On behalf of
MEG Derby Limited.

Intended for
MEG Derby Limited.

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Project Number
1620011104

MEG DERBY
AIR QUALITY MODELLING REPORT

RAMBOLL

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EXECUTIVE SUMMARY

Ramboll UK Ltd (Ramboll) has been commissioned by MEG Derby Ltd to undertake air dispersion modelling in support of an Environmental Permit application incorporating the operation of a gas fired boiler.

This report sets out the method and results of the dispersion modelling; broadly the scope of the air quality assessment includes:

- Review of local air quality data surrounding the Site;
- Desk study of the building arrangements and locations of human and ecological receptors sensitive to a change in local air quality resulting from the boiler emissions; and
- ADMS dispersion modelling of the operational plant emissions to predict process contributions (PCs) and Predicted Environmental Concentrations (PECs) at identified sensitive receptors for comparison against relevant ambient assessment levels.

The modelling assessment has been undertaken on a conservative basis of the boiler operating all year round. The maximum predicted impacts for any of the five years' worth of meteorological data modelled have been reported. Overall, the predicted impacts are considered to be conservative and worst case. As the equipment is gas fired, only emissions of NO_x have been modelled.

Impacts have been predicted at a number of human health and at non-designated ecological receptor locations in the vicinity of the site as there are no designated sites within Environment Agency screening distances.

With the boiler operational all year round, all of the PCs are either insignificant or the long-term PECs are less than 30% of the environmental assessment level at the human health receptor locations. The maximum predicted NO_x PCs at the non-designated sites are insignificant for long term and short term NO_x conentrations and nitrogen deposition assuming woodland habitats.

1. INTRODUCTION

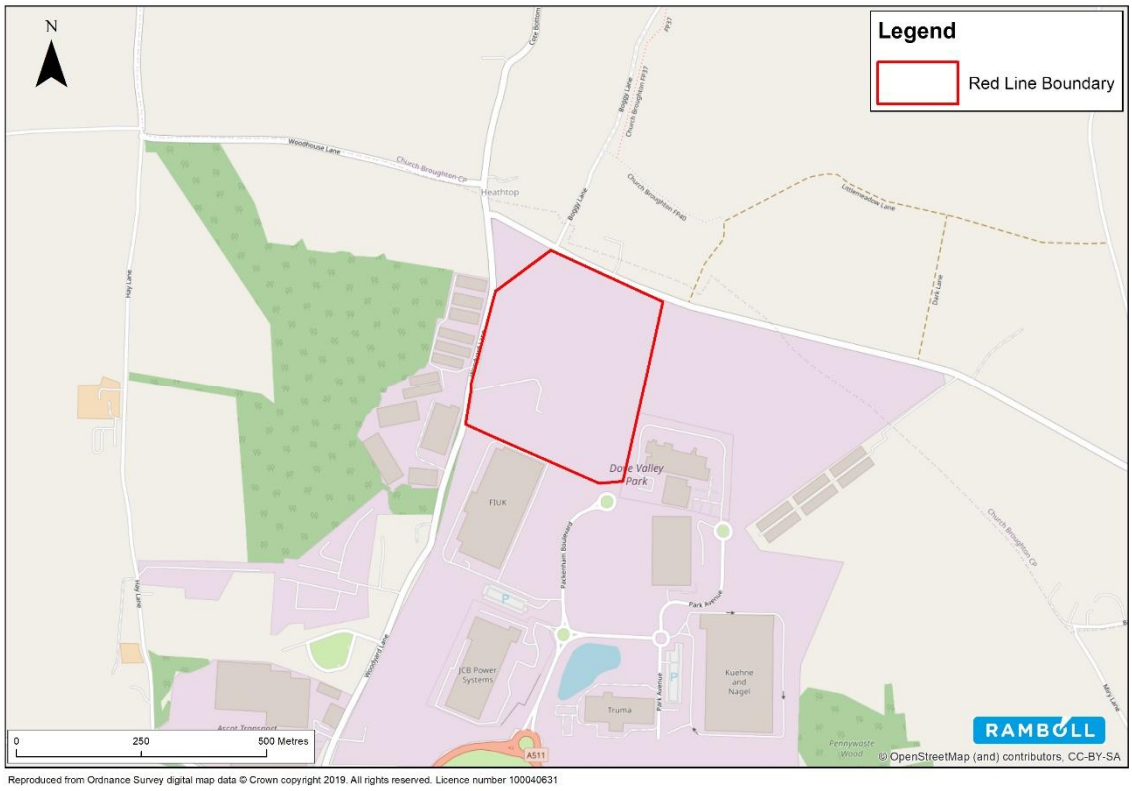
Ramboll UK Ltd (Ramboll) has been commissioned by MEG Derby Ltd ('the client'), to undertake air dispersion modelling in support of an Environmental Permit application at the Lidl site at Dove Valley Park.

This report sets out the method and results of the dispersion modelling used to assess the air quality impacts of the plant.

1.1 Site Description

The site location is shown in Figure 1.1.

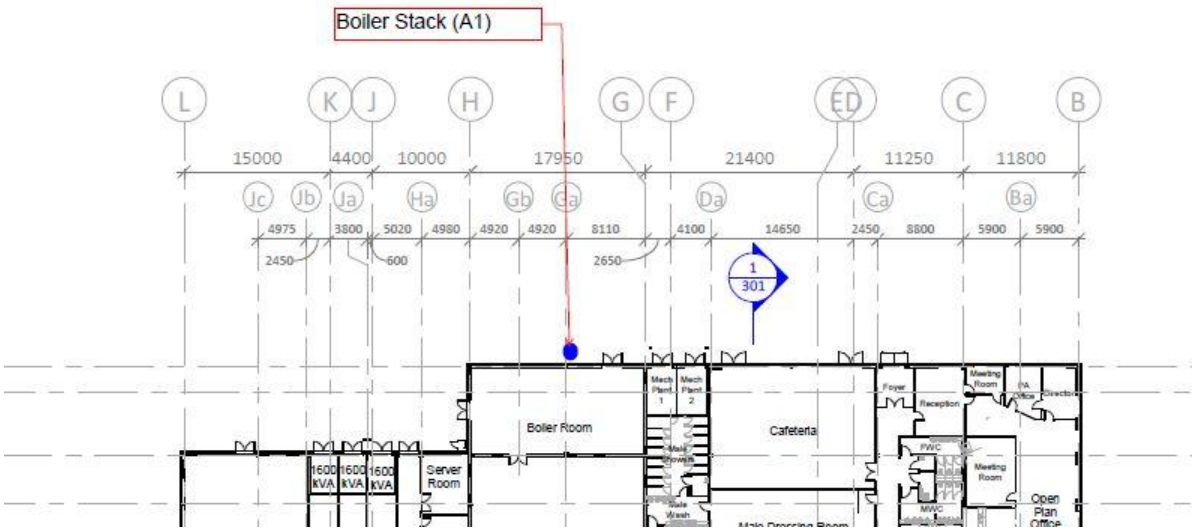
Figure 1.1: Site Location



The site is not located within an Air Quality Management Area (AQMA).

The boiler plant emission point is located to the north of the main processing building, as shown in Figure 1.2.

Figure 1.2: Emission point location



1.2 Scope

The permit application concerns the operation of a 2.25MWth gas fired boiler.

As the boiler is natural gas fired, the pollutant of concern is oxides of nitrogen (NO_x). Natural gas has negligible sulphur content and therefore emissions of sulphur dioxide are considered to be negligible and are not incorporated into the model.

Relevant human health receptors have been identified in the vicinity of the site and impacts have been assessed at specific receptor locations closest to the site. There are no SACs, SPAs within 10km or SSSIs within 2km of the site. The assessed ecological receptors are those identified in the Preliminary Ecological Appraisal undertaken by Middlemarch Environmental[1]:

- Pennywaste Wood Local Wildlife Site (LWS)
- The Coppice LWS
- Conneygree and Rough Woods LWS
- Church Broughton Churchyard Proposed LWS (pLWS)
- Little Meadow Lane pLWS
- Boggy Lane pLWS

[1] Project William, Dove Valley Park, Foston. Preliminary Ecological Appraisal. RT-MME-150467 Rev 1. October 2019

2. METHODOLOGY

2.1 Introduction

The scope of the assessment has been determined by consideration of the following:

- Review of local air quality data for the including Defra background maps and information on the Air Pollution Information System (APIS) website;
- Desk study of the building arrangements and locations of human and ecological receptors sensitive to a change in local air quality resulting from the boiler emissions;
- ADMS dispersion models with operational energy centre emissions to predict process contributions (PCs) and Predicted Environmental Concentrations (PECs) as required at identified sensitive receptors for comparison against relevant assessment levels and loads.

2.2 Air Quality Strategy Objectives

The long-term and short-term National Air Quality Objectives (NAQOs) that are applicable to this assessment are detailed below in Table 2.1.

Table 2.1: National Air Quality Objectives

Pollutant	Concentration ($\mu g/m^3$)	Averaging Period	NAQO Exceedances Allowed	Percentiles
Human Health Impacts				
Nitrogen dioxide (NO_2)	200	One hour mean	18	99.79
Nitrogen dioxide (NO_2)	40	Annual mean	-	-
Ecological receptors				
Oxides of nitrogen (NO_x)	30	Annual mean	-	-

Recent guidance produced by the Institute of Air Quality Management (IAQM)[2] provides an explanation of the reasoning behind setting of the annual mean NO_x objective for the protection of ecosystems (paragraphs D.4.8 to D.4.10):

> *'The critical level does not differentiate between the role of nitrogen deposition and NO_x in the air. It is a precautionary general threshold, not specific to a particular habitat, plant species or impact pathway, below which there is currently a high degree of confidence that no adverse effects on vegetation will arise. Long-term NO_x concentrations below the critical level are therefore desirable. Some species or habitats may not show adverse effects until higher concentrations are present.*
>
> *The long-term (annual mean) concentration of NO_x is most relevant for its impacts on vegetation, as the effects, particularly through the nitrogen deposition pathway, are additive over months and years. This is reflected in the adoption of the long-term guideline in the EU Air Quality Directive as a limit value for vegetation. However,*

[2] A guide to the assessment of air quality impacts on designated nature conservation sites, D.4.9, v1.0 June 2019

atmospheric exposure to very high concentrations of NO_x for short periods (hours/days) may also have an adverse effect under certain conditions even if the long-term concentrations are below the limit value. The WHO guidelines include a short term (24-hour average) NO_x critical level of 75µg/m^3. Originally set at 200µg/m^3 as a four-hour mean, the more detailed CD-ROM version of the 2000 WHO guidelines comments: "Experimental evidence exists that the CLE decreases from around 200µg/m^3 to 75µg/m^3 when in-combination with O_3 or SO_2 at or above their critical levels. In the knowledge that short-term episodes of elevated NO_x concentrations are generally combined with elevated concentrations of O_3 or SO_2, 75µg/m^3 is proposed for the 24 h mean." Ozone and SO_2 concentrations are typically low in the UK compared to many other countries. If a regulator does require the use of the short term NO_x critical level, given the low UK SO_2 concentrations IAQM consider it is most appropriate to use 200µg/m^3 as the short term critical load.

The relative importance of the long-term mean compared to the short term mean is reflected in several studies which state that the 'UNECE Working Group on Effects strongly recommended the use of the annual mean value, as the long-term effects of NO_x are thought to be more significant than the short term effects'. This IAQM guidance, therefore, recommends that only the annual mean NO_x concentration is used in assessments unless specifically required by a regulator; for instance, as part of an industrial permit application where high, short term peaks in emissions, and consequent ambient concentrations, may occur.'

In terms of the assessment of the impacts of NO_x emissions for an Environmental Permit, the assessment is required to consider both the annual mean and daily mean concentrations. As the extract from the IAQM guidance makes clear however, compliance with the annual mean critical level is the more significant of the two parameters and is likely to be highly protective of vegetation in general.

In terms of the daily mean critical level, the published Environmental Assessment Level in EA guidance[3] is 75µg/m^3 and this is likely to be highly conservative in the context of UK O_3 and SO_2 concentrations, and a critical level of 200µg/m^3 is likely to be more appropriate. However, in order to be conservative, the results of the dispersion modelling are compared against the lower critical level of 75µg/m^3 in this assessment.

2.3 Critical Loads

2.3.1 Introduction

For the deposition of air pollutants critical loads have been set for different habitats. The Air Pollution Information System (APIS)[4] provides critical loads for nitrogen deposition (leading to eutrophication) and nitrogen acid deposition (leading to acidification) for different habitat types and specific site relevant critical loads for designated sites. For the assessment of deposition there are two deposition velocities that are used; one for 'short' habitats (i.e. grassland) and one for 'tall' habitats (i.e. woodland). The modelling has therefore considered the type of habitat likely to be present at the site in question.

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

[4] http://www.apis.ac.uk accessed March 2020

2.3.2 Critical loads for non-designated sites

For non-designated sites APIS does not provide critical loads. It is therefore proposed to use the critical loads for nitrogen deposition for broadleaved, mixed and yew woodland habitats listed on APIS as all of the local wildlife sites are woodland based. For nitrogen deposition this is 10kgN/ha/yr and for nitrogen acid deposition there are no critical loads on APIS.

2.4 Significance Criteria

2.4.1 Human Health Receptors

For Environmental Permitting, the process contribution (PC) is compared against the relevant environmental standard. PCs that meet both the following criteria can be screened out from further assessment:

- the short-term PC is less than 10% of the short-term environmental standard,
- the long-term PC is less than 1% of the long-term environmental standard.

Whilst intended to apply to screening assessments and the need to undertake dispersion modelling of emissions, the above criteria are commonly applied to the consideration of the impacts from dispersion modelling. Where the PCs do not screen out, the Predicted Environmental Concentration (PEC) must also be calculated. The PEC includes the background concentration and assesses the cumulative impact in relation to the environmental standard.

The following screening criteria are then applied to the PECs:

- the short-term PC is less than 20% of the short-term environmental standards minus twice the long-term background concentration,
- the long-term PEC is less than 70% of the long-term environmental standards.

Again, whilst these are screening criteria, they are commonly applied to the consideration of the results of modelling assessments.

2.4.2 Ecological Receptors

For non-designated sites such as ancient woodlands and LWS, then consideration is only given to the PC. If concentrations meet both of the following criteria, then the impacts are considered insignificant and no further assessment is necessary:

- the short-term PC is less than 100% of the short-term environmental standard.
- the long-term PC is less than 100% of the long-term environmental standard.

The guidance simply states that if the PC exceeds the screening criteria then detailed modelling must be undertaken.

3. DISPERSION MODELLING

3.1 Introduction

Air quality impacts were modelled using the ADMS5[5] air quality dispersion model. This uses representative meteorological data for the local area and plant emissions data to predict ambient concentrations of pollutants in the vicinity of the stack. Details of the ADMS 5 model set up are provided in Appendix 1 with an overview in the following sections.

3.2 Model Set Up

3.2.1 Emission Rates and Operating Hours

For dispersion modelling purposes it is assumed that the boiler plant will be operational all year round; this will over-estimate both the long-term and short-term concentrations as the equipment is only likely to operate for four months per year on average.

Emission rates and volumetric flowrates have been based on data provided by the client. The flue stack is 12m above ground level.

Table 3.1: Emission Data used in the Modelling

Equipment	Flowrate (Am^3/s)	Temp (°C)	Velocity (m/s)	Normalised Flowrate (Nm^3/s)	NO_x	
					mg/Nm^3	g/s
Ici Caldai 3000 kg/h 2259 kWth	1.00	120*	4.208	0.6944**	100	0.069

*Assumed emission temperature. **Assumed to be dry gas, 3% oxygen.

3.2.2 Meteorological Data

The modelling has used 5 years' worth of meteorological data for 2017-2021 from East Midlands Airport meteorological station which is located approximately 25km to the east of the site. The results from the year that gave the highest predicted concentrations have been reported in the assessment.

3.2.3 Receptor Locations

Annual mean and the 99.79th percentile of one hour mean NO_2 concentrations have been predicted at human health receptor locations in the vicinity of the development. In addition, specific receptor locations were chosen within each ecological habitat to represent the closest points to the site. All human health receptor concentrations were predicted at 1.5m and all ecological concentrations were predicted at ground level. The receptor locations are specified in Table 3.2 overleaf and are shown in Figure 3.1.

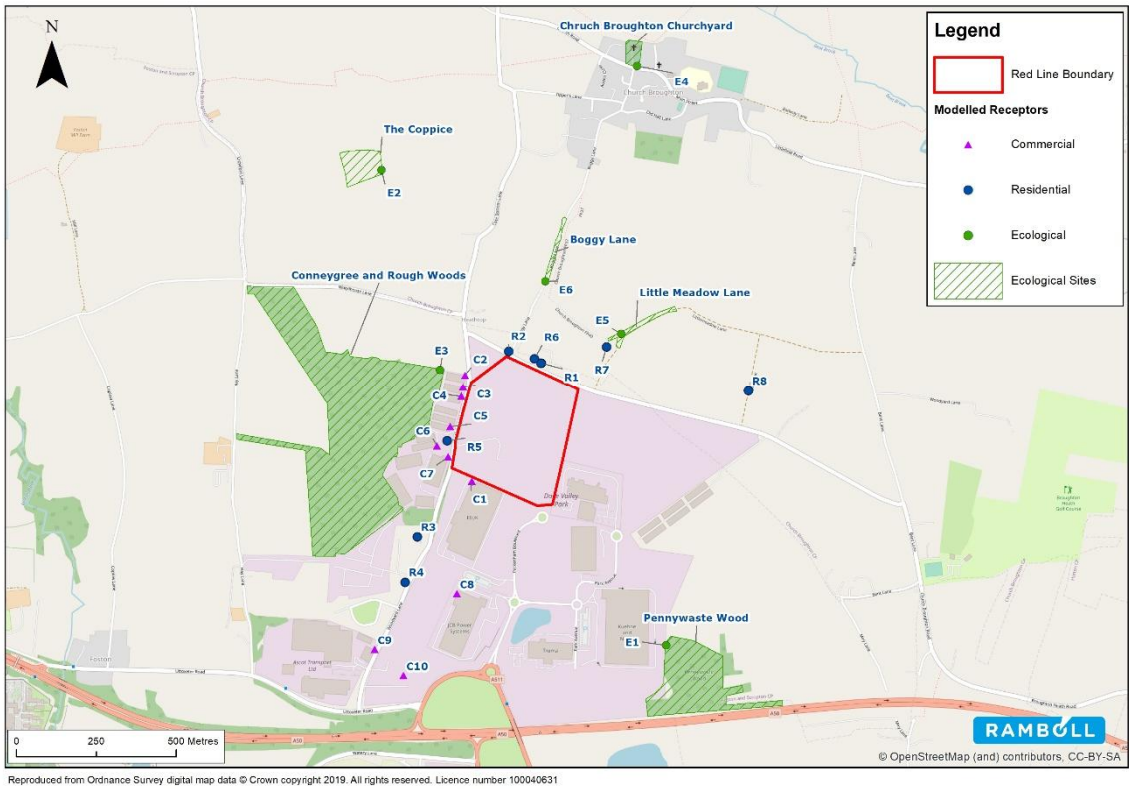
In addition to predicting concentrations at individual receptor locations, a grid of receptors was used to provide a visual interpretation of the dispersion of emissions. The receptor grid was

1,750 metres west to east and north to south approximately centred on the site, with a grid spacing of 17.5 metres.

Table 3.2: Receptor Locations

Designation	Type	Relevant Averaging Period		Grid Reference	
		Long-term	Short Term	x	y
R1	Residental	√	√	420247	332781
R2	Residental	√	√	420146	332818
R3	Residental	√	√	419860	332236
R4	Residental	√	√	419822	332095
R5	Residental	√	√	419953	332536
R6	Residental	√	√	420226	332794
R7	Residental	√	√	420246	332780
R8	Residental	√	√	420452	332831
R9	Residental	√	√	420895	332693
C1	Commercial	x	√	420030	332410
C2	Commercial	x	√	420009	332742
C3	Commercial	x	√	420003	332705
C4	Commercial	x	√	419997	332676
C5	Commercial	x	√	419963	332580
C6	Commercial	x	√	419921	332520
C7	Commercial	x	√	419956	332486
C8	Commercial	x	√	419984	332060
C9	Commercial	x	√	419727	331886
C10	Commercial	x	√	419817	331805
E1 Pennywaste Wood	LWS	√	√	420647	331910
E2 The Coppice	LWS	√	√	419748	333384
E3 Conneygree and Rough Woods	LWS	√	√	419931	332759
E4 Church Broughton Churchyard	pLWS	√	√	420547	333709
E5 Little Meadow Lane	pLWS	√	√	420497	332873
E6 Boggy Lane	pLWS	√	√	420260	333037

Figure 3.1: Receptor Locations



Nitrogen deposition has been calculated from the predicted annual mean NO_x concentrations by using a conversion factor of 0.7 to convert NO_x to NO_2. A deposition velocity of 3mm/s was used to convert NO_2 concentrations into a deposition flux for woodland habitats; and the results converted into kgN/ha/year in accordance with the AQTAG06 guidance[6].

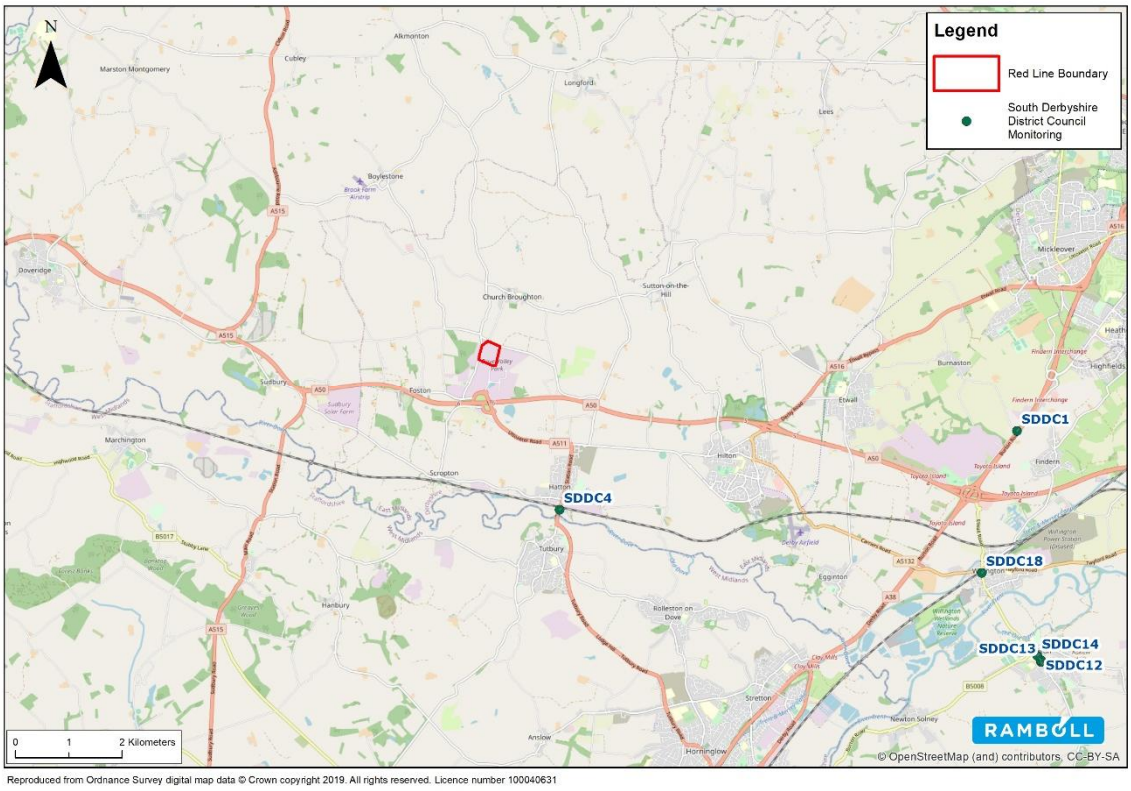
[6] AQTAG06 Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air. 20/4/10, v10

4. BASELINE

4.1 Local Monitoring Data

A review of the South Derbyshire Council monitoring data has been undertaken. The nearest nitrogen dioxide monitoring locations are shown in Figure 4.1

Figure 4.1: Monitoring Locations



The monitoring locations are all adjacent to the main road network and are not representative of the pollutant concentrations in the vicinity of the site.

4.2 Defra Background Map Data

The 2022 Defra predicted background concentrations for the grid squares covering the site and the receptor locations are shown in Table 4.1 below. These show relatively low NO_x and NO_2 concentrations as would be anticipated for the generally rural area.

Table 4.1: 2022 Background Concentrations (µg/m^3)

No	NO_x	NO_2
R1	-	9.2
R2	-	9.2
R3	-	7.3

No	NO_x	NO_2
R4	-	7.3
R5	-	7.3
R6	-	9.2
R7	-	9.2
R8	-	9.2
R9	-	9.2
C1	-	9.2
C2	-	9.2
C3	-	9.2
C4	-	7.3
C5	-	7.3
C6	-	7.3
C7	-	7.3
C8	-	7.3
C9	-	9.2
C10	-	9.2
E1 Pennywaste Wood	13.2	-
E2 The Coppice	8.4	-
E3 Conneygree and Rough Woods	9.3	-
E4 Church Broughton Churchyard	9.1	-
E5 Little Meadow Lane	12.0	-
E6 Boggy Lane	9.1	-

The Defra background concentrations represent modelled pollutant concentrations averaged across the relevant 1km grid square. There will be locally higher concentrations where receptors are located in close proximity to locally busy roads, but this is not the case for either the ecological or human health receptor locations in this study as the area is rural in nature. The Defra background concentrations are therefore likely to be representative of the baseline concentrations in this study area.

To assess the short-term PEC against the short-term air quality objectives, a baseline concentration of double the annual mean has been used.

5. RESULTS

5.1 Introduction

The modelling results in this section are the highest predicted concentrations and deposition from any of the five years' worth of meteorological data modelled except where noted. They represent the boiler operating at its ELV all year round and are therefore conservative. The results are presented for the relevant averaging period appropriate for the receptor, i.e. the annual mean concentrations are only presented at residential receptor locations.

The results are presented for the human health and ecological receptors separately.

5.2 Human Health Impacts

The maximum predicted PCs and PECs for the five years' worth of meteorological data modelled are shown in Tables 5.1 and 5.2.

Table 5.1: Predicted Annual Mean NO_2 Concentrations

Receptor	Baseline Concentration µg/m^3	PC µg/m^3	PC as % of the AQAL	PEC µg/m^3	PEC as a % of the AQAL
R1	9.2	1.96	4.9	11.2	27.9
R2	9.2	0.43	1.1	9.6	24.1
R3	7.3	0.04	0.1	7.3	18.4
R4	7.3	0.03	0.1	7.3	18.3
R5	7.3	0.15	0.4	7.4	18.6
R6	9.2	1.59	4.0	10.8	27.0
R7	9.2	1.99	5.0	11.2	28.0
R8	9.2	0.26	0.6	9.5	23.6
R9	9.2	0.06	0.1	9.3	23.1

The PCs reflect the location of the boiler stack and the proximity to residential receptors. For the residential properties to the north of the boiler stack the PC is above 1%. These results are for the boilers operating all year round and in reality they will operate for approximately equivalent to four months per year, and therefore the actual results will be approximately 1/3rd of the values in Table 5.1.

With the baseline concentration equal to the Defra background concentration, none of the PECs exceeds the air quality assessment level, with the maximum PEC only 28%. The Defra background concentration is likely to be representative of the baseline concentration as these receptors are located away from main roads.

A contour plot of the annual mean PC is shown in Appendix 2. The contour plots are derived from the maximum predicted concentration at each of the receptor grid points for any of the five years of meteorological data modelled, i.e. they are a composite of the individually annually modelled results.

Table 5.2: Predicted Hourly Mean 99.79th %ile NO_2 Concentrations

Receptor	PC µg / m^3	PC as % of the AQAL
R1	7.26	3.6
R2	4.08	2.0
R3	0.66	0.3
R4	0.55	0.3
R5	1.38	0.7
R6	4.99	2.5
R7	7.68	3.8
R8	1.39	0.7
R9	0.60	0.3
C1	1.17	0.6
C2	2.20	1.1
C3	2.06	1.0
C4	1.98	1.0
C5	1.59	0.8
C6	1.18	0.6
C7	1.11	0.6
C8	0.58	0.3
C9	0.44	0.2
C10	0.41	0.2

All of the hourly mean PCs are less than 10% of the assessment level and therefore insignificant in their own right.

5.3 Ecological Impacts

5.3.1 NO_x Concentrations

The maximum predicted NO_x concentrations within the habitats are shown in Tables 5.3 and 5.4.

Table 5.3: Maximum Annual Mean NO_x concentrations

Site	Critical Level (µg / m^3)	PC (µg / m^3)	% PC of Critical Level
E1 Pennywaste Wood	30	0.02	0.1
E2 The Coppice	30	0.03	0.1
E3 Conneygree and Rough Woods	30	0.11	0.4
E4 Church Broughton Churchyard	30	0.04	0.1
E5 Little Meadow Lane	30	0.26	0.9

Site	Critical Level ($\mu g / m^3$)	PC ($\mu g / m^3$)	% PC of Critical Level
E6 Boggy Lane	30	0.22	0.7

The maximum predicted annual mean NO_x concentrations are below 100% of the long-term critical level and are therefore insignificant at the LWS.

Table 5.4: Maximum Daily Mean NO_x concentrations

Site	Critical Level ($\mu g / m^3$)	PC ($\mu g / m^3$)	% PC of Critical Level
E1 Pennywaste Wood	75	0.54	0.7
E2 The Coppice	75	0.62	0.8
E3 Conneygree and Rough Woods	75	1.55	2.1
E4 Church Broughton Churchyard	75	0.34	0.4
E5 Little Meadow Lane	75	1.36	1.8
E6 Boggy Lane	75	1.29	1.7

The maximum predicted daily mean NO_x concentrations are well below 100% of the short-term critical level and are therefore insignificant at the LWS.

5.3.2 Nitrogen Deposition

The maximum predicted nitrogen deposition within the habitats is shown in Table 5.5 for woodland habitats.

Table 5.5: Maximum Nitrogen Deposition – Woodland Habitats

Site	Critical Load (kg/ha/yr)	PC (kg/ha/yr)	% PC of Critical Load
E1Pennywaste Wood	10	0.003	0.03
E2 The Coppice	10	0.005	0.05
E3 Conneygree and Rough Woods	10	0.022	0.22
E4 Church Broughton Churchyard	10	0.008	0.08
E5 Little Meadow Lane	10	0.052	0.52
E6 Boggy Lane	10	0.044	0.44

For woodlands habitats, the nitrogen deposition is well below 100% of the critical load assuming woodland habitats in each of the LWS and therefore insignificant.

5.4 Uncertainty

All of the predicted impacts are presented assuming that the boiler operates at full load all year road where-as in reality the anticipated annual operating hours will be equivalent to approximately 4 months per year. In addition, the maximum of any of the 5 years' worth of data are presented. As an example of the range of predicted impacts for the 5 years, the annual mean NO_2 concentrations at the residential receptor locations are shown in Table 5.6.

Table 5.6: Range of Predicted Annual Mean NO_2 concentrations ($\mu g/m^3$)

Site	2017	2018	2019	2020	2021	Average
R1	1.96	1.60	1.77	1.77	1.58	1.73
R2	0.37	0.40	0.43	0.38	0.34	0.38
R3	0.01	0.04	0.03	0.04	0.04	0.03
R4	0.01	0.02	0.02	0.03	0.03	0.02
R5	0.06	0.15	0.11	0.10	0.13	0.11
R6	1.37	1.32	1.42	1.59	1.31	1.40
R7	1.99	1.64	1.80	1.81	1.62	1.77
R8	0.26	0.19	0.20	0.23	0.20	0.22
R9	0.06	0.04	0.05	0.04	0.05	0.05

The long term average impacts are approximately 70-90% of the maximum impacts for any one year depending on the location of receptor.

6. CONCLUSIONS

An assessment of the impacts of emissions from the boiler plant at the Lidl Derby site has been carried out. The assessment has been undertaken assuming that the boiler operates all year round at the maximum ELV for NO_x of 100 mg/Nm^3. Overall, the predicted impacts are considered to be conservative and worst case.

Impacts have been predicted at a number of human health receptor locations in the vicinity of the site, both residential and office/recreational receptor locations. For the residential receptors, long-term and short-term impacts have been considered where-as for office/recreational receptors only short-term impacts have been considered.

Impacts have also been predicted at non-designated ecological receptor locations in the vicinity of the site as there are no designated sites within Environment Agency screening distances.

With the boiler operational all year round, all of the PCs are either insignificant or the long-term PECs are less than 30% of the environmental assessment level at the human health receptor locations. The maximum predicted NO_x PCs at the non-designated sites are insignificant for long term and short term NO_x concentrations and nitrogen deposition assuming woodland habitats.

APPENDIX 1
MODELLING SET UP

Stack Emissions Modelling Input Parameters

Parameter	
Modelled Stack Location	420205, 332729
Flue height (m)	12
Flue diameter (m)	0.55
Exit velocity (m/s)	4.208
Flue exit Temperature (°C)	120
Actual flue volumetric flow (Am^3/s)	1.00
Oxygen Concentration (%)	10.3
Water vapour content (%)	Dry
Normalised flue volumetric flow (Nm^3/s)	0.694
NO_x emission concentration (mg/Nm^3)	100
NO_x emission (g/s)	0.069

Operational Hours

For modelling purposes, the equipment is assumed to be operating continuously, 24 hours every day or 8,760 hours per year. Actual operating hours will be lower due to maintenance periods.

Special Treatments

Conversion ratios of 70% and 35% have been applied for the conversion of NO_X to NO_2 for annual and hourly mean concentrations in accordance with the *EA Conversion Ratios for NO_x and NO_2*[7].

Buildings Effects

Tall buildings can have a substantial impact on the dispersion of pollutants from stacks, as a result of building downwash i.e. pollutants being drawn down in the wake of a building, giving rise to high concentrations close to the base of the buildings. ADMS5 is able to take account of this

[7] Air Quality Modelling and Assessment Unit, available at file:///Z:/Modelling%20Data/Guidance/noxno2conv2005_1233043.pdf

potential impact by the inclusion of buildings in the model. The buildings included within the modelling are provided in the table below.

Buildings

New Delete

Main	Name	Shape	X (m)	Y (m)	Height (m)	Length / Diameter (m)	Width (m)	Angle (°)
✓	Building 1	Rectangular	420206.1	332712.05	11	29	91.8	20
	Building 2	Rectangular	420170.25	332631.14	11	147.75	80	20
	Warehouse	Rectangular	420114.58	332549.45	21	45	172.25	20

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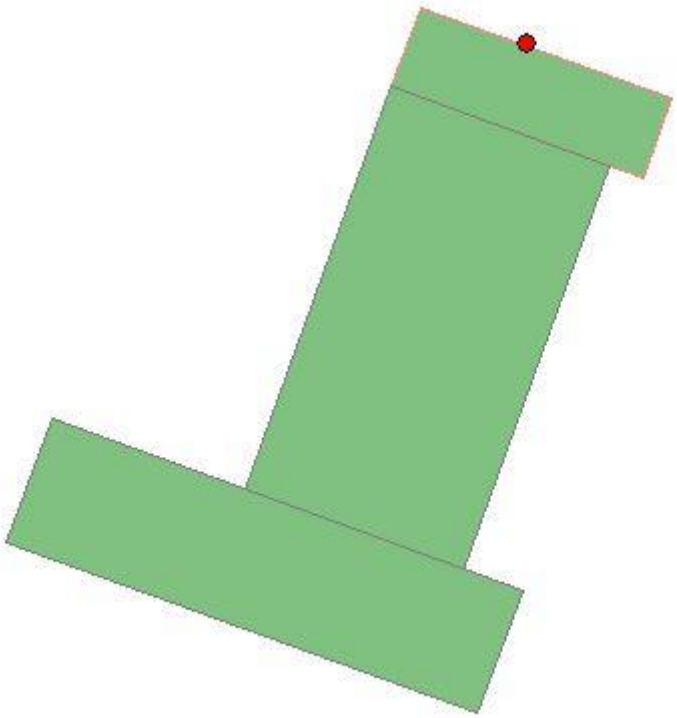

Terrain and Surface Roughness

Terrain was not included in the model as the area in the immediate vicinity of the site is relatively flat. The modelling adopts the maximum surface roughness value of 0.2m for the Site. The meteorological measurement site's surface roughness was set to 0.3m.

Met Data

2017 – 2021 East Midlands Airport hourly sequential meteorological data was used in the assessment.

APPENDIX 2
CONTOUR PLOTS