Drax Generation Developments Ltd

HIRWAUN POWER PROJECT

Air Dispersion Modelling Study, Environmental Permit Application

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EXECUTIVE SUMMARY

Drax Generation Developments Ltd commissioned WSP to carry out an air quality assessment to support the Environmental Permit application for a new Open Cycle Gas Turbine Power Generation Plant at Hirwaun, South Wales. The plant will be capable of providing up to 299MW peaking power.

This report presents the methodology and results of the assessment of the potential impact of the Power Generation Plant on local air quality.

The changes in pollutant concentrations that would occur due to the operation of Power Generation Plant were modelled using the detailed dispersion model ADMS v5.2. The ADMS model takes account of the effects of buildings, terrain and local meteorology on dispersion. The pollutants considered in the assessment were nitrogen oxides, including nitrogen dioxide and its deposition onto surfaces, and carbon monoxide. These are the only local air quality pollutants of concern in relation to natural gas fired combustion plant.

Background pollutant concentrations published by Defra and the Devolved Administrations were used in combination with the ADMS modelled Process Contribution (PC) from the operation of the Power Generation Plant in order to determine the total Predicted Environment Concentration (PEC) for each pollutant and averaging period. The PC and PEC were compared with relevant assessment levels for the protection of human health and ecology.

The results of the assessment showed that the operation of the proposed Plant would not have a significant impact on local air quality. It would not cause exceedances of relevant statutory limit values or national objectives for the concentration of pollutants in ambient air, or result in significant impacts on sites designated for nature conservation.

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INTRODUCTION

INTRODUCTION

1.1 PROJECT BACKGROUND

1.1.1. Drax Generation Developments Ltd commissioned WSP to carry out an air quality assessment to support the Environmental Permit application for a new Open Cycle Gas Turbine Power Generation Plant at Hirwaun, South Wales. The plant will be capable of providing up to 299MW peaking power. The plant lies within the jurisdiction of Rhondda-Cynon-Taf County Borough Council and is located on the Hirwaun Industrial Estate.

1.1.2. An air quality assessment for the proposed plant was undertaken as part of the Development Consent Order (DCO) application submitted in 2014 and granted in 2015. The design and layout of the Power Generation Plant was amended by means of a Non-Material Change Order granted in 2016, with the original 5 unit design replaced with a single gas turbine and stack.

1.1.3. This permit application is based on the latest design parameters for the single stack design and the latest information on background pollutant concentrations and deposition levels. The principal design update from that assessed for the Non-Material Change Order is that stack diameter has been reduced to 7m. This increases the initial rise of the exhaust gases and improves the dispersion of the pollutants.

1.2 SCOPE

1.2.1. The scope of the air quality assessment is as follows:

- Stack height assessment for the proposed 7m diameter stack
- Assessment of impact on local air quality due to emissions to air from the proposed plant at sensitive human and ecological receptor locations in the vicinity of the Plant/

1.2.2. The assessment is supported by technical appendices, including a glossary of terms used (Appendix A) and sensitivity testing of the impact of building downwash and stack location (Appendix B).

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LEGISLATION, POLICY AND GUIDANCE

2 LEGISLATION, POLICY AND GUIDANCE

2.1 AIR QUALITY LEGISLATION & POLICY

2.1.1. A summary of the relevant air quality legislation and policy is provided below.

Ambient Air Quality Directive

2.1.2. Council Directive 96/62/EC on ambient air quality assessment and management (the Air Quality Framework Directive) described the basic principles as to how air quality should be assessed and managed in the Member States. Subsequent Daughter Directives introduced numerical limits, thresholds and monitoring requirements for a variety of pollutants including oxides of nitrogen and sulphur dioxide to guarantee that there are no adverse effects with regard to human health.

2.1.3. Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe (the Ambient Air Quality Directive) merges the Air Quality Framework Directive with the First, Second and Third Daughter Directives. The Ambient Air Quality Directive identifies desired maximum ground level concentrations and the date by which the limit values should be met and introduces new targets for fine particles.

2.1.4. The Air Quality Standards (Wales) Regulations 2010[1] give effect, in Wales, to the Ambient Air Quality Directive.

2.1.5. Across Wales, the limit value for annual mean nitrogen dioxide (NO_2) is exceeded at a number of roadside locations. The Air Quality Standards (Wales) Regulations place Welsh Government under an obligation to develop an Action Plan to ensure that the duration of exceedance of the limit values is as short as possible. Welsh Government is due to issue their latest Air Quality Plan in late spring 2018.

Air Quality Strategy and Regulations 2010

2.1.6. The UK's Air Quality Strategy, last updated in 2007, set a series of standards and objectives for air quality in the UK. The Strategy sets out the UK's national standards and objectives for ambient air quality and measures to help achieve the objectives. The overall aim of the Strategy is to achieve steady improvement in air quality into the long term.

2.1.7. The air quality objectives are set down in Welsh legislation in the Air Quality (Wales) Regulations 2000[2] and the Air Quality (Wales) (Amendment) Regulations 2002[3].

Environment Act 1995

2.1.8. Under Part IV of the Environment Act 1995, local authorities must review and document local air quality within their area by way of staged appraisals and respond accordingly, with the aim of meeting the air quality objectives defined in the Regulations. Where the objectives are not likely to be achieved, an authority is required to designate an Air Quality Management Area (AQMA). For each AQMA the local authority is required to draw up an Air Quality Action Plan (AQAP) to secure improvements in air quality and show how it intends to work towards achieving air quality standards in the future.

Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016) and Industrial Emissions Directive (IED)

2.1.9. Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (IED) recast seven directives related to industrial emissions, in particular Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC) and Directive 2001/80/EC emissions from large combustion plants (LCPD), into a single legislative instrument. The aim of the IED was to improve the permitting, compliance and enforcement regimes adopted by Member States.

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[1] The Air Quality Standards (Wales) Regulations 2010 - Statutory Instrument 2010 No.1433 (W. 126)

[2] The Air Quality (Wales) Regulations 2000 – Statutory Instrument 2000 No 1940 (W. 138)

[3] The Air Quality (Amendment) (Wales) Regulations 2002 – Statutory Instrument 2002 No 3182 (W. 298)

2.1.10. The Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016) consolidated and replaced the EPR 2010 and subsequent amendments. The EPR 2016 is the main implementing regulations for the environmental permitting regime and transpose the requirements of the IED into UK legislation.

2.1.11. The IED laid down measures to prevent or, where that is not practicable, to reduce emissions in the air, water and land from industrial processes and specified emissions limit values (ELV) and best available techniques (BAT) for their control. Recognising that the definition of BAT may evolve over time, the IED makes reference to the associated emission levels (AEL) of recognised Best Available Technology (BAT). For large combustion plant, the latest BAT-AELs are set out in EU IPPC '*Reference Document on Best Available Techniques for Large Combustion Plant*' (2017).

2.1.12. Natural Resources Wales (NRW) will regulate the Power Generation Plant via an Environmental Permit under the EPR 2016. The permit will include specific ELV for the Power Generation Plan for the relevant pollutants considered within the IED and associated BAT-AEL conclusions.

2.1.13. The relevant ELVs for the proposed Plant (Gas-fired, Open-cycle gas turbines operated <1,500 hours per year) are set out in **Table 1**.

Table 1 – Emission limit values (ELV) for the combustion of natural gas in gas turbines (mg/Nm^3, at reference conditions[d])

Type of combustion Plant	Pollutant	Yearly average[c]	Daily or sampling period average
Open-cycle Gas Turbines ≥50MW$_{th}$ (New Plant)	Nitrogen Oxides (as NO_2)[a]	N/A	25 - 50
	Carbon Monoxide[b]	100	

Note a. Source: Commission implementing Decision (EU) 2017/442, 31st July 2017, establishing best available techniques conclusions, under Directive 2010/75/EU of the European Parliament and of the Council for large combustion plants
Note b. Source: Industrial Emissions Directive 2010/75/EU
Note c. Yearly average BAT-AELs do not apply to plant operated <1,500 hrs per year
Note d. Reference conditions: Standard Temperature and Pressure, and 15% O_2, dry.

Ecology and Air Quality

2.1.14. The European Habitats Directive (92/43/EEC) sets out the legal framework requiring EU member states to protect habitat sites supporting vulnerable and protected species, as listed within the Directive. This Directive is transposed into UK law by the Conservation of Habitats and Species Regulations 2010 and requires protection of ecological sites including Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs).

2.1.15. The Ambient Air Quality Directive sets mandatory ambient air quality guidelines for NOx for the protection of ecosystems. This imposes a long-term (annual average) limit for NOx of 30 µg/m3 (critical level). This is mirrored in the Air Quality Standards Regulations 2010 (as discussed above).

2.1.16. Across the UK, site-specific critical loads (which relate to deposition of materials to soils) have been set for a variety of protected habitats and species in order to allow the quantitative assessment of the condition of ecologically sensitive sites and thus the protection of such sites by the relevant competent authorities.

2.2 AIR QUALITY ASSESSMENT CRITERIA

2.2.1. This section sets out the air quality assessment criteria relevant to the assessment, and provides information on their provenance.

2.2.2. The criteria for assessment of impacts at sensitive human receptors are derived from EU Air Quality Directive limit values and the UK's air quality objectives, and are set out in **Table 2**.

Table 2 - Air Quality Criteria for the Protection of Human Health.

Pollutant	Averaging Period	Objective / Limit Value ($\mu g/m^3$)	Number of permitted Exceedances per calendar year	Source
Nitrogen Dioxide (NO_2)	1 Hour	200	18	UK Air Quality Strategy; Air Quality Standards (Wales) Regulations 2010
	Annual	40	-	
Carbon Monoxide (CO)	8 Hour	10,000	-	

2.2.3. For ecological impacts, two metrics are assessed: critical levels (which are expressed as the concentration of a pollutant in air) and critical loads (which are expressed as the deposition of a pollutant to the surface).

2.2.4. The criteria for assessment of impacts at sensitive ecological receptors are derived as follows:

- Pollutant Concentrations (Critical Levels):
  - UK Air Quality Strategy
  - EU Ambient Air Quality Directive
  - Environment Agency targets for protected conservation areas[5]
- Pollutant Deposition (Critical Loads):
  - Critical loads estimated by UNECE and others and set out on the Air Pollution Information System (APIS)[4] website

2.2.5. Critical levels are not habitat or species specific and are the same for all sites. These are set out in **Table 3**. Impacts relating to acid and nutrient nitrogen deposition are habitat and species specific; the site specific critical loads are set out in **Table 4**for the sensitive ecological receptors of interest.

Table 3 - Air Quality Critical Levels used for the Assessment of Impacts on Sensitive Ecological Receptors.

Pollutant	Averaging Period	AQS/Critical Level ($\mu g/m^3$)	Source
Nitrogen Oxides	24 Hour	75	EA
	Annual	30	UK Air Quality Strategy; Air Quality Standards (Wales) Regulations 2010

2.3 GUIDANCE

Environment Agency: Air emissions risk assessment for your environmental permit

2.3.1. In the absence of specific NRW guidance in relation to assessing the impact of emissions to air, the air emissions section[5] of Environment Agency (EA) guidance has been referred to in this local air quality assessment for the proposed Plant.

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[4] http://www.apis.ac.uk (accessed April 2018)

[5] https://www.gov.uk/government/collections/risk-assessments-for-specific-activities-environmental-permits (accessed April 2018)

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METHODOLOGY AND SIGNIFICANCE CRITERIA

3 METHODOLOGY AND SIGNIFICANCE CRITERIA

3.1 METHODOLOGY

Project Scenario for Assessment and 'Realistic Worst Case'

3.1.1. The emission parameters utilised in the dispersion model represent the "realistic worst case" in terms of highest maximum ground level concentration of NO_2 i.e. with emissions at upper limit of the ELVs (Table 1) at all times of operation.

3.1.2. The ground level impact of an emission to air is determined by various factors including atmospheric conditions and the effective height of the release. For all meteorological conditions, the higher the effective release height, the lower the ground level impacts. The effective height of the release is, in turn, determined by the physical height of the release (the stack height), the height of nearby buildings and the buoyancy of the plume in providing initial plume rise before the emissions become well mixed with the surrounding air.

3.1.3. The air quality assessment is based on a scenario employing one (299MW) generator. Stack heights from 25 to 35m were considered in the stack height assessment. The recommendation of the assessment, as set out in the following section, was that the minimum stack height for the Power Generation Plant should be 30m. and, as such, the report considers impacts with the stack at 30m as a worst case.

3.1.4. As a peaking plant, the operation of the Power Generation Plant will be limited through the permitting regime to 1500 hours per annum. The assessment is, therefore, based on the operation of the Power Generation Plant, at full load, for 1500 hours per annum.

3.1.5. As a result, the assumed realistic worst case scenario is robust.

Study Area

3.1.6. The study area extends 10km in all directions from the stacks. This distance conforms to the EA guidance on the assessment of impacts.

3.1.7. The site is located on the Hirwaun Industrial Estate. The surrounding area is largely rural in character, interspersed with small residential settlements such as Hirwaun, Rhigos and Penderyn within a few kilometres of the site. The larger towns of Aberdare and Merthyr Tydfil lie more than 5km from the Power Generation Plant site.

3.1.8. The area includes numerous nature conservation sites relevant to the air quality assessment including areas of upland bog and heaths supporting Marsh Fritillary butterfly, examples of old sessile woods and meadows designated at European level, and numerous other sites designated at national and local level. A summary of the sites and their sensitive features is provided in **Table 4**.

3.1.9. **Figures 1a and 1b** illustrates the extent of the study area and the location of the sensitive habitats.

Table 4 - Designated Nature Conservation Sites Considered in the Air Quality Assessment. Sites shown in bold are internationally designated sites and the habitats shown in bold are the qualifying features for the sites.

Designated Site & Habitat	Nitrogen (kgN/ha/yr)		Acidification (keq/ha/yr)					
			Min			Max		
	Min	Max	$CL_{min}N$	$CL_{max}N$	$CL_{max}S$	$CL_{min}N$	$CL_{max}N$	$CL_{max}S$
Blaen Cynon SAC (and Cors Bryn-y-Gaer SSSI / Woodland Park and Pontpren SSSI) – ~400m NE of stack *Contains an extensive complex of damp pastures and heaths supporting Marsh Fritillary butterfly*								
Marsh Fritillary[a]	**10**	**15**	**0.438**	**1.161**	**0.580**	**0.581**	**2.208**	**1.770**
Blanket/Raised Bog	5	10	0.321	1.078	0.757	0.321	1.139	0.818
Upland Hay Meadow	10	20	0.438	1.161	0.580	0.581	2.208	1.770

Designated Site & Habitat	Nitrogen (kgN/ha/yr)		Acidification (keq/ha/yr)					
			Min			Max		
	Min	Max	$CL_{min}N$	$CL_{max}N$	$CL_{max}S$	$CL_{min}N$	$CL_{max}N$	$CL_{max}S$
Beech Woodland	10	20						
Acidophilus Woodland	10	15	0.5	2.974	2.474	0.500	3.275	2.775
Eutrophic Woodland	15	20						
Acid grassland	8	15	0.581	1.161	0.58	0.581	1.201	0.62
Coedydd Nedd a Mellte SAC (Dyffrynoedd Nedd a Mellte a Moel Penderyn) - ~1,500m NW of stack *Diverse example of old sessile oak woods along deeply incised valleys and ravines with rich bryophyte and lichen assemblages*								
Old Sessile Oak Wood	**10**	**15**	**0.142**	**1.837**	**1.552**	**0.500**	**7.925**	**7.783**
Lowland Beech with lichen	5	15						
Acidophilus Woodland	10	15	0.142	1.867	1.582	0.500	12.213	12.683
Eutrophic Woodland	15	20						
Cwm Cadlan SAC (Cwm Cadlan SSSI) - ~3,000m NE of stack *Extensively developed Molinia meadows (fen meadows) with transition to neutral grassland plus alkaline fen of short-sedge mire communities*								
Alkaline Fens	**15**	**30**	Not Sensitive					
Moist grasslands	**15**	**25**	**0.223**	**1.161**	**0.580**	**0.581**	**4.493**	**4.270**
Mountain Hay Meadow	10	20	0.856	4.940	4.008	1.214	5.222	4.048
Hirwaun Industrial Estate SINC - ~50m N of stack *Brownfield grassland and scrub habitat with ancient peat bog and represents an extension of the Cors Bryn-y-Gaer SSSI / Blaen Cynon SAC*								
Raised/Blanket Bog	5	10	0.321	1.078	0.757	0.321	1.139	0.818
Hirwaun Common SINC - ~350m S of stack *Upland marshy grassland and acid grassland with significant areas of dry heath*								
Raised/Blanket Bog	5	10	0.321	1.078	0.757	0.321	1.139	0.818
Acid Grassland	8	15	0.438	1.161	0.58	0.581	2.208	1.77
Hirwaun Ponds - ~750m SE of stack *Species rich marshy grassland, swamp and ponds*								
Raised/Blanket Bog	5	10	0.321	1.078	0.757	0.321	1.139	0.818
Hirwaun Ponds North - ~750m E of stack *Mosaic of wetlands, ponds and drainage channels with potential and habitat for Marsh Fritillary butterfly – adjacent to Blaen Cynon SAC / Cors Bryn-y-Gaer SSSI*								
Raised/Blanket Bog	5	10	0.321	1.078	0.757	0.321	1.139	0.818

Designated Site & Habitat	Nitrogen (kgN/ha/yr)		Acidification (keq/ha/yr)					
			Min			Max		
	Min	Max	$CL_{min}N$	$CL_{max}N$	$CL_{max}S$	$CL_{min}N$	$CL_{max}N$	$CL_{max}S$
Werfa Farm SINC - ~1,000m NW of stack *Marshy and acid grassland with oak and alder dominated wooded gorge; area of habitat for Marsh Fritillary butterfly*								
Acidophilus Woodland	10	15	0.142	1.867	1.582	0.500	12.210	12.068
Acid Grassland	8	15	0.438	1.161	0.580	0.581	2.208	1.770
Rhigos Tramway SINC - ~1,300m W of stack *Wet and dry grassland, with areas of gorse scrub; acid and neutral dry grassland*								
Acid Grassland	8	15	0.438	1.161	0.580	0.581	2.208	1.77
Gelli-ben-Uchel SINC - ~1,350m NE of stack *Fen meadows with river banks supporting alder, oak, hazel and elm woodland*								
Acidophilus Woodland	10	15	0.500	2.974	2.474	0.500	3.275	2.775
Acid grassland	8	15	0.581	1.161	0.580	0.581	1.201	0.620
Ancient Woodland – various, ~850m N of stack at closest *Woodland habitat; similar to Woodland Park and Pontpren SSSI in east (Acidophilus woodland)/ Dyffrynoedd Nedd a Mellte in west (woodland with lichen communities)*								
Acidophilus Woodland	10	15	0.500	2.974	2.474	0.500	3.275	2.775
Lowland beech with lichen	5	15	0.142	1.867	1.582	0.500	12.21	12.068

Notes

a) Minimum critical loads for Marsh Fritillary butterfly relate to Non-mediterranean dry acid and neutral closed grassland (Nitrogen Deposition) and Acid Grassland (Acidity)

b) Data displayed to the same number of decimal places as provided on APIS i.e. nitrogen deposition critical loads = 0dp; acid deposition critical loads = 3dp

Selection of Background Concentrations

3.1.10. Baseline air quality in the study area has been assessed with reference to the reports prepared by the relevant local authorities under the requirements of the Local Air Quality Management regime and the mapped data provided by Defra and Devolved Administrations (pollutant concentrations in ambient air) and APIS (nitrogen and acid deposition).

3.1.11. Project specific monitoring was not undertaken since, as will be demonstrated in the following sections, the existing data holdings are sufficient to characterise current air quality in the study area (see Section 4).

3.2 AIR DISPERSION MODELLING

3.2.1. The assessment is based on a dispersion modelling exercise undertaken using the ADMS model (v5.2) developed by Cambridge Environmental Research Consultants (CERC). The model has been validated against both field studies and wind tunnel studies of dispersion and is widely used for air quality impact assessment in the UK.

Stack Parameters

3.2.2. The stack parameters for the proposed generator are provided in **Table 5**. The proposed minimum height is 30m. This has been determined by stack height sensitivity testing with heights from 25 – 35m tested.

Table 5 - Emission parameters for the Power Generation Plan (Single generator)

Parameter	Value
Type	Open Cycle Gas Turbine - Industrial
Number	1
Discharge Location	293726, 206306
Discharge Height (m)	30
Discharge Heights Tested (m)	25 – 35
Flue Exit Diameter (mm)	7000
Discharge Temperature (ºC)	590
Flow Rate (m^3/s)	1,742
Flow Rate (Nm^3/s, dry, reference O2[a])	639
Exit Velocity (m/s)	45
NOX Concentration (mg/Nm^3)	50
NO_X Emission Rate (g/s)	32
CO Concentration (mg/Nm3)	100
CO Emission Rate (g/s)	64
[a] Reference conditions 15% oxygen, dry	

3.2.3. The only pollutants of concern in relation to gas combustion are NO_X and carbon monoxide (CO). Gas combustion does not generate significant quantities of particulate matter and sulphur dioxide emissions will be negligible since the sulphur content of natural gas is negligible.

Building Downwash

3.2.4. The dispersion model takes into account the effects of building downwash[6] of pollutants. The principal building in terms of downwash for the generator is the turbine housing unit. This has been included in all model runs at a height of 19m (above local ground level), with a footprint of 50m x 40m, running approximately north-south (50m side of building oriented 5º clockwise from north). The stack is located at the northern end of the turbine housing unit. Since the final design of the turbine unit may be subject to change, Appendix B describes the sensitivity of the modelled impacts to the stack location on the turbine housing unit and the orientation of the housing unit. The base case of the stack located at the northern end of the 50m x 40m building is a robust worst case.

Meteorological Data

3.2.5. The model has been forced with hourly sequential meteorological data from Sennybridge, which lies 20km to the north of the Power Generation Plant. The reported impacts are based on the modelled results for the worst year from 2008 to 2012. Both the location of the Power Generation Plant and Sennybridge are inland sites, in areas of terrain influence. As such, the data from the site are considered appropriate for the assessment.

3.2.6. The generally open setting of the Power Generation Plant with relatively sparse urban/light industrial development in the vicinity (within the principal area of impacts ,~1-2km surrounding the plant, but excluding its immediate surroundings) is taken into account in the modelling by setting the surface roughness length to 0.2m. This is the value recommended by the model developers for agricultural areas (with short vegetation).

[6] Downwash is the enhanced turbulent mixing of pollutants in the lee of buildings which can result in high pollutant concentrations in the wake of the building.

3.2.7. The wind roses for 2008 to 2012 are provided in Appendix C. The predominant winds are south-westerly in all years.

Model Domain

3.2.8. The model domain extends 20km x 20km centred on the Power Generation Plant, with concentrations modelled on a system of 3 nested grids with resolution 200m (20km x 20km centred on the stacks), 100m (10km x 10km) and 25m (2.5km x 2.5km). The finest grid (25m resolution) is well within the recommended minimum grid spacing of 1.5 times the stack height (1.5 x 30m = 45m).

Terrain

3.2.9. Terrain was included in the modelling, with data input at a resolution of 100m over a domain from grid reference 283200, 195800 (near Cynonville) to 304100,216700 (near Torpantau). The terrain grid resolution within the ADMS model was set to 32 x 32.

3.2.10. Sensitivity testing with terrain at 64 x 64 resolution was undertaken for the Environmental Statement and DCO Examination. These grid resolutions are recommended by Cambridge Environmental Research Consultants (CERC) (the developers of the model) as sufficient for most calculations and showed insignificant differences. Therefore, model results presented in this report relate to model runs with 32 x 32 terrain grid resolution.

Atmospheric Chemistry

3.2.11. Emissions of NO_X from combustion sources include both nitrogen dioxide NO_2 and nitric oxide (NO), with the majority being in the form of NO. In ambient air, NO is oxidised to form NO_2, and it is NO_2 which has the more significant health impacts. For this assessment, the conversion of NO to NO_2 has been estimated using the worst case assumptions set out in the EA guidance[7], namely that

- For the assessment of long term (annual mean) impacts, at receptors 70% of NO_X is NO_2
- For the assessment of short term (hourly mean) impacts, at receptors 35% of NO_X is NO_2.

3.2.12. The oxidation of NO to NO_2 is not, however, an instantaneous process and, where the maximum impacts occur within a few hundred metres of the stacks (as will be shown to be the case for the Power Generation Plant), the EA worst case assumptions are likely to be conservative.

Deposition

3.2.13. The deposition of nitrogen is modelled using a deposition velocity approach, where the surface flux of pollutants is modelled by multiplying the ground level concentration by a pollutant specific deposition velocity. The velocity used in the assessment of nitrogen deposition from NO_2 was 1.5mm/s[8] for short vegetation and 3.0mm/s for tall vegetation.

3.2.14. For the emissions from the Power Generation Plant, only nitrogen deposition need be considered. Impacts due to emissions of sulphur dioxide and, by inference deposition of sulphur, have been scoped out of the assessment, although background levels of sulphur deposition are considered in the assessment of acidification.

3.2.15. The deposition calculation is undertaken during post-processing of the model results. The modelled impacts are therefore conservative in that they do not take account of the depletion of plume pollutants through deposition.

Emission Scenario

3.2.16. The Power Generation Plant will be operated as a peaking plant, with operations limited to 1500 hours per year. The maximum number of hours is limited by requirement within in the DCO.

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[7] Conversion Ratios for NO_X to NO_2, Air Quality Modelling and Assessment Unit – Environment Agency, http://webarchive.nationalarchives.gov.uk/20140328232919/http://www.environment-agency.gov.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf . Accessed 06/12/17

[8] Nitrogen oxide, NO, is relatively inert and insoluble and, as such, does not deposit onto surfaces as readily as nitrogen dioxide. The deposition velocity approach is, therefore, applied to modelled concentrations of nitrogen dioxide only.

3.2.17. The assessment of impacts takes into account this limited operation of the plant i.e. is based on a realistic worst case. However, since it is not possible to specify which hours of the year the plant will operate, the method by which this is taken into account in the dispersion modelling is dependent on the standard being assessed e.g. hourly, 8-hourly, daily or annual average concentrations.

3.2.18. The impacts of the Project on short term (8 hours or less) pollutant concentrations were modelled with the assumed full load operation running continuously for a whole year. This is appropriate since the UK and EU objectives and limit values for hourly and 8 hourly concentrations of NO_2 and CO are based on the 18 highest and highest concentrations respectively over a year (Table 1) and, with 1500 hours of operation, it is near certain that operations will, at times, coincide with examples of the poorest dispersion conditions.

3.2.19. In relation to long term (annual mean) concentrations assuming full load operation for the year would be unrealistic. Therefore, long term impacts were estimated by scaling the results for continuous full load operation by the likely operating time i.e. 0.171 (= 1500 (maximum hours of operation)/8760 (total hours in a year)). This approach is appropriate and is based on the assumption that the range of meteorological conditions under which the generator will operate will, over the 1500 hours, be statistically similar to those experienced over a year. Sensitivity testing of this approach was undertaken for the Environmental Statement and DCO Examination and shown to be robust.

3.2.20. The assessment of daily mean concentrations falls between the cases for long and short term concentrations. An assessment of impacts based on continuous operation would be very conservative, but an assessment based on the 0.171 factor (1500 hours out of 8760) may under-represent impacts. Therefore, the assessment is based on 8 hours full load operation each day by scaling the results for continuous full load operation by a factor of 0.33 (= 8 hours of operation / 24 hours in a day). For a peaking plant, this is a realistic assessment of the maximum likely hours of operation in any given day, and the assessment is worst case since it is based on the coincidence of this 8 hours of operation with the poorest dispersion conditions over the year.

3.2.21. The Power Generation Plant will be specifically designed for rapid start up and shut down. Typical start up procedures will take around 10 minutes to complete, and combustion fuel will not be introduced into the system until 2 – 3 minutes of the start up have elapsed. During the next 7 – 8 minutes, fuel will be introduced into the system, first at a low rate and then at an increasing rate, up to full load operations.

3.2.22. During start up, whilst the concentration of pollutants in the engine exhaust (at reference conditions) may be higher than under partial or full load operation during the first few minutes (e.g. minutes 2 to 8, at <75% load), the pollutant mass release rate will actually be lower than under full load operations due to the overall lower flow rates of exhaust gases. (Note: the mass release rate (mg/s) is calculated as the concentration of pollutant (mg/Nm^3) times the exhaust gas flow rate (Nm3/s).) Furthermore, the concentration of pollutants decreases rapidly as start up proceeds and, by around 8 minutes into start up, has decreased to levels equivalent to full load operations.

3.2.23. In relation to air quality impacts, the mass release rate of pollutants is more important than the initial exhaust gas concentration of pollutant, since ground level impacts are proportional to the total mass release. Taking into consideration the competing effects of lower pollutant mass release rate during start up, but reduced plume buoyancy at low load (during early start up).impacts during start up are likely to be imperceptibly different from those during full load operation. Similar conclusions hold for impacts during the ramping down from full load operations i.e. emission rates fall as the fuel flow rate is decreased but impacts of this decrease are countered by the effects of reduced plume buoyancy. Overall, therefore, the start up and shut down periods do no warrant specific assessment for the Project and impacts during these periods are robustly considered in the assessment by the assumed 1500 hours of full load operation for the Plant.

Assessment Criteria

3.2.24. In relation to ambient pollutant concentrations, the criteria used for the assessment of operational impacts are the air quality objectives and limit values set out in **Tables 2 and 3**.

3.2.25. For deposition, no comparable regulated standards exist and the impacts are assessed against critical loads.

3.2.26. A critical load is defined as “a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge[9]". Critical loads are set for effects due to eutrophication (nitrogen deposition) and acidification (combined action of sulphur and nitrogen deposition).

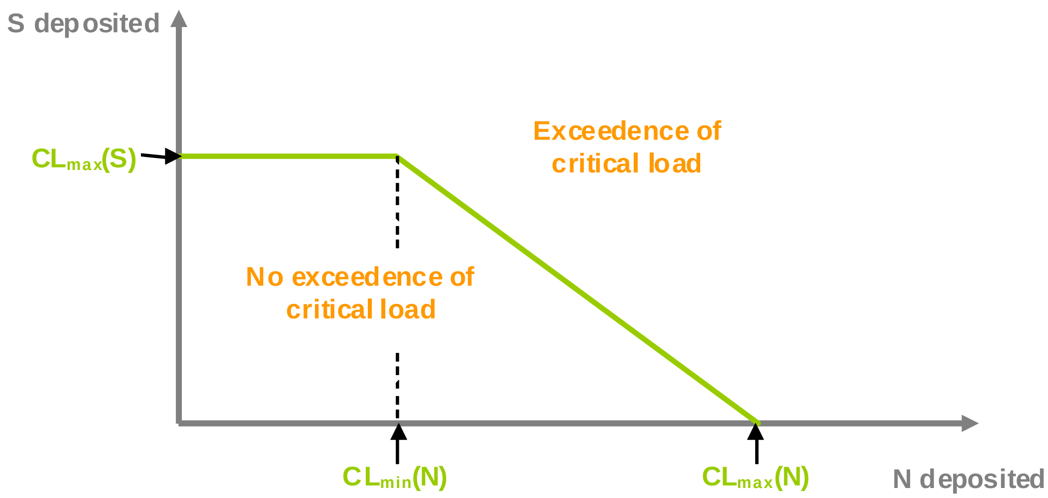
3.2.27. Critical loads are assigned to habitat classes of the European Nature Information System (EUNIS) to enable consistency of habitat terminology and understanding across Europe. They are presented as ranges (e.g. 10-20 kgN/ha/yr) which reflect variations in ecosystem response across Europe. In this assessment, a conservative approach has been adopted and impacts are compared to the lower limit of the specified range.

3.2.28. For acidification, the critical loads are specified through the definition of a critical load function (CLF, **Insert 1**) which identifies the combinations of sulphur and nitrogen deposition that will not cause harmful effects[10]. In the CLF, sulphur deposition is plotted against nitrogen deposition (shown below), and the risk of acidification impacts is characterised by the three following quantities:

- CLmax(S) – Maximum critical load for sulphur
- CLmin(N) – Minimum critical load for nitrogen
- CLmax(N) – Maximum critical load for nitrogen

3.2.29. The critical loads used in the assessment of SSSI and SAC sites were taken from APIS website, using the facility to extract site-specific relevant critical loads[11]. The critical loads are shown in **Table 4**. Critical loads for the locally designated sites were derived from the SSSI data for similar habitats. The data are set out in **Table 4**.

Insert 1 - Schematic of Critical Load Function for acidification



3.3 SIGNIFICANCE CRITERIA

3.3.1. In order to determine the potential significance of the predicted impacts, two parameters have been presented:

- the Process Contribution (PC) which is the pollutant concentration resulting from the contribution of the Plant alone; and
- the Predicted Environmental Concentration (PEC) which is the background concentration plus the process contribution.

[9] http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm

[10] Sulphur deposition forms part of the critical load function. For the Project, sulphur deposition will be unaffected by the operation of the process and the deposition rate used in plotting the CLF is the existing, background deposition level.

[11] http://www.apis.ac.uk, Accessed April 2018.

3.3.2. Both metrics are considered as absolute pollutant concentrations and as a percentage of the relevant assessment standard. Based upon the EA's guidance the significance criteria for assessing impacts in the assessment are set out below.

3.3.3. The PC can be considered insignificant if both:

- the long term process contribution is <1 per cent of the long term air quality standards or guidelines, and
- the short term process contribution is <10 per cent of the short term air quality standards or guidelines.

3.3.4. In relation to impacts on sensitive ecological receptors, the specific sensitivity criteria used in this assessment are taken from EA guidance. These relate to the Critical Loads and Critical Levels set for the protection of habitat sites. Impacts of stack emissions are considered to have insignificant impact (ie no further mitigation or assessment required) on sensitive ecological receptors if:

- the PC <1 per cent of the Long Term Critical Load or Critical Level; or
- If PC >1 per cent, then the PEC <70 per cent of the Critical Load or Critical Level.

3.3.5. This approach is used to give clear definition to those impacts that can be disregarded as insignificant, and which need to be considered in more detail or may require specific further mitigation.

3.4 PRESENTATION OF RESULTS

3.4.1. In the presentation of the results of the dispersion modelling, the numerical outputs are presented to the number of decimal places that allows the impact of the process to be identified by the reader, and varies between metrics. Given the scale of the impacts (very small), this implies that the model output data is presented with a numerical resolution that, in many cases, exceeds any measureable or significant level. In general, the following resolutions should be considered to be the limit of numerical significance in the modelled outputs:

- Concentrations of nitrogen oxides, nitrogen dioxide and carbon monoxide 0.1µg/m^3

which, based on the order of magnitude of the conversion of concentration to deposition, implies

- Deposition of nitrogen 0.01kgN/ha/yr
- Acid deposition 0.001keq/ha/yr

4

BASELINE CONDITIONS

4 BASELINE CONDITIONS

4.1 RCTCBC'S REVIEW & ASSESSMENT OF AIR QUALITY

4.1.1. The proposed Plant lies within the jurisdiction of Rhondda-Cynon-Taf County Borough Council (RCTCBC). In their latest available report, RCTCBC have a total of 15 extant AQMA, all of which are associated with emissions from road transport and major roads / busy junctions and declared on account of exceedances of the objective for annual mean nitrogen dioxide. Away from the AQMA, air quality in the borough is generally good.

4.1.2. The closest AQMA to the proposed Plant is the Aberdare AQMA, over 7km to the south-east of the site. Air quality at the proposed Plant is likely to be good and well within the air quality objectives.

4.1.3. The closest monitoring location to the site is at Woodland Park, Penderyn, 1.8km to the north of the Power Generation Plant. This is a rural site, where concentrations of nitrogen dioxide in 2016 were 8.6µg/m^3 and have been very low (8 - 11µg/m^3) for the past decade (and earlier).

4.1.4. In contrast, in Aberdare, in the AQMA, nitrogen dioxide concentrations widely exceed the annual mean air quality objective, but exceedances are by no means ubiquitous. For example, on Cardiff Street, concentrations at site ID 53 in 2016 were 46.6µg/m3, above the air quality objective, whilst at Whitcombe Street, at site ID 75 concentrations were 34.1µg/m3 and within the objective, even at the roadside. Concentrations within the AQMA are currently increasing, although it is not possible to ascertain whether this is a result of meteorological conditions or trends in local emissions.

4.1.5. Nitrogen dioxide concentrations were monitored on Caswell Close Hirwaun, 2.3km east of the site, until 2006 when concentrations were 27.8µg/m3. Caswell Close lies within 10m of the A465 Heads of the Valleys Road. This is the principal road in the vicinity of site, running approximately south-east to north-west, 250m to the north of the stacks. On average, concentrations of nitrogen dioxide across RCTCBC have declined slightly since 2006 and, as such, the data from Caswell Close are likely to represent a conservative estimate of existing roadside conditions in the study area outside of the AQMA.

Table 6 – Local Authority Air Quality Monitoring: Annual Mean Nitrogen Dioxide (µg/m^3)

Site Name (ID)	Type	Within AQMA	Distance from Site	2006	2014	2015	2016
Rhondda Cynon Taf County Borough Council							
Woodland Pk, Penderyn (21)	Rural	N	1.8km N	9.3	8.0	8.1	8.6
Caswell Close, Hirwaun (54)	Roadside	N	2.3km E	27.8	-	-	-
Cardiff St, Aberdare (53)	Roadside	Y	7.8km SE	**52.8**	**43.4**	**42.0**	**46.6**
Whitcombe St, Aberdare (75)	Roadside	Y	7.4km SE	39.8	30.8	32.6	34.1
Merthyr Tydfil County Borough Council							
Six Bells, Heolcerrig (16)	Suburban	N	10km E	No data	11.4	10.8	10.6
Erw Las, Merthyr Tydfil (31)	Suburban	N	9.8km E	No data	11.5	11.9	12.6

4.1.6. The eastern extreme of the study area lies within Merthyr Tydfil County Borough Council (MTCBC). Monitoring is undertaken by MTCBC throughout their borough, including 2 sites within the study area (Table 1.8). The sites are suburban sites and concentrations of nitrogen dioxide monitored at these sites are low and well below the air quality objective.

4.1.7. Powys Council's area lies around 3km to the north of the Power Generation Plant Site but Powys does not undertake any monitoring in the study area. This reflects an acknowledgement that pollutant concentrations are not of concern in the study area but also reflects the sparse residential development to the north of the Power Generation Plant.

4.1.8. Neath Port Talbot County Borough Council (NPTCBC) no longer monitor air quality within the study area. Up until 2011, they monitored at a suburban site within Glynneath, 5.5km to the west of the Power Generation Plant Site. Concentrations were, in keeping with the other monitoring within the study area, low (14.3µg/m^3 in 2011).

4.1.9. MTCBC, Powys Council and NPTCBC have no AQMA within the study area.

4.1.10. In summary, nitrogen dioxide concentrations across the study area are generally very low, both in rural and suburban areas. At the roadside, outside of urban areas, concentrations are higher but likely to be well within the air quality objectives. In larger urban areas (Aberdare), pockets of poor air quality exist at the roadside but the closest AQMA is more than 7km from the Project Site.

4.1.11. No monitoring of other pollutants including nitrogen oxides or carbon monoxide is undertaken by any local authority in the study area. Baseline concentrations of these pollutants are derived in the following section.

4.2 MAPPED BACKGROUND POLLUTANT CONCENTRATIONS

4.2.1. Defra and the Devolved Administrations provide mapped background pollutant concentrations for the UK on a 1km x 1km grid. For nitrogen oxides and nitrogen dioxide, the latest available data are provided by as hindcasts/projections for all years from 2015 to 2030. For carbon monoxide data are provided for 2001 with factors to project data to later years.

4.2.2. The background pollutant concentrations in the vicinity of the Power Generation Plant (**Table 7**) are currently well within the air quality objectives for the protection of human health and ecosystems. It is anticipated that concentrations will, in general, decrease over time as a result of a predicted overall reduction in emissions from all emission sources and sectors both in the UK and in Europe. However, the rate of improvement is uncertain, particularly in the short to medium term and, as such, the assessment does take into account this expected improvement in air quality between the current year and the first operation of the proposed Plant.

Table 7 - Background Pollutant Concentrations from Defra and Devolved Administrations mapped data for 2018.

Annual Mean Concentration µg/m^3			
Location	Nitrogen Oxides NOx	Nitrogen Dioxide NO_2	Carbon Monoxide
Objective	30 µg/m^3	40 µg/m^3	10,000 µg/m^3
Project Site [a]	***9.5***(15)	***7.3***(2)	***100***
Study Area Range [b]	3.8 – 14.2	3.0 – 10.6	70 – 110

[a] Data for Project Site taken from mapped data for 293500,206500; Figures in brackets show additional decimal places
[b] Data for study area taken from 283500,196500 to 303500,216500

4.2.3. Concentrations in bold italics are used as annual mean background concentrations for the assessment.

4.2.4. A comparison of the mapped Defra concentrations for 2018 with local authority monitoring in the study area shows that the background data are comparable with the monitored concentrations at rural and suburban sites (data to 2016). They are, therefore, considered representative of background concentrations away from major roads.

4.2.5. Short term background pollutant concentrations (averaging periods <=24 hours) are set to twice the annual mean background concentration. This follows EA guidance.

4.3 BACKGROUND DEPOSITION

4.3.1. Background levels of nitrogen and sulphur deposition within the study areas have been taken from the APIS website and are presented in **Table 8**. The data represent the three year average deposition between 2014 and 2016.

4.3.2. For all sites, nitrogen deposition levels exceed the estimated minimum of the critical load range for all habitats, from the most to the least sensitive. Furthermore, for the majority of sites and habitats, the level of nitrogen deposition also exceeds the upper estimate of the critical load.

4.3.3. For acidification, the baseline nitrogen deposition results in an exceedance of the lower estimate of the critical load function (as CLmaxN) for all habitats (except Acidophilus woodland in Gelli-ben-Uchel SINC which has low sensitivity to acid deposition). Sulphur deposition is less than the lower estimate of the critical load (CLmaxS) but the critical load function is exceeded on all sites.

4.3.4. In summary, levels of nitrogen deposition are high and, taking into account uncertainty in the setting of critical loads, are likely to exceed the critical loads for all habitats in the designated sites in the study area. The principal local sources of nitrogen are related to agriculture rather than industrial or transport processes.

4.3.5. For acid deposition, sulphur deposition is relatively low, but nitrogen deposition is high and, as a result, the combined nitrogen/sulphur deposition exceeds the lower estimate of the critical load function for the majority of habitats.

Table 8 - Background Pollutant Deposition for Designated Sites within the study area. Depositions in bold exceed the critical load

Most Sensitive Habitat		Nitrogen (kg/ha/yr)		Acid Deposition (keq/ha/yr)			
		Critical Load	N Depo-sition	Critical Load CLmaxN	N Depo-sition	Critical Load CLmaxS	S Depo-sition
Blaen Cynon SAC							
Cors Bryn-y-Gaer	Raised/blanket bog	5	**23.24**	1.078	**1.660**	0.757	0.460
Woodland Park & Pont Pren	Acidophilus wood	10	**35.00**	2.974	2.500	2.474	0.610
	Acid grassland	8	**26.74**	1.161	**1.910**	0.58	0.540
Coedydd Nedd a Mellte SAC							
Dyffrynoedd Nedd a Mellte	Lowland beech/Old Sessile Oak Woods	5	**30.50**	1.837	**2.180**	1.552	0.520
Cwm Cadlan SAC							
Cwm Cadlan	Mountain Hay Meadow/Moist grassland	10	**26.74**	1.161	**1.910**	0.58	0.540
Locally Designated Sites (SINC / Ancient Woodland)							
Hirwaun Industrial Estate	Raised/blanket bog	5	**23.24**	1.078	**1.660**	0.757	0.460
Hirwaun Ponds North	Raised/blanket bog	5	**26.74**	1.078	**1.910**	0.757	0.540
Hirwaun Ponds	Raised/blanket bog	5	**23.24**	1.078	**1.660**	0.757	0.460
Hirwaun Common	Raised/blanket bog	5	**26.74**	1.078	**1.910**	0.757	0.540

Most Sensitive Habitat		Nitrogen (kg/ha/yr)		Acid Deposition (keq/ha/yr)			
		Critical Load	N Depo-sition	Critical Load CLmaxN	N Depo-sition	Critical Load CLmaxS	S Depo-sition
Werfa Farm	Acidophilus wood	10	**30.52**	1.867	**2.180**	1.582	0.520
	Acid grassland	8	**23.24**	1.161	**1.660**	0.580	0.460
Rhigos Tramway	Acid grassland	8	**23.24**	1.161	**1.660**	0.580	0.460
Gelli-ben-Uchel	Acidophilus wood	10	**35.00**	2.974	2.500	2.474	0.610
	Acid grassland	8	**26.74**	1.161	**1.910**	0.580	0.540
Ancient Woodland	Lowland beech wood	5	**35.00**	1.867	**2.500**	1.582	0.610

5

ASSESSMENT OF IMPACTS

5 ASSESSMENT OF IMPACTS

5.1 STACK SENSITIVITY ASSESSMENT

5.1.1. Stack height sensitivity testing was undertaken using the emissions data set out in **Table 5.** The testing took account of all meteorological data from 2008 to 2012, taking the maximum concentration in any year.

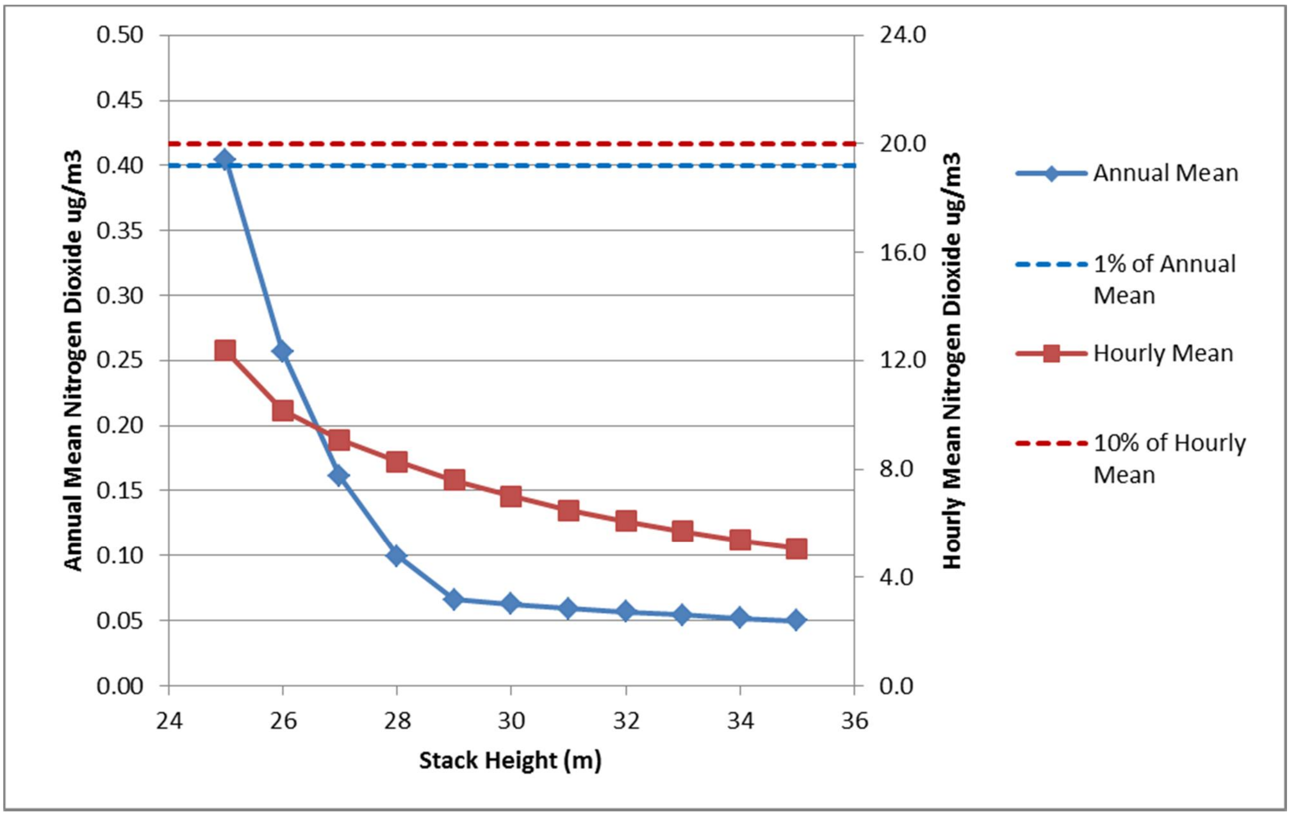
5.1.2. Dispersion model runs were undertaken for various stack heights between 25m and 35m with a model grid resolution of 20m. The appropriate stack height was determined by considering the height above which there is no further significant reduction in impact with increasing stack height. The metrics considered were the maximum annual mean and hourly mean nitrogen dioxide anywhere within the study area, and the maximum nitrogen deposition at a designated site.

5.1.3. **Table 9** and the associated figure (**Insert 2**) show the results of the stack height sensitivity testing. Significant benefits are seen as the stack height increases from 25m to 30m, as the impacts of building downwash reduce. Beyond this height, whilst benefits are still seen with increasing stack height, the rate of reduction in impacts progressively decreases. By 26m, the maximum impact on ground level concentrations of NO_2 anywhere on the grid is less than 1% of the annual mean objective and less than 10% of the hourly mean objective, and the maximum nitrogen deposition over a designated site is less than 1% of the most stringent critical load for any habitat (5kgN/ha/yr). Impacts are, therefore, insignificant at all stack heights above 26m.

5.1.4. Taking into account the insignificant impacts beyond 26m and the step change in the rate of reduction of annual mean impacts beyond 30m, the recommended minimum stack height is **30m**. This height is consistent with the DCO, which allowed for stack heights between 30 and 35m.

Table 9 - Stack Height Sensitivity Testing Results (20m grid resolution).

Stack Height	Maximum Impacts in Study Area					
	Annual Mean NO_2	% Objective	Hourly Mean NO_2	% Objective	Nitrogen Deposition	% Critical Load
Objective/ Critical Load	40 µg/m^3		200 µg/m^3		5kgN/ha/yr	
25	0.40	1.0%	12.4	6.2%	0.018	0.36%
26	0.26	0.6%	10.2	5.1%	0.017	0.34%
27	0.16	0.4%	9.1	4.5%	0.016	0.32%
28	0.10	0.2%	8.3	4.1%	0.015	0.30%
29	0.07	0.2%	7.6	3.8%	0.014	0.28%
30	**0.06**	**0.2%**	**7.0**	**3.5%**	**0.013**	**0.27%**
31	0.06	0.1%	6.5	3.2%	0.013	0.25%
32	0.06	0.1%	6.1	3.0%	0.012	0.24%
33	0.05	0.1%	5.7	2.8%	0.012	0.23%
34	0.05	0.1%	5.4	2.7%	0.011	0.22%
35	0.05	0.1%	5.1	2.5%	0.011	0.21%



Insert 2 - Effect of stack height on maximum ground level pollutant concentration

5.2 POTENTIAL IMPACTS ON HUMAN HEALTH

5.2.1. In this section, the modelled contributions of the Power Generation Plant to pollution levels are presented as maximum ground level concentrations of NO_2 and CO anywhere within the study area. All Process Contributions are modelled with the Power Generation Plant operating at full load. In the case of annual mean impacts only, concentrations and depositions are scaled by the maximum operating time of the Project, namely 1500 hours per annum.

5.2.2. Furthermore, the model results are presented as the contribution of the Power Generation Plant on its own, termed the Process Contribution, and in combination with background concentrations, termed the Predicted Environment Concentration.

5.2.3. **Table 10** shows the range of maximum predicted impacts for the Power Generation Plant, taken over the 5 meteorological years tested (2008 to 2012) for a stack at a height of 30m. The data are shown as the range of predicted Process Contributions and total Predicted Environmental Concentration (with typical background concentrations) for comparison against the UK's air quality objectives.

5.2.4. Both the Process Contribution and the total Predicted Environmental Concentration are well within the UK's air quality objectives for the protection of human health for all years and metrics. For CO, the maximum 8 hourly mean concentration (PC) over the 5 years tested is around 0.5% of the objective. For NO_2, the maximum process contribution is 0.2% of the annual mean objective and 3.5% of the hourly mean objective. As such, no significant health effects are anticipated as a result of the operation of the Power Generation Plant.

5.2.5. The inter-annual variability in the results is high, at around 20 - 60% of the 5 year mean for short and long term concentrations for NO_2 and moderate for CO (20%), although in relation to the relevant objectives the variation is relatively low (<0.1% for long term concentrations; <1.5% for short term concentrations). Variability in the long term is linked to variations in wind statistics between years.

Table 10 - Maximum Operational impacts for Stack at a Height of 30m Above Ground.

Pollutant	Averaging Period (Objective)	Process Contribution (µg/m^3)			Total Predicted Environmental Concentration (µg/m^3)[a]		
		Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective
Nitrogen Dioxide	Annual (40 µg/m^3)	0.02	0.06	0.2%	7.34	7.38	18.5%
	Hourly (200 µg/m^3)	3.4	7.0	3.5%	18.0	21.6	10.8%
Carbon Monoxide	8-Hourly (10,000 µg/m^3)	40.2	51.2	0.5%	232.45	243.44	2.4%

[a] Background concentrations for the total predicted environmental concentration were taken from the Defra & Devolved Administrations mapped data in **Table 7**. Hourly and 8-Hourly background concentrations are taken to be 2 x annual mean background as per guidance.

5.2.6. Maximum annual mean concentrations are close to the average in 2009 and 2012 and higher than average in 2008 and 2011 (**Table 11**). A comparison of the wind roses for Sennybridge for these years shows prevailing winds from the south-westerly sector in all years, but a greater proportion of winds from a north-easterly direction in 2010 (when maximum concentrations were the lowest modelled) and the least variability in wind direction in 2008 and 2011.

Table 11 - Inter-annual Variability in NO_2 and CO Concentrations.

Year	Process Contribution		
	Annual Mean Nitrogen Dioxide	Hourly Mean Nitrogen Dioxide	8-Hourly Mean Carbon Monoxide
Objective	40 µg/m^3	200 µg/m^3	10,000 µg/m^3
2011	0.06	6.7	44.4
2012	0.04	6.6	51.2
2013	0.02	3.4	40.7
2014	0.06	7.0	40.2
2015	0.04	6.0	40.3

5.2.7. Contour plots of the process contribution to the metrics for NO_2 and CO are provided in Figure 2 – 4, modelled using meteorological data from 2011.

5.2.8. Across all years, the point of maximum offsite impact of the plume occurs around 400m to 600m to the north-east of the stacks, in an area of sparse residential development with limited potential for exposure of members of the public. Annual mean impacts are concentrated to the north-east of the stacks reflecting the prevailing south-westerly winds. Hourly and 8 hourly mean impacts are more evenly distributed, reflecting the observation that poor dispersion conditions can occur under winds from any direction, but are also concentrated to the north-east of the stack.

5.2.9. Additional maxima occur onsite, in the immediate vicinity of the stack, adjacent to the turbine housing unit. These impacts are a result of building downwash and are highly localised. These maxima are of lower magnitude than the offsite maxima and there is no potential for public exposure onsite. As such, they are of low significance in the context of the assessment.

5.2.10. The maximum impacts of the Power Generation Plant occur to the north of the A465. Nevertheless, given the scale of the impact of the Power Generation Plant in comparison to background concentrations, the maximum total predicted environmental concentrations will occur at the roadside rather than at the point of maximum impact of the plume. The analysis of baseline air quality determined that roadside annual mean nitrogen dioxide concentrations in the vicinity of Hirwaun are likely to be in the region of 30µg/m^3. Taking a conservative approach, even if the maximum process contribution (0.06 µg/m^3) is added to this roadside background pollutant concentration, total pollutant concentrations will remain below the air quality objective. Hourly mean concentrations also remain well below the air quality objective.

5.2.11. According to the EA significant criteria, the Process Contribution from emission from the Plant on NO_2 and CO emissions are considered not significant.

5.3 POTENTIAL IMPACTS (ECOSYSTEMS)

5.3.1. The designated sites lying to the north-east of the Plant lie close to the areas of maximum impacts. Nevertheless, the impacts of the Plant are negligible for both pollutant concentrations and deposition across all sites.

5.3.2. The maximum Process Contribution to annual mean and daily mean nitrogen oxides and the total Predicted Environmental Concentration are shown in **Table 12** and **Table 13** respectively for all designated site. The impacts are greatest over Blaen Cynon SAC. The site lies within the area of maximum impact of the proposed Plant. On all sites, total pollutant concentrations remain well below the air quality objectives, also termed critical levels, for nitrogen oxides namely 30µg/m^3 as an annual mean and 75µg/m^3 as a daily mean.

5.3.3. The maximum impacts of the Power Generation Plant are less than 0.30% of the annual mean critical level, and . The maximum impacts are less than 5% of the critical level for daily mean NOx. Therefore, according to the EA significance criteria potential impacts are insignificant.

Table 12 - Maximum operational impacts on annual mean nitrogen oxides for a stack at a height of 30m above ground.

Designated Site	Process Contribution (µg/m^3)			Total Predicted Environmental Concentration (µg/m^3)		
	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective
Blaen Cynon SAC						
Cors Bryn-y-Gaer	0.028	0.089	0.30%	9.542	9.604	32.0%
Woodland Park & Pont.	0.028	0.089	0.30%	9.542	9.604	32.0%
Coedydd Nedd a Mellte SAC						
Dyffrynoedd Nedd	0.008	0.015	0.05%	9.523	9.530	31.8%
Cwm Cadlan SAC						
Cwm Cadlan	0.011	0.025	0.08%	9.526	9.540	31.8%
Locally Designated Sites (SINC / Ancient Woodland)						

Designated Site	Process Contribution ($\mu g/m^3$)			Total Predicted Environmental Concentration ($\mu g/m^3$)		
	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective
Hirwaun Industrial Est.	0.009	0.031	0.10%	9.524	9.546	31.8%
Hirwaun Ponds North	0.001	0.001	0.00%	9.516	9.516	31.7%
Hirwaun Ponds	0.0004	0.001	0.00%	9.515	9.515	31.7%
Hirwaun Common	0.001	0.003	0.01%	9.516	9.518	31.7%
Werfa Farm	0.007	0.009	0.03%	9.521	9.524	31.7%
Rhigos Tramway	0.002	0.004	0.01%	9.517	9.519	31.7%
Gelli-ben-Uchel	0.005	0.012	0.04%	9.520	9.527	31.8%
Ancient Woodland	0.024	0.073	0.24%	9.539	9.587	32.0%

Background concentration is 9.515$\mu g/m^3$

Table 13 - Maximum operational impacts on daily mean nitrogen oxides for a stack at a height of 30m above ground. Background concentrations is 19.0$\mu g/m^3$, taken from the Defra mapped data.

Designated Site	Process Contribution ($\mu g/m^3$)			Total Predicted Environmental Concentration ($\mu g/m^3$)		
	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective
Blaen Cynon SAC						
Cors Bryn-y-Gaer	1.54	3.49	4.66%	20.57	22.52	30.0%
Woodland Park & Pont.	1.54	3.49	4.66%	20.57	22.52	30.0%
Coedydd Nedd a Mellte SAC						
Dyffrynoedd Nedd	0.60	0.67	0.90%	19.63	19.70	26.3%
Cwm Cadlan SAC						
Cwm Cadlan	0.42	0.69	0.92%	19.45	19.72	26.3%
Locally Designated Sites						
Hirwaun Industrial Est.	1.13	1.70	2.26%	20.16	20.72	27.6%
Hirwaun Ponds North	0.03	0.07	0.10%	19.06	19.10	25.5%

Designated Site	Process Contribution (µg/m³)			Total Predicted Environmental Concentration (µg/m³)		
	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective	Minimum over 5 Years	Maximum over 5 Years	Maximum as % of Objective
Hirwaun Ponds	0.02	0.05	0.07%	19.05	19.08	25.4%
Hirwaun Common	0.09	0.36	0.48%	19.11	19.39	25.9%
Werfa Farm	0.57	0.97	1.29%	19.60	20.00	26.7%
Rhigos Tramway	0.22	0.52	0.70%	19.25	19.55	26.1%
Gelli-ben-Uchel	0.27	0.51	0.69%	19.30	19.54	26.1%
Ancient Woodland	1.12	2.01	2.67%	20.15	21.03	28.0%

Background concentration is 19.03µg/m³

5.3.4. **Table 14** and **Table 15** show the maximum process contribution to nitrogen and acid deposition resulting from the Power Generation Plant emissions. As shown in **Table 8**, existing deposition levels exceed the lower estimates of the critical loads for all sensitive habitats for nitrogen and for all acid sensitive habitats except acidophilus woodland.

5.3.5. For all sites, the contribution of the Power Generation Plant to total nitrogen or acid deposition is less than 0.2% of the relevant critical load for all habitats in internationally and nationally designated sites (SAC & SSSI), and less than 0.3% over nationally designated sites.

5.3.6. Maximum impacts of the Power Generation Plant occur, as for NOx concentrations, at Blaen Cynon SAC although, due to the sensitivity of the habitats, as a percentage of the critical load, maximum impacts for nitrogen deposition occur over Ancient Woodland sites to the north-east of the Plant. Based on EA guidance this level of impact on nitrogen deposition is insignificant in all cases.

5.3.7. For acid deposition, the deposition of nitrogen has been assessed against the CL_{max}(N) parameter within the critical load function. The maximum impacts are less than 0.1% of this critical load for all habitats. The level of exceedance of the critical load function is wholly dependent on the existing deposition levels and does not change perceptibly with the addition of the impacts of the proposed Plant. Based on EA guidance this level of impact on acid deposition is insignificant.

Table 14 – Nitrogen deposition for Designated Sites within the study area.

Most Sensitive Habitats		Nitrogen Deposition (kgN/ha/yr)					
		Critical Load	Back-ground	Minimum over 5 yrs	Maximum over 5 yrs	Maximum at % of CL	Maximum PEC
Blaen Cynon SAC							
Cors Bryn-y-Gaer	Raised/blanket bog	5	23.24	0.0029	0.0094	0.19%	23.25
Woodland Park & Pont Pren	Acidophilus wood	10	35.00	0.0058	0.0188	0.19%	35.02
	Acid grassland	8	26.74	0.0029	0.0094	0.12%	26.75
Coedydd Nedd a Mellte SAC							
Dyffrynoedd Nedd a Mellte	Lowland beech/Old Sessile Oak Woods	5	30.52	0.0017	0.0031	0.06%	30.52
Cwm Cadlan SAC							
Cwm Cadlan	Mountain Hay Meadow	10	26.74	0.0012	0.0027	0.03%	26.74
Locally Designated Sites							
Hirwaun Industrial Estate	Raised/blanket bog	5	23.24	0.0010	0.0032	0.06%	23.24
Hirwaun Ponds North	Raised/blanket bog	5	26.74	0.0001	0.0001	0.00%	26.74
Hirwaun Ponds	Raised/blanket bog	5	23.24	0.0000	0.0001	0.00%	23.24
Hirwaun Common	Raised/blanket bog	5	26.74	0.0001	0.0003	0.01%	26.74
Werfa Farm	Acid Grassland	8	30.52	0.0007	0.0009	0.01%	30.52
Rhigos Tramway	Acid grassland	8	23.24	0.0002	0.0005	0.01%	23.24
Gelli-ben-Uchel	Acidophilus wood	10	35.00	0.0010	0.0025	0.02%	35.00
	Acid grassland	8	26.74	0.0005	0.0012	0.02%	26.74
Ancient Woodland	Lowland beech wood	5	35.00	0.0051	0.0152	0.30%	35.00

*CL = Critical Load

Table 15 – Acid deposition (from nitrogen) for Designated Sites within the study area.

Most Sensitive Habitats		Nitrogen Deposition (keq/ha/yr)					
		Critical Load	Back-ground	Minimum over 5 yrs	Maximum over 5 yrs	Maximum at % of CL	Maximum PEC
Blaen Cynon SAC							
Cors Bryn-y-Gaer	Raised/blanket bog	1.078	1.660	0.00021	0.00067	0.06%	1.661
Woodland Park & Pont Pren	Acidophilus wood	2.974	2.500	0.00041	0.00134	0.05%	2.501
	Acid grassland	1.161	1.910	0.00021	0.00067	0.06%	1.911
Coedydd Nedd a Mellte SAC							
Dyffrynoedd Nedd a Mellte	Lowland beech/Old Sessile Oak Woods	1.837	2.180	0.00012	0.00022	0.01%	2.180
Cwm Cadlan SAC							
Cwm Cadlan	Mountain Hay Meadow	1.161	1.910	0.00008	0.00019	0.02%	1.910
Locally Designated Sites							
Hirwaun Industrial Estate	Raised/blanket bog	1.078	1.660	0.00007	0.00023	0.02%	1.660
Hirwaun Ponds North	Raised/blanket bog	1.078	1.910	0.00001	0.00001	0.00%	1.910
Hirwaun Ponds	Raised/blanket bog	1.078	1.660	0.00000	0.00000	0.00%	1.660
Hirwaun Common	Raised/blanket bog	1.078	1.910	0.00001	0.00002	0.00%	1.910
Werfa Farm	Acid Grassland	1.161	2.180	0.00005	0.00007	0.01%	2.180
Rhigos Tramway	Acid grassland	1.161	1.660	0.00001	0.00003	0.00%	1.660
Gelli-ben-Uchel	Acidophilus wood	2.974	2.500	0.00007	0.00018	0.01%	2.500
	Acid grassland	1.161	1.910	0.00004	0.00009	0.01%	1.910
Ancient Woodland	Lowland beech wood	1.867	2.500	0.00036	0.00109	0.06%	2.501

6

CONCLUSIONS

6 CONCLUSIONS

6.1.1. The detailed dispersion model ADMS v5.2 was used to predict the changes in pollutant concentrations that would occur due to the operation of the Power Generation Plant.

6.1.2. The pollutants considered in the assessment were nitrogen oxides (including nitrogen dioxide) and carbon monoxide. Background concentrations issued by Defra and the Devolved Administrations were used in combination with the predicted Process Contribution (PC) from the operation of the Power Generation Plant in order to determine the total Predicted Environmental Concentration (PEC) for each pollutant. The PC and PEC were then compared with the relevant assessment levels set out in UK and EU legislation and national guidance.

6.1.3. The modelled PC for the concentration of pollutants in air is insignificant for all statutory and non-statutory assessment levels for the protection of human health and ecosystems (<1% of long term standards, and <10% of short term standards). Furthermore, the modelled PEC is well within the air quality assessment levels.

6.1.4. The deposition of nitrogen (as nutrient nitrogen and as a contribution to acid deposition) was also modelled and the PC shown to be insignificant when compared to appropriate critical loads (<1% of critical load). Total deposition exceeds the critical loads for the majority of sensitive habitats but this is wholly a function of background levels of deposition. The contribution of the Power Generation Plant itself is negligible.

6.1.5. The results of the assessment clearly show that the operation of the Power Generation Plant will be insignificant.

Appendix A

GLOSSARY

GLOSSARY

Term	Definition
Air quality objective	Policy target generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedances within a specific timescale (see also air quality standard).
Air quality standard	The concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects on sensitive sub groups (see also air quality objective).
Ambient air	Outdoor air in the troposphere, excluding workplace air.
Annual mean	The average (mean) of the concentrations measured for each pollutant for one calendar year.
AQMA	Air Quality Management Area.
CL / Critical Load	A quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge[12]". Critical loads are set for effects due to eutrophication (nitrogen deposition) and acidification (combined action of sulphur and nitrogen deposition
Conservative	Tending to over-predict the impact rather than under-predict.
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs.
Deposition	The process by which gases and aerosols from the atmosphere collect themselves on the Earth's surface or the surface of vegetation
Deposition Velocity	A measure of how readily a pollutant deposits via direct deposition (not in precipitation)
DfT	Department for Transport.
Emission rate	The quantity of a pollutant released from a source over a given period of time.
Exceedance	A period of time where the concentrations of a pollutant is greater than the appropriate air quality standard.
LAQM	Local Air Quality Management.
NO_2	Nitrogen dioxide.
NO_x	Nitrogen oxides.
CO	Carbon Monoxide
$\mu g/m^3$ microgrammes per cubic metre	A measure of concentration in terms of mass per unit volume. A concentration of $1ug/m^3$ means that one cubic metre of air contains one microgram (millionth of a gram) of pollutant.

[12] http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm

Appendix B

STACK LOCATION SENSITIVITY

STACK LOCATION SENSITIVITY TESTING

The exact layout of the Power Generation Plant is subject to minor change. To test the sensitivity of the model results to the layout the following scenarios were tested:

- Building oriented North-South (strictly 5 degrees to North, as per DCO Non-Material Order)
  - Stack located on building to the north, centre and south
- Building oriented East-West (strictly 95 degrees to North, rotated 90 degress from DCO)
  - Stack located on building to the east, centre and west

Figure B.1 illustrates the layouts.

The sensitivity testing was undertaken using the exhaust parameters for the single generator set out in Table 5, with meteorological data for 2012.

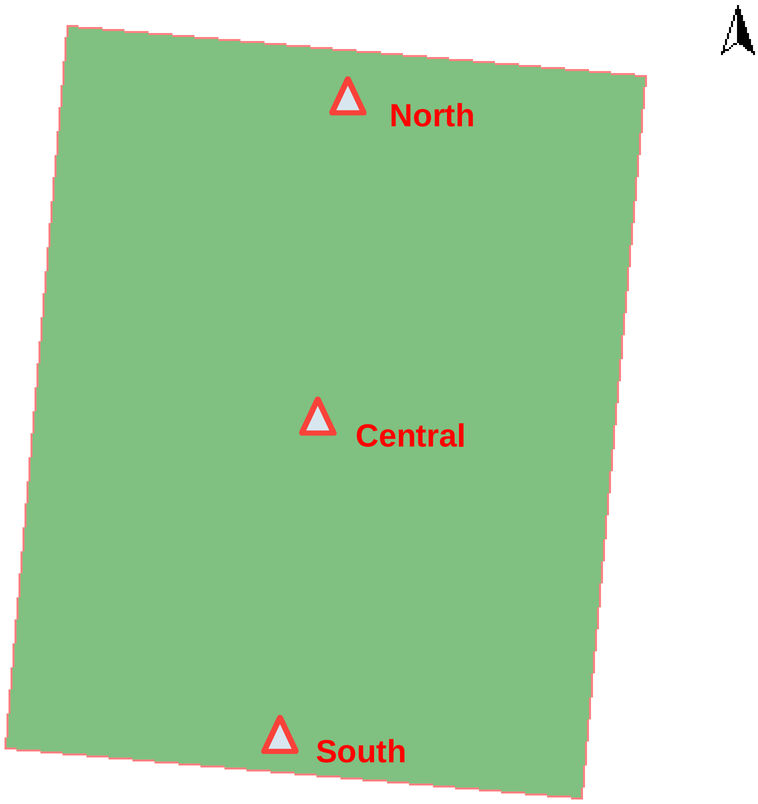
The maximum ground level concentrations of annual mean and hourly mean nitrogen dioxide under the scenarios are shown below

Building Orientation	Stack Location	Maximum Annual Mean Nitrogen Dioxide ($\mu g/m^3$)	Maximum Hourly Mean Nitrogen Dioxide ($\mu g/m^3$)
North-South	**North**	**0.0379**	**6.037**
	Central	0.0369	5.527
	South	0.0365	4.948
East-West	West	0.0366	5.226
	Central	0.0369	5.502
	East	0.0368	5.116

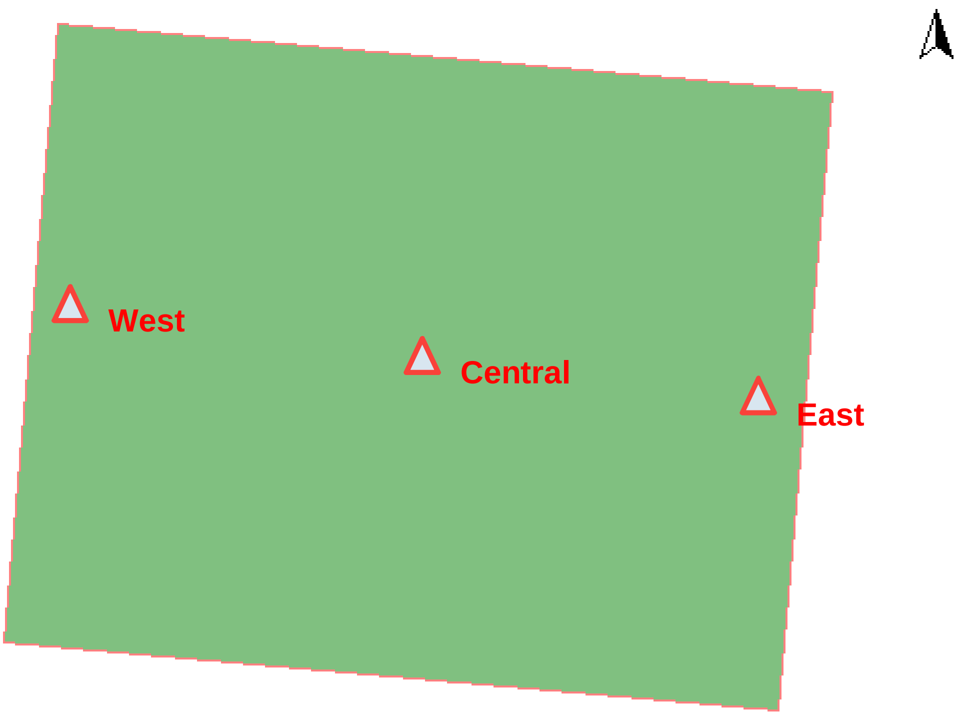
The testing shows that the assessment core scenario of the north-south oriented building with stack located towards the northern edge of the building gives the highest ground level concentrations and is, therefore, a realistic worst case scenario.

Figure B.1 Layout Scenarios Tested

North –South Orientation Building



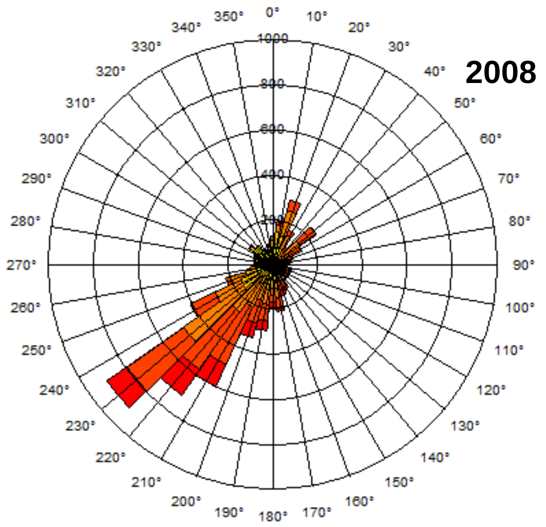
East-West Orientation Building

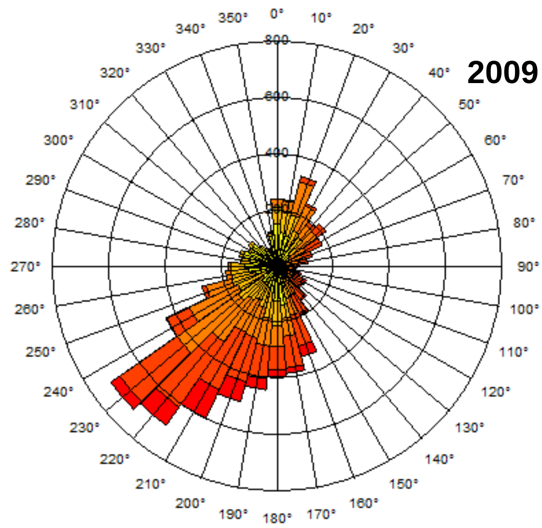


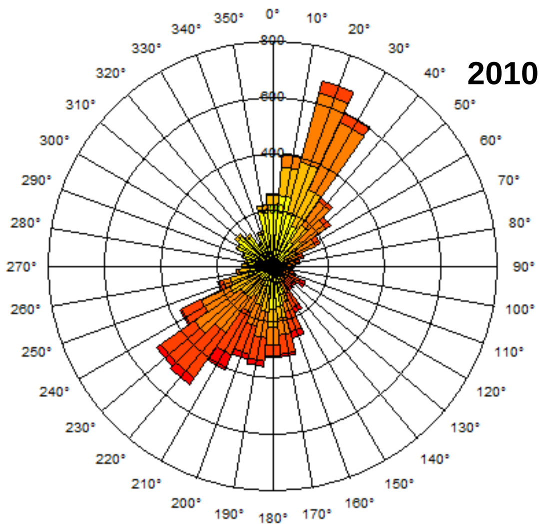
Appendix C

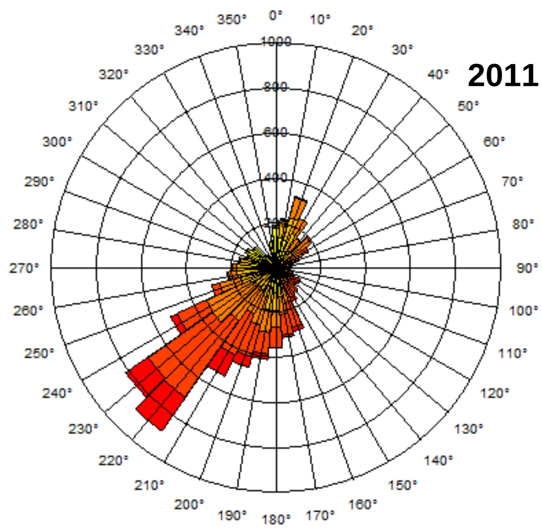
WIND ROSES

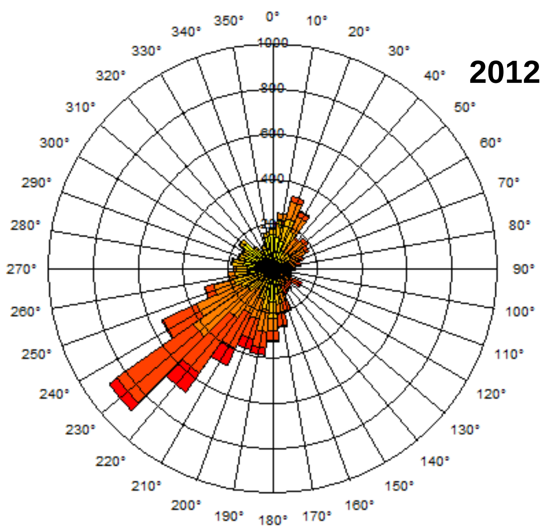
WIND ROSES FOR SENNYBRIDGE, 2008 – 2012

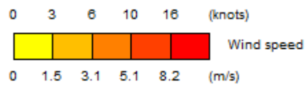












Appendix D

FIGURES

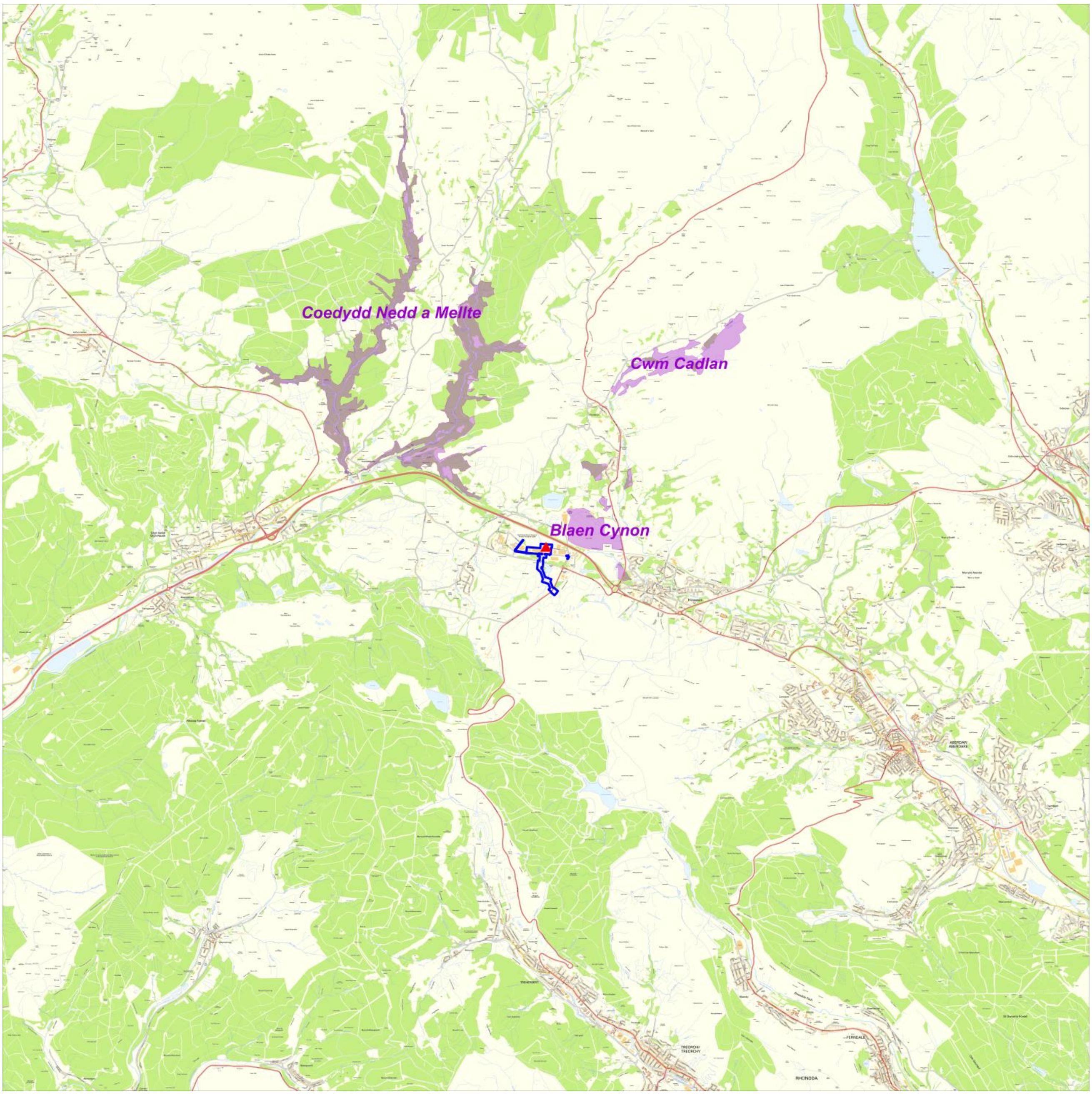


Figure 1 – 1a Wider Study Area and Designated Sites

Key:

Application Site Boundary	
Stack location	
Internationally Designated Sites	

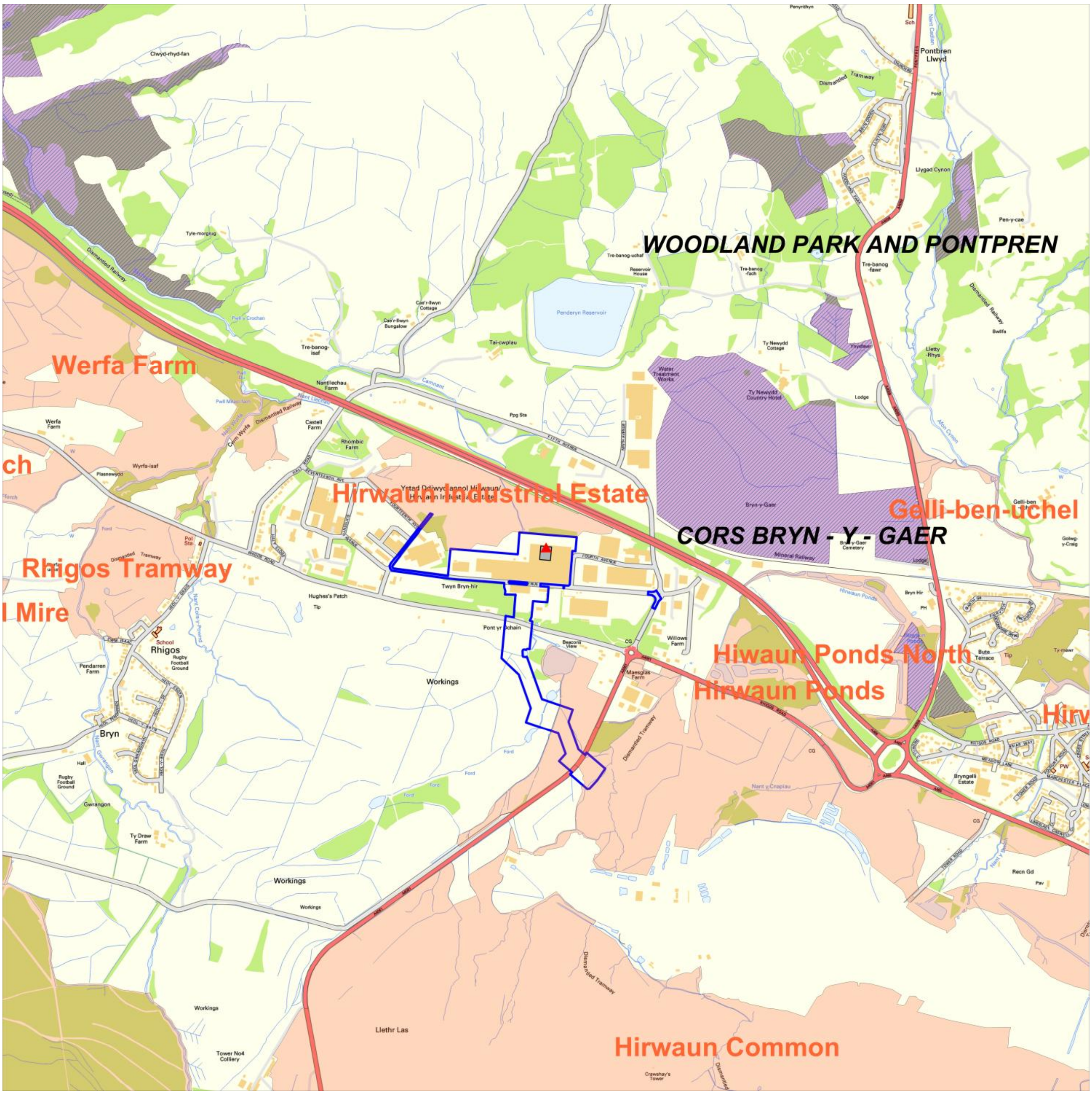


Figure 1 – 1b 2km Study Area and National and Locally Designated Sites

Key:

- Application Site Boundary
- Stack location
- Nationally Designated Sites
- Locally Designated Sites

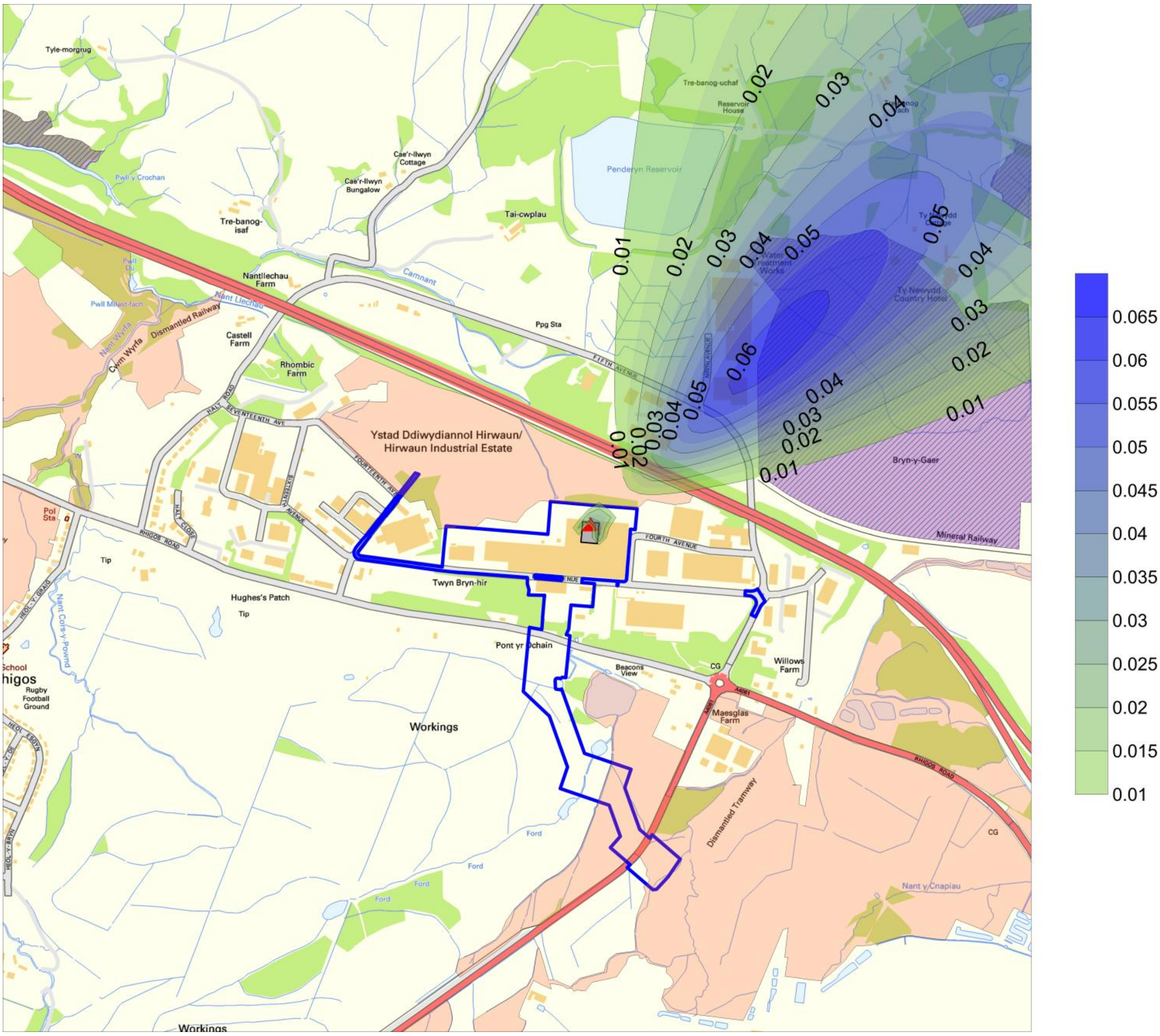


Figure 2 – Contribution of Power Generation Plant to annual mean nitrogen dioxide (µg/m³), modelled using meteorological data from 2011. Contour interval = 0.01µg/m³ (=0.025% of 40µg/m³ objective)

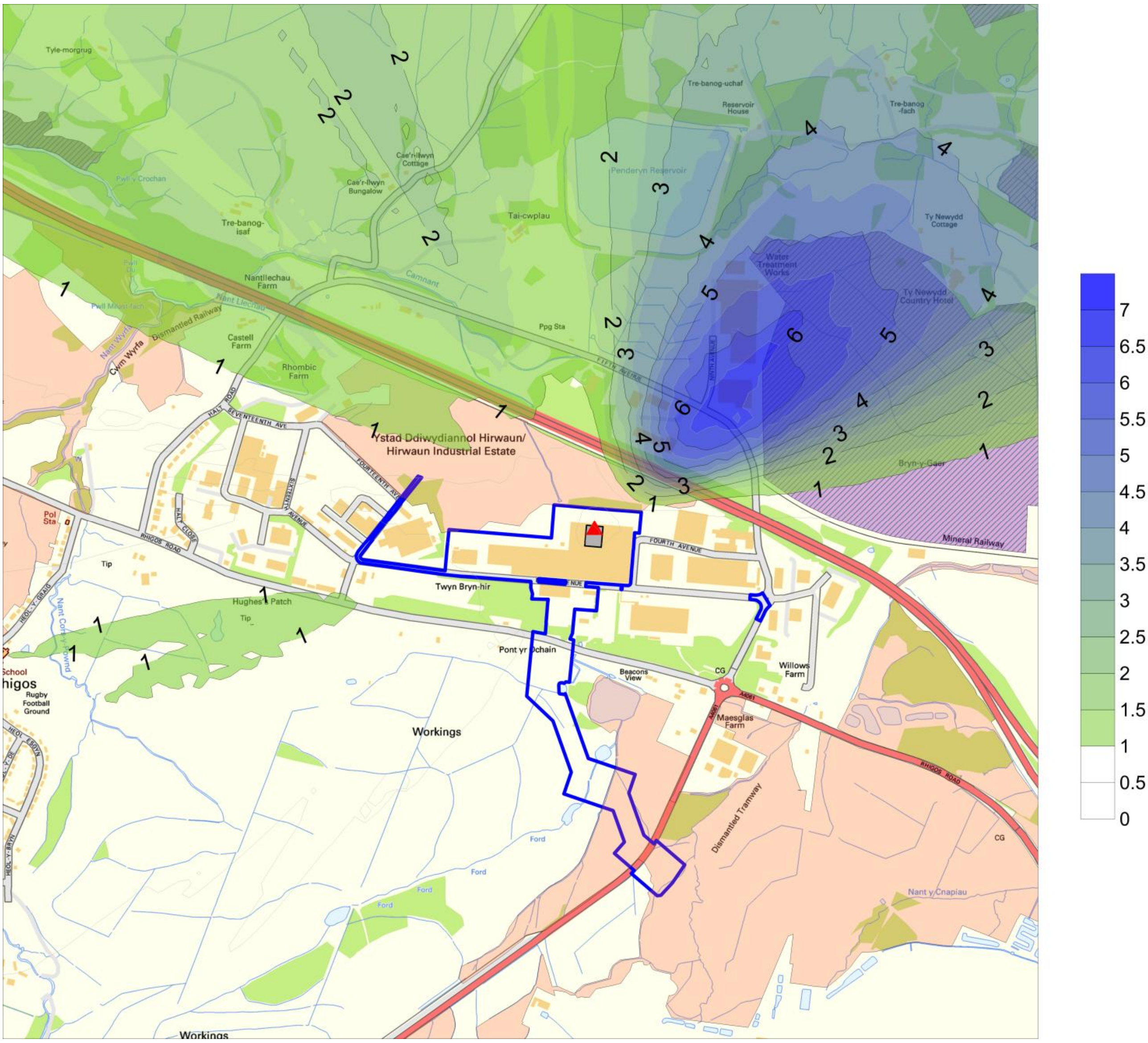


Figure 3 – Contribution of Power Generation Plant to hourly mean nitrogen dioxide ($\mu g/m^3$), modelled using meteorological data from 2011. Contour interval = $0.5\mu g/m^3$ (=0.25% of $200\mu g/m^3$ objective)

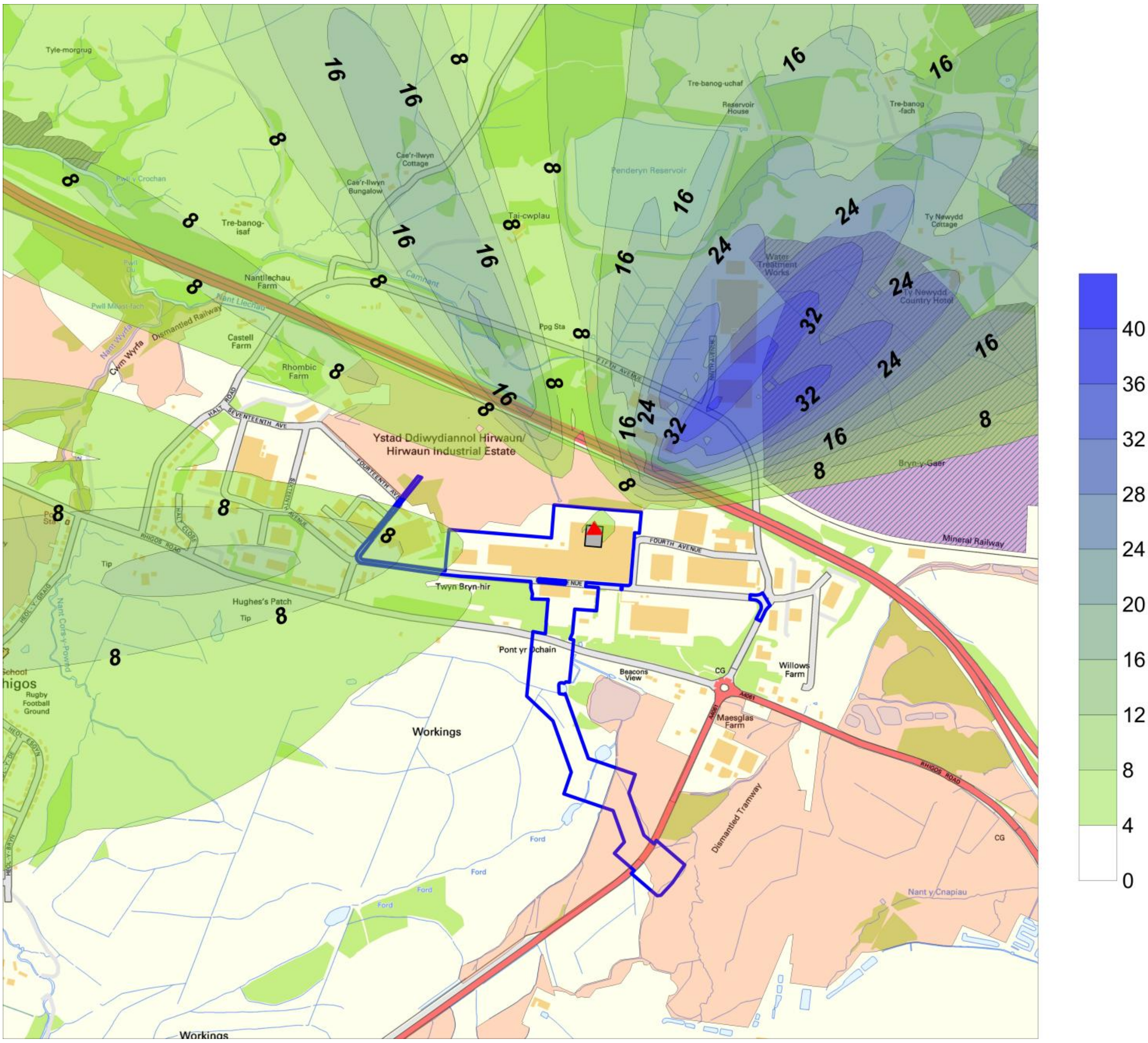


Figure 4 – Contribution of Power Generation Plant to 8-hour mean carbon monoxide (µg/m^3), modelled using meteorological data from 2011. Contour interval = 4µg/m^3 (=0.04% of 10,000µg/m^3 objective)

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