Air Quality Assessment

Arla Foods Settle

Client: EHS Projects Ltd

Reference: 2915r2

Date: 16th April 2020

Report Issue

Report Title: Air Quality Assessment - Arla Foods Settle

Report Reference: 2915

Report Version	Issue Date	Issued By	Comments
1	19th November 2019	Jethro Redmore	-
2	16th April 2020	Jethro Redmore	Updated boiler specification

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Executive Summary

Redmore Environmental Ltd was commissioned by EHS Projects Ltd to undertake an Air Quality Assessment in support of an Environmental Permit Variation Application for Arla Foods Settle, Sowarth Industrial Estate, Settle.

It is proposed to install a new boiler at the site to complement the existing energy plant. Associated atmospheric emissions have the potential to cause air quality impacts at sensitive locations. As such, an Air Quality Assessment was undertaken in order to determine baseline conditions and quantify potential effects.

Dispersion modelling was undertaken in order to predict pollutant concentrations at sensitive locations as a result of emissions from the boilers. The results indicated that impacts on pollutant concentrations were not predicted to be significant at any human receptor location in the vicinity of the site.

Impacts were also predicted at relevant ecological sites. The results indicated that emissions from the plant would not significantly affect existing conditions at any designation.

The modelling results were based on a worst-case assessment scenario of both boilers constantly operating throughout an entire year. As such, predicted pollutant concentrations are likely to overestimate actual impacts.

Table of Contents

1.0 INTRODUCTION

1.1 Background

1.1.1 Redmore Environmental Ltd was commissioned by EHS Projects Ltd to undertake an Air Quality Assessment in support of an Environmental Permit Variation Application for Arla Foods Settle, Sowarth Industrial Estate, Settle.

1.1.2 It is proposed to install a new boiler at the site to complement the existing energy plant. Associated atmospheric emissions have the potential to cause air quality impacts at sensitive locations. As such, an Air Quality Assessment was undertaken in order to determine baseline conditions and quantify potential effects.

1.2 Site Location and Context

1.2.1 The facility is located on land at Sowarth Industrial Estate, Settle, BD24 9AE, at National Grid Reference (NGR): 381430, 463535. Reference should be made to Figure 1 for a map of the site and surrounding area.

1.2.2 It is proposed to install a Liquified Petroleum Gas (LPG) fired boiler at the site. This will complement the existing natural gas fired boiler and provide additional steam for the site. The existing oil fired boiler will be decommissioned as part of the project.

1.2.3 Emissions from the facility have the potential to affect pollution levels at sensitive locations. An Air Quality Assessment was therefore undertaken to define baseline conditions, assess potential impacts and consider the significance of any predicted effects. The results are summarised in the following report.

2.0 LEGISLATION AND POLICY

2.1 European Directives

2.1.1 European Union (EU) air quality legislation is provided within Directive 2008/50/EC, which came into force on 11th June 2008. This Directive consolidated previous legislation which was designed to deal with specific pollutants in a consistent manner and provided new Air Quality Limit Values (AQLVs) for particulate matter with an aerodynamic diameter of less than 2.5µm. The consolidated Directives include:

- Directive 1999/30/EC - the First Air Quality "Daughter" Directive - sets ambient AQLVs for nitrogen dioxide (NO_2), oxides of nitrogen (NO_x), sulphur dioxide, lead and particulate matter with an aerodynamic diameter of less than 10µm;
- Directive 2000/69/EC - the Second Air Quality "Daughter" Directive - sets ambient AQLVs for benzene and carbon monoxide (CO); and,
- Directive 2002/3/EC - the Third Air Quality "Daughter" Directive - seeks to establish long-term objectives, target values, an alert threshold and an information threshold for concentrations of ozone in ambient air.

2.1.2 The fourth daughter Directive was not included within the consolidation and is described as:

- Directive 2004/107/EC - sets health-based limits on polycyclic aromatic hydrocarbons, cadmium, arsenic, nickel and mercury, for which there is a requirement to reduce exposure to as low as reasonably achievable.

2.2 UK Legislation

2.2.1 The Air Quality Standards Regulations (2010) came into force on 11th June 2010 and transposed EU Directive 2008/50/EC into UK law. AQLVs were published in these regulations for 7 pollutants, as well as Target Values for an additional 5 pollutants.

2.2.2 Part IV of the Environment Act (1995) requires UK government to produce a national Air Quality Strategy (AQS) which contains standards, objectives and measures for improving ambient air quality. The most recent AQS was produced by the Department for

Environment, Food and Rural Affairs (DEFRA) and published in July 2007[1]. The AQS sets out Air Quality Objectives (AQOs) that are maximum ambient pollutant concentrations that are not to be exceeded either without exception or with a permitted number of exceedences over a specified timescale. These are generally in line with the AQLVs, although the requirements for the determination of compliance vary.

2.2.3 Table 1 presents the AQOs for pollutants considered within this assessment.

Table 1 Air Quality Objectives

Pollutant	Air Quality Objective	
	Concentration (µg/m^3)	Averaging Period
NO_2	40	Annual mean
	200	1-hour mean, not to be exceeded on more than 18 occasions per annum
CO	10,000	8-hour running mean

2.3 Local Air Quality Management

2.3.1 Under Section 82 of the Environment Act (1995) (Part IV) Local Authorities are required to periodically review and assess air quality within their area of jurisdiction under the system of Local Air Quality Management (LAQM). This review and assessment of air quality involves comparing present and likely future pollutant concentrations against the AQOs. If it is predicted that levels at locations of relevant exposure are likely to be exceeded, the Local Authority is required to declare an Air Quality Management Area (AQMA). For each AQMA the LA is required to produce an Air Quality Action Plan, the objective of which is to reduce pollutant concentrations in pursuit of the AQOs.

2.4 Industrial Pollution Control Legislation

2.4.1 Atmospheric emissions from industry are controlled in England through the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments. The operations undertaken at the plant are included within the Regulations and as such the facility is required to obtain an Environmental Permit issued by the Environment Agency

[1] The AQS for England, Scotland, Wales and Northern Ireland, DEFRA, 2007.

(EA). Compliance with any conditions of the permit must be demonstrated through periodic monitoring requirements, which have been set in order to limit potential impacts in the surrounding area.

2.5 Critical Loads and Levels

2.5.1 A critical load is defined by the UK Air Pollution Information System (APIS)[2] as:

> "A quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. The exceedance of a critical load is defined as the atmospheric deposition of the pollutant above the critical load."

2.5.2 A critical level is defined as:

> "Threshold for direct effects of pollutant concentrations according to current knowledge. Exceedance of a critical level is defined as the atmospheric concentration of the pollutant above the critical level."

2.5.3 A critical load refers to deposition of a pollutant, while a critical level refers to pollutant concentrations in the atmosphere (which usually have direct effects on vegetation or human health).

2.5.4 When pollutant loads (or concentrations) exceed the critical load or level it is considered that there is a risk of harmful effects. The excess over the critical load or level is termed the exceedence. A larger exceedence is often considered to represent a greater risk of damage.

2.5.5 Maps of critical loads and levels and their exceedences have been used to show the potential extent of pollution damage and aid in developing strategies for reducing pollution. Decreasing deposition below the critical load is seen as means for preventing the risk of damage. However, even a decrease in the exceedence may infer that less damage will occur.

[2] UK Air Pollution Information System, www.apis.ac.uk.

2.5.6 Table 2 presents the critical levels for the protection of vegetation for pollutants considered within this assessment.

Table 2 Critical Levels for the Protection of Vegetation

Pollutant	Critical Level	
	Concentration (µg/m^3)	Averaging Period
NO_x	30	Annual mean
	75	24-hour mean

2.5.7 Critical loads have been designated within the UK based on the sensitivity of the receiving habitat and have been identified for the relevant designations considered within the assessment in Section 3.5.

3.0 BASELINE

3.1 Introduction

3.1.1 Existing air quality conditions in the vicinity of the site were identified in order to provide a baseline for assessment. These are detailed in the following Sections.

3.2 Local Air Quality Management

3.2.1 As required by the Environment Act (1995), Craven District Council (CDC) has undertaken Review and Assessment of air quality within their area of jurisdiction. This process has indicated that concentrations of all pollutants considered within the AQS are currently below the relevant AQOs. As such, no AQMAs have been designated within the district.

3.3 Air Quality Monitoring

3.3.1 Monitoring of pollutant concentrations is undertaken by CDC throughout their area of jurisdiction. Recent NO_2 results recorded in the vicinity of the site are shown in Table 3.

Table 3 Monitoring Results

Monitoring Site		Site Classification	Monitored 2017 NO_2 Concentration ($\mu g/m^3$)
DT2	Duke Street Settle	Roadside	27.3

3.3.2 As shown in Table 3, annual mean NO_2 concentrations were below the AQO at the DT2 - Duke Street Settle monitor in 2017. Reference should be made to Figure 2 for a map of the survey position.

3.3.3 CDC does not undertake CO monitoring within the vicinity of the site.

3.4 Background Pollutant Concentrations

3.4.1 Predictions of background pollutant concentrations on a 1km by 1km grid basis have been produced by DEFRA for the entire of the UK to assist Local Authorities in their Review and Assessment of air quality. The site is located in grid square NGR: 381500, 463500. Data

for this location was downloaded from the DEFRA website[3] for the purpose of the assessment and is summarised in Table 4.

Table 4 Background Pollutant Concentration Predictions

Pollutant	Predicted Background Pollutant Concentration (µg/m³)
NO_2	6.06
CO	183

3.4.2 It should be noted that concentrations of NO_2 are predicted for 2019 and CO for 2001. These were the most recent predictions available at the time of assessment and are therefore considered to provide a reasonable representation of background concentrations in the vicinity of the site.

3.5 Sensitive Receptors

3.5.1 A sensitive receptor is defined as any location which may be affected by changes in air quality. These have been defined for human and ecological receptors in the following Sections.

Sensitive Human Receptors

3.5.2 A desk-top study was undertaken in order to identify any sensitive human receptor locations in the vicinity of the site that required specific consideration during the assessment. These are summarised in Table 5.

Table 5 Sensitive Human Receptor Locations

Receptor		NGR (m)	
		X	Y
R1	Settle Church of England Voluntary Controlled Primary School	381621.9	463561.3
R2	Residential - Station Road	381626.1	463463.0
R3	Residential - Station Road	381617.0	463384.3

[3] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html.

Receptor		NGR (m)	
		X	Y
R4	Residential - Station Road	381372.4	463314.6
R5	Residential - Sandholme Close	381333.4	463403.8
R6	Residential - Sandholme Close	381279.4	463413.4
R7	Residential - Lords Close	381151.5	463381.9
R8	Residential - Lords Close	381152.4	463417.1
R9	Residential - Lords Close	381154.4	463457.8
R10	Residential - Riverside	381314.1	463710.2
R11	Residential - Riverside	381332.0	463805.4
R12	Residential - Riverside	381244.2	463695.3
R13	Residential - Kings Mill Lane	381422.2	463730.5
R14	Residential - Kings Mill Lane	381449.5	463736.4
R15	Residential - Kings Mill Lane	381475.8	463785.5
R16	Residential - Kings Mill Lane	381523.9	463777.1
R17	Residential - Kirkgate	381608.2	463800.2
R18	Residential - Kirkgate	381655.4	463802.0
R19	Settle College	381378.2	463977.7
R20	Giggleswick Primary School	381098.9	464048.4
R21	Giggleswick School	381001.5	464042.1
R22	Castlebergh Hospital	381001.2	463692.1

3.5.3 Reference should be made to Figure 3 for a map of the human receptor locations.

Ecological Receptors

3.5.4 Atmospheric emissions from the facility have the potential to impact on receptors of ecological sensitivity within the vicinity of the site. The Conservation of Habitats and Species Regulations (2010) and subsequent amendments require competent authorities to review applications and consents that have the potential to impact on ecological

designations. A pre-application request was therefore submitted to the EA in order to identify the following sites of ecological or nature conservation importance:

- Special Areas of Conservation (SACs), Special Protection Areas or Ramsar sites within 10km of the facility; and,
- Sites of Special Scientific Interest (SSSIs), National Nature Reserves, Local Nature Reserves (LNRs), Ancient Woodland (AW) and Local Wildlife Sites (LWSs) within 2km of the facility.

3.5.5 The pre-application response indicated the following sites of ecological nature conservation importance within the relevant distances:

- Ingleborough Complex SAC;
- Craven Limestone Complex SAC;
- Malham Tarn Ramsar;
- Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI;
- Giggleswick Scar and Kinsey Cave SSSI;
- Lords Wood and Pasture SSSI;
- River Ribble (Long Preston Deeps) SSSI;
- Attermire SSSI;
- Cleatop Park LNR and AW;
- Huntsworth Common LWS;
- Unnamed AW;
- Lords/Kelcow Wood AW;
- Lords/Kelcow Wood AW;
- Springs Wood AW;
- Scaithe Plantation AW; and,
- Hanging Scar Wood AW.

3.5.6 For the purpose of the modelling assessment discrete receptors were placed at the closest points of each designation to the facility to ensure the maximum potential impact was predicted. These are summarised in Table 6.

Table 6 Ecological Receptor Locations

Receptor		NGR (m)	
		X	Y
E1	Ingleborough Complex SAC	378696.5	467853.9
E2	Craven Limestone Complex SAC and Malham Tarn Ramsar	387919.5	466366.9
E3	Craven Limestone Complex SAC	388704.5	465049.0
E4	Craven Limestone Complex SAC	389294.6	463708.3
E5	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	382735.4	465004.1
E6	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	382742.5	464519.2
E7	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	382941.0	464071.2
E8	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	382733.7	463742.7
E9	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	382811.0	463354.4
E10	Giggleswick Scar and Kinsey Cave SSSI	380811.7	464975.4
E11	Lords Wood and Pasture SSSI	381248.2	464474.6
E12	River Ribble (Long Preston Deeps) SSSI	380913.9	462125.1
E13	Attermire SSSI	383458.6	464164.0
E14	Attermire SSSI	383786.9	463677.3
E15	Cleatop Park LNR and AW	381851.3	461529.0
E16	Huntsworth Common LWS	379994.0	464987.2
E17	Unnamed AW	380815.1	464005.3
E18	Lords/Kelcow Wood AW	381101.0	464384.1
E19	Lords/Kelcow Wood AW	381275.0	464484.3
E20	Springs Wood AW	382231.5	464398.8
E21	Scaithe Plantation AW	380798.9	464849.8
E22	Hanging Scar Wood AW	381411.5	465651.7

3.5.7 Reference should be made to Figure 4 for a map of the ecological receptors.

3.5.8 Critical loads have been designated within the UK based on the sensitivity and relevant features of the receiving habitat. A review of information provided by the APIS[4] website and MAGIC web-based interactive mapping service[5], as well as the EA screening request, was undertaken in order to identify the most suitable habitat description and associated critical load for the area of each designation considered within the assessment.

3.5.9 The relevant nitrogen deposition critical loads are presented in Table 7.

Table 7 Critical Loads for Nitrogen Deposition

Ecological Designation	Feature	APIS Habitat	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Ingleborough Complex SAC	Blanket bogs	Raised and blanket bogs	5	10
Craven Limestone Complex SAC and Malham Tarn Ramsar	Active raised bogs	Raised and blanket bogs	5	10
Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	Not sensitive (geological designation)	Not sensitive (geological designation)	-	-
Giggleswick Scar and Kinsey Cave SSSI	Broad-leaved, mixed and yew woodland (Fraxinus excelsior - Acer campestre - Mercurialis perennis woodland)	Meso- and eutrophic Quercus woodland	15	20
Lords Wood and Pasture SSSI	Broad-leaved, mixed and yew woodland (Fraxinus excelsior - Acer campestre - Mercurialis perennis woodland)	Meso- and eutrophic Quercus woodland	15	20
River Ribble (Long Preston Deeps) SSSI	Lowland fen without open water	Rich fens	15	30

4 http://www.apis.ac.uk/.

5 Multi-Agency Geographic Information for the Countryside, www.magic.gov.uk.

Ecological Designation	Feature	APIS Habitat	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Attermire SSSI	Fen, marsh and swamp (Carex rostrata - Calliergon cuspidatum/giganteum (Calliergonella cuspidata/Calliergon giganteum) mire)	Valley mires, poor fens and transition mires	10	15
Cleatop Park LNR and AW	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
Huntsworth Common LWS	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
Unnamed AW	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
Lords/Kelcow Wood AW	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
Lords/Kelcow Wood AW	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
Springs Wood AW	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
Scaithe Plantation AW	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
Hanging Scar Wood AW	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20

3.5.10 The relevant acid deposition critical loads are presented in Table 8.

Table 8 Critical Loads for Acid Deposition

Ecological Designation	Feature	APIS Habitat	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Ingleborough Complex SAC	Calcareous rocky slopes with chasmophytic vegetation	Montane	0.178	0.2	0.521
Craven Limestone Complex SAC and Malham Tarn Ramsar	Active raised bogs	Bogs	0.321	0.385	0.706

Ecological Designation	Feature	APIS Habitat	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	Not sensitive (geological designation)	Not sensitive (geological designation)	-	-	-
Giggleswick Scar and Kinsey Cave SSSI	Broad-leaved, mixed and yew woodland (Fraxinus excelsior - Acer campestre - Mercurialis perennis woodland)	Unmanaged Broadleafed/ Coniferous Woodland	0.142	1.913	2.413
Lords Wood and Pasture SSSI	Neutral grassland (Cynosurus cristatus - Centaurea nigra grassland)	Acid grassland	0.223	4.14	4.363
River Ribble (Long Preston Deeps) SSSI	Lowland fen without open water	Fen, marsh and swamp	-	-	-
Attermire SSSI	Fen, marsh and swamp (Carex rostrata - Calliergon cuspidatum/ giganteum (Calliergonella cuspidata/Calliergon giganteum) mire)	Bogs	0.321	0.489	0.81
Cleatop Park LNR and AW	Broadleaved, Mixed and Yew Woodland	Broadleafed/ Coniferous unmanaged woodland	0.357	2.948	3.305
Huntsworth Common LWS	Broadleaved, Mixed and Yew Woodland	Broadleafed/ Coniferous unmanaged woodland	0.357	2.948	3.305
Unnamed AW	Broadleaved, Mixed and Yew Woodland	Broadleafed/ Coniferous unmanaged woodland	0.357	2.948	3.305
Lords/Kelcow Wood AW	Broadleaved, Mixed and Yew Woodland	Broadleafed/ Coniferous unmanaged woodland	0.357	2.948	3.305

Ecological Designation	Feature	APIS Habitat	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Lords/Kelcow Wood AW	Broadleaved, Mixed and Yew Woodland	Broadleafed/ Coniferous unmanaged woodland	0.357	2.948	3.305
Springs Wood AW	Broadleaved, Mixed and Yew Woodland	Broadleafed/ Coniferous unmanaged woodland	0.357	2.948	3.305
Scaithe Plantation AW	Broadleaved, Mixed and Yew Woodland	Broadleafed/ Coniferous unmanaged woodland	0.357	2.948	3.305
Hanging Scar Wood AW	Broadleaved, Mixed and Yew Woodland	Broadleafed/ Coniferous unmanaged woodland	0.357	2.948	3.305

3.5.11 Baseline pollutant concentrations and deposition rates at each ecological receptor were obtained from the APIS website and are summarised in Table 9.

Table 9 Baseline Pollution Levels

Receptor		Annual Mean NO_x Conc. ($\mu g/m^3$)	Baseline Deposition Rate		
			Nitrogen (kgN/ha/yr)	Acid (keq/ha/yr)	
				Nitrogen	Sulphur
E1	Ingleborough Complex SAC	6.31	28.4	2.00	0.70
E2	Craven Limestone Complex SAC and Malham Tarn Ramsar	5.88	21.7	1.60	0.60
E3	Craven Limestone Complex SAC	5.79	21.7	1.60	0.60
E4	Craven Limestone Complex SAC	5.98	21.8	1.60	0.50
E5	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	7.05	23.8	1.70	0.59
E6	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	6.75	26.32	1.88	0.63
E7	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	6.75	26.32	1.88	0.63

Receptor		Annual Mean NO_x Conc. (µg/m³)	Baseline Deposition Rate		
			Nitrogen (kgN/ha/yr)	Acid (keq/ha/yr)	
				Nitrogen	Sulphur
E8	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	7.19	26.32	1.88	0.63
E9	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	7.19	26.32	1.88	0.63
E10	Giggleswick Scar and Kinsey Cave SSSI	6.57	36.7	2.60	0.70
E11	Lords Wood and Pasture SSSI	7.43	36.7	2.60	0.70
E12	River Ribble (Long Preston Deeps) SSSI	7.06	26.3	1.90	0.60
E13	Attermire SSSI	6.22	26.3	1.90	0.60
E14	Attermire SSSI	6.31	26.3	1.90	0.60
E15	Cleatop Park LNR and AW	7.34	36.68	2.62	0.71
E16	Huntsworth Common LWS	6.73	40.18	2.87	0.83
E17	Unnamed AW	6.57	36.68	2.62	0.71
E18	Lords/Kelcow Wood AW	7.43	36.68	2.62	0.71
E19	Lords/Kelcow Wood AW	7.43	36.68	2.62	0.71
E20	Springs Wood AW	6.75	36.68	2.62	0.71
E21	Scaithe Plantation AW	6.57	36.68	2.62	0.71
E22	Hanging Scar Wood AW	7.60	33.88	2.42	0.70

4.0 METHODOLOGY

4.1 Introduction

4.1.1 Combustion emissions from the boilers have the potential to contribute to elevated pollutant concentrations in the vicinity of the site. These have been quantified through dispersion modelling in accordance with the methodology outlined in the following Sections.

4.2 Dispersion Model

4.2.1 Dispersion modelling was undertaken using ADMS-5.2 (v5.2.4.0), which is developed by Cambridge Environmental Research Consultants (CERC) Ltd. ADMS-5 is a short-range dispersion modelling software package that simulates a wide range of buoyant and passive releases to atmosphere. It is a new generation model utilising boundary layer height and Monin-Obukhov length to describe the atmospheric boundary layer and a skewed Gaussian concentration distribution to calculate dispersion under convective conditions.

4.2.2 The model utilises hourly meteorological data to define conditions for plume rise, transport and diffusion. It estimates the concentration for each source and receptor combination for each hour of input meteorology and calculates user-selected long-term and short-term averages.

4.3 Modelling Scenarios

4.3.1 The scenarios considered in the modelling assessment for human receptors are summarised in Table 10.

Table 10 Human Receptor Assessment Scenarios

Parameter	Modelled As	
	Short Term	Long Term
NO_2	99.8th percentile (%ile) 1-hour mean	Annual mean
CO	8-hour rolling mean	-

4.3.2 Some short-term air quality criteria are framed in terms of the number of occasions in a calendar year on which the concentration should not be exceeded. As such, the %ile shown in Table 10 was selected to represent the relationship between the permitted number of exceedences of short-period concentrations and the number of periods within a calendar year.

4.3.3 The scenarios considered for ecological receptors in the modelling assessment are summarised in Table 11.

Table 11 Ecological Receptor Assessment Scenarios

Parameter	Modelled As	
	Short Term	Long Term
NO_x	24-hour mean	Annual mean
Nitrogen deposition	-	Annual deposition
Acid deposition	-	Annual deposition

4.3.4 Predicted pollutant concentrations were summarised in the following formats:

- Process Contribution (PC) - Predicted pollutant level as a result of emissions from the facility only; and,
- Predicted Environmental Concentration (PEC) - Total predicted pollutant level as a result of emissions from the facility and existing baseline conditions.

4.3.5 Predicted ground level pollutant concentrations and deposition rates were compared with the relevant AQOs, critical loads and critical levels. These criteria are collectively referred to as Environmental Quality Standards (EQSs).

4.4 Assessment Area

4.4.1 The assessment area was defined based on the facility location, anticipated pollutant dispersion patterns and the positioning of sensitive receptors. Ambient concentrations were predicted over NGR: 380700, 462815 to 382200, 464315. One Cartesian grid with a resolution of 10m was used within the model to produce data suitable for contour plotting using the Surfer software package.

4.4.2 Reference should be made to Figure 5 for a graphical representation of the assessment grid extents.

4.5 Process Conditions

4.5.1 A summary of the source parameters used in the assessment is provided in Table 12. These were obtained from a Stack Emissions Monitoring report produced by Socotec in 2019 for the existing plant and supplemented by information provided by the applicant and the proposed LPG boiler supplier.

Table 12 Source Parameters

Parameter	Unit	A1 - Existing Gas Boiler	A3 - Proposed LPG Boiler
Stack position	NGR	381395.3, 463531.9	381443.0, 463607.6
Stack height	m	24	20
Stack diameter	m	0.5	0.72
Exhaust gas temperature	°C	151	134
Exhaust gas moisture content	%	5	5
Exhaust gas oxygen (O_2) content	%	9.6	3.0
Exhaust gas flow rate	m^3/s	1.81	4.41
Exhaust gas flow rate (dry)	Nm^3/s	0.70	2.81
Exhaust gas efflux velocity	m/s	9.24	10.83

4.5.2 Reference should be made to Figure 5 for a map of the source locations.

4.6 Emissions

4.6.1 Emission concentrations were obtained for the existing plant from a Stack Emissions Monitoring report produced by Socotec in 2019 and supplemented by information provided by the proposed LPG boiler supplier. These are shown in Table 13.

Table 13 Pollutant Emission Concentrations

Pollutant	Pollutant Emission Concentration (mg/Nm³)	
	A1 - Existing Gas Boiler	A3 - Proposed LPG Boiler
NO_x	189	200
CO	4	4

4.6.2 The pollutant mass emission rates for use in the assessment were derived from the concentrations shown in Table 13 and the flow rates shown in Table 12. These are summarised in Table 14.

Table 14 Pollutant Mass Emission Rates

Pollutant	Pollutant Mass Emission Rate (g/s)	
	A1 - Existing Gas Boiler	A3 - Proposed LPG Boiler
NO_x	0.1328	0.5620
CO	0.0027	0.0112

4.6.3 Emissions from both boilers were assumed to be constant, with the plant operating 24-hours per day, 365-days per year. This is considered to be a worst-case assessment scenario as plant shutdown or periods of reduced work load are not reflected in the modelled emissions.

4.7 NO_x to NO_2 Conversion

4.7.1 Emissions of total NO_x from combustion processes are predominantly in the form of nitric oxide (NO). Excess oxygen in the combustion gases and further atmospheric reactions cause the oxidation of NO to NO_2. Comparisons of ambient NO and NO_2 concentrations in the vicinity of point sources in recent years has indicated that it is unlikely that more than 30% of the NO_x is present at ground level as NO_2.

4.7.2 Ambient NO_x concentrations were predicted through dispersion modelling. Concentrations of NO_2 shown in the results section assume 70% conversion from NO_x to

NO_2 for annual means and 35% conversion for 1-hour concentrations, based upon EA guidance[6].

4.8 Building Effects

4.8.1 The dispersion of substances released from elevated sources can be influenced by the presence of buildings close to the emission point. Structures can interrupt the wind flows and cause significantly higher ground-level concentrations close to the source than would arise in the absence of the buildings.

4.8.2 Analysis of the site layout indicated that a number of structures should be included within the model in order to take account of effects on pollutant dispersion. Building input geometries are shown in Table 15.

Table 15 Building Geometries

Building	NGR (m)		Height (m)	Length / Diameter (m)	Width (m)	Angle (°)
	X	Y				
Packaging Store 1	381443.0	463644.1	6.5	24.9	60.4	175.9
Packaging Store 2	381427.9	463621.9	8.1	9.1	18.5	175.9
Energy Centre	381436.8	463603.1	8.8	32.5	17.2	175.9
Production	381426.5	463515.3	9.2	38.9	97.9	175.9
Palletisation	381468.8	463481.4	10.9	41.3	24.7	175.9
Boiler House	381398.2	463529.7	9.3	12.1	9.8	175.9
Workshop 1	381401.2	463509.4	9.3	12.4	7.2	175.9
Workshop 2	381401.7	463500.6	13.6	12.7	10.4	175.9
Workshop 3	381400.1	463490.7	6.7	7.5	9.0	175.9

4.9 Meteorological Data

4.9.1 Meteorological data used in the assessment was taken from Bingley meteorological station over the period 1st January 2014 to 31st December 2018 (inclusive). This observation

[6] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports.

station is located at NGR: 408874, 435015, which is approximately 39.3km south-east of the facility. It is anticipated that conditions would be reasonably similar over a distance of this magnitude. The data was therefore considered suitable for an assessment of this nature.

4.9.2 All meteorological files used in the assessment were provided by Atmospheric Dispersion Modelling Ltd, which is an established distributor of data within the UK. Reference should be made to Figure 6 for wind roses of the utilised meteorological records.

4.10 Roughness Length

4.10.1 A roughness length (z_0) of 0.5m was used to describe the modelling extents. This value of z_0 is considered appropriate for the morphology of the area and is suggested within ADMS-5 as being suitable for 'parkland, open suburbia'.

4.10.2 A z_0 of 0.3m was used to describe the meteorological site. This value of z_0 is considered appropriate for the morphology of the area and is suggested within ADMS-5 as being suitable for 'agricultural areas (max)'.

4.11 Monin-Obukhov Length

4.11.1 The Monin-Obukhov length provides a measure of the stability of the atmosphere. A minimum Monin-Obukhov length of 10m was used to describe the modelling extents. This value is considered appropriate for the nature of the area and is suggested within ADMS-5 as being suitable for 'small towns < 50,000'.

4.11.2 A minimum Monin-Obukhov length of 1m was used to describe the meteorological site. This value is considered appropriate for the nature of the area and is suggested within ADMS-5 as being suitable for 'rural areas'.

4.12 Terrain Data

4.12.1 Ordnance Survey OS Terrain 50 data was included in the model for the site and surrounding area in order to take account of the specific flow field produced by variations in ground height throughout the assessment extents. This was pre-processed using the method suggested by CERC.

4.13 Nitrogen Deposition

4.13.1 Nitrogen deposition rates were calculated using the conversion factors provided within EA document 'Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06'[7]. Predicted pollutant concentrations were multiplied by the relevant deposition velocity and conversion factor to calculate the speciated dry deposition flux. The conversion factors used for the determination of nitrogen deposition are presented within Table 16.

Table 16 Conversion Factors to Determine Dry Deposition Flux for Nitrogen Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/m²/s to kg/ha/yr of pollutant species)
	Grassland	Forest	
NO_2	0.0015	0.003	95.9

4.13.2 The relevant deposition velocity for each ecological receptor was selected from Table 16 based on the vegetation type present within the designation.

4.14 Acid Deposition

4.14.1 Predicted ground level NO_2 concentrations were converted to kilo-equivalent ion depositions (keq/ha/yr) for comparison with the critical load for acid deposition at each of the identified ecological receptors. The conversion to units of equivalents, a measure of the potential acidifying effect of a species, was undertaken using the standard conversion factors shown in Table 17.

Table 17 Conversion Factors to Determine Dry Deposition Flux for Acid Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/m²/s to keq/ha/yr of pollutant species)
	Grassland	Forest	
NO_2	0.0015	0.003	6.84

[7] Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06, EA, 2014.

4.14.2 The following formula was used to calculate predicted PCs as a proportion of the critical load function where PECs were identified to be greater than the CLminN value.

PC as %CL function = ((PC of N deposition)/CLmaxN) x 100

4.14.3 The above formula was obtained from the APIS website[8].

4.15 Background Concentrations

4.15.1 Review of existing data in the vicinity of the site was undertaken in Section 3.0 in order to identify suitable background values for use in the assessment. This indicated the closest monitor recorded annual mean NO_2 concentrations above the DEFRA mapped background level. The higher value of 27.3µg/m^3 was therefore utilised in order to ensure a robust assessment.

4.15.2 CO is not monitored in the vicinity of the site. The DEFRA mapped background concentration was therefore utilised in lieu of alternative data sources.

4.15.3 Background levels at the ecological receptors were obtained from the APIS website, as summarised in Table 9.

4.15.4 It is not possible to add short-term peak baseline and process concentrations. This is because the conditions which give rise to peak ground-level concentrations of substances emitted from an elevated source at a particular location and time are likely to be different to the conditions which give rise to peak concentrations due to emissions from other sources. This point is addressed in in EA guidance 'Air emissions risk assessment for your environmental permit'[9], which advises that an estimate of the maximum combined pollutant concentration can be obtained by adding the maximum predicted short-term concentration due to emissions from the source to twice the annual mean baseline concentration. This approach was adopted throughout the assessment.

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

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

4.16 Assessment Criteria

Human Receptors

4.16.1 EA guidance 'Air emissions risk assessment for your environmental permit'[10] states that PCs can be screened as insignificant if they meet the following criteria:

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

4.16.2 If these criteria are exceeded the following guidance is provided on when whether PECs can be screened as insignificant:

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

Ecological Receptors

4.16.3 EA guidance 'Air emissions risk assessment for your environmental permit'[11] states that PCs at SPAs, Ramsar sites and SSSIs can be screened as insignificant if they meet the following criteria:

- The short-term PC is less than 10% of the short-term environmental standard for protected conservation areas; and,
- The long-term PC is less than 1% of the long-term environmental standard for protected conservation areas.

4.16.4 PCs at LWSs, LNRs and AW can be screened as insignificant if they meet the following criteria:

- The short-term PC is less than 100% of the short-term environmental standard for protected conservation areas; and,

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

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

- The long-term PC is less than 100% of the long-term environmental standard for protected conservation areas.

4.16.5 Predicted PCs have been compared to the relevant EQSs and the criteria stated above. Where the impact is within these parameters, the EA concludes that impacts associated with an installation are acceptable.

4.17 Modelling Uncertainty

4.17.1 Uncertainty in dispersion modelling predictions can be associated with a variety of factors, including:

- Model uncertainty - due to model limitations;
- Data uncertainty - due to errors in input data, including emission estimates, operational procedures, land use characteristics and meteorology; and,
- Variability - randomness of measurements used.

4.17.2 Potential uncertainties in the model results were minimised as far as practicable and worst-case inputs used in order to provide a robust assessment. This included the following:

- Choice of model - ADMS-5 is a commonly used atmospheric dispersion model and results have been verified through a number of studies to ensure predictions are as accurate as possible;
- Meteorological data - Modelling was undertaken using five annual meteorological data sets from an observation station local to the site to account for inter-year variability. The assessment was based on the worst-case year to ensure maximum concentrations were considered;
- Surface characteristics - The z_0 and Monin-Obukhov length were determined for both the dispersion and meteorological sites based on the surrounding land uses and guidance provided by CERC;
- Plant operating conditions - Operational parameters were provided by the applicant based on recent monitoring reports and the LPG boiler specification. As such, input parameters are considered to be representative of normal operating conditions;

- Emission rates - Emission rates were provided by the applicant based recent monitoring reports and the LPG boiler specification. As such, these are considered to be representative of anticipated emissions from the installation;
- Background concentrations - Background pollutant levels were obtained from local monitoring results and the DEFRA and APIS websites;
- Receptor locations - A Cartesian Grid was included in the model in order to provide suitable data for contour plotting. Receptor points were also included at sensitive locations to provide additional consideration of these areas; and,
- Variability - All model inputs were as accurate as possible and worst-case conditions were considered as necessary in order to ensure a robust assessment of potential pollutant concentrations.

4.17.3 Results were considered in the context of the relevant EQSs. It is considered that the use of the stated measures to reduce uncertainty and the use of worst-case assumptions when necessary has resulted in model accuracy of an acceptable level.

5.0 RESULTS

5.1 Introduction

5.1.1 Dispersion modelling was undertaken with the inputs described in Section 4.0. The results are outlined in the following Sections.

5.1.2 Reference should be made to Figure 7 to Figure 9 for graphical representations of predicted pollutant concentrations, inclusive of background, throughout the assessment extents. It should be noted that the values shown in the Figures are predictions from the meteorological data set which resulted in the maximum pollutant concentration for that species. For example, the maximum annual mean NO_2 concentration was predicted using the 2017 meteorological data set. As such, the contours shown in Figure 7 were produced from the 2017 model outputs.

5.2 Maximum Pollutant Concentrations

5.2.1 The maximum predicted pollutant concentrations at any point within the modelling extents for any meteorological data set are summarised in Table 18.

Table 18 Maximum Predicted Pollutant Concentrations

Pollutant	Averaging Period	EQS (µg/m³)	PC (µg/m³)	PC Proportion of EQS (%)	PEC (µg/m³)	PEC Proportion of EQS (%)
NO_2	Annual	40	5.47	13.7	32.77	81.9
	99.8th %ile 1-hour	200	31.74	15.9	86.34	43.2
CO	Rolling 8-hour	10,000	368.90	3.7	551.90	5.5

5.2.2 As shown in Table 18, there were no predicted exceedences of any EQS at any location for any pollutant or averaging period of interest.

5.3 Sensitive Human Receptors

5.3.1 Predicted concentrations of each pollutant at the sensitive human receptor locations identified in Table 5 are summarised in the following Sections.

Nitrogen Dioxide

5.3.2 Predicted annual mean NO_2 PECs, inclusive of background levels, are summarised in Table 19.

Table 19 Predicted Annual Mean NO_2 Concentrations

Receptor		Predicted Annual Mean NO_2 PEC (µg/m^3)				
		2014	2015	2016	2017	2018
R1	Settle Church of England Voluntary Controlled Primary School	28.99	29.48	28.91	29.87	29.19
R2	Residential - Station Road	28.23	28.53	28.32	28.71	28.46
R3	Residential - Station Road	27.87	28.04	28.03	28.12	28.04
R4	Residential - Station Road	27.72	27.67	27.82	27.59	27.79
R5	Residential - Sandholme Close	27.98	27.73	28.07	27.66	28.07
R6	Residential - Sandholme Close	27.95	27.63	27.92	27.63	27.96
R7	Residential - Lords Close	27.70	27.49	27.63	27.50	27.64
R8	Residential - Lords Close	27.75	27.52	27.65	27.52	27.66
R9	Residential - Lords Close	27.80	27.55	27.68	27.54	27.70
R10	Residential - Riverside	28.28	28.10	27.97	28.02	28.26
R11	Residential - Riverside	28.01	27.85	27.75	27.84	27.98
R12	Residential - Riverside	27.97	27.90	27.84	27.82	27.97
R13	Residential - Kings Mill Lane	28.66	28.49	28.55	28.47	28.50
R14	Residential - Kings Mill Lane	29.50	29.28	29.53	29.43	29.25
R15	Residential - Kings Mill Lane	29.54	29.38	29.63	29.57	29.35
R16	Residential - Kings Mill Lane	30.03	30.17	30.13	30.21	29.89
R17	Residential - Kirkgate	29.08	29.36	29.13	29.33	29.05

Receptor		Predicted Annual Mean NO_2 PEC (µg/m³)				
		2014	2015	2016	2017	2018
R18	Residential - Kirkgate	28.67	28.92	28.70	28.93	28.66
R19	Settle College	27.73	27.65	27.66	27.66	27.68
R20	Giggleswick Primary School	27.55	27.48	27.46	27.49	27.55
R21	Giggleswick School	27.54	27.48	27.46	27.48	27.54
R22	Castlebergh Hospital	27.50	27.50	27.51	27.46	27.52

5.3.3 As indicated in Table 19, predicted NO_2 concentrations were below the annual mean EQS of 40µg/m³ at all sensitive receptor locations for all meteorological data sets.

5.3.4 Maximum predicted annual mean NO_2 concentrations at the receptor locations are summarised in Table 20. Reference should be made to Figure 7 for a graphical representation of predicted concentrations throughout the assessment extents.

Table 20 Maximum Predicted Annual Mean NO_2 Concentrations

Receptor		Maximum Predicted Annual Mean NO_2 Concentration (µg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
R1	Settle Church of England Voluntary Controlled Primary School	2.57	29.87	6.4	74.7
R2	Residential - Station Road	1.41	28.71	3.5	71.8
R3	Residential - Station Road	0.82	28.12	2.1	70.3
R4	Residential - Station Road	0.52	27.82	1.3	69.6
R5	Residential - Sandholme Close	0.77	28.07	1.9	70.2
R6	Residential - Sandholme Close	0.66	27.96	1.7	69.9
R7	Residential - Lords Close	0.40	27.70	1.0	69.3
R8	Residential - Lords Close	0.45	27.75	1.1	69.4
R9	Residential - Lords Close	0.50	27.80	1.3	69.5
R10	Residential - Riverside	0.98	28.28	2.4	70.7

Receptor		Maximum Predicted Annual Mean NO_2 Concentration (µg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
R11	Residential - Riverside	0.71	28.01	1.8	70.0
R12	Residential - Riverside	0.67	27.97	1.7	69.9
R13	Residential - Kings Mill Lane	1.36	28.66	3.4	71.6
R14	Residential - Kings Mill Lane	2.23	29.53	5.6	73.8
R15	Residential - Kings Mill Lane	2.33	29.63	5.8	74.1
R16	Residential - Kings Mill Lane	2.91	30.21	7.3	75.5
R17	Residential - Kirkgate	2.06	29.36	5.2	73.4
R18	Residential - Kirkgate	1.63	28.93	4.1	72.3
R19	Settle College	0.43	27.73	1.1	69.3
R20	Giggleswick Primary School	0.25	27.55	0.6	68.9
R21	Giggleswick School	0.24	27.54	0.6	68.9
R22	Castlebergh Hospital	0.22	27.52	0.5	68.8

5.3.5 As indicated in Table 20, PECs were above 70% of the EQS at a number of receptors. However, all predictions were well below the relevant EQS. Additionally, the use of a roadside monitoring result to represent baseline concentrations throughout the modelling extents is likely to significantly overestimate levels at the majority of locations. As such, effects on annual mean NO_2 concentrations are not considered to be significant.

5.3.6 Predicted 99.8th %ile 1-hour mean NO_2 PECs, inclusive of background levels, are summarised in Table 21.

Table 21 Predicted 99.8th %ile 1-hour Mean NO_2 Concentrations

Receptor		Predicted 99.8th %ile 1-hour Mean NO_2 PEC (µg/m³)				
		2014	2015	2016	2017	2018
R1	Settle Church of England Voluntary Controlled Primary School	62.14	62.57	62.33	62.56	62.40
R2	Residential - Station Road	60.80	60.84	60.72	60.88	60.89

Receptor		Predicted 99.8th %ile 1-hour Mean NO_2 PEC (µg/m³)				
		2014	2015	2016	2017	2018
R3	Residential - Station Road	59.94	60.19	60.43	60.42	60.16
R4	Residential - Station Road	60.17	60.08	60.23	59.69	60.47
R5	Residential - Sandholme Close	61.96	61.57	61.82	61.23	61.86
R6	Residential - Sandholme Close	60.73	60.25	60.61	60.31	60.67
R7	Residential - Lords Close	58.62	58.29	58.46	58.55	58.36
R8	Residential - Lords Close	58.97	58.92	58.89	58.89	58.61
R9	Residential - Lords Close	59.23	59.11	59.10	58.99	58.90
R10	Residential - Riverside	62.01	62.11	62.13	62.08	62.09
R11	Residential - Riverside	60.77	60.71	60.60	60.60	60.61
R12	Residential - Riverside	60.52	60.45	60.38	60.59	60.36
R13	Residential - Kings Mill Lane	64.33	64.29	64.49	63.70	64.28
R14	Residential - Kings Mill Lane	65.18	65.00	65.56	64.98	65.36
R15	Residential - Kings Mill Lane	63.28	63.05	63.24	63.34	63.18
R16	Residential - Kings Mill Lane	62.49	62.24	62.70	62.57	62.54
R17	Residential - Kirkgate	59.97	59.84	60.61	60.47	60.13
R18	Residential - Kirkgate	59.04	59.14	60.16	60.11	59.40
R19	Settle College	59.40	58.62	58.74	58.71	58.71
R20	Giggleswick Primary School	56.81	56.79	56.85	56.78	56.81
R21	Giggleswick School	56.70	56.67	56.68	56.63	56.70
R22	Castlebergh Hospital	57.30	57.34	57.49	57.34	57.31

5.3.7 As indicated in Table 21, predicted 99.8th %ile 1-hour mean NO_2 concentrations were below the EQS of 200µg/m³ at all sensitive receptor locations for all meteorological data sets.

5.3.8 Maximum predicted 99.8th %ile 1-hour mean NO_2 concentrations at the receptor locations are summarised in Table 22. Reference should be made to Figure 8 for a graphical representation of predicted concentrations throughout the assessment extents.

Table 22 Maximum Predicted 99.8th %ile 1-hour Mean NO_2 Concentrations

Receptor		Maximum Predicted 99.8th %ile 1-hour Mean NO_2 Concentration (µg/m³)		PC Proportion of EQS (%)	PC Proportion of EQS Headroom (%) [a]
		PC	PEC		
R1	Settle Church of England Voluntary Controlled Primary School	7.97	62.57	4.0	5.5
R2	Residential - Station Road	6.29	60.89	3.1	4.3
R3	Residential - Station Road	5.83	60.43	2.9	4.0
R4	Residential - Station Road	5.87	60.47	2.9	4.0
R5	Residential - Sandholme Close	7.36	61.96	3.7	5.1
R6	Residential - Sandholme Close	6.13	60.73	3.1	4.2
R7	Residential - Lords Close	4.02	58.62	2.0	2.8
R8	Residential - Lords Close	4.37	58.97	2.2	3.0
R9	Residential - Lords Close	4.63	59.23	2.3	3.2
R10	Residential - Riverside	7.53	62.13	3.8	5.2
R11	Residential - Riverside	6.17	60.77	3.1	4.2
R12	Residential - Riverside	5.99	60.59	3.0	4.1
R13	Residential - Kings Mill Lane	9.89	64.49	4.9	6.8
R14	Residential - Kings Mill Lane	10.96	65.56	5.5	7.5
R15	Residential - Kings Mill Lane	8.74	63.34	4.4	6.0
R16	Residential - Kings Mill Lane	8.10	62.70	4.0	5.6
R17	Residential - Kirkgate	6.01	60.61	3.0	4.1
R18	Residential - Kirkgate	5.56	60.16	2.8	3.8
R19	Settle College	4.80	59.40	2.4	3.3
R20	Giggleswick Primary School	2.25	56.85	1.1	1.5
R21	Giggleswick School	2.10	56.70	1.1	1.4
R22	Castlebergh Hospital	2.89	57.49	1.4	2.0

NOTE (a) PC proportion of EQS minus twice the long-term background concentration.

5.3.9 As indicated in Table 22, the PC proportion of the EQS was below 10% at all sensitive locations. As such, predicted effects on 1-hour mean NO_2 concentrations are not considered to be significant in accordance with the stated criteria.

Carbon Monoxide

5.3.10 Predicted 8-hour rolling mean CO PECs, inclusive of background levels, are summarised in Table 23.

Table 23 Predicted 8-hour Rolling Mean CO Concentrations

Receptor		Predicted 8-hour Rolling Mean CO PEC (µg/m³)				
		2014	2015	2016	2017	2018
R1	Settle Church of England Voluntary Controlled Primary School	366.34	366.35	366.35	366.40	366.40
R2	Residential - Station Road	366.59	366.30	366.34	366.30	366.48
R3	Residential - Station Road	366.71	366.29	366.32	366.26	366.39
R4	Residential - Station Road	366.70	366.42	366.39	366.45	367.07
R5	Residential - Sandholme Close	366.43	366.42	366.38	366.41	366.36
R6	Residential - Sandholme Close	366.38	366.30	366.31	366.37	366.32
R7	Residential - Lords Close	366.23	366.29	366.20	366.30	366.18
R8	Residential - Lords Close	366.24	366.30	366.22	366.32	366.21
R9	Residential - Lords Close	366.24	366.28	366.24	366.33	366.23
R10	Residential - Riverside	366.37	366.43	366.43	366.36	366.39
R11	Residential - Riverside	366.30	366.39	366.54	366.55	366.40
R12	Residential - Riverside	366.28	366.31	366.29	366.28	366.30
R13	Residential - Kings Mill Lane	366.52	366.48	366.49	366.51	366.44
R14	Residential - Kings Mill Lane	366.56	366.50	366.55	366.50	366.47
R15	Residential - Kings Mill Lane	366.45	366.41	366.47	366.42	366.42
R16	Residential - Kings Mill Lane	366.39	366.43	366.45	366.39	366.39
R17	Residential - Kirkgate	366.25	366.34	366.25	366.54	366.26
R18	Residential - Kirkgate	366.24	366.47	366.21	366.60	366.20

Receptor		Predicted 8-hour Rolling Mean CO PEC (µg/m³)				
		2014	2015	2016	2017	2018
R19	Settle College	366.32	366.18	366.27	366.31	366.33
R20	Giggleswick Primary School	366.14	366.16	366.14	366.11	366.11
R21	Giggleswick School	366.12	366.11	366.16	366.10	366.12
R22	Castlebergh Hospital	366.12	366.14	366.14	366.12	366.15

5.3.11 As indicated in Table 23, predicted CO concentrations were below the 8-hour rolling mean EQS of 10,000µg/m³ at all sensitive receptor locations for all meteorological data sets.

5.3.12 Maximum predicted 8-hour rolling mean CO concentrations at the receptor locations are summarised in Table 24. Reference should be made to Figure 9 for a graphical representation of predicted concentrations throughout the assessment extents.

Table 24 Maximum Predicted 8-hour Rolling Mean CO Concentrations

Receptor		Maximum Predicted 8-hour Rolling Mean CO Concentration (µg/m³)		PC Proportion of EQS (%)	PC Proportion of EQS Headroom (%) [a]
		PC	PEC		
R1	Settle Church of England Voluntary Controlled Primary School	0.40	366.40	0.0	3.7
R2	Residential - Station Road	0.59	366.59	0.0	3.7
R3	Residential - Station Road	0.71	366.71	0.0	3.7
R4	Residential - Station Road	1.07	367.07	0.0	3.7
R5	Residential - Sandholme Close	0.43	366.43	0.0	3.7
R6	Residential - Sandholme Close	0.38	366.38	0.0	3.7
R7	Residential - Lords Close	0.30	366.30	0.0	3.7
R8	Residential - Lords Close	0.32	366.32	0.0	3.7
R9	Residential - Lords Close	0.33	366.33	0.0	3.7
R10	Residential - Riverside	0.43	366.43	0.0	3.7
R11	Residential - Riverside	0.55	366.55	0.0	3.7

Receptor		Maximum Predicted 8-hour Rolling Mean CO Concentration (µg/m³)		PC Proportion of EQS (%)	PC Proportion of EQS Headroom (%) [a]
		PC	PEC		
R12	Residential - Riverside	0.31	366.31	0.0	3.7
R13	Residential - Kings Mill Lane	0.52	366.52	0.0	3.7
R14	Residential - Kings Mill Lane	0.56	366.56	0.0	3.7
R15	Residential - Kings Mill Lane	0.47	366.47	0.0	3.7
R16	Residential - Kings Mill Lane	0.45	366.45	0.0	3.7
R17	Residential - Kirkgate	0.54	366.54	0.0	3.7
R18	Residential - Kirkgate	0.60	366.60	0.0	3.7
R19	Settle College	0.33	366.33	0.0	3.7
R20	Giggleswick Primary School	0.16	366.16	0.0	3.7
R21	Giggleswick School	0.16	366.16	0.0	3.7
R22	Castlebergh Hospital	0.15	366.15	0.0	3.7

NOTE (a) PC proportion of EQS minus twice the long-term background concentration.

5.3.13 As indicated in Table 24, the PC proportion of the EQS was below 10% at all sensitive locations. As such, predicted effects on 8-hour rolling mean CO concentrations are not considered to be significant in accordance with the stated criteria.

5.4 Ecological Receptors

5.4.1 Predicted concentrations and deposition rates of each pollutant at the sensitive ecological receptor locations identified in Table 6 are summarised in the following Sections.

Nitrogen Oxides

5.4.2 Predicted annual mean NO_x PECs at the receptor locations, inclusive of background levels, are summarised in Table 25.

Table 25 Predicted Annual Mean NO_x Concentrations

Receptor	Predicted Annual Mean NO_x PEC (µg/m³)				
	2014	2015	2016	2017	2018
E1	6.34	6.33	6.33	6.33	6.34
E2	5.89	5.89	5.89	5.89	5.89
E3	5.80	5.80	5.80	5.81	5.80
E4	5.99	5.99	5.99	6.00	5.99
E5	7.10	7.11	7.10	7.10	7.10
E6	6.80	6.80	6.80	6.81	6.79
E7	6.80	6.81	6.80	6.82	6.80
E8	7.27	7.28	7.26	7.30	7.27
E9	7.26	7.28	7.26	7.30	7.27
E10	6.63	6.62	6.61	6.61	6.63
E11	7.56	7.53	7.53	7.54	7.55
E12	7.14	7.13	7.18	7.11	7.20
E13	6.26	6.27	6.26	6.27	6.26
E14	6.35	6.36	6.35	6.37	6.35
E15	7.36	7.36	7.37	7.36	7.36
E16	6.81	6.79	6.80	6.80	6.81
E17	6.81	6.77	6.78	6.76	6.80
E18	7.57	7.54	7.53	7.54	7.56
E19	7.57	7.54	7.54	7.55	7.55
E20	6.88	6.91	6.89	6.90	6.88
E21	6.64	6.63	6.62	6.62	6.64
E22	7.66	7.65	7.65	7.65	7.65

5.4.3 As indicated in Table 25, predicted annual mean NO_x concentrations were below the EQS of 30µg/m³ at all ecological receptors.

5.4.4 Maximum predicted annual mean NO_x concentrations at the ecological receptors are summarised in Table 26.

Table 26 Maximum Predicted Annual Mean NO_x Concentrations

Receptor		Maximum Predicted Annual Mean NO_x Concentration (µg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
E1	Ingleborough Complex SAC	0.03	6.34	0.1	21.1
E2	Craven Limestone Complex SAC and Malham Tarn Ramsar	0.01	5.89	0.0	19.6
E3	Craven Limestone Complex SAC	0.02	5.81	0.1	19.4
E4	Craven Limestone Complex SAC	0.02	6.00	0.1	20.0
E5	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.06	7.11	0.2	23.7
E6	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.06	6.81	0.2	22.7
E7	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.07	6.82	0.2	22.7
E8	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.11	7.30	0.4	24.3
E9	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.11	7.30	0.4	24.3
E10	Giggleswick Scar and Kinsey Cave SSSI	0.06	6.63	0.2	22.1
E11	Lords Wood and Pasture SSSI	0.13	7.56	0.4	25.2
E12	River Ribble (Long Preston Deeps) SSSI	0.14	7.20	0.5	24.0
E13	Attermire SSSI	0.05	6.27	0.2	20.9
E14	Attermire SSSI	0.06	6.37	0.2	21.2
E15	Cleatop Park LNR and AW	0.03	7.37	0.1	24.6
E16	Huntsworth Common LWS	0.08	6.81	0.3	22.7
E17	Unnamed AW	0.24	6.81	0.8	22.7
E18	Lords/Kelcow Wood AW	0.14	7.57	0.5	25.2

Receptor		Maximum Predicted Annual Mean NO_x Concentration (µg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
E19	Lords/Kelcow Wood AW	0.14	7.57	0.5	25.2
E20	Springs Wood AW	0.16	6.91	0.5	23.0
E21	Scaithe Plantation AW	0.07	6.64	0.2	22.1
E22	Hanging Scar Wood AW	0.06	7.66	0.2	25.5

5.4.5 As shown in Table 26, PCs were below 1% of the EQS at all SACs, Ramsar sites and SSSIs and 100% of the EQS at all AW, LWSs and LNRs. As such, predicted effects on annual mean NO_x concentrations are not considered to be significant in accordance with the stated criteria.

5.4.6 Predicted 24-hour mean NO_x PECs at the receptor locations, inclusive of background levels, are summarised in Table 27.

Table 27 Predicted 24-hour Mean NO_x Concentrations

Receptor	Predicted 24-hour Mean NO_x PEC (µg/m³)				
	2014	2015	2016	2017	2018
E1	13.44	13.02	13.03	12.88	13.01
E2	11.83	11.93	11.86	11.84	11.84
E3	11.72	11.78	11.72	11.71	11.73
E4	12.10	12.13	12.10	12.09	12.09
E5	14.39	14.38	14.49	14.39	14.46
E6	13.78	13.80	13.83	13.82	14.05
E7	13.87	14.08	13.80	13.83	13.86
E8	15.13	14.86	14.88	14.82	14.82
E9	15.17	14.83	14.84	14.81	14.85
E10	13.87	14.87	13.93	13.85	13.92
E11	16.24	17.49	16.58	16.23	16.63

Receptor	Predicted 24-hour Mean NO_x PEC (µg/m³)				
	2014	2015	2016	2017	2018
E12	15.49	15.96	16.26	15.21	16.40
E13	12.70	12.92	12.67	12.69	12.78
E14	13.01	13.03	12.87	12.99	12.98
E15	15.05	15.11	15.31	15.03	15.14
E16	14.43	14.58	15.09	14.56	14.75
E17	16.35	15.87	16.16	15.77	15.98
E18	16.43	17.91	16.73	16.55	16.76
E19	16.23	17.11	16.39	16.21	16.67
E20	14.24	15.45	14.58	14.46	14.36
E21	13.93	14.73	14.20	13.95	14.08
E22	15.70	15.75	15.67	15.67	15.87

5.4.7 As indicated in Table 27, predicted NO_x concentrations were below the 24-hour mean EQS of 75µg/m³ at all ecological receptor locations.

5.4.8 Maximum predicted 24-hour mean NO_x concentrations at the ecological receptor locations are summarised in Table 28.

Table 28 Maximum Predicted 24-hour Mean NO_x Concentrations

Receptor		Maximum Predicted 24-hour Mean NO_x Concentration (µg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
E1	Ingleborough Complex SAC	0.82	13.44	1.1	17.9
E2	Craven Limestone Complex SAC and Malham Tarn Ramsar	0.17	11.93	0.2	15.9
E3	Craven Limestone Complex SAC	0.20	11.78	0.3	15.7
E4	Craven Limestone Complex SAC	0.17	12.13	0.2	16.2
E5	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.39	14.49	0.5	19.3

Receptor		Maximum Predicted 24-hour Mean NO_x Concentration (µg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
E6	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.55	14.05	0.7	18.7
E7	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.58	14.08	0.8	18.8
E8	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.75	15.13	1.0	20.2
E9	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.79	15.17	1.0	20.2
E10	Giggleswick Scar and Kinsey Cave SSSI	1.73	14.87	2.3	19.8
E11	Lords Wood and Pasture SSSI	2.63	17.49	3.5	23.3
E12	River Ribble (Long Preston Deeps) SSSI	2.28	16.40	3.0	21.9
E13	Attermire SSSI	0.48	12.92	0.6	17.2
E14	Attermire SSSI	0.41	13.03	0.5	17.4
E15	Cleatop Park LNR and AW	0.63	15.31	0.8	20.4
E16	Huntsworth Common LWS	1.63	15.09	2.2	20.1
E17	Unnamed AW	3.21	16.35	4.3	21.8
E18	Lords/Kelcow Wood AW	3.05	17.91	4.1	23.9
E19	Lords/Kelcow Wood AW	2.25	17.11	3.0	22.8
E20	Springs Wood AW	1.95	15.45	2.6	20.6
E21	Scaithe Plantation AW	1.59	14.73	2.1	19.6
E22	Hanging Scar Wood AW	0.67	15.87	0.9	21.2

5.4.9 As shown in Table 28, PCs were below 10% of the EQS at all SACs, Ramsar sites and SSSIs and 100% of the EQS at all AW, LWSs and LNRs. As such, predicted effects on 24-hour mean NO_x concentrations are not considered to be significant in accordance with the stated criteria.

Nitrogen Deposition

5.4.10 Predicted annual nitrogen PC deposition rates at the receptor locations are summarised in Table 29.

Table 29 Predicted Annual Nitrogen Deposition Rates

Receptor	Predicted Annual PC Nitrogen Deposition Rate (kgN/ha/yr)				
	2014	2015	2016	2017	2018
E1	0.003	0.002	0.003	0.002	0.003
E2	0.001	0.001	0.001	0.001	0.001
E3	0.001	0.001	0.001	0.002	0.001
E4	0.001	0.001	0.001	0.002	0.001
E5	0.005	0.006	0.005	0.005	0.005
E6	0.005	0.005	0.005	0.006	0.004
E7	0.005	0.006	0.005	0.007	0.005
E8	0.008	0.009	0.007	0.011	0.008
E9	0.007	0.009	0.007	0.011	0.008
E10	0.012	0.009	0.009	0.009	0.011
E11	0.027	0.021	0.021	0.022	0.024
E12	0.008	0.007	0.012	0.005	0.014
E13	0.004	0.005	0.004	0.005	0.004
E14	0.004	0.005	0.004	0.006	0.004
E15	0.004	0.004	0.005	0.004	0.004
E16	0.017	0.012	0.015	0.014	0.016
E17	0.047	0.040	0.043	0.039	0.045
E18	0.028	0.023	0.020	0.022	0.027
E19	0.028	0.021	0.022	0.024	0.024
E20	0.027	0.033	0.027	0.031	0.026
E21	0.015	0.011	0.010	0.011	0.014

Receptor	Predicted Annual PC Nitrogen Deposition Rate (kgN/ha/yr)				
	2014	2015	2016	2017	2018
E22	0.012	0.009	0.011	0.011	0.010

5.4.11 Maximum predicted annual nitrogen deposition rates at the ecological receptor locations are summarised in Table 30.

Table 30 Maximum Predicted Annual Nitrogen Deposition Rates

Receptor		Maximum Predicted Annual Nitrogen Deposition Rate (kgN/ha/yr)		Proportion of EQS (%)			
		PC	PEC	Low EQS		High EQS	
				PC	PEC	PC	PEC
E1	Ingleborough Complex SAC	0.003	28.403	0.1	568.1	0.0	284.0
E2	Craven Limestone Complex SAC and Malham Tarn Ramsar	0.001	21.701	0.0	434.0	0.0	217.0
E3	Craven Limestone Complex SAC	0.002	21.702	0.0	434.0	0.0	217.0
E4	Craven Limestone Complex SAC	0.002	21.802	0.0	436.0	0.0	218.0
E5	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.006	23.806	-	-	-	-
E6	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.006	26.326	-	-	-	-
E7	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.007	26.327	-	-	-	-
E8	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.011	26.331	-	-	-	-
E9	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.011	26.331	-	-	-	-

Receptor		Maximum Predicted Annual Nitrogen Deposition Rate (kgN/ha/yr)		Proportion of EQS (%)			
		PC	PEC	Low EQS		High EQS	
				PC	PEC	PC	PEC
E10	Giggleswick Scar and Kinsey Cave SSSI	0.012	36.712	0.1	244.7	0.1	183.6
E11	Lords Wood and Pasture SSSI	0.027	36.727	0.2	244.8	0.1	183.6
E12	River Ribble (Long Preston Deeps) SSSI	0.014	26.314	0.1	175.4	0.0	87.7
E13	Attermire SSSI	0.005	26.305	0.1	263.1	0.0	175.4
E14	Attermire SSSI	0.006	26.306	0.1	263.1	0.0	175.4
E15	Cleatop Park LNR and AW	0.005	36.685	0.1	366.9	0.0	183.4
E16	Huntsworth Common LWS	0.017	40.197	0.2	402.0	0.1	201.0
E17	Unnamed AW	0.047	36.727	0.5	367.3	0.2	183.6
E18	Lords/Kelcow Wood AW	0.028	36.708	0.3	367.1	0.1	183.5
E19	Lords/Kelcow Wood AW	0.028	36.708	0.3	367.1	0.1	183.5
E20	Springs Wood AW	0.033	36.713	0.3	367.1	0.2	183.6
E21	Scaithe Plantation AW	0.015	36.695	0.1	366.9	0.1	183.5
E22	Hanging Scar Wood AW	0.012	33.892	0.1	338.9	0.1	169.5

5.4.12 As shown in Table 30, PCs were below 1% of the EQS at all SACs, Ramsar sites and SSSIs and 100% of the EQS at all AW, LWSs and LNRs. As such, predicted effects on nitrogen deposition are not considered to be significant in accordance with the stated criteria.

5.4.13 It should be noted that PECs are predicted to exceed the relevant EQSs at all locations as a base condition.

Acid Deposition

5.4.14 Predicted annual acid PC deposition rates are summarised in Table 31.

Table 31 Predicted Annual PC Acid Deposition Rates

Receptor	Predicted Annual PC Acid Deposition Rate (keq/ha/yr)				
	2014	2015	2016	2017	2018
E1	0.0002	0.0001	0.0002	0.0001	0.0002
E2	0.0001	0.0001	0.0001	0.0001	0.0001
E3	0.0001	0.0001	0.0001	0.0001	0.0001
E4	0.0001	0.0001	0.0001	0.0001	0.0001
E5	0.0003	0.0004	0.0003	0.0003	0.0003
E6	0.0003	0.0004	0.0003	0.0004	0.0003
E7	0.0004	0.0004	0.0004	0.0005	0.0004
E8	0.0006	0.0007	0.0005	0.0008	0.0005
E9	0.0005	0.0007	0.0005	0.0008	0.0005
E10	0.0008	0.0007	0.0006	0.0006	0.0008
E11	0.0019	0.0015	0.0015	0.0016	0.0017
E12	0.0006	0.0005	0.0009	0.0003	0.0010
E13	0.0003	0.0003	0.0003	0.0004	0.0003
E14	0.0003	0.0004	0.0003	0.0004	0.0003
E15	0.0003	0.0003	0.0004	0.0003	0.0003
E16	0.0012	0.0009	0.0010	0.0010	0.0012
E17	0.0034	0.0029	0.0031	0.0027	0.0032
E18	0.0020	0.0016	0.0014	0.0016	0.0019
E19	0.0020	0.0015	0.0016	0.0017	0.0017
E20	0.0019	0.0023	0.0019	0.0022	0.0018
E21	0.0011	0.0008	0.0007	0.0008	0.0010
E22	0.0009	0.0007	0.0008	0.0008	0.0007

5.4.15 Maximum predicted annual acid deposition rates at the ecological receptor locations are summarised in Table 32.

Table 32 Predicted Annual Acid Deposition Rates

Receptor		Maximum Predicted Annual Acid PC Deposition Rate (keq/ha/yr)	Proportion of EQS (%)
E1	Ingleborough Complex SAC	0.0002	0.0
E2	Craven Limestone Complex SAC and Malham Tarn Ramsar	0.0001	0.0
E3	Craven Limestone Complex SAC	0.0001	0.0
E4	Craven Limestone Complex SAC	0.0001	0.0
E5	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.0004	-
E6	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.0004	-
E7	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.0005	-
E8	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.0008	-
E9	Langcliffe Scars and Jubilee, Albert and Victoria Caves SSSI	0.0008	-
E10	Giggleswick Scar and Kinsey Cave SSSI	0.0008	0.0
E11	Lords Wood and Pasture SSSI	0.0019	0.0
E12	River Ribble (Long Preston Deeps) SSSI	0.0010	-
E13	Attermire SSSI	0.0004	0.0
E14	Attermire SSSI	0.0004	0.1
E15	Cleatop Park LNR and AW	0.0004	0.0
E16	Huntsworth Common LWS	0.0012	0.0
E17	Unnamed AW	0.0034	0.1
E18	Lords/Kelcow Wood AW	0.0020	0.1
E19	Lords/Kelcow Wood AW	0.0020	0.1
E20	Springs Wood AW	0.0023	0.1
E21	Scaithe Plantation AW	0.0011	0.0
E22	Hanging Scar Wood AW	0.0009	0.0

5.4.16 As shown in Table 32, annual acid deposition PCs % of the EQS at all SACs, Ramsar sites and SSSIs and 100% of the EQS at all AW, LWSs and LNRs. As such, predicted effects on nitrogen deposition are not considered to be significant in accordance with the stated criteria.

5.5 Sensitivity Analysis

5.5.1 In accordance with EA requirements[12], a sensitivity analysis was undertaken to assess variation in model results associated with a number of individual inputs.

5.5.2 Review of the maximum concentrations for each pollutant and averaging period predicted by the original model, as shown in Table 18, indicated that annual mean NO_2 concentrations were closest to exceeding the relevant EQS. The sensitivity analysis therefore focused on the influence of different scenarios on annual mean NO_2 concentrations.

5.5.3 The maximum annual mean NO_2 PEC was predicted using the 2017 meteorological data set. All scenarios were therefore run for this assessment year.

5.5.4 A total of 10 scenarios were considered, each with a single change to modelling inputs. The following parameters were considered in the analysis:

- Building inputs;
- z_0 used to describe the dispersion site;
- MO used to describe the dispersion site;
- Grid spacing; and,
- Source of meteorological data.

5.5.5 A description of the modelling inputs for each scenario is provided in Table 33, with the varied input shown in **bold**. The original model, which is referred to as version 1 (V1), is included for completeness and ease of comparison.

[12] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports.

Table 33 Sensitivity Analysis Scenarios

Scenario	Buildings	Z_0 Used to Describe Dispersion Site (m)	MO Length Used to Describe Dispersion Site (m)	Grid Spacing (m)	Met. Station Data
V1	On	0.5	10	10	Bingley
V2	**Off**	0.5	10	10	Bingley
V3	On	**1.0**	10	10	Bingley
V4	On	**0.3**	10	10	Bingley
V5	On	0.5	**1**	10	Bingley
V6	On	0.5	**30**	10	Bingley
V7	On	0.5	10	**5**	Bingley
V8	On	0.5	10	**20**	Bingley
V9	On	0.5	10	10	**Leeds Bradford Airport**
V10	On	0.5	10	10	**Shap**

5.5.6 The maximum predicted annual mean NO_2 concentration at any location from each scenario is summarised in Table 34. The maximum impacts are shown in **bold**.

Table 34 Maximum Predicted Concentrations - Sensitivity Analysis

Scenario	EQS (µg/m³)	PC (µg/m³)	PC Proportion of EQS (%)	PEC (µg/m³)	PEC Proportion of EQS (%)
V1	40	5.47	13.7	32.77	81.9
V2	40	5.24	13.1	32.54	81.3
V3	**40**	**6.82**	**17.0**	**34.12**	**85.3**
V4	40	4.59	11.5	31.89	79.7
V5	40	5.23	13.1	32.53	81.3
V6	40	5.51	13.8	32.81	82.0
V7	40	5.48	13.7	32.78	81.9
V8	40	5.47	13.7	32.77	81.9

Scenario	EQS (µg/m³)	PC (µg/m³)	PC Proportion of EQS (%)	PEC (µg/m³)	PEC Proportion of EQS (%)
V9	40	5.94	14.8	33.24	83.1
V10	40	5.15	12.9	32.45	81.1

5.5.7 As shown in Table 34, the maximum concentration was predicted with the input parameters of model version 3. The PEC proportion of the EQS was 85.3%. As the PEC remains below the EQS, the findings of the sensitivity analysis support the conclusion that impacts as a result of the facility are not considered to be significant.

6.0 CONCLUSION

6.1.1 Redmore Environmental Ltd was commissioned by EHS Projects Ltd to undertake an Air Quality Assessment in support of an Environmental Permit Variation Application for Arla Foods Settle, Sowarth Industrial Estate, Settle.

6.1.2 It is proposed to install a new boiler at the site to complement the existing energy plant. Associated atmospheric emissions have the potential to cause air quality impacts at sensitive locations. As such, an Air Quality Assessment was undertaken in order to determine baseline conditions and quantify potential effects.

6.1.3 Dispersion modelling of NO_x and CO emissions was undertaken using ADMS-5. Impacts at sensitive receptors were quantified and the results compared with the relevant EQSs and significance criteria.

6.1.4 Predicted concentrations of all pollutants were below the relevant EQSs at all locations for all meteorological data sets modelled. Resultant impacts were classified as not significant.

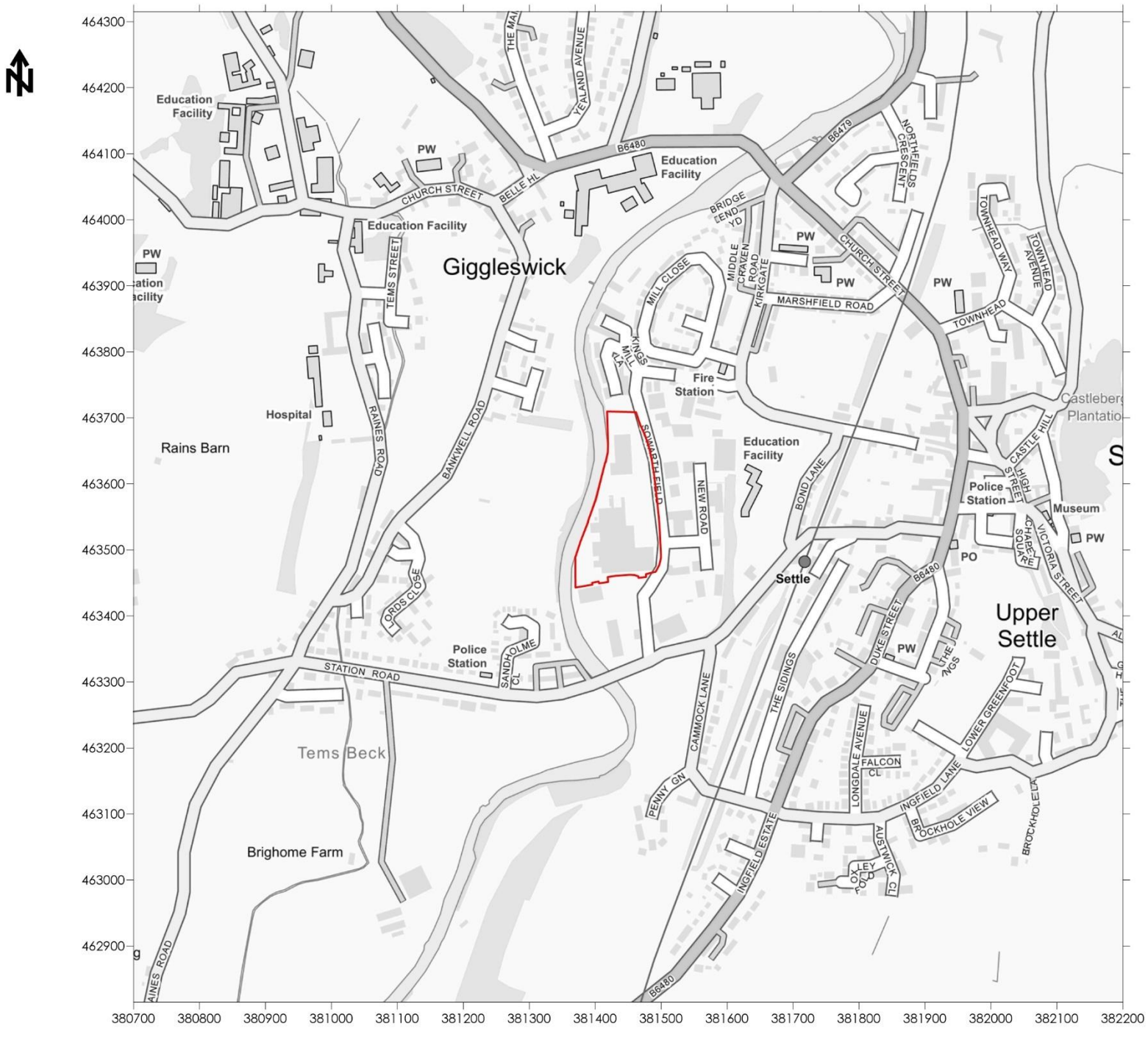
6.1.5 Impacts were also predicted at relevant ecological sites. The results indicated that emissions from the plant would not significantly affect existing conditions at any designation.

6.1.6 The modelling results were based on a worst-case assessment scenario of both boilers constantly operating throughout an entire year. As such, predicted pollutant concentrations are likely to overestimate actual impacts.

7.0 ABBREVIATIONS

APIS	Air Pollution Information System
AQLV	Air Quality Limit Value
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQS	Air Quality Strategy
AW	Ancient Woodland
CDC	Craven District Council
CERC	Cambridge Environmental Research Consultants
CO	Carbon monoxide
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EQS	Environmental Quality Standard
EU	European Union
LAQM	Local Air Quality Management
LNR	Local Nature Reserve
LPG	Liquified Petroleum Gas
LWS	Local Wildlife Site
MAGIC	Multi-Agency Geographic Information for the Countryside
NGR	National Grid Reference
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
PC	Process Contribution
PEC	Predicted Environmental Concentration
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
z_0	Roughness length
%ile	Percentile

Figures



Legend

Site Boundary

Title
Figure 1 - Site Location

Project
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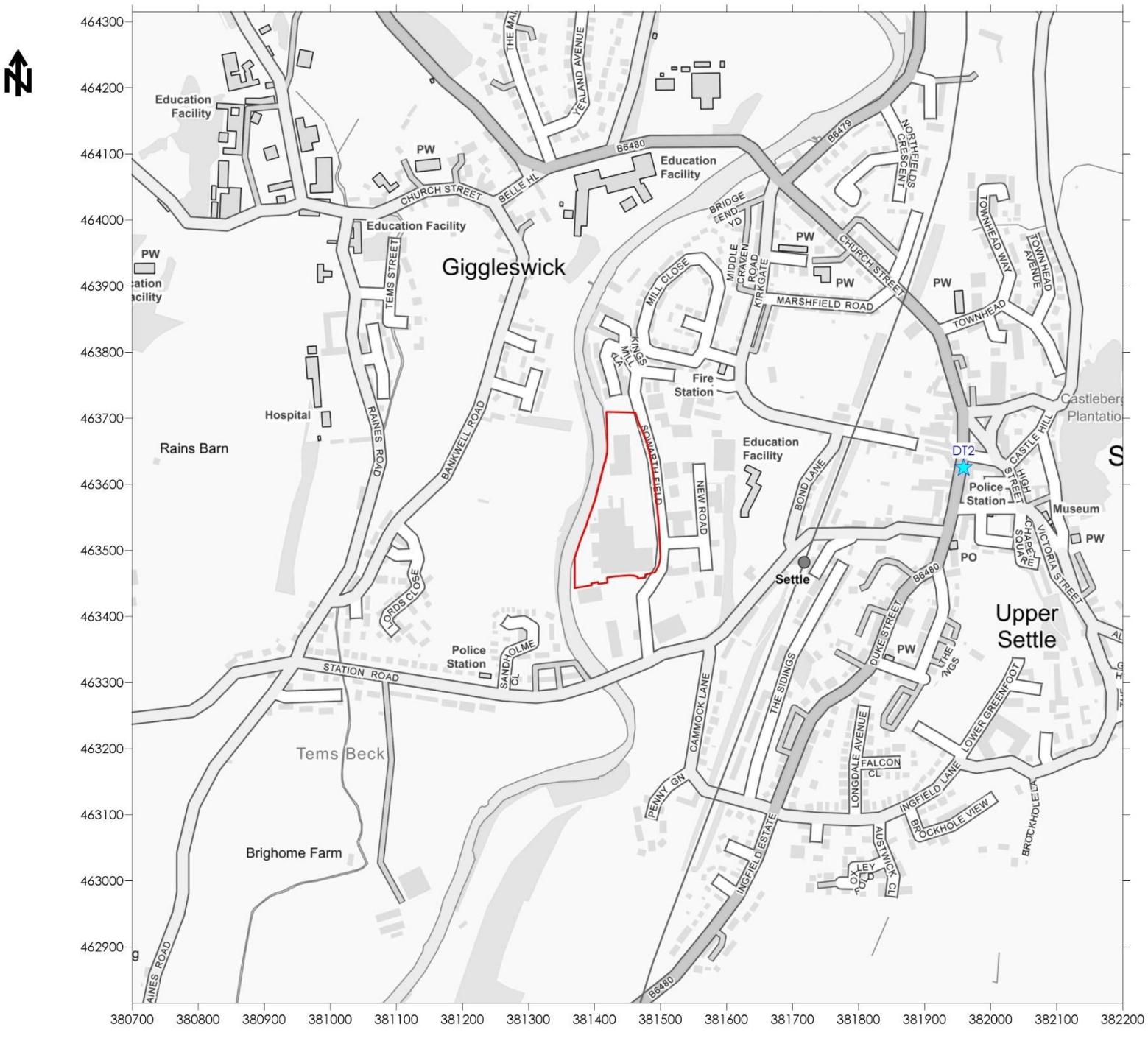

Legend

Site Boundary

Monitor

Title
Figure 2 - Monitoring Location

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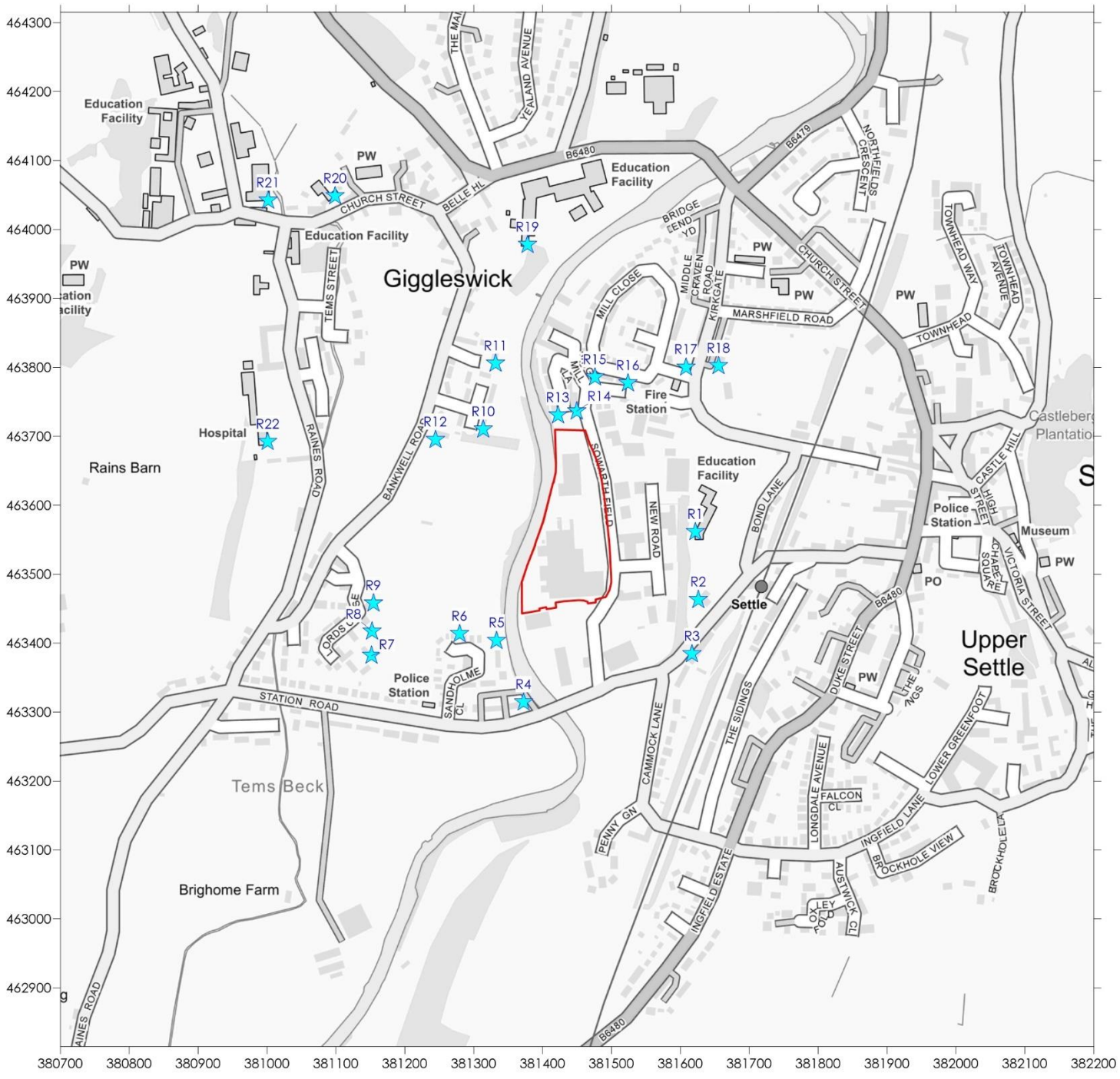

Legend

Site Boundary

Human Receptor

Title
Figure 3 - Human Receptor Locations

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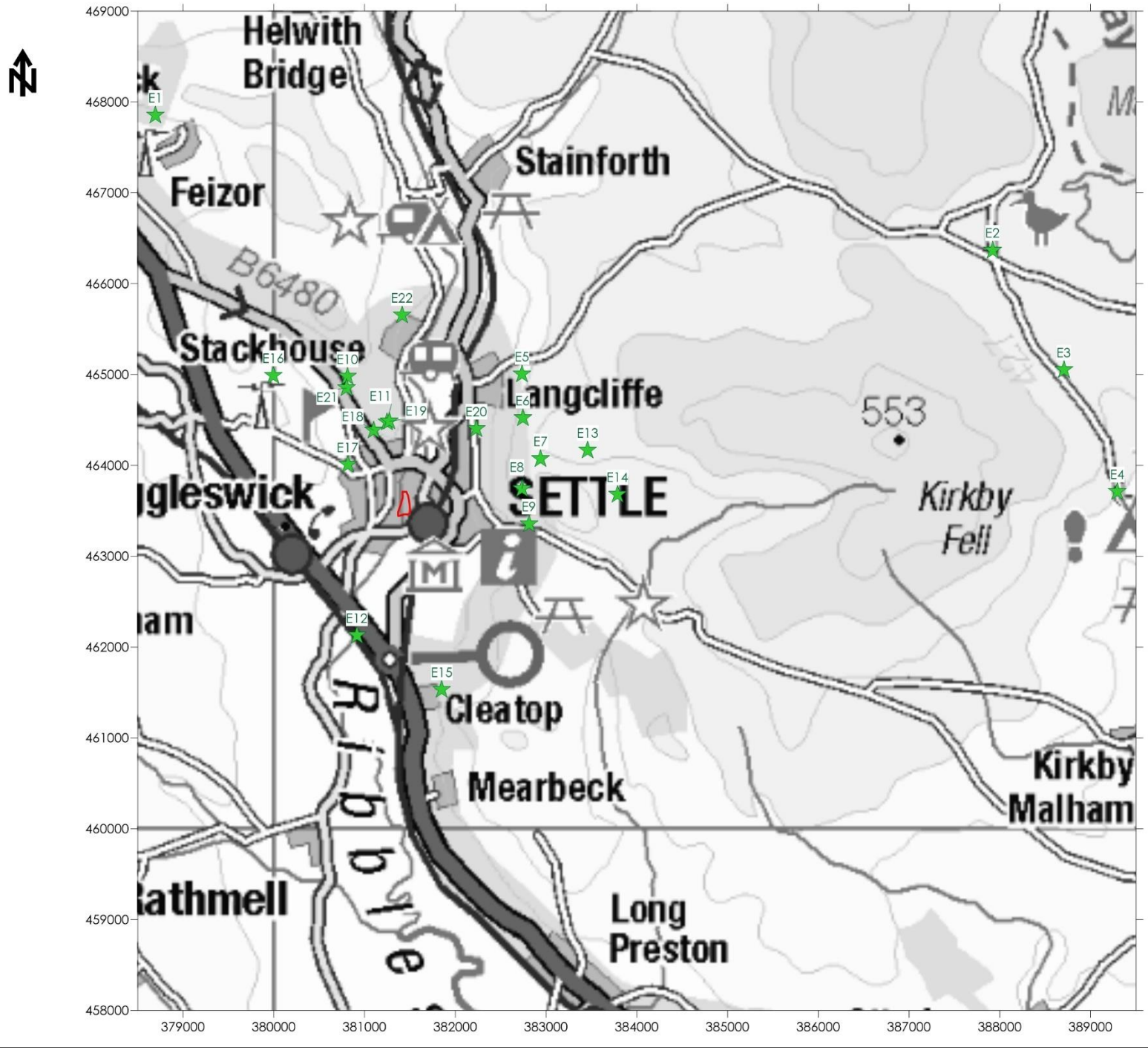

Legend

Site Boundary

Ecological Receptor

Title
Figure 4 - Ecological Receptor Locations

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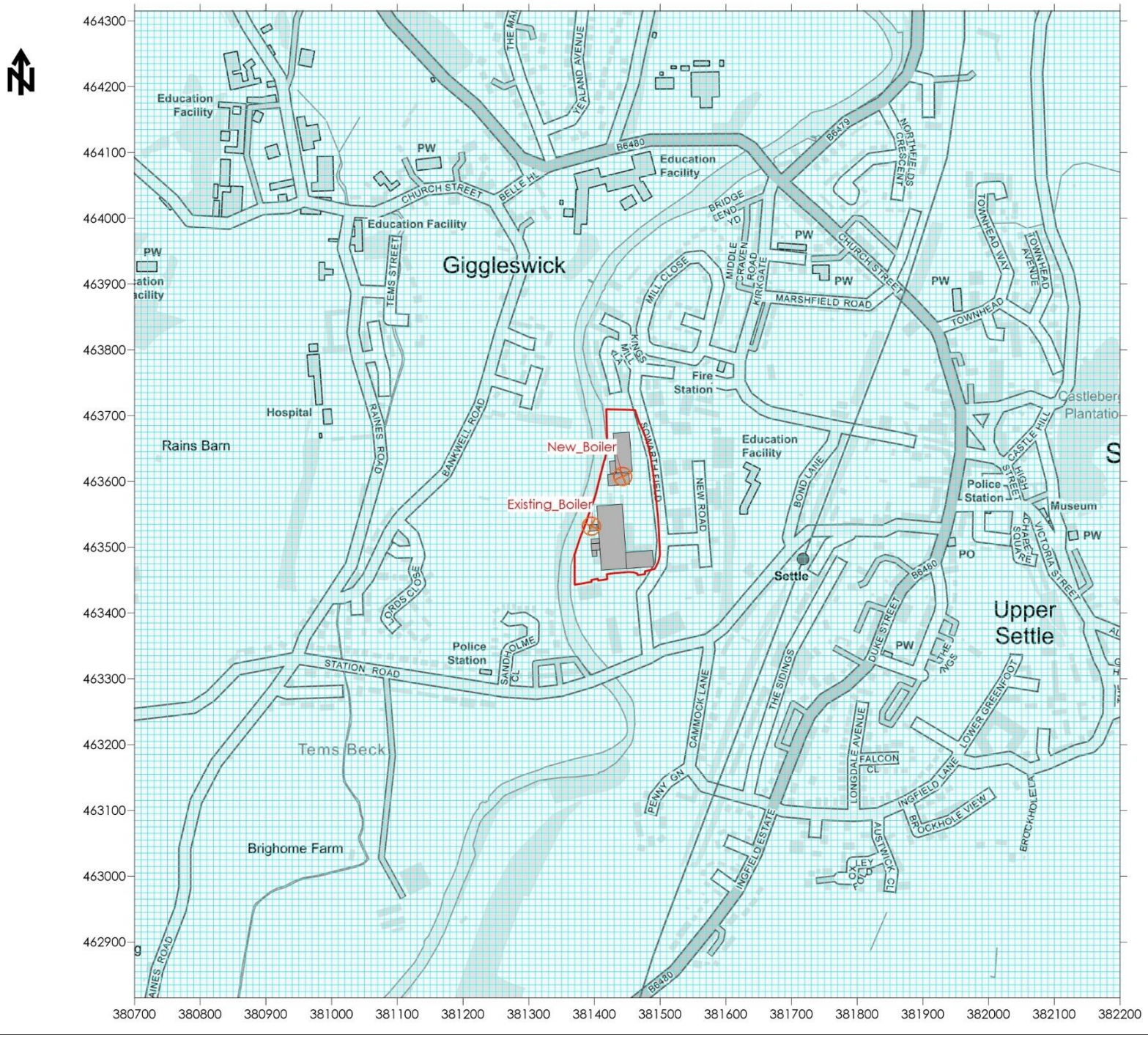

Legend

- Site Boundary
- Stack
- Assessment Grid
- Building

Title
Figure 5 - ADMS-5 Inputs

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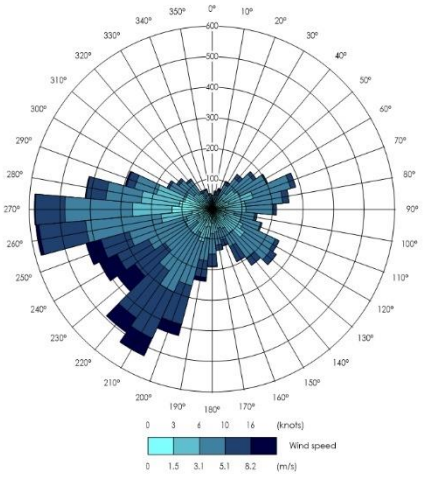
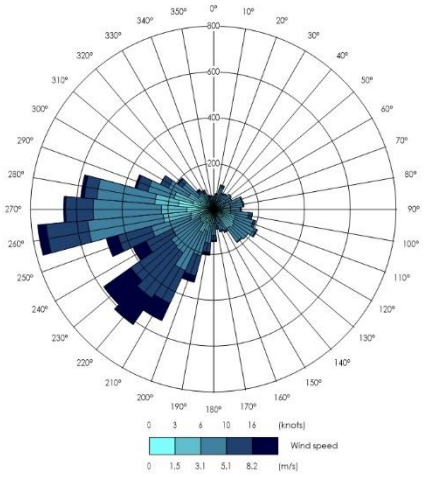
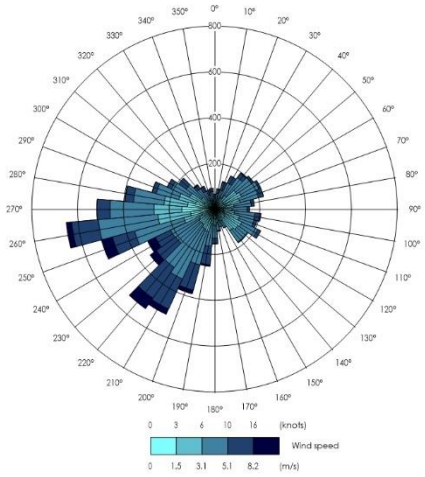


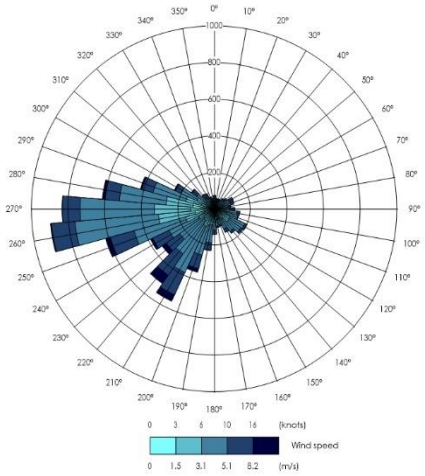
2014 Meteorological Data



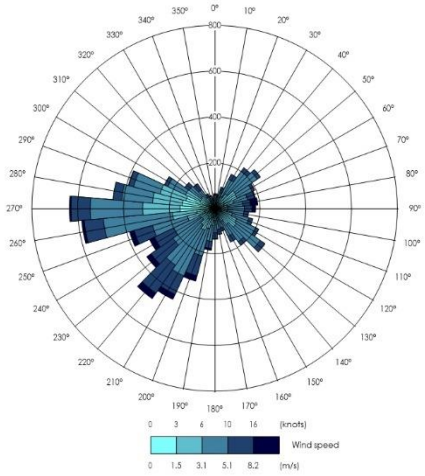
2015 Meteorological Data



2016 Meteorological Data



2017 Meteorological Data



2018 Meteorological Data

Legend

Title
Figure 6 - Wind Roses of 2014 to 2018 Bingley Meteorological Data

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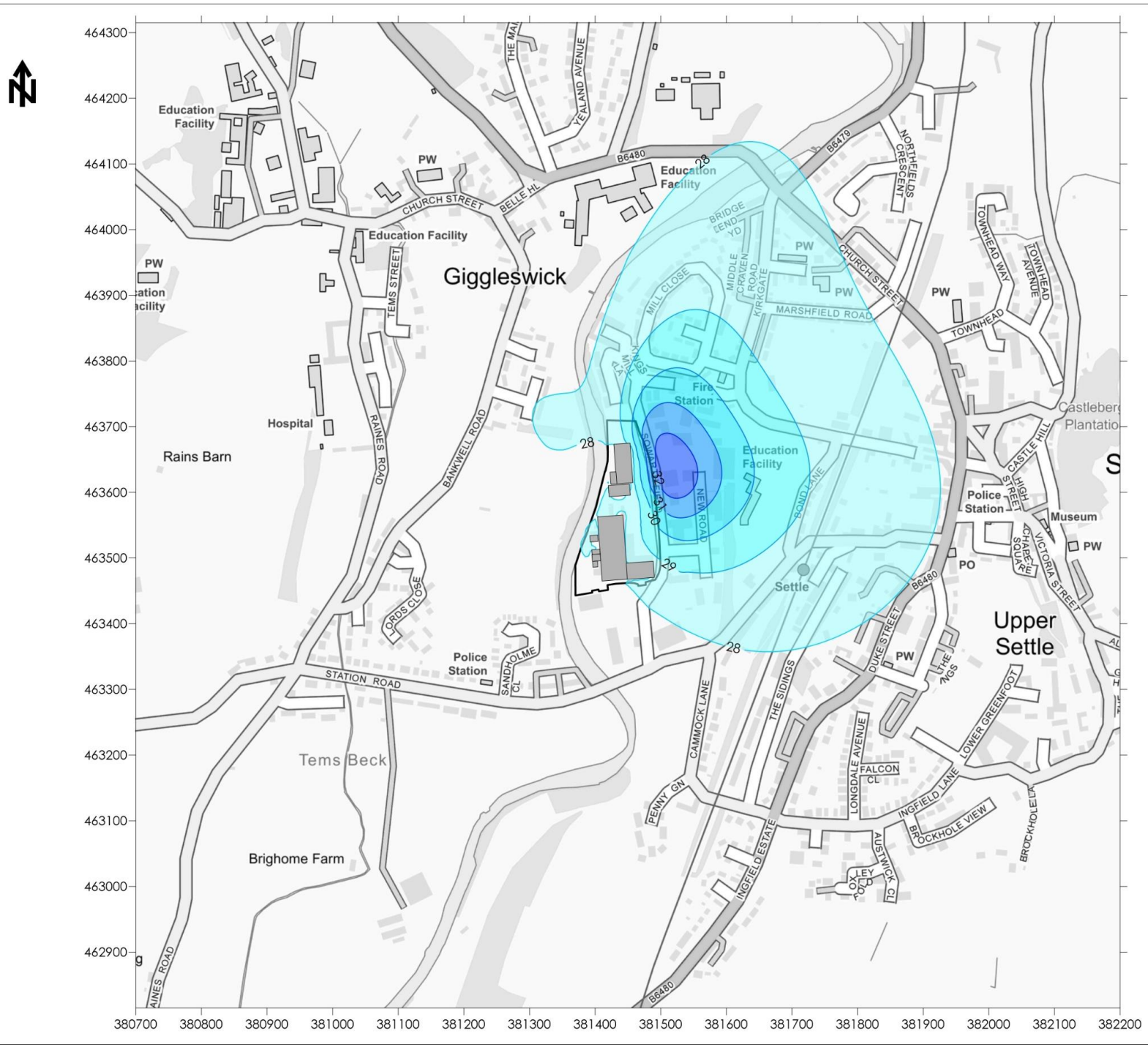

Legend

Site Boundary

Annual Mean NO_2 Concentration ($\mu g/m^3$)

32
31
30
29
28

Title

Figure 7 - Predicted Annual Mean NO_2 Concentration ($\mu g/m^3$) 2017 Meteorological Data

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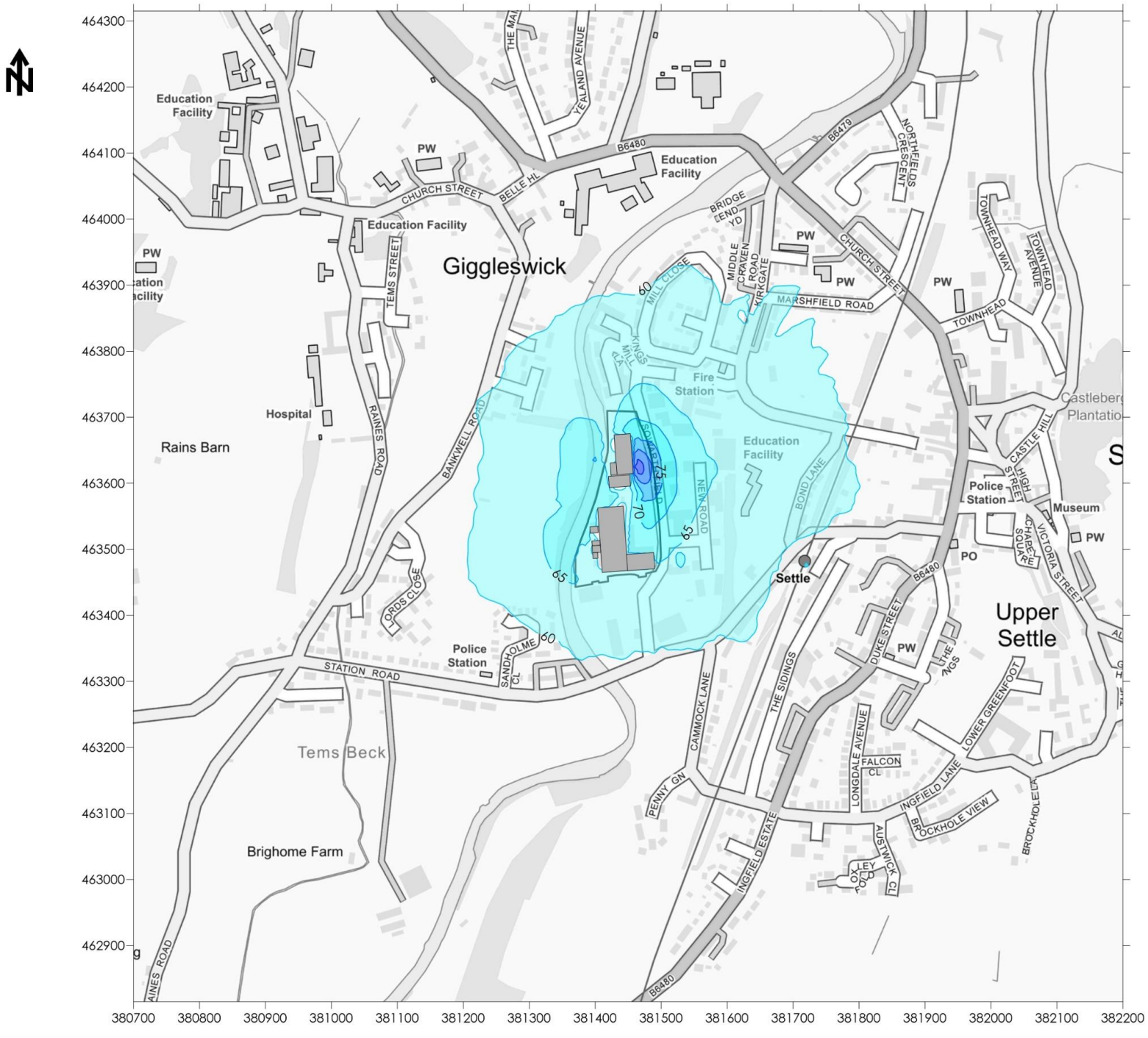

Legend

Site Boundary

Predicted 99.8th %ile 1-hour Mean NO_2 Concentration ($\mu g/m^3$)

60 65 70 75 80 85

Title

Figure 8 - Predicted 99.8th %ile 1-hour Mean NO_2 Concentrations ($\mu g/m^3$)
2017 Meteorological Data

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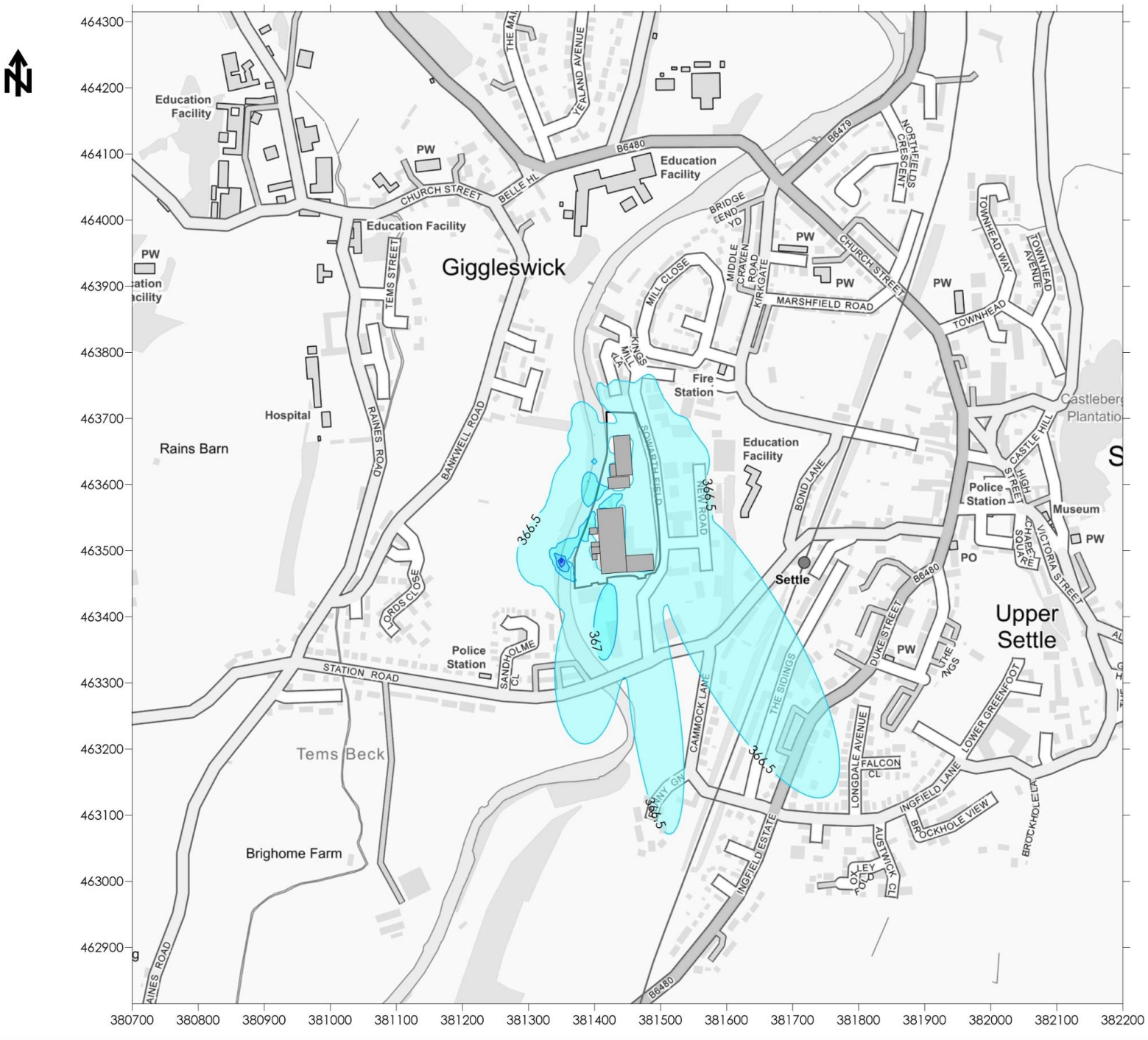

Legend

Site Boundary

Predicted Rolling 8-hour Mean CO Concentration (µg/m³)

368.5
368
367.5
367
366.5

Title

Figure 9 - Predicted Rolling 8-hour Mean CO Concentration (µg/m³) 2014 Meteorological Data

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