COG MOORS WWTW – PROPOSED ADVANCED ANAEROBIC DIGESTION (AAD) PLANT

Air Quality Assessment

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Incorporating

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Non-Technical Summary

An air quality assessment has been undertaken to assess air pollution associated with the proposed advanced anaerobic digestion (AAD) plant at Cog Moors Wastewater Treatment Works (WwTW). The biogas produced by the proposed AAD plant would be used, via a combined heat and power (CHP) plant, to generate heat and renewable electricity for use on site or for export to the electricity grid. The CHP plant and gas boilers used will produce emissions which will be released to atmosphere through a 18m stack in order to allow good dispersion.

A detailed air pollution dispersion model has been used together with information on pollution emissions and hourly weather observations to predict pollution levels at nearby sensitive receptors such as houses and sites of importance for ecology and habitats. The model predictions have been compared against pollution thresholds set by UK Government and EU regulations to protect human health and ecology.
The assessment has been undertaken assuming that the CHP plant is operating at fully capacity, for every hour of the year, which likely overestimates emissions and air pollution, as the plant will not be used continuously at maximum output.

The results of the pollution model indicate that the AAD plant will not lead to exceedances of air pollution thresholds, and pollution levels are expected to be well below human health based thresholds with the plant in operation. The emissions from the AAD plant are also predicted to have no significant effects on ecology and habitats.

1 Introduction

1.1 Background

This report considers the potential air quality effects associated with the proposed advanced anaerobic digestion (AAD) plant at Cog Moors Wastewater Treatment Works (WwTW). The air quality assessment has been undertaken by Arcadis Consulting (UK) Ltd working as part of Dwr Cymru Welsh Water (DCWW) Capital Delivery Alliance (CDA).

The biogas produced by the proposed AAD plant would be used, via a combined heat and power (CHP) plant, to generate heat and renewable electricity for use on site or for export to the electricity grid. The CHP plant would also be supplemented by two gas boilers. The air quality assessment has considered the potential air quality effects of the CHP plant and boilers on human health and ecology.

For CHP units and boilers fuelled by natural gas or biogas the pollutants of concern are oxides of nitrogen (NOx) and nitrogen dioxide (NO_2), as described in EPUK 2012 guidance[1]. The risk assessment associated with Environment Agency standard rules guidance for use of sewage biogas in engines[2] indicates that emissions of NO_x and carbon monoxide (CO) have the potential to affect local air quality, although the potential for adverse CO effects is low (due to low magnitude of CO emissions). This assessment has therefore focussed on the pollutants NO_X and NO_2 as the proposed development is expected to have negligible effects on other air pollutants.

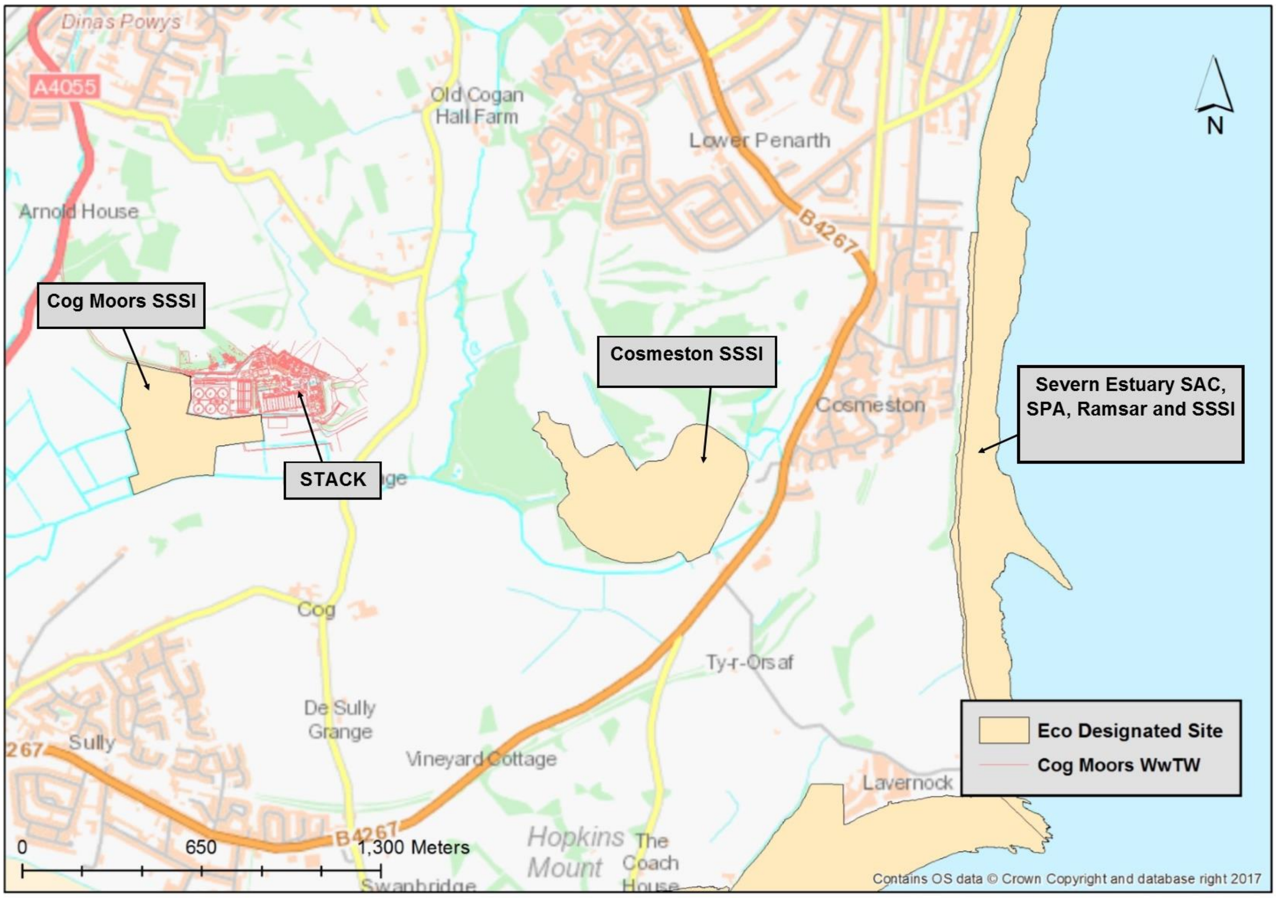
1.2 Location

Cog Moors WwTW is situated to the east of the A4055 Cardiff Road, approximately 2km east of Barry and 1km south of Dinas Powys, as shown in

Figure 1 below. The proposed development site is located in the administrative boundary of Vale of Glamorgan (VoG) Council.

[1] Environmental Protection UK (2012) Combined Heat and Power: Air Quality Guidance for Local Authorities
[2] Environment Agency (2012) SR2009 No4: combustion of biogas in engines at a sewage treatment works

Figure 1 – Location of Cog Moors WwTW



The closest human health receptor to the proposed development site is Downs Farm and cottage, located approximately 230m to the east, off Sully Road.

Cog Moors Site of Special Scientific Interest (SSSI) is located along the south-western boundary of the WwTW, and is designated for its grasslands.

2 Legislation and Policy

2.1 European

The EU Directive on ambient air quality (2008/50/EC)[3] sets out a range of mandatory Limit Values (LVs) for different pollutants including NO_x and NO_2. The Directive consolidated previous air quality Directives (apart from the Fourth Daughter Directive), setting Limit Values for seven pollutants, in addition to Target Values for an additional five pollutants. The Directive also provides a new regulatory framework for particulate matter smaller than 2.5µm in diameter ($PM_{2.5}$), and allows Member States to seek postponement of attainment deadlines.

2.2 National

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

[3] Council of European Committees (2008) Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe

in July 2007[4]. The AQS sets out AQS objectives that are maximum ambient pollutant concentrations not to be exceeded either without exception or with a permitted number of exceedances over a specified timescale.

The regulations referred to in the AQS have been supplemented by the Air Quality Regulations (2010), which came into force on 11th June 2010 and transpose the European Union (EU) Air Quality Directive (2008/50/EC) into UK law. These AQS objectives are generally in line with EU Limit Values, although the requirements for the determination of compliance vary.

The AQS objectives and EU Limit Values for the protection of human health applicable to this assessment are presented in Table 1.

Table 1 - Air Quality Objectives and EU Limit Values for NO_2

Air Quality Objectives				**EU Limit Values**	
Pollutant	**Concentration**	**Averaging Period**	**Compliance Date**	**Concentration**	**Compliance Date**
NO_2	200 µg/m³	1-hour mean (not to be exceeded more than 18 times per year – equivalent to 99.8th percentile)	31 December 2005	200 µg/m³ (1-hour mean not to be exceeded more than 18 times per year – equivalent to 99.8th percentile)	1 January 2010
	40 µg/m³	annual mean	31 December 2005	40 µg/m³ (annual mean)	1 January 2010

The Air Quality Objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). The annual mean objectives apply to all locations where members of the public might be regularly exposed; these include building façades of residential properties, schools, hospitals, care homes, etc. The 1 hour mean objective also applies at these locations as well as at any outdoor location where a member of the public might reasonably be expected to stay for 1 hour or more, such as shopping streets, parks and sports grounds, as well as bus stations and railway stations that are not fully enclosed.

The AQS objectives and EU Limit Values for the protection of vegetation and ecosystems applicable to this assessment are presented in Table 2. It should be noted that the assessment has also considered the non-statutory Environmental Assessment Level (EAL) of 75 µg/m3 for maximum daily mean NOx at ecological sites as recommended by the Environment Agencies (EA's) Air Emissions Risk Assessment5.

4 Defra (2007), The Air Quality Strategy for England, Scotland, Wales and Northern Ireland
5 Department for Environment, Food and Rural Affairs & Environment Agency (2016) Air Emissions Risk Assessment for your Environmental Permit (available online at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit)

Table 2 - Air Quality Objective and EU Limit Value for NO_x

Air Quality Objective				EU Limit Value	
Pollutant	**Concentration**	**Averaging Period**	**Compliance Date**	**Concentration**	**Compliance Date**
NO_x	30 µg/m³	annual mean	31 December 2000	30 µg/m³ (annual mean)	19 July 2001

It is a requirement of the Environment Act (1995) that Local Authorities (LAs) review current and future air quality within their area of jurisdiction under the system of Local Air Quality Management (LAQM). Any areas of relevant exposure where the AQS objectives are not, or unlikely to be, achieved should be identified.

Where it is anticipated that an AQS objective will not be met, it is a requirement that an AQMA be declared. Where an AQMA is declared, the LA is obliged to produce an Action Plan in pursuit of the achievement of the AQS objectives.

2.3 National Planning Policy

Planning Policy Wales[6] was published in November 2016 and sets out the Welsh Government's core policies and principles with respect to land use planning, including air quality. The document includes the following considerations which are relevant to the assessment:

"The potential for pollution affecting the use of land will be a material consideration in deciding whether to grant planning permission. Material considerations in determining applications for potentially polluting development are likely to include:

- *the risk and impact of potential pollution from the development, insofar as this might have an effect on the use of other land and the surrounding environment (the environmental regulatory regime may well have an interest in these issues, particularly if the development would impact on an Air Quality Management Area or a SAC)..."*

2.4 Local Planning Policy

The VoG Local Development Plan (LDP) 2011-2026[7] provides the local planning policy framework for the VoG and was adopted on 28th June 2017.

Policy MD7 – Environmental Protection states:

"Development proposals will be required to demonstrate they will not result in an unacceptable impact on people, residential amenity, property and/or the natural environment from either

1. *Pollution of land, surface water, ground water and the air…*

Where impacts are identified the council will require applicants to demonstrate that appropriate measures can be taken to minimise the impact identified to an acceptable level. Planning conditions may be imposed or legal obligation entered into, to secure any necessary mitigation and monitoring processes.

While many elements of pollution control are outside the remit of the planning system it is important that new development does not lead to unacceptable levels of pollution. If, as a result of consultation with bodies such

[6] Welsh Government (2016) Planning Policy Wales

[7] Vale of Glamorgan Council (2017), Vale of Glamorgan Local Development Plan 2011 - 2026

as Natural Resources Wales and Health and Safety Executive, the Council considers that a development proposal would lead to unacceptable pollution, or make an existing problem worse, then planning permission will not be granted."

3 Methodology

The air quality assessment has been undertaken with due consideration of Defra and Environment Agency's (EA) 'Air emissions risk assessment for your Environmental Permit' guidance[8], which provides advice on assessing releases to air. Although the risk assessment has been developed by Defra and the EA for assessments in England, it is also adopted by Natural Resources Wales (NRW) for assessments in Wales.

3.1 Dispersion Model

The air quality impacts were considered using the United States Environmental Protection Agency (US EPA) dispersion model BREEZE AERMOD. The model integrates the impact of meteorology and topography within the modelling output. AERMOD is routinely used throughout the world for predicting the dispersion of pollutants and the output results are accepted within the UK by the EA, NRW and Defra.

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

Dispersion modelling was undertaken in order to predict concentrations of annual mean NO_x, daily maximum NOx and hourly 99.8th percentile NOx in order to compare impacts against the AQS objectives and EALs discussed in Section 2.2. The annual mean and hourly 99.8th percentile NO_x concentrations were converted to NO_2 as described in Section 3.4.

Odour impacts from the AAD plant are expected to be non-significant and have been considered in a separate odour assessment report[9] for the proposed development.

3.2 Process Conditions and Emissions

The proposed development includes two CHP units fuelled by biogas produced from sludge and two gas boilers that can be fuelled by either biogas or natural gas. The assessment was undertaken assuming a worst-case scenario that the two CHP units and two boilers operate at 100% load for 8760 hours per year (i.e. 24 hours per day for 365 days).

It is expected that although the two boilers can fire on natural gas or biogas, they would operate almost entirely on natural gas. The natural gas boilers are also associated with a higher NO_x emission rate compared to biogas, and as a worst-case assumption, this assessment has therefore been undertaken assuming that the boilers operate on natural gas. An alternative scenario has however been assessed, where it was assumed that the boilers run on biogas, as the exhaust gas exit velocity is lower for biogas compared to natural gas. The results of the alternative scenario are discussed in Section 5.3.

A waste gas burner (biogas flare stack) will also be used during commissioning and intermittently whilst the plant is settled into a stable operating platform. The waste gas burner will be used to combust excess biogas not used in the CHP engine or gas boilers, and will therefore be used infrequently, for short periods, and when the CHP unit and gas boilers are out of operation or operating at low load. The waste gas burner has therefore not been considered in this assessment, as the assumption that both CHP units and gas boilers operate at 100% load for 8760 hours per year is expected to be worst-case relative to an alternative scenario with the waste gas burner in use.

3.3 Emissions

The emission parameters for the CHP units and gas boilers were provided by Edina and Dunphy Combustion Ltd, respectively. There would be one flue for each CHP unit and gas boiler, which would be

[8] Department for Environment, Food and Rural Affairs & Environment Agency (2016) Air Emissions Risk Assessment for your Environmental Permit (available online at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit)
[9] Arcadis (2017) Cog Moors WwTW Proposed Advanced Anaerobic Digestion (AAD) Plant, Odour Assessment

combined into a single stack. The stack and emission parameters used are shown in Table 3 and Table 4, respectively.

Table 3 – Stack Parameters

Parameter	CHP and Boilers
Stack Location (NGR)	316233, 169606
Stack Height (m)	18

Table 4 –Emission Parameters

Parameter	CHP (per unit)	Natural Gas Boiler (per unit)	Biogas Boiler (per unit)
Emission Limit (NO_x) (mg/Nm^3) dry	500 (@5% O_2)	100 (@3% O_2)	70 (@3% O_2)
Emission Rate (NO_X) (g/s)	0.66	0.11	0.08
Temperature (°C)	180	150	150
Flue Diameter (m)	0.45	0.4	0.4
Actual Volumetric Flow (m^3/hr), wet	10590	6161	5956
Exit Velocity (m/s)	18.5	13.6	13.2

When plumes from multiple closely-spaced stacks or flues merge, the plume rise can be enhanced. The four flues were modelled as separate point sources (in the same location) in the AERMOD model, and no account has been made for enhanced plume rise, which is expected to provide a conservative approach.

3.4 NO_x to NO_2 Conversion Rate

Emissions of NO_x from industrial point sources are typically dominated by nitric oxide (NO), with emissions from combustion sources typically in the ratio of NO to NO_2 of 9:1. After emission, NO is oxidised to NO_2 by ozone (O_3), and the rate of oxidation is dependent on the relative concentrations of NO_x and O_3 in the air.

As recommended by the EA's Air Quality Modelling and Assessment Unit (AQMAU)[10], conversion rates of 35% for short term impacts and 70% for long term impacts were used in the assessment.

3.5 Meteorological Data

LAQM.TG (16)[11] recommends using data from meteorological sites within 30km of an assessment area as being suitable for detailed modelling.

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[10] Environment Agency (online) Conversion Ratios for NO_x and NO_2 (available online at: http://webarchive.nationalarchives.gov.uk/20140328084622/http:/www.environment-agency.gov.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf)

[11] Department for the Environment, Food and Rural Affairs (2016) Local Air Quality Management Technical Guidance LAQM.TG(16)

Hourly sequential meteorological data used in this assessment was taken from Rhoose Cardiff International Airport meteorological station for the five-year period from the 1st January 2012 to 31st December 2016. The meteorological data was pre-processed though AERMET before use in the model.

The meteorological station is located at ST066673 approximately 10km south west of the application site. The area surrounding the site is primarily 'rural' and this was taken into consideration when the data was run through the pre-processor AERMET prior to use in the AERMOD model in accordance with guidance issued in the AERMOD Implementation Guide[12].

3.6 Assessment Extents

Ambient concentrations were predicted over a 10-kilometre area (centred on the proposed Stack). Within this area, three nested grids consisting of one 200m grid centred on the proposed stack location with a 20m resolution, a further grid from 200m-1km with a 50m resolution and finally a grid from 1km to 10km with a 100m resolution.

This approach was adopted considering that ground level concentrations from point sources emissions generally peak within 2km of the point of emission.

The grids allow the user to extract data from the model in a format suitable for contour plotting. The adopted resolution of 20m nearest the site is necessary to identify the location of maximum impacts. In order to aid the commentary of the results, nine of the closest human health receptors to the application site were selected at locations expected to be representative of the greatest air quality impacts. These receptors are presented in Table 5. It should be noted that the proposed development site is predominantly surrounded by rural land use, so there are few receptors within 1km of the site.

Table 5 - Human Health Receptors

Receptor ID	Name	X	Y	Distance from Stack
R1	Downs Farm	316522	169656	294m
R2	Cross Common Road	316465	169965	439m
R3	Cross Common Road	316284	170156	556m
R4	Oakfield, Cross Common Road	316045	170352	767m
R5	Arnold House	315434	170206	993m
R6	Ashby Road, Sully	315578	168966	908m
R7	Cog Road	315770	168746	970m
R8	Cog Farm	316263	168811	789m
R9	Sully Road	316389	169244	387m

Ecological sites are sensitive to ambient NO_X and deposition of acid and/or nutrient nitrogen. The point at which an ecological feature cannot tolerate acid/N deposition is known as the critical load. Point sources such as the proposed development have the ability to impact upon these ecological features, as such effects from the proposed development must be appraised.

As recommended by the EA's Air Emissions Risk Assessment[8], impacts were assessed at all European ecological sites (including Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Ramsar designations) within 10km and SSSIs within 2km of the proposed development site. A number of discrete receptor points were added to the edge of each designated site (at closest point to the development) to supplement the cartesian nested grid points, and the maximum concentration in the sites were then obtained. In addition, local nature sites including national nature reserves, local nature reserves and ancient woodlands have been identified and assessed within 2km of the proposed development. Details of the ecological receptors are provided in Section 4.4.

[12] U.S. Environment Protection Agency (2015) AERMOD Implementation Guide

3.7 Background Concentrations

Predictions of total pollutant concentrations include contributions from local emissions sources (such as those from the roads and chimney stacks) and background concentrations. In many areas, the background contribution may represent a significant or dominant proportion of the total concentration. Background concentrations for regulated pollutants are expected to decline in future years as a result of government and EU policies/legislation to reduce emissions.

In order to establish a prediction of total concentrations of pollutants, process contributions are combined with a background concentration. Defra Technical Guidance LAQM.TG(16)[11] (recommends the use of empirically derived national background estimates available from the Defra website, which provide estimated background pollutant concentrations for each 1km x 1km grid square in the UK. In all assessed areas, background concentrations for modelled receptors were taken from the corresponding 1km x 1km grid square.

Year 2017 annual mean background NO_2 and NO_x concentrations have been obtained from Defra[13] and used in the assessment. The maps are periodically updated based on monitoring data and updates in emissions projections; the most recent updates are reflected in the 2013 base mapping issue and are used in the assessment. It should be noted that the background air quality maps forecast a year on year reduction in concentrations due to declining national emissions, and therefore use of the 2017 background concentrations is expected to provide a conservative assessment of air quality when the proposed development is operational.

The Defra background maps have been compared against actual air quality monitoring data from VoG. Monitoring for 2015 was available from VoG. The 2015 Defra background NO_2 concentration predicted from the location corresponding with urban background diffusion tube site 41 (see Section 4.3) is shown in Table 6. The Defra concentration is in good agreement with the monitored concentration, and the background maps are therefore considered appropriate and representative of the assessment study area.

Table 6 - Defra Background NO2 concentration at VoG Diffusion Tube Site 41

Monitoring Site	National Grid Reference	Measured 2015 NO_2 ($\mu g/m^3$)	Defra Background 2015 NO_2 ($\mu g/m^3$)
41 (Dispenser Road)	315278, 168451	13.1	12.1

The EA's advice in the Air Emissions Risk Assessment states that the short-term background concentration of a pollutant should be assumed to be double that of the long-term background concentration. Therefore the 2017 annual mean background concentrations were doubled for all short-term calculations.

Additionally, for impacts on ecological receptors, background nutrient nitrogen and acid deposition rates were acquired from the Air Pollution Information System (APIS)[14].

3.8 Nitrogen and Acid Deposition

The deposition of acid and nitrogen is not directly modelled but can be derived from the Process Contribution (PC) predicted at the ecological site using a methodology based on the EA's AQTAG06 guidance[15]. The guidance details conversion factors which take into account the difference in deposition velocities and mechanisms observed in forest and grasslands. These deposition rates can be used as a proxy for other habitats depending on whether they feature long vegetation (forests, bush) or short vegetation (typically grasslands, swamps, fens). The conversion factors are detailed in Table 7 below.

[13] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html (Accessed July 2017)
[14] Air Pollution Information System (Accessed July 2017, available online at: http://www.apis.ac.uk/)
[15] Environment Agency (2006) AGTAG06 – Technical Guidance on Detailed Modelling Approach For An Appropriate Assessment For Emissions To Air

Table 7 – Acid and Nutrient Nitrogen Deposition Velocities and conversion factors

Conversion	Deposition Velocity – Short Vegetation (m/s)	Deposition Velocity – Long vegetation (m/s)	Conversion Factor for N dep (µg/m²/s to kg/ha/yr)	Conversion Factor for Acid dep (kg/ha/yr to keq N/ha/yr)
NO_2 to Acid	0.0015	0.003	95.9	0.0714
Worked example: 2.5 µg/m³ NO_2	2.5*0.0015 (short veg) = 0.00375 µg/m²/s 0.00375*95.9 = 0.36 kg N/ha/yr 0.36*0.0714 = 0.026 keq N/ha/yr			
NO_x to N deposition	0.0015	0.003	95.9	N/A
Worked example: 3µg/m³ NO_x	3*0.0015 (short veg) = 0.0045 µg/m²/s 0.0045*95.9 = 0.43 kg N/ha/yr			

3.9 Terrain Data

Terrain data was sourced from the Ordnance Survey website open source page in NTF format. The data was then converted from NTF to DEM format for use in AERMOD. The AERMAP module of AERMOD was run so that the correct terrain elevations were assigned for all the receptors, sources and buildings that were input into the model run.

3.10 Building Effects

The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Building downwash occurs when turbulence that is induced by nearby structures, causes pollutants emitted from an elevated source such as a stack, to be displaced and dispersed rapidly towards the ground, resulting in elevated concentrations.

Building heights and dimensions were obtained from plans and drawings of the site including the proposed AAD facility. The buildings included in the model are shown in Appendix A.

3.11 Significance Assessment

According to EA risk assessment guidance[5] there are three types of air quality standards that should be considered for an air quality assessment. These are EU Limit Values, AQS Objectives/EU Target Values, and non-statutory guidelines such as Environmental Assessment Levels (EALs). For ease of reference, these are collectively referred to as 'Environmental Standards' in the context of this assessment. The EU Limit Values and AQS Objectives applicable to the assessment are shown in Table 1 and Table 2. The EA's air emissions risk assessment guidance details EALs which are regarded as non-statutory guideline levels. For this assessment, the EAL of relevant concern is the daily mean critical level for NO_x for the protection of ecosystems.

Acid deposition and nutrient nitrogen deposition should also be considered for European ecological sites and SSSIs. Both are measured against critical loads. In the context of this assessment a critical load is defined as a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive parts of the environment do not occur.

The assessment has considered the process contribution (PC) and predicted environmental concentration (PEC) resulting from the proposed development. The PC describes the environmental concentration of each substance released to air, and the PEC describes the total environmental concentration (i.e. the PC plus the concentration already present in the environment). Under the advice of the EA risk assessment, no action is required if the predicted PEC does not exceed environmental standards. Therefore, for the purpose of this assessment, where PECs are below the environmental standard the impact has been considered to be non-significant.

In terms of local nature sites, the impact is non-significant if both the long and short-term PCs are <100% of the long and short-term environmental standards. The PEC is not required to be calculated for local nature sites.

3.12 Modelling Uncertainty

Uncertainty in dispersion modelling predictions can be associated with a number of different factors, including:

- Model uncertainty-due to model limitations;
- Data uncertainty-due to errors in input data, including emissions estimates, background estimates and meteorology; and
- Variability-randomness of measurements used.

Potential uncertainties in model results have been minimised as practicable and worst-case inputs used in the absence of definitive information. This encompassed the following:

- Choice of model- AERMOD is a commonly used atmospheric dispersion model and results have been verified through a number of studies to ensure predictions are as accurate as possible;
- Meteorological data-Modelling was undertaken using five meteorological datasets from the closest observation site from the proposed development to take account of the worst-case conditions;
- Receptor locations- A Cartesian grid and discrete receptors were included in the model in order to calculate maximum predicted concentrations throughout the assessment extents;
- Variability- All model inputs are as accurate as possible and worst-case conditions have been considered where necessary in order to ensure a robust assessment of potential pollutant concentrations. For example, the assessment has been undertaken assuming:
    - The CHP engines and gas boilers operate continuously at 100% load throughout the year; and
    - background pollutant concentrations have been obtained for the year 2017. These concentrations are predicted to reduce in the future in response to legislation and declining national emissions, and so will be lower than assumed here once the development is operational.
- Results have been considered in the context of relevant long-term and short-term air quality objectives/Critical Load/Critical Level. It is considered that the use of the stated measures to reduce uncertainty and the use of worst case assumptions when necessary has resulted in model accuracy of an acceptable level.

4 Baseline Conditions

4.1 Overview

Within the UK, information on air quality is available from a range of sources including Local Authorities, national network monitoring sites and other published sources.

4.2 Local Authority Review and Assessment

The assessment site is situated within the administrative boundary of the Vale of Glamorgan Council (VGC), who regularly review and assess local air quality in accordance with the Local Air Quality Management (LAQM) Process.

VGC has declared an AQMA for exceedances of the annual mean NO_2 AQS objective on Windsor Road in Penarth (approx. 3km north east of the proposed development), as a result of road traffic emissions.

4.3 VGC Air Quality Monitoring

In 2015 VGC operated automatic monitors on Windsor Road, Penarth approx. 3km north of the development site and at Dinas Powys Infant School approx. 1.8km north. The former of the two monitoring sites measures NO_2, particulate matter and Ozone and later monitors NO_2.

VGC also carries out non-automatic monitoring of NO_2 using Passive Diffusion Tubes (PDTs) at 47 locations throughout the Vale. The closest diffusion tube site to the proposed development is site 41, Dispenser Road, Barry, which is an urban background site located 1.5km south west of the proposed development site.

The NO_2 PDT data captured from 2015-2016 are summarised below in Table 8 for sites located within 2km of the proposed development. All of the monitored annual mean NO_2 concentrations within the vicinity of the proposed development were less than 30 µg/m^3 between 2012 and 2015 which is well below the annual mean AQS objective (40 µg/m^3).

Table 8 - Annual Mean NO_2 Concentrations at Vale of Glamorgan PDT *Sites within 2km of Cog Moors* WwTW

Site ID	Location	X	Y	Site Type	Annual Mean Concentration (µg/m^3)- Adjusted for Bias			
					2012 (Bias Adjustment Factor=0.96)	2013 (Bias Adjustment Factor=0.95)	2014 (Bias Adjustment Factor=0.91)	2015 (Bias Adjustment Factor=0.88)
DINAS POWYS								
7	Cardiff Road/Millbrook	315773	171514	Roadside	29.4	28.5	26.3	24.6
46	46 Cardiff Road	315747	171369	Roadside	23.7	22	19.7	18.6
47	Dinas Powys Health Centre	315710	171385	Roadside	19.2	17.5	15.6	14.4
72a	Dinas Powys Infants School	315841	171527	Roadside	29.1	24.1	27.8	23.8
72b	Dinas Powys Infants School	315841	171527	Roadside	28.5	26.6	28.6	23.3
72c	Dinas Powys Infants School	315841	171527	Roadside	28.4	25	28.5	23.7
BARRY								
41	Dispenser Road	315278	168451	Urban Background	16.1	15	13.1	13.1

4.4 Ecological Sites

Ecological sites are sensitive to ambient NO_X and deposition of acid and/or nutrient nitrogen.

As discussed in Section 3.6, SSSIs have been assessed within 2km of the proposed development, and SACs, SPAs and Ramsar sites have been assessed within 10km of the proposed development.

Cog Moors SSSI is located adjacent to the proposed development. Cosmeston Lakes SSSI and Severn Estuary Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar and SSSI are respectively located 0.8km and 2.3km from the WwTW at their nearest point. No other ecological designated sites have been identified in the assessment study area.

The APIS website was used to acquire critical loads and deposition rates. Table 9 shows the ecological designated sites located within the assessment study area together with the nitrogen critical load, existing nitrogen deposition, acid critical load and existing acid deposition for the designated features in each site. The critical loads for these sites was also confirmed by Natural Resources Wales (NRW) in a pre-application consultation letter between NRW and Caulmert on 28th September 2017.

Existing rates of nitrogen deposition and acid deposition are below the nitrogen critical loads (CL) identified for Cog Moors (SSSI) and below the nitrogen critical load identified for Severn Estuary (SAC, SPA, Ramsar, SSSI).It should be noted that Severn Estuary is not sensitive to acid deposition, and Cosmeston Lakes has been designated for aquatic features only and is not sensitive to nitrogen or acid deposition.

Table 9 - Rates of Nitrogen and Acid Deposition and Critical Loads in Ecological Designated Sites

Site	Habitat	Existing N Deposition[ŧ] (kg N/ha/yr)	N CL (kg N/ha/yr)	Existing Acid Deposition[ŧ] (keq N/ha/yr)	Acid CL (Min N) (keq N/ha/yr)	Acid CL (Max N) (keq N/ha/yr)
Cog Moors SSSI	Neutral Grassland: Neutral Grassland	10.2	20	0.73	0.928	5.71
Cosmeston Lakes SSSI	Standing water	10.2	N/A	0.73	N/A	N/A
Severn Estuary SAC, Ramsar, SPA and SSSI	Pioneer, low-mid, mid-upper saltmarshes	10.2	20	0.73	N/A	N/A

[ŧ]Existing N and acid deposition based on a 3 year average 2013-2015.

N/A Not Applicable (ecological features not sensitive)

There are also a number of local nature site located in the vicinity of the proposed development including Cog Moors Site of Importance for Nature Conservation (SINC), which is located adjacent to the eastern boundary of the proposed development. Cosmeston Lakes Local Nature Reserve is located approximately 430m east of the proposed development and a number of ancient woodland sites are located nearby. The nearest ancient woodlands are located approximately 30m north of the proposed development site. It should be noted that APIS does not provide information on critical loads and deposition rates for local nature sites.

5 Predicted Impacts

The results discussed in this section represent the maximum concentrations predicted across the meteorological years 2012 to 2016. The full set of results per year are presented in Appendix B.

5.1 Human Health Receptors

Annual Mean NO_2

Table 10 presents the maximum predicted annual mean NO_2 PC and PEC concentrations at human health receptors. It should be noted that the maximum concentration predicted in any modelled meteorological year is shown. The table also presents the maximum concentration predicted anywhere across the modelled 10km^2 grid, although note that this is based on the cartesian grid modelled, and does not necessarily correspond with the location of relevant exposure (i.e. human health receptors).

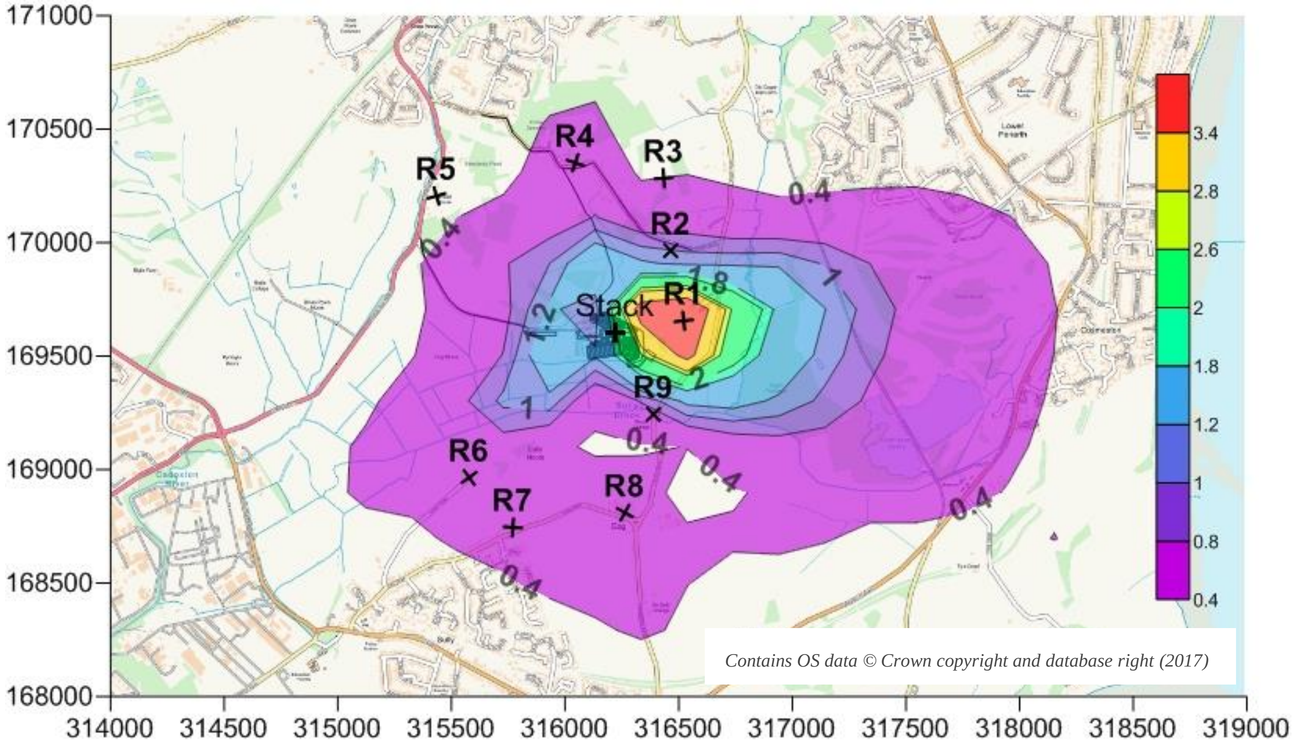
Table 10 – Predicted Annual Mean NO_2 at Human Receptors

Receptor	NO_2 Concentration (µg/m^3)			Percentage of Air Quality Objective	
	Background	PC	PEC	PC	PEC
R1	10.4	3.4	13.8	8.4%	34.5%
R2	10.4	0.8	11.2	1.9%	28.0%
R3	11.4	0.3	11.7	0.8%	29.3%
R4	11.4	0.6	12.0	1.4%	30.0%
R5	12.5	0.2	12.7	0.6%	31.8%
R6	11.1	0.4	11.5	0.9%	28.8%
R7	11.1	0.4	11.5	1.1%	28.8%
R8	9.4	0.6	10.0	1.4%	25.0%
R9	10.4	0.6	11.0	1.6%	27.5%
Maximum PC anywhere in Study Area	-	3.5	-	8.7%	-

The results indicate that the proposed development is unlikely to result in or contribute to an exceedance of the annual mean NO_2 AQS objective (40 µg/m^3). The largest PC predicted across the 10 km^2 modelled domain is 3.5 µg/m^3, which is less than 10% of the annual mean objective. The maximum PC predicted at any human health receptor occurs at R1 (Downs Farm Cottage, ~300m east of the proposed development) and is 3.4 µg/m3 (~8% of the annual mean AQS objective for NO_2). The maximum PEC predicted at any receptor also occurs at R1, and is which is 34.5% of the annual mean AQS objective. It should be noted that the largest annual mean NO_2 PC predicted in Windsor Road AQMA is ~0.03 µg/m^3.

Figure 2 shows the predicted annual mean NO_2 PC contour predicted based on 2015 meteorology. The greatest NO_2 concentrations are predicted approximately 300m east of the stack.

Figure 2 - Annual Mean NO_2 ($\mu g/m^3$) PC Contour (2015 meteorological year)



All annual (long term) PECs are well below the annual mean AQS objective for NO_2, therefore it can be concluded that the proposed development would not have a significant impact on annual mean NO_2 concentrations at receptors.

5.1.1 Hourly Mean NO_2

Table 11 presents the maximum predicted hourly 99.8th percentile NO_2 PC and PEC concentrations at human health receptors. It should be noted that the maximum concentration predicted in any modelled meteorological year is shown. The table also presents the maximum concentration predicted anywhere across the modelled $10km^2$ grid, although note that this is based on the cartesian grid modelled, and does not necessarily correspond with the location of human health receptors.

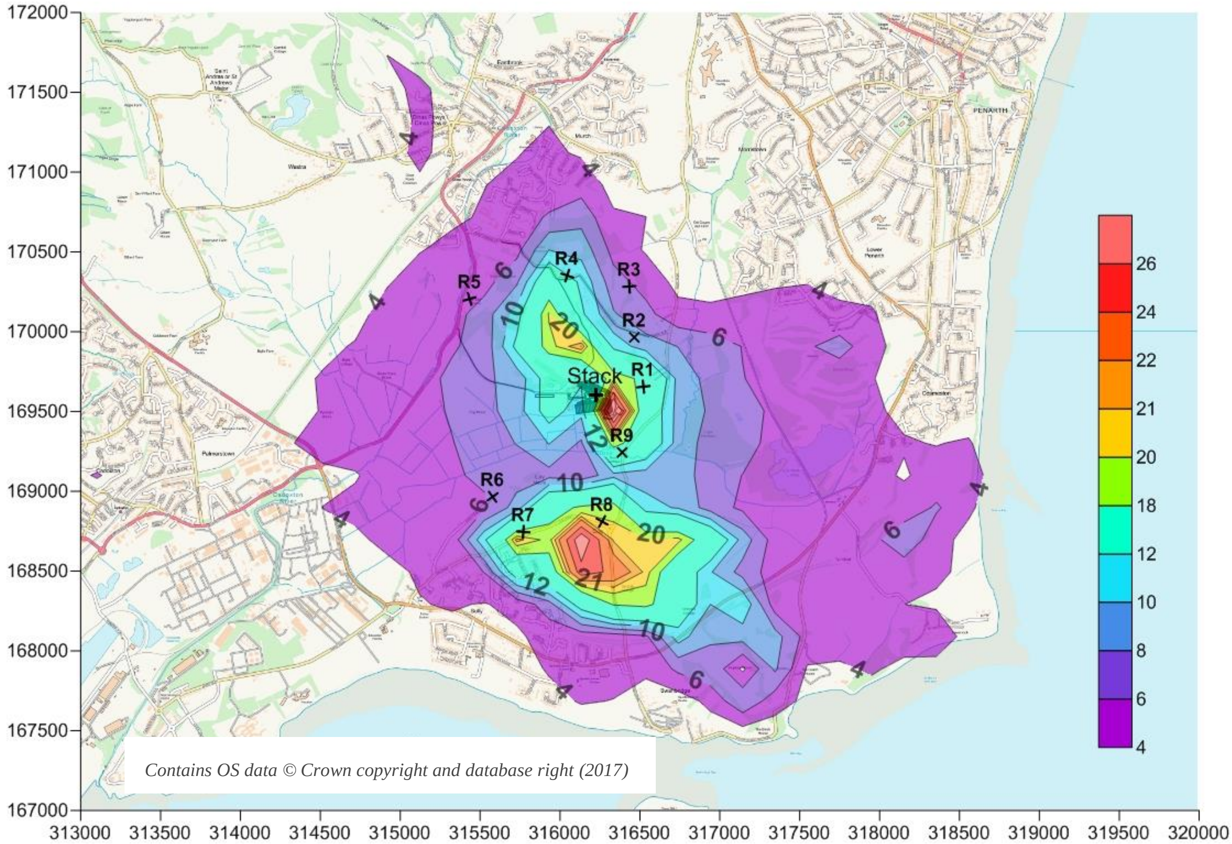
Table 11 – Predicted 1-Hour 99.8th Percentile NO_2 at Human Receptors

Receptor	NO_2 Concentration (µg/m³)			Percentage of Air Quality Objective		PC<20% of AQ objective minus Short Term Background
	Background	PC	PEC	PC	PEC	
R1	20.8	14.9	35.7	7.5%	17.9%	8.3%
R2	20.8	10.7	31.5	5.4%	15.8%	6.0%
R3	22.8	7.3	30.1	3.7%	15.1%	4.1%
R4	22.8	20.6	43.4	10.3%	21.7%	11.6%
R5	24.9	5.9	30.8	2.9%	15.4%	3.4%
R6	22.1	6.4	28.5	3.2%	14.2%	3.6%
R7	22.1	25.6	47.7	12.8%	23.8%	14.4%
R8	18.7	21.1	39.8	10.5%	19.9%	11.6%
R9	20.8	16.3	37.1	8.2%	18.6%	9.1%
Maximum PC anywhere in Study Area	-	32.1	-	16.1%	-	-

The results indicate that the proposed development is unlikely to result in or contribute to an exceedance of the hourly mean NO_2 AQS objective (200 µg/m³). The largest PC predicted across the 10 km² modelled domain is 32.1 µg/m³, which is well below the hourly mean objective. The maximum PC predicted at any human health receptor occurs at R7 (Cog Road, ~970m south of the proposed development) and is 25.6 µg/m³ (12.8% of the hourly AQS objective for NO_2). The maximum PEC predicted at any receptor also occurs at R7, and is 23.8% of the hourly AQS objective.

Figure 3 shows the predicted hourly 99.8th percentile NO_2 PC contour predicted based on 2013 meteorology. The greatest NO_2 concentrations are predicted approximately 1.5km south of the stack, where there are no human receptors.

Figure 3 1-Hour 99.8th Percentile NO_2 (µg/m³) PC Contour (2013 meteorological year)



All hourly (short term) PECs are well below the hourly mean AQS objective for NO_2, therefore it can be concluded that the proposed development would not have a significant impact on hourly mean NO_2 concentrations at receptors.

5.2 Ecological Receptors

This section set out the results of the assessment on ecological receptors from ambient NO_x concentrations, nutrient nitrogen deposition and acid deposition. The results shown correspond with the maximum PC or PEC predicted in any meteorological year.

There are no locations across the entire 10km^2 study area where the NO_x PC is 100% of the long and short term critical level for ecology. Both the long term (Table 12) and short-term PCs (Table 13) are therefore less than 100% of the relevant long and short term critical levels for ambient NO_x at the local nature sites identified, which suggests there will be no adverse impacts on these features. Local nature sites are not featured on APIS and as such there is no information on what the relevant critical loads and background deposition rates are. Therefore, the impacts from the proposed Development on local nature sites is not discussed further.

Annual Mean NO_x

Annual mean (long term) impacts of ambient NO_x on ecological receptors are presented in Table 12. The critical level for annual mean NO_x is 30µg/m^3. Table 12 demonstrates that the PEC for annual mean NO_x is well below the critical level at each of the ecological sites.

Table 12 - Predicted Annual Mean NOx at Ecological Receptors

Receptor	NOx Concentration µg/m3			Percentage of Air Quality Objective	
	Background	PC	PEC	PC	PEC
Cog Moors SSSI	16.0	2.7	18.7	9.0%	62.3%
Cosmeston Lakes SSSI	12.6	1.3	13.9	4.3%	46.3%
Severn Estuary SAC, Ramsar, SPA and SSSI	13.0	0.3	13.3	1.0%	44.3%
Maximum PC anywhere in Study Area	-	5.0	-	16.7%	-

Therefore, it is concluded that emissions from the proposed Development would not have a significant impact on annual mean NO_x at ecological receptors.

Daily Mean NO_x

Daily mean (short term) impacts of ambient NO_x on ecological receptors are presented in Table 13. The critical level for daily maximum NO_x is 75µg/m^3. As suggested in the EA's air emissions risk assessment, long term background NO_x concentrations were doubled.

Table 13 demonstrates that the PEC for daily mean NO_x is below the critical level, therefore, it is concluded that emissions from the proposed Development do not have a significant impact on daily mean NO_x concentrations at ecological receptors.

Table 13 - Predicted Daily Mean NOx at Ecological Receptors

Receptor	NO_x Concentration (µg/m3)			Percentage of AQ Objective	
	Background	PC	PEC	PC	PEC
Cog Moors SSSI	32.0	29.0	61.0	38.7%	81.3%
Cosmeston Lakes SSSI	25.2	9.6	34.8	12.8%	46.4%
Severn Estuary SAC, Ramsar, SPA and SSSI	26.0	3.6	29.6	4.8%	39.5%
Maximum PC anywhere in Study Area	-	47.1	-	62.8%	-

Nitrogen Deposition

Table 14 shows the background nitrogen deposition rates and critical loads at ecological designated sites in the assessment study area. The PC and PEC associated with the proposed Development are also shown. The PEC for nitrogen deposition is well below the critical loads identified.

Acid Deposition

Table 15 shows the background acid deposition rates and critical loads at ecological designated sites in the assessment study area. The PC and PEC associated with the proposed Development is also shown.

It should be noted that the Severn Estuary was screened out of the acid deposition assessment as the habitats identified are not sensitive to acid deposition. Table 15 demonstrates that the PEC for acid deposition is well below the critical load identified.

Table 14 - Predicted Nitrogen Deposition at Ecological Receptors

Receptor	Predicted Dry N Deposition (kg N/ha/yr)			Critical Load (kg N/ha/yr)	% of Critical Load		
	Background	PC	PEC		Background	PC	PEC
Cog Moors SSSI	10.2	0.3	10.3	20.0	51.0%	1.4%	52.4%
Severn Estuary SAC, Ramsar, SPA and SSSI	10.2	0.03	10.3	20.0	51.0%	0.2%	51.2%

Table 15 - Predicted Acid Deposition at Ecological Receptors

Receptor	Acid Deposition (keq N/ha/yr)			Critical Load Max N (keq N/ha/yr)	% of Critical Load		
	Background	PC	PEC		Background	PC	PEC
Cog Moors SSSI	0.73	0.02	0.75	5.71	12.8%	0.3%	13.1%

5.3 Alternative Scenario

The two gas boilers associated with the proposed Development are expected to run on natural gas, but also have the ability to run on biogas. The results presented above assume that the boilers use natural gas, but an alternative scenario has been assessed, where it was assumed that the two gas boilers operate on biogas as oppose to natural gas. The impacts at human and ecological receptors are presented in Appendix C, and show that that the boilers running off biomass fuel result in smaller impacts on NO_2 at human receptors, and smaller impacts on NO_x and nitrogen/acid deposition at ecological receptors compared to natural gas, therefore the impact of the boilers when they are running off biomass fuel would still be non-significant.

6 Cumulative Effects

There is potential for cumulative effects to occur as a result of emissions from the Barry Docks biomass energy plant (planning application reference: 2016/00187/RES). The air quality assessment associated with this plant indicates that the air quality impacts will be localised to Barry. Since the assessment undertaken here has shown that the Cog Moors AAD plant will have negligible impacts across Barry (where the study areas overlap), there are expected to be negligible cumulative effects as a result of the proposed development.

7 Conclusions

This report has considered the potential air quality effects associated with the proposed advanced anaerobic digestion (AAD) plant at Cog Moors Wastewater Treatment Works (WwTW). The biogas produced by the proposed ADD plant would be used, via a combined heat and power (CHP) plant, to generate heat and renewable electricity for use on site or for export to the electricity grid. The CHP plant would also be supplemented by two gas boilers.

Dispersion modelling has been undertaken under the worst-case assumption that the CHP units and gas boilers operate at 100% load for 365 days per year, and under current baseline conditions (baseline air quality will improve by the time the proposed development is operational, due to declining national emissions as a result of policy). The model results show that that the AAD plant will not lead to exceedances of air quality objectives at human receptors, and pollutant concentrations are expected to be well below air quality objectives with the operation of the plant. There are therefore expected to be non-significant air quality effects at human receptors.

The assessment has also considered air quality effects at ecological receptors, including Cog Moors Site of Special Scientific Interest (SSSI), which is located adjacent to the WwTW. The impacts of the AAD plant on air quality and nitrogen and acid deposition at ecological receptors are expected to be non-significant.

APPENDIX A

Building Dimensions

Table 16 - Buildings and dimensions included in the model

Building Description	X	Y	Height (m)
THP Plant	316264	169594	8.8
Boiler House	316237	169608	8
CHP Plant	316239	169588	2.8
MCC1 Kiosk	316178	169609	4.5
Transformer 7 & 8	316234	169591	2.9
Indigenous Dewatering Building	316260	169566	12.7
Cooling Plant	316262	169603	3.1
Siloxane Plant	316239	169620	3.2
Gas Holder	316221	169625	14
Digester C	316204	169641	12.5
Digester D	316215	169663	12.5
Post Digestion Tank	316235	169653	5.7
Digester A	316185	169650	10.72
Digester B	316196	169673	10.72
Final Effluent Holding Tank	316253	169644	12.2
Sludge Control Building	316187	169630	10
Blending Tank A	316160	169678	12.25
Blending Tank B	316172	169689	12.25
Centrifuge Building	316121	169660	7.3
Inlet Works	316056	169658	3.3
Mains Building	316077	169639	7.1
Odour Control Plant C	316272	169495	4.8
Odour Control Plant A	316194	169622	5.1
Overflow Storm Water UV	316183	169601	1.34

Building Description	X	Y	Height (m)
Primary Sludge Storage Tank A	316134	169686	9
Primary Sludge Storage Tank B	316136	169672	9
Final Dewatering Bld	316288	169499	12.7
Polymer Bld	316285	169523	12.7
Polymer Silo A	316276	169534	6.5
Polymer Silo B	316276	169529	6.5
Polymer Silo C	316271	169528	6.5
Polymer Silo D	316270	169534	6.5
Potable Washwater Tank	316292	169495	8.3
Export Silo A	316307	169506	14.9
Export Silo B	316305	169529	14.9
THP Feed Silo Building	316266	169579	15.4
Cake Imports Facility	316293	169581	5.2
CHP Plant	316239	169588	2.8
Centrifuge Feed Tank A	316277	169544	13.2
Centrifuge Feed Tank B	316302	169548	13.2
SAS Tank A	316153	169665	11.3
SAS Tank B	316169	169656	11.3
Primary Strain Press	316134	169662	12.3
SAS Strainpress	316153	169651	12.1
Disinfected Fe Building	316275	169627	5.0
Disinfected Fe Storage Tank	316299	169622	12.5
HV Switchgear Building	316223	169583	6.7
LVDB and MCC3 Building	316231	169590	6.7
Natural Gas Metre Kiosk	316216	169601	2.4
Wash Water Booster Kiosk	316292	169491	2.3

Building Description	X	Y	Height (m)
Wheel Wash Control Kiosk	316282	169614	2.9
Storm and Settlement Tanks	316096	169543	1.1
Pump Building A	316202	169586	1.96
Pump Main Building	316207	169588	2.64
Pump Building B	316221	169588	1.96
OCU4_Inlet Odour Control Large Unit	316056	169653	4.2
OCU4_Inlet Odour Control Small Unit	316056	169649	2

APPENDIX B

Full Model Results

Table 17 - Predicted Annual Mean NO_2 at Human Receptors (Annual Results); µg/m^3

Receptor	Background	PC					Maximum		Maximum PEC % of Objective
		2012	2013	2014	2015	2016	PC	PEC	
R1	10.4	3.3	2.3	2.8	3.4	2.9	3.4	13.8	34.5%
R2	10.4	0.6	0.6	0.8	0.7	0.5	0.8	11.2	28.0%
R3	11.4	0.2	0.2	0.3	0.3	0.2	0.3	11.7	29.3%
R4	11.4	0.4	0.4	0.6	0.4	0.4	0.6	12.0	30.0%
R5	12.5	0.2	0.2	0.2	0.2	0.2	0.2	12.7	31.8%
R6	11.1	0.3	0.4	0.4	0.4	0.4	0.4	11.5	28.8%
R7	11.1	0.3	0.4	0.4	0.4	0.3	0.4	11.5	28.8%
R8	9.4	0.4	0.6	0.3	0.5	0.4	0.6	10.0	25.0%
R9	10.4	0.6	0.6	0.5	0.5	0.5	0.6	11.0	27.5%
Maximum in Gridded Area	-	3.4	3.3	2.9	3.5	3.2	3.5	-	-

Table 18 - Predicted 1-Hour 99.8Th Percentile NO_2 at Human Receptors (Annual Results); µg/m^3

Receptor	Background	PC					Maximum		Maximum	
		2012	2013	2014	2015	2016	PC	PEC	PEC % of Objective	% of Short Term Standard minus Background
R1	20.8	14.8	14.8	14.6	14.6	14.9	14.9	35.8	17.9%	8.3%
R2	20.8	10.4	9.2	10.6	10.7	9.8	10.7	31.5	15.8%	6.0%
R3	22.8	5.1	6.0	7.3	6.2	5.9	7.3	30.1	15.1%	4.1%
R4	22.8	17.2	11.2	20.6	16.8	16.4	20.6	43.4	21.7%	11.6%
R5	24.9	5.0	5.2	5.6	5.8	5.9	5.9	30.8	15.4%	3.4%
R6	22.1	6.0	6.0	6.4	6.2	5.8	6.4	28.5	14.2%	3.6%
R7	22.1	21.7	25.4	25.6	20.0	22.1	25.6	47.7	23.8%	14.4%

R8	18.7	20.7	21.1	17.7	20.7	19.1	21.1	39.8	19.9%	11.6%
R9	20.8	16.3	15.1	14.0	14.9	14.2	16.3	37.1	18.6%	9.1%
Maximum in Gridded Area	-	31.6	32.2	31.3	31.6	31.6	32.2	-	-	-

Table 19 - Predicted Annual Mean NO_X at Ecological Receptors (Annual Results); µg/m³

Receptor	Background	PC					Maximum		
		2012	2013	2014	2015	2016	PC	PEC	PEC % of Objective
Cog Moors SSSI	16.0	2.0	2.7	2.1	2.1	2.6	2.7	18.7	62.3%
Cosmeston Lakes SSSI	12.6	1.3	1.0	1.1	1.1	1.2	1.3	13.9	46.3%
Severn Estuary SAC, Ramsar, SPA and SSSI	13.0	0.3	0.3	0.3	0.3	0.3	0.3	13.3	44.3%

Table 20 - Predicted Daily Mean NO_X at Ecological Receptors (Annual Results); µg/m³

Receptor	Background	PC					Maximum		
		2012	2013	2014	2015	2016	PC	PEC	PEC % of Objective
Cog Moors SSSI	32.0	25.4	28.1	26.7	24.8	29.0	29.0	61.0	81.3%
Cosmeston Lakes SSSI	25.2	9.6	7.8	7.3	7.0	7.1	9.6	34.8	46.4%
Severn Estuary SAC, Ramsar, SPA and SSSI	26.0	3.5	2.7	3.6	2.9	3.0	3.6	29.6	39.5%

Table 21 - Predicted Dry Nitrogen Deposition at Ecological Receptors (Annual Results); kg N/ha/yr

Receptor	Background	PC					Critical Load (kg N/ha/yr)	Maximum		
		2012	2013	2014	2015	2016		PC	PEC	PEC % CL
Cog Moors SSSI	10.2	0.2	0.3	0.2	0.2	0.3	20	0.3	10.5	52.4%
Severn Estuary SAC, Ramsar, SPA and SSSI	10.2	0.03	0.03	0.03	0.03	0.03	20	0.03	10.2	51.2%

Table 22 - Predicted Acid Deposition at Ecological Receptors (Annual Results); keq N/ha/yr

Receptor	Background	PC					Critical Load (keq N/ha/yr)	Maximum		
		2012	2013	2014	2015	2016		PC	PEC	PEC % CL
Cog Moors SSSI	0.73	0.014	0.019	0.015	0.015	0.019	5.71	0.019	0.749	13.1%

APPENDIX C

Alterative Scenario Results

Table 23- Predicted Annual Mean NO_2 at Human Receptors (Maximum in Alt Scenario)

Receptor	NO_2 Concentration µg/m3			Percentage of Air Quality Objective	
	Background	PC	PEC	PC	PEC
R1	10.4	3.2	13.6	8.0%	34.0%
R2	10.4	0.7	11.1	1.8%	27.9%
R3	11.4	0.3	11.7	0.8%	29.3%
R4	11.4	0.5	11.9	1.4%	29.9%
R5	12.5	0.2	12.7	0.5%	31.7%
R6	11.1	0.4	11.4	0.9%	28.5%
R7	11.1	0.4	11.5	1.0%	28.7%
R8	9.4	0.5	9.9	1.4%	24.7%
R9	10.4	0.6	11.0	1.5%	27.6%
Maximum PC in Study Area	-	3.3		8.2	

Table 24 - Predicted 1-Hour 99.8Th Percentile NO_2 at Human Receptors (Maximum in Alt Scenario)

Receptor	NO_2 Concentration (µg/m3)			Percentage of Air Quality Objective		
	Background	PC	PEC	PC	PEC	PC<20% of air quality objective minus short term background
R1	20.8	14.2	35.0	7.1%	17.5%	7.9%
R2	20.8	10.2	31.0	5.1%	15.5%	5.7%
R3	22.8	6.9	29.7	3.4%	14.8%	3.9%
R4	22.8	19.5	42.3	9.7%	21.1%	11.0%
R5	25.0	5.6	30.5	2.8%	15.3%	3.2%
R6	22.2	6.1	28.2	3.0%	14.1%	3.4%
R7	22.2	24.5	46.6	12.2%	23.3%	13.8%
R8	18.8	19.7	38.4	9.8%	19.2%	10.9%
R9	20.8	14.9	35.8	7.5%	17.9%	8.3%
Maximum PC in Study Area	-	18.6	-	9.3%	-	-

Table 25 - Predicted Annual Mean NO_X at Ecological Receptors (Maximum in Alt Scenario)

Receptor	NOx Concentration µg/m3			Percentage of Air Quality Objective	
	Background	PC	PEC	PC	PEC
Cog Moors SSSI	16	2.5	18.5	8.3%	61.7%
Cosmeston Lakes SSSI	12.6	1.3	13.9	4.3%	46.3%
Severn Estuary SAC, Ramsar, SPA and SSSI	13	0.3	13.3	1.0%	44.3%

Table 26 - Predicted Daily Mean NO_x at Ecological Receptors (Maximum in Alt Scenario)

Receptor	NOx Concentration µg/m3			Percentage of Air Quality Objective	
	Background	PC	PEC	PC	PEC
Cog Moors SSSI	32.0	26.7	58.7	35.6%	78.3%
Cosmeston Lakes SSSI	25.2	8.8	34.0	11.7%	45.3%
Severn Estuary SAC, Ramsar, SPA and SSSI	26.0	3.3	29.3	4.4%	39.1%

Table 27 - Predicted Nitrogen Deposition at Ecological Receptors (Maximum in Alt Scenario)

Receptor	Predicted Dry N Deposition (kg N/ha/yr)			Critical Load (kg N/ha/yr)	% of Critical Load		
	Background	PC	PEC		Background	PC	PEC
Cog Moors SSSI	10.2	0.3	10.5	20.0	51.0%	1.3%	52.3%
Severn Estuary SAC, Ramsar, SPA and SSSI	10.2	0.03	10.2	20.0	51.0%	0.2%	51.2%

Table 28 - Predicted Acid Deposition at Ecological Receptors (Maximum in Alt Scenario)

Receptor	Acid Deposition (keq N/ha/yr)			Critical Load Max N (keq N/ha/yr)	% of Critical Load		
	Background	PC	PEC		Background	PC	PEC
Cog Moors SSSI	0.73	0.006	0.73	5.71	32.0%	0.3%	32.3%

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