Air Quality Assessment:
Gas Power Generation Facility, Oaks Lane, Barnsley

June 2017



Experts in air quality management & assessment

Document Control

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1 Introduction

1.1 This report considers the potential for human-health-related air quality impacts associated with the proposed natural-gas power-generation facility at Oaks Lane, Barnsley. The assessment has been carried out by Air Quality Consultants Ltd on behalf of Peak Power Connection Ltd.

1.2 The proposed development will involve the installation of 10 natural-gas generators housed within individual containers. There will also be some associated infrastructure, such as transformers etc. The facility will provide up to ~20 MW_e of reserve electricity to the national grid from the 10 generators. The plant will operate for short periods of time when there is demand and, as such, the exact operation schedule is unknown. For the purposes of this assessment an assumed annual operation of 2,000 hours has been considered.

1.3 Emissions from natural gas combustion have the potential to impact on local air quality. The main air pollutant of concern from the combustion of natural gas is nitrogen dioxide.

1.4 Fuel will be supplied to site via gas lines from the national grid and thus vehicular access will be limited to site maintenance. As such, the impacts of traffic generated by the proposed development can be screened out as *insignificant* and this is not considered further.

1.5 This report has been prepared taking into account relevant local and national guidance and regulations, and consideration has been given to the new Medium Combustion Plant Directive that is soon to be transposed into UK regulations. Where appropriate the assessment has followed a worst-case, and thus conservative, approach so as not to underestimate the impacts of the proposed facility.

2 Policy Context and Assessment Criteria

Air Quality Strategy

2.1 The Air Quality Strategy (Defra, 2007) published by the Department for Environment, Food, and Rural Affairs (Defra) and Devolved Administrations, provides the policy framework for air quality management and assessment in the UK. It provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. Local authorities are seen to play a particularly important role. The strategy describes the Local Air Quality Management (LAQM) regime that has been established, whereby every authority has to carry out regular reviews and assessments of air quality in its area to identify whether the objectives have been, or will be, achieved at relevant locations, by the applicable date. If this is not the case, the authority must declare an Air Quality Management Area (AQMA), and prepare an action plan which identifies appropriate measures that will be introduced in pursuit of the objectives.

Medium Combustion Plant (MCP) Directive

2.2 The European Union regulates pollutant emissions from combustion plant with a rated input between 1 and 50 megawatts (MW_{th}) in its Medium Combustion Plant (MCP) Directive (Directive 2015/2193/EU of the European Parliament and of the Council, 2015). The MCP Directive entered into force in December 2015 and must be transposed into UK law by December 2017.

2.3 The MCP Directive sets emission limits, to be applied from December 2018 for new plant and by 2025 or 2030 for existing plant; depending on plant size. The NOx emission limit for existing engines operating on natural gas is 190 mg/Nm^3, this will need to be met by 2024. New engines will need to operate with a NOx emission limit of 95 mg/Nm^3. Member States may choose to exempt existing plant which operate for fewer than 500 hours per year, but current indications are that the UK Government will not apply this exemption (Department of Energy and Climate Change, 2016). Defra is currently consulting on how to transpose the MCP into UK law (Defra, 2017).

Clean Air Act 1993 & Environmental Protection Act

2.4 Small combustion plant of less than 20 MW net rated thermal input are currently controlled under the Clean Air Act 1993 (HMSO, 1993a). This requires the local authority to approve the chimney height. Plant which are smaller than 366 kW have no such requirement.

2.5 Measures to ensure adequate dispersion of emissions from discharging stacks and vents are included in Technical Guidance Note D1 (Dispersion) (HMSO, 1993b), issued in support of the Environmental Protection Act (HMSO, 1990).

Planning Policy

National Policies

2.6 The National Planning Policy Framework (NPPF) (2012) sets out planning policy for England in one place. It places a general presumption in favour of sustainable development, stressing the importance of local development plans, and states that the planning system should perform an environmental role to minimise pollution. One of the twelve core planning principles notes that planning should *"contribute to…reducing pollution"*. To prevent unacceptable risks from air pollution, planning decisions should ensure that new development is appropriate for its location. The NPPF states that the effects of pollution on health and the sensitivity of the area and the development should be taken into account.

2.7 More specifically the NPPF makes clear that:

"Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan".

2.8 The NPPF is now supported by Planning Practice Guidance (PPG) (DCLG, 2014), which includes guiding principles on how planning can take account of the impacts of new development on air quality. The PPG states that *"Defra carries out an annual national assessment of air quality using modelling and monitoring to determine compliance with EU Limit Values"* and *"It is important that the potential impact of new development on air quality is taken into account … where the national assessment indicates that relevant limits have been exceeded or are near the limit".* The role of the local authorities is covered by the LAQM regime, with the PPG stating that local authority Air Quality Action Plans "*identify measures that will be introduced in pursuit of the objectives*".

2.9 The PPG states that:

"Whether or not air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to generate air quality impact in an area where air quality is known to be poor. They could also arise where the development is likely to adversely impact upon the implementation of air quality strategies and action plans and/or, in particular, lead to a breach of EU legislation (including that applicable to wildlife)".

2.10 The PPG sets out the information that may be required in an air quality assessment, making clear that *"Assessments should be proportional to the nature and scale of development proposed and the level of concern about air quality"*. It also provides guidance on options for mitigating air quality impacts, as well as examples of the types of measures to be considered. It makes clear that

"Mitigation options where necessary, will depend on the proposed development and should be proportionate to the likely impact".

Local Policies

2.11 The Barnsley Local Plan is currently being prepared, and was submitted to the Secretary of State for Communities and Local Government for examination in December 2016 (Barnsley Metropolitan Borough Council, 2016). The new Local Plan sets out the council's strategic vision, and priorities for housing, employment and commercial development, including transport infrastructure and protection of the local environment. Until the Local Plan is adopted, 'saved' policies from the Unitary Development Plan (UDP) will continue to form part of the policy context for planning decisions, together with the adopted Core Strategy, Joint Waste Plan and current national planning policies.

2.12 Within the adopted Core Strategy (Barnsley Metropolitan Borough Council, 2011) there are two policies pertaining to air quality and pollution:

2.13 Policy CSP 41 – Development in Air Quality Management Areas:

"Development which impacts on areas sensitive to air pollution in air quality management areas will be expected to demonstrate that it will not have a harmful effect on the health or living conditions of any future users of the development in terms of air quality (including residents, employees, visitors and customers), taking into account any suitable and proportionate mitigation required for the development.

We will only allow residential development which impacts on areas sensitive to air pollution, where the developer provides an assessment that shows living conditions will be acceptable for future residents, subject to any required mitigation.

We will only allow development which impacts on areas sensitive to air pollution which could cause more air pollution, where the developer provides an assessment that shows there will not be a significantly harmful effect on air quality, subject to any required mitigation.

Furthermore, development which impacts on areas sensitive to air pollution due to traffic emissions will be expected to demonstrate suitable and proportionate mitigation relative to the increased traffic emissions generated by the development."

2.14 Policy CSP 40 - Pollution Control and Protection:

"Development will be expected to demonstrate that it is not likely to result, directly or indirectly, in an increase in air, surface water and groundwater, noise, smell, dust, vibration, light or other pollution which would unacceptably affect or cause a nuisance to the natural and built environment or to people.

We will not allow development of new housing or other environmentally sensitive development where existing air pollution, noise, smell, dust, vibration, light or other pollution levels are unacceptable and there is no reasonable prospect that these can be mitigated against.

Developers will be expected to minimize the effects of any possible pollution and provide mitigation measures where appropriate."

Air Quality and Emissions Good Practice Planning Guidance

2.15 The Metropolitan Borough of Barnsley (Barnsley MBC) has issued planning guidance that sets out the assessment methods expected within an air quality assessment to be submitted to the Council (Barnsley Metropolitan Borough Council, 2014).

Air Quality Action Plans

National Air Quality Plans

2.16 Defra has produced Air Quality Plans to reduce nitrogen dioxide concentrations in major cities throughout the UK (Defra, 2015). Along with a suite of national measures, the Air Quality Plans identify the need to establish Clean Air Zones within five Zones (Birmingham, Leeds, Southampton, Nottingham and Derby) where exceedances of the EU limit values for nitrogen dioxide have been forecast in 2020 and beyond. Within these Zones, lower-emission vehicles will be encouraged. The precise nature of these Clean Air Zones is still to be decided. In Greater London, Defra will continue to support and monitor the delivery of the Mayor's plans for improving air quality to meet the EU limit value for nitrogen dioxide by 2025. The proposed development is not located in any of these zones.

2.17 There is currently no practical way to take account of the effects of these Air Quality Plans on the modelling presented in this report, which is for assessment against the air quality objectives rather than the EU limit values.

Local Air Quality Action Plans

2.18 The Barnsley Air Quality Action Plan (Barnsley MBC, 2017), issued in April 2017, outlines several actions the Council wishes to pursue in order to improve air quality in the borough. These are primarily targeted at the borough's 6 AQMAs, declared along busy roads where traffic emissions are the principal pollution source.

Assessment Criteria

2.19 The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small.

They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality (England) Regulations, 2000, Statutory Instrument 928 (2000) and the Air Quality (England) (Amendment) Regulations 2002, Statutory Instrument 3043 (2002).

2.20 The objectives for nitrogen dioxide were to have been achieved by 2005, and continue to apply in all future years thereafter.

2.21 The objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Defra explains where these objectives will apply in its Local Air Quality Management Technical Guidance (Defra, 2016). The annual mean objective for nitrogen dioxide is considered to apply at the façades of residential properties, schools, hospitals etc.; they do not apply at hotels. The 1-hour mean objective for nitrogen dioxide applies wherever members of the public might regularly spend 1-hour or more, including outdoor eating locations, gardens and fishing areas. Further details on relevant locations for members of the public can be found in the note published by Air Quality Consultants (AQC, 2016).

2.22 The European Union has also set limit values for nitrogen dioxide. The limit values for nitrogen dioxide are the same numerical concentrations as the UK objectives, but achievement of these values is a national obligation rather than a local one (Directive 2008/50/EC of the European Parliament and of the Council, 2008). In the UK, only monitoring and modelling carried out by UK Central Government meets the specification required to assess compliance with the limit values. Central Government does not recognise local authority monitoring or local modelling studies when determining the likelihood of the limit values being exceeded.

2.23 The relevant air quality criteria for this assessment are provided in Table 1.

Table 1: Air Quality Criteria for Nitrogen Dioxide

Pollutant	Time Period	Objective
Nitrogen Dioxide	1-hour Mean	200 μg/m^3 not to be exceeded more than 18 times a year
	Annual Mean	40 μg/m^3

2.24 The approach developed jointly by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)[1] (Moorcroft and Barrowcliffe et al., 2017) provides a method for defining a description of the impacts on local air quality arising from the development. Impact

[1] The IAQM is the professional body for air quality practitioners in the UK.

description involves expressing the magnitude of incremental change as a proportion of a relevant assessment level and then examining this change in the context of the new total concentration and its relationship with the assessment criterion. Table 2 sets out the matrix for determining the impact descriptor for annual mean concentrations at individual receptors, having been adapted from the table presented in the guidance document.

2.25 From this it can be inferred that any change in concentration:

- smaller than 0.5% (0.2 μg/m^3) of the long-term (annual mean) environmental standard will be *negligible*, regardless of the existing air quality conditions;
- any change smaller than 1.5% (0.6 μg/m^3) of the long-term environmental standard will be *negligible* so long as the total (with-scheme) concentration is less than 94% (37.8 μg/m^3) of the standard; and
- any change smaller than 5.5% (2.2 μg/m^3) of the long-term environmental standard will be *negligible* so long as the total (with-scheme) concentration is less than 75% (30.2 μg/m^3) of the standard.

Table 2: Air Quality Impact Descriptors for Individual Receptors for Annual Mean Nitrogen Dioxide Concentrations

Annual Mean Concentration At Receptor In Assessment Year (μg/m^3)	Change in Concentration (μg/m^3)				
	<0.2	0.2-0.6	0.6-2.2	2.2-4.0	>4.0
<30.2	Negligible	Negligible	Negligible	Slight	Moderate
30.2-37.8	Negligible	Negligible	Slight	Moderate	Moderate
37.8-41.0	Negligible	Slight	Moderate	Moderate	Substantial
41.0-43.8	Negligible	Moderate	Moderate	Substantial	Substantial
>43.8	Negligible	Moderate	Substantial	Substantial	Substantial

2.26 Where the impacts are *negligible* the overall significant is thus 'not significant'. Where these criteria are breached then a more detailed assessment may be required.

Short-term (1-hour)

2.27 Given that the short-term objective considers the number of hours exceeding a standard rather than being a single concentration not to be exceeded, it is not possible to usefully assign a magnitude of change. The objective and limit value allow 18 hours a year to exceed the standard of 200 μg/m^3, which can also be expressed as a 99.79th percentile of hourly concentrations. Where the assessed total percentile concentrations, detailed in Appendix A2, are below 200 μg/m^3, based on worst-case modelling assumptions for NOx to NO_2 ratios and baseline concentrations, the impacts in relation to the short-term objective are considered to be negligible.

3 Assessment Approach

Existing Conditions

3.1 Information on existing air quality has been obtained by collating the results of monitoring carried out by the local authority. Background concentrations have been defined using the national pollution maps published by Defra (2017a). These cover the whole country on a 1x1 km grid.

3.2 Exceedances of the annual mean EU limit value for nitrogen dioxide in the study area have been identified using the maps of roadside concentrations published by Defra for 2015 (Defra, 2017c) and for 2020 (Defra, 2016d). These are the maps used by the UK Government, together with the results from national AURN monitoring sites that operate to EU data quality standards, to report exceedances of the limit value to the EU. The maps are currently available for the past years 2001 to 2015 and the future years 2020, 2025 and 2030.

Modelling Methodology

3.3 The impacts of emissions from the proposed facility have been modelled using the ADMS-5.2 dispersion model. ADMS-5.2 is a new generation model that incorporates a state-of-the-art understanding of the dispersion processes within the atmospheric boundary layer. The model input parameters are set out in Appendix A2.

Operating Hours

3.4 Operation of the proposed generators is expected to be limited to when there is demand for the power. There will, however, be some flexibility around this. The operational scenario considered within this assessment is 2,000 annual hours.

3.5 Since the precise hours when the plant will operate are not known, and in order to provide a worst-case assessment, it has been assumed that all the generators will run constantly for 24 hours every day of the year. The predicted annual mean concentrations have been factored to account for the 2,000 hours of operation, as described in Appendix A2. For the assessment of short-term impacts, it has been assumed that the generators will operate continuously to ensure all meteorological conditions are covered.

Receptor Grid

3.6 Concentrations have been predicted across nested Cartesian grids. These grids have a spacing of 5 m x 5 m within 200 m of the facility, 25 m x 25 m within 400 m of the facility, 50 m x 50 m within 1,000 m of the facility, 250 m x 250 m within 2,000 m of the facility and 500 m x 500 m within 5,000 m of the facility. The receptor grid has been modelled at a height of 1.5 m above ground level.

Meteorological Data

3.7 In order to allow for uncertainties in local and future-year meteorological conditions, the dispersion model has been run 5 times, with each run using a different full year of hour-by-hour meteorological data from the nearest appropriate meteorological site. For each individual receptor point on the nested Cartesian grid, the maximum predicted concentration across any of the 5 meteorological datasets has then been determined. It is these maxima which are presented. This approach provides a degree of conservatism and will tend to over-predict the impacts of the facility. Further details of this approach, as well as the meteorological datasets used, are provided in Appendix A2.

Model Result Processing

3.8 Details on how the model outputs have been processed, including the NOx to NO_2 relationship and how the short-term operating hours have been accounted for, are set out in Appendix A2.

Additional Sources of Uncertainty

3.9 The point source dispersion model used in the assessment is dependent upon emission rates, flow rates, exhaust temperatures and other parameters for each source, all of which in reality are variable. There are then additional uncertainties, as models are required to simplify real-world conditions into a series of algorithms. These uncertainties cannot be easily quantified and it is not possible to verify the point-source model outputs. Where these parameters have been estimated the approach has been to use reasonable worst-case assumptions.

3.10 On balance, when taking into account the assumed number of operating hours; the approach taken to meteorological conditions; and the assumed NOx to NO_2 relationship, the assessment will over-predict the impacts of the facility. The approach used thus provides a robust assessment.

4 Site Description and Baseline Conditions

4.1 The proposed development site is located on a small area of disused land within the Oaks Business Park, to the east of Barnsley. The site is immediately bounded by existing industrial operations on all sides.

Air Quality Review and Assessment

4.2 Barnsley Council has investigated air quality within its area as part of its responsibilities under the LAQM regime. The Council has declared six AQMAs for exceedances of the annual mean nitrogen dioxide objective (previously the number was eight, however, two of these AQMAs have since been revoked). The Langsett AQMA in Barnsley has recently been amended to include exceedance of the 1-hour mean for nitrogen dioxide. The nearest of the active AQMAs is located approximately 1.6 km west of the proposed development.

Local Air Quality Monitoring

4.3 Barnsley MBC currently operates two continuous nitrogen dioxide monitors, and 89 diffusion tube monitoring sites, 27 of which are located within the study area.

4.4 Results for monitoring sites within the study area in between 2012 to 2016 are summarised in Table 3 and the monitoring locations are shown in Figure 1.

Table 3: Summary of Nitrogen Dioxide (NO_2) Monitoring (2012 – 2016) [a, b]

Site ID.	Site Type	Location	2012	2013	2014	2015	2016
Automatic Monitors							
CM2	Roadside	Barnsley A628	39	37	35 [c]	39	36
CM3	Urban Background	Barnsley Gawber	21	22	19	19	19
Diffusion Tubes							
DT11	Roadside	Dodworth Rd	**41**	32	**45**	**44**	**43**
DT12	Roadside	Dodworth Rd	**51**	**44**	**50**	**49**	**46**
DT13	Roadside	Dodworth Rd	**46**	**42**	**46**	**43**	**41**
DT14	Roadside	Dodworth Rd	37	35	37	36	36
DT18	Roadside	Dodworth Rd West	**41**	38	**40**	38	33
DT19	Roadside	Crown Hill Rd	34	31	34	31	28
DT20	Roadside	Dodworth Rd Pogmoor	**41**	38	38	34	34
DT21	Roadside	Dodworth Rd Pogmoor	**47**	**42**	**46**	**45**	**40**
DT22	Kerbside	Dodworth Rd Pogmoor	**43**	**41**	**42**	**40**	38
DT23	Roadside	Dodworth Rd Pogmoor	**42**	40	39	38	38
DT32	Roadside	Sheffield Rd	37	35	**40**	38	38
DT33	Roadside	Westway	N/A	N/A	29	31	32
DT34	Roadside	Wakefield Rd	32	30	31	29	29
DT35	Roadside	Wakefield Rd	**43**	**42**	**43**	**42**	**41**
DT36	Roadside	Wakefield Rd	37	35	35	34	35
DT37	Roadside	Wakefield Rd	33	N/A	29	28	29
DT38	Kerbside	Old Mill Lane	34	32	34	33	33
DT39	Kerbside	Burton Rd	37	37	38	37	38
DT40	Roadside	Pontefract Rd	37	37	39	38	38
DT41	Roadside	Harborough Hill Rd	**51**	**44**	N/A	**49**	**50**
DT42	Roadside	Mottram St	34	35	37	33	34
DT43	Roadside	Harborough Hill Rd	**54**	**49**	**54**	**52**	**53**
DT44	Roadside	Harborough Hill Rd	**45**	**41**	**43**	**43**	**41**
DT46	Kerbside	Wombwell Lane	37	35	37	37	37
DT47	Roadside	Sheffield Rd	38	34	39	37	39
DT48	Roadside	Sheffield Rd	**49**	**43**	**48**	**47**	**50**
DT49	Kerbside	Doncaster Rd	N/A	38	39	38	37
Objective			**40**				

[a] Exceedances of the annual mean objective are shown in bold.

[b] Data have been taken from the Barnsley MBC LAQM Annual Status Report (2016).

[c] 74% data capture rate.

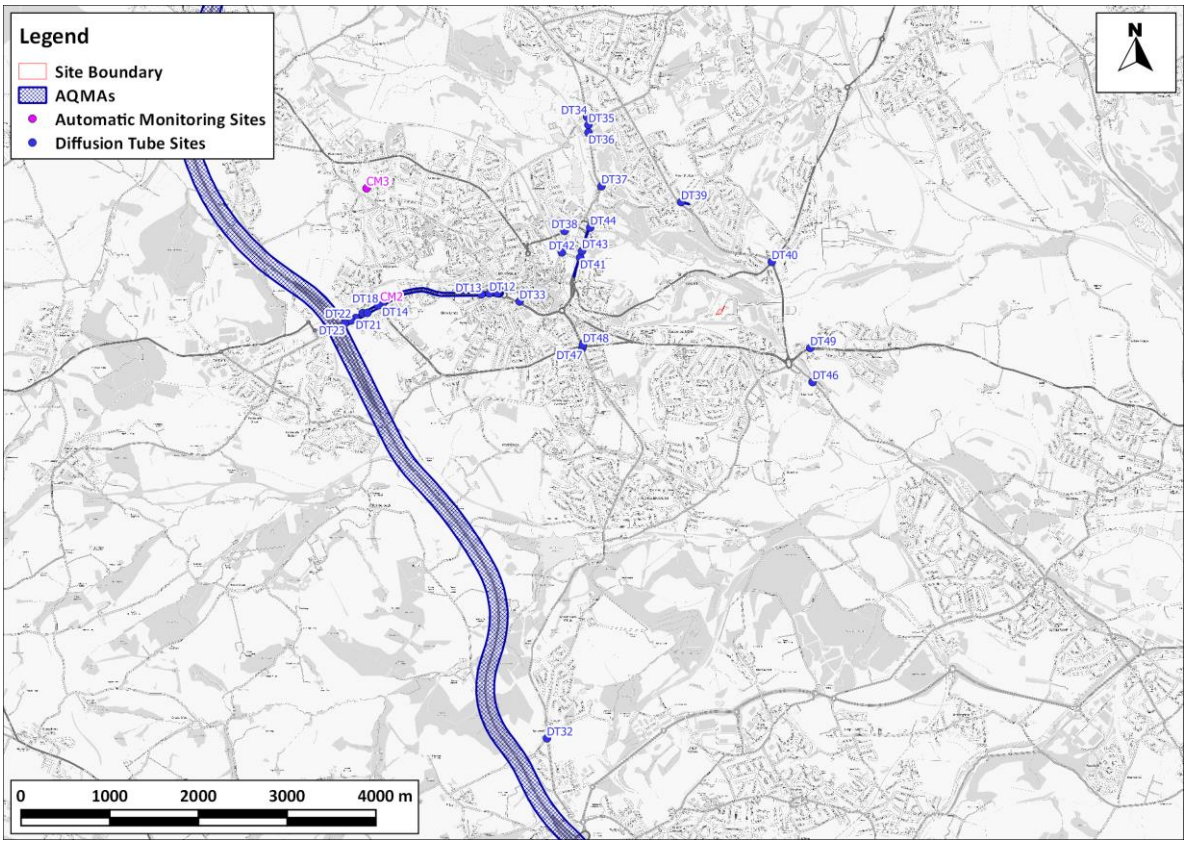


Figure 1: Nitrogen Dioxide Monitoring Locations within the Study Area

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Exceedances of EU Limit Value

4.5 There are no AURN monitoring sites within 1 km of the development site with which to identify exceedances of the annual mean nitrogen dioxide limit value. The national maps of roadside annual mean nitrogen dioxide concentrations in 2015 (Defra, 2017c), used to report exceedances of the limit value to the EU, does not identify any exceedances within 1 km of the development site. Defra's mapping for 2020, which takes account of the measures contained in its 2015 Air Quality Plan (Defra, 2015), also does not identify any exceedances within 1 km of the development site.

Background Concentrations

4.6 The estimated annual mean nitrogen dioxide background concentrations in the study area have been determined for 2017 (Table 4), using Defra's background maps (Defra, 2017b). The background concentrations have been derived as described in Appendix A2, and are well below the objectives.

Table 4: Estimated Annual Mean Background Pollutant Concentrations in 2017 (µg/m^3) [a]

Year	NO_2
2016	12.7 – 32.4
Objectives	**40**

[a] The range covers all the 1 km x 1 km grid squares within the study area.

5 Impact Assessment

Annual Mean Concentrations

5.1 Figure 2 shows concentration contours which define the area over which, if the generators were to run for 2,000 hours per year, their emissions might add more than 0.2, 0.6, 2.2 and 4.0 µg/m^3 to annual mean nitrogen dioxide concentrations. The Figure also sets out existing air quality conditions using the following two sources of data:

- Defra's predicted 'background' concentrations, which represent conditions well away from any emission sources; and
- measurements made by the Local Authority, which represent conditions at the specific location of the monitor and include the influence of existing sources such as local roads.

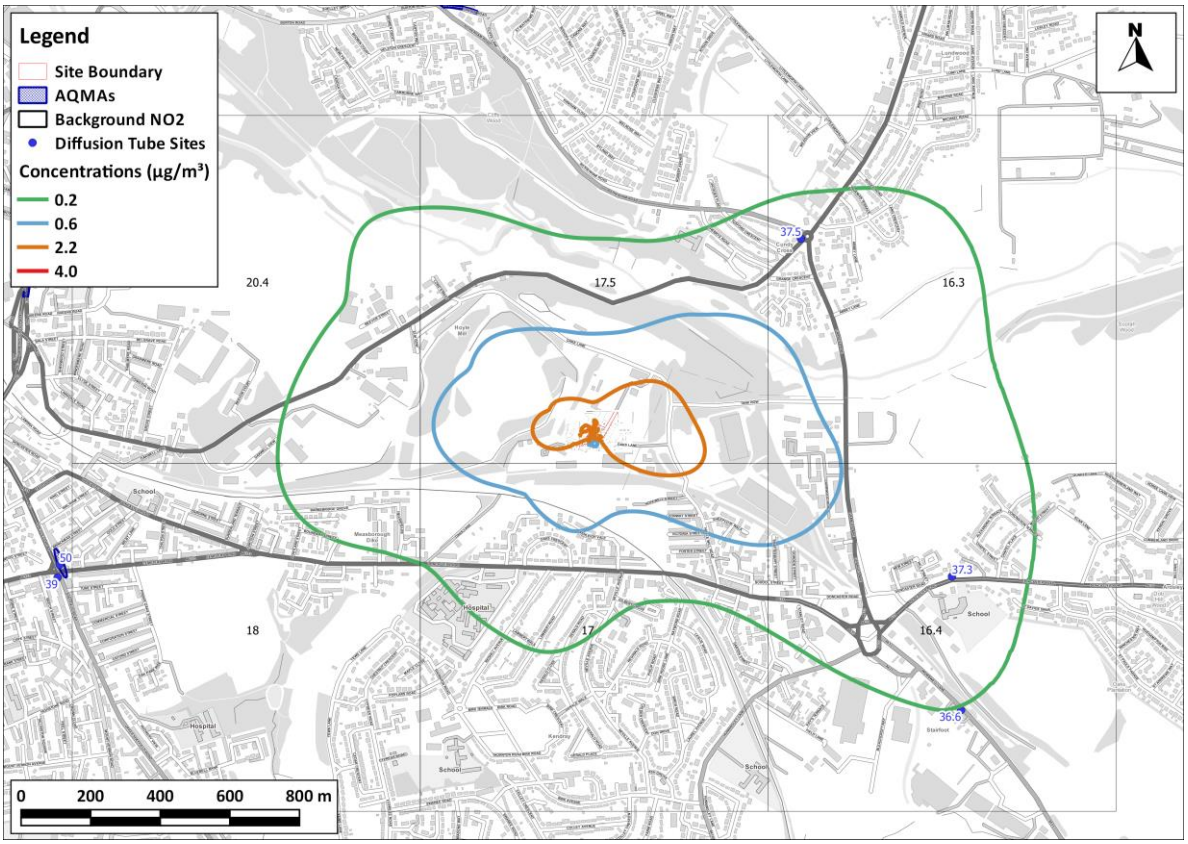


Figure 2: Annual Mean Nitrogen Dioxide Concentration Contours (µg/m^3) for Maximum Process Contributions for 2,000 Hours of Operation. The Labels on the Monitoring Sites Represent the 2016 Measured Annual Mean Concentration.

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5.2 Table 5 sets out the exposure that occurs within each of the four concentration range contours specified in the impact descriptors in Table 2.

Table 5: Relevant Exposure within each Concentration Contour [a]

	Red Contour (>4.0 µg/m^3)	Orange Contour (2.2-4.0 µg/m^3)	Blue Contour (0.6-2.2 µg/m^3)	Green Contour (0.2-0.6 µg/m^3)
Relevant Exposure	No concentrations within this contour	No relevant exposure	Approximately 80 properties	Large number of properties

[a] This is based on examination of OS open data maps and may exclude some isolated properties. The exposure is based on the number between each of the contours.

Assessment using the Environment Agency Risk Assessment Methodology and Defra's Mapped Background Concentrations

5.3 An approach which practitioners often use for assessments of this type, and one which is often accepted by the Environment Agency when permitting industrial processes (as opposed to the development control process), is to assume the impacts are insignificant if the process contribution, when added to Defra's 'mapped' background concentration, is less than 70% of the objective. The Defra 'mapped' background concentrations do not account for the direct effect of local emission sources such as road traffic at specific receptors, and therefore do not represent 'the concentration of the substance that's already present in the environment'[2] at roadside locations, which should be used to describe the total concentration at such locations.

5.4 The maximum predicted concentrations at locations with relevant exposure, based on adding the process contribution to the background[3], are shown in Table 6. For example, within the green contour the maximum would be 21.0 µg/m^3, i.e. 20.4 (maximum background concentration within any contour) + 0.6 µg/m^3 (process contribution). Following this approach (i.e. adding the process contribution to the background values shown numerically in blue in Figure 2), the results show that the total concentrations will remain below 70% of the objective (70% of the 40 µg/m^3 objective is 28 µg/m^3).

[2] The Environment Agency's definition of the background concentration. (Environment Agency, 2016)

[3] It should be noted that the highest background concentration from within any contour has been applied to all receptors within the study area to represent a worst-case assessment.

Table 6: Maximum Potential Background + PC Concentrations at Locations with Relevant Exposure

Area	Concentration (µg/m^3)
Green Contour (0.2-0.6 µg/m^3)	20.4
Blue Contour (0.6-2.2 µg/m^3)	22.6
Orange Contour (2.2-4.0 µg/m^3)	No relevant exposure
Assessment Criterion (70% of the Objective)	**28**

5.5 Based on this approach, the impacts of the scheme within the green and blue contours where there is relevant exposure would be insignificant. Within the orange contour there is no relevant exposure.

Assessment using the EPUK/IAQM Impact Descriptors

5.6 The local authority has declared six AQMAs due to exceedances of the annual mean (40 µg/m^3) objective for nitrogen dioxide, with the nearest AQMA located 1.6 km to the west. Whilst measured concentrations at the AQMA have fallen in recent years and the AQMA falls outside of the green and blue contours, it is useful to go beyond the assessment approach accepted by the Environment Agency for permitting.

5.7 Using the descriptive terminology developed jointly by EPUK and the IAQM, as described in Paragraph 2.24:

- outside the area defined by the 0.2 µg/m^3 (green) contour the impacts will be negligible, regardless of the receptor-specific total concentrations (process contribution plus existing concentration);
- the impacts will also be negligible between the 0.2 and 0.6 µg/m^3 (green and blue) contours, as long as the total baseline concentration is below 37.2 µg/m^3 (the contour threshold of 37.8 µg/m^3 minus the maximum process contribution within the area of 0.6 µg/m^3);
- between the 0.6 and 2.2 µg/m^3 (blue and orange) contours, the impacts will be negligible with a baseline concentration below 28.0 µg/m^3 (the contour threshold of 30.2 µg/m^3 minus the maximum process contribution within the area of 2.2 µg/m^3); and
- non-negligible impacts cannot be discounted inside the 2.2 µg/m^3 (orange) contour wherever there are locations with relevant exposure to the annual mean objective as described in Paragraph 2.21.

5.8 More broadly, using the EPUK and IAQM impact descriptors set out in Table 2, the process contributions between the contour lines would be associated with the impacts presented in the column headings of Table 7 depending on which baseline concentration a receptor is exposed to.

Table 7: Impact Descriptors Associated with Different Baseline Concentrations (µg/m^3) within Each Process Contribution Contour

Process Contribution Contour	Negligible	Slight Adverse	Moderate Adverse	Substantial Adverse
Green to Blue	<37.2	37.2 - 40.4	>40.4	-
Blue to Orange	<28.0	28.0 - 35.6	35.6 - 41.6	>41.6
Orange to Red	-	<26.2	26.2 - 37.0	>37.0

5.9 The area defined by the orange contour falls within the Oak Business Park. Following Defra guidance, the annual mean objective only apply at locations where members of the public might be regularly exposed, and therefore, places of work are not regarded as relevant receptors. As such, there are no receptors within the orange contour, and therefore there will be no impacts within this area.

5.10 There are approximately 80 residential dwellings within the blue contour; these are located in the residential terraces off Hoyle Mill Road to the southeast of the site, and a small number adjacent to the railway line along Ashleigh Vale, southwest of the site. The receptors are located away from local major roads (over 100 m from the nearest A-road) and, accounting for the local nitrogen dioxide monitoring in the study area, the baseline concentrations are expected to be well below 35.6 µg/m^3. Given the distance from the major road traffic emission sources (A628, A633 and A635), it is expected that the baseline concentration at these receptors will be approaching the predicted Defra 'mapped' background concentrations (~17.5 µg/m^3). The exact baseline concentration at each receptor will vary, however, it is expected it will be less than 28.0 µg/m^3 and thus the impacts of the operation of the site are likely to be negligible. In the unlikely scenario that the baseline concentrations exceed 28.0 µg/m^3 the impacts within the blue contour would be described as slight adverse.

5.11 There are a large number of residential dwellings to the southwest, northeast and southeast of the site that are located within the green contour. Locations within this area which are exposed to existing concentrations <37.2 µg/m^3 will experience a negligible impact due to the operation of the development. If concentrations are currently between 37.2 µg/m^3 and 40.4 µg/m^3 then there may be some slight adverse impacts. The A628 and A633 roads run through these areas. Current diffusion tube monitoring along these roads measured concentrations of 37.3 to 37.5 µg/m^3 for 2016. These monitoring sites are located at roadside locations (within 2 m of the kerb). Concentrations are known to reduce rapidly within the first few metres of the road, and are expected to decline in the future. It can be reasonably assumed that similar concentrations exist

along the A628 and A633 roadsides, however, a receptor would have to be located a similar distance from the kerb (within 2 m of the road) in order to experience concentrations over 37.2 µg/m^3. No receptors have been identified within the green contour, which are situated less than 2 m from the roadside of the A628, A633 or A635, and as such, it is expected that there will be an overall negligible impact. Nonetheless there are a small number of properties that are situated within 5 m of one of these A-roads (in particular a terrace of properties on the A633 at Grange Lane) where slight adverse impacts may be experienced.

Table 8: Impacts at Receptors within Different Process Contribution Contours

Process Contribution Contour	Likely Impact
Green to Blue	Negligible to Slight Adverse
Blue to Orange	Negligible
Orange to Red	No Exposure
Red	No Exposure

Short-term Impact Assessment

5.12 Relevant locations for the short-term objectives are locations where members of the public may spend 1 hour or more, at least 18 times in a year. Figure 3 shows the contour representing the assessed percentile concentration (see paragraph A2.18 for details on the percentile assessed) excluding the baseline concentration for the 2,000 hour operational scenario.

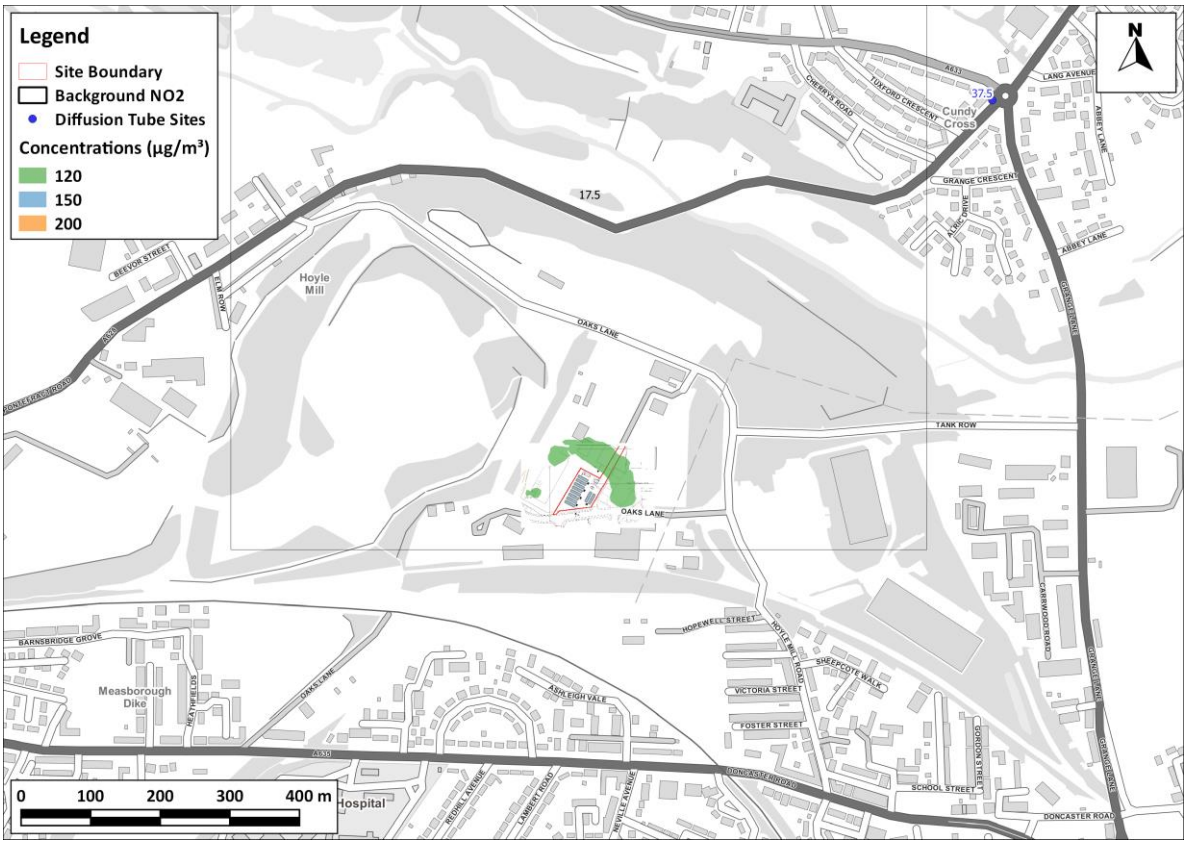


Figure 3: Concentration Contours (µg/m^3) for Maximum Process Contributions for 2,000 Hours of Operation

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5.13 Relevant receptors located:

- within the green band (120 - 150 µg/m^3) would potentially be exposed to a greater than 1% chance of an exceedance of the 1-hour mean nitrogen dioxide objective if the baseline annual mean nitrogen dioxide concentration is greater than 25 µg/m^3 (i.e. roughly the maximum mapped background concentration in the study area) but is less than 40 µg/m^3 (40 µg/m^3 represents road-side properties affected by road traffic emissions); and
- outside the green band, baseline concentrations would need to be significantly elevated (annual mean >40 µg/m^3) for there to be a risk of an exceedance, which is extremely unlikely.

5.14 The area covered by the green band is a small area confined to the vicinity of the site and within the Oaks Business Park. The risk of exceedance of the short-term objective is dependent on members of the public spending around an hour within the green contour, at least 19 times in a year, and the baseline concentrations within the area being elevated above background levels due

to local emission sources. There do not appear to be any locations fitting this criterion, and therefore it is expected that there will not be any relevant exposure.

5.15 Taking the above into account, the development is unlikely to give rise to an exceedance of the short-term objective at any sensitive location.

6 Conclusions

6.1 The impacts associated with the proposed natural-gas-fuelled power-generation facility at Oaks Lane, Barnsley, have been assessed in relation to the air quality objectives set to protect human health. The assessment has considered an operational scenario of 2,000 hours per year.

6.2 The impacts have been predicted using the ADMS-5.2 dispersion model, and assessed following an approach that is common with some practitioners and then following guidance provided by Environmental Protection UK and the Institute of Air Quality Management.

Annual Mean Nitrogen Dioxide Concentrations

- there will be no significant effects outside of the contours shown in Figure 2. Within these contours, impacts will depend on the sensitivity of any receptors exposed to the additional emissions from the facility and potentially significant effects cannot be discounted without detailed assessment of the baseline concentrations;
- if the assessment is based on an approach that is common with some practitioners, which is to add the process contribution from the proposed facility to Defra's 'mapped' background concentrations, without consideration of the magnitude of change, then the annual mean impacts of the scheme in relation to nitrogen dioxide are insignificant;
- however, taking account of the fact that existing concentrations in many locations, in particular close to busy roads, are higher than those given in Defra's background maps, and using descriptive criteria provided by EPUK and the IAQM, impacts are predicted to range from *negligible* to *slight adverse*, the latter only potentially occurring at a small number of properties, although concentrations will remain below the annual mean objective.

1-hour Mean Nitrogen Dioxide Concentrations

- the assessment has shown that there is an insignificant risk of the short-term objective being exceeded at a relevant receptor for the operational scenario considered.

Conclusion

6.3 Overall, it is considered that the air quality effects of the proposed natural-gas-fuelled power-generation facility at Oaks Lane, Barnsley, with the generators operating for up to 2,000 hours a year, will be 'not significant'.

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8 Glossary

ADMS-5	Atmospheric Dispersion Modelling System model for point sources
AQC	Air Quality Consultants
AQMA	Air Quality Management Area
Background	Background concentration representative of a 1x1 km area
Baseline	Baseline concentration representative a specific receptor that may be affected by local sources, such as a road
Defra	Department for Environment, Food and Rural Affairs
EPUK	Environmental Protection UK
Exceedance	A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure
IAQM	Institute of Air Quality Management
µg/m^3	Microgrammes per cubic metre
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides
PC	Process Contribution

9 Appendices

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A1 Professional Experience

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Mr Caird is a Principal Consultant with AQC, with eleven years' experience in the field of air quality including the detailed assessment of emissions from road traffic, airports, heating and energy plant, and a wide range of industrial sources including the thermal treatment of waste. He has experience in ambient air quality monitoring for numerous pollutants using a wide range of techniques and is also competent in the monitoring and assessment of nuisance odours and dust. Mr Caird has worked with a variety of clients to provide expert air quality services and advice, including local authorities, planners, developers and process operators. He is a Member of the Institute of Air Quality Management and is a Chartered Scientist.

Robert Kennedy, BSc (Phys. Chem.) MEIANZ

Mr Kennedy is a Principal Consultant with AQC, with 15 years' experience in the fields of air quality, greenhouse gasses and the environment. Robert has experience across all facets of air quality, including atmospheric dispersion modelling, ambient and stack pollution monitoring, pollution mitigation and control engineering design, air quality and greenhouse gas emissions inventories and assessments, environmental approvals, odour assessments, indoor air quality assessments and air quality and climate change management plans. Robert has worked for numerous clients covering commercial and residential developments, manufacturing, government, industrial, mining and energy (oil and gas) sectors. Robert has international experience, with exposure to both local and global environmental standards and practices on projects in the Middle East, Europe, United States, South-East Asia and Australia.

Kieran Laxen, MEng (Hons) AMIEnvSc MIAQM

Mr Laxen is a Principal Consultant with AQC with over seven years' experience in the field of air quality management and assessment, previously having two years' experience in scientific research on internal combustion engines. He is involved in a wide range of development projects, most of which have involved use of ADMS modelling methodologies for biomass boilers, CHP plant, generators and roads, and is also experienced in the assessment of construction dust. He has pioneered the use of OpenAir software within the Company, which is used to analyse air quality monitoring data, and is responsible for routine calibration of air quality monitoring stations, together with data ratification. He is a Member of the Institute of Air Quality Management.

Full CVs are available at www.aqconsultants.co.uk.

A2 Modelling Methodology

A2.1 The impacts of emissions from the proposed facility have been predicted using the ADMS-5.2 dispersion model. ADMS-5.2 is a new generation model that incorporates a state-of-the-art understanding of the dispersion processes within the atmospheric boundary layer.

Model Inputs

Emissions and Release Conditions

A2.2 The model input parameters for the proposed generators have been derived from the generator datasheets provided by MTU Onsite Energy.

A2.3 The emissions parameters employed in the modelling are given in Table A2.1. These are based on use of natural-gas fuel for 100% of the operation for each of the generators.

Table A2.1: Plant Specifications, Emissions and Release Conditions per Generator.

Parameter	Value
Power output (kW_{out})	2,028
Power output (kVA)	2,800
Generator inputs	
Net Input Fuel Rate (kW_{in})	4,748
Gross Input Fuel Rate (kW_{in})	5,259
Gross Fuel Consumption (kg/hr)	367
Combustion air_{in} (kg/h)	10,482
Excess air (%) [a]	78
Exhaust Temperature (ºC)	412
Exhaust flow (kg/h) for actual flow	10,910
Molar Flow Rate (mol/s) for actual flow	107.5
Molecular Mass (g/mol) for actual flow	28.2
Exhaust flow (Am^3/s) [b, c] for actual flow	6.04
Flue Internal Diameter (m)	0.6
Exhaust velocity (Am^3/s) [b] for actual flow	21.4
Exhaust flow (kg/h) for normalised flow	5,493
Molar Flow Rate (mol/s) for normalised flow	50.8
Exhaust flow (Nm^3/s) [d, e] for normalised flow	1.14

Parameter	Value
Condition Specific Emissions	
NOx Emission rate (mg/m^3) [f]	250
NOx Emission rate (mg/Nm^3) [d]	328.6
NOx Emission rate (g/s)	0.374

Note: Orange highlighted cells contain the values entered into the model. The number of significant figures presented should not be taken to represent the accuracy of the information.

[a] Derived from combustion air m^3/s.

[b] Actual flow conditions assumed to be 412 ºC, 8.6% O_2, wet (11.7% H_2O).

[c] Calculated from molar flow rate x 8.3145 x (412+273.13) / 101325.

[d] Normalised to 0 ºC, 101.325 kPa, 0% O_2, dry.

[e] Calculated from normalised molar flow rate x 8.3145 x (273.13) / 101325.

[f] Standardised to 0 ºC, 101.325 kPa, 5% oxygen, dry.

Spatial Configuration

A2.4 Within the model, the generators have been positioned across the site as shown in Figure A2.1.

A2.5 The flues have been modelled at a height of 7.5 m.

A2.6 Entrainment of the plume into the wake of the generators (the so-called building downwash effect) has been taken into account by including the generators themselves as buildings within the model The exact height of the containers is currently unknown however they are likely to be either 2.9 m or 3.4 m. Five separate modelling scenarios have therefore been run:

- No onsite or offsite buildings (engine containers);
- Onsite ‘buildings’ (engine containers) at 2.9 m, without offsite buildings;
- Onsite ‘buildings’ (engine containers) at 3.4 m, without offsite buildings;
- Onsite ‘buildings’ (engine containers) at 2.9 m, with offsite buildings; and
- Onsite ‘buildings’ (engine containers) at 3.4 m, with offsite buildings.

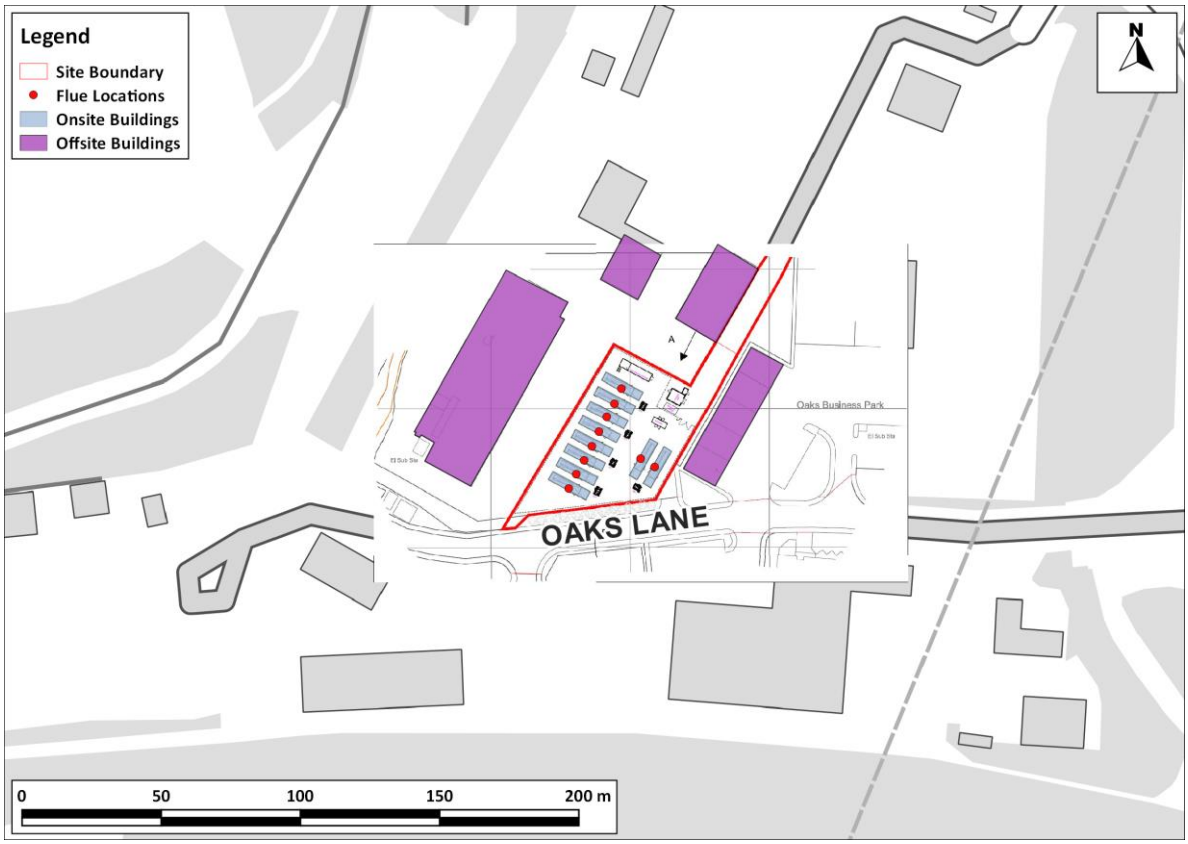


Figure A2.1: Modelled Generator Flue Outlet Layout (red points) and Modelled Buildings

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A2.7 Local terrain has been included within the model based on OS Terrain 50 data.

Meteorological Inputs

A2.8 Hourly sequential meteorological data from Emley Moor for the years 2012-2016 have been used separately for each year in the model. The Emley Moor meteorological monitoring station is located approximately 14 km to the northwest of the proposed site. It is deemed to be the nearest monitoring station representative of meteorological conditions at the proposed development site.

A2.9 Once the dispersion model had been run 5 times, for each receptor and each meteorological year, the maximum value across all 5 datasets was selected and used to inform the conclusions of this report.

Background Concentrations

A2.10 The nitrogen dioxide background pollutant concentration for the location of interest within the study area has been defined using the national pollution maps published by Defra (Defra, 2017a). These

cover the whole country on a 1x1 km grid and are published for each year from 2013 until 2030. The values for the year 2017 have been used in this assessment.

Model Post-processing for Nitrogen Dioxide

A2.11 Emissions from the generators will be predominantly in the form of nitrogen oxides (NOx). ADMS-5.2 has been run to predict the contribution of the generators to annual mean concentrations of nitrogen oxides and a percentile of 1-hour mean nitrogen oxides. The approach recommended by the Environment Agency (Environment Agency, 2005) has been used to predict annual mean nitrogen dioxide concentrations and the percentile of 1-hour mean nitrogen dioxide concentrations. This assumes that:

- annual mean nitrogen dioxide concentrations = annual mean nitrogen oxides x 0.7; and
- percentile of 1-hour mean nitrogen dioxide concentrations = percentile of 1-hour mean nitrogen oxides x 0.35.

A2.12 These NOx to NO_2 ratios are likely to be overly pessimistic within close proximity of the STOR facility. The NOx emissions require time and O_3 available to react and convert to NO_2, thus 35% NO_X to NO_2 ratio for short-term impacts is considered worst-case for receptors within 500 m of the site.

Annual Mean

A2.13 To calculate the relevant annual mean process contribution for the operational scenario the process contribution, based on modelling the generators running for every hour in the year, is scaled by the ratio of the number of hours of operation to the total number of hours modelled.

A2.14 The annual mean concentration at a receptor is then calculated as the sum of:

- the scaled annual mean NO_2 process contribution; and
- the annual mean baseline concentration.

Short-term

A2.15 The short-term impacts are complex to assess, given that the objective is based on the number of hours (18) that a threshold concentration (200 µg/m^3) can be exceeded in a year. The 1-hour mean nitrogen dioxide objective is often assessed by considering the 99.79th percentile of 1-hour concentrations, which represents the 19th highest hourly concentration from a full year of hourly values (a full year is 8,760 hours). In most cases, especially where specific operating hours are not defined, it is important to run the model for a full year of continuous operation, in order to capture the varied meteorological conditions that can occur throughout the year. However, when the operation of the plant is not continuous and annual operation is significantly lower than a full year

this approach is too worst-case. Instead, an approach using hypergeometric distribution can be adopted that considers the number of hours of operation.

A2.16 A hypergeometric distribution is a discrete probability distribution which can be used to determine the probability that the operation of a source for a limited number of hours in a year will cause an exceedance of a given threshold condition. In the case of the 1-hour mean nitrogen dioxide objective, the hypergeometric distribution is used to determine the probability that, from a set of mutually exclusive randomly selected hourly values from a full year's dataset (8,760 hours), there will be 19 hourly nitrogen dioxide concentrations which will exceed the threshold concentration of 200 µg/m^3. The probability is dependent on the number of proposed hours of operation, such that the lower the number of operating hours, the lower the probability that 19 or more of the randomly selected hours will exceed the threshold.

A2.17 This approach can be used in reverse so that, when selecting a limited number of hourly values that corresponds to the number of hours of operation, there is a less than 1% chance that more than 18 of the selected hourly values exceed the 1-hour threshold. This is done by calculating the number of hourly values from a full dataset (8,760 hourly values) that can exceed the 1-hour threshold in order for there to be a less than 1% chance.

A2.18 The number of hours that exceed the threshold in the full dataset can be used to calculate representative percentiles for the operational scenario. The calculated percentile is shown in Table A2.2.

Table A2.2: Percentile for 2,000 Hours of Operation, which Represents a Less than 1% Chance of the Objective being Exceeded if the Concentration is Less than 200 µg/m^3

Proposed hours of operation (per annum)	Number of hourly concentrations from the full dataset that can exceed 200 µg/m^3, for a <1% probability of more than 18 hours > 200 µg/m^3 [a]	Percentile [b]
2,000	49	99.44%

[a] e.g. if the proposed hours of operation are 2,000, then the full dataset may contain 49 hourly concentrations >200 µg/m^3 to ensure that when 2,000 hourly values are randomly selected from the full dataset that there is a <1% chance that more than 18 of them will exceed 200 µg/m^3.

[b] this is the relevant percentile of 8,760 hourly concentrations to determine a <1% risk, i.e. for 2,000 hours of operation, the 99.44 percentile of 8,760 hourly concentrations will return the 49th highest value.

A2.19 For example, assuming 2,000 operating hours, if fewer than 49 hours of a full year (8,760 hours) exceed 200 µg/m^3 then there is a <1% chance that of the 2,000 selected hourly values, more than 18 hours will exceed the limit.