Engreen Environmental Consultants Ltd.

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1 Background

1.1 Introduction

This report address the potential impacts of the releases to air on applicable receptors. The assessment is set out in the classical source-pathway-receptor methodology as per the guidance on the "gov.uk" website. Each element is summarised below and the subsequent sections describe the detail of how emissions have been calculated and impacts assessed.

For completeness the report also enumerates the expected GHG and POCP impacts from the combustion processes at the facility.

1.1.1 Source

The installation has a single stationary combustion source with associated air releases:

- Diesel-fired boiler (AR1)

1.1.2 Pathway

The pathway for the pollutants to potentially impact on receptors is by airborne dispersion.

1.1.3 Receptor

The same table of receptors that was assessed for the main environmental risk and impact assessment has been used for this assessment. The receptors relevant to air emissions are set out in the table below.

Table 1.1: Summary of Sensitive Receptors Identified

Nature of Receptor		Direction	Approximate Distance from the Proposed Installation Boundary[3]	Plan Reference [5]
Human Receptors [8]				
Residential / Commercial / Industrial		N	c.240 metres	**R1**
Residential		ENE	c. 900 metres	**R2**
Residential / Commercial / Recreational / Educational		SW	c. 130 metres	**R3**
Residential / Commercial / Industrial / Recreational		W	c. 120 metres	**R4**
Nature and Conservation Receptors[1]				
Local Nature Reserve (LNR) [1, 7]	Willsbridge Valley Local Nature Reserve	SW	c. 1.75 km	**H1**
Priority Habitat Inventory [1]	Deciduous Woodland (England)	E	c. 200 metres	**H2**
	Good quality semi-improved grassland	N	c. 150 metres	**H3**
	Deciduous Woodland (England)	W	c. 385 metres	**H4**
Open Mosaic Habitat (Draft) [1]	Open Mosaic Habitat – Historic Landfill	SE	c. 500 metres	**H5**
Ecological	No Special Protection Areas (SPAs) within 10 km of the installation boundary.			

Table 1.1: Summary of Sensitive Receptors Identified				
Nature of Receptor		**Direction**	**Approximate Distance from the Proposed Installation Boundary[3]**	**Plan Reference [5]**
Screened Receptors [1]	No Special Areas of Conservation (SACs) within 10 km of the installation boundary.			
	No Ramsar sites (protected wetlands) within 10 km of the installation boundary.			
	No Sites of Special Scientific Interest (SSSIs) within 2 km of the installation boundary.			
	No Ancient Woodland within 2km of the installation boundary.			
	No further Local Wildlife Sites within 2km of the installation boundary based on readily accessible data sets searched in May 2021 – Magic: https://magic.defra.gov.uk Bristol City Council website: https://www.bristol.gov.uk/museums-parks-sports-culture/nature-reserves / https://ckan.publishing.service.gov.uk/publisher/bristol-city-council?q=LWS&sort=score+desc%2C+metadata_modified+desc) Gloucestershire Wildlife Trust: https://www.gloucestershirewildlifetrust.co.uk/wildlife/local-wildlife-sites			
	No National Nature Reserves within 2km of the installation boundary.			
Other Receptors				
Air Quality Management Areas [4]	The site is not located within an Air Quality Management Area.			
Notes: *: Closest receptor identified; 1: Receptors identified using the MAGIC Website (unless stated), May 2021. 2: Closest local road network only, identified on OS mapping provided by Promap; 3: Distance shown measured using Ordnance Survey data provided by Promap to closest Identified Receptors; 4: AQMA locations reviewed through DEFRA's website – May 2021 5: Locations shown on Sensitive Receptor Plan, Report Ref P193-R07-F1 6: Flood Zone identified using the .Gov's https://flood-map-for-planning.service.gov.uk/, May 2021 7: Gloucestershire Wildlife Trust, May 2021: https://www.gloucestershirewildlifetrust.co.uk/wildlife/local-wildlife-sites 8: OS mapping, provided by Promap, May 2021				

The receptors include both human health and habitat receptors and the pathway and impact assessments must account for both of these.

For human health receptors the approach is to calculate maximum ground level concentrations of the key pollutants and compare these to published norms using standard significance criteria. If maximum GLC values, calculated using conservative release and dispersion assumptions, are acceptable then impacts at all receptors will also be acceptable.

For ecological receptors the approach is to calculate ground level concentrations at the receptor locations and compare these to published critical level values.

1.1.4 Background

The background concentration of pollutants to be used in detailed assessments, as 2021 values taken from the LAQM data at grid 368500, 172500 are:

- NO_2 = 7.92 µg/m^3
- PM10 = 12.55 µg/m^3
- PM2.5 = 8.18 µg/m^3

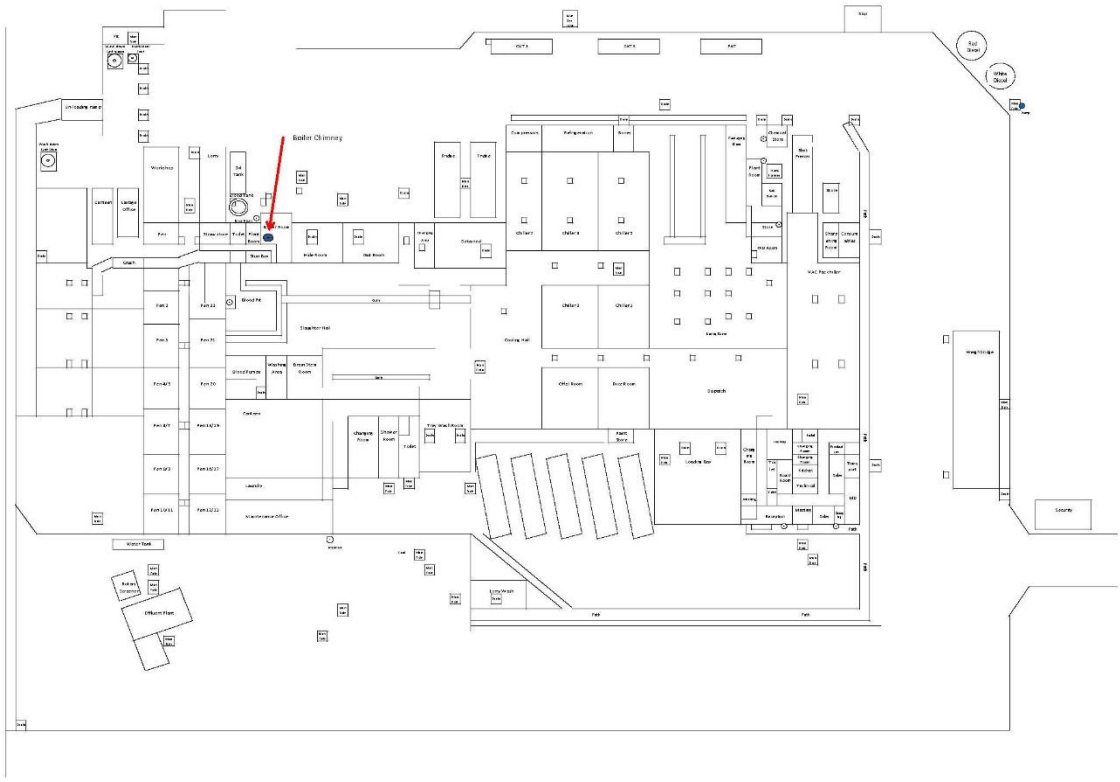
2 Source

2.1 Location

The boiler stack (AR1) is located at ST 68119 72181

2.2 Buildings

There are a number of buildings close to the release stack as shown on the plan below.



For the purposes of accounting for building downwash in the dispersion calculations the buildings can be approximated to a rectangle 130m x 50m and with a height of 4.5m.

2.3 Characteristics

2.3.1 Fuel and Flue Gas

The boiler is a 1000 kg/hr steam raising boiler, equivalent to 0.278 kg/sec.

Typically the sensible and latent heat total to raise plant steam from ambient water is approximately 2600 kJ/kg. Thus the heat into the steam is 2600 * 0.278 = 722 kW.

Taking a thermal efficiency of 80% for the boiler gives a heat input of 903 kW.

According to the UK's DUKES data (Digest of UK Energy Statistics (DUKES): calorific values - GOV.UK (www.gov.uk)) the nett calorific value of diesel is 42.6 MJ/kg.

Fuel use is therefore 0.021 kg/s.

European diesel has an average density of 0.833 kg/litre (Fuels - Densities and Specific Volume (engineeringtoolbox.com)) giving fuel flow 0.025 litre/sec.

Flue gas flow can be estimated from typical factors such as those on the Engineering Toolbox website (Fuels - Combustion Air and Flue Gases (engineeringtoolbox.com)). Typical flue gas for diesel combustion is 10.4 Nm^3/litre. Flue gas flow is then 0.265 Nm^3/sec (953 Nm^3/hr).

2.3.2 Physical Characteristics

Table 2.1: Stack Characteristics		
Stack Parameter	**Units**	**Boiler**
Height	m	9.26
Diameter	m	0.25
Efflux velocity	Am/s	10
Temperature	^oC	240

2.3.3 Emission Rate Factors

To assess impacts it is necessary to know the emission rates of the key potential pollutants. Emission factors are published by the EA (LIT_7825_e97f48.pdf (publishing.service.gov.uk) but cannot be used in this instance since they are limited to boilers above 20MW.

Instead the US EA's AP42 Report on emissions from stationary combustion sources has been used. The AP42 values for the key pollutants are set out in the table below:

Table 2.2: Emission Factors		
Species	**AP42 (lb/10^3gal)**	**Metric (kg/m^3)**
NOx	20	2.4
CO	5	0.6
Particulate	2	0.24
SO_2	0.142	0.017

Sulphur content (S) is 0.001% and AP42 gives sulphur emission as 142S.

2.4 Emissions

2.4.1 Fuel Use

Peak fuel use is as above and is 0.025 litre/sec.

For the calculation of short-term emissions and short-term averages the peak fuel use is used.

For the calculation of longer-term (annual) averages the fuel flowrate needs to be modified to reflect the fact that the boiler is not operational for 100% of the time. Taking a typical 12 hours per weekday and 6 hours per Saturday use the "uptime" of the boiler is 39% and the average fuel use is 0.0098 litre/sec.

2.4.2 Emission Rates

The table below shows the emission rates of the pollutants calculated using the above methodology, factors and fuel use.

Table 2.3: Emission Rates				
Species	**ST (g/s)**	**LT (g/s)**	**ST (mg/m^3)**	**LT (mg/m^3)**
NOx	0.06	0.02357	226.4	88.9
NO_2	0.03	0.02357	113.2	88.9
CO	0.015	0.00589	56.6	22.2
Particulate	0.006	0.00236	22.6	8.9
SO_2	0.000425	0.00017	1.6	0.6

To give a fully conservative assessment the particulate emission figure above was used for both the PM10 and PM2.5 calculations.

2.4.3 GHG Emissions

Latest guidance (Greenhouse gas reporting: conversion factors 2020 - GOV.UK (www.gov.uk)) gives a greenhouse gas emission (GHG) factor of 2.758 kg CO_{2e} per litre gas oil.

Gas oil use = 309053 litre/yr

GHG = 852 Te/yr CO_{2e}

2.4.4 POCP Emissions

AP42 gives VOC emission factors for gas-oil combustion as:

NMVOC	0.0001068	kg/kg
CH4	3.935E-05	kg/kg

These can be used together with the annual fuel use to derive an estimated total VOC release from the gas-oil combustion of 37.6 kg/yr. This needs to be converted to a xylene equivalent to give an estimated overall POCP value. Guidance is available in an old DETR report Development of Species Profiles for UK Emissions of VOCs (defra.gov.uk)) to convert un-speciated VOCs to their xylene equivalent. The document gives a factor of 71.9% for kerosene (gas-oil). Applying this value to the total fuel use and the AP42 factors gives and estimated POCP value of 27.1 kg/yr xylene equivalent.

3 Modelling

3.1 Approach

3.1.1 Human Health Impact

For human health receptors the approach is to calculate maximum ground level concentrations of the key pollutants and compare these to published norms using standard significance criteria. If maximum GLC values, calculated using conservative release and dispersion assumptions, are acceptable then impacts at all receptors will also be acceptable. Key Pollutants

The key pollutants from diesel/kerosene combustion will be NOx, SO_2, Particulate and CO. Following guidance on air emissions ground level concentrations can be treated as "insignificant" where their concentration or process contribution is less than 1% of the long term environmental benchmark or less than 10% of the short term environmental benchmark.

The environmental benchmarks are the Air Quality Objective values that have been set for NO_2, CO and particulate. These are set out in the table below.

Table 3.1 - Air Quality Objective Concentrations µg/m³

Pollutant	Hourly	Daily	Annual
NO_2	200[2]	-	40
CO	-	10,000	-
PM_{10}	-	50[1]	40
$PM_{2.5}$			25
SO_2	350[3]	125[4]	

1. Not to be exceeded more than 35 times per year
2. Not to be exceeded more than 18 times per year
3. Not to be exceeded more than 24 times per year
4. Not to be exceeded more than 3 times per year

3.1.2 Ecological Impact

Guidance for evaluating impacts on habitats sites is published at gov.uk. The guidance suggests using a critical concentration analysis. This analysis compares calculated ground level concentrations to published insignificance criteria.

The relevant pollutants for this study are nitrogen oxides, expressed as NO_2. The criteria listed on gov.uk are:

- 30 µg/m³ annual NO_2
- 75 µg/m³ daily NO_2

These habitats are local nature sites and therefore the criteria for insignificance are for the PC values to be less than 100% of the relevant standard.

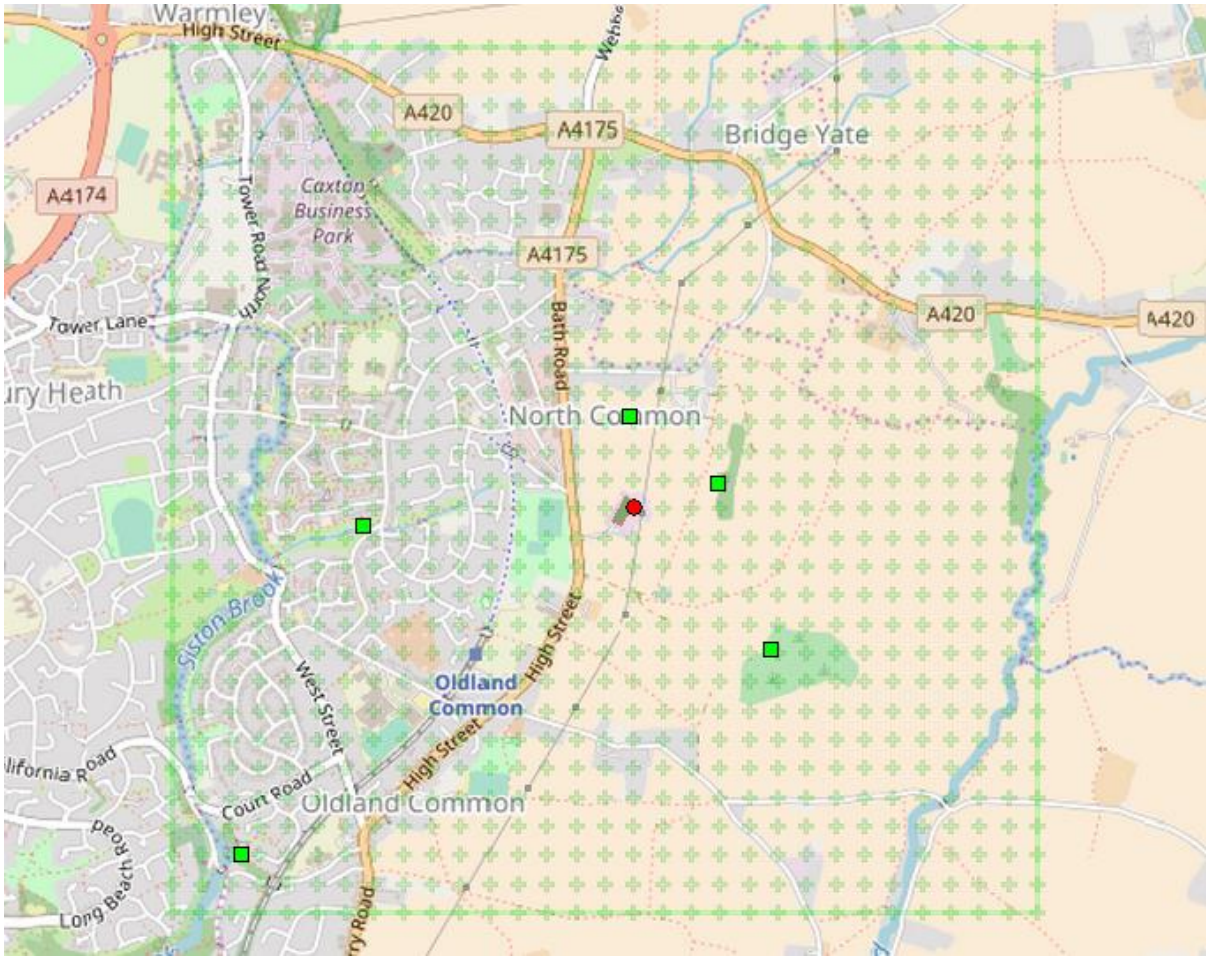
3.2 Background

As part of the assessment process, data is required on the background concentration of particulate and NO_2. The background concentration of pollutants to be used in detailed assessments, as 2021 values taken from the LAQM data at grid 346500, 461500 are:

- NO_2 = 7.92 µg/m³
- PM10 = 12.55 µg/m³
- PM2.5 = 8.18 µg/m³

3.3 Map

The map fragment below shows the location of the receptors relative to site.



3.4 ADMS Modelling

The release parameters above were used as input values for an ADMS assessment. Key elements of the model are set out below.

3.4.1 Terrain

The sensitive receptors and the sources are at approximately the same overall height and the intervening terrain has no major height features. The ADMS manual and EA modelling guidance both state that terrain files are not needed where slopes are <1:10. This condition applies to the current situation and there is therefore no need to input terrain files.

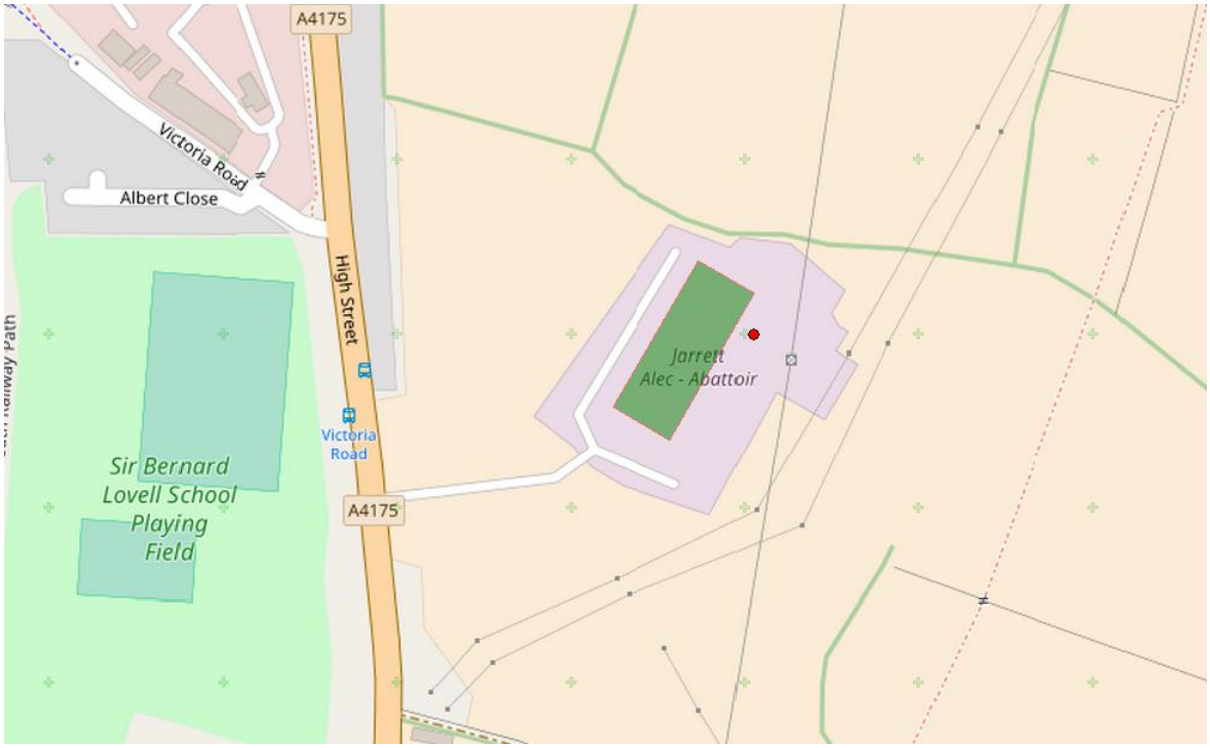
3.4.2 Surface Roughness

The ADMS default surface roughness value of 0.1 has been used in the model.

3.4.3 Buildings

Building downwash in the dispersion calculations was accounted for by approximating the site buildings to an equivalent rectangle 130m x 50m and with a height of 4.5m.

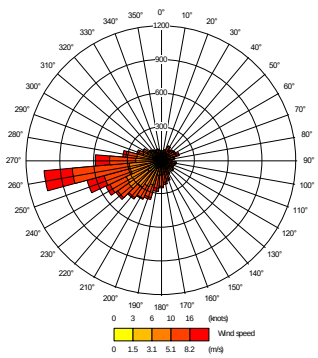
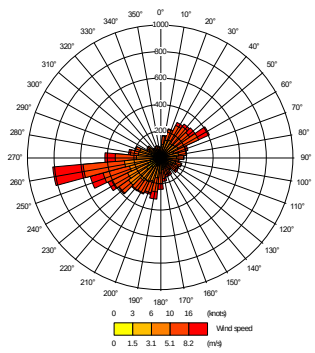
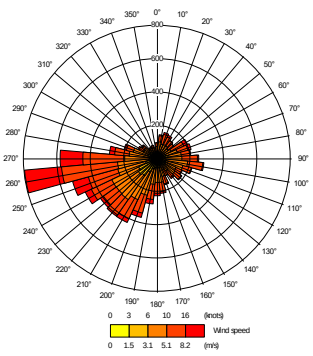
The stack location and equivalent building are shown in the plan below:



3.4.4 Meteorology

As per guidance it was considered that 3 years of sequential met data would be sufficient for this study. The closest weather station with good quality data is at Bristol Filton. Hourly sequential data for 2017, 2018 and 2019 were purchased from AirpollutionServices and used for the dispersion assessment.

The wind roses for the 3 years are set out below:

2017	2018	2019
		

3.4.5 Habitats Receptors

The list of receptors includes woodland and meadow habitats within 2km. Guidance for evaluating impacts on such sites is published at gov.uk. The guidance suggests using a critical concentration analysis. This analysis compares calculated ground level concentrations to published insignificance criteria.

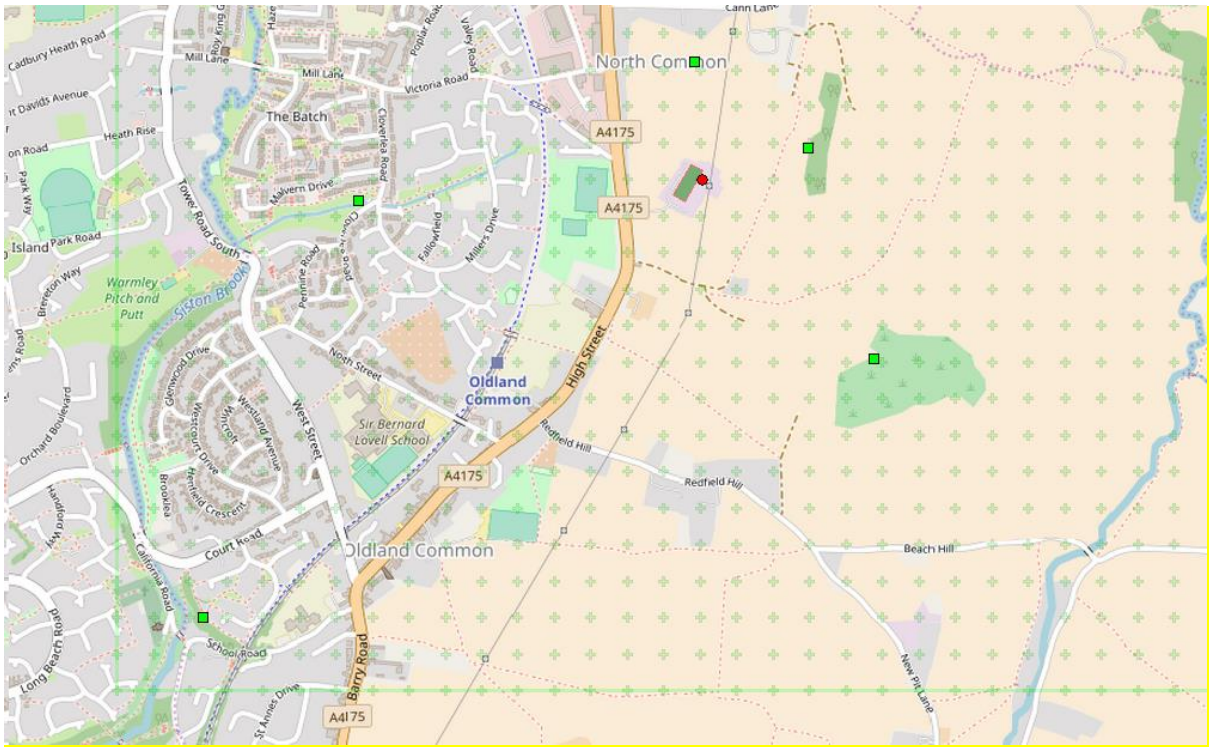
The relevant pollutant for this study is NO_2. The criteria listed on gov.uk are:

- 30 µg/m^3 annual

- 75 µg/m^3 daily

These habitats are local nature sites and therefore the criteria for insignificance are for the PC values to be less than 100% of the relevant standard.

Specific receptors were modelled at the habitat locations as shown in the plan below



4 Results and Impacts

4.1 Combustion Emission Results

4.1.1 Short-term Results

The predicted maximum hourly, 8-hourly and daily average ground level concentrations are:

Table 4.1: Short term results			
Pollutant	**2017 PC Value (µg/m³)**	**2018 PC Value (µg/m³)**	**2019 PC Value (µg/m³)**
NO_2	11.6	11.1	11.8
CO	0.004	0.004	0.004
Particulate	0.49	0.59	0.49
SO_2	0.16	0.15	0.16

- NO_2 corrected to 50% of modelled NOx value as per guidance.

4.1.2 Annual Results

The predicted annual average ground level concentrations are:

Table 4.2: Annual Results			
Pollutant	**2017 PC Value (µg/m³)**	**2018 PC Value (µg/m³)**	**2019 PC Value (µg/m³)**
NO_2	1.76	2.40	1.83
Particulate	0.18	0.24	0.18

4.2 NO_2 Human Impacts

4.2.1 Annual NO_2 Impact

The predicted annual average ground level concentrations are very similar giving a high degree of confidence in the values. The maximum GLC is in 2018 at 2.40 µg/m³. This is not immediately insignificant and the PEC needs to be calculated and evaluated.

The PEC (Process Environmental Contribution) is 10.3 µg/m³. The assessment criterion for insignificance is:

PC long term + background < 70% standard

For NO_2 the PEC of 10.3 µg/m³ is well below the assessment criterion of 28.0 µg/m³ and the impact is non-significant and no further assessment is required.

4.2.2 Hourly NO_2 Impact

The maximum predicted hourly PC is 11.8 µg/m³. This value is considerably below 10% of the AQS and is insignificant.

4.3 CO Impact

The maximum predicted daily average process contribution is well below the assessment criterion of 100µg/m³ and the impact is insignificant.

4.4 Particulate Impact

4.4.1 Annual Particulate

The maximum predicted annual total particulate ground level concentration is less than 1% of the relevant AQS for PM10 and PM2.5 and is insignificant.

4.4.2 Daily Particulate

The maximum predicted daily particulate ground level concentration is less than 10% of the relevant AQS and is insignificant.

4.5 Ecological Impact

4.5.1 Results

Table 4.3: Ecological impact results

Pollutant	2017 PC Value (µg/m^3)	2018 PC Value (µg/m$^{3)}$	2019 PC Value (µg/m^3)
NO_2 Annual	0.18	0.15	0.15
NO_2 Daily	1.79	2.11	1.75

4.5.2 Short-term Impacts

All predicted concentrations are greatly less than 100% of the standard and the impacts are insignificant.

4.5.3 Long-term Impacts

All predicted concentrations are greatly less than 100% of the standard and the impacts are insignificant.

4.6 Sensitivity

4.6.1 General

For the combustion gas emissions a number of highly conservative assumptions have been made in addressing significance:

- 3 years of weather data have been used and the worst case rather than the mean impact taken for assessment of significance.
- Emissions have been calculated at maximum expected emission levels. In practice actual emissions will be lower.
- Maximum ground level impact values have been used rather than calculations at specific receptors.

These conservative assumptions take the place of a sensitivity analysis in that results shown to be acceptable under these assumptions will be acceptable under all likely conditions.

The calculated PCs at all specified habitat receptors meet the insignificance criteria by some margin and there is therefore no need for further assessment.

4.7 Conclusion

Representative combustion gas emission rates have been calculated.

The emissions have been modelled using ADMS 5 and allowing for building downwash; three consecutive years of meteorological file data has been used to derive conservative results. The maximum value for each pollutant has been used to provide a very conservative impact assessment.

Predicted ground level concentrations have been compared to insignificance criteria and all have been shown to be below the criteria for significance and further assessment.