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Consulting Engineers Limited

Lostock Sustainable Energy Plant

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Appendix E2 – Process Emissions Modelling

ENGINEERING + CONSULTING

Document approval

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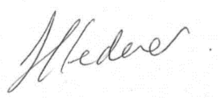
Prepared by:	Hannah Lederer		Environmental Scientist	08/07/2021
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Contents

1 Introduction

This Appendix sets out the approach taken to modelling emissions from the main stack at the Lostock Sustainable Energy Plant (LSEP). The modelling has been carried out to determine the impact of the proposed throughput of 728,000 tonnes per annum (tpa). The appendix includes all model inputs and justifications where appropriate and presents the results of the modelling which are drawn upon in the Air Quality Analysis for Environmental Permit (EP) application.

The appendix also provides the results of a comparison model based on the inputs used for the air quality assessment within the May 2011 ES, which was the most recent air quality assessment undertaken prior to this one. These parameters have been modelled using the latest version of ADMS and meteorological data, but using the emissions parameters and building layout as set out in the May 2011 ES to allow a direct comparison of the changes.

Although the s36 consent (as varied) was granted in July 2019, no further Air Quality Assessment has been carried out and the permissions were granted based on the air quality assessment provided in the May 2011 ES. Therefore, the air quality assessment results for LSEP with the Proposal have been compared to the air quality results of modelling based on the inputs from the May 2011 ES.

1.1 Waste Incineration BREF

The Industrial Emissions Directive (IED) (Directive 2010/75/EU), adopted on 7th January 2013, is the key European Directive which covers almost all regulation of industrial processes in the EU. Within the IED, the requirements of the relevant sector BREF become binding as BAT guidance, as follows.

- Article 15, paragraph 2, of the IED requires that Emission Limit Values (ELVs) are based on best available techniques, referred to as BAT.
- Article 13 of the IED, requires that 'the Commission' develops BAT guidance documents (referred to as BREFs).
- Article 21, paragraph 3, of the IED, requires that when updated BAT conclusions are published, the Competent Authority (in England this is the Environment Agency (EA)) has up to four years to revise permits for facilities covered by that activity to comply with the requirements of the sector specific BREF.

The Waste incineration BREF was adopted by the European IPPC Bureau in December 2019. The EA is required to review and implement conditions within all permits which require operators to comply with the requirements set out in the BREF. This will include the LSEP. The LSEP has an environmental permit to operate (Ref: EPR/QP3136CV/A001) and variation (EPR/WP3934AK),which will need to be varied again to allow for the increase in throughput proposed. At the pre-application meeting it was agreed that the emission limits to use are those for an existing plant, rather than a new plant as set out in the Waste Incineration BREF. It has been assumed that emissions from the LSEP will comply with the BAT-AELs, or the emission limits from Annex VI Part 3 of the IED for waste incineration plants where BAT-AELs are not applicable.

2 Air Quality Standards, Objectives and Guidelines

European air quality legislation is consolidated under the Ambient Air Quality Directive (Directive 2008/50/EC), which came into force on 11th June 2008. This Directive consolidates previous legislation which was designed to deal with specific pollutants in a consistent manner and provides Ambient Air Directive (AAD) Limit Values for sulphur dioxide, nitrogen dioxide, benzene, carbon monoxide, lead and particulate matter with a diameter of less than 10µm (PM_{10}) and a new AAD Target Value and Limit Value for fine particulates (those with a diameter of less than 2.5µm ($PM_{2.5}$). The fourth daughter Directive - 2004/107/EC - was not included within the consolidation. It sets health-based Target Values for polycyclic aromatic hydrocarbons (PAHs), cadmium, arsenic, nickel and mercury, for which there is a requirement to reduce exposure to as low as reasonably achievable. Directives 2008/50/EC and 2004/107/EC are transposed under UK Law into the Air Quality Standards Regulations (2010). The regulations also extend powers, under Section 85(5) of the Environment Act (1995), for the Secretary of State to give directions to local authorities for the implementation of these Directives.

The UK Government and the devolved administrations are required under the Environment Act (1995) to produce a national air quality strategy. This was last reviewed and published in 2007. The Air Quality Strategy (AQS) sets out the UK's air quality objectives and recognises that action at national, regional and local level may be needed, depending on the scale and nature of the air quality problem. This is the method of the implementation of the AADT Limits and Targets. This includes additional targets and limits for 15-minute sulphur dioxide and 1,3-butadiene and more stringent requirements for benzene and PAHs, known as AQS Objectives.

The Air Quality Strategy defines “standards” and “objectives” in paragraph 17:

“For the purposes of the strategy:

- *standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups or on ecosystems; and*
- *objectives are policy targets often expressed as a maximum ambient concentration not to be exceeded, either without exception or with a permitted number of exceedances, within a specified timescale.”*

The status of the objectives is clarified in paragraph 22, which also emphasises the importance of European Directives:

“The air quality objectives in the Air Quality Strategy are a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except in as far as these mirror any equivalent legally binding limit values in EU legislation. Where UK standards or objectives are the sole consideration, there is no legal obligation upon regulators, to set Emission Limit Values (ELVs) any more stringent than the emission levels associated with the use of Best Available Techniques (BAT) in issuing permits under the PPC Regulations. This aspect is dealt with fully in the PPC Practical Guides.”

In 2019 the UK Government published the Clean Air Strategy (CAS). This sets out methods by which air pollution from all sectors will be reduced. The CAS has not introduced any new air quality limits. However, the CAS sets out the actions required across all parks of the government to meet legally binding targets to reduce five key pollutants (fine particulate matter (PM2.5s), ammonia, oxides of nitrogen, sulphur dioxide and non-methane volatile organic compounds (NMVOCs)) by 2020 and 2030 and secure health public heath benefits. The CAS also makes a commitment to bring forward primary legislation on clean air as outlined in the Environment Bill.

The Environment Bill introduces a duty on the government to set a legally binding target for $PM_{2.5}$s. To date this has not yet been set. The Department for the Environment Food and Rural Affairs (DEFRA) fact sheet[1] sets out that:

"The government is committed to evidence-based policy making, and will consider the WHO's annual mean guideline level for $PM_{2.5}$ when setting the target, alongside independent expert advice, evidence and analysis on a diversity of factors – from the health benefits of reducing $PM_{2.5}$, to the practical feasibility and economic viability of taking different actions.

It would be irresponsible to set a target without giving consideration to its achievability and the measures required to deliver on that target.

The target level and achievement date will be developed during the target setting process and will follow in secondary legislation."

The WHO annual mean PM guidelines values are as follows:

- Fine particulate matter ($PM_{2.5}$) – 10 µg/m^3 as an annual mean, and 25 µg/m^3 as a daily mean.
- Course particulate matter (PM_{10}) – 20 µg/m^3 as an annual mean, and 50 µg/m^3 as a daily mean.

For other pollutants the EA set Environmental Assessment Levels (EALs) in the environmental management guidance document 'Air Emissions Risk Assessment for your Environmental Permit'[2] (Air Emissions Guidance). The long-term and short-term EALs from this document have been used when the AQS does not contain relevant objectives. Standards and objectives for the protection of sensitive ecosystems and habitats are also contained within the Air Emissions Guidance and the Air Pollution Information System (APIS[3]).

AAD Target and Limit Values, AQS Objectives, and EALs are set at levels well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups. For the remainder of this report these are collectively referred to as Air Quality Assessment Levels (AQALs). Table 1, Table 3 and Table 2 summarise the air quality objectives and guidelines used in this assessment.

[1] DEEFRA Policy paper 10 March 2020: Air quality factsheet (part 4) - https://www.gov.uk/government/publications/environment-bill-2020/10-march-2020-air-quality-factsheet-part-4

[2] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#environmental-standards-for-air-emissions

[3] http://www.apis.ac.uk

Table 1: Air Quality Assessment Levels (AQALs)

Pollutant	Limit Value (µg/m³)	Averaging Period	Frequency of Exceedances	Source
Nitrogen dioxide	200	1 hour	18 times per year (99.79th percentile)	AQS Objective
	40	Annual	-	AQS Objective
Sulphur dioxide	266	15 minutes	35 times per year (99.9th percentile)	AQS Objective
	350	1 hour	24 times per year (99.73rd percentile)	AQS Objective
	125	24 hours	3 times per year (99.18th percentile)	AQS Objective
Particulate matter (PM_{10})	50	24 hours	35 times per year (90.41st percentile)	AQS Objective
	50	24 hours	-	WHO Guideline
	40	Annual	-	AQS Objective
	20	Annual		WHO Guideline
Particulate matter ($PM_{2.5}$)	20	Annual	-	AQS Target Value
	25	24 hours	-	WHO Guideline
	10	Annual	-	WHO Guideline
Carbon monoxide	10,000	8 hours, running	-	AQS Objective
	30,000	1 hour		Air Emissions Guidance
Hydrogen chloride	750	1 hour	-	Air Emissions Guidance
Hydrogen fluoride	160	1 hour	-	Air Emissions Guidance
	16	Annual	-	Air Emissions Guidance
Ammonia	2,500	1 hour	-	Air Emissions Guidance
	180	Annual	-	Air Emissions Guidance
Lead	0.25	Annual	-	AQS Objective
Benzene	5.00	Annual	-	AQS Objective
	195	1 hour	-	Air Emissions Guidance
1,3-butadiene	2.25	Annual, running	-	AQS Objective
PCBs	6	1-hour	-	Air Emissions Guidance
	0.2	Annual	-	Air Emissions Guidance
PAHs	0.00025	Annual	-	AQS Objective

As shown in Table 1, lead is the only metal included in the AQS. The AQS includes objectives to limit the annual mean to 0.5 µg/m³ by the end of 2004 and to 0.25 µg/m³ by the end of 2008. Only the first objective is included in the Air Quality Directive.

The fourth Daughter Directive on air quality (Commission Decision 2004/107/EC) includes target values for arsenic, cadmium and nickel. However, these values are the same as, or lower than, those included in the Air Emissions Guidance. Therefore, the Environmental Assessment Levels (EALs) from the Air Emissions Guidance shown in Table 2 have been used in this assessment.

Table 2: Environmental Assessment Levels (EALs) for Metals

Metal	Daughter Directive Target Level (µg/m³)	EALs (µg/m³)	
		Long-term	Short-term
Arsenic	0.006	0.006	-
Antimony	-	5	150
Cadmium	0.005	0.005	-
Chromium (II & III)	-	5	150
Chromium (VI)	-	0.0002	-
Cobalt	-	-	-
Copper	-	10	200
Lead	-	0.25	-
Manganese	-	0.15	1500
Mercury	-	0.25	7.5
Nickel	0.020	0.020	-
Thallium	-	-	-
Vanadium	-	5	1

Table 3: Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m³)	Measured as	Source
Nitrogen oxides (as nitrogen dioxide)	75 / 200*	Daily mean	Air Emissions Guidance / WHO
	30	Annual mean	AQS Objective
Sulphur dioxide	10	Annual mean for sensitive lichen communities and bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystem's integrity	Air Emissions Guidance
	20	Annual mean for all higher plants	AQS Objective
Hydrogen fluoride	5	Daily mean	Air Emissions Guidance
	0.5	Weekly mean	Air Emissions Guidance
Ammonia	1	Annual mean for sensitive lichen communities and bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystem's integrity	Air Emissions Guidance
	3	Annual mean For all higher plants	Air Emissions Guidance
NOTE: ** the Institute of Air Quality Management (IAQM) consider it most appropriate to use 200 µg/m³ as the short term critical level.*			

The WHO Guidelines include a short term (24-hour) average NOx Critical Level of 75 µg/m³. However, the CD Rom version of the guidelines[4] expands upon the justification for this level. This shows that experimental evidence exists that the Critical Level reduces from around 200 to 75 µg/m³ when in combination with ozone or sulphur dioxide above their Critical Levels. Given the low ozone and sulphur dioxide levels in the UK the IAQM consider it most appropriate to use 200 µg/m³ as the short-term Critical Level. As such when carrying out this assessment the daily critical level of 75 µg/m³ has been used as an initial screening level, and consideration has also been made of the impact with reference to the much higher critical level of 200 µg/m³.

In addition to the Critical Levels set out in the table above, APIS provides habitat specific Critical Loads for nitrogen and acid deposition. Full details of the habitat specific critical loads can be found in Annex B.

[4] WHO Guidelines CD Rom version

2.1 Areas of relevant exposure

The AQALs apply only at areas of exposure relevant to the assessment level. The following table extracted from Local Authority Air Quality Technical Guidance (2016) (LAQM.TG(16))[5] explains where the AQALs apply.

Table 4: Guidance on Where AQALs Apply

Averaging period	AQALs should apply at:	AQALs should generally not 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 mean and 8-hour mean	All locations where the annual mean AQAL would apply, together with hotels. 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.
1-hour mean	All locations where the annual mean and 24 and 8-hour mean AQALs apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

Source: Box 1.1 LAQM.TG(16)

5 Department for Environment, Food and Rural Affairs, Local Air Quality Management Technical Guidance (TG16), February 2018, available at: https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

3 Sensitive Receptors

As part of this assessment, the predicted Process Contribution (PC) at the point of maximum impact and a number of sensitive receptors has been evaluated.

3.1 Human sensitive receptors

The human sensitive receptors identified for assessment are displayed in Figure 5.2 of the EIA Report and listed in Table 5. Analysis of the receptors from the May 2011 ES shows that there was some incorrect labelling and that they are dated. Therefore, a new set of receptors has been used for the purpose of this assessment. These have been identified as the closest residential properties in each wind direction, along with any schools and hospitals identified within 3 km of the Site.

Table 5: Human Sensitive Receptors

ID	Name	Location		Distance from the stack (m)
		X (m)	Y (m)	
R1	Works Lane	368206	374535	604
R2	Manchester Road 1	368368	374615	675
R3	Griffiths Road	368622	374676	793
R4	Arthur Street	369111	374754	1,133
R5	Station Road	369195	374655	1,128
R6	Lostock Hollow	369059	374205	783
R7	Birches Lane	369119	374030	803
R8	Birches Lane 2	369361	373864	1,043
R9	Village Close	369318	373603	1,053
R10	Cookes Lane	369064	373300	982
R11	Britannia Drive	368534	373024	942
R12	Cottage Close	368298	373564	379
R13	St. Johns Close	368125	373535	452
R14	Middlewich Road	367833	373465	682
R15	Birkenhead Street	367471	373707	882
R16	Bowden Drive	367267	373906	1,055
R17	Manchester Road 2	367609	374375	833
R18	Manchester Road 3	368026	374529	657
R19	Rudheath Senior Academy	367967	373347	692
R20	Rudheath Primary Academy	368034	372783	1,194
R21	Lostock Gralam CoE primary school	369205	374818	1,245
R22	Wincham Community Primary School	368630	376327	2,405
R23	Victoria Road Primary	366687	373822	1,638
R24	Witton Church Walk CofE Primary	366340	373743	1,991

ID	Name	Location		Distance from the stack (m)
		X (m)	Y (m)	
R25	Leftwich community Primary school and Couty High School Leftwich	366499	371744	2,855
R26	Victoria Infirmary	365510	373992	2,811
R27	Lostock Lodge Care Home	369801	375133	1,900
R28	Avandale Lodge Car Home	369110	374998	1,318
R29	Daneside Court Care Home	366121	373674	2,216

The above is not an exhaustive list of receptors. As such reference has also been made to the distribution of emissions where areas of public exposure may not be captured by the specific receptors listed above.

3.2 Ecological sensitive receptors

A study was undertaken to identify the following sites of ecological importance in accordance with the following screening distances laid out in the Air Emissions Guidance:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 15 km of the Site (for large emitters);
- Sites of Special Scientific Interest (SSSIs) within 2 km of the Site; and
- National Nature Reserves (NNR), Local Nature Reserves (LNRs), local wildlife sites (LWS) and ancient woodlands within 2 km of the Site.

The sensitive ecological receptors identified as a result of the study are displayed in Figure 5.3 and Figure 5.3a of the EIA Reportand are listed in Table 6. This includes the potential LWSs which were requested as part of the scoping with the LPA

A review of the citation and APIS website for each site has been undertaken to determine if lichens or bryophytes are an important part of the ecosystem's integrity. If lichens or bryophytes are present, the more stringent Critical Level has been applied as part of the assessment.

Table 6: Ecological Sensitive Receptors

ID	Site	Designa tion	Closest point to site		Distance from stack at closest point (km)	Lichens/ bryo-phytes present
			X (m)	Y (m)		
European designated sites						
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	Ramsar	375306	378759	8.48	Yes
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	Ramsar	373178	381446	8.94	Yes

ID	Site	Designation	Closest point to site		Distance from stack at closest point (km)	Lichens/ bryo-phytes present
			X (m)	Y (m)		
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Ramsar/ SAC	360071	369159	9.54	Yes
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Ramsar/ SAC	355847	372299	12.58	Yes
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Ramsar/ SAC	357792	368052	12.06	Yes
E6	Rostherne Mere	Ramsar	374091	383710	11.34	No
UK designated sites						
E7	Witton Lime Beds	SSSI	366383	374464	2.01	Yes
E8	Plumley Lime Beds	SSSI	370479	374921	2.37	Yes
Locally designated sites						
E9	Ashton's and Neumann's Flashes	LWS	366993	374553	1.46	Yes*
E10	Gadbrok Valley	LWS	367661	372203	1.85	Yes*
E11	Griffiths Park	LWS	368022	373918	0.29	Yes*
E12	Long Wood	LWS	369796	374898	1.77	Yes*
E13	Marston Flashes	LWS	367300	375446	1.82	Yes*
E14	Wade Brook	LWS	368518	374342	0.46	Yes*
E15	Wincham Brook Valley and Mill Wood	LWS	368193	374680	0.76	Yes*
E16	Winnington Wood	AW/LWS/pLWS	369739	375489	2.11	Yes*
E17	River Dane	pLWS	367007	373233	1.49	Yes*
E18	Marshall's Gorse	pLWS	368594	372245	1.72	Yes*
E19	Rudheath Lime Beds	pLWS	368447	373864	0.15	Yes*
E20	Lostock House Orchard	pLWS	370122	373127	1.98	Yes*

Notes:

AW = ancient woodland

*No information on lichen/bryophytes presence available but their presence have been presumed as a conservative measure.

4 Process Emissions Dispersion Modelling Methodology

4.1 Selection of model

Detailed dispersion modelling was undertaken using the model ADMS 5.2, developed and supplied by Cambridge Environmental Research Consultants (CERC) This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and environmental permitting purposes to the satisfaction of the EA and local authorities. The maximum predicted concentration for each pollutant and averaging period has been used to determine the significance of any potential impacts.

4.2 Source and emissions data

The principal inputs to the model with respect to the process emissions to air from the LSEP is presented in Table 7 and Table 8. The emissions data has been provided by the technology provider (which provides an update from the May 2011 ES parameters). This is based on the LSEP having a total thermal input of 120 MW. Assuming the waste has an NVC of 9.5 MJ/kg, this equates to 45.5 tonnes per hour (tph) per line. Assuming an availability of 8,000 hours per year, this equates to a throughput of 728,000 tonnes per annum (tpa). However, the dispersion modelling conservatively assumes continuous operation of 8760 hours per year. The tables show the emissions per line.

Table 7: Stack Source Data – Per Line

Item	Unit	Value
Stack data		
Height	m	90
Internal diameter	m	2.4 (per line)*
Stack 1 location	m, m	368321,373942
Stack 2 location	m, m	368327,373941
Flue gas conditions		
Temperature	°C	135
Exit moisture content	% v/v	18.2%
	kg/kg	0.133
Exit oxygen content	% v/v dry	6.1%
Reference oxygen content	% v/v dry	11.0%
Volume at reference conditions (dry, ref O_2)	Nm^3/s	73.6
Volume at actual conditions	Am^3/s	90.4
Exit velocity	m/s	19.9

Item	Unit	Value
* the May 2011 ES was modelled using a single effective stack location and stack diameter. For the updated modelling in this report, two stack locations at their actual diameters have been used in accordance with the latest details.		

It has been assumed that emissions from the LSEP will comply with the BAT-AELs for an existing plant, or the emission limits from Annex VI Part 3 of the IED for waste incineration plants where BAT-AELs are not applicable. This has been agreed with the EA as part of the pre-application meeting.

Table 8: Stack Emissions Data – Per Line

Pollutant	Conc. (mg/Nm^3)		Release rate (g/s)	
	Daily or periodic	Half-hourly	Daily or periodic	Half-hourly
Oxides of nitrogen (as NO_2)	180	400	13.24	29.43
Sulphur dioxide	40	200	2.94	14.71
Carbon monoxide	50	100	3.68	7.36
Fine Particulate Matter (PM)(2)	5	30	0.38	2.21
Hydrogen chloride	8	60	0.59	4.41
Volatile organic compounds (as TOC)	10	20	0.74	1.47
Hydrogen fluoride	1	4	0.07	0.29
Ammonia	10	-	0.74	-
Cadmium and thallium	0.02	-	1.47 mg/s	-
Mercury	0.02	0.035	1.47 mg/s	2.58 mg/s
Other metals(3)	0.3	-	22.07 mg/s	-
Dioxins and furans	0.08 ng/Nm^3	-	5.89 ng/s	-
Benzo(a)pyrene (PaHs)(4)	0.2 $\mu g/Nm^3$	-	14.71 µg/s	-
PCBs(5)	0.005	-	0.37 mg/s	-

Notes:

All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.

(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.

(2) As a worst-case it has been assumed that the entire PM emissions consist of either PM_{10} or $PM_{2.5}$ for comparison with the relevant AQALs.

(3) Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

(4) The maximum concentration of BaP recorded at a UK plant is 0.2 $\mu g/Nm^3$ (2019 Waste Incineration BREF, Figure 8.121). This is assumed to be the emission concentration for the LSEP.

(5) Table 3.8 of the 2006 Waste Incineration BREF states that the annual average total PCBs is less than 0.005 mg/Nm^3 (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the LSEP.

The LSEP has been designed to operate at full capacity and is not anticipated to have significant changes in loading. Therefore, it is appropriate to base the assessment on the design point of the system. If the LSEP continually operated at the half-hourly limits, the daily limits would be exceeded. The LSEP has been designed to achieve the daily limits and as such will only operate at the short-term limits for short periods on rare occasions.

4.3 Other model inputs

4.3.1 Modelling domain

Modelling has been undertaken over a 6 km x 6 km grid with a spatial resolution of 60 m. The grid spacing in each direction has been chosen to be less than 1.5 times the minimum stack height considered in accordance with the EA's modelling guidance, and to provide accurate results close to the stack. Reference should be made to Figure 1 of Annex D for a graphical representation of the modelling domain used. The extent of the modelling domain is detailed in Table 9.

Table 9: Modelling Domain

Parameter	Value
Grid spacing (m)	60
Grid points	101
Grid Start X (m)	365300
Grid Finish X (m)	371300
Grid Start Y (m)	370900
Grid Finish Y (m)	376900

4.3.2 Meteorological data and surface characteristics

The impact of meteorological data was taken into account by using weather data from Manchester Airport meteorological station for the years 2016 – 2020. RAF Lyneham is approximately 17 km to the north east of the LSEP facility and is the closest and most representative meteorological station available. However, the LSEP is directly upwind of Manchester Airport when considering the prevailing wind direction, has excellent data capture, and is at a similar altitude to the LSEP. Rostherne No. 2 weather station is located slightly closer at 13 km and again is at a similar elevation. Although data capture is excellent for most parameters, missing cloud cover would need to be infilled with data from Manchester Airport. The May 2011 ES had used meteorological data from Woodford Airport, which is no longer in use as a meteorological recording station, but is close to Manchester Airport.

The EA recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. Wind roses for each year are presented in Figure 6 of Annex D.

The minimum Monin-Obukhov length can be selected in ADMS for both the dispersion site and the meteorological site. This is a measure of the minimum stability of the atmosphere and can be adjusted to account for urban heat island effects which prevent the atmosphere in urban areas from ever becoming completely stable. The minimum Monin-Obukhov length has been set to 10 m (small towns) for the dispersion site. This is deemed most representative of the surrounding area of the site due to the mix of industrial areas locally to the site, some residential areas and rural areas. The meteorological site also uses a minimum Monin-Obukhov length of 10 m due to similar land use of the surrounding area.

The model has used a variable surface roughness file. This alters the surface roughness across the modelling domain according to the land use, using surface roughness data provided by Corine land cover data across the same grid and resolution as that used for terrain and presented in Table 11. A visual representation of the surface roughness file used is provided in Figure 3 of Annex D. Using a variable surface roughness file is useful to incorporate the variation in land use and surface roughness surrounding the site. The surface roughness value for the meteorological site has been entered at 0.3 m, as this best represents the open fields and rural surroundings of this location The sensitivity of the modelling to the choice of surface roughness has been considered in Section 5.1.

4.3.3 Buildings

The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways:

- Wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing.
- The rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

The EA recommends that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

The ADMS 5.2 user guide also states that buildings less than one third of the stack height will not have any effect on dispersion.

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 10. The buildings have been modelled at the height of the highest point of the structure. A site plan showing which buildings have been included in the model is presented in Figure 4 of Annex D The main building has been selected as the boiler hall. A desk-top review of the location, height and orientation in relation to wind direction and other building wakes, for the buildings within the wider LSEP site has been undertaken, and it is concluded that no other buildings need be modelled. This is the same approach as the May 2011 ES.

Table 10: Building Details

Buildings	Centre point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Boiler Hall	368377	374038	48	56	48	99
Bunker	368348	374081	36	32	78	99
FGT 1	368331	373990	43	39	38	99
Staircase 2	368310	373980	45	10	5	99
FGT 2	368326	373957	37.7	26	38	99
Staircase 1	368310	374063	50.3	14	14	99

4.3.4 Terrain

It is recommended that, where gradients within 500 m of the modelling domain are greater than 1 in 10, the complex terrain module within ADMS (FLOWSTAR) should be used. A review of the local area has deemed that the effect of terrain should be taken into account in the modelling.

A terrain file large enough to cover the output grid of points was created using Ordnance Survey Terrain 50 data. The parameters of the terrain files used are outlined in Table 11. Reference should be made to Figure 2 of Annex D for a graphical representation of the terrain file used. The sensitivity of the modelling to the use of terrain has been considered in Section 5.1

Table 11: Terrain File Parameters

Parameter	Value
Grid Start X	351727
Grid Finish X	379675
Grid Start Y	363966
Grid Finish Y	387944
Resolution	64 x 64

4.4 Combined flue function

If there are emissions from multiple flues within the same stack (or close to each other) with similar properties, the plumes will act as a single plume with combined source characteristics. ADMS provides the option to account for this which has been used in the modelling. The sensitivity of the modelling to the use of combined flue function has been considered in Section 5.5.

4.5 Chemistry

The LSEP will release nitric oxide (NO) and nitrogen dioxide (NO_2) which are collectively referred to as NOx. In the atmosphere, nitric oxide will be converted to nitrogen dioxide in a reaction with ozone which is influenced by solar radiation. Since the AQALs are expressed in terms of nitrogen dioxide, it is important to be able to assess the conversion rate of nitric oxide to nitrogen dioxide.

Ground level NOx concentrations have been predicted through dispersion modelling. Nitrogen dioxide concentrations reported in the results section assume 70% conversion from NOx to nitrogen dioxide for annual means and a 35% conversion for short term (hourly) concentrations, based upon the worst-case scenario in the EA methodology. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

4.6 Baseline concentrations

Background concentrations for the assessment have been derived from monitoring and national mapping as presented in Appendix E1 [Baseline Analysis] of the EP applicationFor short term averaging periods, the background concentration has been assumed to be twice the long-term ambient concentration following the Air Emissions Guidance methodology.

4.7 Comparison to May 2011 ES

A comparison model has been run in order to compare the impact to the previously consented scheme. The model has used the latest version of ADMS and the most recent meteorological data (2016-2020) from Manchester, but has used the emissions inputs and building layout as stated in the May 2011 ES.

Table 12: Stack Source Data – May 2011 ES – Both lines

Item	Unit	Value
Stack data		
Height	m	90
Internal diameter	m	4 (effective diameter for both lines together)
Stack location	m, m	368311,373933
Flue gas conditions		
Temperature	°C	135
Exit moisture content	% v/v	14.25%*
	kg/kg	0.0988
Exit oxygen content	% v/v dry	**
Reference oxygen content	% v/v dry	11.0%
Volume at reference conditions (dry, ref O_2)	Nm^3/s	157.4
Volume at actual conditions	Am^3/s	191
Exit velocity	m/s	15
Note: * not presented in the May 2011 ES – calculated from the kg/kg moisture content. ** not presented in the May 2011 ES		

Table 13: Stack Emissions Data – May 2011 ES – Both lines

Pollutant	Conc. (mg/Nm^3)		Release rate (g/s)	
	Daily or periodic	Half-hourly	Daily or periodic	Half-hourly
Oxides of nitrogen (as NO_2)	200	400	31.48	62.960
Sulphur dioxide	50	200	7.87	31.480
Carbon monoxide	50	100	7.87	15.740
Fine Particulate Matter (PM)(2)	10	30	1.57	4.722
Hydrogen chloride	10	60	1.57	9.444
Volatile organic compounds (as TOC)	10	20	1.57	3.148
Hydrogen fluoride	1	4	0.16	0.630
Ammonia	10	-	1.57	-

Pollutant	Conc. (mg/Nm^3)		Release rate (g/s)	
	Daily or periodic	Half-hourly	Daily or periodic	Half-hourly
Cadmium and thallium	0.05	-	7.87 mg/s	-
Mercury	0.05	-	7.87 mg/s	-
Other metals(3)	0.5	-	78.70 mg/s	-
Dioxins and furans	0.1 ng/Nm^3	-	15.7 ng/s	-
Benzo(a)pyrene (PaHs)(4)	0.2 $\mu g/Nm^3$	-	31.48 µg/s	-
PCBs(5)	0.005	-	0.79 mg/s	-

Notes:

All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.

(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.

(2) As a worst-case it has been assumed that the entire PM emissions consist of either PM_{10} or $PM_{2.5}$ for comparison with the relevant AQALs.

(3) Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

(4) The maximum concentration of BaP recorded at a UK plant is 0.2 $\mu g/Nm^3$ (2019 Waste Incineration BREF, Figure 8.121). This is assumed to be the emission concentration for the LSEP.

(5) Table 3.8 of the 2006 Waste Incineration BREF states that the annual average total PCBs is less than 0.005 mg/Nm^3 (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the LSEP.

Table 12 shows that the volumetric flow rate used within the May 2011 ES is higher than that currently proposed (note 157.4 Nm^3/s divided by two – for each line is 78.7 Nm^3/s). It is likely that the volumetric flow rate used within the the May 2011 ES was calculated conservatively in lieu of the details from the technology provider.

The differences in the models will also be affected by the change in stack location and building layout. The May 2011 ES building details are as set out in Table 14 and displayed in Figure 5 of Annex D. As shown when compared to the Proposal building layout, the main building for both models is the same height, but there are aspects of the revised buildings which are taller.

Table 14: Building Details –May 2011 ES

Buildings	Centre point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Boiler House	368330	374048	48	55	83	8
Flue Gas Treatment	368316	373969	43	35	55	4
Steam Turbine	368361	374021	24	15	40	8
Air condenser	368391	374007	22	12	127	15
Residue Silo	368395	374093	22	22	20	8
Reception Hall	368328	374111	17	45	37	7

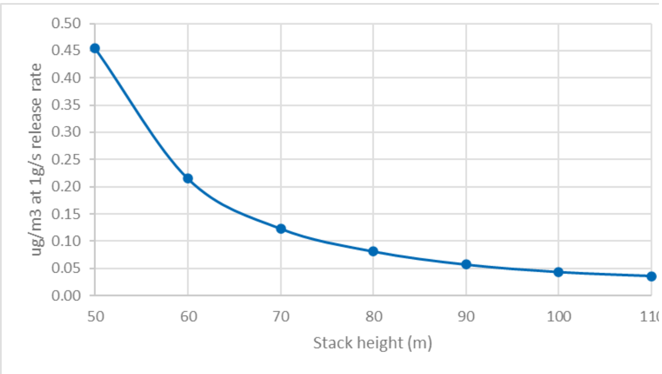
5 Sensitivity Analysis

5.1 Stack height assessment

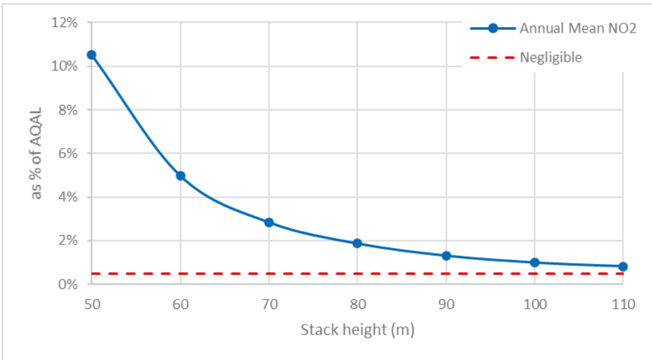
The s36 consent is for a stack height of 90 m. As part of the Proposal it is not proposed to change the stack height. The graphs and analysis below indicate that this is still an appropriate stack height for the increase in tonnage.

Graph 1 shows the annual mean ground level concentration based on an emission rate of 1 g/s from the stack, with increasing stack height. It shows the benefit in increasing the stack decreases with stack height. When determining a suitable stack height, it is best practice to identify the stack height where the rate of reduction in maximum ground level concentration with increased height slows down. This can be identified on a graph as a step change in the slope.

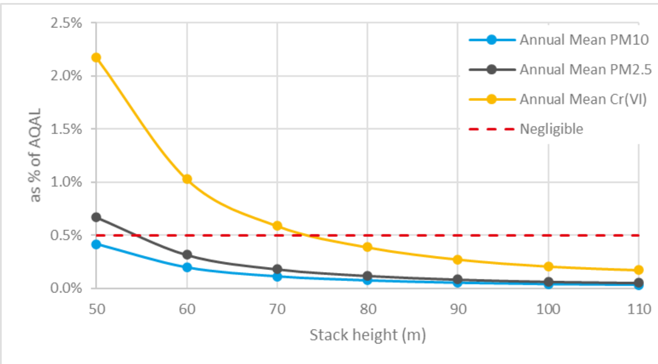
Graph 1: 1 g/s release rate



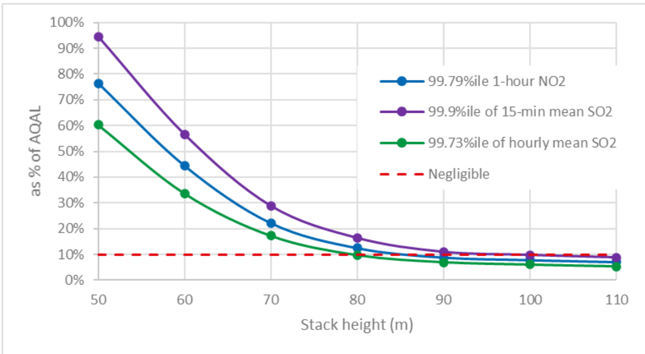
Graph 2: Annual mean NO2



Graph 3: Annual mean – other pollutants



Graph 4: Short term means at the half-hourly ELVs



Graph 1 shows that there is not an obvious change in slope, but that after 90 m there is little change in slope with increased stack height. Graph 2 shows that the annual mean impact of nitrogen dioxide does not screen out as negligible regardless of background conditions at 90 m, but that this is also not achievable at higher stack heights up to 110 m so there is minimal benefit of increasing the stack higher than 90 m. Graph 3 shows that for other annual mean pollutants, the impact can be screened out as negligible regardless of background conditions at 80 m. Graph 4 shows the short term impacts, based on the half-hourly ELVs. Although it shows that 15-minute means of sulphur dioxide cannot be screened out as negligible at 90 m, it does show there is little benefit in increasing the stack higher than this. In reality, the likelihood of both flues operating at the short term ELVs at the same time and under the worst weather conditions is very slight, as investigated further in section 6.2.1.

Overall, Graphs 1 to 4 show that a 90 m stack height remains suitable for the LSEP facility even with the proposed increase in throughput.

5.2 Surface roughness

The sensitivity of the results to using spatially varying surface roughness length has been considered by running the model without a varying surface roughness file. The sensitivity model used a surface roughness value of 0.5 m (parkland and open suburbia) for the dispersion site, which is deemed most appropriate for the mixed industrial and rural surroundings of the dispersion site, and has been kept at 0.3 m for the meteorological site as this best represents the open fields and rural surroundings of this location. For all sensitivity analysis the impact of changing model parameters on the maximum annual mean and short-term concentrations of oxides of nitrogen have been considered.

The following parameters were kept constant:

- Stack height – 90 m
- Buildings – included;
- Terrain file – included at 64 x 64 resolution;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Combined flue additional input file; and
- Meteorological data used – Manchester 2020.

The contribution of the LSEP to the ground level concentration of the emissions of oxides of nitrogen at the point of maximum predicted concentration is presented in Table 15.

Table 15: Surface Roughness Sensitivity Analysis

Scenario	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Using variable surface roughness file	0.56	30.99	0.54	30.14
Without using variable surface roughness file – SR 0.5 m	0.78	29.54	1.30	44.73

As shown, using a variable roughness file results in lower annual mean concentrations but higher short-term concentrations. This is a normal pattern seen when reducing the surface roughness value. This reflects that the surface roughness values provided in the surface roughness file are generally lower than the 0.5 m value used in the sensitivity model. The roughness file provides a more accurate representation of surface roughness because it varies across the modelling domain dependent on the land use, and therefore was used within the assessment model.

5.3 Building parameters

ADMS 5.2 has a buildings effects module to account for the impact of buildings when it calculates the air flow and dispersion of pollutants from a source. The model works by combining the inputted individual buildings into a single effective building for each wind direction.

The sensitivity of the results to the effect of buildings has been considered by running the model with the buildings presented in Table 10 and with no buildings at all.

The following parameters were kept constant:

- Stack height – 90 m;
- Terrain file – included at 64 x 64 resolution;
- Surface roughness file – included at 64 x 64 resolution;
- Meteorological site surface roughness value – 0.3 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Combined flue additional input file; and
- Meteorological data used – Manchester 2020.

Table 16 presents the ground level concentration of oxides of nitrogen at the point of maximum predicted concentration for each building scenario.

Table 16: Effect of Buildings

Scenario	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual Mean	Max 1-hour mean	Annual Mean	Max 1-hour mean
Including buildings as presented in Table 10	0.56	30.99	0.54	30.14
Excluding buildings	0.48	30.61	0.46	29.78

As shown, modelling the presence of buildings results in higher annual mean and short-term concentrations. Buildings have been included in the dispersion model as this represents a realistic and conservative approach.

5.4 Terrain

The sensitivity of the results to the effect of terrain has been considered by running the model with and without the main terrain file presented in section 4.3.4.

The following parameters were kept constant:

- Stack height – 90 m
- Buildings – included;
- Surface roughness file – variable included at 64 x 64 resolution;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Combined flue additional input file; and

- Meteorological data used – Manchester 2020.

Table 17 presents the ground level concentration of oxides of nitrogen at the point of maximum predicted concentration for each terrain scenario.

Table 17: Effect of Terrain

Scenario	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Including terrain	0.56	30.99	0.54	30.14
Excluding terrain	0.54	31.21	0.53	29.82

As shown, including the effect of terrain has a slight increase in the annual mean and slight decrease in the maximum 1-hour concentrations at the point of max impact, but a slight increase for both averaging periods at the maximum impacted receptor. Overall the differences are very slight. The terrain file has been included in the dispersion model as this represents a realistic approach.

5.5 Combined flue

The sensitivity of the results to using the combined flue option have been considered by running the model with and without the combined flue additional input file.

The following parameters were kept constant:

- Stack height – 90 m
- Buildings – included;
- Terrain file - included at 64 x 64 resolution;
- Surface roughness file – variable included at 64 x 64 resolution;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Combined flue additional input file; and
- Meteorological data used – Manchester 2020.

Table 17 presents the ground level concentration of oxides of nitrogen at the point of maximum predicted concentration for each terrain scenario.

Table 18: Effect of Combined Flue File

Scenario	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Combined flue function	0.56	30.99	0.54	29.55
Excluding combined flue function	0.92	71.84	0.89	49.48

Scenario	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Excluding combined flue function single line	0.46	35.92	0.44	24.74

As shown, using the combined flue function has a significant effect on the dispersion of emissions from the stack. The analysis has also been carried out to show the effect should only one line be operational. When both lines are operating at the same time due to the similar properties of the exhaust gases the plumes from each line would act as a single plume. The temperature within the plume would be conserved for longer leading to enhanced dispersion. The impact of both lines operating together remains greater than if only one line was to be operational. As such the dispersion modelling has included the combined flue function within ADMS.

5.6 Sensitivity analysis – operating below the design point

Dispersion modelling has been undertaken based on the emission parameters based on the design point for the LSEP. The LSEP is to be operated as a commercial plant, so it is beneficial to operate at full capacity. If loading does fall below the design point the volumetric flow rate and the exit velocity of the exhaust gases would reduce. The effect on this would decrease the quantity of pollutants emitted but also reduce the buoyancy of the plume due to momentum. The reduction in buoyancy, which would lead to reduced dispersion, would be more than offset by the decrease in the amount of pollutants being emitted, so that the impact of the plant when running below the design point would be reduced.

6 Impact on Human Health

6.1 At the point of maximum impact

Table 19 and Table 20 present the results of the dispersion modelling of process emissions from the LSEP at the point of maximum impact. This is the maximum predicted concentration based on the following:

- Modelling domain size – 6.0 km^2 at 60 m resolution;
- Buildings – included;
- Terrain – included at 64 x 64 resolution;
- Surface roughness – included at 64 x 64 resolution;
- Stack height – 90 m;
- 5 years of weather data 2016 to 2020 from Manchester meteorological recording station;
- Operation at the long term ELVs for 100% of the year;
- Operation at the short term ELVs during the worst-case conditions for dispersion of emissions (Table 20 only);
- EA's worst case conversion of NOx to nitrogen dioxide;
- The entire PM emissions are assumed to consist of either PM_{10}s or $PM_{2.5}$s.
- The entire VOC emissions are assumed to consist of either benzene or 1,3-butadiene; and
- Cadmium is released at the combined emission limit for cadmium and thallium.

The baseline concentration is taken from the review of baseline monitoring contained in Appendix E1 [Baseline Review] of the EP application..

Impacts that cannot be described as 'negligible' irrespective of the total concentration in accordance with the IAQM 2017 criteria are highlighted. Where the impact cannot be screened out 'as 'negligible' irrespective of the total concentration, further analysis has been undertaken. The discussion of the results is contained within the Air Quality Analysis to support the EP application.].

Table 19: Dispersion Modelling Results – Point of Maximum Impact - Daily ELVs

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2016	2017	2018	2019	2020	Max			
Nitrogen dioxide	Annual mean	µg/m³	40	17.05	0.53	0.50	0.38	0.48	0.39	0.53	1.31%	17.58	43.94%
	99.79th%ile of hourly means	µg/m³	200	34.10	7.87	7.37	7.43	7.89	7.44	7.89	3.95%	41.99	21.00%
Sulphur dioxide	99.18th%ile of daily means	µg/m³	125	29.40	1.93	1.47	1.48	1.28	1.31	1.93	1.54%	31.33	25.06%
	99.73rd%ile of hourly means	µg/m³	350	29.40	4.88	4.43	4.53	4.83	4.47	4.88	1.40%	34.28	9.80%
	99.9th%ile of 15 min. means	µg/m³	266	29.40	5.73	5.75	5.67	5.83	5.79	5.83	2.19%	35.23	13.24%
PM_{10}	Annual mean	µg/m³	40	12.98	0.02	0.02	0.02	0.02	0.02	0.02	0.05%	13.00	32.50%
	90.41th%ile of daily means	µg/m³	50	25.96	0.08	0.07	0.06	0.08	0.06	0.08	0.17%	26.04	52.09%
$PM_{2.5}$	Annual mean	µg/m³	20	8.79	0.02	0.02	0.02	0.02	0.02	0.02	0.10%	8.81	44.05%
Carbon monoxide	8 hour running mean	µg/m³	10,000	690.00	5.81	7.60	8.23	6.98	8.61	8.61	0.09%	698.61	6.99%
	Hourly mean	µg/m³	30,000	690.00	10.36	9.04	9.36	9.73	8.61	10.36	0.03%	700.36	2.33%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	0.03	0.03	0.02	0.03	0.03	0.03	0.00%	1.45	0.19%
Hydrogen fluoride	Annual mean	µg/m³	16	2.35	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03%	2.35	14.71%
	Hourly mean	µg/m³	160	4.70	0.21	0.18	0.19	0.19	0.17	0.21	0.13%	4.91	3.07%
Ammonia	Annual mean	µg/m³	180	4.23	0.04	0.04	0.03	0.04	0.03	0.04	0.02%	4.27	2.37%
	Hourly mean	µg/m³	2,500	8.46	2.07	1.81	1.87	1.95	1.72	2.07	0.08%	10.53	0.42%

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2016	2017	2018	2019	2020	Max			
VOCs (as benzene)	Annual mean	µg/m³	5	0.56	0.04	0.04	0.03	0.04	0.03	0.04	0.84%	0.60	12.04%
	Hourly mean	µg/m³	195	1.12	2.07	1.81	1.87	1.95	1.72	2.07	1.06%	3.19	1.64%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.25	0.04	0.04	0.03	0.04	0.03	0.04	1.86%	0.29	12.97%
Mercury	Annual mean	ng/m³	250	0.57	0.08	0.08	0.06	0.08	0.06	0.08	0.03%	2.88	1.15%
	Hourly mean	ng/m³	7,500	1.14	4.15	3.62	3.74	3.89	3.45	4.15	0.06%	9.75	0.13%
Cadmium	Annual mean	ng/m³	5	-	0.08	0.08	0.06	0.08	0.06	0.08	1.67%	0.65	13.07%
	Hourly mean	ng/m³	-		4.15	3.62	3.74	3.89	3.45	4.15	-	5.29	-
PAHs	Annual mean	pg/m³	250	0.98	0.84	0.79	0.61	0.76	0.63	0.84	0.33%	1.82	0.73%
Dioxins	Annual mean	fg/m³	-	32.99	0.33	0.32	0.24	0.30	0.25	0.33	-	33.32	-
PCBs	Annual mean	ng/m³	200	128.93	0.02	0.02	0.02	0.02	0.02	0.02	0.01%	128.95	64.48%
	Hourly mean	ng/m³	6,000	257.86	1.04	0.90	0.94	0.97	0.86	1.04	0.02%	258.90	4.31%
Other metals	Annual mean	ng/m³	-	-	1.25	1.19	0.91	1.14	0.94	1.25	See metals assessment – Section 6.2.1		
	Hourly mean	ng/m³	-	-	62.19	54.27	56.15	58.38	51.68	62.19			

Note:
All assessment is based on the maximum PC using all 5 years of weather data.

Table 20: Dispersion Modelling Results – Point of Maximum Impact - Short-Term ELVs

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2016	2017	2018	2019	2020	Max			
Nitrogen dioxide	99.79th%ile of hourly means	µg/m³	200	34.10	17.49	16.38	16.52	17.54	16.52	17.54	8.77%	51.64	25.82%
Sulphur dioxide	99.73rd%ile of hourly means	µg/m³	350	29.40	24.42	22.14	22.63	24.14	22.33	24.42	6.98%	53.82	15.38%
	99.9th%ile of 15 min. means	µg/m³	266	29.40	28.67	28.75	28.35	29.15	28.95	29.15	10.96%	58.55	22.01%
Carbon monoxide	8 hour running mean	µg/m³	10000	690.00	11.62	15.20	16.45	13.96	17.22	17.22	0.17%	707.22	7.07%
	Hourly mean	µg/m³	30000	690.00	20.73	18.09	18.72	19.46	17.23	20.73	0.07%	710.73	2.37%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	12.44	10.86	11.23	11.68	10.34	12.44	1.66%	13.86	1.85%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.70	0.83	0.72	0.75	0.78	0.69	0.83	0.52%	5.53	3.46%
VOCs (as benzene)	Hourly mean	µg/m³	195	1.12	4.15	3.62	3.74	3.89	3.45	4.15	2.13%	5.27	2.70%
Mercury	Hourly mean	ng/m³	7500	5.60	4.15	3.62	3.74	3.89	3.45	4.15	0.06%	9.75	0.13%

Note:
All assessment is based on the maximum PC using all 5 years of weather data and operation at the short-term ELVs.

As shown, at the point of maximum impact all of the PCs are less than 10% of the short-term AQAL and less than 0.5% of the annual mean AQAL when operating at the daily ELVs and can be screened out as 'negligible' irrespective of the total concentration in accordance with the IAQM 2017 guidance, with the exception of the following :

- Annual mean nitrogen dioxide impacts;
- Annual mean VOCs impacts and
- Annual mean cadmium impacts.

At the point of maximum impact all of the PCs are less than 10% of the short-term AQAL when operating at the half-hourly ELVs and can be screened out as 'negligible' irrespective of the total concentration in accordance with the IAQM 2017 guidance, with the exception of sulphur dioxide (as the 99.9th percentile of 15-minute means).

Further analysis of the likely future baseline concentrations has been undertaken to define the magnitude of change for annual mean impacts for, and the extent of relevant exposure has been undertaken to determine the magnitude of change for short-term impacts. In addition, this has included additional consideration of the impact of particulate emissions in line with the WHO guideline values.

6.2 Further assessment

6.2.1 Annual mean nitrogen dioxide

The annual mean nitrogen dioxide PC from the LSEP is predicted to be 1.31% of the AQAL at the point of maximum impact. Figure 7 of Annex D show the location of the point of maximum impact is to the north of the LSEP, within fields to the north of Manchester Road (i.e. an area where the annual mean AQAL does not apply). Baseline concentrations in the area where the point of maximum impact occurs are likely to be similar to the mapped background concentration (i.e. 17.05 µg/m^3). Applying this baseline concentration, the PEC at the point of maximum impact would be 43.94% of the AQAL.

Although all other areas will have a lesser impact than at the point of maximum impact as described above, the impact at local residential receptors has also been investigated, the detailed results table is provided in Annex A and spatially shown in Figure 7 of Annex D. As shown, there are 13 of the identified sensitive receptors at which the PC exceeds 0.5% of the AQAL and 2 at which the PC exceeds 1% of the AQAL. The maximum impacted receptor is R8 (Birches Lane 2), at which the impact is 1.13% of the AQAL. Figure 7 of Annex D shows there are two areas in which the impact exceeds the 1% of the AQAL; to the east of the LSEP site where R8 and R9 are located, and in a mostly rural area to the north of the site above Manchester Road. Using the mapped background concentration of 17.05 µg/m^3, the PEC at R8 is 43.76% of the AQAL, well below the 70% screening criteria. All other areas PECs are also well below 70% of the AQAL.

6.2.2 Annual mean VOCs

There are two VOCs for which an AQAL has been set: benzene and 1,3-butadiene. For the purpose of this analysis it has been assumed that the entire VOC emissions consist of only benzene or 1,3-butadiene. This is a highly conservative assumption as it does not take into account the speciation of VOCs in the emissions and the modelling does not take into account the volatile nature of the compounds.

The PC from the LSEP is predicted to be 0.84% of the AQAL for benzene and 1.86% of the AQAL for 1,3-butadiene at the point of maximum impact.

Figure 8a of Annex D shows the spatial distribution of VOCs as benzene impacts. The location of the point of maximum impact is to the north of the LSEP facility, within fields to the north of Manchester Road (i.e. an area where the annual mean AQAL does not apply). Baseline concentrations in the area where the point of maximum impact occurs are likely to be similar to the mapped background concentration (i.e. 0.56 µg/m^3). Applying this baseline concentration, the PEC at the point of maximum impact would be 12.04% of the AQAL.

Although all other areas will have a lesser impact than at the point of maximum impact as described above, the impact at local residential receptors has also been investigated. The detailed results table is provided in Annex A and spatially shown in Figure 8a of Annex D. As shown, there are 10 of the identified sensitive receptors at which the PC exceeds 0.5%. The maximum impacted receptor is R8 (Birches Lane 2), at which the impact is 0.72% of the AQAL. Using the mapped background concentration of 0.56 µg/m^3, the PEC at R8 is 11.92% of the AQAL, well below the 70% screening criteria. All other areas PECs are also well below 70% of the AQAL.

Figure 8b of Annex D shows the spatial distribution of VOCs as 1,3-butadiene impacts. The location of the point of maximum impact is to the north of the LSEP facility, within fields to the north of Manchester Road (i.e. an area where the annual mean AQAL does not apply). Baseline concentrations in the area where the point of maximum impact occurs are likely to be similar to the mapped background concentration (i.e. 0.25 µg/m^3). Applying this baseline concentration, the PEC at the point of maximum impact would be 12.97% of the AQAL.

Although all other areas will have a lesser impact than at the point of maximum impact as described above, the impact at local residential receptors has also been investigated, the detailed results table is provided in Annex A and spatially shown in Figure 8b of Annex D. As shown, there are 18 of the identified sensitive receptors at which the PC exceeds 0.5% of the AQAL and 10 at which the PC exceeds 1% of the AQAL. The maximum impacted receptor is R8 (Birches Lane 2), at which the impact is 1.60% of the AQAL. Figure 8b of Annex D shows there is an extended area to the north east of the LSEP facility in which the impact exceeds 1% of the AQAL, and two smaller areas to the east and north which exceed 1.5% of the AQAL. Using the mapped background concentration of 0.25 µg/m^3, the PEC at R8 is 12.71% of the AQAL, well below the 70% screening criteria. All other areas PECs are also well below 70% of the AQAL.

6.2.3 Annual mean cadmium

The annual mean cadmium PC from the LSEP facility is predicted to be 1.67% of the AQAL. However, this assumes that the entire cadmium and thallium emissions consist of only cadmium. The Waste Incineration BREF shows that the average concentration recorded from UK plants equipped with bag filters was 1.6 µg/Nm^3 (or 8% of the ELV of 0.02 mg/Nm^3), the highest recorded concentration of cadmium and thallium was 14 µg/Nm^3 (or 70% of the ELV of 0.02 mg/Nm^3) and only three lines recorded concentrations higher than 10 µg/Nm^3 (or 50% of the ELV of 0.02 mg/Nm^3).

Table 36 within Annex A shows the annual mean cadmium PC at the identified sensitive human receptor locations, for cadmium emitted at 100%, 50% and 8% of the ELV, referred to as the ‘screening’, ‘worst case’ and ‘typical’ scenarios. PCs greater than 0.5% of the AQAL are highlighted. Figure 9 of Annex D shows the spatial distribution of emissions of cadmium for each of the scenarios. As shown, there are no areas exceeding 1% of the AQAL when it is assumed that cadmium is emitted at 8% of the combined cadmium and thallium emission limit (i.e. similar to a typical facility).

6.2.1 Half hourly ELVs

The impact of 15 min. means of sulphur dioxide if it assumed that the plant operates at the half-hourly ELV, is predicted to be 10.96% of the AQAL at the point of maximum impact.

This impact is based on the assumption that both lines are operating at the half hourly ELVs at the same time, during the worst-case weather conditions. This scenario is extremely unlikely. If just one line is operating at the half hourly ELVs, and the other at the daily ELV, the predicted impact at the point of maximum impact is reduced to 3.06% of the AQAL.

6.2.2 Particulate matter

As in section 2, the WHO recommends guidelines for particulate matter which are more stringent than those currently set in UK legislation. The Environment Bill introduces a duty to set a legally binding target for PM2.5s although to date this has not been set. For completeness, the maximum predicted impact of particulate matter has been compared to the WHO guidelines in Table 21. As shown, the maximum predicted impact is well within the 0.5% of the long term guideline and 10% of the short term guideline value from the WHO. This conservatively assumes that the entire dust emissions consist of only PM_{10} or $PM_{2.5s}$.

Table 21: Further Analysis of PM Impacts

Pollutant	WHO guideline (µg/m³)	Bg conc. (µg/m³)	PC at point of maximum impact		PEC (PC +Bg)	
			µg/m³	as % of AQAL	µg/m³	as % of AQAL
Annual mean						
PM_{10}	20	12.98	0.02	0.10%	13.00	65.00%
$PM_{2.5}$	10	8.79	0.02	0.21%	8.81	88.11%
Maximum daily mean						
PM_{10}	50	25.96	0.43	0.86%	26.39	52.78%
$PM_{2.5}$	25	17.58	0.43	1.73%	18.01	72.05%

6.2.3 Heavy metals – at the point of maximum impact

Table 22 and Table 23 detail the PC and PEC assuming that each metal is released at the combined metal ELVs respectively. If the PC is greater than 1% of the AQAL when it is assumed that each metal is emitted at the total metal ELV, further analysis has been undertaken assuming the release is no greater than the maximum monitored at an existing waste facility. The EA's metals guidance details the maximum monitored concentrations of group 3 metals emitted by Municipal Waste Incinerators and Waste Wood Co-Incinerators as a percentage of the group ELV. The maximum monitored emission presented in the EA's analysis has been used as a conservative assumption.

Table 22: Long-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Background conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Metals emitted as per EA maximum			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	3	1.10	1.25	41.76%	2.35	78.43%	8.3%	0.10	3.48%	1.20	40.15%
Antimony	5000	-	1.25	0.03%	-	-	3.8%	0.05	0.00%	-	-
Chromium	5000	39.00	1.25	0.03%	40.25	0.81%	30.7%	0.38	0.01%	39.38	0.79%
Chromium (VI)	0.2	7.80	1.25	626.4%	9.05	4526.4%	0.043%	0.00	0.27%	7.80	3900.27%
Cobalt	-	0.92	1.25	-	2.17	-	1.9%	0.02	-	0.94	-
Copper	10000	33.00	1.25	0.01%	34.25	0.34%	9.7%	0.12	0.001%	33.12	0.33%
Lead	250	16.00	1.25	0.50%	17.25	6.90%	16.8%	0.21	0.08%	16.21	6.48%
Manganese	150	36.00	1.25	0.84%	37.25	24.84%	20.0%	0.25	0.17%	36.25	24.17%
Nickel	20	14.00	1.25	6.26%	15.25	76.26%	73.3%	0.92	4.59%	14.92	74.59%
Vanadium	5000	1.70	1.25	0.03%	2.95	0.06%	2.0%	0.03	0.001%	1.73	0.03%

Notes:
(1) Metal as maximum percentage of the group 3 BAT-AEL, as detailed in EA metals guidance document (V.4) Table A1.

Table 23: Short-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Background conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Metals emitted no worse than a currently permitted facility			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	2.20	62.19	-	64.39	-	8.3%	0.00	-	7.38	-
Antimony	150,000	-	62.19	0.04%	-	-	3.8%	2.38	0.002%	-	-
Chromium	150,000	78.00	62.19	0.04%	140.19	0.09%	30.7%	19.07	0.01%	97.07	0.06%
Chromium (VI)	-	15.60	62.19	-	77.79	-	0.043%	0.03	-	15.63	-
Cobalt	-	1.84	62.19	-	64.03	-	1.9%	1.16	-	3.00	-
Copper	200,000	66.00	62.19	0.03%	128.19	0.06%	9.7%	6.01	0.003%	72.01	0.04%
Lead	-	32.00	62.19	-	94.19	-	16.8%	10.43	-	42.43	-
Manganese	1,500,000	72.00	62.19	0.00%	134.19	0.01%	20.0%	12.44	0.001%	84.44	0.006%
Nickel	-	28.00	62.19	-	90.19	-	73.3%	45.61	-	73.61	-
Vanadium	1,000	3.40	62.19	6.22%	65.59	6.56%	2.0%	1.24	0.124%	4.64	0.46%

Notes:
(1) Metal as maximum percentage of the group 3 BAT-AEL, as detailed in EA metals guidance document (V.4) Table A1.

As shown in Table 22 and Table 23, if it is assumed that the entire emissions of metals consist of only one metal, the impact is generally less than 1% of the long term and less than 10% of the short term AQAL, with the exception of annual mean impacts of arsenic, chromium (VI) and , nickel. The PEC is only predicted to exceed the long term AQAL for chromium (VI) using this worst-case screening assumption, and this is due to the high background concentrations. If it is assumed that the LSEP facility would perform no worse than a currently operating facility, the PC is below 1% of the long term and 10% of the short term AQAL for all pollutants with the exception of annual mean arsenic and nickel. The PEC is only predicted to exceed the long term AQAL for chromium (VI) and this is due to the high background concentrations, the PC is less than 1%.

6.3 Comparison to May 2011 ES

The results of the comparison model are presented in Table 24 and Table 25. It should be noted that the consented model which has been run for this comparison uses an updated version of ADMS and updated meteorological data, so the results will not exactly reflect those presented in the May 2011 ES.

Table 24: Dispersion Modelling Results – Comparison with May 2011 ES - Daily ELVs

Pollutant	Quantity	Units	AQAL	PC at point of maximum impact					
				May 2011 ES		LSEP facility with the Proposal		Change – i.e the Proposal	
				Max PC	as % of AQAL	Max PC	as % of AQAL	PC	as % of AQAL
Nitrogen dioxide	Annual mean	µg/m³	40	0.61	1.52%	0.53	1.31%	-0.08	-0.21%
	99.79th %ile of hourly means	µg/m³	200	10.61	5.30%	7.89	3.95%	-2.72	-1.35%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	2.59	2.07%	1.93	1.54%	-0.66	-0.53%
	99.73rd %ile of hourly means	µg/m³	350	7.46	2.13%	4.88	1.40%	-2.58	-0.73%
	99.9th %ile of 15 min. means	µg/m³	266	8.75	3.29%	5.83	2.19%	-2.92	-1.10%
PM10	Annual mean	µg/m³	40	0.04	0.11%	0.02	0.05%	-0.02	-0.06%
	90.41st %ile of daily means	µg/m³	50	0.18	0.36%	0.08	0.17%	-0.1	-0.19%
PM2.5	Annual mean	µg/m³	20	0.04	0.22%	0.02	0.10%	-0.02	-0.12%
Carbon monoxide	8 hour running mean	µg/m³	10,000	9.19	0.09%	8.61	0.09%	-0.58	0.00%
	Hourly mean	µg/m³	30,000	10.86	0.04%	10.36	0.03%	-0.5	-0.01%
Hydrogen chloride	Hourly mean	µg/m³	750	2.17	0.29%	0.03	0.00%	-2.14	-0.29%
Hydrogen fluoride	Annual mean	µg/m³	16	0.00	0.03%	0.00	0.03%	0	0.00%
	Hourly mean	µg/m³	160	0.22	0.14%	0.21	0.13%	-0.01	-0.01%
Ammonia	Annual mean	µg/m³	180	0.04	0.02%	0.04	0.02%	0	0.00%
	Hourly mean	µg/m³	2,500	2.17	0.09%	2.07	0.08%	-0.1	-0.01%
VOCs (as benzene)	Annual mean	µg/m³	5	0.04	0.87%	0.04	0.84%	0	-0.03%
	Hourly mean	µg/m³	195	2.17	1.11%	2.07	1.06%	-0.1	-0.05%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.04	1.93%	0.04	1.86%	0	-0.07%

Pollutant	Quantity	Units	AQAL	PC at point of maximum impact					
				May 2011 ES		LSEP facility with the Proposal		Change – i.e the Proposal	
				Max PC	as % of AQAL	Max PC	as % of AQAL	PC	as % of AQAL
Mercury	Annual mean	ng/m³	250	0.22	0.09%	0.08	0.03%	-0.14	-0.06%
	Hourly mean	ng/m³	7,500	10.86	0.14%	4.15	0.06%	-6.71	-0.08%
Cadmium	Annual mean	ng/m³	5	0.22	4.34%	0.08	1.67%	-0.14	-2.67%
	Hourly mean	ng/m³	-	10.86	-	4.15	-	-6.71	-!
PAHs	Annual mean	pg/m³	250	0.87	0.35%	0.84	0.33%	-0.03	-0.02%
Dioxins	Annual mean	fg/m³	-	0.43	-	0.33	-	-0.1	-
PCBs	Annual mean	ng/m³	200	0.02	0.01%	0.02	0.01%	0	0.00%
	Hourly mean	ng/m³	6,000	1.09	0.02%	1.04	0.02%	-0.05	0.00%
Other metals	Annual mean	ng/m³	-	2.61	-	1.25	-	-1.36	-
	Hourly mean	ng/m³	-	130.32	-	62.19	-	-68.13	-

Table 25: Dispersion Modelling Results – Comparison with May 2011 ES - Short Term ELVs

Pollutant	Quantity	Units	AQAL	PC at point of maximum impact					
				May 2011 ES		LSEP facility with the Proposal		Change – i.e the Proposal	
				Max PC	as % of AQAL	Max PC	as % of AQAL	PC	as % of AQAL
Nitrogen dioxide	99.79th %ile of hourly means	µg/m³	200	21.22	10.61%	17.54	8.77%	-3.68	-1.84%
Sulphur dioxide	99.73rd %ile of hourly means	µg/m³	350	29.83	8.52%	24.42	6.98%	-5.41	-1.54%
	99.9th %ile of 15 min. means	µg/m³	266	35.00	13.16%	29.15	10.96%	-5.85	-2.20%
Carbon monoxide	8 hour running mean	µg/m³	10000	18.38	0.18%	17.22	0.17%	-1.16	-0.01%
	Hourly mean	µg/m³	30000	21.72	0.07%	20.73	0.07%	-0.99	0.00%
Hydrogen chloride	Hourly mean	µg/m³	750	13.03	1.74%	12.44	1.66%	-0.59	-0.08%
Hydrogen fluoride	Hourly mean	µg/m³	160	0.87	0.54%	0.83	0.52%	-0.04	-0.02%
VOCs (as benzene)	Hourly mean	µg/m³	195	4.34	2.23%	4.15	2.13%	-0.19	-0.10%

The comparison model shows that the LSEP with the Proposal actually decreases predicted impacts when compared to the results based on the May 2011 ES, which was the latest air quality assessment undertaken. This is because the LSEP with the Proposal has been modelled using more accurate emissions data, as provided by the technology provider. The provided data has a lower volumetric flow rate than the May 2011 ES, meaning that less pollutant is emitted per second from the stack, and a higher exit velocity which means better buoyancy and better dispersion. Therefore, the impacts of the LSEP with the Proposal are lower than the current s36 consent.

7. Impact at Ecological Receptors

This section provides an assessment of the impact of emissions at the ecological receptors identified in Section 3.2.

7.1 Methodology

7.1.1 Atmospheric emissions - Critical Levels

The impact of emissions from the LSEP has been compared to the Critical Levels listed in Table 3 and the results are presented in Section 7.2.

For the purpose of the ecological assessment, the mapped background dataset from APIS has been used. If the PC is than 1% of the long-term or 10% of the short-term Critical Level further consideration will be made to the baseline concentrations.

7.1.2 Deposition of emissions - Critical Loads

In addition to the Critical Levels for the protection of ecosystems, habitat specific Critical Loads for nature conservation sites at risk from acidification and nitrogen deposition (eutrophication) are outlined in APIS.

An assessment has been made for each habitat feature identified in APIS for the specific site. The site specific features tool has been used to identify the feature habitats. The lowest Critical Loads for each designated site have been used to ensure a robust assessment. The impact has been assessed against these Critical Load functions. Where a Critical Load function for acid deposition is not available, the total nitrogen and sulphur deposition has been presented and compared with the background concentration.

APIS does not include site specific Critical Loads for locally designated sites. In lieu of this, the search by location function of APIS has been used to obtain Critical Loads based on the broad habitat type and location. The relevant Critical Loads are presented in Annex B [APIS Critical Loads].

If the impact of process emissions from the LSEP upon nitrogen or acid deposition is greater than 1% of the Critical Load, further assessment has been undertaken.

7.1.3 Calculation methodology – nitrogen deposition

The impact of deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG 6 (March 2014). The steps to this method are as follows.

1. Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.
2. Calculate the dry deposition flux ($\mu g/m^2/s$) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 26.
3. Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 26.
4. Compare this result to the nitrogen deposition Critical Load.

Table 26: Deposition Factors

Pollutant	Deposition velocity (m/s)		Conversion factor ($\mu g/m^2/s$ to kg/ha/year)
	Grassland	Woodland	
Nitrogen dioxide	0.0015	0.003	96.0
Sulphur dioxide	0.0120	0.024	157.7
Ammonia	0.0200	0.030	259.7
Hydrogen chloride	0.0250	0.060	306.7

Source: AQTAG 6 (March 2014)

7.1.3.1 Acidification

Deposition of nitrogen, sulphur, hydrogen chloride and ammonia can cause acidification and should be taken into consideration when assessing the impact of the LSEP facility with the Proposal.

The steps to determine the acid deposition flux are as follows.

1. Determine the dry deposition rate in kg/ha/yr of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined in Section 7.1.3.
2. Apply the conversion factor for N outlined in Table 26 to the nitrogen and ammonia deposition rate in kg/ha/year to determine the total keq N/ha/year.
3. Apply the conversion factor for S to the sulphur deposition rate in kg/ha/year to determine the total keq S/ha/year.
4. Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the dry keq Cl/ha/year.
5. Determine the wet deposition rate of HCl in kg/ha/yr by multiplying the model output by the factors presented in Table 27.
6. Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the wet keq Cl/ha/year.
7. Add the contribution from S to HCl dry and wet and treat this sum as the total contribution from S.
8. Plot the results against the Critical Load functions.

Table 27: Conversion Factors

Pollutant	Conversion factor (kg/ha/year to keq/ha/year)
Nitrogen	Divide by 14
Sulphur	Divide by 16
Hydrogen chloride	Divide by 35.5

Source: AQTAG (March 2014)

The March 2014 version of the AQTAG 6 document states that, for installations with an HCl emission, the PC of HCl, in addition to S and N, should be considered in the acidity Critical Load assessment. The H+ from HCl should be added to the S contribution (and treated as S in APIS tool). This should include the contribution of HCl from wet deposition.

Consultation with AQMAU confirmed that the maximum of the wet or dry deposition rate for HCl should be included in the calculation. For the purpose of this analysis it has been assumed that wet deposition of HCl is double dry deposition.

The contribution from the LSEP has been calculated using APIS formula:

Where PEC N Deposition < CLminN:

PC as % of CL function = PC S deposition / CLmaxS

Where PEC N Deposition > CLminN:

PC as % of CL function = (PC S + N deposition) / CLmaxN

7.2 Results – atmospheric emissions - Critical Levels

The impact of emissions from the operation of the LSEP has been compared to the Critical Levels. For the purpose of the ecological assessment, the mapped background dataset from APIS has been used. If the emissions of a particular pollutant are greater than 1% of the long-term or 10% of the short-term Critical Level, further assessment would be undertaken. The PC has been calculated based on the maximum predicted using all five years of weather data.

7.2.1 Results - designated ecological sites

The following tables present the results at the ecological sites. Where screening criteria have been exceeded the result is highlighted.

Table 28: Critical Level Summary – European and UK Designated Sites

Site ID	Site name	Site designation	Lichen Sensitive	Pollutant impacts as a % of CL					
				Annual mean NOx	Daily mean NOx	Annual mean SO_2	Daily mean HF	Weekly mean HF	Annual mean NH_3
Critical level (µg/m^3)				30	75*	10 / 20	0.5	5	1 / 3
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	Ramsar	Yes	0.4%	1.4%	0.3%	0.4%	0.1%	0.6%
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	Ramsar	Yes	0.6%	1.9%	0.4%	0.6%	0.2%	1.0%
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Ramsar	Yes	0.3%	1.5%	0.2%	0.7%	0.1%	0.4%
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Ramsar	Yes	0.2%	1.6%	0.1%	0.7%	0.1%	0.3%
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Ramsar	Yes	0.2%	1.3%	0.1%	0.5%	0.1%	0.4%
E6	Rostherne Mere	Ramsar	No	0.5%	1.6%	0.2%	0.5%	0.1%	0.3%
E7	Witton Lime Beds	SSSI	Yes	0.4%	4.8%	0.3%	1.5%	0.4%	0.7%
E8	Plumley Lime Beds	SSSI	Yes	1.2%	5.9%	0.8%	2.3%	0.5%	2.1%

Note:
Daily mean impacts have been compared to the Critical Level of 75 µg/m^3 as a screening noting that the Critical Level of 200 µg/m^3 is more appropriate.

Table 28 shows that at all European and UK designated sites, the PC is less than 1% of the Critical Level and can be screened out as 'insignificant' for all pollutants considered, with the exception of annual mean oxides of nitrogen and ammonia impacts at Plumley Lime Beds. This has been further assessed below. The significance of these results will be assessed by the project ecologist in Appendix E of the EP application.

7.2.1.1 Further assessment – Plumley Lime Beds SSSI

At the point of maximum impact across Plumley Lime Beds SSSI, the impacts of annual mean oxides of nitrogen ammonia emissions exceed the screening criteria.

For oxides of nitrogen, although the PC exceeds the screening criteria, when the background conditions are considered, the PEC is 51.0% of the Critical Level, and therefore is below the 70%. This is not the case for ammonia, due to high background levels of 4.24 ug/m^3. Figure 13 of Annex D shows that ammonia impact is over 2% of the Critical Level for just a small section to the west, however the impact across the entire site is greater than 1% of the Critical Level. Table 29 compares the impact of the LSEP (with the proposed throughput) to the results based on the May 2011 ES inputs, which was the latest air quality assessment undertaken. . As shown, the impact of LSEP with the Proposal is lower than the impact with the May 2011 ES inputs. This is due to the difference in model inputs from the May 2011 ES. The lower volumetric flow rate means less pollutant is emitted per second from the stack, and there is a higher exit velocity which means a better buoyancy and better dispersion. Therefore, the impacts of the LSEP with the Proposal are actually lower than those for the current s36 consent.

Table 29: Further Assessment – Plumley Lime Beds

Pollutant	May 2011 ES	LSEP with the Proposal	Change – i.e the Proposal
NOx (as a % of CL)	1.5%	1.2%	-0.3%
NH^3 (as a % of CL)	2.3%	2.1%	-0.2%

7.2.2 Results – local ecological sites

The results at local ecological sites are presented in Table 30. As shown, there are multiple sites at which the screening criteria is exceeded. Table 31 shows the PECs of oxides of nitrogen and sulphur dioxide impacts. It shows that when the baseline concentrations are considered, the PECs for oxides of nitrogen and sulphur dioxide impacts are all below 70%. This is not the case for ammonia due to high background levels. Table 32 compares the impact of the LSEP (with the proposed throughput) to results based on the May 2011 ES inputs, which was the latest air quality assessment undertaken. As shown, the impact of LSEP with the Proposal is lower than the impact with the May 2011 ES inputs. This is due to the difference in model inputs from the May 2011 ES. The lower volumetric flow rate means less pollutant is emitted per second from the stack, and there is a higher exit velocity which means a better buoyancy and better dispersion. Therefore, the impacts of the LSEP with the Proposal are actually lower than those for the current s36 consent.

The spatial distribution of impacts are shown in Figure 10 to Figure 14. They show that the area where the impact exceeds the screening threshold occur in area to the north and east of the LSEP, and to the south west. At some ecological sites, it is only a section of the site which is in exceedance of the screening criteria. At these sites, the locations of specific habitats and assessment of significance has been undertaken by the project ecologist and presented in Appendix E of the EP application.

Table 30: Critical Level Summary – Maximum over 5 Years

Site ID	Site name	PC as a % of CL								
		Annual mean					Weekly mean	Daily mean		
		NOx	SO2		NH3		HF	NOx		HF
Critical level (μg/m³)		**30**	**10***	**20**	**1***	**3**	**5**	**75**	**200**	**0.5**
E9	Ashton's and Neumann's Flashes	0.6%	0.4%	0.2%	0.9%	0.3%	0.5%	6.2%	2.3%	1.8%
E10	Gadbrok Valley	0.4%	0.3%	0.1%	0.7%	0.2%	0.9%	10.9%	4.1%	3.1%
E11	Griffiths Park	0.7%	0.5%	0.2%	1.2%	0.4%	0.7%	8.6%	3.2%	2.5%
E12	Long Wood	1.6%	1.1%	0.5%	2.6%	0.9%	0.6%	6.9%	2.6%	2.4%
E13	Marston Flashes	0.4%	0.3%	0.1%	0.7%	0.2%	0.5%	5.7%	2.1%	1.0%
E14	Wade Brook	1.5%	1.0%	0.5%	2.5%	0.8%	0.9%	10.3%	3.9%	2.8%
E15	Wincham Brook Valley and Mill Wood	2.4%	1.6%	0.8%	4.0%	1.3%	1.0%	12.5%	4.7%	3.6%
E16	Winnington Wood	1.5%	1.0%	0.5%	2.4%	0.8%	0.6%	6.8%	2.5%	1.8%
E17	River Dane	1.1%	0.7%	0.4%	1.8%	0.6%	0.8%	10.2%	3.8%	3.2%
E18	Marshall's Gorse	0.4%	0.3%	0.1%	0.7%	0.2%	0.6%	7.7%	2.9%	1.8%
E19	Rudheath Lime Beds	1.3%	0.9%	0.4%	2.2%	0.7%	1.0%	12.2%	4.6%	2.6%
E20	Lostock House Orchard	1.5%	1.0%	0.5%	2.6%	0.9%	0.6%	6.6%	2.5%	2.3%

Note:
* CL applicable where lichens are present.

Table 31: Locally Designated Sites - Further Assessment – Annual Mean PEC – NOx and SO_2

Site ID	Site name	NOx			SO_2		
		Bg (ug/m^3)	PC (as % of CL)	PEC (as % of CL)	Bg (ug/m^3)	PC (as % of CL)	PEC (as % of CL)
E9	Ashton's and Neumann's Flashes	15.36	0.6%	-	1.83	0.4%	-
E10	Gadbrok Valley	19.27	0.4%	-	1.83	0.3%	-
E11	Griffiths Park	15.00	0.7%	-	1.83	0.5%	-
E12	Long Wood	16.35	1.6%	56.1%	1.83	1.1%	19.4%
E13	Marston Flashes	15.11	0.4%	-	1.51	0.3%	-
E14	Wade Brook	15.64	1.5%	53.6%	1.83	1.0%	-
E15	Wincham Brook Valley and Mill Wood	15.64	2.4%	54.5%	1.83	1.6%	19.9%
E16	Winnington Wood	14.35	1.5%	49.3%	1.51	1.0%	-
E17	River Dane	14.65	1.1%	49.9%	1.83	0.7%	-
E18	Marshall's Gorse	17.03	0.4%	-	1.83	0.3%	-
E19	Rudheath Lime Beds	15.00	1.3%	51.3%	1.83	0.9%	-
E20	Lostock House Orchard	12.37	1.5%	42.8%	1.38	1.0%	14.8%

Note:
Has assumed lichens are present as a conservative assumption.

Table 32: Locally Designated Sites - Further Assessment – Annual Mean NH_3

Site ID	Site name	PC as % of CL for lichen sensitive communities			PC as % of CL for non-lichen sensitive communities		
		May 2011 ES	LSEP with the Proposal	Change – i.e the Proposal	May 2011 ES	LSEP with the Proposal	Change – i.e the Proposal
E9	Ashton's and Neumann's Flashes	1.0%	0.9%	-0.1%	0.3%	0.3%	0.0%
E10	Gadbrok Valley	0.8%	0.7%	-0.1%	0.3%	0.2%	0.0%
E11	Griffiths Park	1.5%	1.2%	-0.3%	0.5%	0.4%	-0.1%
E12	Long Wood	3.0%	2.6%	-0.4%	1.0%	0.9%	-0.1%
E13	Marston Flashes	0.8%	0.7%	-0.1%	0.3%	0.2%	0.0%
E14	Wade Brook	3.7%	2.5%	-1.2%	1.2%	0.8%	-0.4%
E15	Wincham Brook Valley and Mill Wood	4.1%	4.0%	-0.1%	1.4%	1.3%	-0.1%
E16	Winnington Wood	2.9%	2.4%	-0.5%	1.0%	0.8%	-0.1%
E17	River Dane	2.1%	1.8%	-0.3%	0.7%	0.6%	-0.1%
E18	Marshall's Gorse	0.7%	0.7%	0.0%	0.2%	0.2%	0.0%
E19	Rudheath Lime Beds	2.5%	2.2%	-0.3%	0.8%	0.7%	-0.1%
E20	Lostock House Orchard	2.7%	2.6%	-0.1%	0.9%	0.9%	-0.1%

7.3 Results - deposition of emissions - Critical Loads

Annex C [Deposition Analysis at Ecological Sites] presents the results at each of the identified designated ecological receptors. The contribution from the LSEP facility has been assessed against the most sensitive feature in each site.

As shown in Annex C, at all European designated sites, the PC is less than 1% of the Critical Load and can be screened out as 'insignificant', excluding Midland Meres and Misses Phase 2 receptor 1, at which Acid deposition (grassland) exceeds the 1% when using the minimum critical load for bogs.

For UK designated sites, the PC is less than 1% of the Critical Load and can be screened out as 'insignificant', excluding for nitrogen deposition and acid deposition for Broadleaved woodlands at Plumley Lime Beds.

For the local sites, there are multiple sites at which the screening criteria is exceeded, for both nitrogen and acid deposition.

As for other pollutants the results are less for the LSEP facility with the Proposal than they are for the results based on the May 2011 ES inputs, which was the latest air quality assessment undertaken... This is because of the more accurate emissions data, as provided by the technology provider, which have been used for the model used to assess the LSEP scheme with the Proposal. A lower volumetric flow rate means less pollutant is emitted per second from the stack, and there is a higher exit velocity which means a better buoyancy and better dispersion. Therefore, the impacts of the LSEP facility with the Proposal are actually lower than the current s36 consent.

The deposition results are shown spatially in Figure 15 to Figure 18 Further assessment of the appropriate Critical Levels, the PEC and specific locations of habitats where appropriate is provided in Appendix E4 of the EP application.

Annexes

A Detailed Results Tables at Human Sensitive Receptors

Table 33: Annual Mean Nitrogen Dioxide Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.11	0.28%	17.16	42.90%
R2	0.23	0.57%	17.28	43.19%
R3	0.32	0.81%	17.37	43.44%
R4	0.37	0.92%	17.42	43.54%
R5	0.38	0.95%	17.43	43.58%
R6	0.27	0.66%	17.32	43.29%
R7	0.30	0.76%	17.35	43.38%
R8	0.45	1.13%	17.50	43.76%
R9	0.42	1.06%	17.47	43.69%
R10	0.23	0.58%	17.28	43.21%
R11	0.11	0.26%	17.16	42.89%
R12	0.02	0.05%	17.07	42.67%
R13	0.04	0.09%	17.09	42.72%
R14	0.14	0.35%	17.19	42.98%
R15	0.19	0.48%	17.24	43.10%
R16	0.16	0.41%	17.21	43.03%
R17	0.09	0.23%	17.14	42.85%
R18	0.10	0.24%	17.15	42.86%
R19	0.11	0.28%	17.16	42.90%
R20	0.10	0.25%	17.15	42.87%
R21	0.37	0.92%	17.42	43.54%
R22	0.36	0.90%	17.41	43.52%
R23	0.17	0.42%	17.22	43.04%
R24	0.15	0.39%	17.20	43.01%
R25	0.11	0.28%	17.16	42.91%
R26	0.10	0.24%	17.15	42.86%
R27	0.32	0.80%	17.37	43.43%
R28	0.36	0.91%	17.41	43.53%
R29	0.15	0.37%	17.20	43.00%

Notes:
PEC includes of baseline concentration of 17.05 µg/m³

Table 34: Annual Mean VOC as benzene impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	ng/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.01	0.18%	0.57	11.38%
R2	0.02	0.36%	0.58	11.56%
R3	0.03	0.52%	0.59	11.72%
R4	0.03	0.58%	0.59	11.78%
R5	0.03	0.60%	0.59	11.80%
R6	0.02	0.42%	0.58	11.62%
R7	0.02	0.48%	0.58	11.68%
R8	0.04	0.72%	0.60	11.92%
R9	0.03	0.67%	0.59	11.87%
R10	0.02	0.37%	0.58	11.57%
R11	0.01	0.17%	0.57	11.37%
R12	<0.01	0.03%	0.56	11.23%
R13	<0.01	0.06%	0.56	11.26%
R14	0.01	0.22%	0.57	11.42%
R15	0.02	0.30%	0.58	11.50%
R16	0.01	0.26%	0.57	11.46%
R17	0.01	0.15%	0.57	11.35%
R18	0.01	0.15%	0.57	11.35%
R19	0.01	0.18%	0.57	11.38%
R20	0.01	0.16%	0.57	11.36%
R21	0.03	0.58%	0.59	11.78%
R22	0.03	0.57%	0.59	11.77%
R23	0.01	0.26%	0.57	11.46%
R24	0.01	0.25%	0.57	11.45%
R25	0.01	0.18%	0.57	11.38%
R26	0.01	0.15%	0.57	11.35%
R27	0.03	0.51%	0.59	11.71%
R28	0.03	0.58%	0.59	11.78%
R29	0.01	0.24%	0.57	11.44%

Notes:
PEC includes of baseline concentration of 0.56 µg/m³

Table 35: Annual Mean VOC as 1,3-butadiene Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	ng/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.01	0.39%	0.26	11.51%
R2	0.02	0.80%	0.27	11.91%
R3	0.03	1.15%	0.28	12.26%
R4	0.03	1.30%	0.28	12.41%
R5	0.03	1.34%	0.28	12.45%
R6	0.02	0.94%	0.27	12.05%
R7	0.02	1.07%	0.27	12.18%
R8	0.04	1.60%	0.29	12.71%
R9	0.03	1.50%	0.28	12.61%
R10	0.02	0.82%	0.27	11.93%
R11	0.01	0.37%	0.26	11.48%
R12	<0.01	0.07%	0.25	11.18%
R13	<0.01	0.13%	0.25	11.24%
R14	0.01	0.49%	0.26	11.61%
R15	0.02	0.67%	0.27	11.79%
R16	0.01	0.57%	0.26	11.68%
R17	0.01	0.32%	0.26	11.43%
R18	0.01	0.34%	0.26	11.45%
R19	0.01	0.39%	0.26	11.50%
R20	0.01	0.35%	0.26	11.46%
R21	0.03	1.30%	0.28	12.41%
R22	0.03	1.27%	0.28	12.38%
R23	0.01	0.59%	0.26	11.70%
R24	0.01	0.55%	0.26	11.66%
R25	0.01	0.40%	0.26	11.51%
R26	0.01	0.34%	0.26	11.45%
R27	0.03	1.14%	0.28	12.25%
R28	0.03	1.28%	0.28	12.39%
R29	0.01	0.52%	0.26	11.64%

Notes:
PEC includes of baseline concentration of 0.25 µg/m³

Table 36: Annual Mean Cadmium Impact at Identified Sensitive Receptors

Receptor	PC					
	Screening		Worst-case		Typical	
	ng/m³	% AQAL	ng/m³	% AQAL	ng/m³	% AQAL
R1	17.76	0.36%	8.88	0.18%	1.42	0.03%
R2	36.01	0.72%	18.01	0.36%	2.88	0.06%
R3	51.54	1.03%	25.77	0.52%	4.12	0.08%
R4	58.43	1.17%	29.22	0.58%	4.67	0.09%
R5	60.40	1.21%	30.20	0.60%	4.83	0.10%
R6	42.24	0.84%	21.12	0.42%	3.38	0.07%
R7	48.16	0.96%	24.08	0.48%	3.85	0.08%
R8	71.80	1.44%	35.90	0.72%	5.74	0.11%
R9	67.46	1.35%	33.73	0.67%	5.40	0.11%
R10	36.89	0.74%	18.44	0.37%	2.95	0.06%
R11	16.79	0.34%	8.39	0.17%	1.34	0.03%
R12	3.01	0.06%	1.51	0.03%	0.24	0.00%
R13	5.95	0.12%	2.98	0.06%	0.48	0.01%
R14	22.26	0.45%	11.13	0.22%	1.78	0.04%
R15	30.36	0.61%	15.18	0.30%	2.43	0.05%
R16	25.82	0.52%	12.91	0.26%	2.07	0.04%
R17	14.54	0.29%	7.27	0.15%	1.16	0.02%
R18	15.23	0.30%	7.61	0.15%	1.22	0.02%
R19	17.69	0.35%	8.84	0.18%	1.42	0.03%
R20	15.87	0.32%	7.94	0.16%	1.27	0.03%
R21	58.38	1.17%	29.19	0.58%	4.67	0.09%
R22	57.10	1.14%	28.55	0.57%	4.57	0.09%
R23	26.44	0.53%	13.22	0.26%	2.11	0.04%
R24	24.61	0.49%	12.30	0.25%	1.97	0.04%
R25	18.10	0.36%	9.05	0.18%	1.45	0.03%
R26	15.17	0.30%	7.58	0.15%	1.21	0.02%
R27	51.13	1.02%	25.56	0.51%	4.09	0.08%
R28	57.68	1.15%	28.84	0.58%	4.61	0.09%
R29	23.62	0.47%	11.81	0.24%	1.89	0.04%

B APIS Critical Loads

Table 37: Nitrogen Deposition Critical Loads

ID	Site	Species/Habitat Type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Maximum Background (kgN/ha/yr)
European designated sites						
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	Fens, marsh and swamp	Valley mires, poor fens and transition mires	10	15	23.66
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	Fens, marsh and swamp	Valley mires, poor fens and transition mires	10	15	23.80
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Oligotrophic waters	Permanent oligotrophic waters: Softwater lakes	5	10	15.60
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Oligotrophic waters	Permanent oligotrophic waters: Softwater lakes	5	10	15.60
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Oligotrophic waters	Permanent oligotrophic waters: Softwater lakes	5	10	15.60
E6	Rostherne Mere	Littoral Sediment	Pioneer, low-mid, mid-upper saltmarshes	20	30	14.20
UK designated sites						
E7	Witton Lime Beds	Calcareous grassland	Sub-atlantic semi-dry calcareous grassland	15	25	26.40
E8	Plumley Lime Beds	Broad-leaved mixed and yew woodland	Broadleaved deciduous woodland	10	20	52.80
		Calcareous grassland	Sub-atlantic semi-dry calcareous grassland	15	25	30.50

ID	Site	Species/Habitat Type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Maximum Background (kgN/ha/yr)
Locally designated sites						
E9	Ashton's and Neumann's Flashes	Fens, marsh and swamp	Valley mires, poor fens and transition mires	10	15	26.46
E10	Gadbrok Valley	Broad-leaved mixed and yew woodland	Broadleaved deciduous woodland	10	20	45.50
		Neutral Grassland	Low and medium altitude hay meadows	20	30	26.46
E11	Griffiths Park	Broad-leaved mixed and yew woodland	Broadleaved deciduous woodland	10	20	45.50
		Neutral Grassland	Low and medium altitude hay meadows	20	30	26.46
E12	Long Wood	Broad-leaved mixed and yew woodland	Broadleaved deciduous woodland	10	20	45.50
E13	Marston Flashes	Fens, marsh and swamp	Valley mires, poor fens and transition mires	10	15	25.76
E14	Wade Brook	Neutral Grassland	Low and medium altitude hay meadows	20	30	26.46
E15	Wincham Brook Valley and Mill Wood	Fens, marsh and swamp	Valley mires, poor fens and transition mires	10	15	26.46
E16	Winnington Wood	Broad-leaved mixed and yew woodland	Broadleaved deciduous woodland	10	20	43.40
E17	River Dane	Broad-leaved mixed and yew woodland	Broadleaved deciduous woodland	10	20	45.50
E18	Marshall's Gorse	Broad-leaved mixed and yew woodland	Broadleaved deciduous woodland	10	20	45.50

ID	Site	Species/Habitat Type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Maximum Background (kgN/ha/yr)
E19	Rudheath Lime Beds	Fens, marsh and swamp	Valley mires, poor fens and transition mires	10	15	26.46
E20	Lostock House Orchard	Neutral Grassland	Low and medium altitude hay meadows	20	30	30.52
		Broad-leaved mixed and yew woodland	Broadleaved deciduous woodland	10	20	52.92

Table 38: Acid Deposition Critical Loads

ID	Site	Species/Habitat Type	Acidity Class	Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
				CLminN	CLmaxN	CLmaxS	Nitrogen	Sulphur
European designated sites								
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	Fens, marsh and swamp	*Not sensitive to acidity*	-	-	-	1.69	0.21
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	Fens, marsh and swamp	*Not sensitive to acidity*	-	-	-	1.70	0.22
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Transition mires and quaking bogs	Bogs	0.321	0.54	0.219	1.80	0.20
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Transition mires and quaking bogs	Bogs	0.32	0.54	0.22	1.80	0.20
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Transition mires and quaking bogs	Bogs	0.32	0.54	0.22	1.80	0.20
E6	Rostherne Mere	Transition mires and quaking bogs	*Not sensitive to acidity*	-	-	-	1.00	0.20
UK designated sites								
E7	Witton Lime Beds	Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	1.90	0.20

ID	Site	Species/Habitat Type	Acidity Class	Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
				CLminN	CLmaxN	CLmaxS	Nitrogen	Sulphur
E8	Plumley Lime Beds	Broadleaved mixed and yew woodland	Unmanaged Broadleafed Coniferous Woodland	0.36	1.89	1.53	3.80	0.20
		Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	2.20	0.20
Locally designated sites								
E9	Ashton's and Neumann's Flashes	Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	1.89	0.21
E10	Gadbrok Valley	Broadleaved mixed and yew woodland	Unmanaged Broadleafed Coniferous Woodland	0.36	3.02	2.66	3.25	0.25
		Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	1.89	0.21
E11	Griffiths Park	Broadleaved mixed and yew woodland	Unmanaged Broadleafed Coniferous Woodland	0.36	1.90	1.54	3.25	0.25
		Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	1.89	0.21
E12	Long Wood	Broadleaved mixed and yew woodland	Unmanaged Broadleafed Coniferous Woodland	0.36	1.90	1.54	3.25	0.25
E13	Marston Flashes	Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	1.84	0.22
E14	Wade Brook	Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	1.89	0.21
E15	Wincham Brook Valley and Mill Wood	Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	1.89	0.21

ID	Site	Species/Habitat Type	Acidity Class	Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
				CLminN	CLmaxN	CLmaxS	Nitrogen	Sulphur
E16	Winnington Wood	Broadleaved mixed and yew woodland	Unmanaged Broadleafed Coniferous Woodland	0.36	1.87	1.51	3.10	0.26
E17	River Dane	Broadleaved mixed and yew woodland	Unmanaged Broadleafed Coniferous Woodland	0.38	1.90	1.54	3.25	0.25
E18	Marshall's Gorse	Broadleaved mixed and yew woodland	Unmanaged Broadleafed Coniferous Woodland	0.36	3.02	2.66	3.25	0.25
E19	Rudheath Lime Beds	Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	1.89	0.21
E20	Lostock House Orchard	Neutral Grassland	Calcareous grassland	1.07	5.07	4.00	2.18	0.21
E20	Lostock House Orchard	Broadleaved mixed and yew woodland	Unmanaged Broadleafed Coniferous Woodland	0.36	1.9	1.53	3.78	0.25

C Deposition Analysis at Ecological Sites

Table 39: Annual Mean PC used for Deposition Analysis

ID	Site	Annual mean PC (ng/m³)			
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	80.1	25.4	5.1	6.4
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	123.8	39.3	7.9	9.8
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	55.0	17.5	3.5	4.4
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	33.7	10.7	2.1	2.7
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	45.7	14.5	2.9	3.6
E6	Rostherne Mere	109.4	34.7	7.0	8.7
E7	Witton Lime Beds	92.1	29.3	5.9	7.3
E8	Plumley Lime Beds	262.1	83.2	16.7	20.8
E9	Ashton's and Neumann's Flashes	119.2	37.9	7.6	9.5
E10	Gadbrok Valley	92.2	29.3	5.9	7.3
E11	Griffiths Park	150.8	47.9	9.6	12.0
E12	Long Wood	331.6	105.3	21.1	26.3
E13	Marston Flashes	88.5	28.1	5.6	7.0
E14	Wade Brook	312.5	99.2	19.9	24.8
E15	Wincham Brook Valley and Mill Wood	502.6	159.6	31.9	39.9

ID	Site	Annual mean PC (ng/m³)			
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia
E16	Winnington Wood	308.4	97.9	19.6	24.5
E17	River Dane	224.5	71.3	14.3	17.8
E18	Marshall's Gorse	85.4	27.1	5.4	6.8
E19	Rudheath Lime Beds	279.7	88.8	17.8	22.2
E20	Lostock House Orchard	323.9	102.8	20.6	25.7

Table 40: Deposition Calculation - Grassland

ID	Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	0.01	0.05	0.04	0.03	0.04	<0.01	0.01
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	0.02	0.07	0.06	0.05	0.07	<0.01	0.01
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	0.01	0.03	0.03	0.02	0.03	<0.01	<0.01
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	0.00	0.02	0.02	0.01	0.02	<0.01	<0.01
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	0.01	0.03	0.02	0.02	0.03	<0.01	<0.01
E6	Rostherne Mere	0.02	0.07	0.05	0.05	0.06	<0.01	<0.01
E7	Witton Lime Beds	0.01	0.06	0.04	0.04	0.05	<0.01	0.01
E8	Plumley Lime Beds	0.04	0.16	0.13	0.11	0.15	0.01	0.02
E9	Ashton’s and Neumann’s Flashes	0.02	0.07	0.06	0.05	0.07	<0.01	0.01
E10	Gadbrok Valley	0.01	0.06	0.04	0.04	0.05	<0.01	0.01
E11	Griffiths Park	0.02	0.09	0.07	0.06	0.08	0.01	0.01
E12	Long Wood	0.05	0.20	0.16	0.14	0.18	0.01	0.02
E13	Marston Flashes	0.01	0.05	0.04	0.04	0.05	<0.01	0.01
E14	Wade Brook	0.04	0.19	0.15	0.13	0.17	0.01	0.02
E15	Wincham Brook Valley and Mill Wood	0.07	0.30	0.24	0.21	0.28	0.02	0.03
E16	Winnington Wood	0.04	0.19	0.15	0.13	0.17	0.01	0.02

ID	Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E17	River Dane	0.03	0.13	0.11	0.09	0.12	0.01	0.01
E18	Marshall's Gorse	0.01	0.05	0.04	0.04	0.05	<0.01	0.01
E19	Rudheath Lime Beds	0.04	0.17	0.14	0.12	0.16	0.01	0.02
E20	Lostock House Orchard	0.05	0.19	0.16	0.13	0.18	0.01	0.02

Table 41: Deposition Calculation - Woodland

	Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	0.02	0.10	0.09	0.05	0.07	0.01	0.01
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	0.04	0.15	0.14	0.08	0.11	0.01	0.02
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	0.02	0.07	0.06	0.03	0.05	<0.01	0.01
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	0.01	0.04	0.04	0.02	0.03	<0.01	<0.01
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	0.01	0.05	0.05	0.03	0.04	<0.01	0.01
E6	Rostherne Mere	0.03	0.13	0.13	0.07	0.10	0.01	0.02
E7	Witton Lime Beds	0.03	0.11	0.11	0.06	0.08	0.01	0.01
E8	Plumley Lime Beds	0.08	0.31	0.31	0.16	0.24	0.02	0.04
E9	Ashton's and Neumann's Flashes	0.03	0.14	0.14	0.07	0.11	0.01	0.02
E10	Gadbrok Valley	0.03	0.11	0.11	0.06	0.08	0.01	0.01
E11	Griffiths Park	0.04	0.18	0.18	0.09	0.14	0.01	0.02
E12	Long Wood	0.10	0.40	0.39	0.21	0.30	0.02	0.05
E13	Marston Flashes	0.03	0.11	0.10	0.05	0.08	0.01	0.01
E14	Wade Brook	0.09	0.38	0.37	0.19	0.28	0.02	0.04
E15	Wincham Brook Valley and Mill Wood	0.14	0.60	0.59	0.31	0.46	0.03	0.07
E16	Winnington Wood	0.09	0.37	0.36	0.19	0.28	0.02	0.04

	Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E17	River Dane	0.06	0.27	0.26	0.14	0.20	0.01	0.03
E18	Marshall's Gorse	0.02	0.10	0.10	0.05	0.08	0.01	0.01
E19	Rudheath Lime Beds	0.08	0.34	0.33	0.17	0.25	0.02	0.04
E20	Lostock House Orchard	0.09	0.39	0.38	0.20	0.29	0.02	0.05

Table 42: Detailed Results – Nitrogen Deposition

ID	Site name	NCL Class	Site designation	Lower CL	Upper CL	Background	PC impacts as a % of CL		PEC	
							% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
European designated sites										
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	Valley mires, poor fens and transition mires	Ramsar	10	15	23.66	0.4%	0.3%	237.0%	158.0%
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	Valley mires, poor fens and transition mires	Ramsar	10	15	23.80	0.7%	0.5%	238.7%	159.1%
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Permanent oligotrophic waters: Softwater lakes	Ramsar	5	10	15.60	0.6%	0.3%	312.6%	156.3%
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Permanent oligotrophic waters: Softwater lakes	Ramsar	5	10	15.60	0.4%	0.2%	312.4%	156.2%
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Permanent oligotrophic waters: Softwater lakes	Ramsar	5	10	15.60	0.5%	0.3%	312.5%	156.3%
E6	Rostherne Mere	Pioneer, low-mid, mid-upper saltmarshes	Ramsar	20	30	14.20	0.3%	0.2%	71.3%	47.5%
UK designated sites										
E7	Witton Lime Beds	Sub-Atlantic semi-dry calcareous grassland	SSSI	15	25	26.40	0.3%	0.2%	176.3%	105.8%

ID	Site name	NCL Class	Site designation	Lower CL	Upper CL	Background	PC impacts as a % of CL		PEC	
							% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
E8	Plumley Lime Beds	Broadleaved deciduous woodland	SSSI	10	20	52.80	2.4%	1.2%	530.4%	265.2%
E8	Plumley Lime Beds	Sub-Atlantic semi-dry calcareous grassland	SSSI	15	25	30.50	1.0%	0.6%	204.3%	122.6%
Locally Designated Sites										
E9	Ashton's and Neumann's Flashes	Valley mires, poor fens and transition mires	LWS	10	15	26.46	0.7%	0.4%	265.3%	176.8%
E10	Gadbrok Valley	Broadleaved deciduous woodland	LWS	10	20	45.50	0.8%	0.4%	455.8%	227.9%
E10	Gadbrok Valley	Low and medium altitude hay meadows	LWS	20	30	26.46	0.3%	0.2%	132.6%	88.4%
E11	Griffiths Park	Broadleaved deciduous woodland	LWS	10	20	45.50	1.4%	0.7%	456.4%	228.2%
E11	Griffiths Park	Low and medium altitude hay meadows	LWS	20	30	26.46	0.4%	0.3%	132.7%	88.5%
E12	Long Wood	Broadleaved deciduous woodland	LWS	10	20	45.50	3.0%	1.5%	458.0%	229.0%
E13	Marston Flashes	Valley mires, poor fens and transition mires	LWS	10	15	25.76	0.5%	0.3%	258.1%	172.1%
E14	Wade Brook	Low and medium altitude hay meadows	LWS	20	30	26.46	0.9%	0.6%	133.2%	88.8%
E15	Wincham Brook Valley and Mill Wood	Valley mires, poor fens and transition mires	LWS	10	15	26.46	2.8%	1.9%	267.4%	178.3%

ID	Site name	NCL Class	Site designation	Lower CL	Upper CL	Background	PC impacts as a % of CL		PEC	
							% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
E16	Winnington Wood	Broadleaved deciduous woodland	AW	10	20	43.40	2.8%	1.4%	436.8%	218.4%
E17	River Dane	Broadleaved deciduous woodland	pLWS	10	20	45.50	2.0%	1.0%	457.0%	228.5%
E18	Marshall's Gorse	Broadleaved deciduous woodland	pLWS	10	20	45.50	0.8%	0.4%	455.8%	227.9%
E19	Rudheath Lime Beds	Valley mires, poor fens and transition mires	pLWS	10	15	26.46	1.6%	1.0%	266.2%	177.4%
E20	Lostock House Orchard	Low and medium altitude hay meadows	pLWS	20	30	30.52	0.9%	0.6%	153.5%	102.3%
E20	Lostock House Orchard	Broadleaved deciduous woodland	pLWS	10	20	52.92	2.9%	1.5%	532.1%	266.1%

Table 43: Detailed Results – Acid Deposition

Site ID	Site name	Acidity Class	Site designation	Background N	Background S	PC impacts as a % of Min CL Function	PEC as a % of Min CL Function
E1	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI)	Not sensitive to acidity	Ramsar	1.69	0.21	-	-
E2	Midland Meres and Mosses – Phase 1 (also the Mere Mere SSSI and Tatton Meres SSSI) 2	Not sensitive to acidity	Ramsar	1.70	0.22	-	-
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Bogs	Ramsar	1.80	0.20	1.1%	371.4%
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Bogs	Ramsar	1.80	0.20	0.7%	371.0%
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Bogs	Ramsar	1.80	0.20	0.9%	371.3%
E6	Rostherne Mere	Not sensitive to acidity	Ramsar	1.00	0.20	-	-
E7	Witton Lime Beds	Calcareous grassland	SSSI	1.90	0.20	0.2%	41.6%
E8	Plumley Lime Beds	Unmanaged Broadleafed Coniferous Woodland	SSSI	3.80	0.20	2.9%	214.9%
E8	Plumley Lime Beds	Calcareous grassland	SSSI	2.20	0.20	0.5%	47.9%
E9	Ashton's and Neumann's Flashes	Not sensitive to acidity	LWS	1.89	0.21	-	-
E9	Ashton's and Neumann's Flashes	Calcareous grassland	LWS	1.89	0.21	0.2%	41.7%

Site ID	Site name	Acidity Class	Site designation	Background		PC impacts as a % of Min CL Function	PEC as a % of Min CL Function
				N	S		
E10	Gadbrok Valley	Unmanaged Broadleafed Coniferous Woodland	LWS	3.25	0.25	0.6%	116.6%
E10	Gadbrok Valley	Calcareous grassland	LWS	1.89	0.21	0.2%	41.6%
E11	Griffiths Park	Unmanaged Broadleafed Coniferous Woodland	LWS	3.25	0.25	1.6%	186.1%
E11	Griffiths Park	Calcareous grassland	LWS	1.89	0.21	0.3%	41.7%
E12	Long Wood	Unmanaged Broadleafed Coniferous Woodland	LWS	3.25	0.25	3.6%	188.1%
E13	Marston Flashes	Calcareous grassland	LWS	1.84	0.22	0.2%	40.8%
E14	Wade Brook	Calcareous grassland	LWS	1.89	0.21	0.6%	42.1%
E15	Wincham Brook Valley and Mill Wood	Calcareous grassland	LWS	1.89	0.21	1.0%	42.5%
E16	Winnington Wood	Unmanaged Broadleafed Coniferous Woodland	AW	3.10	0.26	3.4%	183.0%
E17	River Dane	Unmanaged Broadleafed Coniferous Woodland	pLWS	3.25	0.25	2.4%	186.9%
E18	Marshall's Gorse	Unmanaged Broadleafed Coniferous Woodland	pLWS	3.25	0.25	0.6%	116.7%
E19	Rudheath Lime Beds	Calcareous grassland	pLWS	1.89	0.21	0.6%	42.0%

Site ID	Site name	Acidity Class	Site designation	Background		PC impacts as a % of Min CL Function	PEC as a % of Min CL Function
				N	S		
E20	Lostock House Orchard	Calcareous grassland	pLWS	2.18	0.21	0.7%	47.8%
E20	Lostock House Orchard	Unmanaged Broadleafed Coniferous Woodland	pLWS	3.78	0.25	3.5%	217.3%

D Figures

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