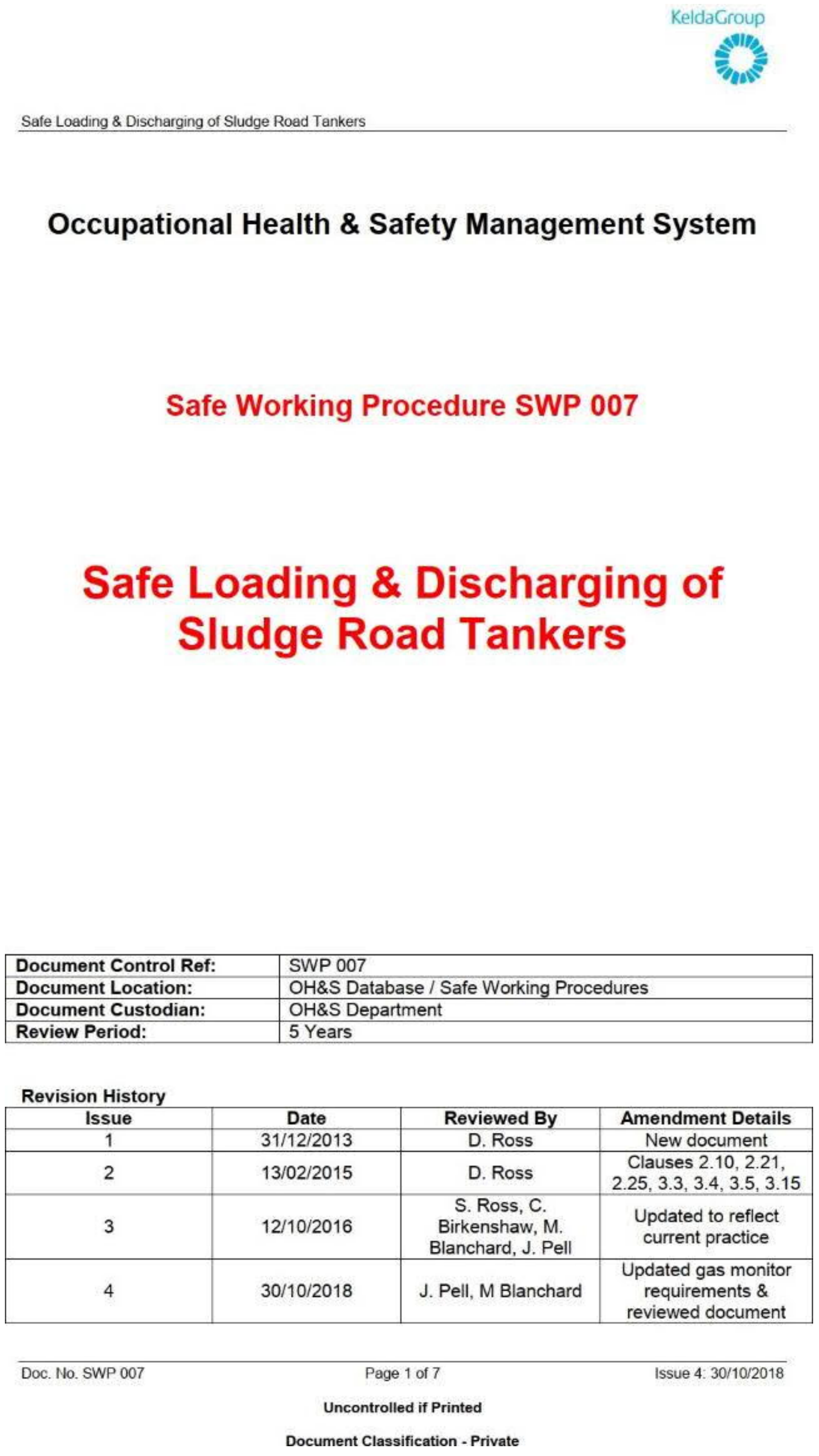
Appendix 5 Sniff Testing Record Sheet

Test by		Start Time	
Date		End Time	
Weather Condition		Temperature	
Wind Strength		Wind Direction	

Location No. / Name	Nearest Receptor Sensitivity	Intensity	What does it smell like?	Frequency of odour?	Is the source evident?	Other comments / observations
1. Odour Control Unit	Low / Medium / High	0 No odour 1 Very faint 2 Faint odour 3 Distinct odour 4 Strong odour 5 Very strong odour 6 Extremely strong odour.		Constant / Intermittent	Yes / No Source area / name to be provide. Might be that maintenance work if occurring and you can detect increased odours due to that activity, or call smell cake import wagon etc	Are there odours detected from other sources? Farm / Landfill / other industry etc
2. Drum Thickener building						
3. North of Dewatering Building						
4. Gas Holders						

5. Site Boundary – North-East						
6. Sludge Screens						
7. Cake Pad - Fresh						
8. Cake Pad East						
9. Cake Pad South-East						

Appendix 6 Safe Loading and Discharge of Sludge Road Tankers



Occupational Health & Safety Management System

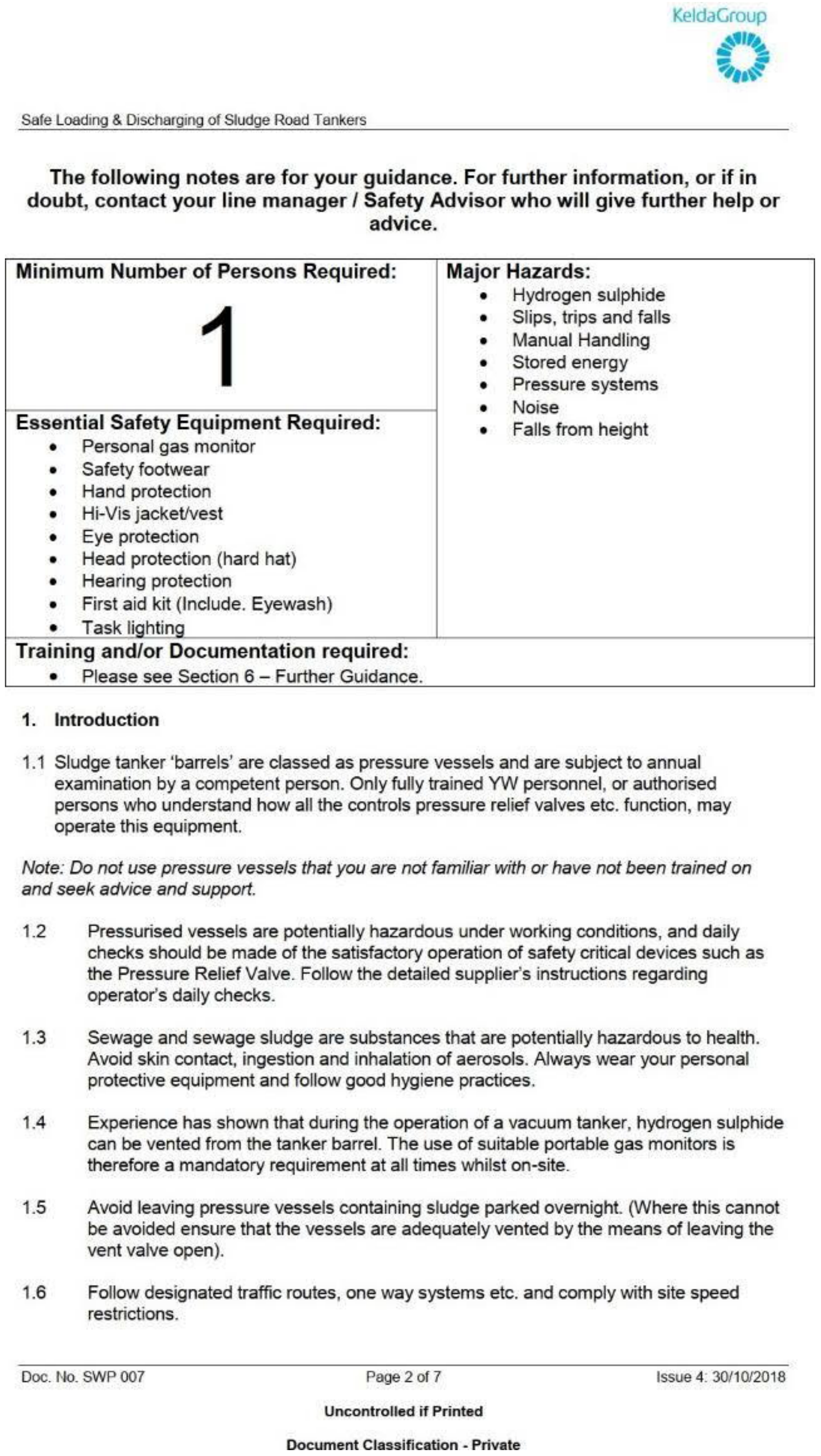
Safe Working Procedure SWP 007

Safe Loading & Discharging of Sludge Road Tankers

Document Control Ref:	SWP 007
Document Location:	OH&S Database / Safe Working Procedures
Document Custodian:	OH&S Department
Review Period:	5 Years

Revision History

Issue	Date	Reviewed By	Amendment Details
1	31/12/2013	D. Ross	New document
2	13/02/2015	D. Ross	Clauses 2.10, 2.21, 2.25, 3.3, 3.4, 3.5, 3.15
3	12/10/2016	S. Ross, C. Birkenshaw, M. Blanchard, J. Pell	Updated to reflect current practice
4	30/10/2018	J. Pell, M Blanchard	Updated gas monitor requirements & reviewed document



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Safe Loading & Discharging of Sludge Road Tankers

The following notes are for your guidance. For further information, or if in doubt, contact your line manager / Safety Advisor who will give further help or advice.

Minimum Number of Persons Required: 1	**Major Hazards:** • Hydrogen sulphide • Slips, trips and falls • Manual Handling • Stored energy • Pressure systems • Noise • Falls from height
Essential Safety Equipment Required: • Personal gas monitor • Safety footwear • Hand protection • Hi-Vis jacket/vest • Eye protection • Head protection (hard hat) • Hearing protection • First aid kit (Include. Eyewash) • Task lighting	
Training and/or Documentation required: • Please see Section 6 – Further Guidance.	

1. Introduction

1.1 Sludge tanker 'barrels' are classed as pressure vessels and are subject to annual examination by a competent person. Only fully trained YW personnel, or authorised persons who understand how all the controls pressure relief valves etc. function, may operate this equipment.

Note: Do not use pressure vessels that you are not familiar with or have not been trained on and seek advice and support.

1.2 Pressurised vessels are potentially hazardous under working conditions, and daily checks should be made of the satisfactory operation of safety critical devices such as the Pressure Relief Valve. Follow the detailed supplier's instructions regarding operator's daily checks.

1.3 Sewage and sewage sludge are substances that are potentially hazardous to health. Avoid skin contact, ingestion and inhalation of aerosols. Always wear your personal protective equipment and follow good hygiene practices.

1.4 Experience has shown that during the operation of a vacuum tanker, hydrogen sulphide can be vented from the tanker barrel. The use of suitable portable gas monitors is therefore a mandatory requirement at all times whilst on-site.

1.5 Avoid leaving pressure vessels containing sludge parked overnight. (Where this cannot be avoided ensure that the vessels are adequately vented by the means of leaving the vent valve open).

1.6 Follow designated traffic routes, one way systems etc. and comply with site speed restrictions.

Doc. No. SWP 007 Page 2 of 7 Issue 4: 30/10/2018

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Safe Loading & Discharging of Sludge Road Tankers

Task

2. Loading the Tanker (Vacuum Transfer)

2.1 On arrival on site, check that your personal gas monitor is turned on – has been calibrated (in a clean air environment) - and is worn on your person at all times whilst on-site (near your breathing zone).

2.2 Complete a 360º check of the tanker/loading area. Consider the environment around you – hazard identification, wind direction, vehicle movements, people in close proximity to the vehicle e.g. operators/contractors etc. Ensure all inlet and outlet valves are closed and then open the vent breaker valve before removing the end-cap.

2.3 Where practicable attach sufficient 'vent bagging' to the compressor exhaust extension pipe to vent any hydrogen sulphide away from the work area to ensure a safe working area is provided. Also consider the positioning or repositioning of your vehicle to reduce the potential of H2S in the working zone.

Note: Ensure that any gases being vented away from the tanker are not creating additional hazards to other people or processes and are not likely to enter a confined space.

2.4 If loading from a hose already connected to sludge holding tank, check hose for weight kick and gently lift (hose may possibly still have liquid left in it). Never assume any hose is sound - check for splits and excessive wear. Also check that couplings are in good condition and the correct sealing ring is in place before using the tanker hose. If the tanker hose is found to have faults, the tanker hose must never be used and be disposed of correctly.

2.5 Connect the hose between the tanker inlet valve and the loading point. Check that all connections are correctly fitted and all air taps are closed.

Note: The use of gloves in couplings is an unacceptable practice – do not use to create a seal in the bauer coupling.

2.6 Ensure that the changeover valves are in the vacuum/suck position.

2.7 Open the travel valve (if not automatic where fitted).

2.8 Once connections to vehicle and sludge tanks are made and vehicle power take off (PTO) is engaged if applicable, the driver should carefully monitor the loading operation. This may be achieved by standing in a safe location outside of the vehicle, observing the loading procedure.

Note: Keep clear of the exhaust area when loading and venting the barrel.

Doc. No. SWP 007 Page 3 of 7 Issue 4: 30/10/2018

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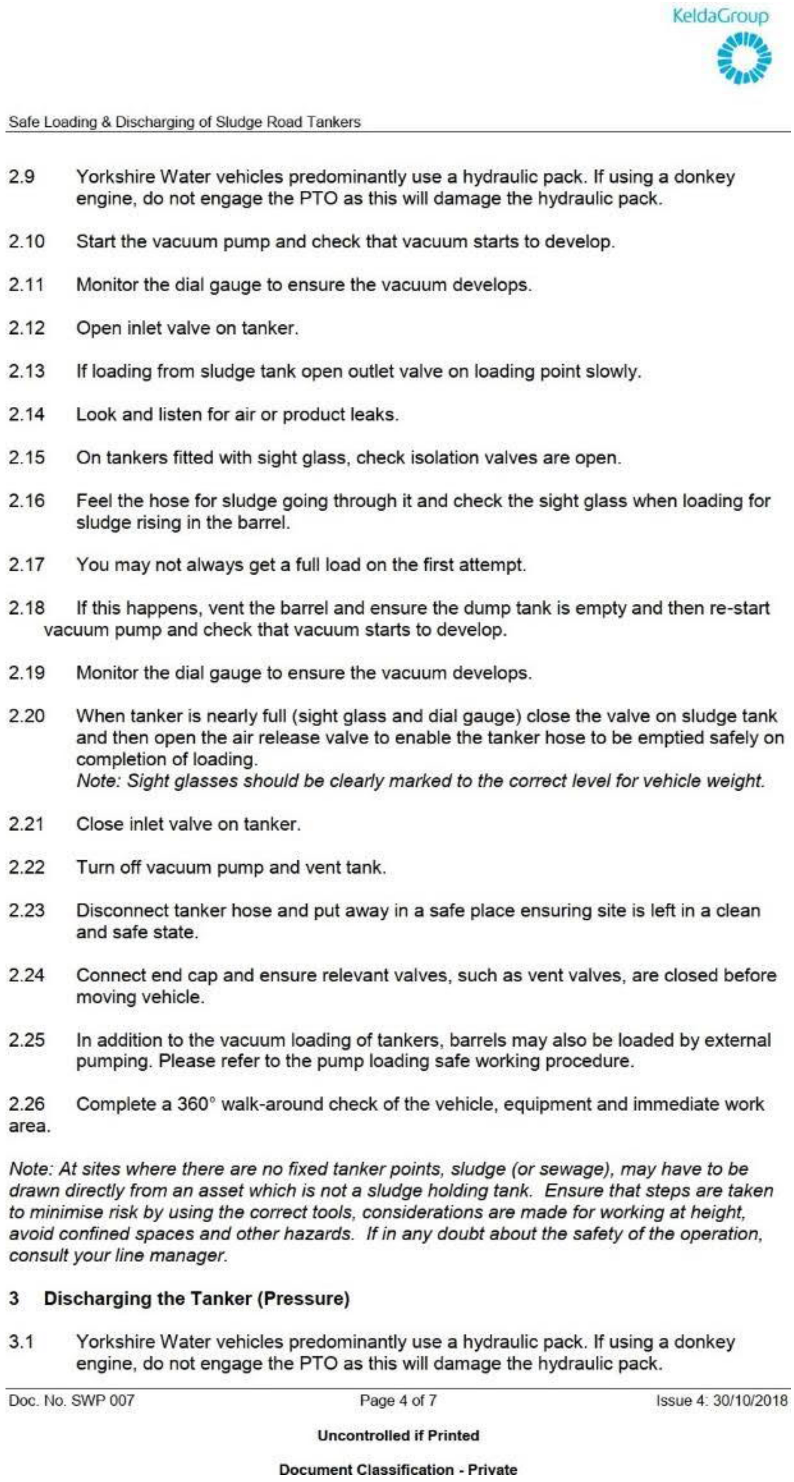

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Safe Loading & Discharging of Sludge Road Tankers

2.9 Yorkshire Water vehicles predominantly use a hydraulic pack. If using a donkey engine, do not engage the PTO as this will damage the hydraulic pack.

2.10 Start the vacuum pump and check that vacuum starts to develop.

2.11 Monitor the dial gauge to ensure the vacuum develops.

2.12 Open inlet valve on tanker.

2.13 If loading from sludge tank open outlet valve on loading point slowly.

2.14 Look and listen for air or product leaks.

2.15 On tankers fitted with sight glass, check isolation valves are open.

2.16 Feel the hose for sludge going through it and check the sight glass when loading for sludge rising in the barrel.

2.17 You may not always get a full load on the first attempt.

2.18 If this happens, vent the barrel and ensure the dump tank is empty and then re-start vacuum pump and check that vacuum starts to develop.

2.19 Monitor the dial gauge to ensure the vacuum develops.

2.20 When tanker is nearly full (sight glass and dial gauge) close the valve on sludge tank and then open the air release valve to enable the tanker hose to be emptied safely on completion of loading.
Note: Sight glasses should be clearly marked to the correct level for vehicle weight.

2.21 Close inlet valve on tanker.

2.22 Turn off vacuum pump and vent tank.

2.23 Disconnect tanker hose and put away in a safe place ensuring site is left in a clean and safe state.

2.24 Connect end cap and ensure relevant valves, such as vent valves, are closed before moving vehicle.

2.25 In addition to the vacuum loading of tankers, barrels may also be loaded by external pumping. Please refer to the pump loading safe working procedure.

2.26 Complete a 360° walk-around check of the vehicle, equipment and immediate work area.

Note: At sites where there are no fixed tanker points, sludge (or sewage), may have to be drawn directly from an asset which is not a sludge holding tank. Ensure that steps are taken to minimise risk by using the correct tools, considerations are made for working at height, avoid confined spaces and other hazards. If in any doubt about the safety of the operation, consult your line manager.

3 Discharging the Tanker (Pressure)

3.1 Yorkshire Water vehicles predominantly use a hydraulic pack. If using a donkey engine, do not engage the PTO as this will damage the hydraulic pack.

Doc. No. SWP 007 Page 4 of 7 Issue 4: 30/10/2018

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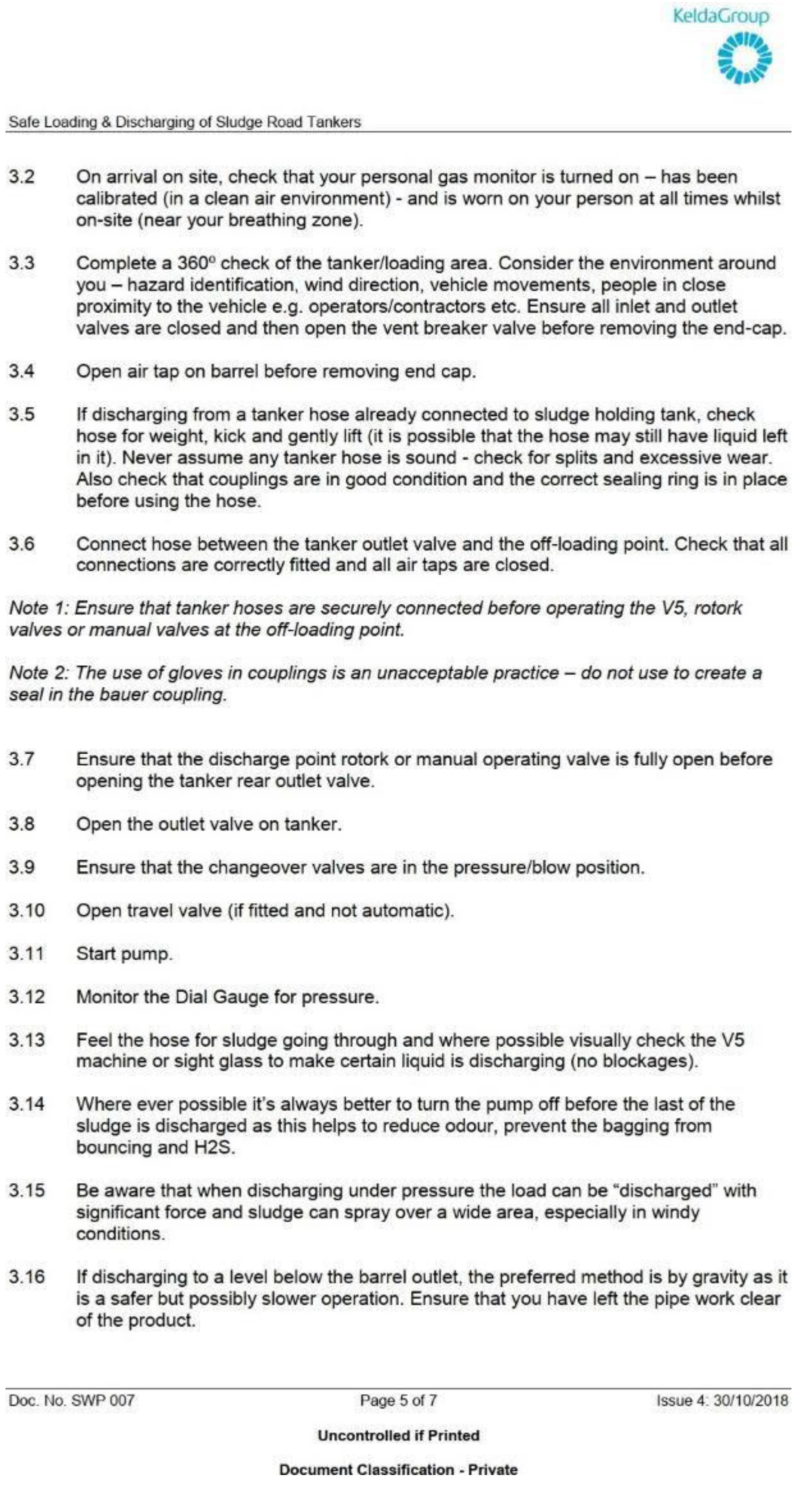

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3.2 On arrival on site, check that your personal gas monitor is turned on – has been calibrated (in a clean air environment) - and is worn on your person at all times whilst on-site (near your breathing zone).

3.3 Complete a 360° check of the tanker/loading area. Consider the environment around you – hazard identification, wind direction, vehicle movements, people in close proximity to the vehicle e.g. operators/contractors etc. Ensure all inlet and outlet valves are closed and then open the vent breaker valve before removing the end-cap.

3.4 Open air tap on barrel before removing end cap.

3.5 If discharging from a tanker hose already connected to sludge holding tank, check hose for weight, kick and gently lift (it is possible that the hose may still have liquid left in it). Never assume any tanker hose is sound - check for splits and excessive wear. Also check that couplings are in good condition and the correct sealing ring is in place before using the hose.

3.6 Connect hose between the tanker outlet valve and the off-loading point. Check that all connections are correctly fitted and all air taps are closed.

Note 1: Ensure that tanker hoses are securely connected before operating the V5, rotork valves or manual valves at the off-loading point.

Note 2: The use of gloves in couplings is an unacceptable practice – do not use to create a seal in the bauer coupling.

3.7 Ensure that the discharge point rotork or manual operating valve is fully open before opening the tanker rear outlet valve.

3.8 Open the outlet valve on tanker.

3.9 Ensure that the changeover valves are in the pressure/blow position.

3.10 Open travel valve (if fitted and not automatic).

3.11 Start pump.

3.12 Monitor the Dial Gauge for pressure.

3.13 Feel the hose for sludge going through and where possible visually check the V5 machine or sight glass to make certain liquid is discharging (no blockages).

3.14 Where ever possible it's always better to turn the pump off before the last of the sludge is discharged as this helps to reduce odour, prevent the bagging from bouncing and H2S.

3.15 Be aware that when discharging under pressure the load can be "discharged" with significant force and sludge can spray over a wide area, especially in windy conditions.

3.16 If discharging to a level below the barrel outlet, the preferred method is by gravity as it is a safer but possibly slower operation. Ensure that you have left the pipe work clear of the product.

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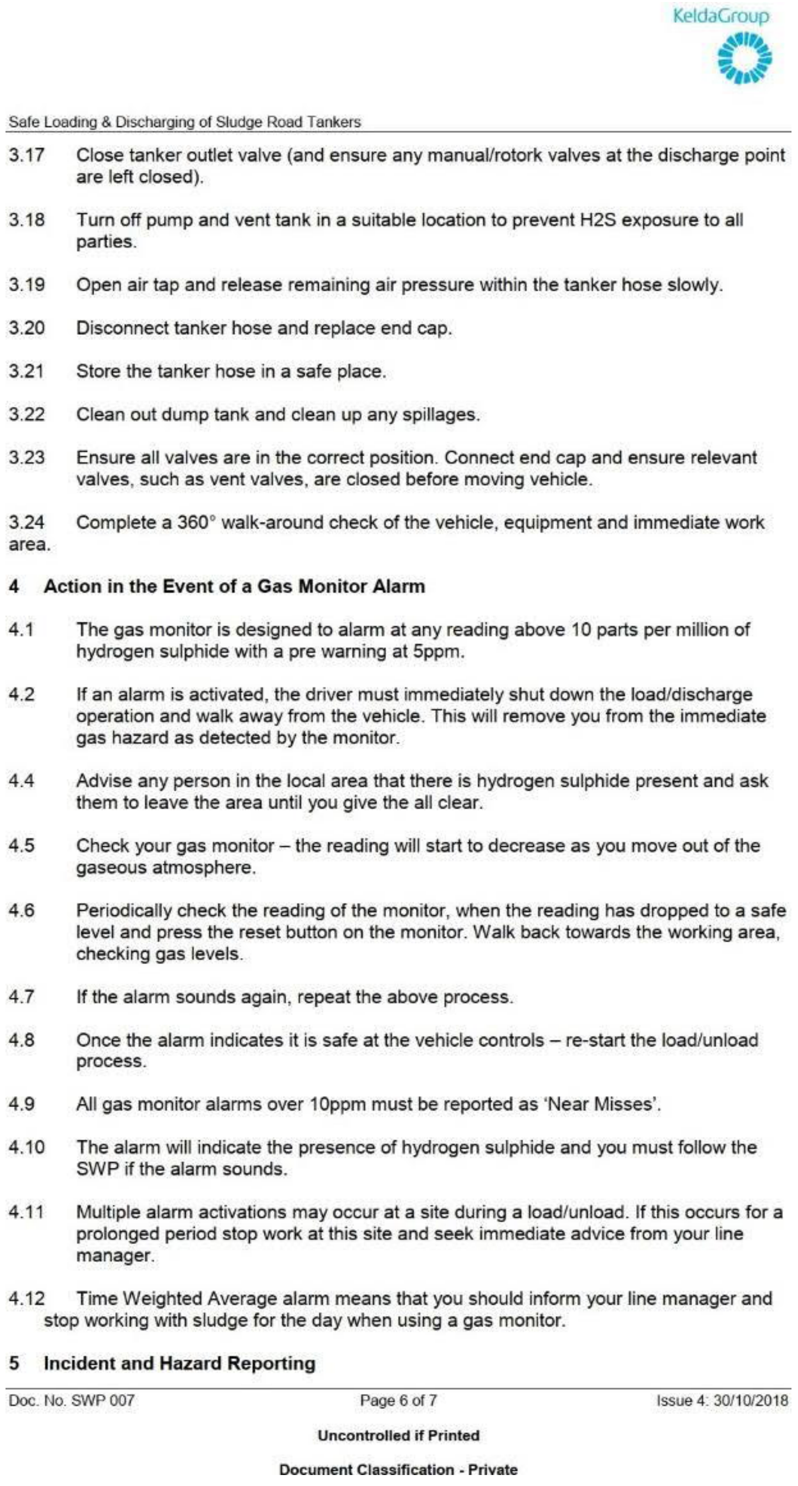


3.17 Close tanker outlet valve (and ensure any manual/rotork valves at the discharge point are left closed).

3.18 Turn off pump and vent tank in a suitable location to prevent H2S exposure to all parties.

3.19 Open air tap and release remaining air pressure within the tanker hose slowly.

3.20 Disconnect tanker hose and replace end cap.

3.21 Store the tanker hose in a safe place.

3.22 Clean out dump tank and clean up any spillages.

3.23 Ensure all valves are in the correct position. Connect end cap and ensure relevant valves, such as vent valves, are closed before moving vehicle.

3.24 Complete a 360° walk-around check of the vehicle, equipment and immediate work area.

4 Action in the Event of a Gas Monitor Alarm

4.1 The gas monitor is designed to alarm at any reading above 10 parts per million of hydrogen sulphide with a pre warning at 5ppm.

4.2 If an alarm is activated, the driver must immediately shut down the load/discharge operation and walk away from the vehicle. This will remove you from the immediate gas hazard as detected by the monitor.

4.4 Advise any person in the local area that there is hydrogen sulphide present and ask them to leave the area until you give the all clear.

4.5 Check your gas monitor – the reading will start to decrease as you move out of the gaseous atmosphere.

4.6 Periodically check the reading of the monitor, when the reading has dropped to a safe level and press the reset button on the monitor. Walk back towards the working area, checking gas levels.

4.7 If the alarm sounds again, repeat the above process.

4.8 Once the alarm indicates it is safe at the vehicle controls – re-start the load/unload process.

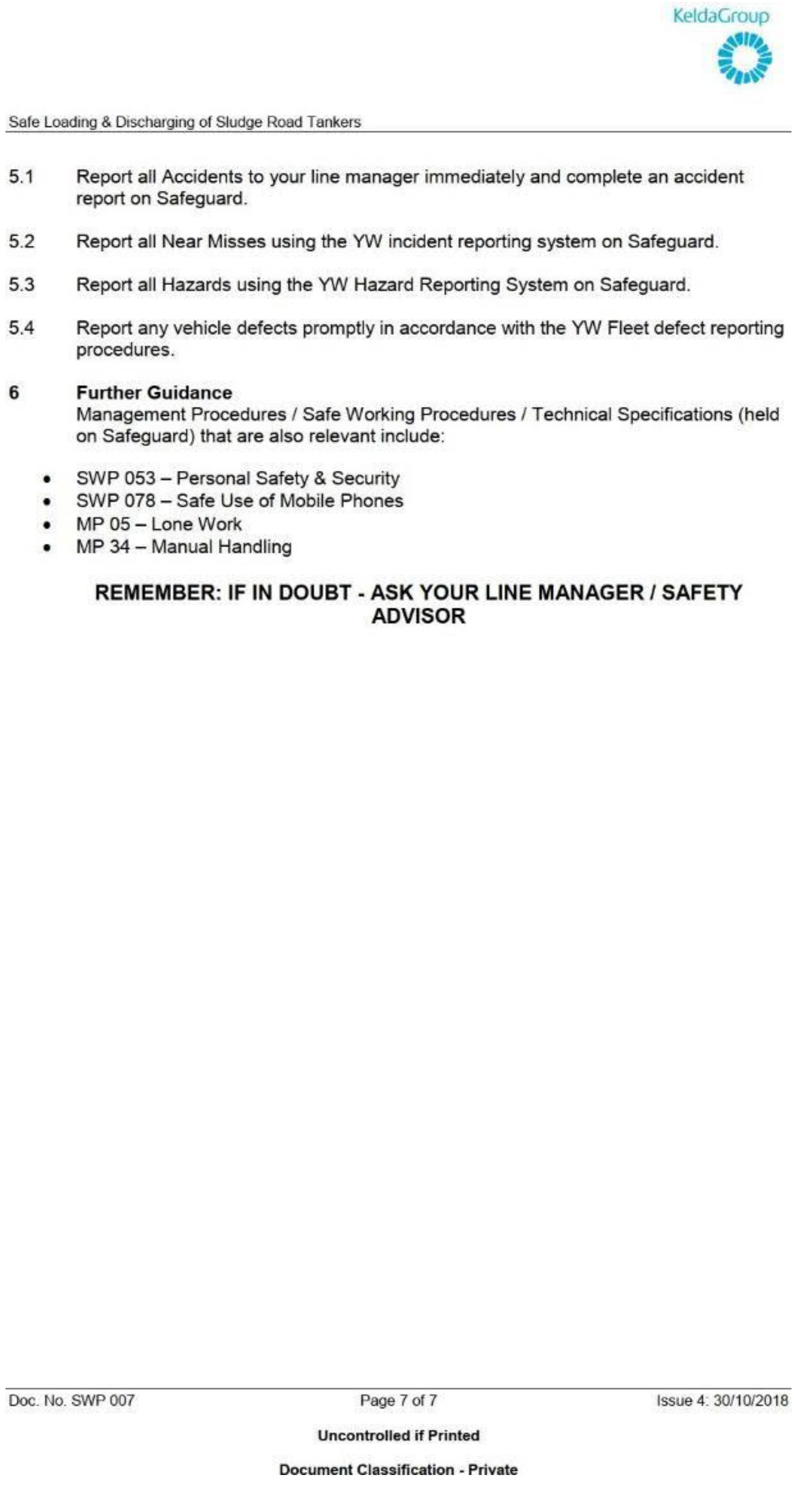
4.9 All gas monitor alarms over 10ppm must be reported as 'Near Misses'.

4.10 The alarm will indicate the presence of hydrogen sulphide and you must follow the SWP if the alarm sounds.

4.11 Multiple alarm activations may occur at a site during a load/unload. If this occurs for a prolonged period stop work at this site and seek immediate advice from your line manager.

4.12 Time Weighted Average alarm means that you should inform your line manager and stop working with sludge for the day when using a gas monitor.

5 Incident and Hazard Reporting



5.1 Report all Accidents to your line manager immediately and complete an accident report on Safeguard.

5.2 Report all Near Misses using the YW incident reporting system on Safeguard.

5.3 Report all Hazards using the YW Hazard Reporting System on Safeguard.

5.4 Report any vehicle defects promptly in accordance with the YW Fleet defect reporting procedures.

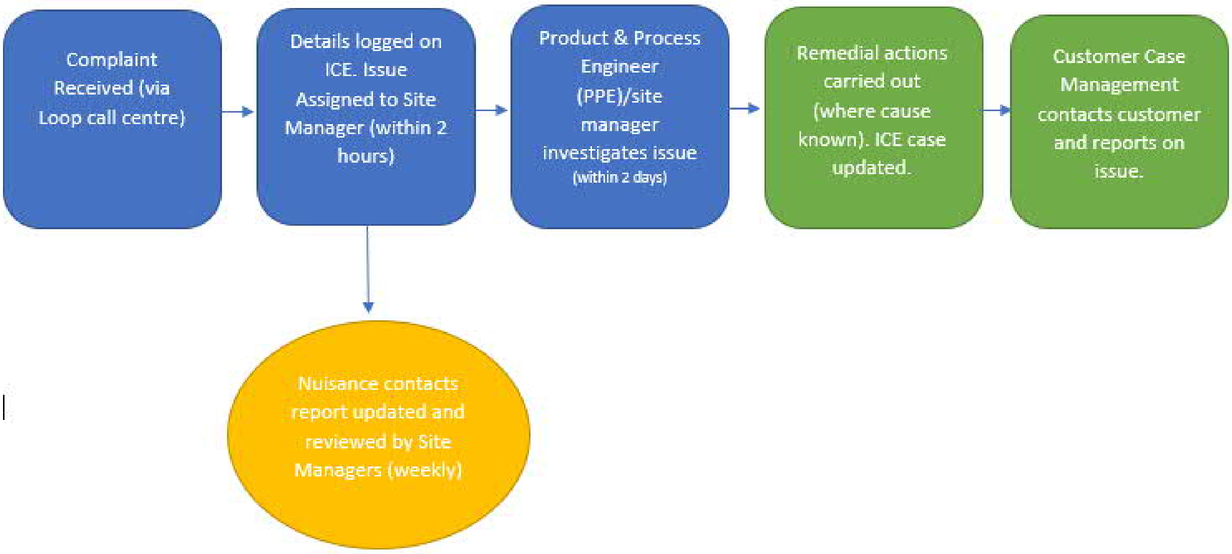
6 Further Guidance

Management Procedures / Safe Working Procedures / Technical Specifications (held on Safeguard) that are also relevant include:

- SWP 053 – Personal Safety & Security
- SWP 078 – Safe Use of Mobile Phones
- MP 05 – Lone Work
- MP 34 – Manual Handling

REMEMBER: IF IN DOUBT - ASK YOUR LINE MANAGER / SAFETY ADVISOR

Appendix 7 Odour Complaint Process



Appendix 8 STF Odour Complaint Form

Loop handle customer complaints being reported to Yorkshire Water. The call Handler will work with the complainant to try and locate the odour. Loop uses a software system called ICE to record the issue. If the issue is believed to be arising from a sewage works, the call handler will work through the following forms to pinpoint the issue.

Customer’s details (name and address, if provided)	
When did the odour occur	
Time when the odour occurred	
Where was the location of the odour	
Is the odour happening now or was it in the past	
Does the customer know what is causing the smell	
What is a description of the odour (sewage / drains / eggy / sweet composting)	
Is this the first time the odour has been noticed	
Where is the odour at its worst (inside/outside house/boundary)	
Any other comment	

Appendix 9 Odour Investigation Form

The following investigation form will be used by Operational staff in the event of an odour complaint being received.

Date of odour complaint	
Time of odour (if known)	
Name of YW colleague investigating issue	
Postcode where the issue was identified (if known)	
Weather at the time of odour complaint (including temperature)	
Wind Direction (from onsite wind monitor) and strength (no wind, light, gusty, heavy)	
Description of smell from Complainant (if known)	
Is this linked with other complaints	
Do you know what asset is causing the issue	
Can the asset be identified through sniff testing (follow sniff testing monitoring programme in the odour management plan)	
Can the issue be resolved immediately	
If no, what actions are needed to resolve the issue	
If the issue is going to take >2 days to resolve, can the issue be mitigated to reduce the odour effect	
Does the odour management plan need updating to discuss the cause/action/mitigation	
Date when resolved	

Appendix 11 Secondary Containment Risk Assessment

Lundwood Secondary Containment Assessment

December **2023**

Sign-Off Sheet

Project details	
Project number	331001762 100.2401
Project name	Environmental permitting for IED sites
Date	December 2023
Client details	
Client name	Yorkshire Water Service Ltd
Client address	Western House Halifax Road Bradford West Yorkshire BD6 2SZ
Document details	
Document title	Lundwood Secondary Containment Assessment
Document version	Final2
Report author	Kiran Parmar
Report reviewed by	Sam Walmsley
Report approved by	
Report by	Stantec Stantec House Kelburn Court Birchwood Warrington WA3 6UT

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Contents

List of Figures

List of Tables

1 Introduction

As part of the Industrial Emissions Directive (IED) permit application for Lundwood Sludge Treatment Facility (STF), Yorkshire Water (YW) has undertaken an assessment of the significance and potential environmental risks associated with a loss of containment of process vessels. YW has also reviewed existing provisions and potential improvement options against Best Available Techniques (BAT) principles, in alignment with CIRIA C736[1].

Lundwood STF falls under the IED as a Part A(1) installation by virtue of exceeding the 100t/d capacity limit for anaerobic digestion (AD. The permit will cover raw sludge storage, handling and thickening, digested sludge storage, handling and dewatering, sludge cake secondary treatment and storage, biogas storage, utilisation and flaring. This document focuses on the secondary containment aspects of the permit requirements, in particular the application of BAT, and should be viewed in parallel with the main permit application document, in particular Section II: Technical Description, Section III: Accident Risk Assessment and Appendix 4: Site Condition Report.

1.1 Site details

Lundwood Wastewater Treatment Works (WwTW) was constructed circa 1960 in the village of Lundwood, 3.2km east of Barnsley, South Yorkshire. Lundwood STF is located adjacent to the WwTW. The River Dearne is located to the south and the STF installation is bordered primarily by farmland to the south and east and by housing to the North and to the Northwest. Lundwood STF treats indigenous sludge from the co-located WwTW and liquid sludge imported from other YW WwTW.

An aerial view of Lundwood STF along with its installation boundary is shown Figure 1. The key activities at Lundwood STF are illustrated via a process flow diagram in Figure 2. Key activities include sludge thickening; anaerobic digestion; biogas handling and combustion; sludge dewatering and associated routes of gaseous, liquid, and solid materials and energy vectors. These processes are further discussed in Section 3.2.1.

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[1] CIRIA (2014) Containment systems for the prevention of pollution: Secondary, tertiary, and other measures for industrial and commercial premises (C736; 2014)

Figure 1. Lundwood STF aerial view, installation boundary in green. © Google, 2021

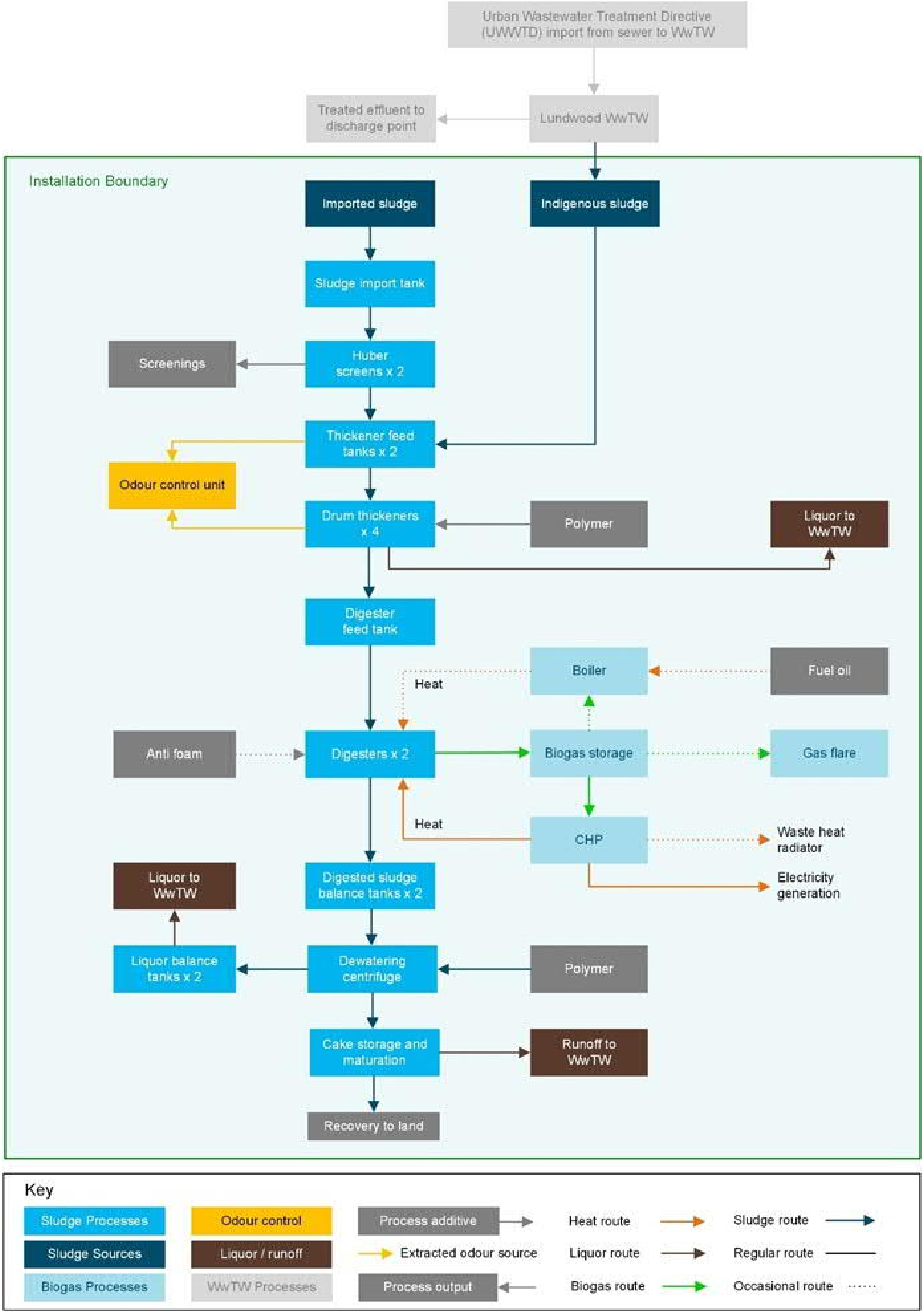


Figure 2. Process flow diagram Lundwood STF.

1.2 Overview

YW commissioned Stantec to assess existing provisions and, where necessary, improvement options for secondary containment at the site. Stantec have provided risk-based supporting evidence to accompany the permit application, which demonstrates the most appropriate solution(s) for BAT compliance using CIRIA C736 standards. To fully understand the requirement for secondary containment and to provide environmental protection at Lundwood, two different industry standard tools have been used, these are shown within the flow chart in Figure 3.

Firstly, the Anaerobic Digestion and Biogas Association (ADBA) secondary containment risk assessment tool has been applied to assets at Lundwood. The ADBA assessment tool uses a risk-based methodology to determine the class of secondary containment systems required at a site, based on an assessment of sources, pathways and receptors, and the control measures which already provide protection.

As an existing installation in continuous operation, retrospectively applying a standard secondary containment bund to all sludge tanks and containers may present significant technical, operational, safety and logistical challenges. It is also noted that the location of Lundwood STF within a wider wastewater treatment works (WwTW) presents opportunities in terms of utilising existing YW assets as part of the pollution containment and prevention solution. Recognising this limitation, a bespoke source, pathway, receptor approach has been developed by Stantec and applied to identify and risk assess bunding solutions in line with the ADBA approach. These findings have then been used to develop as well site-specific options for secondary containment.

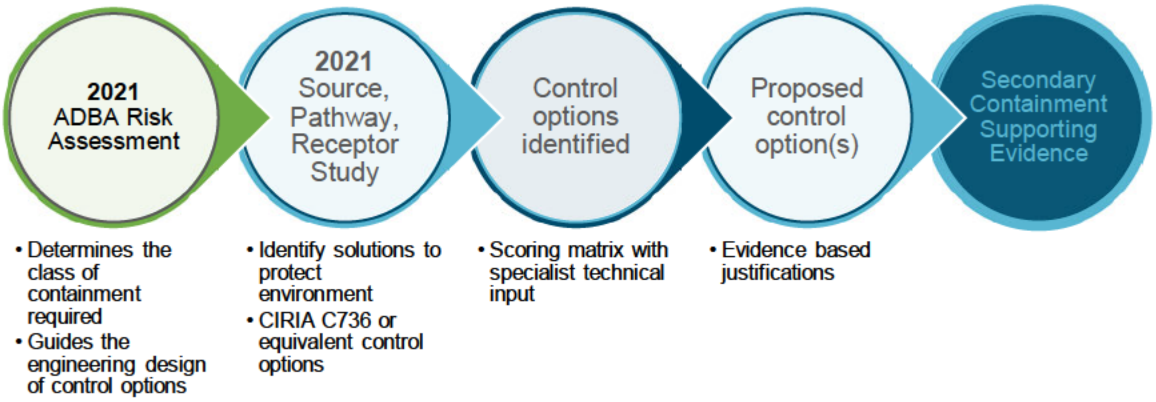


Figure 3. Flow chart showing the approach taken to provide secondary containment supporting evidence.

2 ADBA risk assessment tool findings

The ADBA Risk Assessment Tool is based on CIRIA C736 requirements for the prevention of pollution: including secondary and tertiary containment, and other measures for industrial and commercial premises. An assessment is presented in Appendix 1 and the findings are summarised in this chapter.

2.1 Class of required secondary containment for Lundwood

To identify the class of containment deemed to provide sufficient environmental protection in the ADBA Risk Assessment, the tool uses a source, pathway, receptor model. This identifies hazards posed to the environment and assigns a class of containment based on the site hazard rating and likelihood of loss of primary containment. The approach is summarised in Figure 4 below.

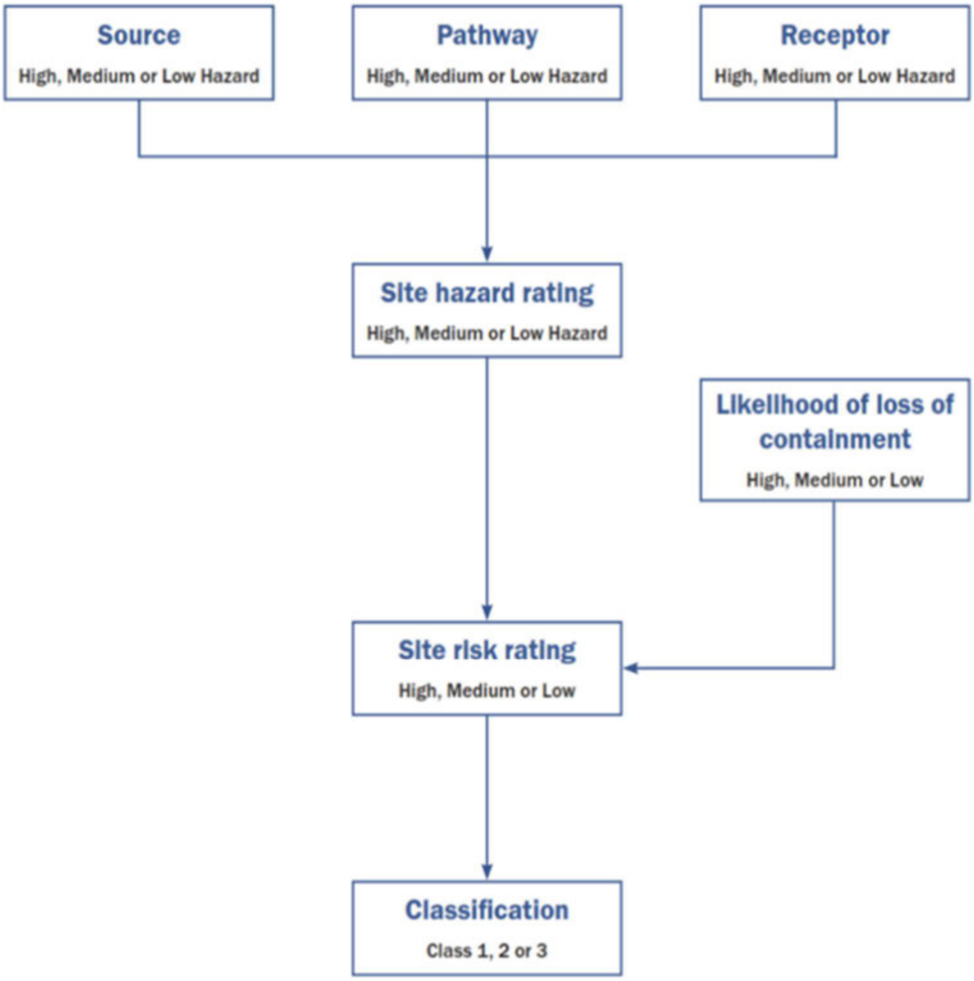


Figure 4. ADBA risk assessment classification flowchart.

The ADBA Risk Assessment Tool scored the source element as ‘High risk’, pathway elements as ‘High risk’ and the receptor element as ‘High risk’ at Lundwood owing to the significant volumes of sewage sludge stored on site and site drainage pathways to the sensitive receptor, the River Dearne. In summary, this assessment approach indicates that Lundwood STF has an overall site hazard rating of ‘High Risk’. The likelihood of failure was ‘Low Risk’ due to the type of infrastructure involved and the mitigations at the site e.g., regular tank inspections and level sensors.

According to Table 4 within the ADBA tool (box 2.2 CIRIA C736), reproduced in Figure 5 below, the combination of a high site hazard rating and a low likelihood rating, gives the overall site risk as medium. The indicated class of secondary containment for **Lundwood STF was therefore deemed as being Class 2.**

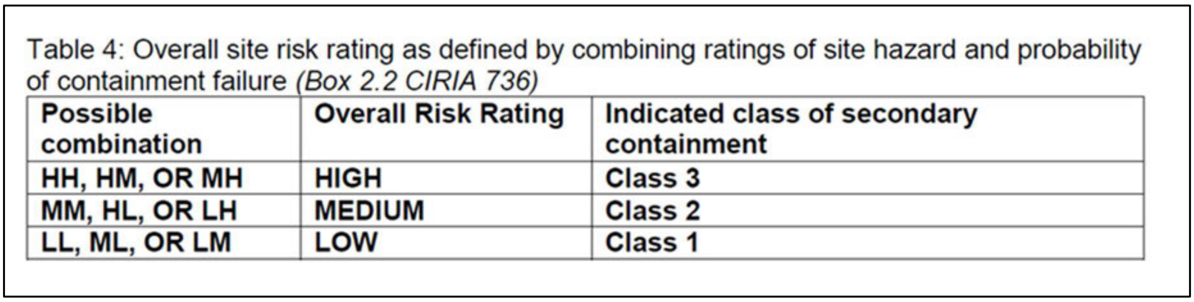


Table 4: Overall site risk rating as defined by combining ratings of site hazard and probability of containment failure *(Box 2.2 CIRIA 736)*

Possible combination	**Overall Risk Rating**	**Indicated class of secondary containment**
HH, HM, OR MH	**HIGH**	**Class 3**
MM, HL, OR LH	**MEDIUM**	**Class 2**
LL, ML, OR LM	**LOW**	**Class 1**

Figure 5. ADBA classification matrix.

The ‘Lundwood STF ADBA Secondary Containment Risk Assessment’ outlines the information and data utilised in greater detail, as well as the assumptions applied to undertake a secondary containment risk assessment. The requirement for ‘Class 2’ type secondary containment within Lundwood STF will be used to inform the next stage of secondary containment assessment, carried out by Stantec to support the permit application process (See Chapter 3).

3 Solution appraisal

3.1 Objectives

The purpose of this stage of the assessment is to determine the significance and potential environmental risks associated with a loss of containment from sludge vessels within the Lundwood STF, and to review existing provisions and potential improvement options against BAT principles, including CIRIA C736. As described previously, this stage of the process is informed by the outputs of the ADBA tool, but also considers options which are outside the scope of the ADBA scoring system utilising a bespoke methodology which adopts source-pathway-receptor principles in a qualitative risk-based framework.

3.2 Sources at Lundwood STF

The sources of risk which have been identified at Lundwood as shown in Figure 6. These STF operational assets comprise of sludge import, thickening, digestion, dewatering and cake storage areas.

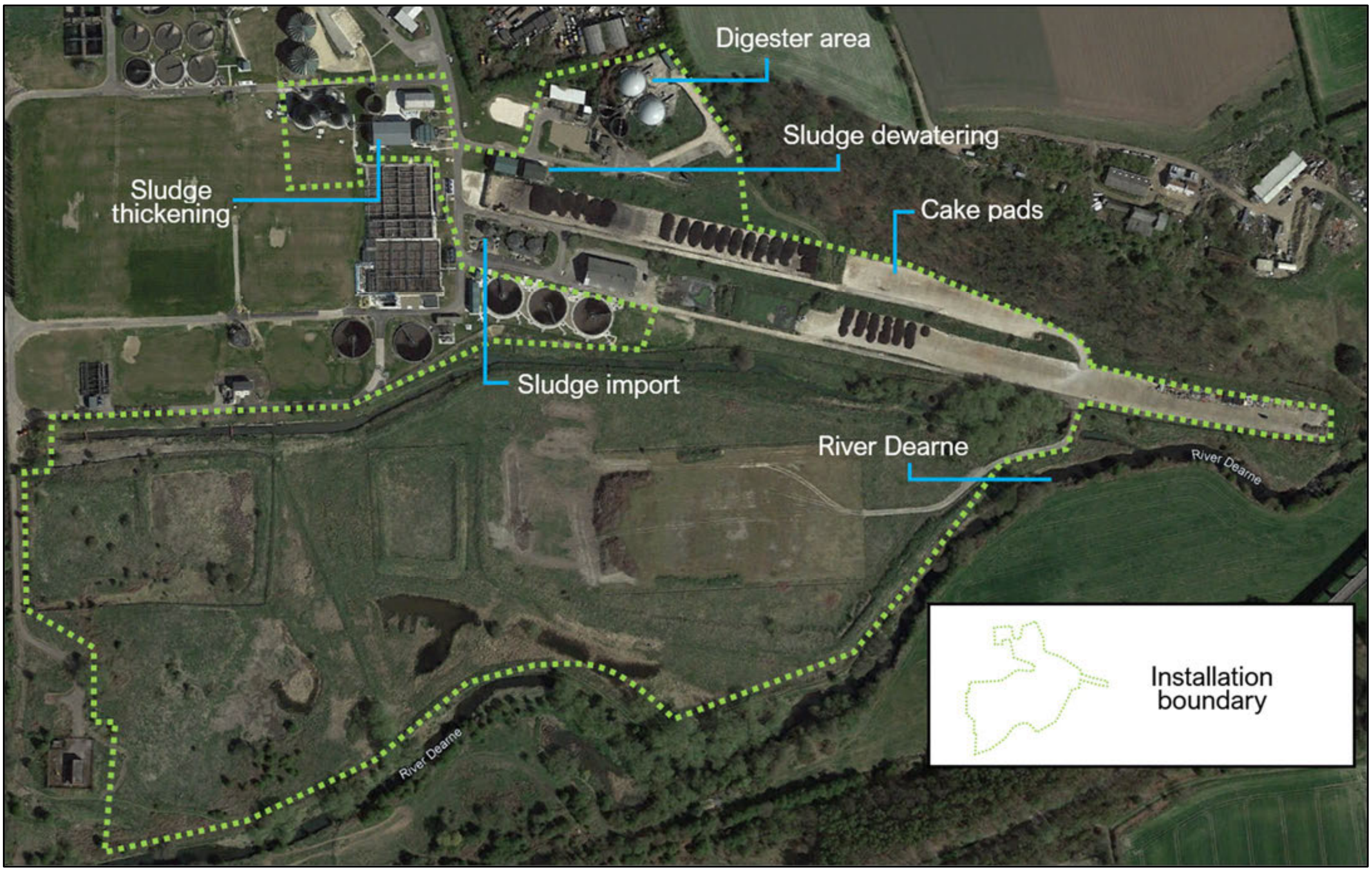


Figure 6. Lundwood sources of risk and site areas.

3.2.1 Bulk storage vessels

The bulk storage vessel locations are shown and labelled in Figure 7 and Figure 8. Further description of how these vessels are utilised, the sources of risk, existing controls and mitigations associated with the STF is provided in the discussion.

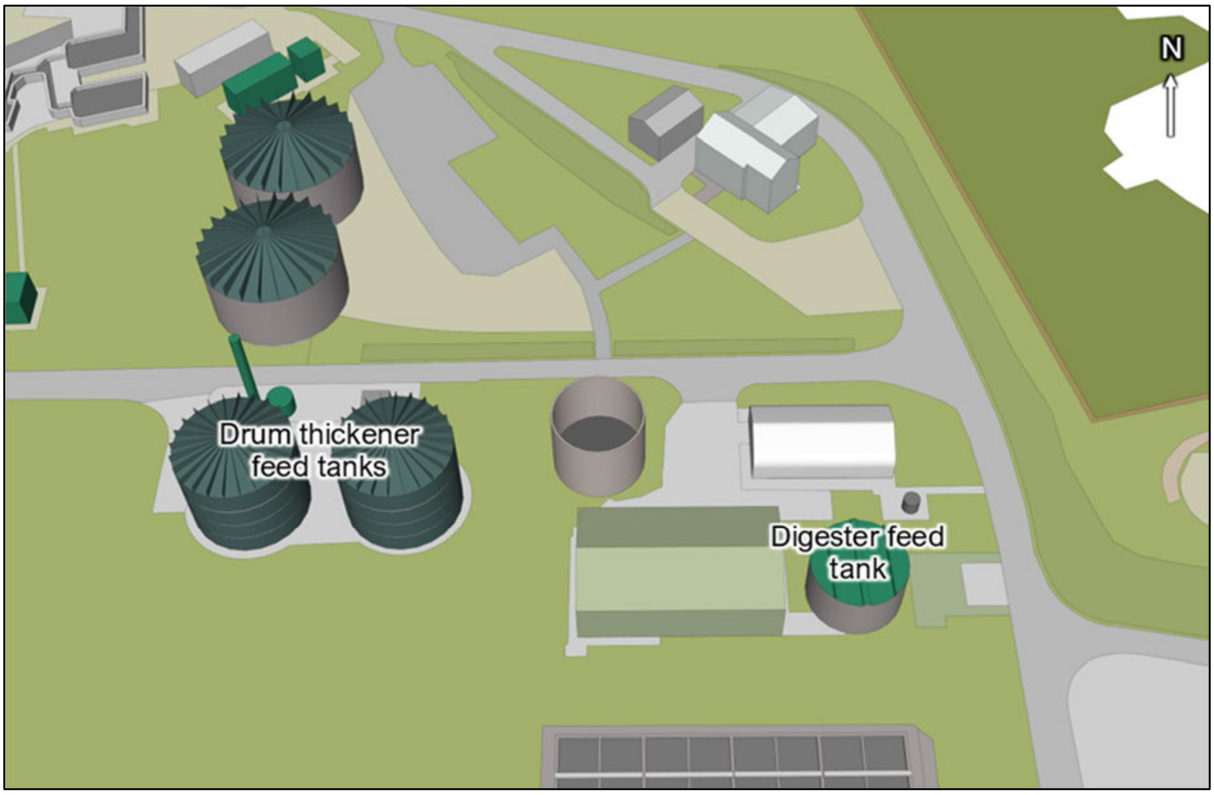


Figure 7. Sludge vessels located in the northern and central section of the site.

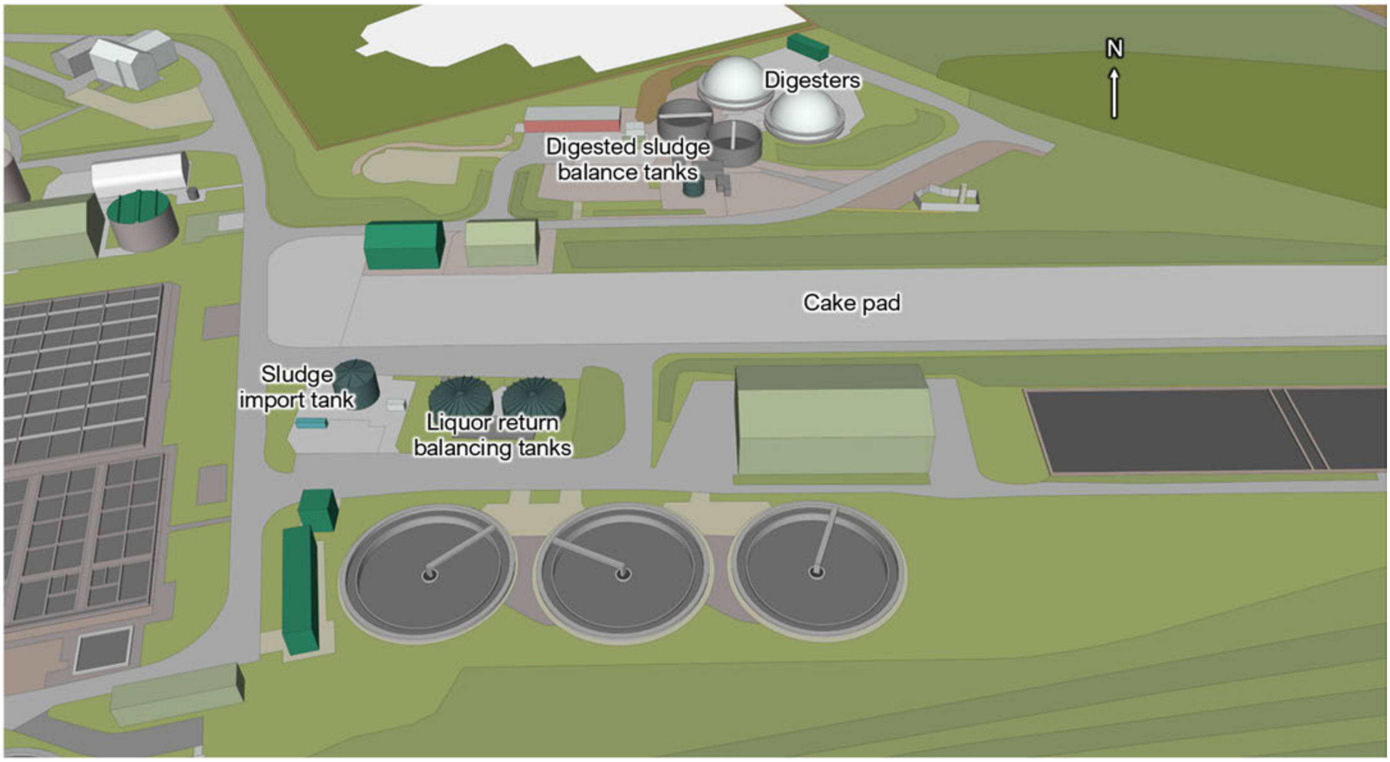


Figure 8. Sludge vessels located in the eastern section of the site.

3.2.1.1 Sludge reception, treatment, and handling

Lundwood STF treats the following sewage sludges:

- Indigenous primary sludges and surplus activated sludge (SAS) arising from sewage treatment processes operating within the wider Lundwood WwTW that are piped directly to the STF.
- Liquid sludges generated by other YW Wastewater Treatment Works (WwTW) (with lower capacity or capability for treating sludges on-site) that are imported to Lundwood STF for additional treatment.

Imported liquid sludge is delivered to site by tanker. The tanker unloads at the dedicated sludge import area and sludge is pumped (using vehicle mounted pumps) into the sludge screen feed tank (Figure 9, 150 m^3 covered steel tank). The maximum load is typically 28 tonnes with unloading taking up to 30 minutes. Only appropriately authorised vehicles can discharge at the site. This is controlled using a ‘WaSP’ logger; valves on the discharge pipework will only open when a driver presents appropriate authentication to the system. The WaSP logger records the source of the sludge, the time and date of delivery, the total volume discharged and average percentage dry solids of the load.

Figure 9. Sludge import tank.

After screening, imported liquid sludge is pumped via a sub-surface concrete sump, in pipework (largely underground) to the thickener feed tanks (Figure 10, 2 no. 1,589 m^3 covered steel tanks). These tanks are air mixed and operate in fill / draw mode with tanks changing over every 24 hours. The tanks are covered with headspace air extracted and routed to a two-stage odour control unit.

Indigenous SAS and primary sludge from the wider Lundwood WwTW is piped directly to the thickener feed tanks and mixed with the imported screened liquid sludge prior to onward transfer to the drum thickener building.

Figure 10. Drum thickener feed tanks (2 no.).

Sludge from the thickener feed tanks is then transferred to the thickener building via above and below ground pipework serving two thickening process streams, which operate on a duty/standby basis. Each sludge stream comprises a dedicated thickener feed pump drawing blended sludge, a polymer dosing pump drawing made-up polymer, a flocculation tank and a pair of drum thickeners (thus there are four thickeners in total). Concentrated liquid polymer is diluted with potable water, then mixed with treated final effluent as a carrier and mixed with the sludge in the flocculation tank. Each flocculation tank feeds two drum thickeners at an equal rate. The polymer encourages separation of water and sludge as the sludge is rotated in the drum to remove excess liquid. The resulting liquor is transferred to a wet well located to the west of the thickener feed tanks and from there is pumped back to the WwTW for full treatment. Each sludge stream has been sized with sufficient capacity to process site daily throughput requirements over a 16-hour period i.e., there is adequate redundant capacity in the event of plant failure.

The drum thickeners are equipped with automatic spray bars which provide continual self-cleaning. In addition, an automatic hot wash system is run periodically in accordance with the planned maintenance regime. The hot wash is designed to break down any fats that would blind the drum filter material. The automatic spray bars operate using treated final effluent and the hot wash system utilises mains potable water.

The liquid polymer delivery point is located in the roadway outside the thickener building; liquid polymer is delivered in 1m^3 IBCs and pumped from these to a 10 m^3 bulk storage tank located within the thickener building. Located above the same concrete sump bund within the thickener building as the bulk storage tank is the 5 m^3 capacity polymer solution storage tank containing the diluted polymer solution.

Best available techniques for sludge reception, treatment and handling includes trace heating, reducing fracture on freezing and largely automated PLC. PLC includes level sensors to reduce risk of tank overtopping, resulting in contamination and potential odour generation. Tanks also have an emergency overspill facility connected to site drainage (that is discharged back to the WwTW inlet) as a last line of defence to prevent overtopping.

3.2.1.2 Sludge digestion

The thickened sludge is transferred to a 712 m^3 digester feed tank (Figure 11). This tank is of concrete construction, mixed and covered. Sludge is passed forward continually from this tank to the anaerobic digesters (Figure 12, 2 no. 2,056 m^3 concrete tanks). The digesters are located on steeply sloping ground and therefore are partly buried below ground on one side, with approximately an above ground volume of 441 m^3. The anaerobic digesters operate as a continuous process with sludge being added and treated sludge extracted. The two digesters have a typical feed rate of around 120 m^3/day combined; the combined maximum feed rate is 308m^3/day (at 6% dry solids) giving a 12-day retention time as required by Hazard Analysis and Critical Control Points (HACCP) controls. The digesters are mixed by gas mixing systems, which utilise biogas from the headspace of each digester; the gas is compressed and then reintroduced using an array of mixing nozzles on the floor of the digester.

Figure 11. Digester feed tank.

A hot water circuit provides heating to ensure optimum conditions for digester microbial activity. Potable water is heated to around 70°C by the CHP and/or boiler. This hot water then heats the digester using tube-in-tube, counter-current heat exchangers. Sludge from the digesters is continually recirculated around the heat exchangers using 2 no. (duty/standby) recirculation pumps per digester. A 3-way modulating valve on the water side moderates the amount of hot water that passes into the heat exchanger, depending on the heat demand of the digesters.

Grit build up within digesters is a normal feature of operation; the digesters are cleaned out (including accumulated grit) every 10 years as part of the planned periodic inspection which also includes an internal and external inspection of tank integrity and replacement of instrumentation and gas mixing equipment as required.

An automatic anti-foam dosing system is in place to control digester foaming. This system uses a radar level probe in the digester headspace and compares this to the pressure level sensor at the bottom of the digester to determine the depth of foam. Upon detection of foam, treated final effluent is sprayed into the digester head space through nozzles in the digester roof. If this is not effective in breaking up the foam, a chemical anti-foam is mixed with treated final effluent and dosed into the headspace of the digester via the same spray nozzles. This system includes operator-adjustable dosing setpoints and failsafe systems; if the foam level continues to increase mixing systems are inhibited and if this continues the digester feed will be inhibited. Antifoam is stored in 20 litre plastic containers on a drip tray located within the digester compound prior to transfer to the integrally bunded antifoam dosing tank (approximate capacity of 0.5m^3).

Figure 12. Digesters (2 no.).

A boiler is available for use as an alternative heat source for the digesters. The boiler can be fired by either biogas or fuel oil and has a thermal input of approximately 833 kW. This is located within the same building as the CHP (in an adjacent room) and combustion products are discharged via a 3.5m high (approximately) stack located to the rear of the building. In normal operations boiler use is limited as heat recovery from the CHP engine meets the digester heat demand. Fuel oil used as back up supply for the boilers is stored within a 35,000 litre integrally bunded steel tank.

Best available techniques for sludge digestion include largely automated PLC, monitoring for optimum digester health and foam levels to avoid potential loss of containment, including an anti-foaming system. Additionally, an inspection and testing programme for above and below ground vessels, pipes and valves is in place. This incorporates a combination of visual examinations and non-destructive testing (e.g., ultrasonic thickness measurements).

3.2.1.3 Digested sludge treatment, handling and disposal

Digested sludge is gravity fed from the digesters to the adjacent digested sludge balance tanks (Figure 13, 2 no. concrete open topped tank with capacity of 880m^3). These tanks are periodically mixed to prevent settlement and anoxic conditions. Powdered polymer stored in 750kg bags is dispensed via a hopper dosing system which feeds a polymer 'ageing' tank where the powdered polymer is mixed with potable water and transferred to a stock tank (approximate capacities of 6m^3). The polymer solution is injected into the sludge stream and taken to the digested sludge dewatering centrifuge where the sludge coagulates and supernatant liquor is removed by centrifugal forces

Figure 13. Digested sludge storage tanks (2 no.).

Dewatered liquor is transferred to two liquor balancing tanks (Figure 14, covered steel tanks, each with a capacity of 250 m^3) prior to transfer to the WwTW for full treatment.

The final digested and dewatered sludge cake is transferred via a conveyer from the centrifuge up over a push-wall and onto the cake pad (Figure 15). The area under the conveyer and adjacent sludge cake pads are an engineered impermeable surface, with water runoff collected in drains running along the bottom edge of the pad. These liquids are pumped back to the WwTW for full treatment.

Figure 14. Liquor return balancing tanks (2 no.).

Figure 15. Sludge cake conveyor and pad.

Once on the cake pad, sludge cake is moved by mechanical loaders into storage rows (Figure 16). There is no lime addition at Lundwood STF; instead, cake is stored in piles according to age and is left to mature for a minimum of six weeks in accordance with HACCP requirements. Approximately 3,000 tonnes sludge cake will normally be held on site at any one time. However, the maximum storage capacity of the cake pad is significantly greater than this, up to 12,750 tonnes; greater volumes may be stored on site in emergency/abnormal conditions such as following processing problems at other YW sites or in extreme weather conditions when landspreading operations are temporarily paused. Once maturation is complete, sludge cake is removed from site and landspread in accordance with legislative requirements. Samples of digested, matured cake are taken every 3 months, or whenever a Critical Control Point (CCP) (e.g., digestion retention time or temperature) is not within specification and analysed for metals and pathogens to ensure HACCP standards are being met.

Figure 16. Sludge cake storage pad.

The best available techniques for digested sludge treatment, handling and disposal comprises of an engineered cake pad with leachate and washwater collection for treatment at the WwTW, and an inspection and testing programme for pipes and valves, which include surveys using in-pipe leak detection technology.

3.2.2 Tank volumes

The storage volumes, date constructed and construction materials of the sludge and non-sludge tanks within the STF are summarised in Table 1.

Table 1. Lundwood STF tanks, capacities, age, and construction materials.

Tank	Size m^3 (each tank)	Year constructed	Construction material
1 no. sludge import tank	150	2009	Steel
2 no. drum thickener feed tanks	1,589	2019	Steel
2 no. liquid polyelectrolyte tank (neat and mixed)	10 5	2019	PE
1 no. digester feed tank	712	2008	Concrete
2 no. digesters	2,056 ([a]441)	1962	Concrete
2 no. digested sludge storage tanks	880	1970, 1971	Concrete
2 no. polymer tanks (stock and ageing)	6	2009	Steel
1 no. potable water tank	60	2002	PE
2 no. liquor return balancing tanks	250	2002, 2015	Steel
1 no. gas oil tank	35	2011	Steel

[a] volume of sludge stored above ground for subsurface installations.

3.2.3 Engineering and maintenance standards

YW technical standards define the types of assets that meet the requirements of the business, including how they should be built and then maintained. In relation to Lundwood, this covers:

- Design and construction of all assets, including selection of appropriately qualified design and build contractors.
- Procedures for inspection and testing of storage vessels, including internal and external inspections, thickness assessment and non-destructive testing.
- Regular inspections of above ground assets and associated pipework at defined intervals.
- Documented log of any actions arising because of these inspections.

YW's asset standards have been developed over many years and where relevant comply with Civil Engineering Specification for the Water Industry (CESWI) Seventh Edition March 2011 and the Water Industry Mechanical and Electrical Specifications (WIMES 9.02).

Contractors involved in the design/build of the Lundwood scheme were YW framework contractors, appointed following a rigorous EU tender process; this process involved an assessment of experience, technical competency, design capability and quality procedures.

The combination of all these measures significantly reduces the risk of a catastrophic tank failure, thus reducing the likelihood of secondary containment being required. Nonetheless, it is recognised that the risk of a catastrophic tank failure cannot be eliminated, and external factors could always arise leading to very low likelihood, high consequence events (such as missile generation arising from other plant failure, domino effects or *force majeure*, for example an aircraft impact or terrorist attack).

3.3 Existing site surfacing

Most of the active process areas within the installation are covered by buildings and hardstanding, with some peripheral areas of soft landscaping (grass and gravel cover). Surfacing was generally observed to be in good condition across the site with no significant evidence of cracks or erosion. Site surfacing for Lundwood is illustrated in Figure 17.

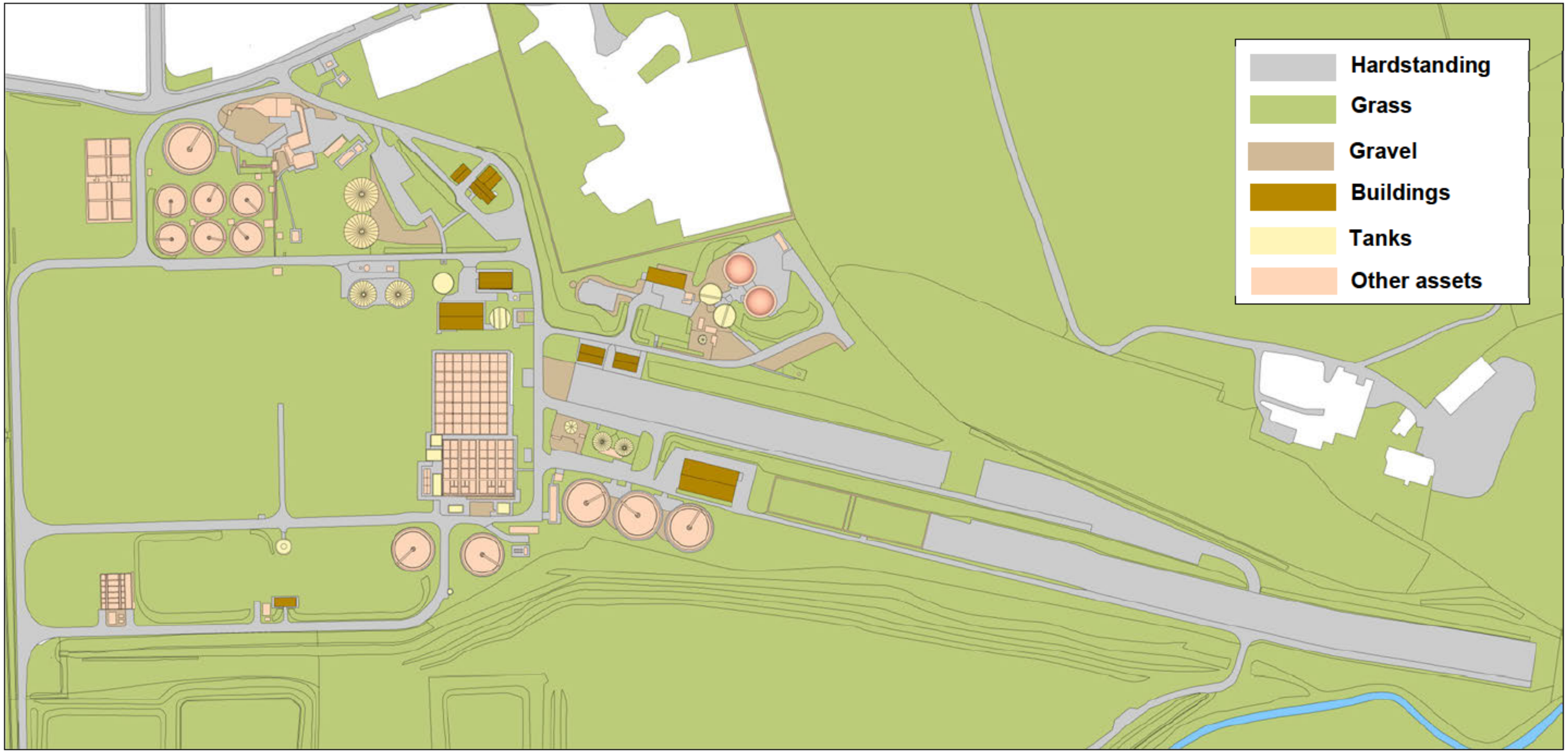


Figure 17. Lundwood existing site surfaces.

3.4 Pathways

Pathways are the routes by which pollutants could travel from a source to the point where they could cause damage, the receptor. The potential pathways in this assessment were determined using computation flow modelling based on defined source spillage volumes. The modelling approach, limitations and spill volumes are outlined in the following sections, allowing the principal pathways to be identified.

3.4.1 Spill modelling

To model the potential impact of spills to the environment from the various sludge treatment assets at Lundwood STF and defined credible pathways, YW has used PondSIM, a computational overland flow modelling tool. PondSIM can represent the flow of a liquid spill across an area of ground, taking account of local topography and flow restrictions (such as barriers). Applying this to the Lundwood site has allowed visualisation of the likely effects of a spill occurring within each of the key areas of the permitted installation.

3.4.1.1 Modelling limitations and uncertainties

As with any computational modelling tool, there are several assumptions required and associated modelling limitations and uncertainties:

- PondSIM is designed to model the overland flow of water; as such it is not able to account for the typically higher viscosities associated with sludge, which results in a larger modelled inundation extent than would be expected.
- The model cannot allow for flow to drains and other subsurface features.
- Surge is not accounted for within the model. Instead, this will be allowed for by ensuring final designs consider CIRIA C736 recommendations, while recognising the loss of kinetic energy as viscous sludge travels over flat ground.
- The model assumes that no mitigation measures are put in place following an incident to curtail flow.
- The model assumes that the full modelled volume spills from a single point.
- Assets are treated as simple flow barriers in the model, which may result in deflections being observed where flow would spread out.

Therefore, the modelled outputs are a worst-case inundation scenario resulting from sludge spills at Lundwood. Notwithstanding these limitations, the use of PondSIM is considered appropriate as an initial screening tool for this study.

3.4.2 Spill scenarios and volumes

YW has followed CIRIA C736 guidance on spill volumes to be modelled i.e., values equivalent to the containment provided by bunded tanks have been used. For a single tank the volume should be calculated based on 110 per cent of the capacity of that tank. For multi-tank installations, the containment volume should be calculated based on 25 per cent of the total capacity of all the tanks in a common area (which assumes that it is unlikely that more than 25 per cent of tanks will fail simultaneously), or 110 per cent of the largest tank, whichever is greatest. Tanks which are hydraulically linked should be treated as if they were a single tank.

The Lundwood sludge storage tanks and treatment processes are installed as either multi-tank or single tank installations, as shown in Figure 18, where blue is a single tank installation and numbered yellow areas are multi-tank installation areas. Non-sludge vessels (i.e., polymer, water, and gas oil tanks etc.) have not been included within the PondSIM modelling. This is due to the site already having appropriate secondary containment measures in place, in accordance with YW's asset standards. The CIRIA C736 rule spill modelling scenario and associated containment volumes is listed in Table 2. As the digesters at Lundwood are located partially below ground, the below ground volume can be considered contained. Therefore, the above ground volume, as shown in Figure 19, was used in the calculation of modelling volumes.

Table 2. Volume of material used in spill modelling scenarios.

Scenario	Capacity calculation	Modelled containment volume (m^3)	Modelling reference
CIRIA C736 rule	Single tank and multi-tank installations	3,774	Figure 20

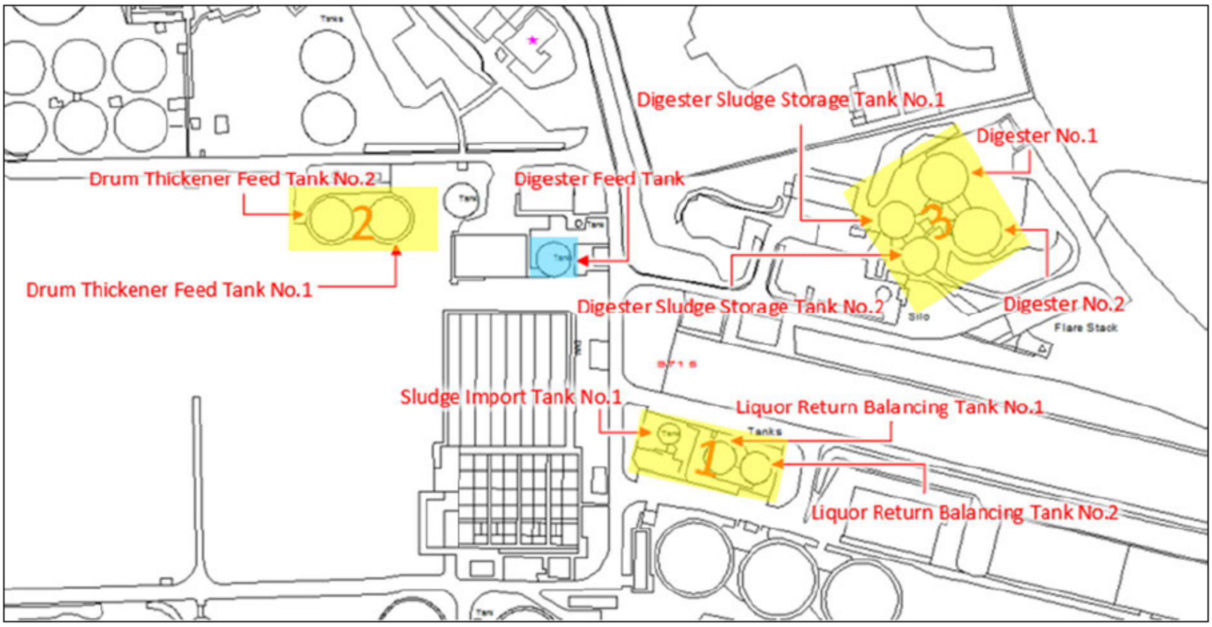


Figure 18. Lundwood single tank and multi-tank installation areas.

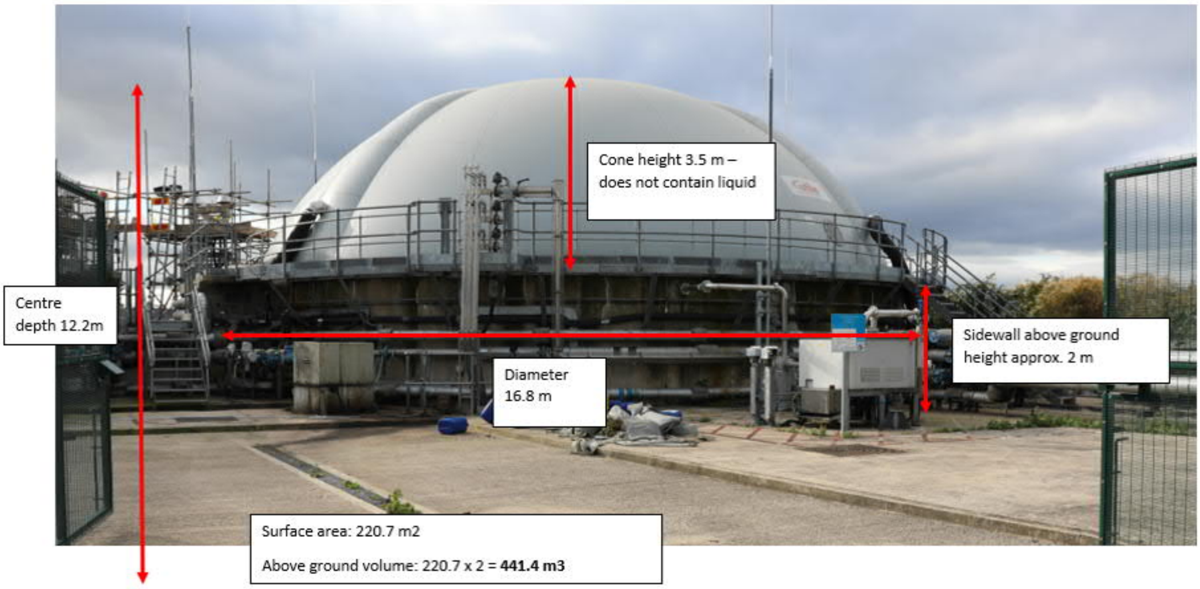


Figure 19. Calculation of digester above ground volumes.

3.5 PondSIM modelling of unmitigated pathways

This section presents the modelling outputs showing unmitigated spills and resulting pathways from the identified sources, via surface pathways as calculated by PondSIM to the identified receptors.

This modelling assessment considered the effect of a simultaneous loss of containment from all the single and multi-sludge tank areas at the STF. Therefore, the model presented in Figure 20 represents the CIRIA C736 scenario, recognising limitations discussed in 3.4.1 Spill modelling. The location and direction of the modelled spills and adjacent treatment assets are discussed in section 3.6 Spill pathways.

It is important to note that owing to the limitations described in 3.4.1.1, and the specific topography of the Lundwood site, it is not felt that PondSIM outputs at Lundwood are representative of the likely impact of a tank collapse. The detail of this is discussed in following sections, but common themes are:

- PondSIM models fluids as having very low viscosity. In the hilly areas of a site such as Lundwood, this leads to fluids travelling significant distances. In practice, pooling is likely to occur i.e., large spread in a small area, rather than long ‘streams’ covering significant distances.
- The aerial survey used to support the modelling is imperfect. At Lundwood there are several small surface features which would be likely to retain sludge, that were not captured in the aerial survey. See photos in the following section for additional detail.
- PondSIM cannot model capture of liquid within site drainage system. In practice, the modelled flows travel over some areas of ground that has contained drainage which will capture a proportion of spilt material.

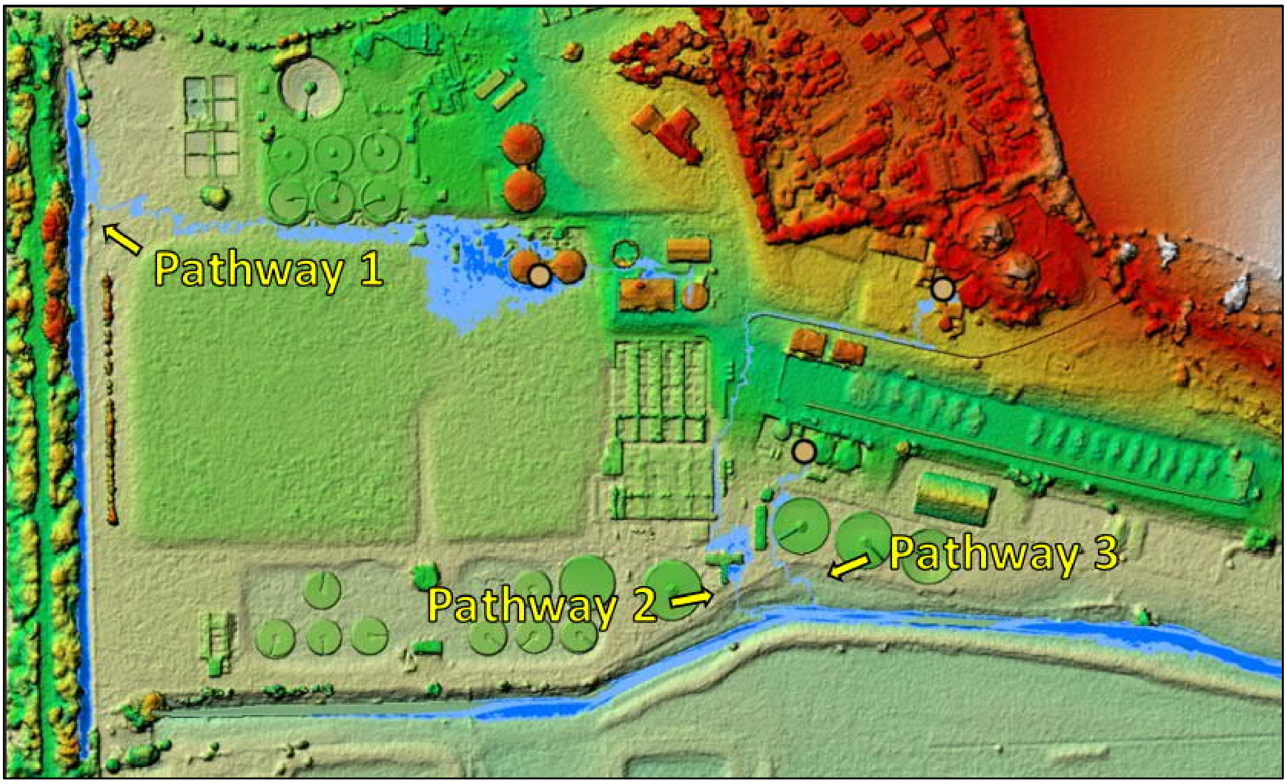


Figure 20. Model showing unmitigated result of spills and resulting pathways from existing tanks at Lundwood STF using the CIRIA C736 rule.

3.6 Spill pathways

3.6.1 Surface drainage

A surface water drainage survey was completed at Lundwood WwTW in October 2020. The survey mapped the location of gullies and manholes, separating them into contained and non-contained drainage routes, as illustrated in Figure 21. Surface water drainage routes shown in red are routed to the inlet of the WwTW i.e., contained. Lundwood STF has not been found to have surface water drainage that discharges directly to River Dearne, although there are roof water downpipes that discharge to soakaway (i.e., are non-contained). The downpipes would not be affected by a sludge spill and are not considered further within this report.

Two areas of uncertainty have been identified in respect of the drainage system in two specific areas within the installation. These are as follows:

- Effluent and surface water runoff from the CHP/boiler compound and roadway are directed to a drain which is reported to have collapsed. This source comprises surface water runoff, and potentially condensate from the biogas pipeline feeding the boilers/CHP and boiler blowdown. YW is committed to investigating, and as required repairing the drains (prior to issue of the permit) in this area so that all liquors arising are returned to the WwTW for full treatment.

- Surface water runoff from the digester area is directed to a drainage route which cannot be fully traced due to line length. Adopting a precautionary approach, as this line may also include condensate from the biogas pipeline feeding the flare, YW is committed to investigating the drains (prior to issue of the permit) to ensure that all liquors arising are returned to the WwTW for full treatment.

In summary, the unmitigated spill modelling demonstrates that a sludge spill does not have potential to reach a receptor via site drainage. Addition of bunding will further contain spills. No amendments to existing site drainage are required.

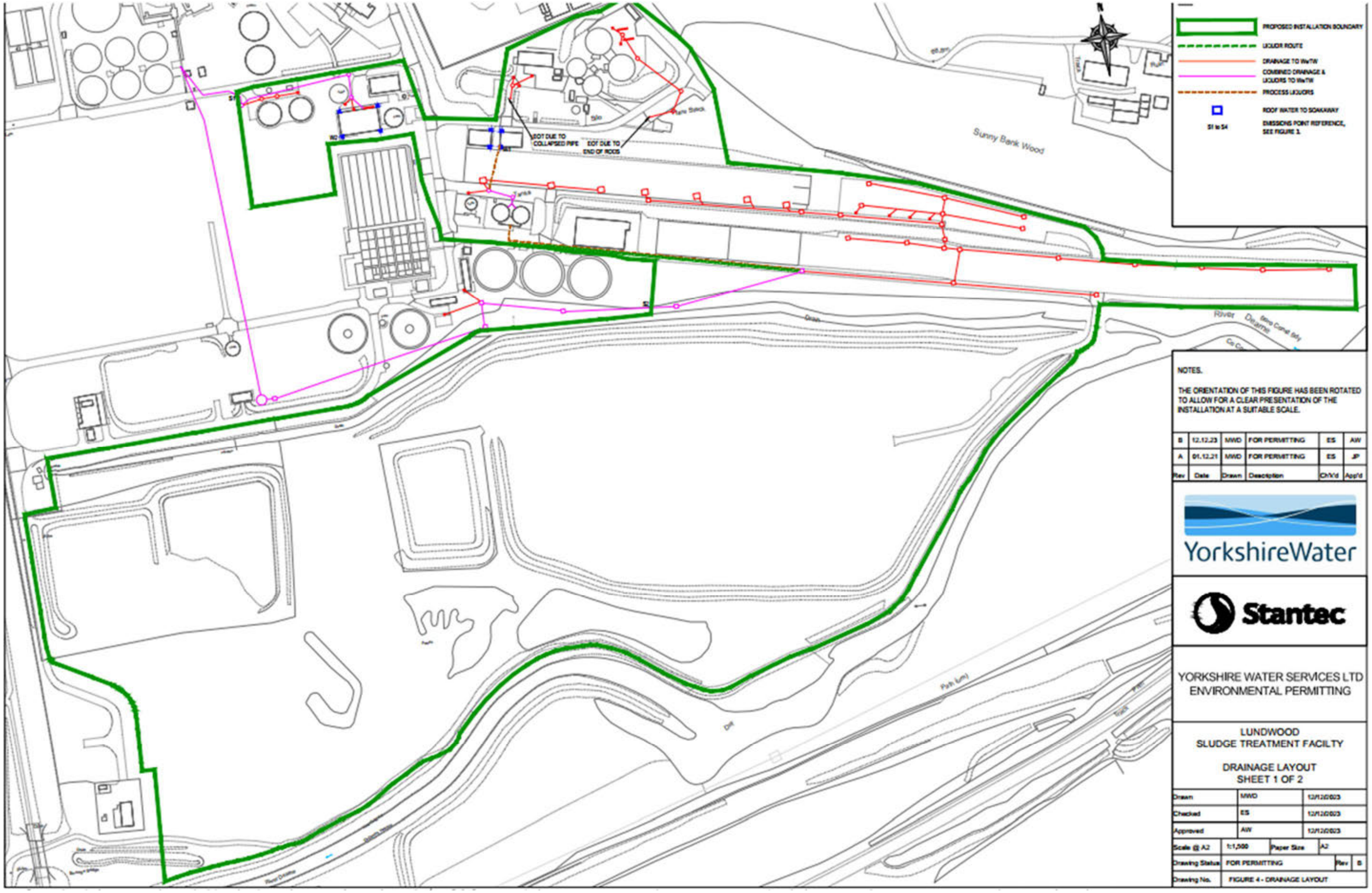


Figure 21. Lundwood WwTW surface drainage route survey.

3.6.2 Pathway 1

The unmitigated modelled spills show potential pooling of sludge on permeable grassy surfaces predominantly around the drum thickener feed tanks and a direct route (Pathway 1) to a sensitive receptor, stemming from the multi-installation area 2 and the single digester feed tank, as shown in Figure 22. This area, as part of the wider field, was previously occupied by settlement tanks, which have been decommissioned and filled in to create a site for future development. Therefore, the surface is likely to be permeable. Contained surface water drainage is present within the drum thickener feed tank compound, this returns to the WwTW for treatment.

There is low confidence in the modelled route of sludge shown in Pathway 1 due to the limitations of PondSIM modelling, and its inability to reflect surface drainage containment, spill viscosity and rough terrain. The model shows the spill continuing along the access road, over thick vegetation and into a ditch which allows inundation of a north-south flowing overland flow route, which is hydraulically connected to the west-east flowing drainage ditch which confluences with the River Dearne. Whilst the model at this section of site is unlikely to be representative of a true sludge spill, this spill pathway shows a route to the sensitive receptor, River Dearne.

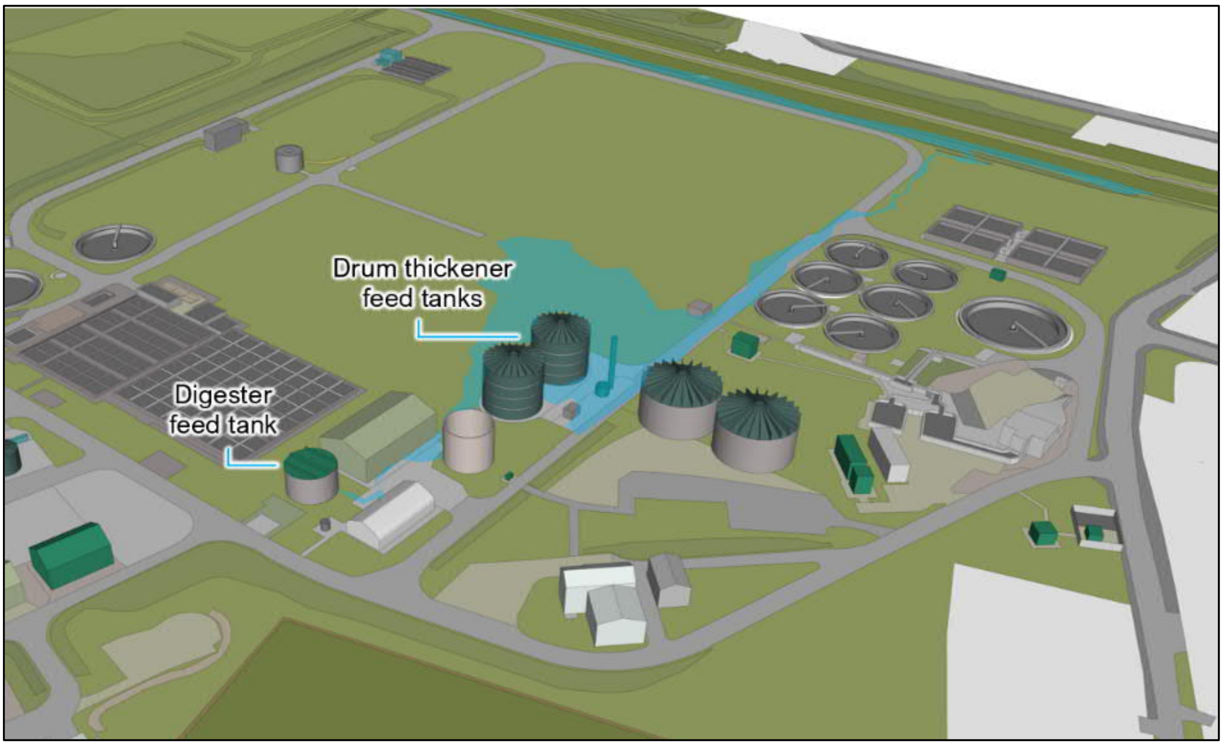


Figure 22. Pathway 1: pooling potential around the drum thickener tanks.

NB. This output is heavily affected by the limitations of PondSIM.

In support of this assessment, photographic evidence Figure 23a) shows a potential sludge spill would have to navigate over a slight incline covered in rough vegetation before reaching the ditch, additionally Figure 23b) shows that the access road has a camber towards the inner kerbed section. Given the rheology (i.e., the flow and deformation) of sludge, it is likely that a sludge spill would tend to spread in the area near the source (thickener feed tanks), with only small amounts travelling along the road toward the boundary fence.

Figure 23 a) elevated bank with rough vegetation, b) curving access road with camber towards kerbed inner section.

Furthermore, Figure 24a) shows thick vegetation between the overland flow route and palisade fencing, whilst Figure 24b) shows vegetation butted up against the lower section of fence. Given the distance from the source it is unlikely that significant quantities of sludge material would penetrate this section to reach the overland flow route, as an operational clean up team would be deployed within 24 hours, further mitigating impact to the sensitive watercourse.

In summary, Pathway 1 was generally given a low confidence rating due to:

- Surface drainage located in the drum thickener compounds
- Sludge rheology i.e., properties of a thick viscous material.
- Camber present to the inner section of the road away from the overland flow route.
- Thick and rough vegetation present prior to the ditch and in between the access road and overland flow route.

Figure 24, a) thick vegetation and fenced section near overland flow route, b) fenced section and vegetation along access road.

3.6.3 Pathway 2

Figure 25 shows sludge spills from the multi-tank installation area 3, i.e., the digester compound, and a route to a sensitive receptor (Pathway 2). Modelling results show that the sludge pools within the hardstanding surface areas in the digester compound and access roads, before flowing down to the south of the site along another access road and adjacent to the ASPs. The sludge spill continues downhill, flows between kiosk buildings, through thick vegetation before reaching the drainage ditch that confluences with the River Dearne. The spill pathway represented here shows a direct pathway to the sensitive receptor.

Pathway 2 is also given a low confidence due to the limitation of the PondSIM modelling software. Whilst a high degree of confidence is given for the sludge flow from the digester compound to the access roads due to the elevation and volumes contained, it is very unlikely a spill would travel down to the site of the site due to the distances involved. In practice a sludge spill would spread rather than forming a long stream. The large surface area of the access roads has potential to contain a significant volume of sludge preventing onward flow toward the watercourse.

In summary, Pathway 2 was generally given a low confidence rating due to:

- Sludge rheology i.e., properties of a thick viscous material resulting in a tendency to form large pools, rather than the long streams created in PondSIM.
- Distances involved from multi-tank installation 3 to the sensitive receptor.
- Thick vegetation present at the south of the site.
- Surface drainage features present along the access roads.

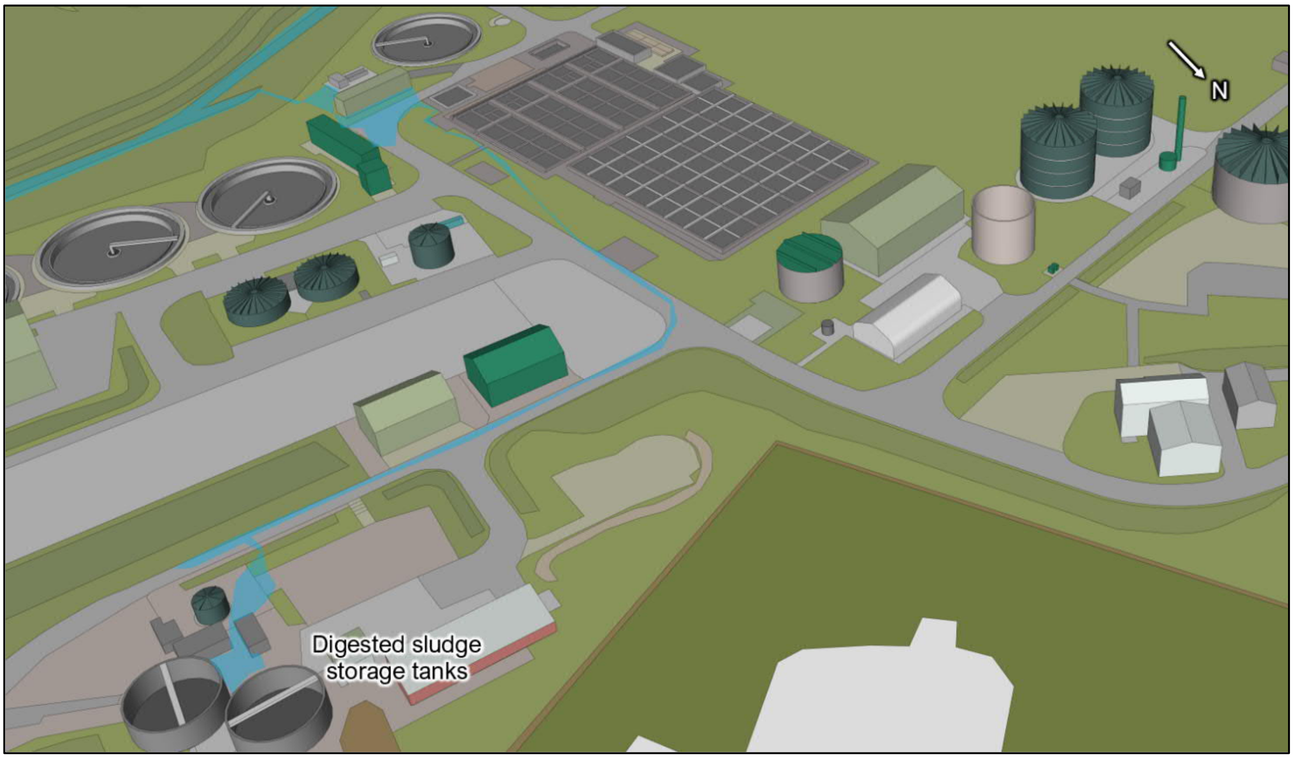


Figure 25. Pathway 2: modelled pooling around the digester area access road and south of site.

NB. This output is heavily affected by the limitations of PondSIM.

3.6.4 Pathway 3

Pathway 3, a direct / indirect pathway to a sensitive receptor is illustrated in Figure 26. A medium confidence rating is given to Pathway 3 due to the close vicinity of the multi-tank installation area 1 to the drainage ditch that confluences with the River Dearne.

The model shows the spill starting at the tanks, crossing the access road between the tank installation area and FSTs and flowing through a dropped kerbed area, as shown in Figure 27. A high confidence rating for Pathway 3 cannot be given due to the likely significant effect of small elevation changes in this area e.g., the height of the dropped kerb and thick vegetation. In reality, a sludge spill is unlikely to impact the FSTs due to loss of velocity at the kerb adjacent to the road, and the lip around the tanks, also shown in Figure 26. Any sludge entering the FST area would flow and pool around the FSTs and given the relatively low viscosity of liquor return balancing tanks content. The model shows the spill continuing south from the FST heading downhill, through palisade fencing and thick vegetation before entering the drainage ditch.

Figure 28 shows an alternative, and perhaps more likely, flow route for spills in this area. The fall on the road is towards a site building near the boundary fence. In front of this building is a surface water drain, any liquid entering this is contained and ultimately returned for treatment within the WwTW. This has potential to prevent spills from the liquor return tanks spreading to permeable surfaces.

A medium confidence rating was given to this pathway, a conclusion supported by photographic evidence provided in Figure 29, which shows a sloping route to the receptor.

In summary, Pathway 3 was given a low confidence rating due to the:

- Likely impact of minor gradient and elevation changes in this area, which have not been accurately captured in aerial survey data.
- Potential for liquor flow to be captured within existing site drainage.
- Thick and rough vegetation present between the palisade fence and sensitive receptor.
- Mixed sludge rheology i.e., moderate, and low viscosity material from sludge import and liquor tanks respectively.

Considering the evidence for the requirement for enhanced environmental protection, mitigative options will be considered for Pathway 3, but additional investigation is required to collect data to support the decision-making process.

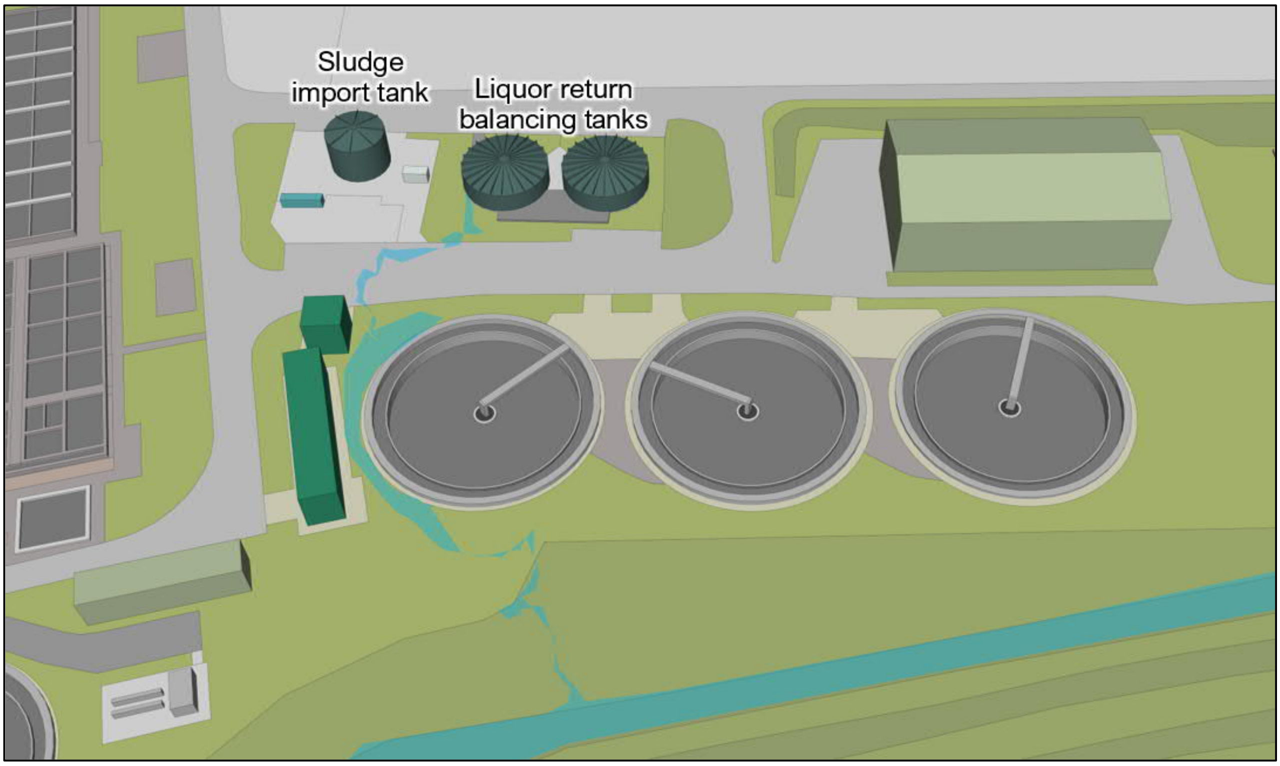


Figure 26. Potential pooling and pathway around the liquor return balancing tanks and FSTs.

NB. This output is heavily affected by the limitations of PondSIM and is unlikely to be as severe in the event of a real-world spill.

Figure 27. Section of dropped kerb on access road near FSTs.

Figure 28. Potential flow route for spills passing dropped kerb.

Figure 29. Sloping embankment south of the FSTs adjacent to sensitive receptor.

3.6.5 Spill pathway summary

The table below lists the pathways associated with tank failure at Lundwood determined using the PondSIM model. Full model results are presented in Section 3.4.

Table 3. Surface pathways from the key assets at Lundwood.

Common Area / Tank	Surface Pathways	Comments
Multi-tank installation area 1. (Sludge import tank, 2 no. liquor return balancing tanks)	Pathway 3 – overall low confidence. Overland run-off over mostly sealed surfaces to: • South of the site towards the FSTs	Spill volume captured on existing site access roads hardstanding areas before reaching a permeable grassy section and a sensitive receptor south of site. Local surface water drainage in this area is contained and is returned to the WwTW for treatment prior to discharge.
Digester feed tank	Pathway 1 – overall low confidence. Overland run-off over mostly sealed surfaces to: • The drum thickener feed tank and OCU compound. • West of the site towards the drainage ditch.	Spill flows across and is captured on hardstanding and road surfaces before reaching a drainage ditch at the western section of the whole site. Surface water drainage is present in the digester feed and drum thickener feed tank compound areas, this is contained and returned to the main WwTW for treatment prior to discharge.
Multi-tank installation area 2. (2 no. drum thickener tanks)	Pathway 1 – overall low confidence. Overland run-off over mostly sealed surfaces to: • The drum thickener feed tank and OCU compound. • West of the site towards the drainage ditch.	Spill flows across and is captured on hardstanding and road surfaces before reaching a drainage ditch at the western section of the whole site. Surface water drainage is present in the digester feed and drum thickener feed tank compound areas, this is contained and returned to the main WwTW for treatment prior to discharge.
Multi-tank installation area 3. (2 no. digesters, digesters, 2 no. digested sludge storage tanks)	Pathway 2 – overall low confidence. Overland run-off over un-sealed surfaces to: • Northern access road. • Central access road and ASP area. • Sensitive receptor south of the site.	Principal spill volume captured on existing site hardstanding areas within access roads, before reaching a before reaching a permeable grassy section and sensitive receptor south of site. Surface water drainage in this area is contained and returned to the main WwTW for treatment prior to discharge.

3.7 Receptors

To complete the source pathway receptor model, a review of sensitive receptors was conducted in conjunction with the accompanying ADBA Assessment and Site Condition Report (Appendix 4) detailing site setting, geology and groundwater. These were identified based on professional judgement, modelling results and potential flow paths which may take any cardinal direction in lower lying areas. Figure 30 shows the receptors identified which could theoretically be impacted by a loss of containment from sludge vessels at Lundwood.

Table 4 lists the type of pathway potentially leading to each receptor e.g., indirect, such as via FSTs, permeable surfaces or direct to the environment, e.g., a flow path into the River Dearne.

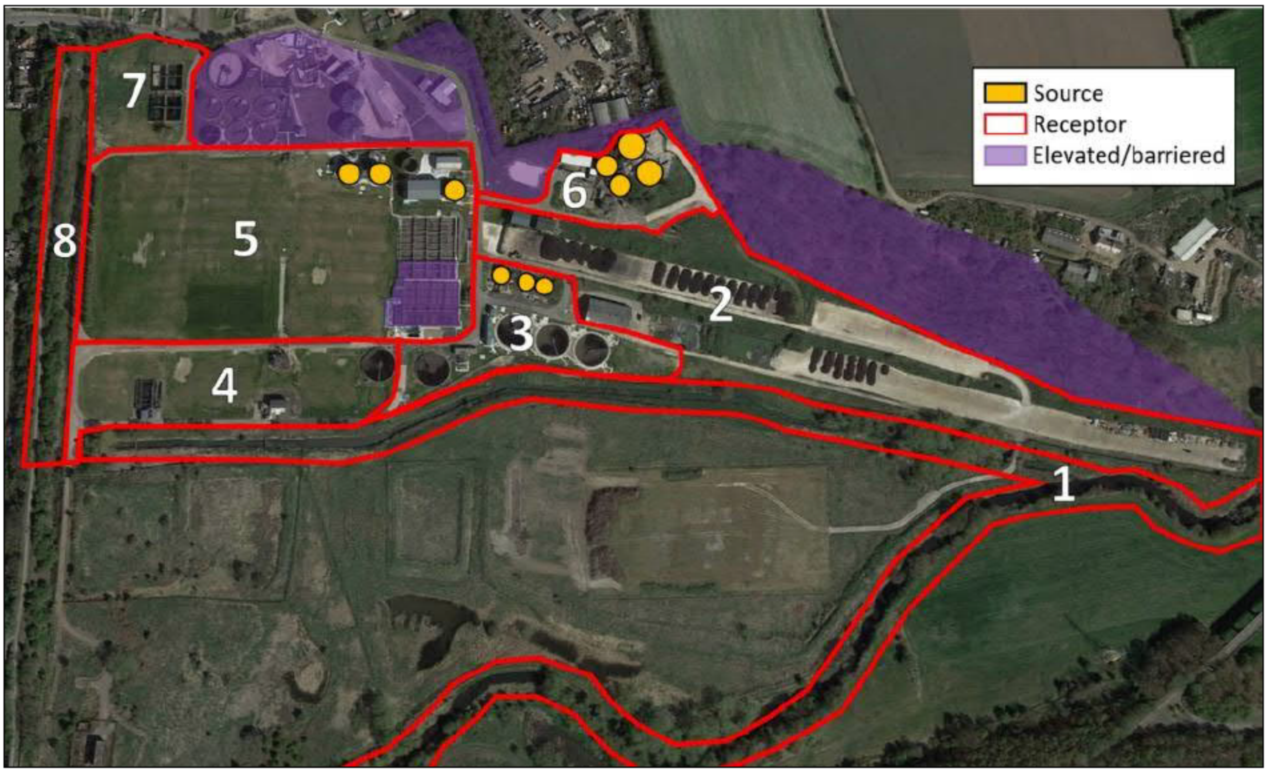


Figure 30. Map of numbered receptors at Lundwood. © Google, 2021

Table 4. Receptor number and description.

Receptor no.	Receptor
1	Drainage ditch merging with the River Dearne (including adjacent habitats).
2	Ground / groundwater – areas around and within the cake pads.
3	Ground / groundwater - area around sludge import and liquor balancing tanks, including the FSTs.
4	Ground / groundwater - areas surrounding the westerly FSTs.
5	Ground / groundwater - areas surrounding drum thickener, digester feed tanks and ASPs.
6	Ground / groundwater - areas including and surrounding the digester compound (digester and digested sludge tanks).
7	Ground /groundwater – area surrounding tanks.
8	Overland flow route – level linked to rainfall

3.8 Source-pathway-receptor summary

A summary of the receptors at risk following the modelling of spill pathways from identified sources at Lundwood STF is listed in Table 5.

Table 5. Source-pathway-receptor summary

Common Area / Tanks	Surface Pathways	Receptors at risk
Multi-tank installation area 1. (Sludge import tank, 2 no. liquor return balancing tanks)	Pathway 3 – overall low confidence. Overland run-off over mostly sealed surfaces to: • South of the site towards the FSTs.	• Receptor 3 - Ground / groundwater - area around sludge import and liquor return balancing tanks, including the FSTs [medium confidence]. • Receptor 1 – Drainage ditch merging with the River Dearne (including adjacent habitats) [low confidence].
Digester feed tank	Pathway 1 – overall low confidence. Overland run-off over mostly sealed surfaces to: • The drum thickener feed tank and OCU compound. • West of the whole site towards the drainage ditch.	• Receptor 5 - Ground / groundwater - areas surrounding drum thickener, digester feed tanks and ASPs [medium confidence]. • Receptor 7 - Ground /groundwater – area surrounding tanks [low confidence]. • Receptor 8 - Overland flow route – [low confidence].
Multi-tank installation area 2. (2 no. drum thickener tanks)	Pathway 1 – overall low confidence. Overland run-off over mostly sealed surfaces to: • The drum thickener feed tank and OCU compound. • West of the site towards the drainage ditch.	• Receptor 5 - Ground / groundwater - areas surrounding drum thickener, digester feed tanks and ASPs [medium confidence]. • Receptor 7 - Ground /groundwater – area surrounding tanks [low confidence]. • Receptor 8 - Overland flow route – [low confidence].
Multi-tank installation area 3. (2 no. digesters, digesters, 2 no. digester sludge storage tanks)	Pathway 2 – overall low confidence. Overland run-off over un-sealed surfaces to: • Northern cake pad. • Southern Lagoons. • Surface water drain south of the site.	• Receptor 6 - Ground / groundwater - areas including and surrounding the digester compound (digester and digested sludge tanks) [high confidence]. • Receptor 2 - Ground / groundwater – areas around and within the cake pads [medium confidence]. • Receptor 3 - Ground / groundwater - area around sludge import and liquor return balancing tanks, including the FSTs [low confidence]. • Receptor 1 - Drainage ditch merging with the River Dearne (including adjacent habitats) [low confidence].

3.9 Mitigation solutions

An iterative process was completed to develop bunding options that provide environmental protection in accordance with CIRIA C736, including different methods for achieving impermeable surfaces within the bunded area. Determination of the preferred solution considered financial viability, sustainability to reduce impacts from embodied carbon and availability of materials to allow timely implementation given the timeframes of meeting compliance.

The solution identified is illustrated in Figures 31 to 34, with further specification and dimensions given in Appendix 2. This solution achieves CIRIA C736 compliance, including approaches for improving the sustainability of construction in the following ways:

- **Bund height:** calculated using the CIRIA 25/110 percent rule, divided by the area encompassing the bunded area not including the footprint of tanks, buildings, and other obstructions. Rainwater handling was also considered.
- **Surge allowance:** CIRIA C736 table 6.3 specifies the freeboard required to protect against surge. Recognising these recommendations, an allowance of 0.25m for walling and 0.75m for earth works has been added to the bund heights to protect against surge.
- **Drainage**: all surface drainage infrastructure will be assessed during the design phase to confirm sufficient capacity is available to deal with rainwater falling into the bund.
- **Walling**: in-situ or pre-cast products are considered to allow for installation where space is limited and considers pre-existing walling as part of the installation.
- **Earth works:** non-engineered and engineered constructed earth bund materials are considered where space is available, this includes existing earth embankments. Where earth bunds are a preferred option, bentonite clay matting, concrete matting, or poured concrete will be used to produce an impermeable outer surface.
- **Permeable areas:** all permeable areas of land that could receive a spill will be made impermeable or protected by a bund.
- **Ramps & flood gates:** will be used as required to provide access into bunds. Ramps are the preferred solution, as they provide access without affecting the integrity of the bund. Floodgates may be installed where the need for access is very infrequent, and installation of a ramp is not practical. Where floodgates are required an appropriate management system will be implemented to ensure an appropriate level of environmental protection is maintained when they are in use.
- **Hardstanding areas:** existing areas of hardstanding that will form part of the containment solution (in-situ concrete, access roads) will be assessed to ensure that they provide a level of containment consistent with the requirements of CIRIA C736.

YW have committed to install a containment solution that complies with CIRIA C736. The current preferred design is shown below but may be subject to minor modifications and amendments during detailed design phase.

The total containment volumes required within the bunding was calculated as per Table 6. Following the CIRIA requirement to contain the larger volume of 110% of the largest tank or 25% of all tanks, a bund volume of 783 m^3, 275 m^3, 1,748 m^3 and 968 m^3 is necessary for sludge containment within the single tanks and multi-tank areas 1, 2 and 3. An additional volume will be allowed for freeboard to handle surge (Appendix Table 1).

Table 6. Containment volume calculations.

Tank	Area	Hydraulically linked to another tank?	Volume m^3 (per tank)	Total volume m^3 (group)	110% size m^3
Digester feed tank	Single tank	NA	712	712	783
			Largest 110% size		783
			Total volume	712	
			25% of total volume	178	
Sludge import tank	Multi-tank area 1	No	150	150	165
2 liquor return balancing tanks		No	250	500	275
			Largest 110% size		275
			Total volume	650	
			25% of total volume	163	
2 drum thickener feed tanks	Multi-tank area 2	No	1,589	3,178	1,748
			Largest 110% size		1,748
			Total volume	3,178	
			25% of total volume	795	
2 digesters	Multi-tank area 3	Yes	441[a]	882	970.2
2 digested sludge storage tanks		No	880	1,760	968
			Largest 110% size		968
			Total volume	2,642	
			25% of total volume	661	

Figures 31 to 34 show localised bunding solutions for single and multiple tanks. As access for operation is crucial for these tanks the bunds have incorporated road slopes and any existing site structures. For example, a sloping hardstanding access road is utilised as containment, this is evidenced in Figure 33 where the road shows a significant gradient with a retaining wall adjacent to the tanks.

Figure 31. Mitigation - multi-tank area 1

Figure 32. Mitigation - multi-tank area 2

Figure 33. Mitigation - multi-tank area 3

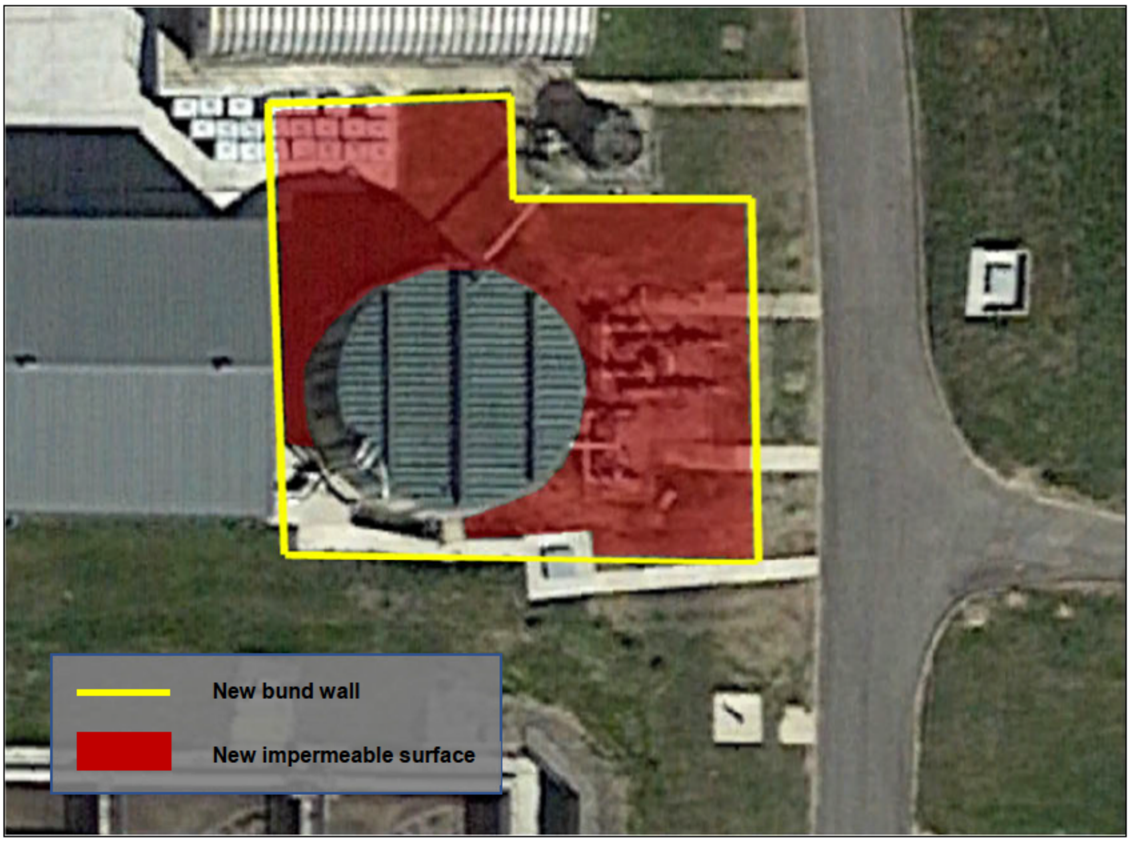


Figure 34. Mitigation - digester feed tank

3.9.1 Surge

The catastrophic collapse of a tank would lead to a rapid release of sludge which will then flow across the surrounding area. This is particularly true on steep gradients, which will encourage flow to travel further. As flow travels across flat ground, it will lose speed and the risk from surge will rapidly decrease.

Sludge released in this way will tend to flow over obstacles, but physics limits the height of barrier which it can pass. It is possible, but complex to calculate the extent of flow over obstacles using specialist software, but it would be prohibitively expensive to do this for every site where containment is being considered. In the absence of detailed modelling, CIRIA C736 provides guidance on the additional height of bund wall (Figure 35), above settled spill level, that is required to ensure surge flow does not pass containment walls.

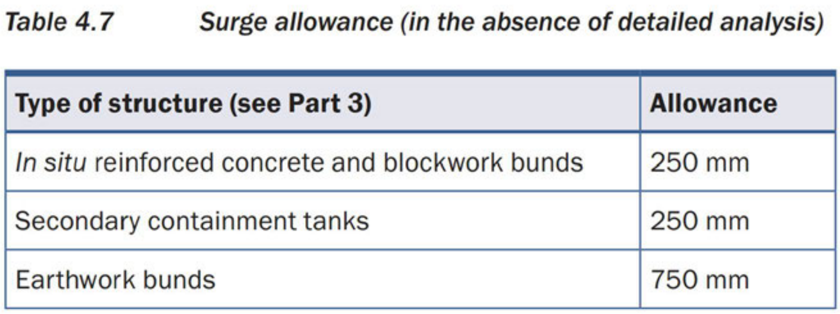


Table 4.7 Surge allowance (in the absence of detailed analysis)

Type of structure (see Part 3)	Allowance
In situ reinforced concrete and blockwork bunds	250 mm
Secondary containment tanks	250 mm
Earthwork bunds	750 mm

Figure 35. Surge protection requirements. Taken from CIRIA C736 pg 54.

Lundwood is a large site, with significant distances between assets. It is also built on the sides of a hill, which means sludge has potential to travel a significant distance. However, the velocity of flow is expected to be diminished because of its rheology and the significant areas of unmade, rough, ground. Although there are open topped tanks at Lundwood, these are all a significant distance from sludge holding tanks and outside of bunded areas. Recognising this, no additional surge protection is required outside of bunded areas.

3.9.2 Jetting

The EA guidance on spills to permeable surfaces means YW has reconsidered its approach to jetting and recognises that surfaces which could receive a sludge spill because of tank failure will require an impermeable surface. This means tank leaks, including jetting, within the tank locations at Lundwood will be contained as the immediate and surrounding surfaces will be made impermeable.

The risk of environmental harm as a result of jetting from these tanks has been assessed as low for the following reasons:

- YW design, construction and monitoring controls ensure tanks are constructed to a high standard and would identify any critical weaknesses at an early stage, and well before catastrophic failure occurred.
- For tanks constructed of concrete, the formation of a hole large enough to allow jetting, but small enough to avoid total tank collapse is unlikely. If failure were to occur, it is much more likely to initially show as cracking, giving time to respond before significant sludge escaped.
    - A technical note has been provided in 0 confirming the failure mechanism of a tank constructed from concrete.
- The sludge in the concrete digesters is relatively viscous and this is likely to reduce the extent of jetting as viscous materials will travel relatively slowly through an orifice.
- The most likely cause, albeit it still very unlikely, of a tank wall puncture that would allow jetting is a direct impact, the most likely cause of which would be an out-of-control vehicle. If this were to happen, it would almost certainly be at ground level. In most cases, new bund walling and existing site structures will protect tanks from direct impact.

Yorkshire Water understand that while risk is low, consideration of jetting remains a requirement of CIRIA C736.

The blue circles in Figures 36 to 41 show areas which could be affected by jetting. These have been calculated according to CIRIA C736 guidelines (Appendix Figure 2).

3.9.2.1 Multi-tank area 1

Figure 36 Jetting potential for multi-tank area 1

The import tank to the west of multi-tank installation 1 appears to present a risk of jetting, but in practice the high wall to the north of the tank will mitigate the risk of tank content passing over the wall, Figure 37. During detailed design of the containment solution for this area, it will be confirmed that the wall height, and distance from the tank, provide full compliance with CIRIA C736.

There is also some risk of jetting passing over the eastern edge of the bund, but in practice it is likely that the final wall height will provide containment in line with CIRIA C736. Again, this will be confirmed during detailed design.

Figure 37 View from elevated ground to the north of the import tank

3.9.2.2 Multi-tank area 2

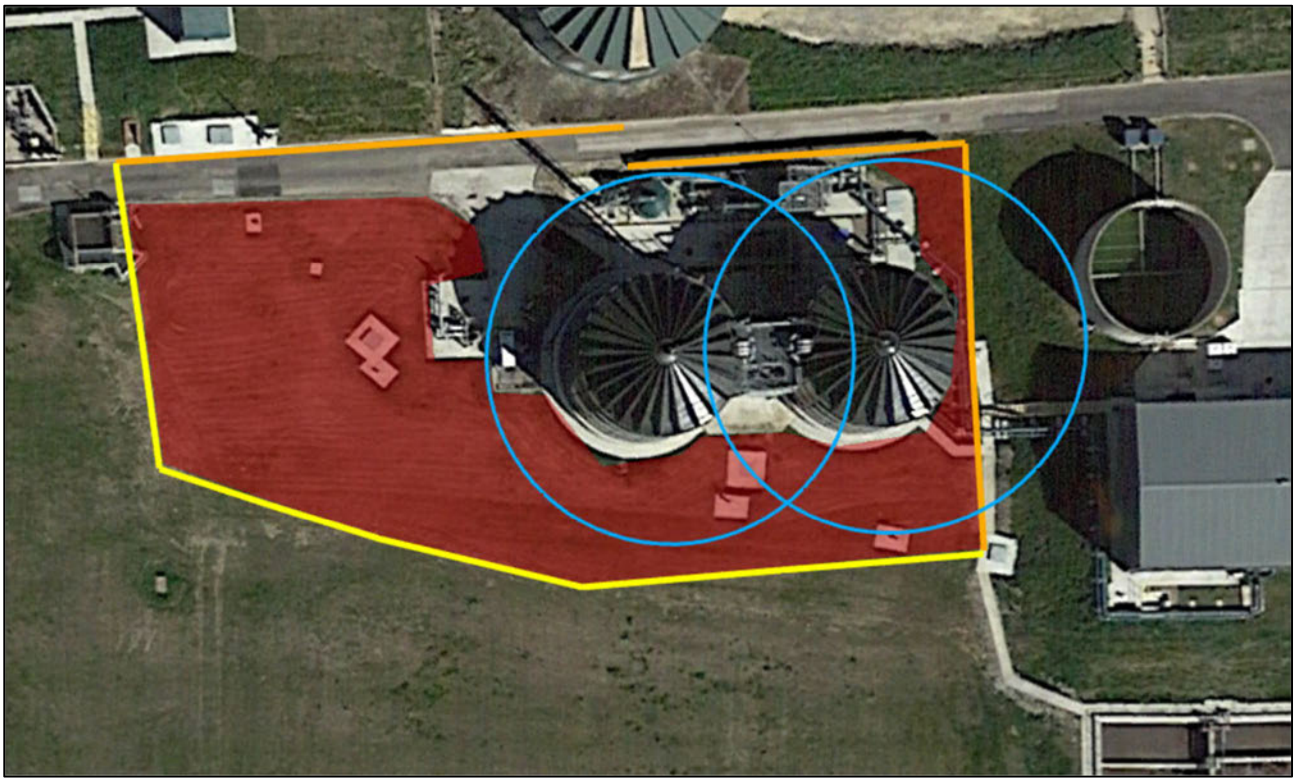


Figure 38 Jetting potential for multi-tank area 2

Multi-tank area 2 contains two large, steel, thickener feed tanks. Initial analysis shows that potential jetting from the more westerly tank will be entirely captured within the bunded area. The easterly tank has potential for jetting to pass over the bund wall. Note that the land rises in this direction, during detailed design YW commit to either installing jetting protection in this area and/or extending the bund up the existing bank to ensure potential jetting is captured on an impermeable surface.

Figure 39 - Land rises to east of thickener feed tanks

3.9.2.3 Multi-tank area 3

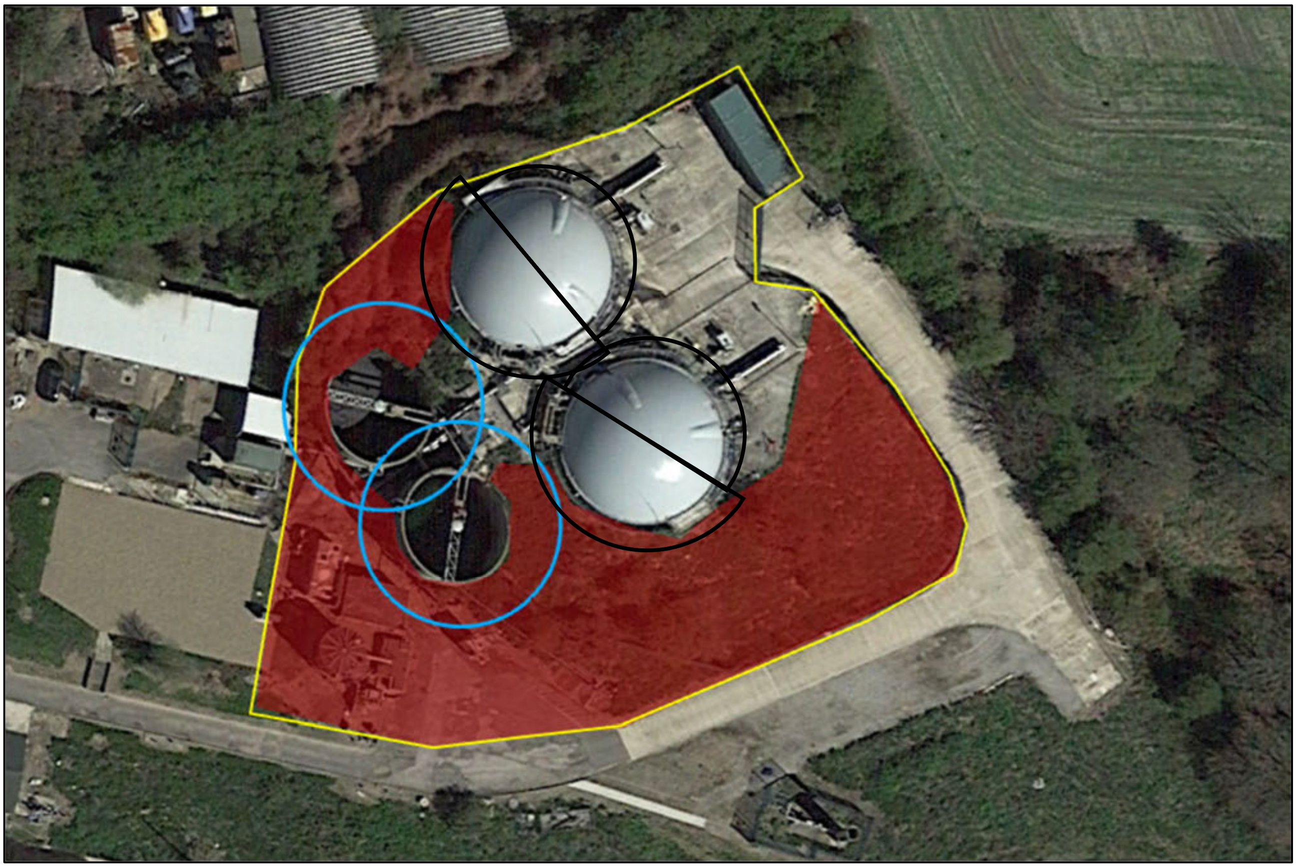


Figure 40 Jetting potential for multi-tank area 3

Multi-tank area 3 includes the digesters and the digested sludge balance tanks. All tanks are constructed of concrete and as discussed previously; the failure mode of concrete tanks makes jetting very unlikely. Notwithstanding this and recognising the EA preference for modelling of jetting in line with CIRIA C736, see image above. CIRIA aligned analysis of jetting from the digesters is complex, as the tanks are partially set into the ground, with ground level altering around the circumference of the tank. As shown in the image above, based on current data, jetting from all tanks in this area will largely be capture within the

3.9.2.4 Digester feed tank

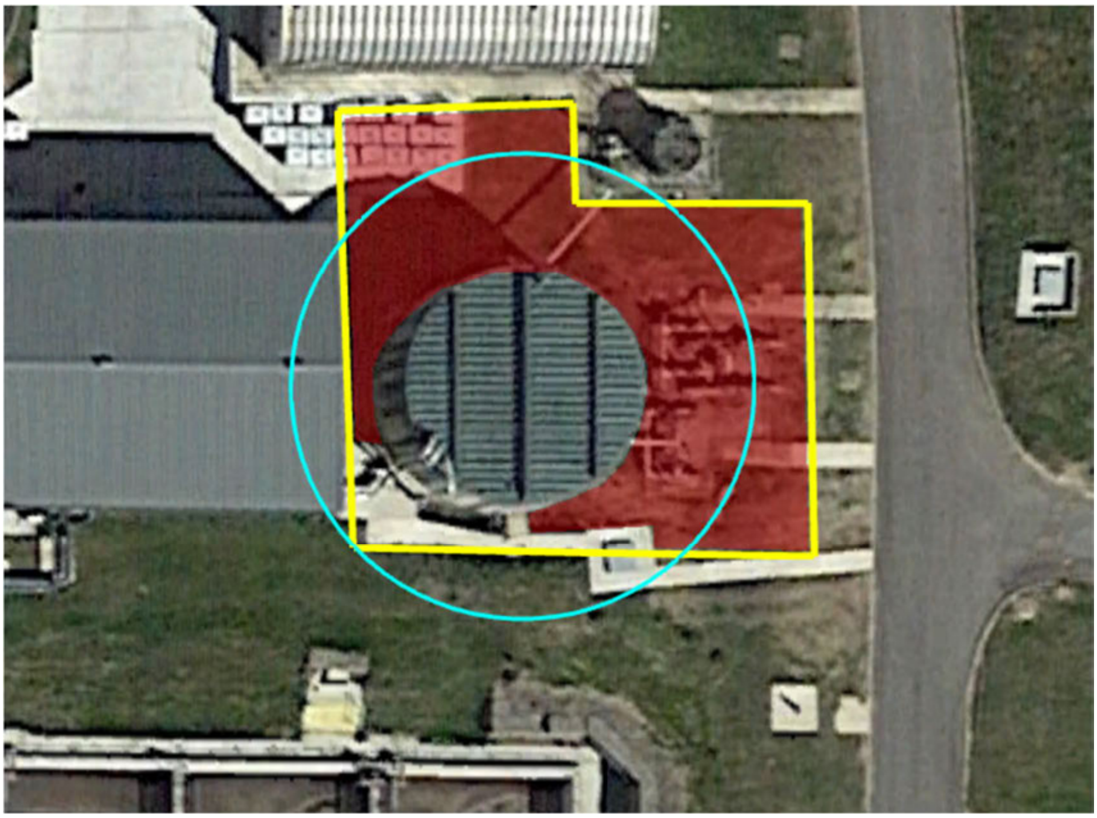


Figure 41 Jetting potential for digester feed tank

The digester feed tank is of concrete construction and is extremely unlikely to fail in a way that leads to jetting, see engineer’s note (Appendix 3). If an analysis in line with CIRIA C736 is completed, the potential risk of jetting passing the bund wall to the west and south of the tank can be seen. As additional protection, to the west, the existing building will provide a degree of containment, and during final design of the bund it will be confirmed that any tank content reaching this wall will be ultimately contained within the bund.

3.10 CIRIA C736 compliance and construction.

The secondary containment solution at Lundwood will be implemented by contractors chosen via YW’s procurement process. This process is designed to ensure contractors have the knowledge and experience to build a secondary containment solution that complies with CIRIA C736.

The effectiveness of the containment and jetting solution will be confirmed by the appointed construction company, who will use the bunding design described in this document as a starting point for development of detailed design. YW will confirm that the final bunding solution is acceptable to the EA prior to commencement of the build.

4 Preventative maintenance and inspection regime

4.1 Above ground tanks

All tanks are tested and inspected as part of initial construction quality assurance checks; an example of a tank check is shown in Appendix 5.

The tanks at Lundwood are regularly inspected by a qualified engineer. As part of these inspections, the reinspection period of each tank will be determined by the inspection engineer (anywhere from 6-months to 3 years depending on the condition of the tank). Any defects identified during inspections will be actioned and remedial works carried out as soon as possible.

Visual checks on tanks also form part of daily/weekly operational checks. These ensure that any damage or major degradation of tanks is identified as a risk and is reported before a hazard can develop.

4.2 Below ground level tanks/chambers

- Yorkshire Water understand the environmental risk associated with underground structures and are committed to identifying and rectifying any leaks from them. To support this aim, YW commit to the following:
- Daily visual inspection (Mon-Fri on certain sites) of subsurface tanks, wells, and surrounding ground by site operational team. These checks will identify major structural issues visible above liquid/ground level and any changes in ground conditions.
- Monthly external visual inspection of subsurface tanks, wells, and surrounding ground by a technically competent manager.
- Risk assessed additional monitoring.
- Three monitoring techniques have been identified as potentially appropriate for subsurface tanks/chambers identified as high risk.
    - Drop testing - the chamber/tank will be filled to normal maximum operating level, covered to prevent loss by evaporation, and left for 24 hours. For each tank an acceptable drop in level will be specified, if this is passed during the test, a repair will be completed.
    - Empty and inspect – tanks will be emptied, cleaned and a visual inspection completed.
    - Borehole monitoring – sampling of up- and down-hydraulic gradient boreholes located around a tank perimeter will allow leaks from the tank to be detected and investigated as required. Following an initial period of monitoring to establish a baseline, trigger levels will be set and agreed with the EA.
- Repair timescales.
    - Where a leak is detected using any of the above techniques, YW will isolate the source of the leak e.g., empty or bypass the tank as soon as practicable. The tank will not be returned to service until a repair has been completed.
- The use of inlet/outlet flowmeters to detect leaks has been considered, but the large volumes of flow passing through pipes combined with accuracy limitations of the instrument mean that leaks are likely to have already had an environmental impact, visible at ground level, by the time they are large enough to be detected. On this basis YW do not consider flow comparison to be a useful tool for leak detection.

4.3 Underground pipes

To mitigate the risk of failure of underground pipework, e.g., cracks and splits, surveys are completed using in-pipe crack detection technology every 5 years if mechanical joints are present, and 10 years if they are not. For future pipe installations, underground pipework will be avoided. Where this is not possible, pipes will be installed with secondary containment and leak detection.

In the event of an incident/ accident a team will be deployed immediately to isolate the damaged pipe and a spill management procedure will be followed. Thereafter, repairs to the damaged pipework will be arranged. Additionally, the incident will be logged, and hazard assessed to reduce or eliminate the risk of occurrence.

4.4 Impermeable surfaces

Appropriate containment of potential spills in large part relies on capturing them on impermeable surfaces that protect underlying ground. At Lundwood these surfaces are typically made of concrete and YW are committed to keeping these in good condition to ensure that any potentially polluting liquids cannot pass the impermeable layer. The most likely path for liquids is through cracks and other damaged areas.

Responsibility for monitoring the condition of impermeable surfaces sits with two roles within YW.

- Site operators will carry out daily visual inspection of impermeable surfaces as part of their normal duties.

- The Technically Competent Manager (TCM) with responsibility for the site will carry out a monthly inspection of impermeable surfaces.

Where damage is identified a high priority job will be raised for repairs to be completed through the YW reactive maintenance system. In cases of severe damage, temporary protection will be installed around the damaged area to ensure that effective liquid capture is maintained.

5 Implementation and timescales

5.1 Construction

A plan outlining the implementation of containment solutions identified is shown in Table 7. The timescales and estimated dates are indicative, and subject to timely external contract appointment, including acceptance of the procedures and ideal weather conditions for construction. Furthermore, bottlenecks, such as resource availability due to ongoing number of installations has not been factored in. These will be revisited once contractors are appointed, and capacities understood.

Table 7. Secondary containment implementation stages and schedule.

Stage	**Estimated date complete**
Completed detailed final design	1st March 2024
Commence construction	30th April 2024
Complete construction	December 2024

6 Conclusions and recommendations

This study has considered the risks associated with CIRIA C736 defined loss of containment scenarios at Lundwood STF. This assessment was completed using a source-pathway-receptor model. A computational modelling study has been undertaken, which adopted conservative assumptions to understand a worst-case scenario for the spread of spills. A computational modelling study has been undertaken, which adopted conservative assumptions to understand a worst-case scenario for the spread of spills. This enabled the potential effects of a substantial, unmitigated loss of containment to be considered; this has shown that further mitigation is required to protect sensitive receptors (the metric of compliance being an equivalence to a traditional 25 / 110 per cent capacity secondary containment bund in line with CIRIA C736 via the ADBA study).

The need for additional secondary containment infrastructure has been confirmed and YW commit to installing this. YW also understand the following factors and existing mitigation measures should be maintained to ensure an appropriate level of environmental protection:

Current controls

- Continuation of the measures already in place to minimise the likelihood of catastrophic failure of sludge vessels, through the use of stringent technical standards, SCADA technologies and regular visual inspections.

Existing infrastructure

- Site drains are able to return liquid to the inlet works for treatment, providing containment and flow mitigation.
- The sludge cake storage and loading pad has been engineered to drain liquid contents which returns to the inlet works of the WwTW, acting as remote containment.
- In some areas spills, leaks and catastrophic pipe failures the site surfacing and drainage would transfer liquid to the WwTW, which would contain and minimise potential effects of loss of containment.

Reducing Likelihood

- Whilst the potential for catastrophic tank failure can never be wholly mitigated when sites are operated with large tank inventories, the likelihood of substantial failure is very low, as evidenced by YW's own track record of operating sludge storage/treatment vessels across its asset base.
- In support of likelihood of failure YW has reviewed actual failure data. YW has over 40 years of experience in operating AD plants and STF's. YW has 14 AD sites, 5 of these sites have Environmental Permits. Within this time YW has not experienced the catastrophic collapse of a storage vessel.
- YW has found from experience that 'failures' of concrete tanks are generally associated with ancillaries such as joints, waterstops, seals, etc, rather than any inherent defect with the actual civil structure. YW has experienced one incident of note, and this was at Hull STF digester number 5. This example is a case in point; the release of sludge that occurred was caused by the failure of a 'link seal' mechanical coupling that should have provided a watertight seal around the outside of a mixer pipe intrusion. In comparison with a catastrophic collapse scenario, this resulted in relatively controlled spill of small volume.

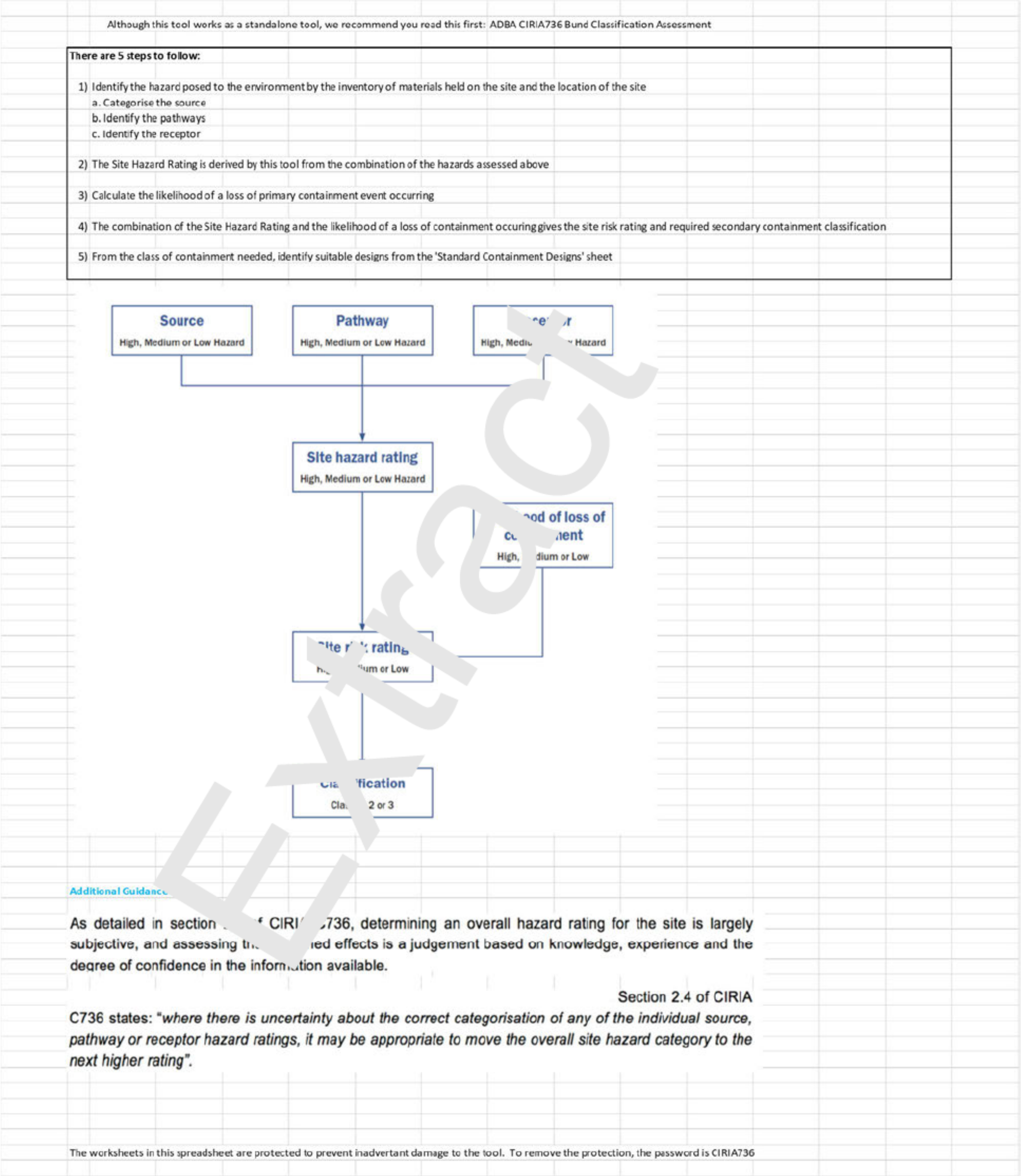
Environmental impact

- Receptors in the area must be protected from the effects of major sludge spills to reduce pollution and impacts to biodiversity.

7 Appendices

Appendix 1 - ADBA assessment tool

Screenshot from spreadsheet containing full assessment. Full document included as part of permit submission.



Although this tool works as a standalone tool, we recommend you read this first: ADBA CIRIA736 Bund Classification Assessment

There are 5 steps to follow:

1) Identify the hazard posed to the environment by the inventory of materials held on the site and the location of the site
   a. Categorise the source
   b. Identify the pathways
   c. Identify the receptor
2) The Site Hazard Rating is derived by this tool from the combination of the hazards assessed above
3) Calculate the likelihood of a loss of primary containment event occurring
4) The combination of the Site Hazard Rating and the likelihood of a loss of containment occuring gives the site risk rating and required secondary containment classification
5) From the class of containment needed, identify suitable designs from the 'Standard Containment Designs' sheet

Additional Guidance

As detailed in section [illegible] CIRI[illegible]736, determining an overall hazard rating for the site is largely subjective, and assessing th[illegible]ied effects is a judgement based on knowledge, experience and the degree of confidence in the information available.

Section 2.4 of CIRIA C736 states: "*where there is uncertainty about the correct categorisation of any of the individual source, pathway or receptor hazard ratings, it may be appropriate to move the overall site hazard category to the next higher rating*".

The worksheets in this spreadsheet are protected to prevent inadvertant damage to the tool. To remove the protection, the password is CIRIA736

Appendix Figure 1. ADBA spreadsheet screenshot

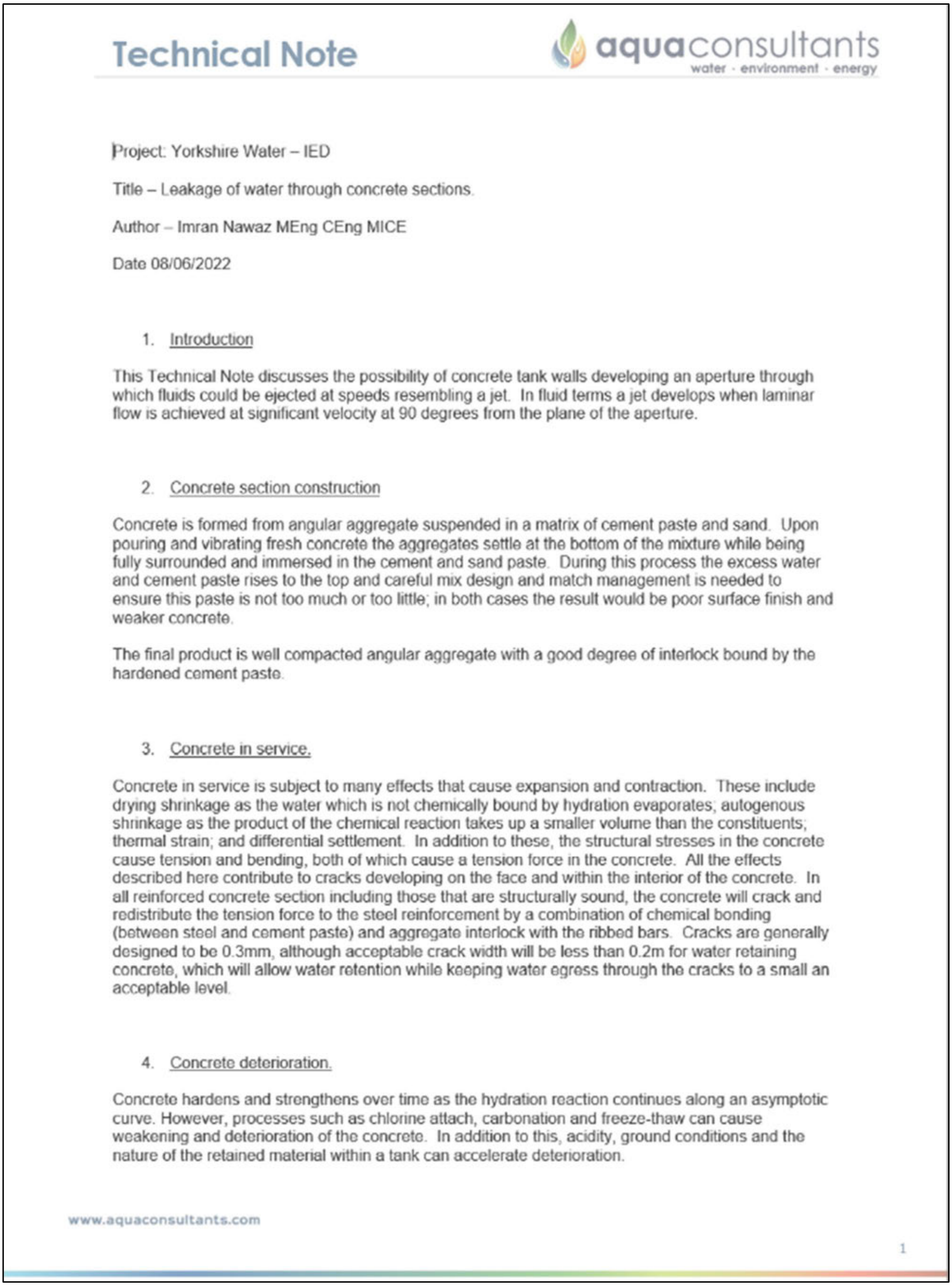
Appendix 2 - CIRIA C736 compliant solution

Appendix Table 1. Lundwood bunding solution design specification and dimensions.

Category	Criteria	Unit	Value
Multi-tank area 1 -import			
Design specification	CIRIA C736 spill volume [25/110%]	m^3	275
	Bund perimeter length	m	137
	Total containment surface area	m^2	741
	Maximum Final Spill depth	m	0.37
Bunding requirements	Concrete bund height	m	0.62
	Total concrete wall length	m	137
	Earth bund height	m	n/a
	Total earth bund length	m	n/a
Existing bunding	Existing concrete walling length	m	62
	Existing earth works length	m	0
Build required	Required concrete walling length	m	75
	Required earth works length	m	0
	Impermeable surfacing area	m^2	639
	Trief kerb length	m	0
Multi-tank area 2 – thickener			
Design specification	CIRIA C736 spill volume [25/110%]	m^3	1748
	Bund perimeter length	m	223
	Total containment surface area	m^2	2606
	Maximum Final Spill depth	m	0.67
Bunding requirements	Concrete bund height	m	0.92
	Total concrete wall length	m	188
	Earth bund height	m	1.42
	Total earth bund length	m	35
Existing bunding	Existing concrete walling length	m	74
	Existing earth works length	m	30
Build required	Required concrete walling length	m	114
	Required earth works length	m	5
	Impermeable surfacing area	m^2	1496
	Trief kerb length	m	0
Multi-tank area 3			
Design specification	CIRIA C736 spill volume [25/110%]	m^3	968
	Bund perimeter length	m	251

Category	Criteria	Unit	Value
	Total containment surface area	m^2	3616
	Maximum Final Spill depth	m	0.31
Bunding requirements	Concrete bund height	m	0.56
	Total concrete wall length	m	183
	Earth bund height	m	1.06
	Total earth bund length	m	68
Existing bunding	Existing concrete walling length	m	0
	Existing earth works length	m	68
Build required	Required concrete walling length	m	183
	Required earth works length	m	0
	Impermeable surfacing area	m^2	2009
	Trief kerb length	m	0
Digester feed tank area			
Design specification	CIRIA C736 spill volume [25/110%]	m^3	783
	Bund perimeter length	m	120
	Total containment surface area	m^2	3749
	Maximum Final Spill depth	m	0.21
Bunding requirements	Concrete bund height	m	0.46
	Total concrete wall length	m	120
	Earth bund height	m	n/a
	Total earth bund length	m	n/a
Existing bunding	Existing concrete walling length	m	0
	Existing earth works length	m	0
Build required	Required concrete walling length	m	183
	Required earth works length	m	n/a
	Impermeable surfacing area	m^2	605
	Trief kerb length	m	0

Appendix 3 - Structural integrity note for concrete tanks



Technical Note

aquaconsultants
water · environment · energy

Project: Yorkshire Water – IED

Title – Leakage of water through concrete sections.

Author – Imran Nawaz MEng CEng MICE

Date 08/06/2022

1. Introduction

This Technical Note discusses the possibility of concrete tank walls developing an aperture through which fluids could be ejected at speeds resembling a jet. In fluid terms a jet develops when laminar flow is achieved at significant velocity at 90 degrees from the plane of the aperture.

2. Concrete section construction

Concrete is formed from angular aggregate suspended in a matrix of cement paste and sand. Upon pouring and vibrating fresh concrete the aggregates settle at the bottom of the mixture while being fully surrounded and immersed in the cement and sand paste. During this process the excess water and cement paste rises to the top and careful mix design and match management is needed to ensure this paste is not too much or too little; in both cases the result would be poor surface finish and weaker concrete.

The final product is well compacted angular aggregate with a good degree of interlock bound by the hardened cement paste.

3. Concrete in service.

Concrete in service is subject to many effects that cause expansion and contraction. These include drying shrinkage as the water which is not chemically bound by hydration evaporates; autogenous shrinkage as the product of the chemical reaction takes up a smaller volume than the constituents; thermal strain; and differential settlement. In addition to these, the structural stresses in the concrete cause tension and bending, both of which cause a tension force in the concrete. All the effects described here contribute to cracks developing on the face and within the interior of the concrete. In all reinforced concrete section including those that are structurally sound, the concrete will crack and redistribute the tension force to the steel reinforcement by a combination of chemical bonding (between steel and cement paste) and aggregate interlock with the ribbed bars. Cracks are generally designed to be 0.3mm, although acceptable crack width will be less than 0.2m for water retaining concrete, which will allow water retention while keeping water egress through the cracks to a small an acceptable level.

4. Concrete deterioration.

Concrete hardens and strengthens over time as the hydration reaction continues along an asymptotic curve. However, processes such as chlorine attach, carbonation and freeze-thaw can cause weakening and deterioration of the concrete. In addition to this, acidity, ground conditions and the nature of the retained material within a tank can accelerate deterioration.

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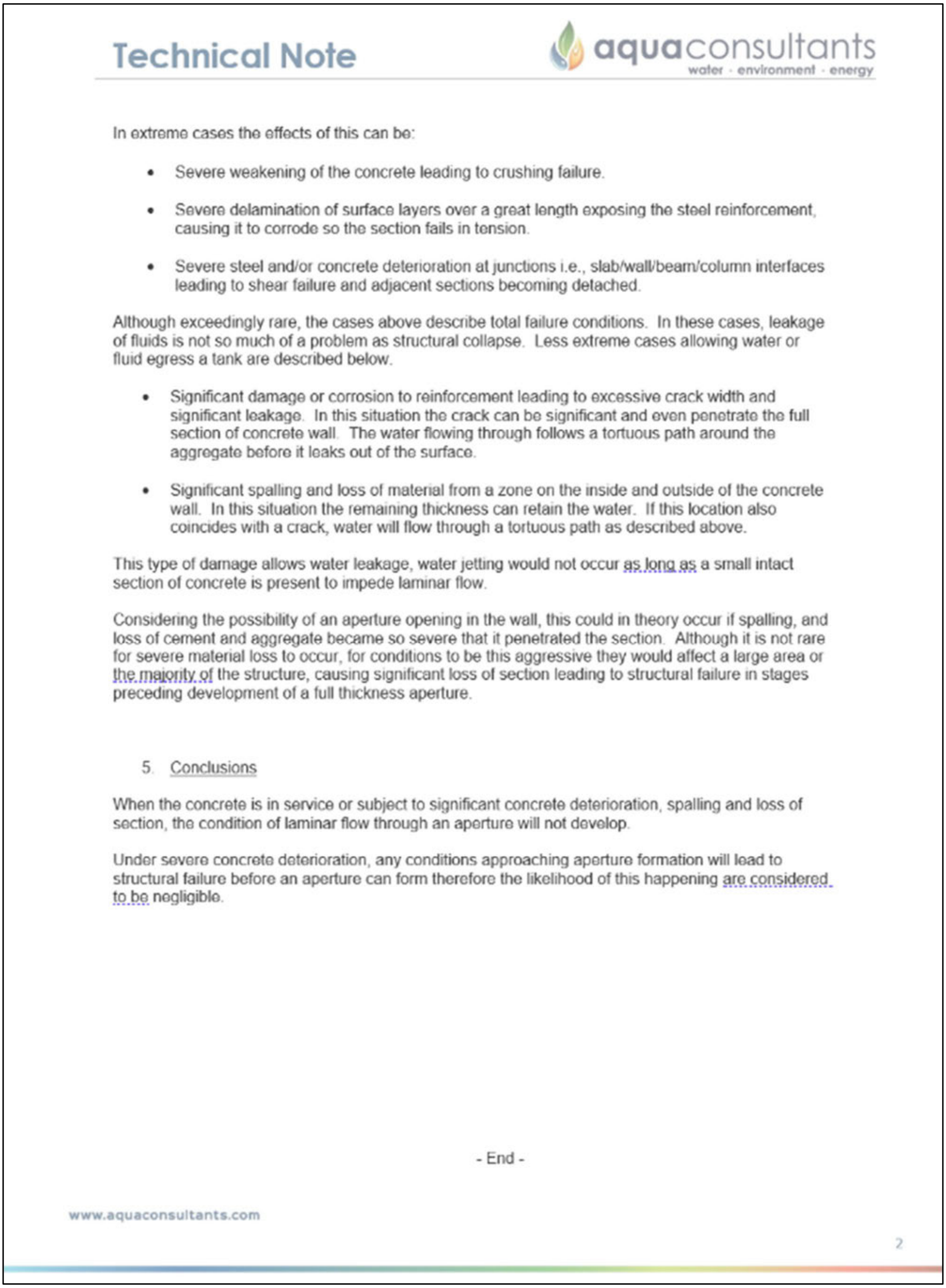
1



In extreme cases the effects of this can be:

- Severe weakening of the concrete leading to crushing failure.
- Severe delamination of surface layers over a great length exposing the steel reinforcement, causing it to corrode so the section fails in tension.
- Severe steel and/or concrete deterioration at junctions i.e., slab/wall/beam/column interfaces leading to shear failure and adjacent sections becoming detached.

Although exceedingly rare, the cases above describe total failure conditions. In these cases, leakage of fluids is not so much of a problem as structural collapse. Less extreme cases allowing water or fluid egress a tank are described below.

- Significant damage or corrosion to reinforcement leading to excessive crack width and significant leakage. In this situation the crack can be significant and even penetrate the full section of concrete wall. The water flowing through follows a tortuous path around the aggregate before it leaks out of the surface.
- Significant spalling and loss of material from a zone on the inside and outside of the concrete wall. In this situation the remaining thickness can retain the water. If this location also coincides with a crack, water will flow through a tortuous path as described above.

This type of damage allows water leakage, water jetting would not occur as long as a small intact section of concrete is present to impede laminar flow.

Considering the possibility of an aperture opening in the wall, this could in theory occur if spalling, and loss of cement and aggregate became so severe that it penetrated the section. Although it is not rare for severe material loss to occur, for conditions to be this aggressive they would affect a large area or the majority of the structure, causing significant loss of section leading to structural failure in stages preceding development of a full thickness aperture.

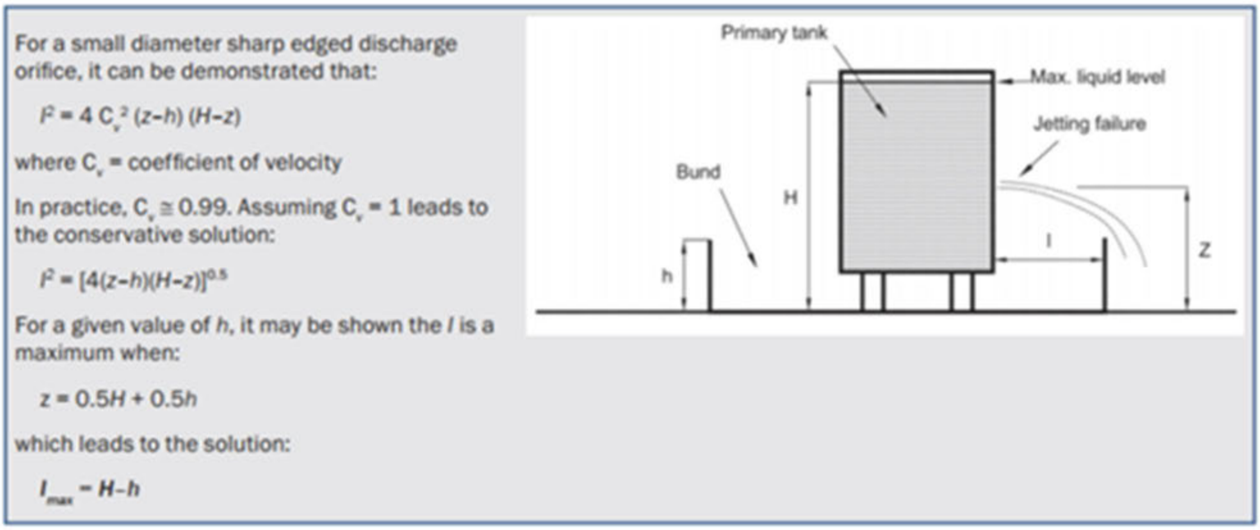
5. Conclusions

When the concrete is in service or subject to significant concrete deterioration, spalling and loss of section, the condition of laminar flow through an aperture will not develop.

Under severe concrete deterioration, any conditions approaching aperture formation will lead to structural failure before an aperture can form therefore the likelihood of this happening are considered to be negligible.

- End -

Appendix 4 - CIRIA C736 jetting calculation



For a small diameter sharp edged discharge orifice, it can be demonstrated that:

$$l^2 = 4\,C_v^{\,2}\,(z-h)\,(H-z)$$

where C_v = coefficient of velocity

In practice, $C_v \cong 0.99$. Assuming $C_v = 1$ leads to the conservative solution:

$$l^2 = [4(z-h)(H-z)]^{0.5}$$

For a given value of h, it may be shown the l is a maximum when:

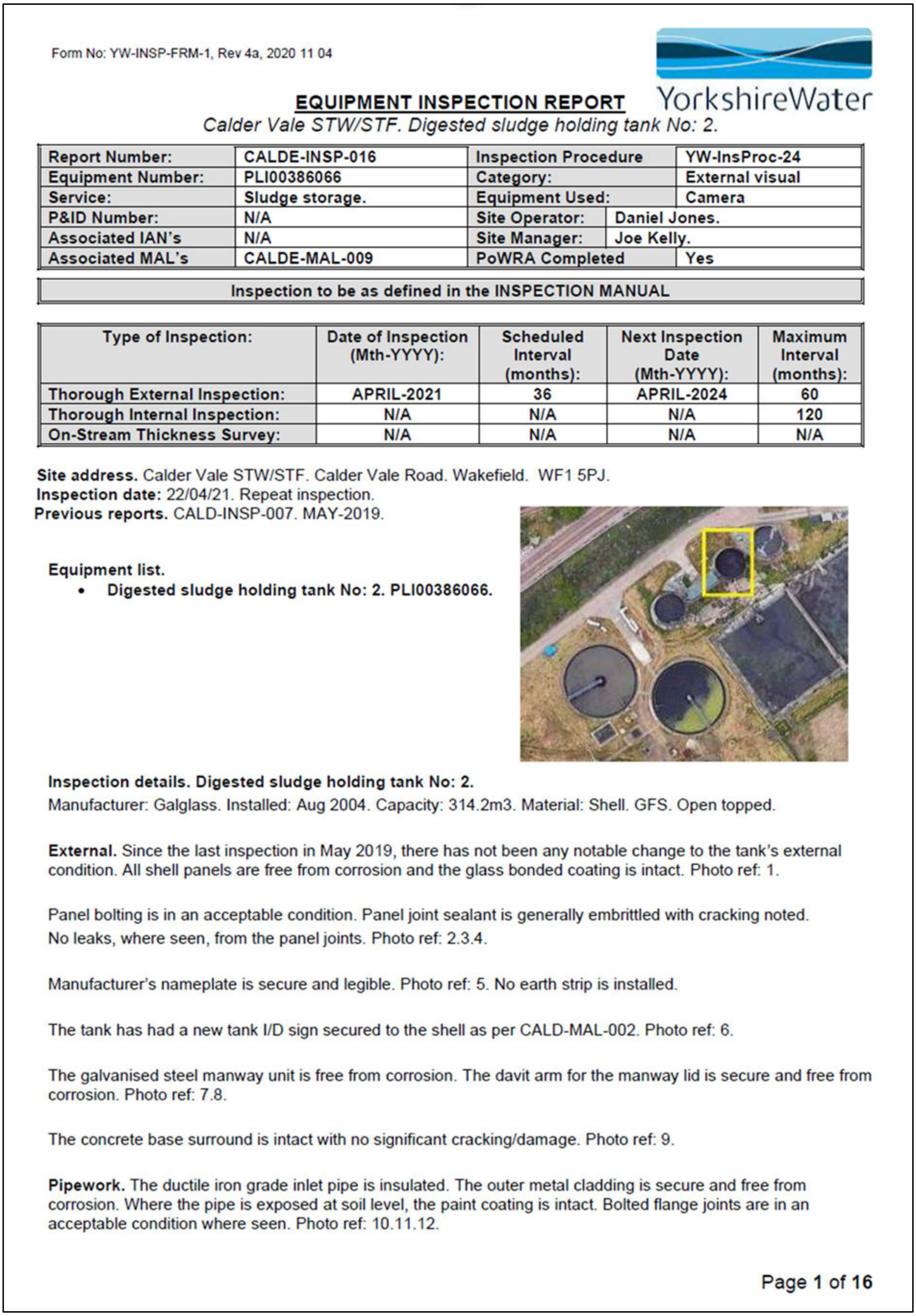
$$z = 0.5H + 0.5h$$

which leads to the solution:

$$\boldsymbol{l_{max} = H-h}$$

Appendix Figure 2. CIRIA C736 jetting calculation to determine jetting solution.

Appendix 5 - Example tank inspection report



Form No: YW-INSP-FRM-1, Rev 4a, 2020 11 04

EQUIPMENT INSPECTION REPORT

Calder Vale STW/STF. Digested sludge holding tank No: 2.

Report Number:	**CALDE-INSP-016**	**Inspection Procedure**	**YW-InsProc-24**
Equipment Number:	**PLI00386066**	**Category:**	**External visual**
Service:	**Sludge storage.**	**Equipment Used:**	**Camera**
P&ID Number:	N/A	**Site Operator:**	**Daniel Jones.**
Associated IAN's	N/A	**Site Manager:**	**Joe Kelly.**
Associated MAL's	**CALDE-MAL-009**	**PoWRA Completed**	**Yes**

Inspection to be as defined in the INSPECTION MANUAL

Type of Inspection:	**Date of Inspection (Mth-YYYY):**	**Scheduled Interval (months):**	**Next Inspection Date (Mth-YYYY):**	**Maximum Interval (months):**
Thorough External Inspection:	**APRIL-2021**	**36**	**APRIL-2024**	**60**
Thorough Internal Inspection:	**N/A**	**N/A**	**N/A**	**120**
On-Stream Thickness Survey:	**N/A**	**N/A**	**N/A**	**N/A**

Site address. Calder Vale STW/STF. Calder Vale Road. Wakefield. WF1 5PJ.
Inspection date: 22/04/21. Repeat inspection.
Previous reports. CALD-INSP-007. MAY-2019.

Equipment list.

- **Digested sludge holding tank No: 2. PLI00386066.**

Inspection details. Digested sludge holding tank No: 2.
Manufacturer: Galglass. Installed: Aug 2004. Capacity: 314.2m3. Material: Shell. GFS. Open topped.

External. Since the last inspection in May 2019, there has not been any notable change to the tank's external condition. All shell panels are free from corrosion and the glass bonded coating is intact. Photo ref: 1.

Panel bolting is in an acceptable condition. Panel joint sealant is generally embrittled with cracking noted. No leaks, where seen, from the panel joints. Photo ref: 2.3.4.

Manufacturer's nameplate is secure and legible. Photo ref: 5. No earth strip is installed.

The tank has had a new tank I/D sign secured to the shell as per CALD-MAL-002. Photo ref: 6.

The galvanised steel manway unit is free from corrosion. The davit arm for the manway lid is secure and free from corrosion. Photo ref: 7.8.

The concrete base surround is intact with no significant cracking/damage. Photo ref: 9.

Pipework. The ductile iron grade inlet pipe is insulated. The outer metal cladding is secure and free from corrosion. Where the pipe is exposed at soil level, the paint coating is intact. Bolted flange joints are in an acceptable condition where seen. Photo ref: 10.11.12.

Page **1** of **16**

Appendix Figure 3. Example equipment inspection report

Appendix 12 Waste Pre-acceptance and Acceptance Procedure

Waste pre-acceptance, acceptance and rejection Procedure for Anaerobic Digestion

YorkshireWater

Document Control

Document Control Ref:	V001
Document Location:	YW IMS (Environment and Waste > Waste and Installations > IED)
Document Custodian:	David Shaw
Review Period:	Every 12 months or sooner if: - the waste changes - the process giving rise to the waste changes - if waste is found to be non-compliant.

Document Approval

Name	**Name**
David Shaw Policy and Assurance	
Document Owner (Author)	**Document Approval Manager (Tier 3)**

Document Revision History

Version	Date	Revised By	Reviewed By	Amendment Details
1	20/12/2023	David Shaw	Hazel Morgan	New document
2				
3				

Business areas affected by this document
This applies to colleagues that are operating an IED STF or colleagues moving sludge on behalf of Yorkshire Water (YW) into a YW Anaerobic Digestion (AD) Site. It may also be applicable to any YW colleague that wants to export an abnormal sludge load into an IED AD facility.

1. Introduction

This document details the waste pre-acceptance, acceptance and rejection procedures for wastes received for anaerobic digestion (AD) at the Sludge Treatment Facility (STF) located at Yorkshire Water (YW).

This details how YW has established procedures that align with the guidance in the Best Available Techniques Reference (BREF) Document for Waste Treatment, for operational techniques to improve environmental performance.

This procedure is written using guidance produced by the Environment Agency on 'Biological waste treatment: Appropriate measures for permitted facilities' (September 2022).

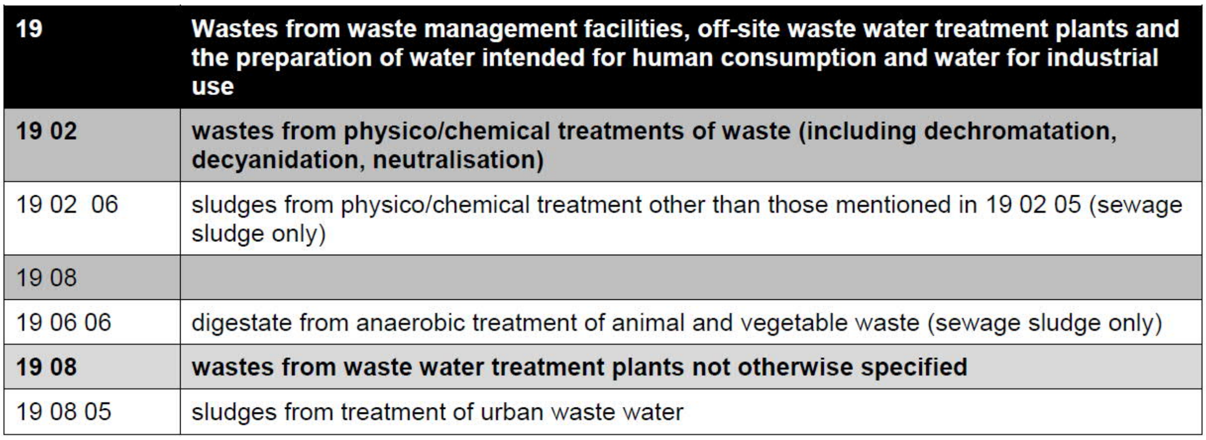
1.1. Waste steams treated by AD

The YW AD facility treats only sewage sludges arising from YW waste water treatment works (WwTW). These non-hazardous waste water sludges arrive at the AD facility via two routes:

- ***Indigenous sludges***. Originating from the adjacent wastewater treatment works (WwTW) on the wider YW site and transferred to the AD facility via above or below ground pipes as liquid sludge.
- ***Imported sludges***. Arriving via sludge tanker from smaller WwTWs that have limited or no capacity for AD treatment. Imported sludges arrive as either liquid (typically 2-6%dry solids) or as cake (typically >16% dry solids).

No commercial waste will be treated at the facility.

The only wastes that will be accepted for AD will be the EWC code wastes listed in the environmental permit in schedule 2, table 2.2, reproduced in table 1 below.



19	**Wastes from waste management facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use**
19 02	**wastes from physico/chemical treatments of waste (including dechromatation, decyanidation, neutralisation)**
19 02 06	sludges from physico/chemical treatment other than those mentioned in 19 02 05 (sewage sludge only)
19 08	
19 06 06	digestate from anaerobic treatment of animal and vegetable waste (sewage sludge only)
19 08	**wastes from waste water treatment plants not otherwise specified**
19 08 05	sludges from treatment of urban waste water

Table 1 –Permitted wastes

Table 2 provides a summary of the wastes accepted at the AD facility by waste stream, EWC code and origin.

Waste Stream	EWC code	Origin
Indigenous sludges	19 08 05 sludges from treatment of urban waste water	Sewage sludges arising from adjacent WwTW.
Imported sludges	19 08 05 sludges from treatment of urban waste water	Sewage sludge originating from other WwTW sites, delivered directly to the AD facility by tanker, comprising raw sludge.
	19 02 06 sludges from physico/chemical treatment other than those mentioned in 19 02 05	Thickened sludge arising from dewatering activities originating from other WwTW sites, delivered directly to the AD facility by tanker.
	19 02 06 sludges from physico/chemical treatment other than those mentioned in 19 02 05	Sludge cake that may originate from other WwTW sites and is stored on the STF cake pad as a contingency measure (Note 1). This sludge cake will require treatment at the AD facility.

Note 1: Sludge cake may need to be relocated for environmental protection reasons (e.g. flood risk to site) or if an unforeseen breakdown with the cake import facility has occurred.

Table 2 – Description of wastes

1.2. Key site personnel and responsibilities

This document details the characteristics of the sludge to be treated and confirms the conditions in which the sludge would be rejected. It is a requirement of the site permit that this document is in place and adhered to.

It is the responsibility of the Site Manager, the site Technically Competent Manager (TCM) and the Site Operators to ensure this procedure is adhered to.

1.3. Tracking system

This waste pre-acceptance and acceptance procedure is part of the YW Management System. The company's Sludge Delivery Scheduling system together with its WaSP software (for logging the delivery of sludges by individual tankers) ensures that a system is in place to track waste from the point of sludge pre-acceptance enquiry through to delivery at the AD facility.

2. Waste Pre-acceptance procedure

Waste pre-acceptance activities will be undertaken to determine if the waste is suitable for treatment at the AD facility. A risk-based approach will be undertaken to characterise the waste, assess the risks to process safety/occupational safety/the wider environment and to assess the impact of the waste stream on the AD process and outputs. These activities will take place prior to waste acceptance at the facility.

2.1. Legal suitability checks

An initial legal check will be undertaken on the waste. The waste type must be listed in the environmental permit for it to be suitable for AD. Information on the source, nature and point of origin of the waste will be obtained and verified against the permit EWC codes and the information presented in Table 2.

Only waste arising from WwTW sites will be treated by AD. Any enquiry from a commercial customer to deliver waste for treatment by AD will be rejected.

The proposed method for delivering the wastes to the STF will be assessed to determine if it complies with the YW safety procedures. Imported waste must be delivered in an appropriate tanker that can discharge safely into the sludge import tank.

If the waste is legally suitable, then further information will be requested on the potential quantities and characteristics of the waste, as described in this procedure.

2.2. Sampling procedures

YW commits to pre-acceptance testing of indigenous and imported sludge in order to determine its suitability for AD. This testing will also provide a bank of information that will enable YW to monitor the consistency and variability of waste from different origins.

Indigenous sludges are generally fresher in age than imported sludges. The age of indigenous sludge ranges from a few hours old up to 10 days in normal operation. Imported sludges are generally anywhere from 1 day – 6 months for the smallest WwTW sites. The sludge age is important as it can lower the sludge calorific value and affect digester health and in turn the amount of biogas that is generated. It is worth noting that smaller sites, which have a relatively older sludge age, will produce a much smaller quantity of sludge than larger WwTWs and have a lesser impact on digester health.

A representative sample of sludge will be collected for testing. The following information will be recorded for each sludge sample:

- Origin of waste – indigenous or imported, including the name of the originating WwTW
- EWC code/method of production – filter works, activated sludge, thickened sludge
- Size of sample
- Age of the sludge sampled
- Date of sample

An STF typically accepts sludge from ~100 smaller WwTW. The sludge is deemed to be consistent and therefore samples for waste characterisation will be carried out on a risk-based approach.

Sludge samples will be taken from a minimum of 10 of the 100 exporting sites. These will be selected on a risk basis and shall include sites that:

- Are the largest contributors of sludge (by volume)
- Have industrial customers within their catchment whose effluent could contain compounds with potential to disrupt/impact AD biology.

These sites would have the greatest potential to negatively impact on AD operations and therefore it is important to understand their waste characteristics.

The sampling will be undertaken by the TCM or appropriately trained Site Operator and tested at a third-party laboratory with a documented management system accredited to EN ISO 17025.

2.3. Waste Characterisation

Information on the characteristics of the waste will be obtained prior to acceptance of the waste at the STF. These characteristics fall into four groupings:

- Visual – colour, cake or liquid
- Physical – thickness (pumpability), total solids
- Level of acidity/alkalinity - measurement of pH
- Chemical – e.g. lab test results for contamination with heavy metals

Table 3 lists the test parameters for sludge samples taken during pre-acceptance. These parameters will provide information on the consistency of the sludge, the biodegradability and alert YW to any contamination/toxicity that may cause it to be unsuitable or inhibit biological activity.

These parameters have been selected as the most relevant to sewage sludge because they have the greatest potential to impact on the digestion process and on the quality of the digestate, the end product. The selection of the testing approach and acceptable ranges/trigger points is informed by operational experience, guidance on input material testing in PAS110:2014[1] and the Inhibition Values for anaerobic processes in section 13 of the EA guidance 'Biological waste treatment: Appropriate measures for permitted facilities'.

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[1] PAS 110:2014 – Specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials.

Parameter	**Testing Standard /Approach**	**Acceptable Range**
Colour	Qualitative testing	Within typical colour range
Particle Size distribution and physical contaminants	Qualitative testing	Evidence of rags and large contaminants will be rejected unless sludge passes through a screening system
pH value	BS EN 13037	Sewage sludge is usually slightly acidic pH hydrolysis and fermentation acido and aceto genesis – optimal pH 5-7 Methanogenesis – optimal pH7-8; operational 6.5-8.5 Typical pH range of sewage sludge 6.5-8
Total solids	BS EN 14346	WaSP system records total solids. Sludges greater than 20% dry solids have a reduced capacity for being pumped through the system.
Potentially toxic elements (PTEs) Heavy metals • chromium • zinc • copper • nickel • cadmium • lead	Various EN standards available (e.g. EN ISO 11885, EN ISO 17294-2, EN ISO 15586)	Heavy metals, if above acceptable levels, may cause a toxic effect on the digester biology.
Ammonia and total nitrogen content	EN 12260, EN ISO 11905-1	Ammonium build up may inhibit the anaerobic process No threshold data provided

Note: It is Recognised that the inhibitory values are under review and may be added, removed or amended. This table will be updated when data is available or otherwise in agreement with the Environment Agency.

Table 3 – Test parameters

This information will assist YW in understanding how each waste type would be processed, the effect of the different waste streams/sources on the AD process, in order to manage the facility more efficiently, predicting gas generation and digested sludge properties.

The likely weekly volumes, delivery frequencies and estimated annual quantities of each waste identified for AD treatment will also be recorded.

2.4. Record keeping

The pre-acceptance waste characteristics information will be obtained in writing or electronic form. All information will be stored electronically on a central database system called ROD.

The pre-acceptance records will be retained for at least 3 years using the YW computerised waste tracking systems following receipt of the waste. If an enquiry does not lead to receipt of the waste, a record does not need to be kept.

2.5. Reassessment of waste

Wastes will be reassessed should the following occur:

- There are significant changes in the waste e.g. the physical description is different to previous samples taken from the site source
- There are process changes at the WwTW that results in changes to the waste changes e.g. a different type of sludge thickening agent is used
- There are significant changes to industrial waste water sources
- The waste received does not conform to the pre-acceptance information

Irrespective of the above, an annual pre-acceptance review will be undertaken to ensure the waste sources remain suitable for AD.

2.6. Confirmation of suitability

The Site Operator, under the instruction of the TCM, will determine if the pre-acceptance information received meets the legal and technical requirements of the AD facility.

3. Acceptance

The AD facility treats only sludges arising from WwTW sites. These are known sources and the waste will be consistent in its characteristics. It's anticipated that only on rare occasions will waste need to be rejected.

In accordance with Section 6.8 of guidance produced by the Environment Agency on 'Biological waste treatment: Appropriate measures for permitted facilities' (September 2022), acceptance sampling requirements do not apply to sewage sludge and septic tank sludge. Instead, visual checks and periodic audits against pre-acceptance characteristics will be undertaken.

The following sections of this procedure detail how visual acceptance checks will be undertaken, the waste rejection process, record keeping and periodic testing.

3.1. Characteristic checks prior to tanker/tipper loading

Tankers are used to collect liquid sludges from smaller YW WwTW sites to a STF for AD. This should be consistent in colour and odour. The tanker driver will undertake a visual and / or odour check on the waste prior to loading. If the waste has a typical appearance and odour it will be loaded and delivered to the AD site.

Tipper vehicles are used to transport sludge cake from smaller YW WwTW sites to a STF for AD. Prior to loading, the tipper driver will inspect the cake to ensure it is not too wet/has high dry solids and therefore will not seep out of the vehicle onto the road. The waste will be rejected if the water content is too high or if it has weeds growing on it.

The waste will be rejected for collection if it:

- Has a darker colour than usual
- Appears to be contaminated with oil
- Has a different/unusual odour suggesting the waste is septic or has other contamination

These visual and odour checks take place prior to collection of the waste from the WwTW.

3.2. Visual and physical characteristic inspection at the STF

Waste is only received and accepted under the supervision of a suitably qualified operational team member. A visual inspection of solid feedstocks is carried out before any waste is unloaded. This will check for any unusual malodours and visual appearance differences, to confirm the waste is consistent with agreed pre-acceptance parameters.

Under normal operation, every liquid sludge waste load received on site will enter the AD import facility via a WaSP logger, a software data management system. This records the total quantity of waste and the % dry solids (total solids) in addition to the time and date on when the waste was unloaded. The system will only permit the waste to be unloaded if there is sufficient storage capacity in the holding tank. Insufficient storage capacity will cause the valve to close, which will automatically turn off the tanker pumps and unloading will cease as a result.

3.3. Storage of sludge cake

Any sludge that has failed acceptance testing and needs to be quarantined must not be stored on site for longer than 5 working days.

In exceptional operating circumstances, for example where cake import facility is unavailable due to mechanical downtime, sludge cake may be imported onto the cake pad awaiting further processing through the AD. Any imported cake must be stored appropriately so as not to cause a contamination risk to any digested sludge piles or an amenity impact.

3.4. Rejection of waste in import tank

Sludge that does not meet the agreed quality criteria must not enter AD treatment. Through the visual inspection process, early identification of issues should eliminate problems. However, imported liquid and sludge cake are soon fed into the process. Any problem not identified at visual inspection stage may have entered the process by the time a problem has been identified. If this occurs the following steps will be undertaken:

1- Waste will be isolated in the tank
2- A tanker will couple up to the appropriate tank and empty it of its contents
3- No further imports will be accepted whilst this emptying is occurring

4- The tank will not be put back in service until all contents are removed. Only at this point will the site be open to imports

3.5. Treatment of septic sludges

Treating a high load of septic sludges can cause increased foaming, reduce biogas yield and produce more carbon dioxide and hydrogen sulphide. In addition, sludges may be higher in metal concentration due to evaporation of sludges, which can be toxic to the digester bacteria causing rapid bacterial poisoning and a reduction in biogas yield. Sludges may be outside of a normal pH range, a shock impact of which could affect digester health and impact biogas yield.

Sludges that are septic in nature, and where the load is deemed significant, will be subject to testing prior to acceptance at the AD import facility. A sample of the waste must be taken before it has left the exporting site and the results submitted to the TCM for review*. The results will be used in a digester toxicity calculator to determine the correct course of action. The possible outcome of this toxicity analysis are as follows:

- Acceptance of the sludge at the requested site
- Acceptance of the sludge at another YW AD site (where the toxicity calculator demonstrates there will be no issue to digester health)
- Reduced load acceptance at the requested site (i.e. part load acceptance to enable blending with normal sludges)
- Acceptance of load over a longer period of time
- Combination of the above
- Rejection of the sludge in its entirety and another outlet (i.e. landfill) to be found**

* At minimum, Sludges will be tested for the following… pH, volatile solids concentration, ammonia, potential toxic elements (PTEs).

**Sludge will be rejected if a reduction in the sludge load and / or increase of import time makes no difference to the waste’s toxicity and it continues to fail toxicity limits.

Rejected loads will be sent to a suitable facility for processing and any records of the decision to reject abnormal loads and the associated digester toxicity calculation will be kept for no less than 3 years.

3.6. Waste tracking

All Imported sludge loads are tracked through the WaSP import facility. In the event of an issue arising with digester health, the WaSP system can be interrogated to identify the sludge origin. The outcome of any investigation will be to minimise the reoccurrence of an issue arising in the future.

3.7. Periodic sampling

Testing will be carried out on the parameters listed in table 3 when a problem with a waste source has been identified at the STF or if the waste may have changed in characteristic as detailed in section 2.5. Sampling and inspection may only be carried out by operators with appropriate technical knowledge to identify and deal with non-conforming feedstocks.

This test results will be used to ensure the waste characterisation in section 2 remains accurate.

4. Definitions

Definitions of Terms Used:	
Yorkshire Water	Yorkshire Water is used in this document to refer to Yorkshire Water Services Limited and all other subsidiary companies within Kelda Holdings.
Anaerobic Digestion	AD is used to refer to anaerobic digestion. The process which imported waste is subject to at this sewage treatment facility.

5. Compliance with this document

Colleagues shall comply with the requirements of this document, in line with the company Conduct Policy.

6. Assurance

Regular monitoring of compliance with these requirements shall be undertaken by the assurance providers documented as part of the Assurance Framework.

Any sampling that is undertaken will be taken in accordance with sampling procedures as documented in the internal guidance document Operator Self-Monitoring, which can be found on the Integrated Management System. Samples must be tested at a UKAS accredited laboratory.

7. Related Documents

Appendix 13 LDAR Plan

Management Procedure

Lundwood Leak Detection and Repair (LDAR) Plan

Document Control

Document Control Ref:	Version 1
Document Location:	IMS
Document Custodian:	IMS Team
Review Period:	2 Years or as defined using a risk-based approach by the document owner.

Document Approval

Ed Sutherland Project Sponsor Bioresource Asset Management **Document Owner (Author)**	**Alex Cook** Site Manager Energy and Recycling South **Document Approval Manager (Tier 3)**

Document Revision History

Version	Date	Revised By	Reviewed By	Amendment Details
1	15/09/2023	Ed Sutherland	Hazel Morgan	
2				
3				
4				

Contents

1. Introduction to LDAR

1.1 Purpose

As operators of Sludge Treatment Facilities (STFs), Yorkshire Water (YW) shall comply, as applicable, with the Environment Agency's document 'Appropriate Measures for the Biological Treatment of Waste' which provides guidance on how to comply with legislation governing anaerobic digestion of sewage sludge. One specific requirement in the appropriate measures document is the provision of an LDAR (Leak Detection and Repair) Plan to control emissions of organic compounds, including biogas, to air from the STF and associated infrastructure (for example, pipework, conveyors, lagoons or tanks).

"Leak detection and repair (LDAR) programme'' means a structured approach to reduce fugitive emissions of organic compounds by detection and subsequent repair or replacement of leaking components. Currently, sniffing (described by EN 15446) and optical gas imaging methods are available for the identification of leaks as set out in BAT 14 and section 6.6.2 of the Waste Treatment BAT Conclusions.

This management procedure outlines the overarching requirements of Yorkshire Water's LDAR programme and specifically how these shall be applied at the Lundwood STF.

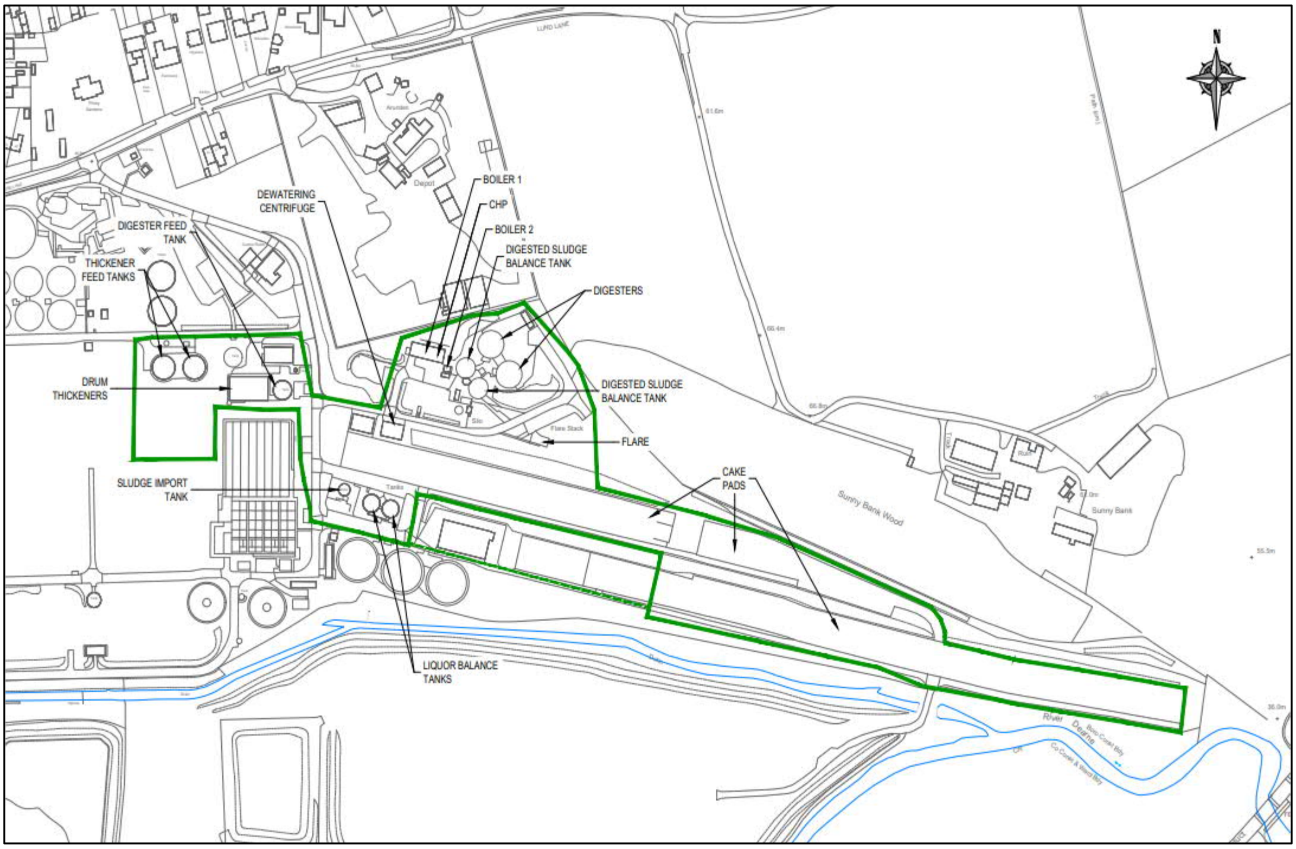


Figure 1 – Site layout IED permit boundary

1.2 Scope

This Management Procedure shall apply to all plant and equipment within the boundary of the STF which has the potential in normal (or abnormal) operating conditions to result in the release of potentially polluting or nuisance causing substances arising from the unintentional releases. This plant and equipment, includes, but is not limited to the following:

- Anaerobic Digester Tanks
- Pressure Relief Valves
- Biogas pipework from AD to biogas treatment and storage
- Natural gas pipework
- Biogas storage
- Pipework from biogas treatment to flare stack and engine
- CHPs
- Boilers
- Flare Stack

And all such related connections, pipework, valves, pumps and other connections

1.3 Responsibilities

It is the responsibility of the Site Operations Manager to ensure the implementation of the LDAR plan.

1.4 Assurance

Regular monitoring of procedure compliance shall be undertaken by the assurance providers documented as part of the Assurance Framework.

2 LDAR Considerations

The LDAR programme provides a structured approach to identifying and controlling releases of volatile organic compounds to air from equipment within the IED permit boundary. Typical causes of these releases would be damage to or degradation of items such as pipework, joints and other equipment linked to the transport, storage or processing of biogas or natural gas.

2.1 Biogas

Biogas is produced by bacteria within the anaerobic digester. Its composition is variable but will typically be within the following range.

Compound	Formula	%
Methane	CH_4	50–75
Carbon dioxide	CO_2	25–50
Nitrogen	N_2	0–10
Hydrogen	H_2	0–1
Hydrogen sulphide	H_2S	0–3
Oxygen	O_2	0–0.5

From an environmental and H&S perspective the key concern associated with uncontrolled releases of biogas are levels of methane (an explosive gas that is also environmentally damaging) and H_2S (typically found in low concentrations, but extremely toxic).

2.2 Natural Gas

Natural (mains) gas is used as a backup fuel on anaerobic digestion sites when insufficient biogas is available due to process limitations or disruption. It is most commonly used as a supplemental fuel source for boilers.

2.3 Leak Detection Equipment

Scheduled inspections under the LDAR programme shall be carried out using optical imaging devices with appropriate filters to detect methane and/or ‘sniffer’ style devices that detect methane directly.

The standard YW equipment for detecting release of gases is an FLIR GF77 camera fitted with an appropriate lens for detecting biogas and/or natural gas.

The scheduled inspection shall be supported by regular inspections by the site operational team. Although the focus is on prevention of leaks, in the event that one does develop, site staff are likely to identify this by its distinctive smell. As an additional detection measure, standard operational H&S requirements include the wearing of personal gas monitors at all times within the STF, these will alarm in the event of a large-scale release of gas.

2.4 Leak Volume Measurement

Should a leak be identified, an estimation of the measurement of fugitive emissions of volatile organic compounds (VOCs) shall be undertaken by Yorkshire Water with assistance of technical experts as required. The estimation shall be based on the known gas composition and the concentration of VOC's (ppm) at the interface of the leak. It will then be converted to a mass emission rate to quantify the estimated release of VOCs in kilograms per hour (kg/h). This calculation will be undertaken using the correlation values detailed within the European Standard EN 15446:2008.

The estimation may be determined utilising the following information:

- Calculation based on flow rate, pressure and size of leak area.
- Leak definitions adopted e.g. mass emission rates detailed within EN 15446:2008.

If point source monitoring is undertaken using portable detection equipment, the average value of the total mass emission over the reporting period shall be taken as the average between the total emission rate at the beginning of the reporting period and the total emission rate at the end of the reporting period, multiplied by the duration of the reporting period.

The site operations team are responsible for ensuring that the estimated size of the fugitive emission is recorded on a Schedule 5 notification and sent to the EA, as well as arranging repair of the leak.

As part of normal operations, the gas composition from the digesters (in the case of biogas leaks) will be obtained and can be used in conjunction with the results of the methane leak detection rate to calculate the leak of all biogas constituents based on a percentage basis.

2.5 Maintenance Schedule

YW follow a risk-based maintenance schedule to ensure that their assets are functional and safe.

2.6 DSEAR

AD sites operate under the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR). This legislation defines duties related to the control of dangerous substances, including biogas. There is significant overlap between DSEAR requirements and LDAR, all activities described in this document shall comply with DSEAR requirements.

3 Site

This management procedure details the process for LDAR at the Knostrop site.

3.1 Site Plan- Emission Sources

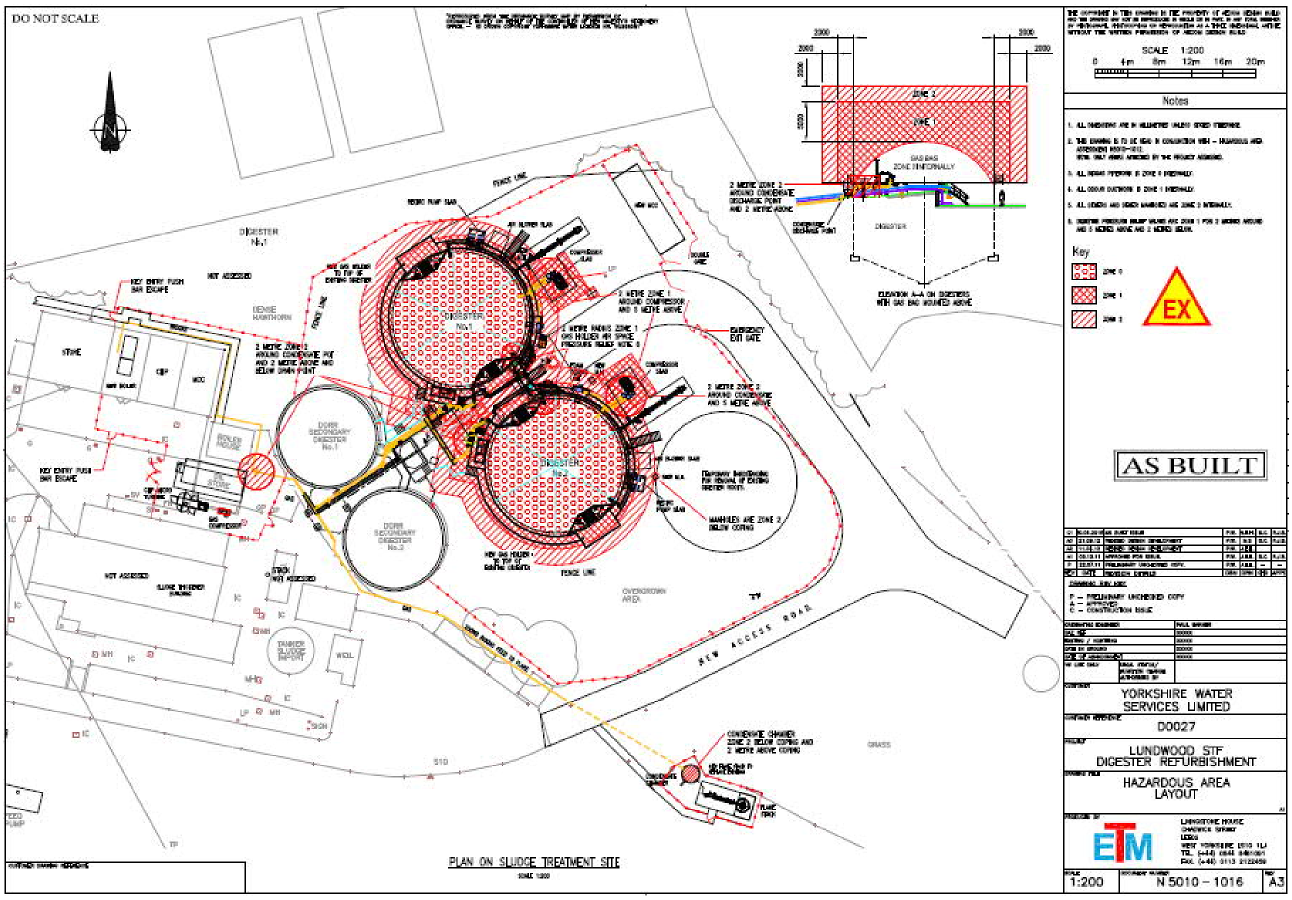


Figure 2A: General Digester Tank Emissions Sources

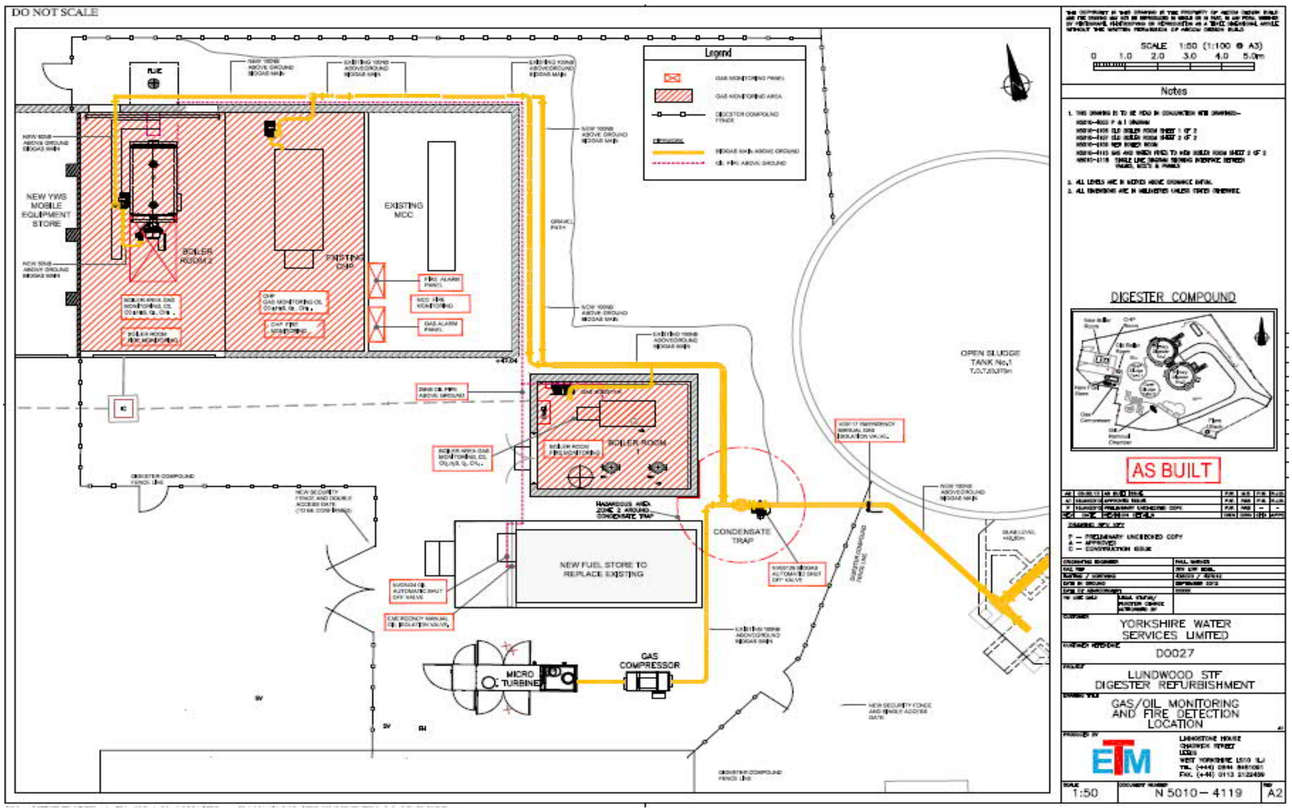


Figure 2B: CHP and Boilers Emission Sources

3.2 Key site information

e.g. typical daily methane production, gas consumers, normal operating pressure(s) of gas lines, over/under pressure setting on PRVs

Typical daily biogas production	1,200 m3/day @ 65% methane
Gas consumers	CHP x 1 Boilers x2 Flare Stack
Normal biogas operating pressure (unboosted)	25mbar
Digester PRV over-pressure release (mb)	28.5mbar
Biogas holder PRV over-pressure release (mb)	-2.5mbar

3.3 Site Specific LDAR Plan

The following actions shall be completed as part of LDAR work:

3.4 Routine operational checks

Visual checks of biogas systems are a daily task for site operational staff. These are recorded on the operational daily spreadsheet.

The purpose of these checks is to identify large scale leaks from the biogas system. They are unlikely to detect minor leaks. To ensure these are addressed, pro-active checks are carried out according to the maintenance schedule.

Staff wear personal gas monitors, although these are primarily a H&S tool, they will provide an audible alert if significant levels of biogas are detected.

3.5 STF Tanks (Anaerobic Digesters)

The only tanks in which biogas would routinely be found are the anaerobic digesters. These tanks are fully cleaned and inspected by competent engineers from the YW Asset Integrity team as per the frequency determined. Currently this means a full internal and external inspection every 10 years.

Any defects that are picked up by the 10-year inspection are addressed immediately via remedial works before the digester is approved to be put back into service for another 10 years.

3.6 Pressure Relief Valves

Pressure relief valves ensure a fail-safe route for gas escape that prevents catastrophic failure of other components within the gas system as a result of excessive pressure build up. They typically also provide under-pressure protection i.e. they prevent a vacuum forming within the gas system. Gas passing through the valves in a genuine high-pressure situation should not be considered a fault, and it is important that PRVs are never isolated from the rest of the system.

PRV’s are serviced and calibrated every 12 months via removal from the digester roof and bench-testing to ensure they will relieve at the correct pressure setpoints. There are duty/standby valves on each digester to allow this service/calibration to take place while the digester is still in operation.

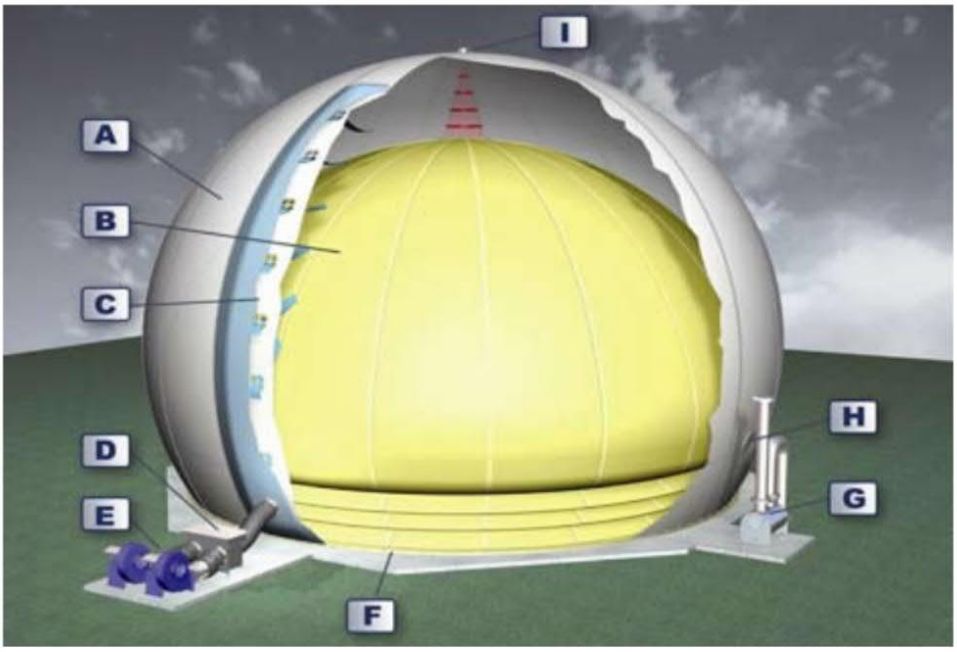
3.7 Biogas pipework

All inspections are scheduled as per the YW Asset Integrity inspection data base. The assets are all inspected using a FLIR GF77 camera with filters specifically designed for detecting methane gas releases. Each AD site is inspected annually. After inspection, any leaks or defects detected will be rectified as a matter of urgency.

3.7.1 Biogas storage

Site equipment includes a biogas holder installed on top of the 2no digesters. This is a double membrane design, with an outer layer that is constantly inflated using fans and an inner membrane that rises and falls depending on the amount of gas held within it. The positive pressure within the outer membrane ensures that under normal operation no biogas will pass from the inner membrane to the pressurised void.

The space between the inner and outer membranes is fitted with a methane detector which generates an alarm if the inner membrane becomes damaged, allowing biogas to escape.



A	Outer Membrane
B	Inner Membrane
C	Air Flow System
D	Non Return Valve
E	Radial Ventilator
F	Anchor Ring
G	Safety Valve
H	Inspection Window
I	Ultrasonic Sensor

Figure 3: Gas holder construction. Copyright Utile https://www.utileengineering.co.uk/gas-holders/

The first inspection of a gas holder is completed 5 years after installation. After this point, inspections take place every 2 years, with frequency increasing further if recommended by the inspecting company. The interval will be recommended by the specialist contractors completing work and agreed with the Yorkshire Water asset integrity team.

Inspection of the gas holder is a specialist task with significant H&S risks, as a result YW use a third-party to complete these inspections.

3.7.2 Pipework from biogas treatment to flare stack and engine

All inspections are scheduled as per the YW Asset Integrity inspection data base. The assets are all inspected using a FLIR GF77 camera with filters specifically designed for detecting methane gas releases. Each AD site is inspected annually. After inspection, any leaks or defects detected will be rectified as a matter of urgency.

3.7.3 Biogas Engine

Routine servicing and inspection of the biogas CHP engine is carried out by specialist contractors as per the recommended servicing schedule and include emergency responses to alarms and breakdowns. The internal compartment housing the engine contains gas leak detection which generates an alarm, isolates the fuel supply, and shuts down the engine on detection. The system also electrically isolates the engine, with the exception of the ventilation fans which will keep running to clear any hazardous gases.

The biogas CHP engine is also included in the annual inspection carried out by the YW Asset Integrity team using the FLIR GF77 camera with filters specifically designed for detecting methane gas releases.

It is the responsibility of the Site Operations Manager in collaboration with the Bioresource Asset Management team to deal with any recommendations or actions from the biogas CHP engine contractors.

Exhaust emissions

A poorly calibrated or maintained engine can lead to methane passing through the engine unburnt and being released to atmosphere as part of exhaust emissions. Annual emissions monitoring at site includes measurement of methane within exhaust gases to ensure that it remains within specified limits and as required by environmental permits.

3.7.4 Boilers (including boiler house)

Routine servicing and inspection of the boilers is carried out by specialist boiler contractors as per the recommended servicing schedule and include emergency responses to alarms and breakdowns. The boiler house contains gas leak detection which generates an alarm and shuts down electrical systems and isolates fuel supplies to the boiler on detection.

The boilers are also included in the annual inspection carried out by the YW Asset Integrity team using the FLIR GF77 camera with filters specifically designed for detecting methane and/or natural gas releases.

It is the responsibility of the Site Operations Manager in collaboration with the Bioresource Asset Management team to deal with any recommendations or actions from the biogas CHP engine contractors.

3.7.5 Flare Stack

Routine servicing and inspection of the flare stack is carried out by specialist flare stack contractors as per the recommended servicing schedule and includes safety interlocks as part of a valve proving sequence to prevent leakage of biogas.

The flare stack is also included in the annual inspection carried out by the YW Asset Integrity team using the FLIR GF77 camera with filters specifically designed for detecting methane and/or natural gas releases.

It is the responsibility of the Site Operations Manager in collaboration with the Bioresource Asset Management team to deal with any recommendations or actions from the biogas CHP engine contractors.

3.8 Natural gas pipework from mains network to gas consumers.

All inspections are scheduled as per the YW Asset Integrity team asset inspection data base. The assets are all inspected using a FLIR GF77 camera with filters specifically designed for detecting natural gas releases. Each AD site is inspected annually.

Appendix 14 STF processing capacity calculations

Site: Lundwood STF

Overall Summary:
The figures provided below represent Lundwood STF's peak throughput capacity. Under normal circumstances the plant runs at a lower throughput than this, which is moderated by the amount of liquid imports that are brought into the site.

1) Digesters Commentary:
The 2no digesters at Lundwood are the heart of the process. Therefore, their size and throughput capacity dictates the sizing of all upstream and downstream tanks and assets. At peak throughput, they are able to process up to

Digesters		
Individual Digester Volume	2,056	m3
Total Digester Volume (@90% active)	3,701	m3
Peak feed rate @ 12 days HRT (day)	308	m3/d
Peak feed rate @ 12 days HRT (year)	112,566	m3/yr
Peak Digester Throughput at 6% ds (day	18.5	tDS/d
Peak Digester Throughput at 6% ds (yea	6,754	tDS/Yr

Thickeners Outlet Sludge		
Peak sludge output at 6% ds	308	m3/day
Peak sludge output at 6% ds	112,566	m3/Yr

2) Thickeners Commentary:
The thickeners thicken the site indigenous primary and SAS sludges, as well as liquid imports brought into the site via road tanker.
At peak throughput, the thickeners process a sludge feed flow of up to 1,866m3/day and thicken this up to a target output of 6% dry solids at a volume of 308m3/day, which

Thickeners: Duty/Assist sized to process 71m3/hr each. So able to process up to 3,408m3/day.

Drum Thickener Feed Sludge		
Total Volume Feed to Drums	1,866	m3/day
Maximum Feed Volume Primary	313	m3/day
Maximum Feed Volume SAS	1,254	m3/day
Maximum Feed Volume Liquid Imports	299	m3/day

3) Imports and Sludge Screening:
Sludge is discharged from liquid import tankers via the onboard offload pump able to offload a 28m3 artic tanker in just 15 minutes.

Liquid Import sludge is passed through sludge screens and downstream transfer pumps which are designed with a capacity to process and pass forward sludge quickly to

Screened Sludge Transfer Pumps: Duty/Standby pumps sized to process 20m3/hr each. So able to process up to 480m3/day.

Sludge Screening: Duty/Standby Screens sized to process

Primary Transfer Pumps: Duty/standby pump in sequence at a

Onboard Tanker offload pump: Duty sized to discharge

SAS Transfer Pumps: Duty/Standby at 90m3/hr each. So

Site Indigenous Primary Sludge		
Peak amount produced by site	2,510	tDS/Yr
Minimum sludge thickness	2.2	%
Maxium sludge volume (per day)	313	m3/day
Maxium sludge volume (per year)	114,091	m3/year
Maximum sludge thickness	5.1	%
Minimum sludge volume (per day)	135	m3/day
Minimum sludge volume (per year)	49,216	m3/year

Liquid Sludge Imports from other treatment works		
Peak amount produced by site	2,184	tDS/Yr
Minimum sludge thickness	2	%
Maxium sludge volume (per day)	299	m3/day
Maxium sludge volume (per year)	109,198	m3/year
Maximum sludge thickness	6	%
Minimum sludge volume (per day)	100	m3/day
Minimum sludge volume (per year)	36,399	m3/year

Site Indigenous SAS Sludge		
Peak amount produced by site	2,060	tDS/Yr
Minimum sludge thickness	0.45	%
Maxium sludge volume (per day)	1,254	m3/day
Maxium sludge volume (per year)	457,778	m3/year
Maximum sludge thickness	1	%
Minimum sludge volume (per day)	564	m3/day
Minimum sludge volume (per year)	206,000	m3/year

4) Indigenous Primary Sludge Commentary:
The indigenous primary sludge coming off Lundwood wastewater treatment works and being passed forward for thickening peaks at 2,510tDS/year.
The thickness and therefore the volume of the sludge being passed forward for thickening varies between 114,091m3/year when the dry solids are at their minimum 2.2%. Down to 49,216m3/year

5) Liquid Sludge Imports Commentary:
The liquid sludge imports coming from other wastewater treatment works and being passed forward for thickening peaks at 2,184tDS/year.
The thickness and therefore the volume of the sludge being passed forward for thickening varies between 109,198m3/year when the dry solids are at their minimum 2%. Down to 36,399m3/year when the dry solids are at their maximum 6%.

6) Indigenous SAS Sludge Commentary:
The indigenous SAS sludge coming off Lundwood wastewater treatment works and being passed forward for thickening peaks at 2,060tDS/year.
The thickness and therefore the volume of the sludge being passed forward for thickening varies between 457,778m3/year when the dry solids are at their minimum 0.45%. Down to 206,000m3/year when the dry solids are at their maximum 1%.

Appendix 15 Materials Safety Data Sheets

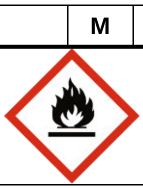
YorkshireWater

Form 34 - COSHH Assessment Form

Substance Name:	**Gas Oil**		
REACH Registration Number:	Not supplied	Last Review:	09/09/2020
Assessed By:	Richard Jelfs	Review Due:	08/09/2025
Name of Site:	Waste Water	Reference No:	CW-WW-023 v1

1	Physical Description	Straw to amber fluid; may be dyed red
2	Usage - General	Depending on the process application & used for cleaning – estimated 1 x weekly
	a. Risk from Chemical	Medium
	b. Specific Use	Fuel for plant and equipment e.g. generators
	c. Process Description	When fuel is required for on-site use, it is pumped from the bunded tank, into a vehicle or Gerry can. If this fuel is used on site, it is then carried to the required location and distributed from the Gerry can. The mandatory 5 points of PPE are worn during this process.
	d. Exposure Times	Less than 30 minutes, approximately 1000 litres per week
	e. Substitution	Due to the nature of the product and its use - no substitution possible.

3	Staff / Persons at Risk	Operators	Maintenance	Office Based	Contractors	Visitors
	Staff Numbers Exposed	**16**				
	Final Risk Ratings	**M**				

4	Hazards Identification a. Pictograms	
	b. Hazard Statements As per EC 1272/2008	These oils, particularly when catalytically and thermally cracked hydrocarbons are present, may contain polycyclic aromatic hydrocarbons (PCAs); some PCAs have been shown to have a potential to cause skin cancer (category 3 carcinogen). There are small concentrations of cetane no. improvers, flow improvers, anti-foam and detergent additives and marker/dye that are not considered to represent a health risk. Injection of fuel under the skin may have serious medical effects. Classified as dangerous for the environment
5	Tasks	**A) Delivery:**
	a. Controls	The chemical (fuel), is ordered via the SRM by the Product & Process Engineer (PPE). It is delivered by contractor direct to site, where they fill up the existing tank. This is witnessed by the Yorkshire Water PPE.
	b. PPE	• Eye protection BS EN 166 • Hand and skin protection - Hand and skin protection recommended at all times. Where • exposure is likely protective clothing must be worn, including nitrile gloves approved to BS EN 374 with a breakthrough time of >360 minutes.
	c. Documents	• Material Safety Data Sheet. • Task Specific Risk Assessment • Specific site procedures
		B) Fuel for internal combustion engines:
	a. Controls	• Stored in line with MSDS in well ventilated area • Wash hands well after use • Use mechanical lifting aid where possible
	b. PPE	• Eye protection BS EN 166 • Hand and skin protection - Hand and skin protection recommended at all times. Where • exposure is likely protective clothing must be worn, including nitrile gloves approved to BS EN 374 with a breakthrough time of >360 minutes.
	c. Documents	• Material Safety Data Sheet. • Task Specific Risk Assessment
6	Exposure Limits	Long term exposure limit - (8 hour TWA reference period) 5 milligrams per cubic metre. Short term exposure limit - (15 minute reference period) - 10 milligrams per cubic metre.
	a. Estimation of Risk	Low
7	Health Surveillance Required	No
	Health Surveillance Details	Not applicable

Form 34 - COSHH Assessment Form

	Substance Name:	**Gas Oil**
8	First Aid	
	a. Skin Contact	• Wash skin as soon as possible with soap and water. • Change contaminated clothing and launder before reuse. Get medical advice if irritation persists.
	b. Eye Contact	• Wash out thoroughly with large amounts of water. If redness and/or irritation continues get medical advice.
	c. Inhalation	• If inhalation of vapour causes irritation or drowsiness remove to fresh air. Get medical advice if the symptoms continue.
	d. Ingestion	• Wash mouth out with water and give water to drink. • If a large amount has been swallowed get medical advice. • DO NOT INDUCE VOMITING BECAUSE OF THEDANGER OF ASPIRATION.
9	a. Storage General	• The design, construction and maintenance of bulk storage and handling facilities are covered by codes of practice published by the Institute of Petroleum, British Standards • Institution and the Health and Safety Executive. • Drums should be stored on their sides on racks preferably under cover, out of direct sunlight, in well ventilated conditions. • Other types of containers should be stored under cover out of direct sunlight, in well ventilated conditions. Care should be taken to avoid over-stacking.
	b. Storage Specific	The chemical (fuel) is stored in a bunded tank, which is locked off with the key stored in a key safe - PPE's are the only personnel whom have access. The tank is fitted a gauge on it and a spill kit is stored near to the area
10	Spillage	• Treat any spillage as a fire hazard. Spray, vapour or mist can be a potential fire or explosion hazard. • Contain spillage - do not wash spillage down drain. Absorb using absorbent clay, diatomaceous clay or other suitable absorbent.
11	Disposal	• Container to be segregated on site and disposed on as hazardous waste Must not be disposed together with household garbage. Do not allow product to reach sewage system • Should a spillage occur on site, this should be cleaned by using a spill kit, this should then be classed as hazardous waste and disposed of on-site at the recycling hub. • Disposal must be made according to official regulations.
12	Additional Site Specific Information	• The design, construction and maintenance of bulk storage and handling facilities are covered by codes of practice published by the Institute of Petroleum, British Standards • Institution and the Health and Safety Executive. • Drums should be stored on their sides on racks preferably under cover, out of direct • sunlight, in well ventilated conditions. • Other types of containers should be stored under cover out of direct sunlight, in well ventilated conditions. • Care should be taken to avoid over-stacking.

Form 34 - COSHH Assessment Form

Substance Name:	**Diesel**		
REACH Registration Number:	Not supplied	Last Review:	23/08/2017
Assessed By:	Lisa Cuthbert	Review Due:	22/08/2022
Name of Site:	Waste Water	Reference No:	CA-WW-030 v1

1	Physical Description	Liquid
2	Usage - General	Fuel for on-road diesel-powered engines. Fuel for use in offroad diesel engines, boilers, gas turbines and other combustion equipment.
	a. Risk from Chemical	Low
	b. Specific Use	Fuel for pumps and machines
	c. Process Description	When the fuel is needed, it is funnelled from the fuel can into the pumps or machines where it is required
	d. Exposure Times	30 minutes
	e. Substitution	No substitution

3	Staff / Persons at Risk	Product & Process Engineers	Maintenance	Office Based	Contractors	Visitors
	Staff Numbers Exposed	**1-5**	**1-5**	**0**	**0**	**0**
	Final Risk Ratings	**L**	**L**			

4	Hazards Identification a. Pictograms	
	b. Hazard Statements As per EC 1272/2008	H226 Flammable liquid and vapour. H227 Combustible liquid. H304 May be fatal if swallowed and enters airways. H315 Causes skin irritation. H332 Harmful if inhaled. H351 Suspected of causing cancer. H373 May cause damage to organs or organ systems through prolonged or repeated exposure. H401 Toxic to aquatic life. H411 Toxic to aquatic life with long lasting effects.
5	Tasks	**A) Delivery, Storage & Use:**
	a. Controls	• Avoid inhaling vapour and/or mists. • Avoid prolonged or repeated contact with skin. • When using do not eat or drink. • Extinguish any naked flames. Do not smoke. Remove ignition sources. • Avoid sparks. Earth all equipment. • Properly dispose of any contaminated rags or cleaning materials in order to • prevent fires. • Use local exhaust ventilation if there is risk ofinhalation of vapours, mists or aerosols. The vapour is heavier than air, spreads along the ground and distant ignition is • possible.
	b. PPE	• Chemical resistant gloves/gauntlets, • boots, and • apron (where risk of splashing).
	c. Documents	• Task Specific Risk Assessment. • Material Safety Data Sheet.
6	Exposure Limits	Not applicable
	a. Estimation of Risk	Low risk – exposure at point of transferring fuel
7	Health Surveillance Required	No
	Health Surveillance Details	No
8	First Aid	**GENERAL:** In all cases of doubt, seek medical attention.

Form 34 - COSHH Assessment Form

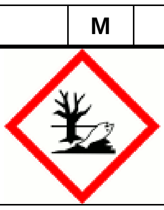
	Substance Name:	**Diesel**
	a. Skin Contact	- Remove contaminated clothing. Immediately flush skin with large amounts of water for at least 15 minutes, and follow by washing with soap and water if available. If redness, swelling, pain and/or blisters occur, transport to the nearest medical facility for additional treatment. - When using high pressure equipment, injection of product under the skin can occur. If high pressure injuries occur, the casualty should be sent - immediately to a hospital. Do not wait for symptoms to develop.
	b. Eye Contact	- Flush eye with copious quantities of water. If persistent irritation occurs, obtain medical attention
	c. Inhalation	- Remove to fresh air. If rapid recovery does not occur, transport to nearest medical facility for additional treatment.
	d. Ingestion	- If swallowed, do not induce vomiting: transport to nearest medical facility for additional treatment. - If vomiting occurs spontaneously, keep head below hips to prevent aspiration. - If any of the following delayed signs and symptoms appear within the next 6 hours, transport to the nearest medical facility: fever greater than 101° F (38.3°C), shortness of breath, chest congestion or continued coughing or wheezing. Give nothing by mouth.
9	a. Storage General	Store in well ventilated area
	b. Storage Specific	- Drum and small container storage: Drums should be stacked to a maximum of 3 high. Ensure adequate bunds in the event of damage - Store away from sunlight - Use properly labelled and closeable containers. - Tank storage: Tanks must be specifically designed for use with this product. Bulk storage tanks should be bunded - Locate away from heat and other sources of ignition.
10	Spillage	- Evacuate the area of all nonessential personnel. Ventilate contaminated area thoroughly. Take precautionary measures against static discharges. - Prevent from spreading or entering into drains, ditches or rivers by using sand, earth, or other appropriate barriers. - Do not flush away residues with water. Retain as contaminated waste. - Allow residues to evaporate or soak up with an appropriate
11	Disposal	- Treat as hazardous waste - Use licensed waste contractors
12	Additional Site Specific Information	N/A

Form 34 - COSHH Assessment Form

Substance Name:	**Renolin B 10 VG 32 Oil**		
REACH Registration Number:	01-2119490822-33	Last Review:	13/01/2017
Assessed By:	Colin Barton	Review Due:	12/01/2022
Name of Site:	Waste Water	Reference No:	CA-WW-032 v1

1	Physical Description	Pale yellow liquid
2	Usage - General	Used to lubricated the hydraulic pumps on site
	a. Risk from Chemical	Medium
	b. Specific Use	The substance is used to lubricated the hydraulic pumps on site
	c. Process Description	The chemical is added to the pumps by adding litres (qty does vary) into hyro-pack, in order to allow for the pumps to run in their normal application
	d. Exposure Times	<30 minutes
	e. Substitution	None

3	Staff / Persons at Risk	Operators	Maintenance	Office Based	Contractors	Visitors
	Staff Numbers Exposed	**1-5**				
	Final Risk Ratings	**M**				

4	Hazards Identification a. Pictograms	
	b. Hazard Statements As per EC 1272/2008	H35 Causes skin irritation H400 Very toxic to aquatic life. H410 Very toxic to aquatic life with long lasting effects.
5	Tasks	**A) Adding to pumps:**
	a. Controls	• Area is restricted to persons performing the task. • Task is performed under SWP • Item to be stored in line with MSDS • Deliveries made in bunded area. • Wear PPE as listed. Remove contaminated clothes immediately and wash before further use
	b. PPE	• Hard hat (in date) • Safety Goggles/face shield are recommended. • Hi vis jacket or vest. • Standard issue safety footwear (steel toe capped) • Chemical resistant safety gloves - Nitri Foam Grip or equivalent • Lightweight chemical resistant coveralls • If handling large quantities, full chemical body suit & boots • Other Protection - Chemical resistant apron
	c. Documents	Material Safety Data Sheet Task Specific Risk Assessment.
6	Exposure Limits	None of the components have assigned exposure limits.
	a. Estimation of Risk	Although the substance is contained, and PPE provides protection for residual risk, it has nonetheless been decided that residual risk should be rated as **Medium** due to the severity of potential consequences.
7	Health Surveillance Required	No
	Health Surveillance Details	No applicable
8	First Aid	If first aid applied or ill health experienced, inform line manager and ensure incident reported in accordance with YW Accident Reporting Procedure. Where medical intervention is required, ensure this document and the Safety Data Sheet (SDS) is shown.
	a. Skin Contact	Wash off immediately with soap and plenty of water. The product is not skin irritating.
	b. Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Consult an eye specialist immediately. Go to an ophthalmic hospital if possible.
	c. Inhalation	None Hazardous. .
	d. Ingestion	Clean mouth with water and drink afterwards plenty of water.

Form 34 - COSHH Assessment Form

	Substance Name:	**Renolin B 10 VG 32 Oil**
9	a. Storage General	The substance is stored within PTP building or Gallery, and sat on a bunded area. The substance is stored alone with no contact / contamination with other chemicals, with the lids on the bottles tightly closed.
	b. Storage Specific	The chemical should be used in a well-ventilated area.
10	Spillage	Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders sawdust). Keep in suitable, closed containers for disposal.
11	Disposal	Container to be segregated on site and disposed on as hazardous waste
12	Additional Site Specific Information	The product may not be released into the environment without control.

COSHH Assessment Form

Substance Name:	**Sodium Bicarbonate Powder**		
REACH Registration Number:	01-2119457606-32-xxxx	Last Review:	26/07/22
Assessed By:	Helen Darby	Review Due:	26/07/23
Name of Site:	Various	Reference No:	CA-WW-074 (Version 1)

1	Physical Description	White crystalline powder.
2	Usage - General	pH control.
	a. Risk from Chemical	Low.
	b. Specific Use	Control of pH, alkalinity and the purification process in water treatment facilities.
	c. Process Description	Substance is delivered and offloaded by the supplier and stored on delivery pallets in 25 kg bags.
	d. Exposure Times	< 15 minutes.
	e. Substitution	Not possible.

3	Staff / Persons at Risk	Operators			Driver											
	Staff Numbers Exposed	**1 - 2**			**1**											
	Final Risk Ratings	**L**			**L**											

4	Hazards Identification a. Pictograms	Product is not classified as dangerous according to Regulation (EC) No. 1272/2008.
	b. Hazard Statements As per EC 1272/2008	None.
5	Tasks	**A) Delivery:**
	a. Controls	• Delivered by the supplier directly adjacent to the dosing point. • Suitable signage in place. • Driver checks delivery prior to offloading. • Delivery driver controls offloading. • Supplier delivery is undertaken in accordance with their own delivery procedures. • Spill kit, emergency shower and eye wash facilities are available on site.
	b. PPE	Yorkshire Water 5 points of PPE.
	c. Documents	Safety data sheet.
		B) Dosing of powder
	a. Controls	• Do not dose in high winds or at exposed locations (to avoid dust exposure). • Product can become slippery when wet – Any dosing area spillages must be cleaned up. • Spill kit, emergency shower and eye wash facilities are available on site.
	b. PPE	5 points of PPE including: • Safety goggles (EN 166). • Nitrile gloves (EN 374). • FFP3 dust mask (EN 149).
	c. Documents	• Safety data sheet. • Point of work risk assessment (PoWRA).
6	Exposure Limits	Contains no substances with occupational exposure limit values.
	a. Estimation of Risk	Low.
7	Health Surveillance Required	None.
	Health Surveillance Details	N/A.
8	First Aid	General – No specific precautions required.
	a. Skin Contact	Wash off with soap and water. If skin irritation persists, seek medical attention.
	b. Eye Contact	Rinse thoroughly with plenty of water, also under the eyelids. If eye irritation persists, seek medical attention
	c. Inhalation	Remove to fresh air. If symptoms persist, seek medical attention.
	d. Ingestion	Rinse mouth with water. Never give anything by mouth to an unconscious person. Do not induce vomiting. If symptoms persist, seek medical attention.

COSHH Assessment Form

	Substance Name:	**Sodium Bicarbonate Powder**
9	a. Storage General	Store in original packaging away from other chemicals. Avoid moisture contamination.
	b. Storage Specific	Place on hardstanding protected by contained site drainage.
10	Spillage	• Do not flush into surface water or sanitary sewer system. • Avoid subsoil penetration. • Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders) or use spill kit booms and mats. • Keep spillage waste suitable, closed containers for disposal through a YW approved waste contractor.
11	Disposal	Dispose of any waste from through a YW approved waste contractor.
12	Additional Site Specific Information	Sites may have ferric sulphate dosing facilities and sodium bicarbonate is incompatible with ferric sulphate as reaction between the two chemicals is exothermic and produces carbon dioxide. The chemicals must be segregated and simultaneous deliveries of both chemicals prohibited. Clear signage must be in place. Avoid exposing sodium bicarbonate to > 50°C as decomposition may occur, also producing carbon dioxide.

SAFETY DATA SHEET

According to Regulations (EC) No 2015/830 and (EC) No 1907/2006

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name:	FLOPAM™ EM 640 TBD
Type of product:	Mixture.

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses:	Processing aid for industrial applications.
Uses advised against:	None.

1.3. Details of the supplier of the safety data sheet

Company:	SNF (UK) Limited Solutions House, Ripley Close Normanton WF6 1TB United Kingdom
Telephone:	01924-311000
Telefax:	01924-311099
E-mail address:	sds@snf.fr

1.4. Emergency telephone number

24-hour emergency number:	+33 477 36 87 25
National Poison Information Service:	NHS Direct: 0845 4647 or 111 (24/24, 7/7); Scotland: NHS 24 - 08454 24 24 24 (24/24, 7/7)

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification according to Regulation (EC) 1272/2008:

Not classified.

2.2. Label elements

Labelling according to Regulation (EC) 1272/2008:

Hazard pictogram(s):	None.
Signal word:	None.

Hazard statement(s):	None.
Precautionary statement(s):	None.
Additional elements:	EUH210 - Safety data sheet available on request

2.3. Other hazards

Spills produce extremely slippery surfaces.

PBT and vPvB assessment:
Does not fulfill the criteria according to Annex XIII of REACH.

For explanation of abbreviations see Section 16.

SECTION 3: Composition/information on ingredients

3.1. Substances
Not applicable, this product is not a substance.

3.2 Mixtures

Hazardous components

Hydrocarbons, C12-C15, n-alkanes, isoalkanes, cyclics, < 2% aromatics

Concentration/ -range:	20 - 30%
ECHA List Number: (Assigned to substances without a CAS N° or other numerical identifier.)	920-107-4
REACH Registration Number:	01-2119453414-43-XXXX
Classification according to Regulation (EC) No.1272/2008:	Asp. Tox. 1;H304

Notes
Does not result in classification of the mixture if the kinematic viscosity is greater than 20.5 mm²/s measured at 40°C.

Isotridecanol, ethoxylated

Concentration/ -range:	< 5%
EC-No.:	Polymer
REACH Registration Number:	Not applicable (polymer).
Classification according to Regulation (EC) No.1272/2008:	Acute Tox. 4;H302, Eye Dam. 1;H318

For explanation of abbreviations see section 16

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation:
Move to fresh air. No hazards which require special first aid measures.

Skin contact:
Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. In case of persistent skin irritation, consult a physician.

Eye contact:
Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention immediately.

Ingestion:
Rinse mouth with water. Do NOT induce vomiting. Call a physician or poison control centre immediately.

4.2. Most important symptoms and effects, both acute and delayed

None under normal use.

4.3. Indication of any immediate medical attention and special treatment needed.

None reasonably foreseeable.

Other information:
None.

SECTION 5: Fire-fighting measures

5.1. Extinguishing media

Suitable extinguishing media:
Water. Water spray. Foam. Carbon dioxide ($CO2$). Dry powder.

Unsuitable extinguishing media:
None.

5.2. Special hazards arising from the substance or mixture

Hazardous decomposition products:
Ammonia. Carbon oxides (COx). Nitrogen oxides (NOx). Hydrogen chloride. Hydrogen cyanide (hydrocyanic acid) may be produced in the event of combustion in an oxygen deficient atmosphere.

5.3. Advice for fire-fighters

Protective measures:
Wear self-contained breathing apparatus and protective suit.

Other information:
Spills produce extremely slippery surfaces.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions:
Do not touch or walk through spilled material. Spills produce extremely slippery surfaces.

Protective equipment:
Wear adequate personal protective equipment (see Section 8 Exposure Controls/Personal Protection).

Emergency procedures:
Keep people away from spill/leak.

6.2. Environmental precautions

Do not contaminate water.

6.3. Methods and material for containment and cleaning up

Small spills:
Do not flush with water. Soak up with inert absorbent material. Sweep up and shovel into suitable containers for disposal.

Large spills:
Do not flush with water. Dam up. Clean up promptly by scoop or vacuum.

Residues:
Soak up with inert absorbent material. After cleaning, flush away traces with water.

6.4. Reference to other sections

SECTION 7: Handling and storage; SECTION 8: Exposure controls/personal protection; SECTION 13: Disposal considerations;

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Avoid contact with skin and eyes. Renders surfaces extremely slippery when spilled. When using, do not eat, drink or smoke.

7.2. Conditions for safe storage, including any incompatibilities.

Keep away from heat and sources of ignition. Freezing will affect the physical condition and may damage the material. Incompatible with oxidizing agents.

7.3. Specific end use(s)

None.

SECTION 8. Exposure controls/personal protection

8.1. Control parameters

National occupational exposure limits:
None.

Derived No and Minimum Effect Levels (DNELs/DMELs)
None known.

Hydrocarbons, C12-C15, n-alkanes, isoalkanes, cyclics, < 2% aromatics

Isotridecanol, ethoxylated

Predicted no-effect concentrations (PNECs)
None known.

8.2. Exposure controls

Appropriate engineering controls:

Ensure adequate ventilation, especially in confined areas. Use local exhaust if misting occurs. Natural ventilation is adequate in absence of mists.

Individual protection measures, such as personal protective equipment:

a) Eye/face protection:
Safety glasses with side-shields.

b) Skin protection:
Wear coveralls and/or chemical apron and rubber footwear where physical contact can occur.

i) Hand protection:
PVC or other plastic material gloves.

c) Respiratory protection:
No personal respiratory protective equipment normally required.

d) Additional advice:
Wash hands and face before breaks and immediately after handling the product. Wash hands before breaks and at the end of workday.

Environmental exposure controls:

Do not allow uncontrolled discharge of product into the environment.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

a) Appearance:	Viscous liquid, Milky.
b) Odour:	Aliphatic.
c) Odour Threshold:	No data available.
d) pH:	4 - 6 @ 5 g/L
e) Melting point/freezing point:	< 5°C
f) Initial boiling point and boiling range:	> 100°C
g) Flash point:	Does not flash.
h) Evaporation rate:	No data available.
i) Flammability (solid, gas):	Not applicable.
j) Upper/lower flammability or explosive limits:	Not expected to create explosive atmospheres.
k) Vapour pressure:	2.3 kPa @ 20°C

l) Vapour density: 0.804 g/litre @ 20°C

m) Relative density: 1.0 - 1.1

n) Solubility(ies): Completely miscible.

o) Partition coefficient: Not applicable.

p) Autoignition temperature: Not applicable.

q) Decomposition temperature: > 150°C

r) Viscosity: > 20.5 mm²/s @ 40°C

s) Explosive properties: Not expected to be explosive based on the chemical structure.

t) Oxidizing properties: Not expected to be oxidising based on the chemical structure.

9.2. Other information

None.

SECTION 10: Stability and reactivity

10.1. Reactivity

Stable under recommended storage conditions.

10.2. Chemical stability

Stable under recommended storage conditions.

10.3. Possibility of hazardous reactions

Oxidizing agents may cause exothermic reactions.

10.4. Conditions to avoid

Protect from frost, heat and sunlight.

10.5. Incompatible materials

Oxidizing agents.

10.6. Hazardous decomposition products

Thermal decomposition may produce: hydrogen chloride gas, nitrogen oxides (NOx), carbon oxides (COx). Ammonia. Hydrogen cyanide (hydrocyanic acid).

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Information on the product as supplied:

Acute oral toxicity: LD50/oral/rat > 5000 mg/kg.

Acute dermal toxicity:	LD50/dermal/rat > 5000 mg/kg
Acute inhalation toxicity:	The product is not expected to be toxic by inhalation.
Skin corrosion/irritation:	Non-irritating to skin.
Serious eye damage/eye irritation:	Not irritating. (OECD 437)
Respiratory/skin sensitisation:	Not sensitizing.
Mutagenicity:	Not mutagenic.
Carcinogenicity:	Not carcinogenic.
Reproductive toxicity:	Not toxic for reproduction.
STOT - single exposure:	No known effects.
STOT - repeated exposure:	No known effects.
Aspiration hazard:	Due to the viscosity, this product does not present an aspiration hazard.

Relevant information on the hazardous components:

Hydrocarbons, C12-C15, n-alkanes, isoalkanes, cyclics, < 2% aromatics

Acute oral toxicity:	LD50/oral/rat > 5000 mg/kg. (OECD 401)
Acute dermal toxicity:	LD50/dermal/rabbit > 5000 mg/kg (OECD 402)
Acute inhalation toxicity:	LC50/inhalation/4 h/rat = 4951 mg/m^3. (OECD 403)
Skin corrosion/irritation:	Not irritating. (OECD 404) Repeated exposure may cause skin dryness or cracking.
Serious eye damage/eye irritation:	Not irritating. (OECD 405)
Respiratory/skin sensitisation:	By analogy with similar products, this product is not expected to be sensitizing. (OECD 406)
Mutagenicity:	Not mutagenic. (OECD 471, 473, 474, 476, 478, 479)
Carcinogenicity:	Carcinogenicity study in rats (OECD 451): Negative.
Reproductive toxicity:	By analogy with similar substances, this substance is not expected to be toxic for reproduction. NOAEL/rat = 300 ppm. (OECD 421)
STOT - single exposure:	No known effects.
STOT - repeated exposure:	NOAEL/oral/rat/90 days >= 3000 mg/kg/day (OECD 408) (Based on results obtained from tests on analogous products).
Aspiration hazard:	May be fatal if swallowed and enters airways.

Isotridecanol, ethoxylated

Acute oral toxicity:	LD50/oral/rat = 500 - 2000 mg/kg.

Acute dermal toxicity: LD50/dermal/rabbit > 2000 mg/kg

Acute inhalation toxicity: No data available.

Skin corrosion/irritation: Not irritating. (OECD 404)

Serious eye damage/eye irritation: Causes serious eye irritation. (OECD 405)

Respiratory/skin sensitisation: The results of testing on guinea pigs showed this material to be non-sensitizing.

Mutagenicity: Not mutagenic.

Carcinogenicity: Not carcinogenic.

Reproductive toxicity: Two-Generation Reproduction Toxicity (OECD 416)
NOAEL/rat > 250 mg/kg/day
Prenatal Development Toxicity Study (OECD 414)
NOAEL/Maternal toxicity/rat > 50 mg/kg/day
NOAEL/Developmental toxicity/rat > 50 mg/kg/day

STOT - single exposure: No known effects.

STOT - repeated exposure: NOAEL/oral/rat/600 days = 50 mg/kg/day

Aspiration hazard: No known effects.

SECTION 12: Ecological information

12.1. Toxicity

Information on the product as supplied:

Acute toxicity to fish: LC50/Fish/96 hours = 10 - 100 mg/L (Estimated)

Acute toxicity to invertebrates: EC50/Daphnia/48 hours = 10 - 100 mg/L (Estimated)

Acute toxicity to algae: Algal inhibition tests are not appropriate. The flocculation characteristics of the product interfere directly in the test medium preventing homogenous distribution which invalidates the test.

Chronic toxicity to fish: No data available.

Chronic toxicity to invertebrates: No data available.

Toxicity to microorganisms: No data available.

Effects on terrestrial organisms: No data available. Readily biodegradable, exposure to soil is unlikely.

Sediment toxicity: No data available. Readily biodegradable, exposure to sediment is unlikely.

Relevant information on the hazardous components:

Hydrocarbons, C12-C15, n-alkanes, isoalkanes, cyclics, < 2% aromatics

Acute toxicity to fish: LC0/Oncorhynchus mykiss/96 hours > 1000 mg/L. (OECD 203)

Acute toxicity to invertebrates: EC0/Daphnia magna/48 hours > 1000 mg/L. (OECD 202)

Acute toxicity to algae: IC0/Pseudokirchneriella subcapitata/72 hours > 1000 mg/L. (OECD 201)

Chronic toxicity to fish: NOEC/Oncorhynchus mykiss/28 days > 1000 mg/L.

Chronic toxicity to invertebrates: NOEC/Daphnia magna/21 days > 1000 mg/L.

Toxicity to microorganisms: EC50/Tetrahymena pyriformis/ 48h > 1000 mg/L.

Effects on terrestrial organisms: No data available.

Sediment toxicity: No data available. Readily biodegradable, exposure to sediment is unlikely.

Isotridecanol, ethoxylated

Acute toxicity to fish: LC50/Cyprinus carpio/96 hours = 1 - 10 mg/L (OECD 203)

Acute toxicity to invertebrates: EC50/Daphnia/48 hours = 1 - 10 mg/L (OECD 202)

Acute toxicity to algae: IC50/Desmodesmus subspicatus/72 hours = 1 - 10 mg/L (OECD 201)

Chronic toxicity to fish: No data available.

Chronic toxicity to invertebrates: No data available.

Toxicity to microorganisms: EC10/activated sludge/17 hours > 10000 mg/L (DIN 38412-8)

Effects on terrestrial organisms: No data available.

Sediment toxicity: No data available.

12.2. Persistence and degradability

Information on the product as supplied:

Degradation: Readily biodegradable.

Hydrolysis: At natural pHs (>6) the polymer degrades due to hydrolysis to more than 70% in 28 days. The hydrolysis products are not harmful to aquatic organisms.

Photolysis: No data available.

Relevant information on the hazardous components:

Hydrocarbons, C12-C15, n-alkanes, isoalkanes, cyclics, < 2% aromatics

Degradation: Readily biodegradable.

Hydrolysis: Does not hydrolyse.

Photolysis: No data available.

Isotridecanol, ethoxylated

Degradation: Readily biodegradable. > 60% / 28 days (OECD 301 B)

Hydrolysis: Does not hydrolyse.

Photolysis: No data available.

12.3. Bioaccumulative potential

Information on the product as supplied:

The product is not expected to bioaccumulate.

Partition co-efficient (Log Pow): Not applicable.

Bioconcentration factor (BCF): No data available.

Relevant information on the hazardous components:

Hydrocarbons, C12-C15, n-alkanes, isoalkanes, cyclics, < 2% aromatics

Partition co-efficient (Log Pow): 3 - 6

Bioconcentration factor (BCF): No data available.

Isotridecanol, ethoxylated

Partition co-efficient (Log Pow): > 3

Bioconcentration factor (BCF): No data available.

12.4. Mobility in soil

Information on the product as supplied:

No data available.

Relevant information on the hazardous components:

Hydrocarbons, C12-C15, n-alkanes, isoalkanes, cyclics, < 2% aromatics

Koc: No data available.

Isotridecanol, ethoxylated

Koc: > 5000

12.5. Results of PBT and vPvB assessment

PBT assessment:
Does not fulfill the criteria according to Annex XIII of REACH.

vPvB assessment:
Does not fulfill the criteria according to Annex XIII of REACH.

12.6. Other adverse effects

None.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste from residues/unused products:

Dispose in accordance with local and national regulations.

Contaminated packaging:

Rinse empty containers with water and use the rinse-water to prepare the working solution. If recycling is not practicable, dispose of in compliance with local regulations.

Recycling:

Store containers and offer for recycling of material when in accordance with the local regulations.

SECTION 14: Transport information

Land transport (ADR/RID)

Not classified.

Sea transport (IMDG)

Not classified.

Air transport (IATA)

Not classified.

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

All components of this product have been registered or pre-registered with the European Chemicals Agency or are exempt from registration.

15.2. Chemical safety assessment

A Chemical Safety Assessment for this product has been carried out by the person responsible for producing this Safety Data Sheet. All relevant information used to conduct this assessment are included in this Safety Data Sheet as well any as any resulting Risk Reduction Measures.

SECTION 16: Other information

This data sheet contains changes from the previous version in section(s):

SECTION 3. Composition/information on ingredients, SECTION 16. Other Information.

Key or legend to abbreviations and acronyms used in the safety data sheet:

Abbreviations
Asp. Tox. 1 = Aspiration hazard Category Code 1
Acute Tox. 4 = Acute toxicity Category Code 4
Eye Dam 1 = Serious eye damage/eye irritation Category Code 1

H-Phrases
H302 - Harmful if swallowed
H304 - May be fatal if swallowed and enters airways
H318 - Causes serious eye damage

This SDS was prepared in accordance with the following:

Regulation (EU) No. 2015/830
Regulation (EC) No. 1272/2008
Regulation (EC) No. 1907/2006

Version: 16.01.b

ENCC046

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

ANNEX(ES)

This product is not hazardous as supplied and does not contain:

- hazardous components which require REACH registration; or,
- demonstrate relevant effects which would require a chemical safety assessment; or,
- are present at concentrations above their cut-off value.

Therefore, according to Regulation (EC) No 1907/2006, Article 31, paragraph 7, an Exposure Scenario is not required as an annex to the Safety Data Sheet.

SAFETY DATA SHEET

According to Regulation (EC) No 1907/2006 and its amendments

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name:	FLOPAM™ FO 4490
Type of product:	Mixture.

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses:	Processing aid for industrial applications.
Uses advised against:	None.

1.3. Details of the supplier of the safety data sheet

Company:	SNF (UK) Limited Solutions House, Ripley Close Normanton WF6 1TB United Kingdom
Telephone:	01924-311000
Telefax:	01924-311099
E-mail address:	sds@snf.fr

1.4. Emergency telephone number

24-hour emergency number:	+33 477 36 87 25
National Poison Information Service:	NHS Direct: 0845 4647 or 111 (24/24, 7/7); Scotland: NHS 24 - 08454 24 24 24 (24/24, 7/7)

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification according to Regulation (EC) No.1272/2008:

Not classified.

2.2. Label elements

Labelling according to Regulation (EC) 1272/2008:

Hazard pictogram(s):	None.
Signal word:	None.

Hazard statement(s):	None.
Precautionary statement(s):	None.
Additional elements:	EUH210 - Safety data sheet available on request

2.3. Other hazards

Aqueous solutions or powders that become wet render surfaces extremely slippery.

PBT and vPvB assessment:
Does not fulfill the criteria according to Annex XIII of REACH.

For explanation of abbreviations see Section 16.

SECTION 3: Composition/information on ingredients

3.1. Substances

Not applicable, this product is a mixture.

3.2. Mixtures

Hazardous components

Adipic acid

Concentration/ -range:	<= 2.5%
EC-No.:	204-673-3
REACH Registration Number:	01-2119457561-38-XXXX
Classification according to Regulation (EC) No.1272/2008:	Eye Irrit. 2;H319

Sulphamidic acid

Concentration/ -range:	<= 2.5%
EC-No.:	226-218-8
REACH Registration Number:	01-2119982121-44-0000 / 01-2119488633-28-XXXX
Classification according to Regulation (EC) No.1272/2008:	Skin Irrit. 2;H315, Eye Irrit. 2;H319, Aquatic Chronic 3;H412

For explanation of abbreviations see section 16

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation:
Move to fresh air. Get medical attention if symptoms occur.

Skin contact:
Wash off with soap and plenty of water. Get medical attention if irritation develops and persists.

Eye contact:
Rinse immediately with plenty of water, also under the eyelids. Get medical attention.

Ingestion:
Rinse mouth. If conscious, give the victim plenty of water to drink. Induce vomiting, but only if victim is fully conscious.

4.2. Most important symptoms and effects, both acute and delayed

Powder can cause localised skin irritation in folds of the skin or under tight clothing. Contact with dust can cause mechanical irritation or drying of the skin.

4.3. Indication of any immediate medical attention and special treatment needed.

None.

Other information:
No information available.

SECTION 5: Fire-fighting measures

5.1. Extinguishing media

Suitable extinguishing media:
Water. Water spray. Foam. Carbon dioxide (CO2). Dry powder.
Warning! Aqueous solutions or powders that become wet render surfaces extremely slippery.

Unsuitable extinguishing media:
none.

5.2. Special hazards arising from the substance or mixture

Hazardous decomposition products:
Thermal decomposition may produce: hydrogen chloride gas, nitrogen oxides (NOx), carbon oxides (COx). Hydrogen cyanide (hydrocyanic acid) may be produced in the event of combustion in an oxygen deficient atmosphere.

5.3. Advice for fire-fighters

Protective measures:
Wear self contained breathing apparatus for fire fighting if necessary.

Other information:
Aqueous solutions or powders that become wet render surfaces extremely slippery.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions:
Aqueous solutions or powders that become wet render surfaces extremely slippery.

Protective equipment:
Wear adequate personal protective equipment (see Section 8 Exposure Controls/Personal Protection).

Emergency procedures:
Keep people away from spill/leak. Prevent further leakage or spillage if safe to do so.

6.2. Environmental precautions

As with all chemical products, do not flush into surface water.

6.3. Methods and material for containment and cleaning up

Small spills:
Do not flush with water. Clean up promptly by sweeping or vacuum.

Large spills:
Do not flush with water. Prevent unauthorized access. Sweep up and shovel into suitable containers for disposal.

Residues:
Sweep up to prevent slip hazard. After cleaning, flush away traces with water.

6.4. Reference to other sections

SECTION 7: Handling and storage; SECTION 8: Exposure controls/personal protection; SECTION 13: Disposal considerations;

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Avoid contact with skin and eyes. Avoid dust formation. Avoid breathing dust. Wash hands before breaks and at the end of workday.

7.2. Conditions for safe storage, including any incompatibilities

Keep in a dry place. Incompatible with oxidizing agents.

7.3. Specific end use(s)

Processing aid for industrial applications.

SECTION 8. Exposure controls/personal protection

8.1. Control parameters

National occupational exposure limits:
None.

Derived No and Minimum Effect Levels (DNELs/DMELs)

Adipic acid

Workers

Acute systemic effects:

Skin contact	38 mg/kg/day
Inhalation	264 mg/m^3

Acute local effects:

Inhalation	5 mg/m^3

Long-term systemic effects:

Skin contact	38 mg/kg/day
Inhalation	264 mg/m^3

Long-term local effects:

Inhalation	5 mg/m^3

Consumer:

Acute systemic effects:

Ingestion	19 mg/kg/day
Skin contact	19 mg/kg/day
Inhalation	65 mg/m^3

Long-term systemic effects:

Ingestion	19 mg/kg/day
Skin contact	19 mg/kg/day
Inhalation	65 mg/m^3

Sulphamidic acid

Workers

Long-term systemic effects:

Skin contact	10 mg/kg/day

Consumer:

Long-term systemic effects:

Ingestion	5 mg/kg/day
Skin contact	5 mg/kg/day

Predicted no-effect concentrations (PNECs)

Adipic acid

Freshwater:	0.126 mg/L
Marine water:	0.0126 mg/L
Intermittent release:	0.46 mg/L
Sewage treatment plant:	59.1 mg/L
Sediment (freshwater):	0.484 mg/kg
Sediment (marine water):	0.0484 mg/kg
Soil:	0.0228 mg/kg

Sulphamidic acid

Freshwater:	0.048 mg/L
Marine water:	0.0048 mg/L
Intermittent release:	0.48 mg/L
Sewage treatment plant:	2 mg/L
Sediment (freshwater):	0.173 mg/kg
Sediment (marine water):	0.0173 mg/kg
Soil:	0.00638 mg/kg
Oral (secondary poisoning):	The product is not expected to bioaccumulate.

8.2. Exposure controls

Appropriate engineering controls:

Use local exhaust if dusting occurs. Natural ventilation is adequate in absence of dusts.

Individual protection measures, such as personal protective equipment:

a) Eye/face protection:
Safety glasses with side-shields. Do not wear contact lenses where this product is used.

b) Skin protection:
Chemical resistant apron or protective suit if splashing or repeated contact with solution is likely.

i) Hand protection:
PVC or other plastic material gloves.

c) Respiratory protection:
Dust safety masks recommended where working powder concentration is more than 10 mg/m^3.

d) Additional advice:
Wash hands before breaks and at the end of workday. Handle in accordance with good industrial hygiene and safety practice.

Environmental exposure controls:

Do not allow uncontrolled discharge of product into the environment.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

a) Appearance:	Granular solid, white.
b) Odour:	None.
c) Odour Threshold:	Not applicable.
d) pH:	2.5 - 4.5 @ 5g/L
e) Melting point/freezing point:	> 100°C
f) Initial boiling point and boiling range:	Not applicable.
g) Flash point:	Not applicable.
h) Evaporation rate:	Not applicable.
i) Flammability (solid, gas):	Not combustible.
j) Upper/lower flammability or explosive limits:	Not expected to create explosive atmospheres.
k) Vapour pressure:	Not applicable.
l) Vapour density:	Not applicable.
m) Relative density:	0.6 - 0.9
n) Solubility(ies):	Soluble in water.

o) Partition coefficient:	< 0
p) Autoignition temperature:	Not applicable.
q) Decomposition temperature:	> 200°C
r) Viscosity:	See Technical Bulletin.
s) Explosive properties:	Not expected to be explosive based on the chemical structure.
t) Oxidizing properties:	Not expected to be oxidising based on the chemical structure.

9.2. Other information

None.

SECTION 10: Stability and reactivity

10.1. Reactivity

Hazardous polymerisation does not occur.

10.2. Chemical stability

Stable.

10.3. Possibility of hazardous reactions

Oxidizing agents may cause exothermic reactions.

10.4. Conditions to avoid

None known.

10.5. Incompatible materials

Oxidizing agents.

10.6. Hazardous decomposition products

Thermal decomposition may produce: hydrogen chloride gas, nitrogen oxides (NOx), carbon oxides (COx). Hydrogen cyanide (hydrocyanic acid) may be produced in the event of combustion in an oxygen deficient atmosphere.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Information on the product as supplied:

Acute oral toxicity:	LD50/oral/rat > 5000 mg/kg.
Acute dermal toxicity:	LD50/dermal/rat > 5000 mg/kg
Acute inhalation toxicity:	The product is not expected to be toxic by inhalation.
Skin corrosion/irritation:	Not irritating.

Serious eye damage/eye irritation: Testing conducted according to the Draize technique showed the material produces no corneal or iridial effects and only slight transitory conjuctival effects similar to those which all granular materials have on conjuctivae.

Respiratory/skin sensitisation: The results of testing on guinea pigs showed this material to be non-sensitizing.

Mutagenicity: Not mutagenic.

Carcinogenicity: Not carcinogenic.

Reproductive toxicity: Not toxic for reproduction.

STOT - single exposure: No known effects.

STOT - repeated exposure: No known effect.

Aspiration hazard: No hazards resulting from the material as supplied.

Relevant information on the hazardous components:

Adipic acid

Acute oral toxicity: LD50/oral/rat > 2000 mg/kg.

Acute dermal toxicity: LD50/dermal/rabbit > 2000 mg/kg

Acute inhalation toxicity: LC0/inhalation/4 hours/rat > 7.7 mg/L

Skin corrosion/irritation: Slightly irritating.

Serious eye damage/eye irritation: Not irritating. (OECD 405) (SNF)

Respiratory/skin sensitisation: Not sensitizing.

Mutagenicity: Negative in the In vitro Mammalian Cell Gene Mutation Test (OECD 476).

Carcinogenicity: Not carcinogenic.

Reproductive toxicity: Not toxic for reproduction.

STOT - single exposure: No known effects.

STOT - repeated exposure: No known effect.

Aspiration hazard: No known effects.

Sulphamidic acid

Acute oral toxicity: LD50/oral/rat > 2000 mg/kg.

Acute dermal toxicity:	NOAEL/dermal/rat = 2000 mg/kg (OECD 402)
Acute inhalation toxicity:	The product is not expected to be toxic by inhalation.
Skin corrosion/irritation:	Not irritating. (OECD 404) (SNF)
Serious eye damage/eye irritation:	Moderately irritating to the eyes. (EPA OPPTS 870.2400)
Respiratory/skin sensitisation:	The product is not expected to be sensitizing.
Mutagenicity:	Negative in the Ames Test (OECD 471) Negative in the In vitro Mammalian Cell Gene Mutation Test (OECD 476). Not mutagenic. (OECD 472, 487)
Carcinogenicity:	Based on the absence of mutagenicity, it is unlikely that the substance is carcinogenic.
Reproductive toxicity:	No data available.
STOT - single exposure:	No known effects.
STOT - repeated exposure:	No known effect.
Aspiration hazard:	No known effects.

SECTION 12: Ecological information

12.1. Toxicity

Information on the product as supplied:

Acute toxicity to fish:	LC50/Danio rerio/96 hours = 5 - 10 mg/L (OECD 203)
Acute toxicity to invertebrates:	EC50/Daphnia magna/48 hours = 20 - 50 mg/L. (OECD 202)
Acute toxicity to algae:	Algal inhibition tests are not appropriate. The flocculation characteristics of the product interfere directly in the test medium preventing homogenous distribution which invalidates the test.
Chronic toxicity to fish:	No data available.
Chronic toxicity to invertebrates:	No data available.
Toxicity to microorganisms:	No data available.
Effects on terrestrial organisms:	No data available. Readily biodegradable, exposure to soil is unlikely.
Sediment toxicity:	No data available. Readily biodegradable, exposure to sediment is unlikely.

Relevant information on the hazardous components:

Adipic acid

Acute toxicity to fish:	LC0/Danio rerio/96 hours >= 1000 mg/L
Acute toxicity to invertebrates:	EC50/Daphnia magna/48 hours = 46 mg/L. (OECD 202)
Acute toxicity to algae:	IC50/Selenastrum capricornutum/72 hours = 59 mg/L (OECD 201)
Chronic toxicity to fish:	No data available.
Chronic toxicity to invertebrates:	NOEC/Daphnia magna/21 days = 6.3 mg/L (OECD 211)
Toxicity to microorganisms:	EC50/activated sludge/3 hours = 4747 mg/L (OECD 209)
Effects on terrestrial organisms:	No data available.
Sediment toxicity:	No data available.

Sulphamidic acid

Acute toxicity to fish:	LC50/Pimephales promelas/96 hours = 70.3 mg/L (OECD 203)
Acute toxicity to invertebrates:	EC50/Daphnia magna/48 hours = 71.6 mg/L. (OECD 202)
Acute toxicity to algae:	IC50/Scenedesmus subspicatus/72 hours = 48 mg/L (OECD 201)
Chronic toxicity to fish:	No data available.
Chronic toxicity to invertebrates:	No data available.
Toxicity to microorganisms:	EC50/activated sludge/3 hours > 200 mg/L (OECD 209)
Effects on terrestrial organisms:	No data available.
Sediment toxicity:	No data available.

12.2. Persistence and degradability

Information on the product as supplied:

Degradation:	Readily biodegradable.
Hydrolysis:	At natural pHs (>6) the polymer degrades due to hydrolysis to more than 70% in 28 days. The hydrolysis products are not harmful to aquatic organisms.
Photolysis:	No data available.

Relevant information on the hazardous components:

Adipic acid

Degradation:	Readily biodegradable. > 70% / 28 days (OECD 301 D)
Hydrolysis:	Does not hydrolyse.
Photolysis:	Half-life (indirect photolysis): = 2.9 days

Sulphamidic acid

Degradation:	Not relevant (inorganic).
Hydrolysis:	Does not hydrolyse.
Photolysis:	No data available.

12.3. Bioaccumulative potential

Information on the product as supplied:

The product is not expected to bioaccumulate.

Partition co-efficient (Log Pow):	< 0
Bioconcentration factor (BCF):	No data available.

Relevant information on the hazardous components:

Adipic acid

Partition co-efficient (Log Pow):	0.093 @ 25°C, pH 3.3
Bioconcentration factor (BCF):	No data available.

Sulphamidic acid

Partition co-efficient (Log Pow):	-4.34 @ 20°C
Bioconcentration factor (BCF):	No data available.

12.4. Mobility in soil

Information on the product as supplied:

No data available.

Relevant information on the hazardous components:

Adipic acid

Koc:	No data available.

Sulphamidic acid

Koc:	No data available.

12.5. Results of PBT and vPvB assessment

PBT assessment:
Does not fulfill the criteria according to Annex XIII of REACH.

vPvB assessment:
Does not fulfill the criteria according to Annex XIII of REACH.

12.6. Other adverse effects

None known.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste from residues/unused products:

Dispose in accordance with local and national regulations. Can be landfilled or incinerated, when in compliance with local regulations.

Contaminated packaging:

Rinse empty containers with water and use the rinse-water to prepare the working solution. If recycling is not practicable, dispose of in compliance with local regulations. Can be landfilled or incinerated, when in compliance with local regulations.

Recycling:

In accordance with local and national regulations.

SECTION 14: Transport information

Land transport (ADR/RID)

Not classified.

Sea transport (IMDG)

Not classified.

Air transport (IATA)

Not classified.

SECTION 15: Regulatory information

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

All components of this product have been registered or pre-registered with the European Chemicals Agency or are exempt from registration.

15.2. Chemical safety assessment

A Chemical Safety Assessment for this product has been carried out by the person responsible for producing this Safety Data Sheet. All relevant information used to conduct this assessment are included in this Safety Data Sheet as well any as any resulting Risk Reduction Measures.

SECTION 16: Other information

This data sheet contains changes from the previous version in section(s):

SECTION 13. Disposal considerations, SECTION 16. Other Information.

Key or legend to abbreviations and acronyms used in the safety data sheet:

Abbreviations
Eye Irrit. 2 = Serious eye damage/eye irritation Category Code 2
Skin Irrit. 2 = Skin corrosion/irritation Category Code 2
Aquatic Chronic 3 = Hazardous to the aquatic environment Chronic Category Code 3

H-Phrases
H319 - Causes serious eye irritation
H315 - Causes skin irritation
H412 - Harmful to aquatic life with long lasting effects

This SDS was prepared in accordance with the following:

Regulation (EC) N°1907/2006, as amended
Regulation (EC) N°1272/2008, as amended

Version: 17.01.a

PRCC003

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

ANNEX(ES)

This product is not hazardous as supplied and/or does not contain hazardous components:

- which require REACH registration; or,
- which demonstrate relevant effects which would require a chemical safety assessment; or,
- which are present at concentrations above their cut-off value.

Therefore, according to Regulation (EC) No 1907/2006, Article 31, paragraph 7, an Exposure Scenario is not required as an annex to the Safety Data Sheet.

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE PRODUCT AND THE COMPANY

Product Name: **FLOFOAM 139F**

Supplier:

SNF (UK) LIMITED
Solutions House, Ripley Close,
Normanton Industrial Estate
Normanton, WF6 1TB.

Telephone Number: +44 (0) 1924 311000 **Fax:** +44 (0) 1924 311099

Product Use: Process aid for industrial applications.

2. HAZARDS IDENTIFICATION

This product is not hazardous to health according to EC criteria.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components presenting hazards : Blend of hydrocarbons, fatty acid esters and surfactants.

Hazardous Component	CAS No	Concentration	R Phrase	Classification
Kerosene	064742-81-0	<55%	R65	Xn

4. FIRST AID MEASURES

Product in eyes : Wash thoroughly with water. If irritation persists, seek medical advice.

Product on skin : Remove all contaminated clothing and footwear. Wash with soap and water. In case of persistent skin irritation, consult a physician.

Product inhaled : No hazard anticipated.

Product ingested : Do not induce vomiting. Give milk to drink. Seek medical advice.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media : WATER SPRAY, FOAM, CARBON DIOXIDE (CO2), POWDERS, AQUEOUS FILM FORMING FOAM (AFFF).

Unsuitable extinguishing media : Strong water jet.

Specific hazards : NOT classified as flammable according to EC criteria, but may present a risk in the event of a fire.
Combustible liquid. However, it does not catch fire easily.

6. ACCIDENTAL RELEASE MEASURES

Wash small spillages away with cold water. Absorb large spillages with sand or earth.
Dispose in accordance with national and local regulations.

7. HANDLING AND STORAGE

Store between 5°C and 30°C. Extremes of temperature may adversely affect viscosity and stability.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering measures :	No specific measures are required provided the product is handled in accordance with the general rules of occupational hygiene and safety.
Personal protective equipment :	
Hand protection :	Protective gloves.
Eye Protection :	Goggles or visor.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance :	Clear amber liquid.
S.G.:	Approx 0.88.

10. STABILITY AND REACTIVITY

No known hazardous reactions.

11. TOXICOLOGICAL INFORMATION

Product in eyes :	This product is mildly irritating to the eyes.
Product on skin :	Moderately irritant to the skin, prolonged contact may cause dermatitis.
Product inhaled :	No hazard anticipated.
Product ingested :	This product has low systemic toxicity. If aspiration occurs (e.g. during vomiting) this can lead to intense irritation of the lung tissue, and chemically induced pneumonia.

12. ECOLOGICAL INFORMATION

OECD 301D Biodegradability test. 14 days >80% Biodegradation.

13. DISPOSAL CONSIDERATIONS

Incineration under approved conditions.

14. TRANSPORT INFORMATION

This product is not classified as dangerous.

15. REGULATORY INFORMATION

EC Labelling

- Symbol (s)	None.
- R Phrase (s)	None.
- S Phrase (s)	None.

16. OTHER INFORMATION

Further information:

This MSDS was prepared in accordance with the following:

Council Directive 92/32/EEC of 30 April 1992 amending for the seventh time Directive 67/548/EEC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances and all subsequent adaptations to technical progress.

Directive 1999/45/EC of the European Parliament and of the Council of 31 May 1999 concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations.

Commission Directive 2001/58/EC of 27 July 2001 amending for the second time Directive 91/155/EEC defining and laying down the detailed arrangements for the system of specific information relating to dangerous preparations in implementation of Article 14 of European Parliament and Council Directive 1999/45/EC and relating to dangerous substances in implementation of Article 27 of Council Directive 67/548/EEC (safety data sheets).

ISO 110140-1 : Material Safety Data Sheet for Chemical Product.

Contact: SNF (UK) Ltd.
Tele: 01924 311000

SAFETY DATA SHEET

SECTION 1 Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

- Product Name: OXYGEN SCAVENGER PLUS
- Product Part Number: 698712 (25 liter)

1.2 Relevant identified uses of the substance or mixture and uses advised against

- Use of the substance/mixture: Water treatment

1.3 Details of the supplier of the safety data sheet

- Name of Supplier: Wilhelmsen Ships Service AS
- Address of Supplier: Willem Barentszstraat 50, 3165AB Rotterdam, The Netherlands
- Telephone: Telephone: +31 4877 777 Fax: +31 4877 888
-
- Head office: Wilhelmsen Ships Service AS
- Strandveien 20, N1324 Lysaker
- Norway, Tel: (47) 6349 440 35
-
-
- Other suppliers SEE SECTION 16!!!
- For quotations contact your local Customer Services
-
- Responsible Person: Product HSE Manager
- Telephone: +31 10 4877775
- Email: WSS.GLOBAL.SDSINFO@wilhelmsen.com
- Email: WSS.GLOBAL.SDSINFO@wilhelmsen.com

1.4 Emergency telephone number

- ****ONLY TO BE USED IN CASE OF AN INCIDENT****
-
- International 24hrs Emergency NCEC:+ 44 1865 407333
- American 24hrs Emergency CHEMTREC (800) 424 9300
- American Chemistry Council 24hrs +1 703 527 3887
- Greece: Poisoning emergency center, +30 210 7793777
- Norway: Poison information centre, +47 22591300
- Sweden: Poison information centre, +46 08 33 12 31
- China NRCC 24hrs emergency telephone number: +86-0532-8388 9090
- Wilhelmsen Ships Service, Melbourne, AUSTRALIA Emergency 24hrs: +61 3 9630 0998

SECTION 2 Hazards identification

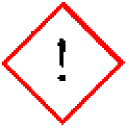
2.1 Classification of the substance or mixture

- Counsil Directive 1999/45/EEC Classification, packing and labelling of dangerous preparations.
- Refer to current The Dangerous Substances Directive (67/548/EEC)
- Symbols: Xn
- Harmful by inhalation and in contact with skin (R20/21)
- Irritating to eyes, respiratory system and skin (R36/37/38)
-
- Regulations 1272/2008/EEC. Classification, labeling and packing of dangerous substances and preparations

SECTION 2 Hazards identification (....)

- Symbols: GHS07
- Signal Word: Warning
- Acute Tox. 4
- Eye Irrit. 2
- Skin Irrit. 2
- Harmful if swallowed (H302).
- Causes serious eye irritation (H319).
- Causes skin irritation (H315).

2.2 Label elements



- Signal Word: Warning
-
- Contains:
- Diethylhydroxylamine
-
- Hazard phrases
  Harmful if swallowed (H302).
  Causes serious eye irritation (H319).
  Causes skin irritation (H315).
-
- Precautionary Phrases
  Wear protective gloves/protective clothing/eye protection/face protection (P280).
  IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing (P305+P351+P338).
  If eye irritation persists: Get medical advice/attention (P337+P313).
  IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician (P301+P310).

2.3 Other hazards

- Not applicable
- Not a PBT according to REACH Annex XIII
- Odour: Amine odour
- Appearance: Liquid, pale yellow, soluble in water

SECTION 3 Composition/information on ingredients

3.1 Mixtures

- Diethylhydroxylamine
  Concentration: 10-30%
  CAS Number: 3710-84-7
  EC Number: 223-055-4
  Symbols: Xn, GHS07, GHS02
  R/H Phrases: R10, R20/21, R36/37/38 - H226, H302, H319, H315
  Categories: Flam. Liq. 3, Acute Tox. 4, Eye Irrit. 2, Skin Irrit. 2

SECTION 4 First aid measures

4.1 Description of first aid measures

SECTION 4 First aid measures (....)

- IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower (P303+P361+P353).
- IF ON SKIN: Wash with plenty of soap and water (P302+P352).
- Contaminated clothing should be laundered before reuse
-
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing (P305+P351+P338).
- If eye irritation persists: Get medical advice/attention (P337+P313).
-
- IF SWALLOWED: rinse mouth. Do NOT induce vomiting (P301+P330+P331).
- Give 200-300mls (half pint) water to drink
- Obtain immediate medical attention
-
- IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing (P304+P340).
- When in doubt or symptoms persist, seek medical attention

4.2 Most important symptoms and effects, both acute and delayed

- Causes irritation
- May cause gastro-intestinal disturbances

4.3 Indication of any immediate medical attention and special treatment needed

- No information available

SECTION 5 Fire-fighting measures

5.1 Extinguishing media

- Not flammable. In case of fire use extinguishing media appropriate to surrounding conditions

5.2 Special hazards arising from the substance or mixture

- Smoke from fires is irritating

5.3 Advice for firefighters

- Wear chemical protection suit and positive-pressure breathing apparatus

SECTION 6 Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

- Wear protective clothing as per section 8

6.2 Environmental Precautions

- Do not allow to enter public sewers and watercourses
- Do not flush spilt material into any public water system

6.3 Methods and material for containment and cleaning up

- Absorb spillage in inert material and shovel up
- Ventilate the area and wash spill site after material pick-up is complete

6.4 Reference to other sections

- See Section 13

SECTION 7 Handling and storage

7.1 Precautions for safe handling

- Wear protective clothing as per section 8
- Do not get in eyes, on skin, or on clothing (P262).
- Eyewash bottles should be available

7.2 Conditions for safe storage, including any incompatibilities

SECTION 7 Handling and storage (....)

- Store in a dry place. Store in a closed container (P402+P404).
- Store in a well-ventilated place (P403).

7.3 Specific end use(s)

- Proper chemicals handling procedures should be adopted

SECTION 8 Exposure controls/personal protection

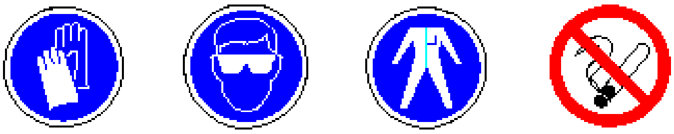
8.1 Control parameters

- Diethylhydroxylamine
  No exposure limits have been set for this substance

8.2 Exposure controls

- No special precautions are required for this product

8.3 Occupational exposure controls



- Wear suitable protective clothing, including eye/face protection and gloves (plastic or rubber are recommended)
- Penetration time of glove material:
  The exact break trough time has to be found out by the manufacturer of the protective gloves and has to be observed.
- Respiratory protection may be required under exceptional circumstances when excessive air contamination exists
- Wear suitable respiratory protection. Gas cartridge (organic substances).

SECTION 9 Physical and chemical properties

9.1 Information on basic physical and chemical properties

- Odour: Amine odour
- Appearance: Liquid, pale yellow, soluble in water
- pH 10 - 11 at 100 % concentration
- Density 0,995 - 1,005 g/cm3 at 20 deg C
- Flash point > 62 deg C (CC)
- Partition Coefficient (n-Octanol/Water): Log Pow -1,5
- Non combustible

9.2 Other information

- No information available

SECTION 10 Stability and reactivity

10.1 Reactivity

- No information available

10.2 Possibility of hazardous reactions

- No hazardous reactions known if used for its intended purpose

10.3 Incompatible materials

- Incompatible with amines
- Incompatible with oxidizing substances
- Incompatible with reducing agents
- Incompatible with acid

10.4 Conditions to avoid

SECTION 10 Stability and reactivity (....)

- Avoid contact with water
- No special precautions are required for this product

10.5 Hazardous Decomposition Products

- Decomposition products may include toxic gas
- Decomposition products may include Nitrous gases (NOX)
- Decomposition products may include amines
- Decomposition products may include ammonia
- Decomposition products may include hydrogen

SECTION 11 Toxicological information

11.1 Information on toxicological effects

- LD50 (oral,rat) >2190 mg/kg
- LD50 (skin,rabbit) 1300 mg/kg
- LC50 (inhalation, rat) 3140 ppm /4h

11.2 Contact with eyes

- Causes irritation

11.3 Contact with skin

- Causes irritation

11.4 Ingestion

- May cause gastro-intestinal disturbances

11.5 Inhalation

- Vapours or aerosols may cause irritation of eyes, nose and respiratory tract

SECTION 12 Ecological information

12.1 Toxicity

- LC50 (fish) Diethylhydroxylamine 150 mg/l (96 hr)
- EC50 (daphnia) Diethylhydroxylamine 130.1 mg/l (48 hr)
- Biodegradability. OECD-test. 28 days 20 % (Diethylhydroxylamine)
-
- This product does not contain ingredients which are classified in the EU as dangerous for the environment.

12.2 Persistence and degradability

- Degrades rapidly on exposure to air

12.3 Bioaccumulation Potential

- Bioaccumulation of the components in this product is insignificant.

12.4 Mobility in soil

- Completely soluble in water

12.5 Results of PBT and vPvB assessment

- Not a PBT according to REACH Annex XIII

12.6 Other Adverse Effects

- No environmental problems are expected when the product is used / handled correctly.

SECTION 13 Disposal considerations

13.1 Waste treatment methods

- Do not discharge into drains or the environment, dispose to an authorised waste collection point
- Disposal should be in accordance with local, state or national legislation

SECTION 13 Disposal considerations (....)

13.2 Classification

- EU Waste class: 07.01.99

SECTION 14 Transport information

14.1 UN

- UN No.: Not applicable
- Proper Shipping Name: Not applicable
- Hazard Class: Not applicable
- Packing Group: Not applicable

Not classified as hazardous for transport

14.2 Environmental hazards

- Not Classified
- Presents little or no hazard to the environment

14.3 Special precautions for user

- Not classified as hazardous for transport

14.4 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC code

- Not applicable

14.5 Road/Rail (ADR/RID)

- ADR UN No.: Not applicable
- Proper Shipping Name: Not applicable
- ADR Hazard Class: Not applicable
- ADR subrisk: Not applicable
- ADR Packing Group: Not applicable
- ADR Flashpoint: Not applicable

14.6 Sea (IMDG)

- IMDG UN No.: Not applicable
- Proper Shipping Name: Not applicable
- IMDG Hazard Class: Not applicable
- IMDG subrisk: Not applicable
- IMDG Pack Group.: Not applicable
- IMDG EmS: Not applicable
- IMDG Flashpoint: Not applicable

14.7 Air (ICAO/IATA)

- ICAO UN No.: Not applicable
- Proper Shipping Name: Not applicable
- ICAO Packing Group: Not applicable
- ICAO Hazard Class: Not applicable
- ICAO subrisk: Not applicable
- ICAO Flashpoint: Not applicable

14.8 DOT / CFR (US Department of Transportation)

- Identification Number: Not applicable
- DOT Proper Shipping Name: Not applicable
- DOT Labels: Not applicable
- Product RQ (lbs): Not applicable
- Hazardous Material: Not applicable

SECTION 14 Transport information (....)

- Hazard Class: Not applicable
- DOT subrisk: Not applicable
- DOT Flashpoint: Not applicable

SECTION 15 Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

- Counsil Directive 1999/45/EEC Classification, packing and labelling of dangerous preparations.
- This Safety Data Sheet is provided in compliance with The Dangerous Substances Directive (67/548/EEC)
- Regulations 1272/2008/EEC. Classification, labeling and packing of dangerous substances and preparations
-
- Norwegian Productregistration no: 52696
- This Safety Data Sheet has been prepared in accordance with article 31 and annex II in REACH and Directive 453/2010/EU.

15.2 Chemical Safety Assessment

- None

SECTION 16 Other information

Text not given with phrase codes where they are used elsewhere in this safety data sheet:- H226: Flammable liquid and vapour. H302: Harmful if swallowed. H315: Causes skin irritation. H319: Causes serious eye irritation. R10: Flammable. R20/21: Harmful by inhalation and in contact with skin. R36/37/38: Irritating to eyes, respiratory system and skin.

The data given here is based on current knowledge and experience. This Safety Data Sheet describes the product in terms of safety requirements and does not signify any warranty with regard to the product's properties

The data given here only applies when product used for proper application(s). The product is not sold as suitable for other applications - usage in such may cause risks not mentioned in this sheet. Do not use for other application(s) without seeking advice from manufacturer

The information provided about the product on this Safety Data Sheet has been compiled from knowledge of the individual constituents

The most up-to-date version of this MSDS can be found on www.wilhelmsen.com/shipsservice

OTHER CONTACT INFORMATION MAJOR CHEMICAL OFFICES

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Tel: +61 3 9630 0900 Emergency 24hrs: +61 3 9630 0998

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SECTION 16 Other information (....)

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SAFETY DATA SHEET
sodium hydroxide

According to Regulation (EC) No 1907/2006, Annex II, as amended. Commission Regulation (EU) No 2015/830 of 28 May 2015.

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name	sodium hydroxide
Product number	ACF-00219
Synonyms; trade names	caustic soda, sodium hydroxide
REACH registration number	01-2119457892-27-XXXX
CAS number	1310-73-2
EU index number	011-002-00-6
EC number	215-185-5

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses	Industry Professional Consumer

1.3. Details of the supplier of the safety data sheet

Supplier

Airedale Chemical Company Limited
Airedale Mills
Skipton Road
Cross Hills
Keighley
West Yorkshire
BD20 7BX
+44 (0) 1535 637876 (Mon - Fri, 08:00 - 17:00 UK time only)
+44 (0) 1535 630740
sds@airedalechemical.co.uk

1.4. Emergency telephone number

Emergency telephone +44 (0) 1535 637876 (Mon - Fri, 08:00 - 17:00 UK time only)

National emergency telephone number National Poisons Information Service

For medical advice or information you should contact your GP or NHS 111 (or NHS 24 in Scotland) on 111 (for 24 hour health advice)

If you are a healthcare professional with an enquiry please visit www.TOXBASE.org

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification (EC 1272/2008)

Physical hazards	Met. Corr. 1 - H290
Health hazards	Skin Corr. 1A - H314 Eye Dam. 1 - H318
Environmental hazards	Not Classified

2.2. Label elements

EC number	215-185-5

Pictogram

Signal word	Danger
Hazard statements	H290 May be corrosive to metals. H314 Causes severe skin burns and eye damage.
Precautionary statements	P264 Wash contaminated skin thoroughly after handling. P280 Wear protective gloves/ protective clothing/ eye protection/ face protection. P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing. P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Supplementary precautionary statements	P234 Keep only in original packaging. P260 Do not breathe dust/ fume/ gas/ mist/ vapours/ spray. P310 Immediately call a POISON CENTER/ doctor. P321 Specific treatment (see medical advice on this label). P363 Wash contaminated clothing before reuse. P390 Absorb spillage to prevent material damage. P405 Store locked up. P406 Store in a corrosion-resistant/… container with a resistant inner liner. P501 Dispose of contents/ container in accordance with national regulations.

2.3. Other hazards

This substance is not classified as PBT or vPvB according to current EU criteria.

SECTION 3: Composition/information on ingredients

3.1. Substances

Product name	sodium hydroxide
REACH registration number	01-2119457892-27-XXXX
EU index number	011-002-00-6
CAS number	1310-73-2
EC number	215-185-5

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	Remove affected person from source of contamination. Move affected person to fresh air and keep warm and at rest in a position comfortable for breathing. Maintain an open airway. Loosen tight clothing such as collar, tie or belt. When breathing is difficult, properly trained personnel may assist affected person by administering oxygen. Place unconscious person on their side in the recovery position and ensure breathing can take place. Get medical attention immediately.

Ingestion	Rinse mouth thoroughly with water. Do not induce vomiting unless under the direction of medical personnel. Get medical attention immediately.
Skin contact	It is important to remove the substance from the skin immediately. Take off immediately all contaminated clothing. Rinse immediately with plenty of water. Continue to rinse for at least 15 minutes and get medical attention. Chemical burns must be treated by a physician.
Eye contact	Rinse immediately with plenty of water. Remove any contact lenses and open eyelids wide apart. Continue to rinse for at least 10 minutes. Get medical attention immediately.
Protection of first aiders	First aid personnel should wear appropriate protective equipment during any rescue. Wash contaminated clothing thoroughly with water before removing it from the affected person, or wear gloves. It may be dangerous for first aid personnel to carry out mouth-to-mouth resuscitation.

4.2. Most important symptoms and effects, both acute and delayed

Inhalation	Corrosive to the respiratory tract. Symptoms following overexposure may include the following: Severe irritation of nose and throat. Chemical burns.
Ingestion	May cause chemical burns in mouth, oesophagus and stomach. Symptoms following overexposure may include the following: Severe stomach pain. Nausea, vomiting.
Skin contact	Causes severe burns. Symptoms following overexposure may include the following: Pain or irritation. Redness. Blistering may occur.
Eye contact	Causes serious eye damage. Symptoms following overexposure may include the following: Pain. Profuse watering of the eyes. Redness. May cause chemical eye burns. Corneal damage. Blindness.

4.3. Indication of any immediate medical attention and special treatment needed

Notes for the doctor	Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media	The product is non-combustible. Use fire-extinguishing media suitable for the surrounding fire.
Unsuitable extinguishing media	Water.

5.2. Special hazards arising from the substance or mixture

Specific hazards	In contact with some metals can generate hydrogen gas, which can form explosive mixtures with air. Severe corrosive hazard. Water used for fire extinguishing, which has been in contact with the product, may be corrosive. Control run-off water by containing and keeping it out of sewers and watercourses.

5.3. Advice for firefighters

Protective actions during firefighting	Avoid breathing fire gases or vapours. Evacuate area. Keep upwind to avoid inhalation of gases, vapours, fumes and smoke. Avoid discharge to the aquatic environment. Control run-off water by containing and keeping it out of sewers and watercourses. If risk of water pollution occurs, notify appropriate authorities.
Special protective equipment for firefighters	Regular protection may not be safe. Wear chemical protective suit. Wear positive-pressure self-contained breathing apparatus (SCBA) and appropriate protective clothing. Firefighter's clothing conforming to European standard EN469 (including helmets, protective boots and gloves) will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions	No action shall be taken without appropriate training or involving any personal risk. Keep unnecessary and unprotected personnel away from the spillage. Wear protective clothing as described in Section 8 of this safety data sheet. Follow precautions for safe handling described in this safety data sheet. Wash thoroughly after dealing with a spillage. Ensure procedures and training for emergency decontamination and disposal are in place. Do not touch or walk into spilled material. Avoid inhalation of dust and vapours. Use suitable respiratory protection if ventilation is inadequate. Avoid contact with skin and eyes. Avoid contact with contaminated tools and objects.

6.2. Environmental precautions

Environmental precautions	The product may affect the acidity (pH) of water which may have hazardous effects on aquatic organisms. Avoid discharge into drains and the aquatic environment. Spillages or uncontrolled discharges into watercourses must be reported immediately to the Environmental Agency or other appropriate regulatory body.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up	Wear protective clothing as described in Section 8 of this safety data sheet. Clear up spills immediately and dispose of waste safely. This product is corrosive. Approach the spillage from upwind. Avoid generation and spreading of dust. Collect spillage with a shovel and broom, or similar and reuse, if possible. Collect and place in suitable waste disposal containers and seal securely. Flush contaminated area with plenty of water. Wash thoroughly after dealing with a spillage. Dispose of waste to licensed waste disposal site in accordance with the requirements of the local Waste Disposal Authority.

6.4. Reference to other sections

Reference to other sections	For personal protection, see Section 8. See Section 11 for additional information on health hazards. See Section 12 for additional information on ecological hazards. For waste disposal, see Section 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Usage precautions	Wear protective clothing as described in Section 8 of this safety data sheet. Provide adequate ventilation. Keep away from food, drink and animal feeding stuffs. Keep container tightly sealed when not in use. This product is corrosive. Avoid generation and spreading of dust. Immediate first aid is imperative. Do not handle until all safety precautions have been read and understood. Do not handle broken packages without protective equipment. Do not reuse empty containers. Always dilute by carefully pouring the product into water.
Advice on general occupational hygiene	Wash promptly if skin becomes contaminated. Take off contaminated clothing. Wash contaminated clothing before reuse. Do not eat, drink or smoke when using this product. Wash at the end of each work shift and before eating, smoking and using the toilet. Change work clothing daily before leaving workplace.

7.2. Conditions for safe storage, including any incompatibilities

Storage precautions	Store in accordance with local regulations. Store away from incompatible materials (see Section 10). Keep only in the original container. Keep container tightly closed, in a cool, well ventilated place. Protect containers from damage. The substance is hygroscopic and will absorb water by contact with the moisture in the air.
Storage class	Corrosive storage.

7.3. Specific end use(s)

Specific end use(s)	The identified uses for this product are detailed in Section 1.2.

SECTION 8: Exposure controls/Personal protection

8.1. Control parameters

Occupational exposure limits

Short-term exposure limit (15-minute): WEL 2 mg/m³

WEL = Workplace Exposure Limit

DNEL	Industry - Inhalation; Long term local effects: 1 mg/m³ Consumer - Inhalation; Long term local effects: 1 mg/m³

8.2. Exposure controls

Protective equipment

Appropriate engineering controls	Observe any occupational exposure limits for the product or ingredients. Provide adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls as the primary means to minimise worker exposure. Personal protective equipment should only be used if worker exposure cannot be controlled adequately by the engineering control measures. Ensure control measures are regularly inspected and maintained. Ensure operatives are trained to minimise exposure.
Eye/face protection	Wear tight-fitting, dust-resistant, chemical splash goggles if airborne dust is generated. Personal protective equipment for eye and face protection should comply with European Standard EN166. If inhalation hazards exist, a full-face respirator may be required instead.
Hand protection	Wear protective gloves. The most suitable glove should be chosen in consultation with the glove supplier/manufacturer, who can provide information about the breakthrough time of the glove material. To protect hands from chemicals, gloves should comply with European Standard EN374. Considering the data specified by the glove manufacturer, check during use that the gloves are retaining their protective properties and change them as soon as any deterioration is detected. Frequent changes are recommended.
Other skin and body protection	Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
Hygiene measures	Provide eyewash station and safety shower. Contaminated work clothing should not be allowed out of the workplace. Wash contaminated clothing before reuse. Clean equipment and the work area every day. Good personal hygiene procedures should be implemented. Wash at the end of each work shift and before eating, smoking and using the toilet. When using do not eat, drink or smoke. Warn cleaning personnel of any hazardous properties of the product.
Respiratory protection	If ventilation is inadequate, suitable respiratory protection must be worn. Wear a respirator fitted with the following cartridge: Particulate filter, type P2. Particulate filters should comply with European Standard EN143.
Environmental exposure controls	Keep container tightly sealed when not in use. Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels. Store in a demarcated bunded area to prevent release to drains and/or watercourses.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Appearance	Solid.
Colour	White.

Odour	Odourless.
pH	pH (diluted solution): > 14 at 100g/l
Melting point	323°C @ 1013 hPa
Initial boiling point and range	1388°C @ 1013 hPa
Flash point	Not applicable.
Vapour pressure	1 Pa @ 513°C
Relative density	2.13 @ 20°C
Solubility(ies)	Soluble in water. 520 g/l water @ 25°C
Partition coefficient	Not applicable. Substance is inorganic.
Explosive properties	There are no chemical groups present in the product that are associated with explosive properties.
Oxidising properties	Does not meet the criteria for classification as oxidising.

9.2. Other information

SECTION 10: Stability and reactivity

10.1. Reactivity

Reactivity See Section 10.3 (Possibility of hazardous reactions) for further information.

10.2. Chemical stability

Stability Stable at normal ambient temperatures and when used as recommended.

10.3. Possibility of hazardous reactions

Possibility of hazardous reactions The following materials may react with the product: Acids. Alcohols. Hydrocarbons - halogenated. In contact with some metals can generate hydrogen gas, which can form explosive mixtures with air. Reactions with the following materials may generate heat: Water

10.4. Conditions to avoid

Conditions to avoid The substance is hygroscopic and will absorb water by contact with the moisture in the air. Avoid exposure to high temperatures or direct sunlight. Avoid freezing.

10.5. Incompatible materials

Materials to avoid Acids. Alcohols. Aluminium. Copper. Magnesium. Phenols, cresols. Zinc. Tin. Lead. Leather. Ammonia. Chlorohydrocarbons. Oxidising materials. Organic compounds.

10.6. Hazardous decomposition products

Hazardous decomposition products Does not decompose when used and stored as recommended. Thermal decomposition or combustion products may include the following substances: Hydrogen.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity - oral

Notes (oral LD_{50}) Endpoint waived according to REACH Annex VII, IX or XI. Corrosive Small amounts may cause serious damage.

Skin corrosion/irritation

Skin corrosion/irritation Skin Corr. 1A - H314 Causes severe burns.

Serious eye damage/irritation

Serious eye damage/irritation	Eye Dam. 1 - H318 Corrosive to skin. Corrosivity to eyes is assumed.

Respiratory sensitisation

Respiratory sensitisation	Not applicable. Corrosive

Skin sensitisation

Skin sensitisation	Not sensitising.

Germ cell mutagenicity

Genotoxicity - in vitro	Based on available data the classification criteria are not met.
Genotoxicity - in vivo	Based on available data the classification criteria are not met.

Carcinogenicity

Carcinogenicity	Scientifically unjustified.

Reproductive toxicity

Reproductive toxicity - fertility	Scientifically unjustified.
Reproductive toxicity - development	Scientifically unjustified.

Specific target organ toxicity - single exposure

STOT - single exposure	Not classified as a specific target organ toxicant after a single exposure.

Specific target organ toxicity - repeated exposure

STOT - repeated exposure	Not classified as a specific target organ toxicant after repeated exposure.

Aspiration hazard

Aspiration hazard	Not relevant. Solid.

General information	The severity of the symptoms described will vary dependent on the concentration and the length of exposure.
Inhalation	Corrosive to the respiratory tract. Symptoms following overexposure may include the following: Severe irritation of nose and throat. Chemical burns.
Ingestion	May cause chemical burns in mouth, oesophagus and stomach. Symptoms following overexposure may include the following: Severe stomach pain. Nausea, vomiting.
Skin contact	Causes severe burns. Symptoms following overexposure may include the following: Pain or irritation. Redness. Blistering may occur.
Eye contact	Causes serious eye damage. Symptoms following overexposure may include the following: Pain. Profuse watering of the eyes. Redness. May cause chemical eye burns. Corneal damage. Blindness.
Acute and chronic health hazards	This product is corrosive. Causes severe burns.
Route of exposure	Ingestion Inhalation Skin and/or eye contact
Target organs	No specific target organs known.

SECTION 12: Ecological information

Ecotoxicity	The product may affect the acidity (pH) of water which may have hazardous effects on aquatic organisms.

12.1. Toxicity

Toxicity	Based on available data the classification criteria are not met.

Acute aquatic toxicity

Acute toxicity - aquatic invertebrates	EC_{50}, 48 hour: 40.4 mg/l, Daphnia magna

12.2. Persistence and degradability

Persistence and degradability	The product contains only inorganic substances which are not biodegradable.
Stability (hydrolysis)	Substance is inorganic.

12.3. Bioaccumulative potential

Bioaccumulative potential	The product is not bioaccumulating.
Partition coefficient	Not applicable. Substance is inorganic.

12.4. Mobility in soil

Mobility	The product is water-soluble and may spread in water systems.

12.5. Results of PBT and vPvB assessment

Results of PBT and vPvB assessment	This substance is not classified as PBT or vPvB according to current EU criteria.

12.6. Other adverse effects

SECTION 13: Disposal considerations

13.1. Waste treatment methods

General information	The generation of waste should be minimised or avoided wherever possible. Reuse or recycle products wherever possible. This material and its container must be disposed of in a safe way. Disposal of this product, process solutions, residues and by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any local authority requirements. When handling waste, the safety precautions applying to handling of the product should be considered. Care should be taken when handling emptied containers that have not been thoroughly cleaned or rinsed out. Empty containers or liners may retain some product residues and hence be potentially hazardous.
Disposal methods	Dispose of waste to licensed waste disposal site in accordance with the requirements of the local Waste Disposal Authority.

SECTION 14: Transport information

14.1. UN number

UN No. (ADR/RID)	1823
UN No. (IMDG)	1823
UN No. (ICAO)	1823
UN No. (ADN)	1823

14.2. UN proper shipping name

Proper shipping name (ADR/RID)	SODIUM HYDROXIDE, SOLID
Proper shipping name (IMDG)	SODIUM HYDROXIDE, SOLID
Proper shipping name (ICAO)	SODIUM HYDROXIDE, SOLID
Proper shipping name (ADN)	SODIUM HYDROXIDE, SOLID

14.3. Transport hazard class(es)

ADR/RID class	8
ADR/RID classification code	C6
ADR/RID label	8
IMDG class	8
ICAO class/division	8
ADN class	8

Transport labels

14.4. Packing group

ADR/RID packing group	II
IMDG packing group	II
ICAO packing group	II
ADN packing group	II

14.5. Environmental hazards

Environmentally hazardous substance/marine pollutant
No.

14.6. Special precautions for user

EmS	F-A, S-B
ADR transport category	2
Emergency Action Code	2W
Hazard Identification Number (ADR/RID)	80
Tunnel restriction code	(E)

14.7. Transport in bulk according to Annex II of MARPOL and the IBC Code

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable.

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations	Health and Safety at Work etc. Act 1974 (as amended). The Chemicals (Hazard Information and Packaging for Supply) Regulations 2009 (SI 2009 No. 716). The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (SI 2009 No. 1348) (as amended) ["CDG 2009"]. EH40/2005 Workplace exposure limits.

EU legislation	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (as amended). Commission Regulation (EU) No 453/2010 of 20 May 2010. Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures (as amended). Commission Regulation (EU) No 2015/830 of 28 May 2015.

15.2. Chemical safety assessment

No chemical safety assessment has been carried out.

SECTION 16: Other information

Abbreviations and acronyms used in the safety data sheet	ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road. ADN: European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways. RID: European Agreement concerning the International Carriage of Dangerous Goods by Rail. IATA: International Air Transport Association. ICAO: Technical Instructions for the Safe Transport of Dangerous Goods by Air. IMDG: International Maritime Dangerous Goods. CAS: Chemical Abstracts Service. ATE: Acute Toxicity Estimate. LD_{50}: Lethal Dose to 50% of a test population (Median Lethal Dose). EC_{50}: 50% of maximal Effective Concentration. PBT: Persistent, Bioaccumulative and Toxic substance. vPvB: Very Persistent and Very Bioaccumulative. DNEL: Derived No Effect Level. PNEC: Predicted No Effect Concentration. REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (EC) No 1907/2006. UN: United Nations. IBC: International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (International Bulk Chemical Code).
Classification abbreviations and acronyms	Met. Corr. = Corrosive to metals Eye Dam. = Serious eye damage Skin Corr. = Skin corrosion
Key literature references and sources for data	Source: European Chemicals Agency, http://echa.europa.eu/
Classification procedures according to Regulation (EC) 1272/2008	Eye Dam. 1 - H318: Skin Corr. 1A - H314: : Expert judgement. Met. Corr. 1 - H290: : Expert judgement.
Training advice	Read and follow manufacturer's recommendations. Only trained personnel should use this material.
Revision date	04/05/2017
Revision	2
Supersedes date	25/11/2015

Hazard statements in full	H290 May be corrosive to metals. H314 Causes severe skin burns and eye damage. H318 Causes serious eye damage.

Exposure scenario
Manufacturing of liquid NaOH

Identification

Product name	Caustic Soda
REACH registration number	01-2119457892-27-XXXX
CAS number	1310-73-2
EC number	215-185-5
EU index number	011-022-00-6
Revision date	04/05/2017
Version number	1
Es reference	ES1
Supplier	Airedale Chemical Company Limited Airedale Mills Skipton Road Cross Hills Keighley West Yorkshire BD20 7BX +44 (0) 1535 637876 (Mon - Fri, 08:00 - 17:00 UK time only) +44 (0) 1535 630740 sds@airedalechemical.co.uk

1. Title of exposure scenario

Main title	Manufacturing of liquid NaOH
Sector of use	SU3 Industrial uses SU8 Manufacture of bulk, large-scale chemicals (including petroleum products)

Environment

Environmental release category	ERC1 Manufacture of the substance

Worker

Manufacturing of liquid NaOH

Process category

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

2. Conditions of use affecting exposure (Industrial - Environment 1)

Control of environmental exposure

Environmental release category ERC1 Manufacture of the substance

Product characteristics

Physical state Liquid

Concentration details Covers concentrations up to 50 %.

Frequency and duration of use

Continuous.

Technical onsite conditions and measures to reduce or limit discharges to air, water and soil

Avoid discharging NaOH solutions into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. In general discharges should be carried out such that pH changes in receiving surface waters are minimised. In general most aquatic organisms can tolerate pH values in the range 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms.

Conditions and measures related to external treatment of waste for disposal

Liquid waste should be reused or discharged to the industrial wastewater and further neutralized if needed.

2. Conditions of use affecting exposure (Workers - Health 1)

Control of workers exposure

Process category

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

Product characteristics

Physical state Liquid

Manufacturing of liquid NaOH

Concentration details Covers concentrations up to 50 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use closed systems or covering of open containers. Replace where appropriate, manual processes by automated/and or closed processes. Use long-handled tools where possible. Avoid splashing. Local exhaust ventilation and/or general ventilation is good practice.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Replace where appropriate, manual processes by automated/and or closed processes. Avoid formation of irritating mists, spraying and subsequent potential splashes. Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

2. Conditions of use affecting exposure (Workers - Health 2)

Control of workers exposure

Process category
PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

Product characteristics

Physical state Liquid

Concentration details Covers concentrations up to 50 %.

Frequency and duration of use

Manufacturing of liquid NaOH

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use closed systems or covering of open containers. Replace where appropriate, manual processes by automated/and or closed processes. Use long-handled tools where possible. Avoid splashing. Local exhaust ventilation and/or general ventilation is good practice.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Replace where appropriate, manual processes by automated/and or closed processes. Corrosive to skin and eyes. Avoid formation of irritating mists, spraying and subsequent potential splashes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

3. Exposure estimation (Environment 1)

Environmental release category ERC1 Manufacture of the substance

The aquatic effect and risk assessment only deals with the effect on organisms/ecosystems due to possible pH changes related to OH- discharges, as the toxicity of the metal ion is expected to be insignificant compared to (potential) pH effect. The high water solubility and very low vapour pressure indicates that the substance will predominantly in water. When the risk management measures related to the environment are implemented, there is no exposure to the activated sludge of a STP and there is no exposure to the receiving surface water. The sediment compartment is not considered, because it is not relevant for the substance. If emitted to the aquatic compartment, sorption to sediment particles will be negligible. Significant emissions to air are not expected due to the very low vapour pressure of the substance. If emitted to air as a water based aerosol, the substance will rapidly neutralised as a result of its reaction with CO_2 (or acids). Significant emissions to the terrestrial environment are not expected. The sludge application route is not relevant for the emission to agricultural soil, as no sorption of the substance to particulate matter will occur in STPs/WWTPs. If emitted to soil, sorption to soil particles will be negligible. Depending on the buffer capacity of the soil, OH-will be neutralised in the soil pore water or the pH may increase. Bioaccumulation will not occur.

3. Exposure estimation (Health 1)

Manufacturing of liquid NaOH

Process category

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

Assessment method Used ECETOC TRA model.

Specific conditions Modelled exposure data, very low vapour pressure, without local exhaust ventilation, without respiratory protection.

Exposure Inhalation worker exposure.: Exposure 0.17 mg/m³, DNEL , RCR 0.17

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 1)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted. As this product contains ingredients with exposure limits, process enclosures, local exhaust ventilation or other engineering controls should be used to keep worker exposure below any statutory or recommended limits, if use generates dust, fumes, gas, vapour or mist.

3. Exposure estimation (Health 2)

Process category

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

Assessment method Used ECETOC TRA model.

Specific conditions Measured exposure data, worst case.

Exposure Worker - inhalation, short-term - local: Exposure 0.33 mg/m³, DNEL , RCR 0.33
Worker - inhalation, long-term - local: Exposure 0.14 mg/m³, DNEL , RCR 0.14

Manufacturing of liquid NaOH

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 2)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted. As this product contains ingredients with exposure limits, process enclosures, local exhaust ventilation or other engineering controls should be used to keep worker exposure below any statutory or recommended limits, if use generates dust, fumes, gas, vapour or mist.

Exposure scenario
Manufacturing of Solid NaOH

Identification

Product name	Caustic Soda
REACH registration number	01-2119457892-27-XXXX
CAS number	1310-73-2
EC number	215-185-5
EU index number	011-022-00-6
Revision date	04/05/2017
Version number	1
Es reference	ES2
Supplier	Airedale Chemical Company Limited Airedale Mills Skipton Road Cross Hills Keighley West Yorkshire BD20 7BX +44 (0) 1535 637876 (Mon - Fri, 08:00 - 17:00 UK time only) +44 (0) 1535 630740 sds@airedalechemical.co.uk

1. Title of exposure scenario

Main title	Manufacturing of Solid NaOH
Sector of use	SU3 Industrial uses SU8 Manufacture of bulk, large-scale chemicals (including petroleum products)

Environment

Environmental release category	ERC1 Manufacture of the substance

Worker

Process category	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC4 Chemical production where opportunity for exposure arises PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

2. Conditions of use affecting exposure (Industrial - Environment 1)

Control of environmental exposure

Environmental release category ERC1 Manufacture of the substance

Product characteristics

Physical state Solid

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Continuous.

Technical onsite conditions and measures to reduce or limit discharges to air, water and soil

Avoid discharging NaOH solutions into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. In general discharges should be carried out such that pH changes in receiving surface waters are minimised. In general most aquatic organisms can tolerate pH values in the range 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms.

Conditions and measures related to external treatment of waste for disposal

Disposal method Liquid waste should be reused or discharged to the industrial wastewater and further neutralized if needed.

2. Conditions of use affecting exposure (Workers - Health 1)

Control of workers exposure

Process category	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC4 Chemical production where opportunity for exposure arises PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

Product characteristics

Physical state Solid

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use closed systems or covering of open containers. Replace where appropriate, manual processes by automated/and or closed processes. Avoid formation of irritating mists, spraying and subsequent potential splashes. Use long-handled tools where possible. Local exhaust ventilation and/or general ventilation is good practice.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

2. Conditions of use affecting exposure (Workers - Health 2)

Control of workers exposure

Process category PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

Product characteristics

Physical state Solid

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use closed systems or covering of open containers. Replace where appropriate, manual processes by automated/and or closed processes. Avoid formation of irritating mists, spraying and subsequent potential splashes. Use long-handled brushes and rollers where possible. Local exhaust ventilation and/or general ventilation is good practice.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should comply with the requirements of EN 374.
Gloves should have a breakthrough time of >480 minutes.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

3. Exposure estimation (Environment 1)

Environmental release category ERC1 Manufacture of the substance

The aquatic effect and risk assessment only deals with the effect on organisms/ecosystems due to possible pH changes related to OH- discharges, as the toxicity of the metal ion is expected to be insignificant compared to (potential) pH effect. The high water solubility and very low vapour pressure indicates that the substance will predominantly in water. When the risk management measures related to the environment are implemented, there is no exposure to the activated sludge of a STP and there is no exposure to the receiving surface water. The sediment compartment is not considered, because it is not relevant for the substance. If emitted to the aquatic compartment, sorption to sediment particles will be negligible. Significant emissions to air are not expected due to the very low vapour pressure of the substance. If emitted to air as a water based aerosol, the substance will rapidly neutralised as a result of its reaction with CO2 (or acids). Significant emissions to the terrestrial environment are not expected. The sludge application route is not relevant for the emission to agricultural soil, as no sorption of the substance to particulate matter will occur in STPs/WWTPs. If emitted to soil, sorption to soil particles will be negligible. Depending on the buffer capacity of the soil, OH-will be neutralised in the soil pore water or the pH may increase. Bioaccumulation will not occur.

3. Exposure estimation (Health 1)

Process category PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities

Assessment method Used ECETOC TRA model.

Specific conditions Modelled exposure data, very low vapour pressure, without local exhaust ventilation, without respiratory protection.

Exposure

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
Inhalation worker exposure.: Exposure 0.01 mg/m³, DNEL , RCR 0.01

PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
Inhalation worker exposure.: Exposure 0.1 mg/m³, DNEL , RCR 0.1

PROC4 Chemical production where opportunity for exposure arises
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
Inhalation worker exposure.: Exposure 0.5 mg/m³, DNEL , RCR 0.5

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 1)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

3. Exposure estimation (Health 2)

Process category PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)

Assessment method Used ECETOC TRA model.

Specific conditions Measured exposure data, worst case.

Exposure

PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
Worker - inhalation, short-term - local: Exposure 0.26 mg/m³, DNEL , RCR 0.26

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 2)

Manufacturing of Solid NaOH

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

Exposure scenario
Industrial use

Identification

Product name	Caustic Soda
REACH registration number	01-2119457892-27-XXXX
CAS number	1310-73-2
EC number	215-185-5
EU index number	011-022-00-6
Revision date	04/05/2017
Version number	1
Es reference	ES3
Supplier	Airedale Chemical Company Limited Airedale Mills Skipton Road Cross Hills Keighley West Yorkshire BD20 7BX +44 (0) 1535 637876 (Mon - Fri, 08:00 - 17:00 UK time only) +44 (0) 1535 630740 sds@airedalechemical.co.uk

1. Title of exposure scenario

Main title	Industrial use
Sector of use	SU3 Industrial uses

Environment

Environmental release category	ERC2 Formulation into mixture ERC4 Use of non-reactive processing aid at industrial site (no inclusion into or onto article) ERC6a Use of intermediate ERC6b Use of reactive processing aid at industrial site (no inclusion into or onto article) ERC7 Use of functional fluid at industrial site

Worker

Industrial use

Process category

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC5 Mixing or blending in batch processes
PROC7 Industrial spraying
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
PROC10 Roller application or brushing
PROC13 Treatment of articles by dipping and pouring.
PROC15 Use as laboratory reagent.
PROC19 Manual activities involving hand contact
PROC23 Open processing and transfer operations at substantially elevated temperature
PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles

2. Conditions of use affecting exposure (Industrial - Environment 1)

Control of environmental exposure

Environmental release category

ERC2 Formulation into mixture
ERC4 Use of non-reactive processing aid at industrial site (no inclusion into or onto article)
ERC6a Use of intermediate
ERC6b Use of reactive processing aid at industrial site (no inclusion into or onto article)
ERC7 Use of functional fluid at industrial site

Product characteristics

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Continuous.

Technical onsite conditions and measures to reduce or limit discharges to air, water and soil

Avoid discharging NaOH solutions into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. In general discharges should be carried out such that pH changes in receiving surface waters are minimised. In general most aquatic organisms can tolerate pH values in the range 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms.

Conditions and measures related to external treatment of waste for disposal

Liquid waste should be reused or discharged to the industrial wastewater and further neutralized if needed.

2. Conditions of use affecting exposure (Workers - Health 1)

Control of workers exposure

Industrial use

Process category PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC5 Mixing or blending in batch processes
PROC7 Industrial spraying
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
PROC10 Roller application or brushing
PROC13 Treatment of articles by dipping and pouring.
PROC15 Use as laboratory reagent.

Product characteristics

Physical state Liquid Solid, low dustiness

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use closed systems or covering of open containers. Replace where appropriate, manual processes by automated/and or closed processes. Avoid formation of irritating mists, spraying and subsequent potential splashes. Use long-handled tools where possible. Local exhaust ventilation and/or general ventilation is good practice.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

2. Conditions of use affecting exposure (Workers - Health 2)

Control of workers exposure

Industrial use

Process category

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
PROC10 Roller application or brushing
PROC13 Treatment of articles by dipping and pouring.
PROC15 Use as laboratory reagent.
PROC19 Manual activities involving hand contact

Product characteristics

Physical state Liquid Solid, low dustiness

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use closed systems or covering of open containers. Replace where appropriate, manual processes by automated/and or closed processes. Avoid formation of irritating mists, spraying and subsequent potential splashes. Use long-handled tools where possible. Local exhaust ventilation and/or general ventilation is good practice.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.50 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

2. Conditions of use affecting exposure (Workers - Health 3)

Control of workers exposure

Industrial use

Process category PROC4 Chemical production where opportunity for exposure arises
PROC5 Mixing or blending in batch processes
PROC14 Tabletting, compression, extrusion, pelletisation, granulation

Product characteristics

Physical state Liquid Solid, low dustiness

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use closed systems or covering of open containers. Replace where appropriate, manual processes by automated/and or closed processes. Avoid formation of irritating mists, spraying and subsequent potential splashes. Use long-handled tools where possible. Local exhaust ventilation and/or general ventilation is good practice.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

2. Conditions of use affecting exposure (Workers - Health 4)

Control of workers exposure

Process category PROC23 Open processing and transfer operations at substantially elevated temperature
PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles

Product characteristics

Physical state Liquid Solid, low dustiness

Concentration details Covers concentrations up to 100% .

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Industrial use

Technical protective measures Use closed systems or covering of open containers. Replace where appropriate, manual processes by automated/and or closed processes. Avoid formation of irritating mists, spraying and subsequent potential splashes. Use long-handled tools where possible. Local exhaust ventilation and/or general ventilation is good practice.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.50 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

3. Exposure estimation (Environment 1)

Environmental release category ERC2 Formulation into mixture
ERC4 Use of non-reactive processing aid at industrial site (no inclusion into or onto article)
ERC6a Use of intermediate
ERC6b Use of reactive processing aid at industrial site (no inclusion into or onto article)
ERC7 Use of functional fluid at industrial site

The aquatic effect and risk assessment only deals with the effect on organisms/ecosystems due to possible pH changes related to OH- discharges, as the toxicity of the metal ion is expected to be insignificant compared to (potential) pH effect. The high water solubility and very low vapour pressure indicates that the substance will predominantly in water. When the risk management measures related to the environment are implemented, there is no exposure to the activated sludge of a STP and there is no exposure to the receiving surface water. The sediment compartment is not considered, because it is not relevant for the substance. If emitted to the aquatic compartment, sorption to sediment particles will be negligible. Significant emissions to air are not expected due to the very low vapour pressure of the substance. If emitted to air as a water based aerosol, the substance will rapidly neutralised as a result of its reaction with CO2 (or acids). Significant emissions to the terrestrial environment are not expected. The sludge application route is not relevant for the emission to agricultural soil, as no sorption of the substance to particulate matter will occur in STPs/WWTPs. If emitted to soil, sorption to soil particles will be negligible. Depending on the buffer capacity of the soil, OH-will be neutralised in the soil pore water or the pH may increase. Bioaccumulation will not occur.

3. Exposure estimation (Health 1)

Industrial use

Process category

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC5 Mixing or blending in batch processes
PROC7 Industrial spraying
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
PROC10 Roller application or brushing
PROC13 Treatment of articles by dipping and pouring.
PROC14 Tabletting, compression, extrusion, pelletisation, granulation
PROC15 Use as laboratory reagent.
PROC19 Manual activities involving hand contact
PROC23 Open processing and transfer operations at substantially elevated temperature
PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles

Assessment method

Used ECETOC TRA model.

Specific conditions

Liquid, no LEV, no respiratory protection (RPE).

Exposure

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC5 Mixing or blending in batch processes
PROC7 Industrial spraying
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
PROC10 Roller application or brushing
PROC13 Treatment of articles by dipping and pouring.
PROC14 Tabletting, compression, extrusion, pelletisation, granulation
PROC15 Use as laboratory reagent.
PROC19 Manual activities involving hand contact
PROC23 Open processing and transfer operations at substantially elevated temperature
PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles
Inhalation worker exposure., Worker - inhalation, short-term - local: Exposure 0.17 mg/m³, DNEL , RCR

Industrial use

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 1)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

3. Exposure estimation (Health 2)

Process category	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC10 Roller application or brushing PROC13 Treatment of articles by dipping and pouring. PROC15 Use as laboratory reagent. PROC19 Manual activities involving hand contact
Assessment method	Used ECETOC TRA model.
Specific conditions	Solid, no LEV, no respiratory protection (RPE).

Industrial use

Exposure

PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
Worker - inhalation, short-term - local: Exposure 0.01 mg/m³, DNEL , RCR

PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC15 Use as laboratory reagent.
Worker - inhalation, short-term - local: Exposure 0.1 mg/m³, DNEL , RCR

PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
PROC10 Roller application or brushing
PROC13 Treatment of articles by dipping and pouring.
PROC19 Manual activities involving hand contact
Worker - inhalation, short-term - local: Exposure 0.5 mg/m³, DNEL , RCR

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 2)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

3. Exposure estimation (Health 3)

Process category

PROC4 Chemical production where opportunity for exposure arises
PROC5 Mixing or blending in batch processes
PROC14 Tabletting, compression, extrusion, pelletisation, granulation

Assessment method

Used ECETOC TRA model.

Specific conditions

Solid, no respiratory protection (RPE).

Exposure

PROC4 Chemical production where opportunity for exposure arises
PROC5 Mixing or blending in batch processes
PROC14 Tabletting, compression, extrusion, pelletisation, granulation
Worker - inhalation, short-term - local: Exposure 0.2 mg/m³, DNEL , RCR

Industrial use

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 3)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

3. Exposure estimation (Health 4)

Process category	PROC23 Open processing and transfer operations at substantially elevated temperature PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles
Assessment method	Used ECETOC TRA model.
Specific conditions	Solid, with PRE (90%)
Exposure	PROC23 Open processing and transfer operations at substantially elevated temperature Worker - inhalation, short-term - local: Exposure 0.4 mg/m³, DNEL , RCR PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles Worker - inhalation, short-term - local: Exposure 0.5 mg/m³, DNEL , RCR

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 4)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

Exposure scenario
Professional use

Identification

Product name	Caustic Soda
REACH registration number	01-2119457892-27-XXXX
CAS number	1310-73-2
EC number	215-185-5
EU index number	011-022-00-6
Revision date	04/05/2017
Version number	1
Es reference	ES4
Supplier	Airedale Chemical Company Limited Airedale Mills Skipton Road Cross Hills Keighley West Yorkshire BD20 7BX +44 (0) 1535 637876 (Mon - Fri, 08:00 - 17:00 UK time only) +44 (0) 1535 630740 sds@airedalechemical.co.uk

1. Title of exposure scenario

Main title	Professional use
Sector of use	SU22 Professional uses

Environment

Environmental release category	ERC8a Widespread use of non-reactive processing aid (no inclusion into or onto article, indoor) ERC8b Widespread use of reactive processing aid (no inclusion into or onto article, indoor) ERC8d Widespread use of non-reactive processing aid (no inclusion into or onto article, outdoor) ERC9a Widespread use of functional fluid (indoor)

Worker

Professional use

Process category	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC4 Chemical production where opportunity for exposure arises PROC5 Mixing or blending in batch processes PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC10 Roller application or brushing PROC11 Non industrial spraying PROC13 Treatment of articles by dipping and pouring. PROC14 Tabletting, compression, extrusion, pelletisation, granulation PROC15 Use as laboratory reagent. PROC19 Manual activities involving hand contact PROC22 Manufacturing and processing of minerals and/or metals at substantially elevated temperature PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles

2. Conditions of use affecting exposure (Industrial - Environment 1)

Control of environmental exposure

Environmental release category	ERC2 Formulation into mixture ERC4 Use of non-reactive processing aid at industrial site (no inclusion into or onto article) ERC6a Use of intermediate ERC6b Use of reactive processing aid at industrial site (no inclusion into or onto article) ERC7 Use of functional fluid at industrial site

Product characteristics

Concentration details	Covers concentrations up to 100 %.

Frequency and duration of use

Continuous.

Technical onsite conditions and measures to reduce or limit discharges to air, water and soil

Avoid discharging NaOH solutions into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. In general discharges should be carried out such that pH changes in receiving surface waters are minimised. In general most aquatic organisms can tolerate pH values in the range 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms.

Conditions and measures related to external treatment of waste for disposal

Liquid waste should be reused or discharged to the industrial wastewater and further neutralized if needed.

Conditions and measures related to external recovery of waste

Liquid waste should be reused or discharged to the industrial wastewater and further neutralized if needed.

2. Conditions of use affecting exposure (Workers - Health 1)

Professional use

Control of workers exposure

Process category
PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC4 Chemical production where opportunity for exposure arises
PROC5 Mixing or blending in batch processes
PROC7 Industrial spraying
PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
PROC10 Roller application or brushing
PROC13 Treatment of articles by dipping and pouring.
PROC15 Use as laboratory reagent.

Product characteristics

Physical state Liquid Solid, low dustiness

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use long-handled tools where possible. Avoid splashing.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

2. Conditions of use affecting exposure (Workers - Health 2)

Control of workers exposure

Professional use

Process category	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC10 Roller application or brushing PROC13 Treatment of articles by dipping and pouring. PROC15 Use as laboratory reagent. PROC19 Manual activities involving hand contact

Product characteristics

Physical state Liquid Solid, low dustiness

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use long-handled tools where possible. Avoid splashing.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Rubber (natural, latex).
Polyvinyl chloride (PVC).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

2. Conditions of use affecting exposure (Workers - Health 3)

Control of workers exposure

Process category	PROC4 Chemical production where opportunity for exposure arises PROC5 Mixing or blending in batch processes PROC14 Tabletting, compression, extrusion, pelletisation, granulation

Product characteristics

Professional use

Physical state Liquid Solid, low dustiness

Concentration details Covers concentrations up to 100 %.

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use long-handled tools where possible. Avoid splashing.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter. P2

2. Conditions of use affecting exposure (Workers - Health 4)

Control of workers exposure

Process category PROC23 Open processing and transfer operations at substantially elevated temperature
PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles

Product characteristics

Physical state Liquid Solid, low dustiness

Concentration details Covers concentrations up to 100% .

Frequency and duration of use

Covers frequency up to 8 hours/day, 200 days/year, .

Technical conditions and measures at process level (source) to prevent release

Technical protective measures Use long-handled tools where possible. Avoid splashing.

Organisational measures to prevent/limit releases, dispersion and exposure

Organisational measures Corrosive to skin and eyes. Ensure operatives are trained to minimise exposures.

Risk management measures

Professional use

Wear suitable protective equipment, including gloves, goggles/face shield, respirator, boots, clothing or apron, as appropriate.
It is recommended that chemical-resistant, impervious gloves are worn.
It is recommended that gloves are made of the following material:
Butyl rubber.
Polyvinyl chloride (PVC).
Rubber (natural, latex).
Thickness: 0.5 mm
Gloves should have a breakthrough time of >480 minutes.
Nitrile rubber.
Viton rubber (fluoro rubber).
Thickness: 0.35-0.40 mm
Gloves should have a breakthrough time of >480 minutes.
Wear tight-fitting, chemical splash goggles or face shield.
In case of dust or aerosol formation use suitable respiratory protection with approved filter.
P2

3. Exposure estimation (Environment 1)

Environmental release category

ERC2 Formulation into mixture
ERC4 Use of non-reactive processing aid at industrial site (no inclusion into or onto article)
ERC6a Use of intermediate
ERC6b Use of reactive processing aid at industrial site (no inclusion into or onto article)
ERC7 Use of functional fluid at industrial site

The aquatic effect and risk assessment only deals with the effect on organisms/ecosystems due to possible pH changes related to OH- discharges, as the toxicity of the metal ion is expected to be insignificant compared to (potential) pH effect. The high water solubility and very low vapour pressure indicates that the substance will predominantly in water. When the risk management measures related to the environment are implemented, there is no exposure to the activated sludge of a STP and there is no exposure to the receiving surface water. The sediment compartment is not considered, because it is not relevant for the substance. If emitted to the aquatic compartment, sorption to sediment particles will be negligible. Significant emissions to air are not expected due to the very low vapour pressure of the substance. If emitted to air as a water based aerosol, the substance will rapidly neutralised as a result of its reaction with CO2 (or acids). Significant emissions to the terrestrial environment are not expected. The sludge application route is not relevant for the emission to agricultural soil, as no sorption of the substance to particulate matter will occur in STPs/WWTPs. If emitted to soil, sorption to soil particles will be negligible. Depending on the buffer capacity of the soil, OH-will be neutralised in the soil pore water or the pH may increase. Bioaccumulation will not occur.

3. Exposure estimation (Health 1)

Professional use

Process category	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC4 Chemical production where opportunity for exposure arises PROC5 Mixing or blending in batch processes PROC7 Industrial spraying PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC10 Roller application or brushing PROC13 Treatment of articles by dipping and pouring. PROC14 Tabletting, compression, extrusion, pelletisation, granulation PROC15 Use as laboratory reagent. PROC19 Manual activities involving hand contact PROC23 Open processing and transfer operations at substantially elevated temperature PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles
Assessment method	Used ECETOC TRA model.
Specific conditions	Liquid, no LEV, no respiratory protection (RPE).
Exposure	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC4 Chemical production where opportunity for exposure arises PROC5 Mixing or blending in batch processes PROC7 Industrial spraying PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC10 Roller application or brushing PROC13 Treatment of articles by dipping and pouring. PROC14 Tabletting, compression, extrusion, pelletisation, granulation PROC15 Use as laboratory reagent. PROC23 Open processing and transfer operations at substantially elevated temperature PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles Inhalation worker exposure., Worker - inhalation, short-term - local: Exposure 0.17 mg/m³, DNEL , RCR

Professional use

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 1)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

3. Exposure estimation (Health 2)

Process category	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC10 Roller application or brushing PROC13 Treatment of articles by dipping and pouring. PROC15 Use as laboratory reagent. PROC19 Manual activities involving hand contact
Assessment method	Used ECETOC TRA model.
Specific conditions	Solid, no LEV, no respiratory protection (RPE).

Professional use

Exposure	PROC1 Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions PROC2 Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions Worker - inhalation, short-term - local: Exposure 0.01 mg/m³, DNEL , RCR
	PROC3 Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition PROC15 Use as laboratory reagent. Worker - inhalation, short-term - local: Exposure 0.1 mg/m³, DNEL , RCR
	PROC8a Transfer of substance or mixture (charging and discharging) at non-dedicated facilities PROC8b Transfer of substance or mixture (charging and discharging) at dedicated facilities PROC9 Transfer of substance or mixture into small containers (dedicated filling line, including weighing) PROC10 Roller application or brushing PROC13 Treatment of articles by dipping and pouring. PROC19 Manual activities involving hand contact Worker - inhalation, short-term - local: Exposure 0.5 mg/m³, DNEL , RCR
	This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 2)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

3. Exposure estimation (Health 3)

Process category	PROC4 Chemical production where opportunity for exposure arises PROC5 Mixing or blending in batch processes PROC14 Tabletting, compression, extrusion, pelletisation, granulation
Assessment method	Used ECETOC TRA model.
Specific conditions	Solid, no respiratory protection (RPE).
Exposure	PROC4 Chemical production where opportunity for exposure arises PROC5 Mixing or blending in batch processes PROC14 Tabletting, compression, extrusion, pelletisation, granulation Worker - inhalation, short-term - local: Exposure 0.2 mg/m³, DNEL , RCR

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 3)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

3. Exposure estimation (Health 4)

Process category	PROC23 Open processing and transfer operations at substantially elevated temperature PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles
Assessment method	Used ECETOC TRA model.
Specific conditions	Solid, with PRE (90%)
Exposure	PROC23 Open processing and transfer operations at substantially elevated temperature Worker - inhalation, short-term - local: Exposure 0.4 mg/m³, DNEL , RCR PROC24 High (mechanical) energy work-up of substances bound in/on materials and/or articles Worker - inhalation, short-term - local: Exposure 0.5 mg/m³, DNEL , RCR

This substance is corrosive. For handling of corrosive substances and formulations, immediate dermal contact occur only occasionally and it is assumed that the repeated daily dermal exposure can be neglected. Dermal exposure to the substance was not quantified. The substance is not expected to be systematically available in the body under normal handling and use conditions. Systemic effects of NaOH dermal or inhalation exposure are not expected to occur. Based on workplace measurements and following the proposed risk management measures controlling worker and professional exposure, the inhalation exposure is below the DNEL.

4. Guidance to check compliance with the exposure scenario (Health 4)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.

Exposure scenario
Consumer use

Identification

Product name	Caustic Soda
REACH registration number	01-2119457892-27-XXXX
CAS number	1310-73-2
EC number	215-185-5
EU index number	011-022-00-6
Revision date	04/05/2017
Version number	1
Es reference	ES5
Supplier	Airedale Chemical Company Limited Airedale Mills Skipton Road Cross Hills Keighley West Yorkshire BD20 7BX +44 (0) 1535 637876 (Mon - Fri, 08:00 - 17:00 UK time only) +44 (0) 1535 630740 sds@airedalechemical.co.uk

1. Title of exposure scenario

Main title	Consumer use
Product category	PC20 Processing aids such as pH-regulators, flocculants, precipitants, neutralization agents PC35 Washing and cleaning products PC39 Cosmetics, personal care.
Sector of use	SU21 Consumer uses

Environment

Environmental release category	ERC8a Widespread use of non-reactive processing aid (no inclusion into or onto article, indoor) ERC8b Widespread use of reactive processing aid (no inclusion into or onto article, indoor) ERC8d Widespread use of non-reactive processing aid (no inclusion into or onto article, outdoor) ERC9a Widespread use of functional fluid (indoor)

2. Conditions of use affecting exposure (Non-industrial - Environment 1)

Control of environmental exposure (Non-industrial)

Consumer use

Environmental release category	ERC8a Widespread use of non-reactive processing aid (no inclusion into or onto article, indoor) ERC8b Widespread use of reactive processing aid (no inclusion into or onto article, indoor) ERC8d Widespread use of non-reactive processing aid (no inclusion into or onto article, outdoor) ERC9a Widespread use of functional fluid (indoor)

Product characteristics

Concentration details Covers concentrations up to 100 %.

Risk management measures

There are no specific risk management measures relating to environment.

Conditions and measures related to external treatment of waste for disposal

This material and its container must be disposed of in a safe way. If container is empty trash as regular municipal waste. Batteries should be recycled as much as possible.

2. Conditions of use affecting exposure (Non-industrial - Health 1)

Control of Non-industrial exposure

PC20 Processing aids such as pH-regulators, flocculants, precipitants, neutralization agents PC35 Washing and cleaning products PC39 Cosmetics, personal care.

Product characteristics

Physical state Liquid , or: Solid, low dustiness

Concentration details Covers concentrations up to 100 %.

Other given operational conditions affecting Non-industrial exposure

Keep out of the reach of children. Avoid contact with skin and eyes. To avoid risks to human health and the environment, comply with the instructions for use. It is recommended that chemical-resistant, impervious gloves are worn. Wear chemical splash goggles. In case of dust or aerosol formation use suitable respiratory protection with approved filter. P2

3. Exposure estimation (Environment 1)

Environmental release category	ERC8a Widespread use of non-reactive processing aid (no inclusion into or onto article, indoor) ERC8b Widespread use of reactive processing aid (no inclusion into or onto article, indoor) ERC8d Widespread use of non-reactive processing aid (no inclusion into or onto article, outdoor) ERC9a Widespread use of functional fluid (indoor)

Consumer uses relate to already diluted products which will further be neutralized quickly in the sewer, well before reaching WWTP or surface water.

3. Exposure estimation (Health 1)

Process category	PC20 Processing aids such as pH-regulators, flocculants, precipitants, neutralization agents PC35 Washing and cleaning products PC39 Cosmetics, personal care.
Assessment method	ConsExpo. SrayExpo.
Specific conditions	Assessed only for the most critical use.
Exposure	Consumer - inhalation, short-term - local: Exposure 0.3 - 1.6 mg/m³, DNEL , RCR <1

Consumer use

4. Guidance to check compliance with the exposure scenario (Health 1)

Estimated workplace exposures are not expected to exceed DNELs when the identified risk management measures are adopted.