# AIR DISPERSION MODELLING REPORT OF RELEASES FROM TWO PACKAGE BOILERS AT PRINCES, PORTMANMOOR ROAD, CARDIFF

**Princes Limited,**
**Unit 69, Portmanmoor Road,**
**Cardiff.**
**CF24 5HB**

**ECL Ref: ECL.046.01.01/ADM**
**August 2020**
**Issue: 1(a)**

# AIR DISPERSION MODELLING REPORT OF RELEASES FROM TWO PACKAGE BOILERS AT PRINCES, CARDIFF

## TABLE OF CONTENTS

# TABLE OF CONTENTS (cont.)

# LIST OF TABLES



# LIST OF FIGURES

# ACRONYMS / TERMS USED IN THIS REPORT

| | |
|---|---|
| AAD | Ambient Air Directive |
| ADMS | Atmospheric Dispersion Modelling System |
| AMS | Automatic Monitoring Site |
| APIS | Air Pollution Information System |
| AQAL | Air Quality Assessment Level |
| AQMA | Air Quality Management Area |
| AQO | Air Quality Objective |
| AQS | Air Quality Standard |
| AW | Ancient Woodland |
| CCC | City of Cardiff Council |
| CERC | Cambridge Environmental Research Consultants |
| CO | Carbon monoxide |
| cSAC | Candidate Special Area of Conservation |
| DEFRA | Department for Environment, Food and Rural Affairs |
| DT | Diffusion Tube |
| EA | Environment Agency |
| ECL | Environmental Compliance Ltd |
| ELV | Emission Limit Value |
| EPAQS | Expert Panel on Air Quality Standards |
| EPUK | Environmental Protection UK |
| GLC | Ground Level Concentration |
| IAQM | Institute of Air Quality Management |
| LNR | Local Nature Reserves |
| LPA | Local Planning Authority |
| LWS | Local Wildlife Sites |
| MCPD | Medium Combustion Plant Directive |
| Met data | Meteorological data |
| Met Office | Meteorological Office |
| Met year | Meteorological year |
| NNR | National Nature Reserves |
| $NO_x$ | Oxides of nitrogen |
| $NO_2$ | Nitrogen dioxide |
| NRW | Natural Resources Wales |
| PC | Process Contribution |
| PEC | Predicted Environmental Concentration |
| Princes | Princes Limited |
| Ramsar | The Ramsar Convention on Wetlands of International Importance |
| SAC | Special Area of Conservation |
| SINC | Sites of Importance for Nature Conservation |
| SPA | Special Protection Area |
| SSSI | Site of Special Scientific Interest |
| The Site | Princes Limited, Cardiff |
| WHO | World Health Organisation |

# 1. INTRODUCTION

## 1.1. The Study

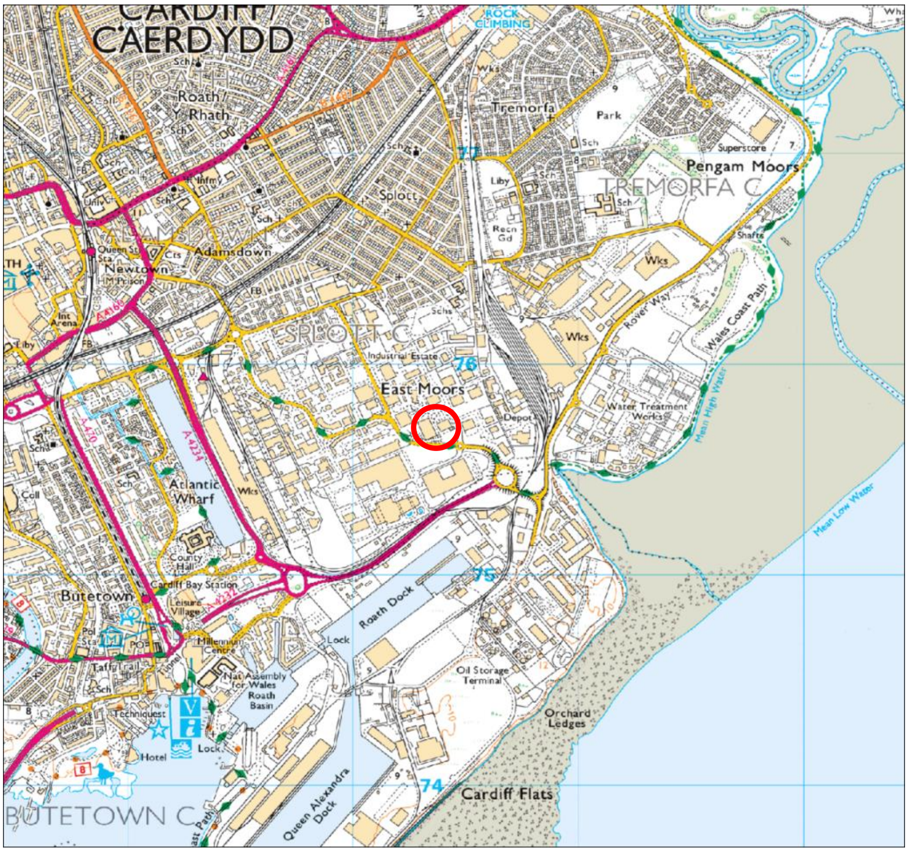
1.1.1. Environmental Compliance Ltd ("ECL") have been commissioned by Princes Limited ("Princes") to undertake an air quality assessment of releases from one existing boiler and one proposed boiler operating simultaneously at Princes Limited, Cardiff ("the Site") as part of a Permit Variation to be submitted to Natural Resources Wales ("NRW") and a Planning Application to be submitted to the Local Planning Authority ("LPA").

1.1.2. The study has been conducted to determine the impact of oxides of nitrogen ("NOx") (as nitrogen dioxide ("$NO_2$")) and carbon monoxide ("CO") on human health for receptors within a 2km radius of the Site. Specified environmental receptors within both a 10km and 2km radius of the discharge stacks have also been assessed, as outlined in the relevant guidance (see Section 2.4).

1.1.3. The study was undertaken using the ADMS modelling package, which is one of the models recognised by the Local Planning Authority and Natural Resources Wales as Regulators as being suitable for this type of study.

1.1.4. The location of the Site is circled in red and central on the Site Location Map which is presented as Figure 1.

**Figure 1: Site Location Map**



## 1.2. Objectives of the Study

1.2.1. The objectives of this study are as follows:

- to determine suitable heights for the one existing and one proposed boiler stacks;
- to determine the maximum ground level concentrations ("GLCs") arising from the emission of NOx as $NO_2$ and CO from the two boilers' (one existing and one proposed) discharge stacks; and
- to assess the impact of emissions from the boilers (one existing and one proposed) on existing local air quality in relation to human and environmental health at a range of potentially sensitive receptors by comparison with relevant air quality standards ("AQSs"). All pollutants are assumed to be released from the Site at their maximum permitted Emission Limit Value ("ELV").

## 1.3. Scope of the Study

1.3.1. Modelling was carried out using the appropriate ELVs as specified in Medium Combustion Plant Directive ("MCPD"). The emission characteristics are explained in more detail in Tables 9 and 10 of Section 2.10.

1.3.2. The effects of prevailing meteorological conditions, building downwash effects, local terrain and existing ambient air quality were also taken into account.

1.3.3. This report spans a number of guidance documents. The EA online guidance[1] was used for assessing if process contributions ("PCs") are insignificant as approved by NRW. The Environmental Protection UK ("EPUK") and the Institute of Air Quality Management ("IAQM") guidance 2017[2] was used where applicable (i.e. where PCs exceeded the assessment criteria outlined in the EA online guidance).

1.3.4. The maximum predicted pollutant GLCs - also known as the process contributions ("PCs") - for releases were compared with the relevant AQSs.

1.3.5. The predicted environmental concentrations ("PECs") - the sum of the pollutant PC and the existing pollutant background concentration from other sources - were also compared to the relevant standards. Results are presented as the maximum predicted GLC and the maximum sensitive receptor GLC.

1.3.6. The maximum predicted pollutant GLCs at the specified potentially sensitive human receptor sites and ecological designations (refer to Tables 1 and 2 of Sections 2.3. and 2.4., respectively) were also compared to the relevant AQSs.

1.3.7. There are four Air Quality Management Areas ("AQMA)" in the City of Cardiff Council ("CCC"), namely:

- Cardiff City Centre AQMA (declared: 1st April 2013) - Former St Mary Street AQMA with the addition of Westgate Street in Cardiff City Centre;

[1] Available online via: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports
[2] Available online via: http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

- Stephenson Court AQMA (declared: 1st December 2010) - From NE and NW boundaries of Stephenson Court, NW boundary of Burgess Court, NW and SW boundaries of Four Elms Court, SW corner of Four Elms Court south across Newport road to the junction with Orbit street, West across Newport Road to the SE corner of Stephenson Court;
- Llandaff AQMA (declared: 1st April 2013) – Centre on Cardiff Road through Llandaff village; and
- Ely Bridge AQMA (declared: 1st December 2000 (amended 1st February 2007)) - A number of residential premises along the A48 Cowbridge Road West, Western Avenue and A4119 through Llandaff Village Cardiff Road.

1.3.8. $NO_2$ is the pollutant declared for all four AQMAs identified and is therefore relevant to this study.

1.3.9. Of the four AQMAs declared by CCC, Llandaff AQMA and Ely Bridge AQMA are both more than 5km west from the Site and, consequently, will not be considered further in this assessment.

1.3.10. The effect of the modelled emissions on Cardiff City Centre AQMA and Stephenson Court AQMA will be taken into account by assessing maximum predicted GLCs against the relevant AQSs.

1.3.11. Using ADMS, the rates of deposition for acids (nitrogen as kilo-equivalents) and nutrient nitrogen were also predicted for select habitat sites (outlined in Table 5). These rates were then compared to the appropriate critical loads for the type and location of each habitat.

# 2. METHOD STATEMENT

## 2.1. Choice of Model

2.1.1. The UK-ADMS model was developed jointly by Cambridge Environmental Research Consultants ("CERC"), Her Majesty's Inspectorate of Pollution (the EA's predecessor body), the Meteorological Office and National Power, with sponsorship from the UK Government and a number of commercial organisations. UK-ADMS is a computer-based model of dispersion from both point and non-point sources in the atmosphere, and is one of the modelling packages that are suitable for this type of study. The current version is ADMS 5.2.4.

2.1.2. ADMS 5.2.4 has been validated against a number of data sets in order to assess various configurations of the model such as flat or complex terrain, line/area/volume sources, buildings, dry deposition fluctuations and visible plumes. The model results have been compared to observational data or other model results if available.

2.1.3. ADMS 5.2.4 is a new generation Gaussian plume air dispersion model, which means that the atmospheric boundary layer properties are characterised by two parameters:

- the boundary layer depth, and
- the Monin-Obukhov length,

rather than in terms of the single parameter Pasquill-Gifford class.

2.1.4. Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution (shown by validation studies to be a better representation than a symmetrical Gaussian expression).

2.1.5. ADMS 5.2.4 is therefore considered to be suitable for use in this assessment.

## 2.2. Key Assumptions

2.2.1. The study will be undertaken on the basis of a worst-case scenario. Consequently, the following assumptions have been made:

- the release concentrations of the pollutants will be at the permitted ELVs on a 24-hourly basis, 365 days of the year; in practice, when the plant is operating, the release concentrations will be below the ELVs; furthermore, taking shutdowns for planned maintenance into account, the plant will not operate for 365 days;
- the highest predicted pollutant GLCs for the five years of meteorological data for each averaging period (annual mean, hourly, etc.) have been used;
- concentrations of $NO_2$ in the emissions have been calculated assuming a long-term 70% NOx to $NO_2$ conversion rate, and a short-term 35% NOx to $NO_2$); and
- maximum predicted GLCs at any location, irrespective of whether a sensitive receptor is characteristic of public exposure, are compared against the relevant AQSs for each pollutant; in addition, the predicted maximum sensitive receptor GLC has also been assessed.

## 2.3. Sensitive Human Receptors

2.3.1. In addition to predicting concentrations over a 4km by 4km grid, there are ten specified potentially sensitive human receptors and two AQMAs considered in the assessment. Details of these are provided in Table 1.

**Table 1: Sensitive Human Receptors**

| ADMS Ref. | Location | Easting | Northing | Distance from Site[a] (m) | Heading (degrees) |
|---|---|---|---|---|---|
| HSR1 | Industrial estate | 320663 | 175211 | 537 | 157 |
| HSR2 | Mary Price Court | 320222 | 176234 | 577 | 337 |
| HSR3 | Moorland Primary School | 320456 | 176290 | 586 | 1 |
| HSR4 | Industrial estate | 321203 | 175788 | 759 | 84 |
| HSR5 | Youth club and sporting grounds | 319702 | 175920 | 778 | 286 |
| HSR6 | Apartments, Bute East Dock | 319518 | 175137 | 1090 | 239 |
| HSR7 | Holiday Inn | 319250 | 175462 | 1223 | 259 |
| HSR8 | Willows High School | 321114 | 176741 | 1232 | 33 |
| HSR9 | St Cuthbert's School | 319033 | 175475 | 1434 | 261 |
| HSR10 | Travellers' site | 321862 | 176756 | 1762 | 53 |
| AQMA1 | Stephenson Court AQMA | 319432 | 176981 | 1632 | 321 |
| AQMA2 | Cardiff City Centre AQMA | 318399 | 175995 | 2071 | 278 |

Notes to Table 1

(a) The distance from Site is calculated as the crow flies from the coordinates between the two boiler stacks (320449 (X), 175704 (Y)) to the approximate nearest point of the potentially sensitive human receptor or AQMA location.

## 2.4. Sensitive Ecological Receptors

2.4.1. In accordance with EA guidance the impact of emissions to air on vegetation and ecosystems from the Site should be assessed for the following sensitive environmental receptors within 10km of the discharge stacks:

- Special Protection Areas ("SPAs") and potential SPAs designated under the EC Birds Directive;
- Special Areas of Conservation ("SACs") and candidate SACs ("cSACs") designated under the EC Habitats Directive; and
- Ramsar Sites designated under the Convention on Wetlands of International Importance.

2.4.2. In addition, the impact of emissions to air on vegetation and ecosystems from the Site should be assessed for the following sensitive environmental receptors within 2km of the discharge stacks:

- Sites of Special Scientific Interest ("SSSI") established by the 1981 Wildlife and Countryside Act; and
- local nature sites (ancient woodland ("AW"), local wildlife sites ("LWSs") (also referred to as Sites of Importance for Nature Conservation ("SINCs") and national and local nature reserves ("NNRs" and "LNRs")).

2.4.3. Habitat receptor designations that have been identified within the distance criteria are presented in Table 2. The various ecological sites each cover a large area, consequently grid references for the ecological sites have been taken as the point of the ecological site closest to the Site (with the exception of the LWSs – refer to the notes to Table 2 for details).

**Table 2: Specific Sensitive Habitat Receptors Considered for the Assessment**

| ADMS Ref. | Name | Designation(s) | Easting | Northing | Distance from Site (m) | Heading (degrees) |
|---|---|---|---|---|---|---|
| SE1 | Severn Estuary | Ramsar, SAC, SPA, SSSI | 321267 | 175290 | 917 | 117 |
| SE2 | | | 320709 | 174131 | 1594 | 171 |
| SE3 | | | 321854 | 176572 | 1651 | 58 |
| CBW1 | Cardiff Beech Woods | SAC | 314346 | 183183 | 9653 | 321 |
| LNR1 | Cardiff Bay Wetlands and Hamadryad Park | LNR | 318902 | 174259 | 2117 | 227 |
| LWS1 | Tidal Sidings | LWS | 320700 | 175500 | 323 | 129 |
| LWS2 | Ocean Park South | | 320500 | 175300 | 407 | 173 |
| LWS3 | Cardiff Heliport Fields | | 321100 | 175000 | 959 | 137 |
| LWS4 | Pengam Moors | | 321600 | 176900 | 1660 | 44 |
| LWS5 | Beach Sidings | | 320500 | 174000 | 1705 | 178 |
| LWS6 | Cardiff Bay Wetland Reserve | | 318800 | 174000 | 2371 | 224 |

<u>Notes to Table 2</u>

The distance from Site is calculated as the crow flies from the coordinates between the two boiler stacks (320449 (X), 175704 (Y)) to the approximate nearest point of the habitat receptor.

For the LWS locations, these coordinates have been obtained from Section 2.5 of *Ecology and Biodiversity Technical Guidance Note*, November 2017, *Part 2 – The Cardiff Resource* (within *Cardiff Green Infrastructure SPG*), available online via: https://cardiff.moderngov.co.uk/documents/s18690/Item%209%20App%201%20SPG%20Green%20Infrastructure.pdf

Please note, that as the Site's permitted boundary spans a larger area, the distance between the 'Source' and the site boundary has been taken into consideration in the interest of being conservative. Therefore, sites that appear to exceed the 2km search criteria are either close to or just within the relevant search radii.

## 2.5. Air Quality Standards for the Protection of Human Health

2.5.1. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007) details Air Quality Strategy Objectives for a range of pollutants, including a number that are directly relevant to this study, i.e. $NO_2$ and CO. In addition, the Regulatory Authorities must ensure that the proposals do not exceed Ambient Air Directive ("AAD") limit values.

2.5.2. In this report, the generic term Air Quality Standard ("AQS") is used to refer to any of the above values. The various AQSs are intended to be used as guidelines for the protection of human health and the management of local air quality. The values relevant to this study are detailed in Table 3.

**Table 3: Air Quality Standards for the Protection of Human Health**

| Pollutant | Averaging Period | AQS ($\mu g/m^3$) | Comments |
|---|---|---|---|
| Nitrogen Dioxide ($NO_2$) | annual | 40 | UK Air Quality Objective ("AQO") and Ambient Air Directive ("AAD") Limit |
| | 1-hour | 200 | UK AQO and AAD Limit, not to be exceeded more than 18 times per annum, equivalent to the 99.79th percentile of 1-hour means |
| Carbon Monoxide (CO) | 8-hour | 10,000 | UK AQO and AAD Limit |

## 2.6. Air Quality Standards for the Protection of Sensitive Habitat Sites and Ecosystems

2.6.1. For dispersion modelling purposes, the specified habitat co-ordinates are a precautionary approach, and are those located at the boundary of the protected site approximately closest in proximity to the Site. The maximum predicted impact for each of the habitat sites has been identified for comparison with relevant assessment criteria.

2.6.2. **Critical Levels**

2.6.3. Critical levels are thresholds of airborne pollutant concentrations above which damage may be sustained to sensitive plants and animals. High concentrations of pollutants in ambient air directly cause harm to leaves and needles of forests and other plant communities. Oxidised nitrogen can have both a toxic effect on vegetation and an impact on nutrient nitrogen.

2.6.4. The 2008 Air Quality Directive set limit values for the protection of vegetation and ecosystems and these have been adopted by the Air Quality Strategy, but are not currently set in Regulations. The current objectives are summarised in Table 4.

**Table 4: Assessment Criteria for the Protection of Sensitive Habitats and Ecosystems**

| Pollutant | Averaging Period | Critical Level ($\mu g/m^3$) | Comments |
|---|---|---|---|
| Nitrogen Oxides (as $NO_2$) | annual | 30 | Air Quality Objective |
| | daily | 75 | (a) |

Notes to Table 4
(a) WHO (2000) Air Quality Guidelines for Europe; 2nd Edition. WHO Regional Publications, European Series, No. 91.

2.6.5. **Critical Loads**

2.6.5.1. Critical Loads are 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"*[(3)].

2.6.5.2. Critical loads for nutrient nitrogen are set under the Convention on Long-Range Transboundary Air Pollution based on empirical evidence, mainly observations from experiments and gradient studies. Critical loads[(4)] are assigned to habitat classes of the European Nature Information System[(5)] in units of kgN/ha/yr.

2.6.5.3. Predicted $NO_x$ deposition rates in units of µg $m^{-2}$ $s^{-1}$ are converted to units of kg/ha/yr as nitrogen for direct comparison with critical loads as follows:

- kgN/ha/yr = µg/$m^2$/s × (14/46)[(6)] × 315.36[(7)]

2.6.5.4. Exceedance of critical loads for nitrogen deposition can result in significant terrestrial and freshwater impacts due to changes in species composition, reduction in species richness, increase in nitrate leaching, increases in plant production, changes in algal productivity and increases in the rate of succession[(8)].

2.6.5.5. In the UK, an empirical approach is applied to critical loads for acidity for non-woodland habitats; and the simple mass balance equation is applied to both managed and unmanaged woodland habitats. For freshwater ecosystems, national critical load maps are currently based on the First-order Acidity Balance model. All of these methods provide critical loads for systems at steady-state[(4)] in units of keq/ha/yr.

2.6.5.6. The unit kiloequivalent (keq) is the molar equivalent of potential acidity resulting from sulphur or oxidised and reduced nitrogen. Predicted acid deposition rates in units of µg/$m^2$/s are converted to units of keq/ha/yr) as hydrogen for direct comparison with critical loads as follows:

- nitrogen from $NO_x$ (keq) =([$NO_x$]µg/$m^2$/s × (14/46) × 315.36) ÷ 14[(9)] (which equates approximately to the conversion factor provided in the AQTAG06 guidance of 6.84);

2.6.5.7. Dry and wet deposition were modelled using ADMS. For modelling wet deposition, washout coefficients are required. The default parameters for $NO_x$ (as $NO_2$) were used in the model (i.e. values of 0.0001 for parameter A and 0.64 for parameter B).

2.6.5.8. Exceedance of the critical loads for acid deposition can result in significant terrestrial and freshwater impacts due to leaching and subsequent increase in availability of potentially toxic metal ions.

(3) From http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm
(4) From http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm
(5) See http://eunis.eea.europa.eu/ for details
(6) Ratio of atomic weight( of nitrogen to molecular weight of nitrogen dioxide
(7) Conversion factor from g/m² to kg/ha.
(8) From http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm#_Toc279788052
(9)14kg nitrogen/ha/yr = 1keq nitrogen/ha/yr

2.6.5.9. Table 5 lists the site-specific critical loads for nutrient nitrogen deposition and acid deposition respectively. Features are as indicated on the Air Pollution Information System ("APIS") website for SACs, SPAs and SSSIs. Where a primary feature identified in the citation was not listed on the APIS website, an equivalent feature was used to derive critical loads as indicated in the Habitats Table on the APIS website [10].

(10) http://www.apis.ac.uk/habitat_table.html

**Table 5: Critical Loads for Deposition**

| Ref | Site Name | Habitat Interest | Habitat Feature | Nutrient Nitrogen Deposition | | Acid Deposition | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Critical Load (kgN/ha/yr) | Upper Critical Load (kgN/ha/yr) | CL Min N (keq/ha/yr) | CL Max N (keq/ha/yr) | CL Max S (keq/ha/yr) |
| SE1 -SE3 | Severn Estuary – Ramsar | Coastal Saltmarsh | Pioneer, low-mid, mid-upper saltmarshes | 20 | 30 | Not sensitive to acidification | | |
| SE1 – SE3 | Severn Estuary – SAC | Estuaries | Pioneer, low-mid, mid-upper saltmarshes | 20 | 30 | Not sensitive to acidification | | |
| | | Atlantic salt meadows | Pioneer, low-mid, mid-upper saltmarshes | 20 | 30 | Not sensitive to acidification | | |
| | | Sandbanks which are slightly covered by water all the time | None assigned | Not sensitive to eutrophication | | Not sensitive to acidification | | |
| | | Mudflats and sandflats not covered be seawater at low tide | | No comparable habitat with established critical load estimates available | | Not sensitive to acidification | | |
| | | Reefs | | Not sensitive to eutrophication | | Not sensitive to acidification | | |
| | | Petromyzon marinus – Sea lamprey | Rivers and streams | No comparable habitat with established critical load estimates available | | No critical loads available for this feature | | |
| | | Lampetra fluviatilis – River lamprey | | | | | | |
| | | Alosa fallax – Twaite Shad | | | | | | |

**Table 5: Critical Loads for Deposition (cont.)**

| Ref | Site Name | Habitat Interest | Habitat Feature | Nutrient Nitrogen Deposition | | Acid Deposition | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Critical Load (kgN/ha/yr) | Upper Critical Load (kgN/ha/yr) | CL Min N (keq/ha/yr) | CL Max N (keq/ha/yr) | CL Max S (keq/ha/yr) |
| SE1 – SE3 | Severn Estuary – SPA | Common shelduck - Wintering | Littoral sediment | 20 | 30 | Not sensitive to acidification | | |
| | | Common redshank - Wintering | | | | | | |
| | | Greater white-fronted goose - Wintering | | | | | | |
| | | Tundra swan - Wintering | Improved grassland | Not sensitive to eutrophication | | Not sensitive to acidification | | |
| | | | Arable and horticulture | | | | | |
| | | | Standing open water and canals | No comparable habitat with established critical load estimates available | | No expected negative impact on the species due to impacts on the species' broad habitat | | |
| | | Gadwall - Wintering | Standing open waters and canals | No comparable habitat with established critical load estimates available | | | | |
| SE1 – SE3 | Severn Estuary - SSSI | Fen, marsh and swamp | Rich Fens | 15 | 30 | Not sensitive to acidification | | |
| | | Neutral grassland | Low and medium altitude hay meadows | 20 | 30 | 0.223 | 1.063 | 0.84 |
| | | | | | | 0.856 | 4.856 | 4 |

**Table 5: Critical Loads for Deposition (cont.)**

| Ref | Site Name | Habitat Interest | Habitat Feature | Nutrient Nitrogen Deposition | | Acid Deposition | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Critical Load (kgN/ha/yr) | Upper Critical Load (kgN/ha/yr) | CL Min N (keq/ha/yr) | CL Max N (keq/ha/yr) | CL Max S (keq/ha/yr) |
| SE1 – SE3 | Severn Estuary - SSSI (cont.) | Littoral sediment | Pioneer, low-mid, mid-upper saltmarshes | 20 | 30 | Not assessed for this feature | | |
| | | Vascular plant assemblage | No broad habitat assigned | No comparable habitat with established critical load estimates available | | No Comparable Acidity Class | | |
| | | Dunlin | Bird – non-breeding; littoral sediment | 20 | 30 | Not sensitive to acidification | | |
| | | Ringed Plover | | | | | | |
| | | Curlew | | | | | | |
| | | Grey Plover | | | | | | |
| | | Shelduck | | | | | | |
| | | Redshank | | | | | | |
| | | Non-breeding waterbirds | Bird – non-breeding; standing open waters and canals | No comparable habitat with established critical load estimates available | | No values given via APIS | | |
| | | Allis Shad | Rivers and streams | | | | | |

### Table 5: Critical Loads for Deposition (cont.)

| Ref | Site Name | Habitat Interest | Habitat Feature | Nutrient Nitrogen Deposition | | Acid Deposition | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Critical Load (kgN/ha/yr) | Upper Critical Load (kgN/ha/yr) | CL Min N (keq/ha/yr) | CL Max N (keq/ha/yr) | CL Max S (keq/ha/yr) |
| SE1 – SE3 | Severn Estuary - SSSI (cont.) | Twaite Shad | Rivers and streams | No comparable habitat with established critical load estimates available | | No values given via APIS | | |
| | | River Lamprey | | | | | | |
| | | Sea Lamprey | | | | | | |
| | | Atlantic Salmon | | | | | | |
| CBW1 | Cardiff Beech Woods - SAC | Asperulo-Fagetum beech forests | Fagus woodland | 10 | 20 | 0.142 | 1.428 | 1.286 |
| | | Tilio-Acerion forests of slopes, screes and ravines | Meso- and eutrophic Quercus woodland | 15 | 20 | 0.142 | 1.428 | 1.286 |

## 2.7. Habitat Site Specific Baseline Concentrations and Deposition Rates

### 2.7.1. Airborne $NO_X$ Concentrations

2.7.1.1. A summary of site-specific baseline concentrations of $NO_X$, as provided by APIS, is presented in Table 6. Background concentrations for each ecological receptor have been obtained at the same point as listed in Table 2 i.e. the closest grid square to the point of the site used in the assessment.

**Table 6: Baseline Concentrations of $NO_X$**

| ADMS Receptor Reference | Description & Designation | $NO_X$ Background Concentration[a] (µg/m³) | |
|---|---|---|---|
| | | Annual Mean | 24 Hour[b] Mean |
| SE1 | Severn Estuary – Ramsar, SAC, SPA, SSSI | 21.89 | 25.83 |
| SE2 | | 25.14 | 29.67 |
| SE3 | | 24.91 | 29.39 |
| CBW1 | Cardiff Beech Woods – SAC | 15.69 | 18.51 |
| LNR1 | Cardiff Bay Wetlands and Hamadryad Park – LNR | 26.86 | 31.69 |
| LWS1 | Tidal Sidings - LWS | 35.11 | 41.43 |
| LWS2 | Ocean Park South - LWS | 35.11 | 41.43 |
| LWS3 | Cardiff Heliport Fields - LWS | 21.89 | 25.83 |
| LWS4 | Pengam Moors - LWS | 24.91 | 29.39 |
| LWS5 | Beach Sidings - LWS | 25.14 | 29.67 |
| LWS6 | Cardiff Bay Wetland Reserve - LWS | 26.86 | 31.69 |

Notes to Table 6

(a) Background concentrations for the relevant ecological habitats have been taken from the APIS website for the closest grid square to the site (data year: 2016 – 2018).

(b) The 24-hour mean baseline concentration is twice the annual mean multiplied by a factor of 0.59, in accordance with the H1 guidance.

### 2.7.2. Nutrient Nitrogen and Acid Deposition

2.7.2.1. A summary of site-specific baseline nutrient nitrogen and acid deposition rates, as provided by APIS, is presented in Table 7. Again, the specific deposition rates for each ecological receptor have been obtained from the same point as listed in Table 2, i.e. the closest grid square to the point of the site used in the assessment.

**Table 7: Background Nutrient Nitrogen and Acid Deposition**

| ADMS Receptor Reference | Description & Designation | Nutrient Nitrogen Background (kgN/ha/yr) | Acid Deposition Background (keq/ha/yr) | |
|---|---|---|---|---|
| | | | Nitrogen | Sulphur |
| SE1 | Severn Estuary – Ramsar, SAC, SPA, SSSI | 13.16 | 0.94 | 0.27 |
| SE2 | | 0 | 0 | 0.26 |
| SE3 | | 13.16 | 0.94 | 0.27 |
| CBW1 | Cardiff Beech Woods – SAC | 26.32 | 1.88 | 0.28 |
| LNR1 | Cardiff Bay Wetlands and Hamadryad Park – LNR | 12.46 | 0.89 | 0.22 |
| LWS1 | Tidal Sidings - LWS | 13.16 | 0.94 | 0.27 |
| LWS2 | Ocean Park South - LWS | 13.16 | 0.94 | 0.27 |
| LWS3 | Cardiff Heliport Fields - LWS | 13.16 | 0.94 | 0.27 |
| LWS4 | Pengam Moors - LWS | 13.16 | 0.94 | 0.27 |
| LWS5 | Beach Sidings - LWS | 0 | 0 | 0.26 |
| LWS6 | Cardiff Bay Wetland Reserve - LWS | 12.46 | 0.89 | 0.22 |

Notes to Table 7
Background concentrations, for both nutrient nitrogen and acid deposition, for the relevant ecological habitats have been taken from the APIS website (data year: 2016-2018).

## 2.8. Deposition Parameters - Sensitive Habitats

2.8.1. Deposition of nitrogen and acids at designated habitats sites was also included in the assessment. This focused on sites within 10km of the Site as detailed in Section 2.4.3. The pollutant deposition rates are presented in Table 8. These parameters are detailed in AQTAG06. Since woodland sites have a greater surface area, higher deposition velocities are adopted for these sites.

2.8.2. For both nutrient nitrogen and acidification impacts, the deposition of oxides of nitrogen are considered.

**Table 8: Acid/Nitrogen Deposition Parameters [11]**

| Pollutant | Dry Deposition Velocity for Grassland (m/s) | Dry Deposition Velocity for Woodland (m/s) |
|---|---|---|
| Oxides of Nitrogen (as $NO_2$) | 0.0015 | 0.003 |

Note to Table 8
(a) As detailed in AQTAG06.

[11] As detailed in AQTAG06.

## 2.9. Background Air Quality

2.9.1. For the purposes of this assessment the most representative background concentration to the point being assessed (i.e. the maximum GLC or sensitive receptor location) will be used, where necessary, to calculate the PEC for long-term $NO_2$. The source, location and concentration of the background air quality data will be specified in the appropriate section.

## 2.10. Stack Emission Parameters and Emission Limit Values

2.10.1. The stack emission parameters used in the study are presented in Table 9.

**Table 9: Stack Emission Parameters**

| Parameter | | Existing Boiler[(a)] | Proposed Boiler[(a)] |
|---|---|---|---|
| Rated Thermal Input (MWth) | | 4.02 | 4.02 |
| Stack Height (m) | | TBC | TBC |
| Stack Exit Diameter (m) | | 0.504 | 0.430 |
| Stack Gas Discharge Velocity (actual) (m/s) | | 9.52 | 12.74 |
| Stack Gas Discharge Temperature (°C) | | 149 | 127 |
| Stack Centre Coordinates | Easting (X) | 320446 | 320451 |
| | Northing (Y) | 175703 | 175705 |
| Oxygen Concentration in Stack Emission (%) | | 3.7 | 2.54 |
| Moisture Concentration in Stack Emission (%) | | 10.63 | 10.80 |
| Normalised Volumetric Flowrate ($Nm^3/s$)[(b)] | | 1.05 | 1.16 |

Notes to Table 9
(a) Stack emission parameters provided by Princes
(b) Referenced to 273K, 1 atmosphere, 3% oxygen, dry.

2.10.2. The ELVs assumed for each pollutant and the pollutant mass emission rate for the study are presented in Table 10 for the one existing and one proposed boiler. These are the assumed daily ELVs used for the main modelling assessment.

**Table 10: Pollutant Emission Rates**

| Pollutant | ELV [a] (mg/Nm$^3$) | Existing Boiler (g/s) | Proposed Boiler (g/s) |
|---|---|---|---|
| Nitrogen dioxide | 250 [b] | 0.26 | n/a |
| | 100 [c] | n/a | 0.12 |
| Carbon monoxide | 1000 | 1.05 | 1.16 |

Notes to Table 10

(a) Concentrations are at reference conditions i.e. 273K, 1 atmosphere, 3% oxygen, dry.

(b) ELV as per Table 1 of Part 1 of Annex II of the Medium Combustion Plant Directive

(c) ELV as per Table 1 of Part 2 of Annex II of the Medium Combustion Plant Directive

## 2.11. Meteorological (Met) Data

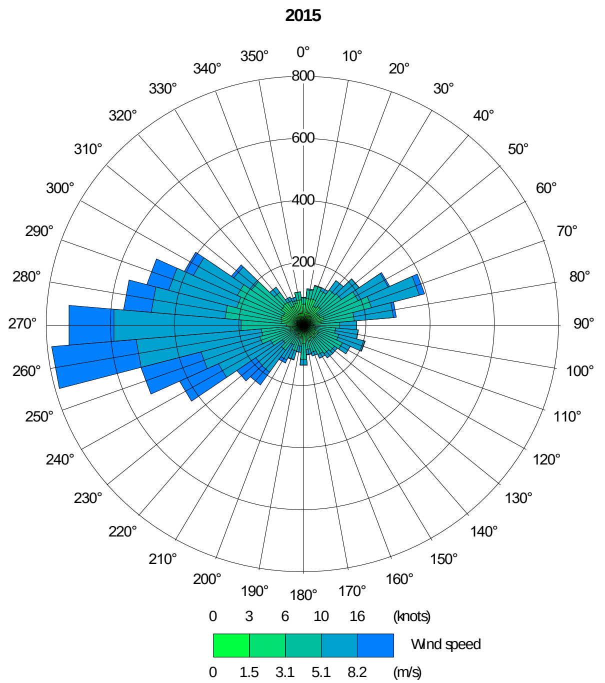
2.11.1. ADMS has a meteorological pre-processing capability, which calculates the required boundary layer parameters from a variety of data. Meteorological data ("met data") can be utilised in its sequentially analysed form, which estimates the pattern of dispersion through 10 degree sectors from the source or as raw data.

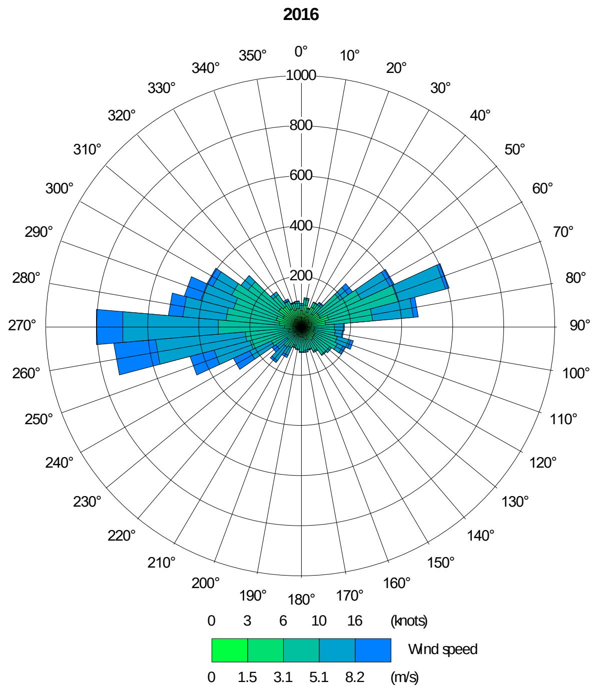
2.11.2. The nearest suitable met data available from the Meteorological Office ("Met Office") is from St Athan. This site is located approximately 22km west-southwest of the Site.

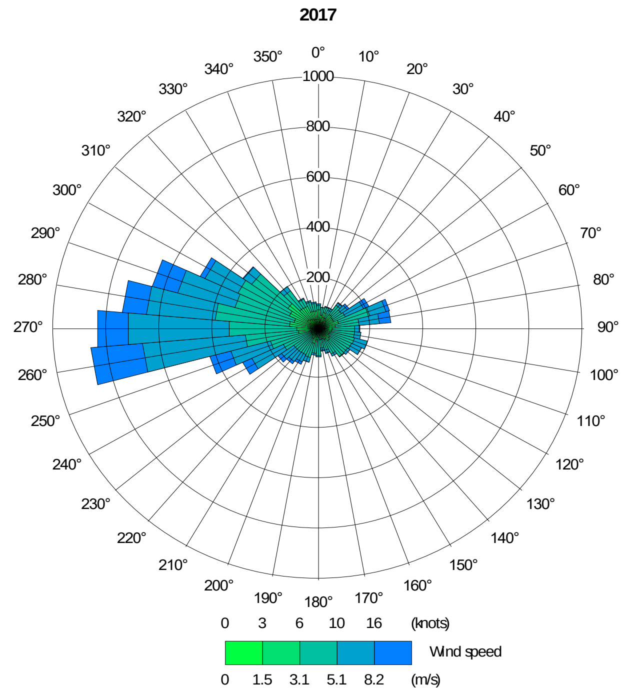
2.11.3. The assessment utilises five years (2015 - 2019) of hourly sequentially analysed data in sectors of 10 degrees. Wind roses for the data are presented in Figure 2; these show that the prevailing winds are predominantly westerly, with a few easterly components.

2.11.4. Over the five years of meteorological data used (43,824 hours), ADMS reported that 709 hours contained inadequate data, 13 hours were calm and 380 hours were non-calm met data lines with a wind speed less than the minimum value (0.75 m/s). These represent 1.62%, 0.03% and 0.87% of the data respectively.

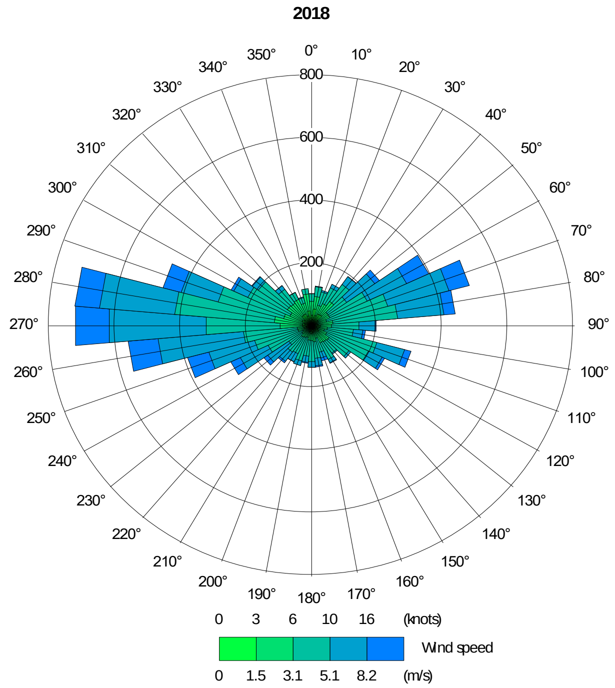
# Figure 2: Wind Roses - Met Years 2015-2019

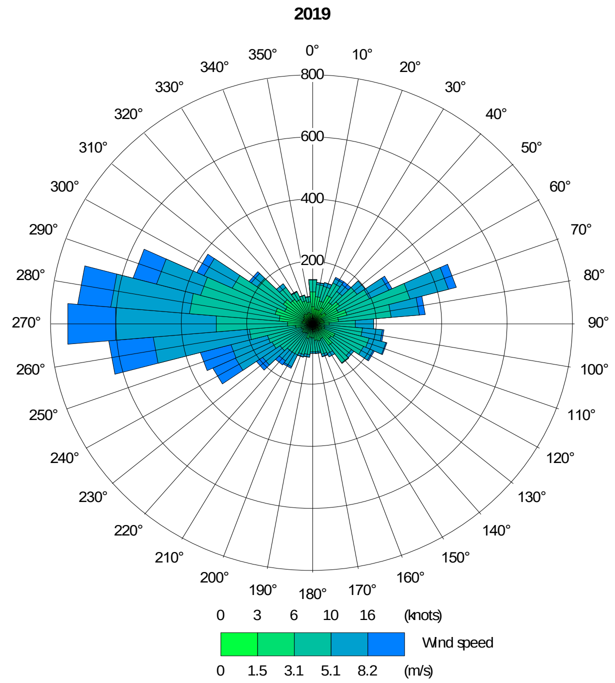


# Figure 2: Wind Roses - Met Years 2015-2019 (cont.)



## 2.12. Building Parameters

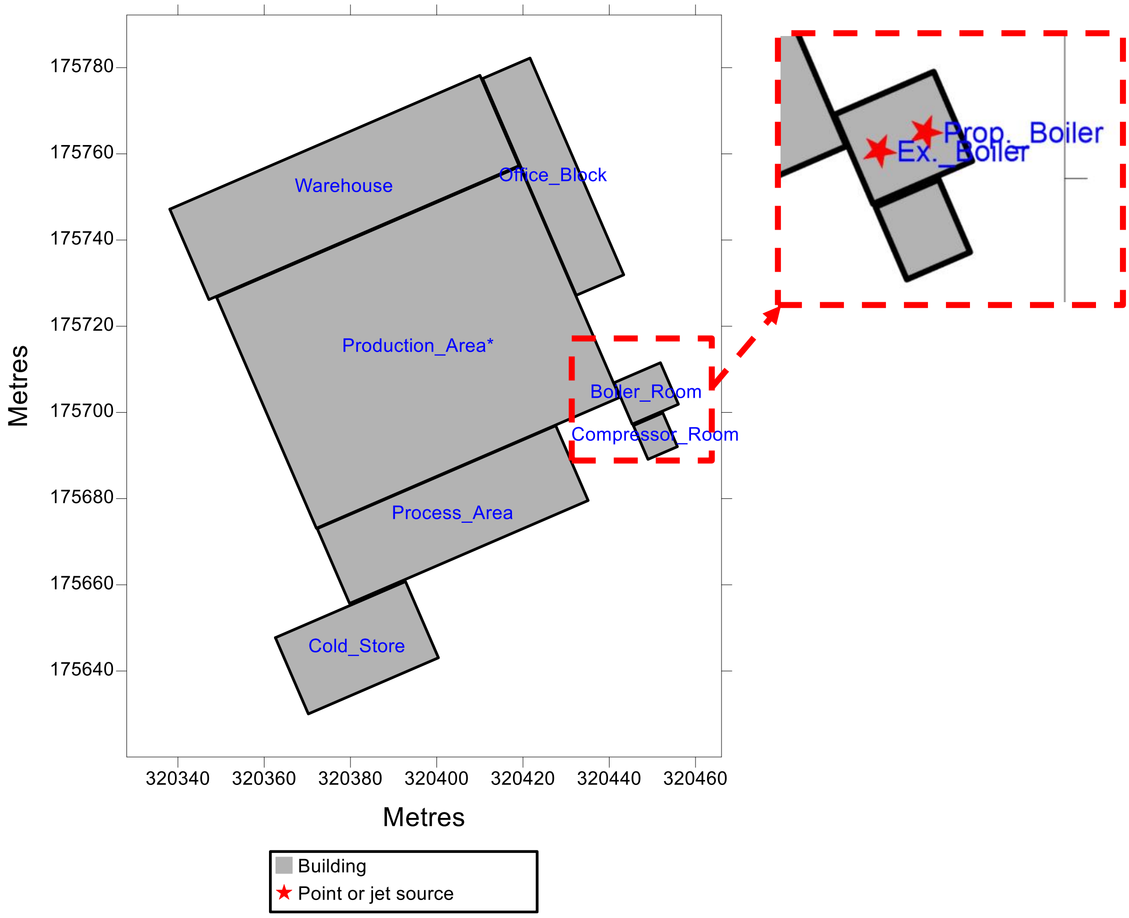
The building parameters utilised for the study are detailed in Table 11 and a visual representation is provided as Figure 3.

**Table 11: On-Site and nearest Off-site Building Parameters**

| Building | X[(a)] | Y[(a)] | Angle (°)[(b)] | Height (m)[(c)] | Length/ Diameter (m)[(c)] | Width (m)[(c)] |
|---|---|---|---|---|---|---|
| Production Area | 320396 | 175715 | 66.64 | 10.32 | 76.62 | 58.38 |
| Process Area | 320404 | 175676 | 66.64 | 10.20 | 60.25 | 18.92 |
| Warehouse | 320379 | 175752 | 66.64 | 12.49 | 78.32 | 22.85 |
| Office Block | 320427 | 175755 | 66.64 | 13.86 | 11.98 | 54.79 |
| Boiler Room | 320449 | 175704 | 66.64 | 5.13 | 11.67 | 10.50 |
| Compressor Room | 320451 | 175695 | 66.64 | 3.70 | 7.44 | 8.53 |
| Cold Store | 320382 | 175645 | 66.64 | 12.90 | 32.86 | 19.27 |

Notes to Table 11
(a) X(m), Y(m) denote the grid reference co-ordinates of the centre of the building.
(b) Angle denotes the angle between north and the side designated as length in the ADMS model.
(c) Building dimensions confirmed by Princes Limited.

**Figure 3: Buildings Layout**



## 2.13. Terrain Data

2.13.1. ADMS has a terrain pre-processing capability, which calculates the required boundary layer parameters from a variety of data.

2.13.2. Terrain data was used for an area of 400km$^2$ (20 km by 20 km), which is considerably larger than the output grid area. The terrain data used was of sufficient size to ensure that it would encompass all sensitive human receptors. The terrain file was created by compiling the data from the relevant Ordnance Survey tiles. The terrain data file was created using an ADMS terrain grid resolution of 64 x 64.

## 2.14. Roughness Length

2.14.1. The surface nature of the terrain is defined in terms of Roughness Length ($Z_o$). The roughness length is dependent on the type of terrain and its physical properties. The ADMS model gives values to various types of terrain, for example, sea areas are classed as 0.0001m, parkland and open suburbia is classed as 0.5m and cities and large urban areas are classed as 1.5m.

2.14.2. Given the nature of the surrounding land use and the presence of the Severn Estuary, a variable surface roughness file was created to account for these variations in surface roughness length.

2.14.3. This approach was discussed with CERC and was achieved by means of manually editing the terrain file created to assign areas (based on their coordinates) within the output extent with surface roughness values of:

- 0.0001m (indicative of sea) - for areas covered by the Severn Estuary;
- 0.2m (indicative of agricultural areas (min)) - for areas predominantly populated by open green space / farmers' fields; and
- 1.0m (indicative of cities and woodlands) - for land principally occupied by urban infrastructure and wooded areas.

## 2.15. Model Output Parameters

2.15.1. The ADMS model calculates the likely pollutant GLCs at locations within a definable grid system pre-determined by a user. Output grids may be determined in terms of a Cartesian or Polar co-ordinate system. For the purpose of this study the Cartesian system was used.

2.15.2. A Cartesian grid is constructed with reference to an initial origin, which is taken to be the bottom left corner of the grid. The lines of the grid are inserted at regular pre-defined increments in both northerly and easterly directions. Pollutant GLCs are calculated at the intersection of these grid lines; they are calculated in this manner primarily to aid in the generation of pollutant contours.

2.15.3. For assessing the maximum point of impact, a grid resolution of 4km x 4km was utilised in order to capture values of the predicted pollutant GLCs arising from the model. The grid co-ordinates were X = 318449 to 322449 and Y = 173704 to 177704, with 101 nodes along each axis i.e. a grid spacing of 40m.

2.15.4. For assessing the impact of emissions on human health and ecological sites the grid references of each were included as specified points within the ADMS model.

## 2.16. Scenarios Modelled

2.16.1. A stack height screening study has been undertaken for the two boilers (one existing and one proposed) utilising the emission parameter values and emission rates shown in Tables 9 and 10, with modelled stack heights ranging from 10m - 24m.

2.16.2. The optimum stack height is determined by assessment of the following averaging periods: the annual mean of hourly averages ($NO_2$), the 99.79$^{th}$ percentile of 1 hour means ($NO_2$) and the 100$^{th}$ percentile of 8 hour-rolling means (CO).

2.16.3. The screening assessment considers the maximum ground level concentration of pollutants only. Following this, an assessment of significance has been undertaken for all stack heights. The significance criteria used in accordance with the EA Online Guidance is provided in Section 2.17.

2.16.4. The following scenarios were modelled:

- impact assessment of emissions from the one existing and one proposed boiler at the maximum point of impact;
- impact assessment of emissions from the one existing and one proposed boiler at potentially sensitive human receptor locations and on the AQMAs; and
- impact assessment of emissions from the one existing and one proposed boiler at the designated ecological sites relevant to the study (inclusive of deposition rates).

## 2.17. Assessment of Significance of Impact Guidelines – Maximum GLC and Human Receptors

2.17.1. Both the EA online guidance and IAQM guidance has been used for the purposes of significance assessment, and this guidance details the guidelines upon which the assessment of the significance of impact can be established.

2.17.2. In the first instance, the EA online guidance indicates that PCs can be considered insignificant if:

- the long-term PC is <1% of the long-term environmental standard; and
- the short-term PC is <10% of the short-term environmental standard.

2.17.3. As outlined in the EA online guidance, there are no criteria to determine whether:

- PCs are significant; and
- PECs are insignificant or significant.

Consequently, significance will be judged based on the site-specific circumstances and on the EPUK and IAQM methodology as described in Sections 2.17.4 and 2.17.5.

2.17.4. **Long-Term Impacts**

2.17.4.1. If the PCs exceed the long-term criteria outlined in the EA online guidance, the potential long-term effects on human receptors from the operation of the existing and proposed boilers will be assessed in accordance with the latest guidance produced by EPUK and IAQM in January 2017.

2.17.4.2. The guidance provides a basis for a consistent approach that could be used by all parties to professionally judge the overall significance of the air quality effects based on the severity of air quality impacts.

2.17.4.3. The following rationale is used in determining the severity of the air quality impacts at individual human receptors:

- the effects are provided as a percentage of the AQAL;
- the absolute concentrations are also considered in terms of the AQAL and are divided into categories for long-term concentrations. The categories are based on the sensitivity of the individual receptor in terms of harmful potential. The degree of potential to change increases as absolute concentrations are close to or above the AQAL;
- severity of the effect is described as qualitative descriptors; negligible, slight, moderate or substantial by taking into account in combination the harm potential and air quality effect. This means that a small increase at a receptor which is already close to or above the AQAL will have higher severity compared to a relatively large change at a receptor which is significantly below the AQAL, >75% AQAL;
- the effects can be adverse when the air quality concentration increases or beneficial when the concentration decreases as a result of development; and
- the judgement of overall significance of the effects is then based on severity of effects on all the individual receptors considered.

2.17.4.4. The impact descriptors for individual receptors are presented in Table 12.

**Table 12: Impact Descriptors for Individual Receptors – Long-Term Concentrations**

| Long-term average concentration at receptor in assessment year | % Change in concentration relative to AQAL | | | |
|---|---|---|---|---|
| | 1 | 2-5 | 6-10 | >10 |
| ≤75% of AQAL | Negligible | Negligible | Slight | Moderate |
| 76-94% of AQAL | Negligible | Slight | Moderate | Moderate |
| 95-102% of AQAL | Slight | Moderate | Moderate | Substantial |
| 103-109% of AQAL | Moderate | Moderate | Substantial | Substantial |
| ≥ 110% of AQAL | Moderate | Substantial | Substantial | Substantial |

2.17.5. **Short-Term Impacts**

2.17.5.1. As stated in EPUK / IAQM guidance, January 2017 (Land-Use Planning & Development Control: Planning for Air Quality') in Section 6.36, Page 27: *"For any point source, some consideration must also be given to the impacts resulting from short term, peak concentrations of those* *pollutants that can affect health through inhalation. The Environment Agency uses a threshold criterion of 10% of the short term AQAL as a screening criterion for the maximum short-term impact. This is a reasonable value to take and this guidance also adopts this as a basis for defining an impact that is sufficiently small in magnitude to be regarded as having an insignificant effect. Background concentrations are less important in determining the severity of impact for short term concentrations, not least because the peak concentrations attributable to the source and the background are not additive."*

2.17.5.2. Short-term concentrations in the context laid out in the IAQM guidance are those averaged over periods of an hour or less. These exposures would be regarded as acute and occur when a plume from an elevated source affects airborne concentrations experienced by a receptor over an hour or less.

2.17.5.3. The IAQM guidance offers the following severity of impact descriptors for peak short-term concentrations from an elevated source:

- 11-20% of the relevant AQAL – the magnitude can be regarded as 'small';
- 21-50% of the relevant AQAL – the magnitude can be regarded as 'medium'; and
- 51% or more of the relevant AQAL – the magnitude can be regarded as 'large'.

It is argued that this approach is intended to be a streamlined and pragmatic assessment procedure that avoids undue complexity.

## 2.18. Assessment of Significance of Impact Guidelines – Ecological Receptors

2.18.1. When there are SPAs, SACs, Ramsar sites or SSSIs within the specified distance the EA online guidance state the following criteria should be used to assess significance:

- the long-term PC is <1% of the long-term environmental standard; and
- the short-term PC is <10% of the short-term environmental standard.

If the above criteria are met, no further assessment is required. If the above criteria are exceeded for the long-term environmental standard the PEC needs to be calculated. These PECs will be classified adopting the impact descriptors laid out in Table 12. If the short-term PC exceeds the screening criteria then further modelling needs to be undertaken.

2.18.2. When there are local nature sites within the specified distance the EA online guidance states the following criteria should be used to assess significance:

- the long-term PC is <100% of the long-term environmental standard; and
- the short-term PC is <100% of the short-term environmental standard.

If the above criteria are met then no further assessment is required. PECs are not calculated for local nature sites and therefore if a PC exceeds the criteria outlined above then further modelling needs to be undertaken.

## 2.19. $NO_x$ to $NO_2$ conversion Rates

2.19.1. EA online guidance states that emissions of $NO_x$ should be recorded as $NO_2$ as follows:

- for the long-term PCs and PECs, assume 100% of the emissions of $NO_x$ convert to $NO_2$; and
- for the short-term PCs and PECs assume 50% of the emissions of $NO_x$ convert to $NO_2$.

2.19.2. However, further to detailed discussion with the EA and NRW on previous studies, a long-term 70% NO to $NO_2$ conversion rate, and a short-term 35% NO to $NO_2$ as required by guidance on $NO_x$ and $NO_2$ Conversion Ratios as referenced in AQTAG06 *Technical guidance on detailed modelling approach for an appropriate assessment* (April 2010) should be used in all detailed modelling assessments. The conversion rates as provided in section 2.19.1. should only be used for screening assessment.

# 3. IDENTIFICATION OF APPROPRIATE STACK HEIGHT

## 3.1. Building Screening Assessment

3.1.1. Due to the number of buildings on-site, a building screening assessment was undertaken for the three largest buildings (i.e. in terms of building height or floor area covered) in proximity to the one existing and one proposed boiler. Consequently, the Production Area, Process Area and Office Block (refer to Table 11 and Figure 3 in Section 2.12. for details) buildings were screened to determine which building, when defined as the 'Main' building, was associated with the highest (i.e. worst case) modelled long-term $NO_2$ PCs arising from the emission points considered, for all five met years assessed. The results from the building screening assessment are presented in Table 13, with the highest PC for each height highlighted bold.

**Table 13: Building Screening Assessment**

| Pollutant | Stack Height (m) | Main Building | Worst Case Met Year (2015-2019) | Max PC (µg/m³) | AQS (µg/m³) | PC as % of AQS |
|---|---|---|---|---|---|---|
| $NO_2$ (annual) | 10m | Production Area | 2017 | **23.78** | 40 | 59.46% |
| | | Process Area | 2017 | 19.73 | | 49.33% |
| | | Office Block | 2017 | 13.93 | | 34.82% |
| | 12m | Production Area | 2017 | **15.58** | | 38.94% |
| | | Process Area | 2017 | 9.38 | | 23.44% |
| | | Office Block | 2017 | 8.00 | | 20.01% |
| | 14m | Production Area | 2017 | **9.78** | | 24.46% |
| | | Process Area | 2017 | 6.20 | | 15.49% |
| | | Office Block | 2017 | 5.55 | | 13.87% |
| | 16m | Production Area | 2017 | **7.72** | | 19.30% |
| | | Process Area | 2017 | 4.21 | | 10.53% |
| | | Office Block | 2017 | 3.61 | | 9.02% |
| | 18m | Production Area | 2017 | **6.30** | | 15.75% |
| | | Process Area | 2017 | 3.13 | | 7.83% |
| | | Office Block | 2017 | 2.86 | | 7.15% |
| | 20m | Production Area | 2017 | **4.91** | | 12.28% |
| | | Process Area | 2017 | 2.49 | | 6.21% |
| | | Office Block | 2017 | 2.20 | | 5.50% |
| | 22m | Production Area | 2017 | **3.43** | | 8.58% |
| | | Process Area | 2017 | 1.92 | | 4.80% |
| | | Office Block | 2017 | 1.81 | | 4.52% |
| | 24m | Production Area | 2017 | **2.70** | | 6.75% |
| | | Process Area | 2017 | 1.58 | | 3.94% |
| | | Office Block | 2017 | 1.46 | | 3.66% |

3.1.2. It can be seen from the results in Table 13 that the highest (and therefore the worst case) long-term $NO_2$ PCs are associated with the Production Area as the 'Main' building. Consequently, the Production Area will be defined as the 'Main' building for all scenarios modelled (refer to Section 2.16. for details).

## 3.2. Effect of Stack Height on Ground Level Concentrations

3.2.1. This assessment considered the effect of stack height on the annual mean and the 99.79th percentile of 1 hour means of $NO_2$ and the 100th percentile of 8-hour rolling means of CO. The results of this assessment, for each met year considered (2015-2019) for the one existing and one proposed boiler are shown in Figures 4-8.

**Figure 4: Effect of Stack Height on Ground Level Concentrations, Met Year 2015**

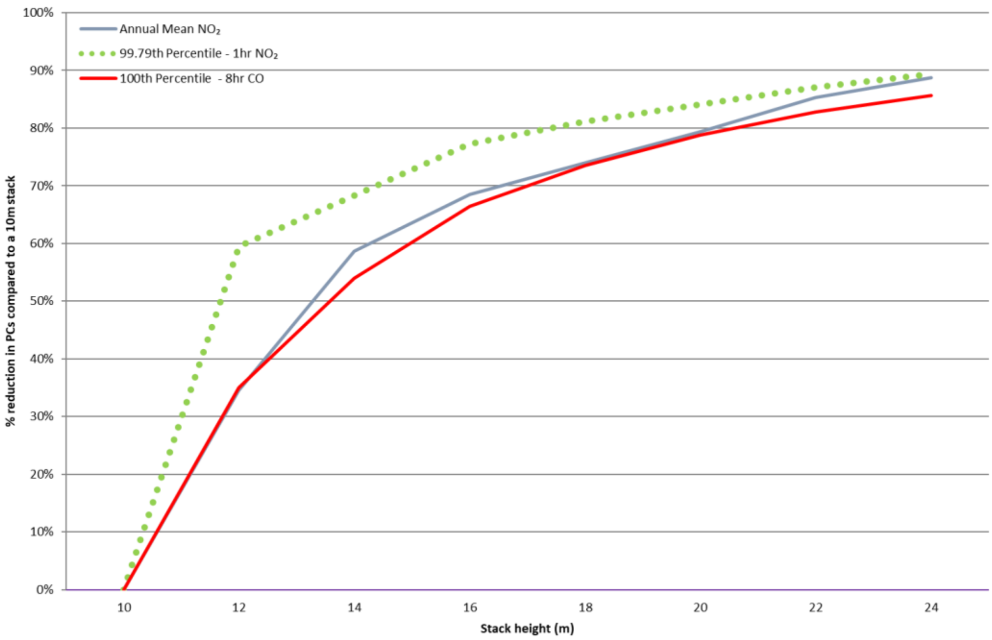



**Figure 5: Effect of Stack Height on Ground Level Concentrations, Met Year 2016**

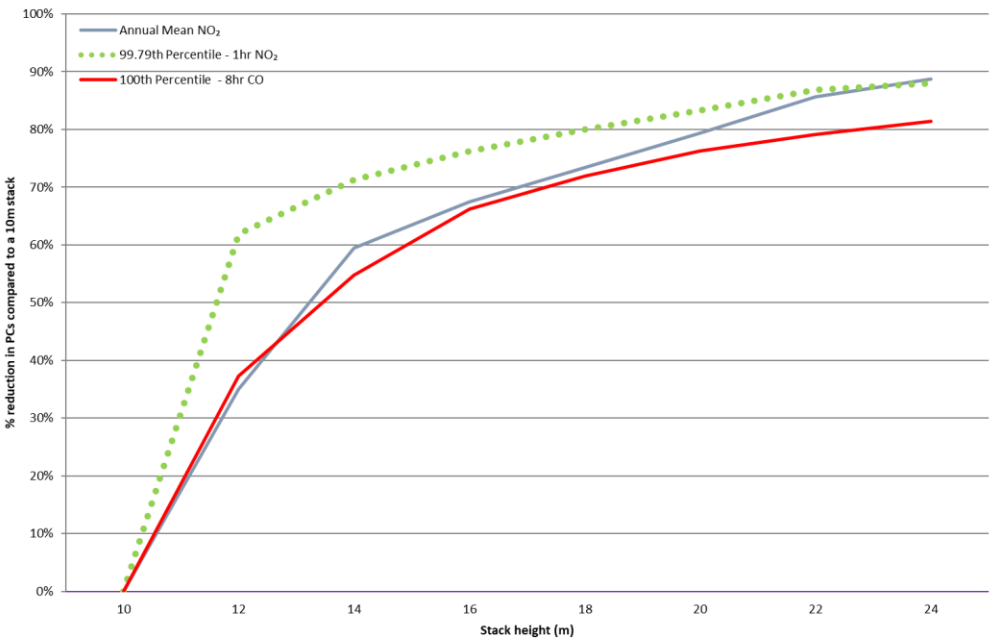


**Figure 6: Effect of Stack Height on Ground Level Concentrations, Met Year 2017**

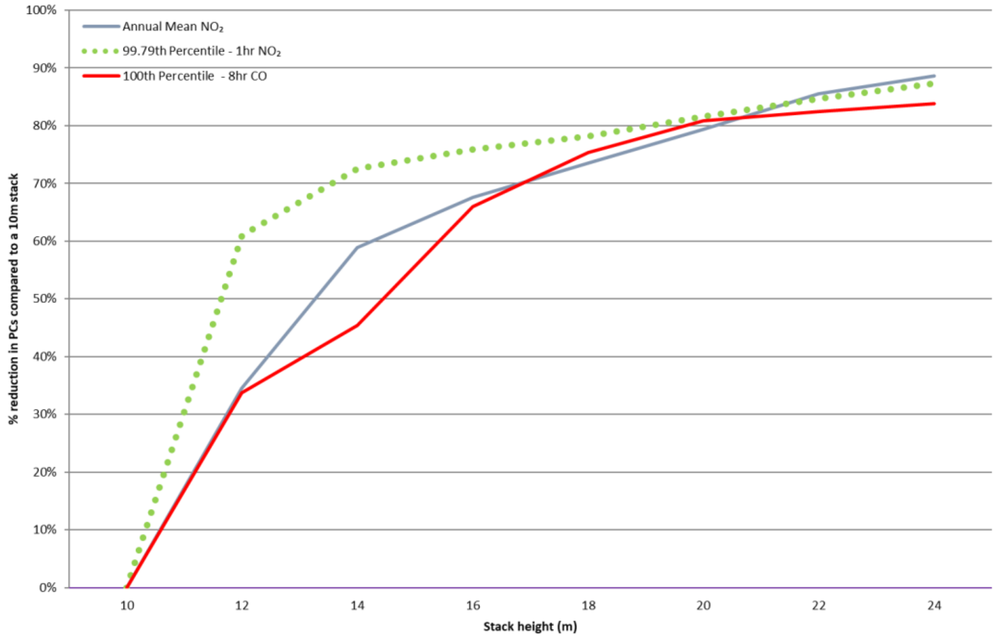



**Figure 7: Effect of Stack Height on Ground Level Concentrations, Met Year 2018**

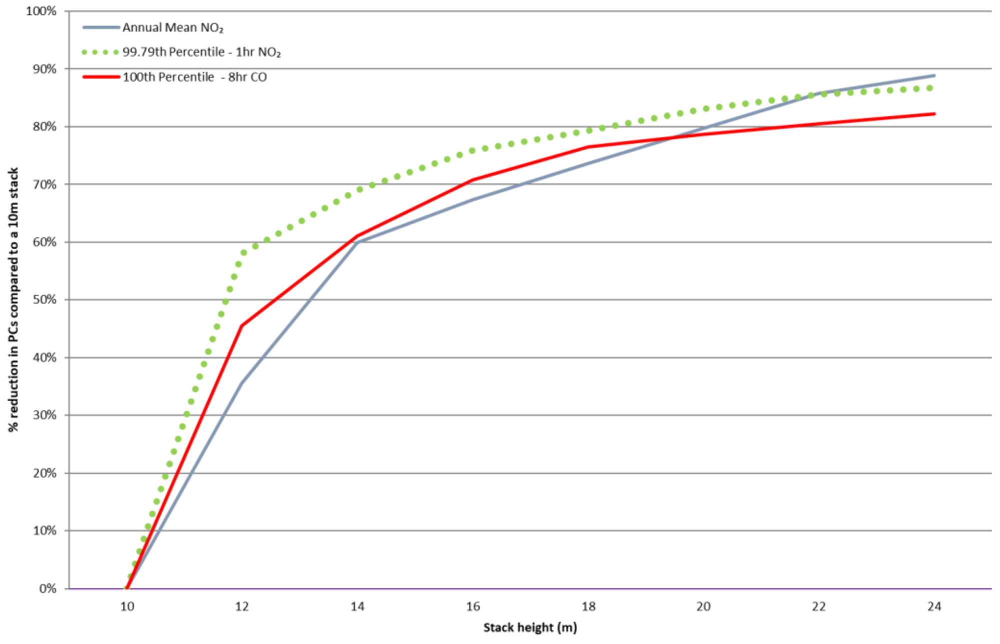
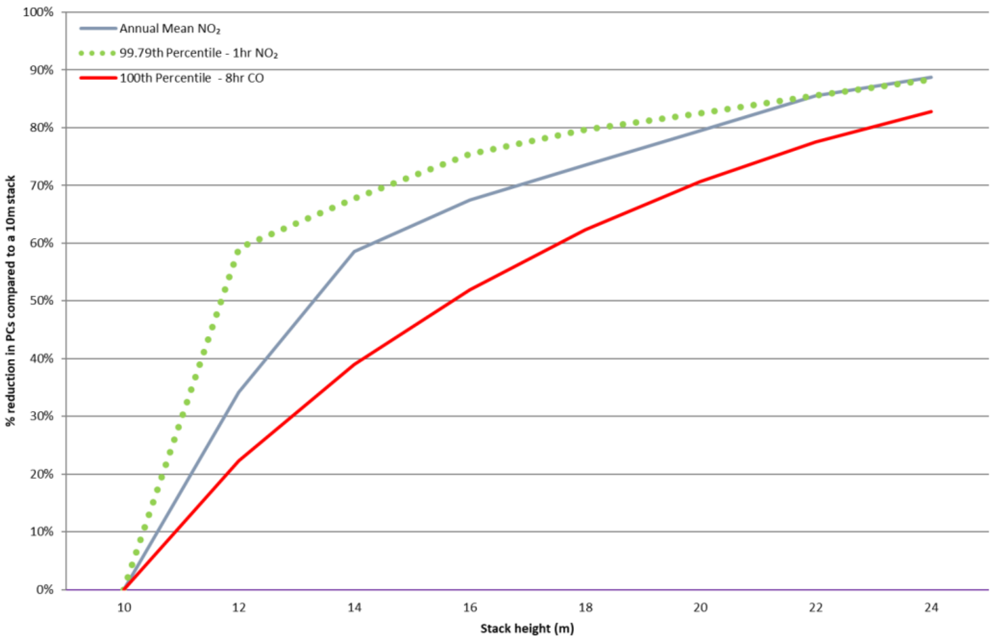


**Figure 8: Effect of Stack Height on Ground Level Concentrations, Met Year 2019**




3.2.2. Figures 4-8 indicate that increasing the stack heights of the two boilers (i.e. the one existing and the one proposed boiler), from 10m to 24m, has the effect of decreasing the modelled maximum ground level PC. The purpose of Figures 4-8 is to help determine an 'optimum' stack height by identifying a compromise between the required mitigation on impacts from air quality and the increased negative impacts of extending the stack height.

3.2.3. There would appear to be points of inflection at boiler stack heights of 12m (for all pollutants and met years assessed, with the exception of met year 2019 for CO) and at boiler stack heights of 14m (all met years for long-term $NO_2$, and met year 2017 in particular for short-term $NO_2$ and CO). These points of inflection help to demonstrate, for the relevant pollutants, the point at which continuing to increase the stack height much further would not result in a significant improvement in terms of aiding plume dispersion and lowering the predicted GLCs.

3.2.4. However, in order to determine the optimum stack height for the emission points considered, and the impact of emissions on the environment, all modelled stack heights will be assessed for impact at the maximum GLC. This will help to further assess the significance of the emissions arising from the existing boiler and the proposed boiler in accordance with the criteria (see Section 2.17.)

# 4. ASSESSMENT OF AIR QUALITY IMPACTS

## 4.1. Human Health Impacts at Maximum GLCs

4.1.1. The predicted PCs for each of the pollutants considered in the assessment at the maximum point of impact for the one existing and the one proposed boiler have been extracted and are presented in Table 14. The maximum predicted PCs are also compared to their respective AQSs.

4.1.2. Maximum concentrations are considered potentially significant if the long-term prediction is greater than 1% of the long-term AQS, and, for short-term predictions, a potentially significant concentration would be greater than 10% of the short-term AQS (see Section 2.17. of this document). In Table 14, any PCs that are above these significance criteria are indicated in bold type.

**Table 14: Comparison of Maximum PCs with Air Quality Standards**

| Pollutant | Stack Height (m) | WCMY* (2015-2019) | Max PC (µg/m³) | Location of Max PC X Coord. | Location of Max PC Y Coord. | AQS (µg/m³) | PC as % of AQS |
|---|---|---|---|---|---|---|---|
| $NO_2$ (annual) | 10 | 2017 | **23.78** | 320489 | 175704 | 40 | **59.46%** |
| | 12 | 2017 | **15.58** | 320489 | 175704 | | **38.94%** |
| | 14 | 2017 | **9.78** | 320489 | 175704 | | **24.46%** |
| | 16 | 2017 | **7.72** | 320529 | 175704 | | **19.30%** |
| | 18 | 2017 | **6.30** | 320529 | 175704 | | **15.75%** |
| | 20 | 2017 | **4.91** | 320529 | 175704 | | **12.28%** |
| | 22 | 2017 | **3.43** | 320529 | 175704 | | **8.58%** |
| | 24 | 2017 | **2.70** | 320569 | 175704 | | **6.75%** |
| $NO_2$ (1 hour, 99.79$^{th}$ percentile) | 10 | 2017 | **79.19** | 320449 | 175664 | 200 | **39.60%** |
| | 12 | 2018 | **31.85** | 320489 | 175704 | | **15.93%** |
| | 14 | 2019 | **24.50** | 320489 | 175704 | | **12.25%** |
| | 16 | 2017 | 19.08 | 320489 | 175664 | | 9.54% |
| | 18 | 2017 | 17.28 | 320489 | 175664 | | 8.64% |
| | 20 | 2017 | 14.61 | 320489 | 175664 | | 7.31% |
| | 22 | 2017 | 12.14 | 320489 | 175664 | | 6.07% |
| | 24 | 2018 | 10.03 | 320489 | 175664 | | 5.02% |
| CO (8 hour, 100th percentile) | 10 | 2019 | **1042.20** | 320449 | 175664 | 10,000 | **10.42%** |
| | 12 | 2019 | 809.56 | 320449 | 175664 | | 8.10% |
| | 14 | 2019 | 636.33 | 320449 | 175664 | | 6.36% |
| | 16 | 2019 | 501.07 | 320449 | 175664 | | 5.01% |
| | 18 | 2019 | 392.67 | 320449 | 175664 | | 3.93% |
| | 20 | 2019 | 305.32 | 320449 | 175664 | | 3.05% |
| | 22 | 2019 | 233.99 | 320449 | 175664 | | 2.34% |
| | 24 | 2019 | 179.24 | 320449 | 175664 | | 1.79% |

Notes to Table 14
*Worst Case Met Year (WCMY)
Refer to Figure 9 for a visual representation of the location of the maximum PCs for long-term $NO_2$ (that correspond with the colour coded coordinates in Table 14).

4.1.3. It can be seen from the data in Table 14 that, with the exception of 99.79$^{th}$ percentile $NO_2$ at stack heights of 16m and taller and CO at stack heights of 12m and taller, the impacts of the

PCs for the remaining pollutants and stack heights (i.e. the PCs in bold type) are potentially significant. Consequently, further assessments are required for the PCs that have not screened out.

4.1.4. For the potentially significant long-term $NO_2$ PCs, PECs must be calculated. PECs are calculated by adding the long-term process contribution to the long-term ambient background concentration. CCC undertake automatic as well as non-automatic (passive) diffusion tube ("DT") monitoring for $NO_2$ throughout the county. The nearest automatic monitoring site ("AMS") and DT $NO_2$ data to the Site (i.e. observed data) are displayed in Table 15 for 2018 (the latest available data year).

**Table 15: Nearest Monitoring Site Locations to Site[a]**

| Monitor Type | ID / Name & Pollutant Monitored | 2018 Conc. (µg/m$^3$) | Easting Coord. (X) | Northing Coord. (Y) | Distance from Source (m)[b] | Heading (°) |
|---|---|---|---|---|---|---|
| Automatic | AMS1 – Cardiff Centre AURN | 20 | 318416 | 176525 | 2193 | 292 |
| DT | 153 – Magic Roundabout | 25 | 319491 | 176183 | 1071 | 297 |

Notes to Table 15

(a) Information obtained online from CCC (*2019 Air Quality Progress Report for Cardiff Council*). Available via: https://cardiff.moderngov.co.uk/documents/s35876/Cabinet%2021%20November%202019%20Local%20Air%20Quality%20Progress%20Report%20App.pdf

(b) Distances are measured as the crow flies from the monitoring site coordinates displayed in Table 15 to the 'Source'. The 'Source' is the collective term for the approximate halfway location between the two boiler stacks (320449 (X), 175704 (Y)).

4.1.5. Annual $NO_2$ data is also available from the Department for Environment, Food and Rural Affairs ("DEFRA"), for the year 2018, with the nearest mapped modelled concentrations to Site displayed in Table 16.

**Table 16: Nearest Background DEFRA Data to Site[a]**

| Ref. | Pollutant | 2018 Annual Mean Conc. (µg/m$^3$) | Easting Coordinate (X) | Northing Coordinate (Y) | Distance from Source (m)[b] | Heading (°) |
|---|---|---|---|---|---|---|
| BN1 – NW | Annual $NO_2$ | 21.36 | 319500 | 176500 | 1239 | 310 |
| BN2 – NE | | 18.32 | 320500 | 176500 | 798 | 4 |
| BN3 – SE | | 21.06 | 320500 | 175500 | 210 | 166 |
| BN4 – SW | | 22.31 | 319500 | 175500 | 971 | 258 |

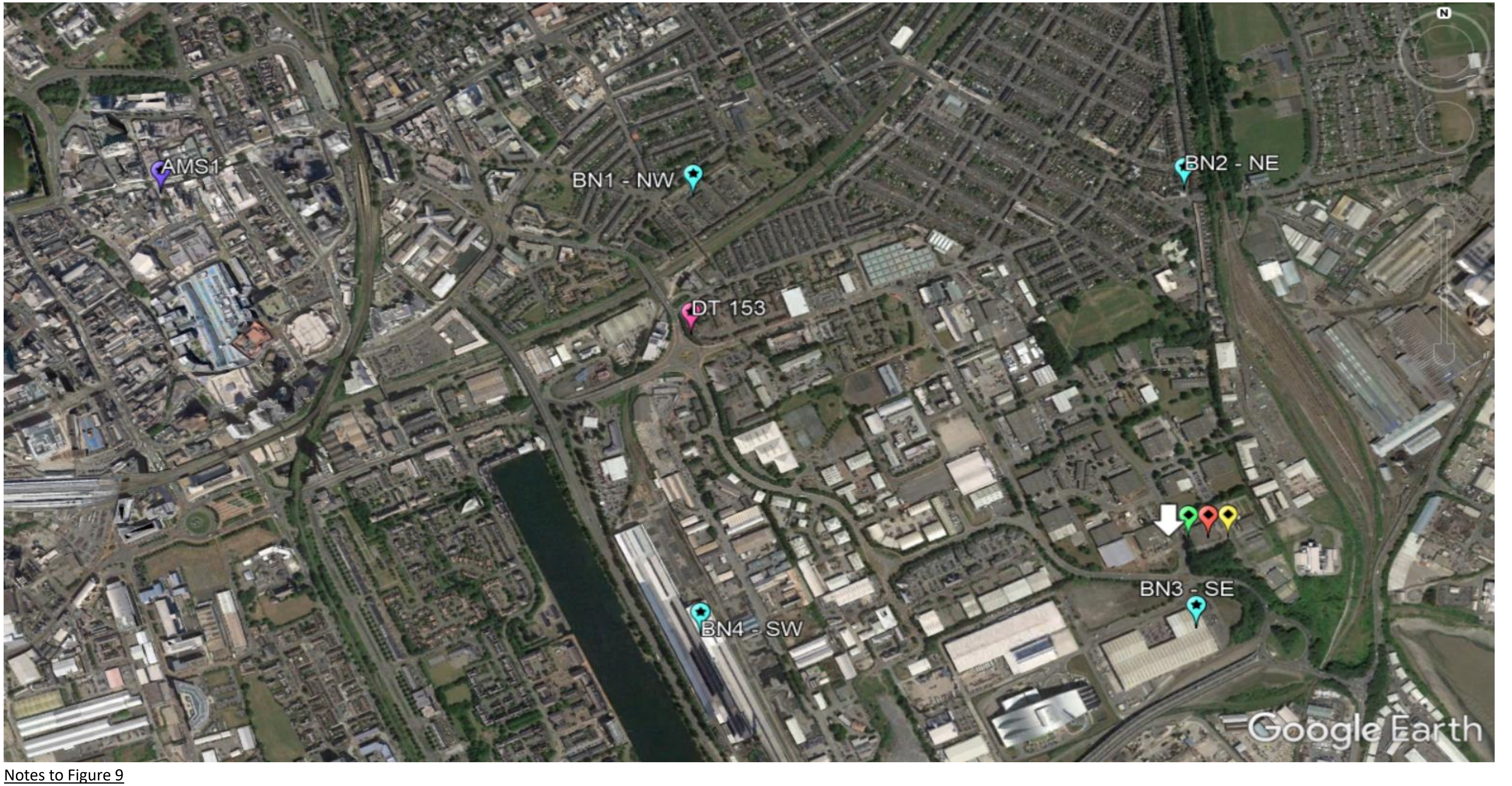
Notes to Table 16

(a) Information obtained from the latest DEFRA background pollution maps, available from: https://uk-air.defra.gov.uk/data/pcm-data.

(b) Distances are measured as the crow flies from the DEFRA coordinates displayed in Table 16 to the 'Source'. The 'Source' is the collective term for the approximate halfway location between the two boiler stacks (320449 (X), 175704 (Y)).

4.1.6. When calculating PECs, it is important to consider the location of the maximum GLC in order to assign an appropriate background concentration. The location of the maximum GLCs (PCs) for all met years for long-term $NO_2$ are displayed in Table 14. Figure 9 demonstrates the location of the nearest background sources (as outlined in Tables 15 and 16) in relation to the maximum long-term $NO_2$ PCs for the worst case met year, for each stack height assessed.

**Figure 9: Nearest Background Sources of $NO_2$ in Relation to the Maximum PC Locations for Long-Term $NO_2$**




Notes to Figure 9

The greed, red and yellow pins represent the locations of the maximum long-term $NO_2$ PCs for the stack heights assessed for the worst case met years (refer to Table 14 for further details – the colour coded coordinates in Table 14, for long-term $NO_2$, correspond to the colour coded icons displayed in Figure 9);

The white arrow is the approximate location of where the existing and proposed boiler stacks are situated (two in total); and

The blue, pink and purple annotated icons represent the locations of the nearest sources of background $NO_2$ concentrations (refer to Tables 15 and 16 for details).

4.1.7. It can be seen from Figure 9 that the maximum PCs, for all stack heights assessed (for the worst case met years) are all closest in proximity to the DEFRA modelled background location BN3 - SE (refer to Table 16 for further details). This site had a 2018 annual $NO_2$ concentration of 21.06 $\mu g/m^3$ (or 53% of the AQS).

4.1.8. Consequently, for the purposes of calculating the PECs for long-term $NO_2$, at the maximum point of impact, the DEFRA modelled background location, BN3 – SE, will be used as the source of the background concentration. The PEC assessment for long-term $NO_2$ is provided in Table 17. The PECs calculated have been compared with the relevant long-term AQS and the significance categorised adopting the IAQM guidance and impact descriptors shown in Table 12 of Section 2.17.4.4.

**Table 17: Comparison of Maximum PCs and Maximum PECs with AQS**

| Pollutant | Stack Height (m) | WCMY* (2015 – 2019) | Max PC (µg/m³) | AQS (µg/m³) | PC as % of AQS | Location of Max PC X Coord. | Location of Max PC Y Coord. | 2018 Annual Background $NO_2$ Concentration (µg/m³) | Max PEC (µg/m³) | PEC as % of AQS | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $NO_2$ (annual) | 10 | 2017 | **23.78** | 40 | **59.46%** | 320489 | 175704 | 21.06 | 44.84 | 112.11% | **Substantial** |
| | 12 | 2017 | **15.58** | | **38.94%** | 320489 | 175704 | | 36.64 | 91.59% | **Moderate** |
| | 14 | 2017 | **9.78** | | **24.46%** | 320489 | 175704 | | 30.84 | 77.11% | **Moderate** |
| | 16 | 2017 | **7.72** | | **19.30%** | 320529 | 175704 | | 28.78 | 71.95% | **Moderate** |
| | 18 | 2017 | **6.30** | | **15.75%** | 320529 | 175704 | | 27.36 | 68.40% | **Moderate** |
| | 20 | 2017 | **4.91** | | **12.28%** | 320529 | 175704 | | 25.97 | 64.93% | **Moderate** |
| | 22 | 2017 | **3.43** | | **8.58%** | 320529 | 175704 | | 24.49 | 61.23% | Slight |
| | 24 | 2017 | **2.70** | | **6.75%** | 320569 | 175704 | | 23.76 | 59.40% | Slight |

Notes to Table 17

*Worst Case Met Year (WCMY)

Background source – DEFRA BN3 - SE (2018 data). Refer to Table 16 in Section 4.1.5. for further details.

4.1.9. It can be seen from the data in Table 17, that the PECs of long-term $NO_2$ emissions arising from the one existing and the one proposed boiler can be considered 'Substantial' for stack heights of 10m, 'Moderate' for stack heights of 12m to 20m (inclusive) and 'Slight' for stack heights of 22m and 24m. This categorisation of the impacts has been carried out in accordance with the impact descriptors outlined in the IAQM (2017) guidance (refer to Table 12 of Section 2.17.4.4. for details).

4.1.10. It should be noted that, when using the EA online guidance for screening assessments for emissions to air, further detailed modelling is not required if PECs are less than 70% of the long-term AQS. Based on that guidance, the PECs of long-term $NO_2$ for stack heights of 18m and taller (for the existing and proposed boiler flues) would be considered not significant.

4.1.11. Following discussions with Princes in August 2020, it is anticipated that a further package boiler (identical to the current proposed boiler considered in this assessment) could potentially be installed in the future to allow for expansion and operational flexibility on-site. Subsequently, an investigatory scenario was modelled to ascertain the maximum GLCs associated with three emission points (i.e. the one existing boiler and two identical proposed boilers) operating simultaneously. As part of this investigation a building screening and a stack height screening assessment was undertaken. The results of the investigatory modelled runs demonstrated that the recommended minimum stack heights to adopt, for all three flues, should be at least 20m.

4.1.12. It is considered that opting for 20m high stacks, over 18m stacks, for this investigation (i.e. the one existing and the one proposed boiler) should also help to future proof the suitability of these flue heights in the event that one further emission point is proposed (which would subsequently require additional air quality assessments to be undertaken).

4.1.13. Consequently, as the nearest tallest building to the existing and the proposed boiler is approximately 14m high (refer to Section 2.12. for further details on the Site's building layout and dimensions), the long-term $NO_2$ PECs are less than 70% of the AQS at stack heights of 18m and taller and stack heights of 20m and taller are also suitable when modelling three boilers concurrently (when taking existing ambient air quality data into consideration) - stack heights of 20m can be considered appropriate for the existing and proposed boiler flues.

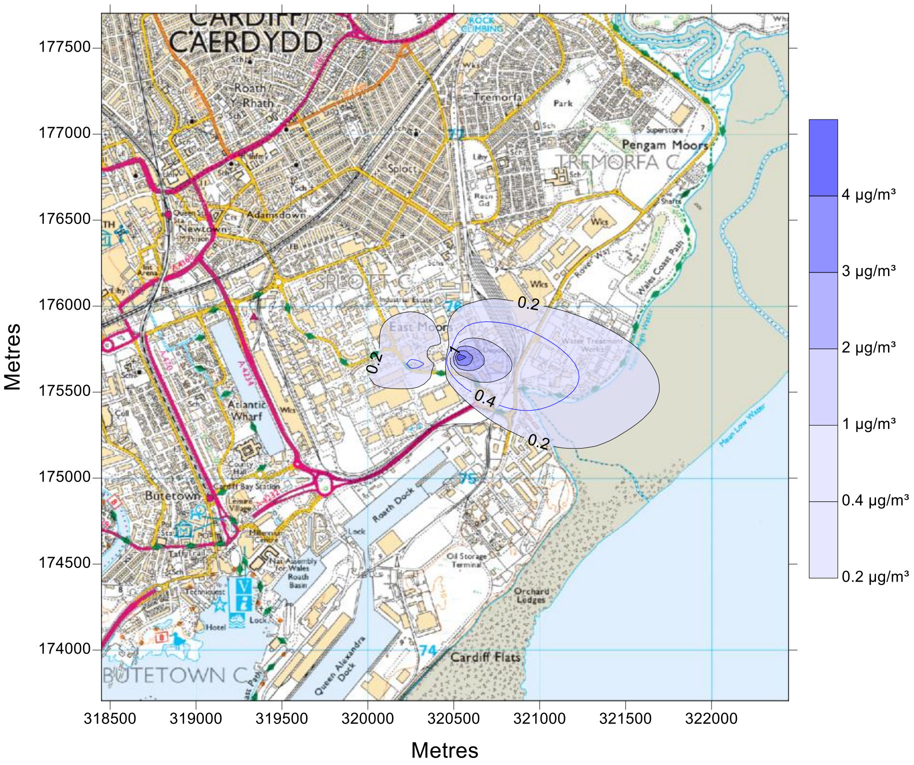
4.1.14. The significance of the impact of the potentially significant short-term $NO_2$ and CO PCs (as shown in Table 14) therefore screen out as being insignificant at modelled boiler stack heights of 20m (i.e. the PCs are less than 10% of the relevant AQS).

4.1.15. Based on the results of the significance assessment of the worst-case PCs, at the maximum point of impact, boiler stack heights of 20m will be used from this point forward for the impact assessment at the potentially sensitive human receptors locations and at the ecological sites (as outlined in Tables 1 and 2 of Sections 2.3. and 2.4., respectively).

## 4.2. Isopleths

4.2.1. The isopleths for long-term and short-term $NO_2$ and CO, at stack heights of 20m, are presented as Figures 10 to 13 for the worst case met years (2017, 2017 and 2019, respectively).

## Figure 10: Isopleth for Long-Term $NO_2$, Met Year 2017




## Figure 11: Isopleth for Short-Term $NO_2$, Met Year 2017

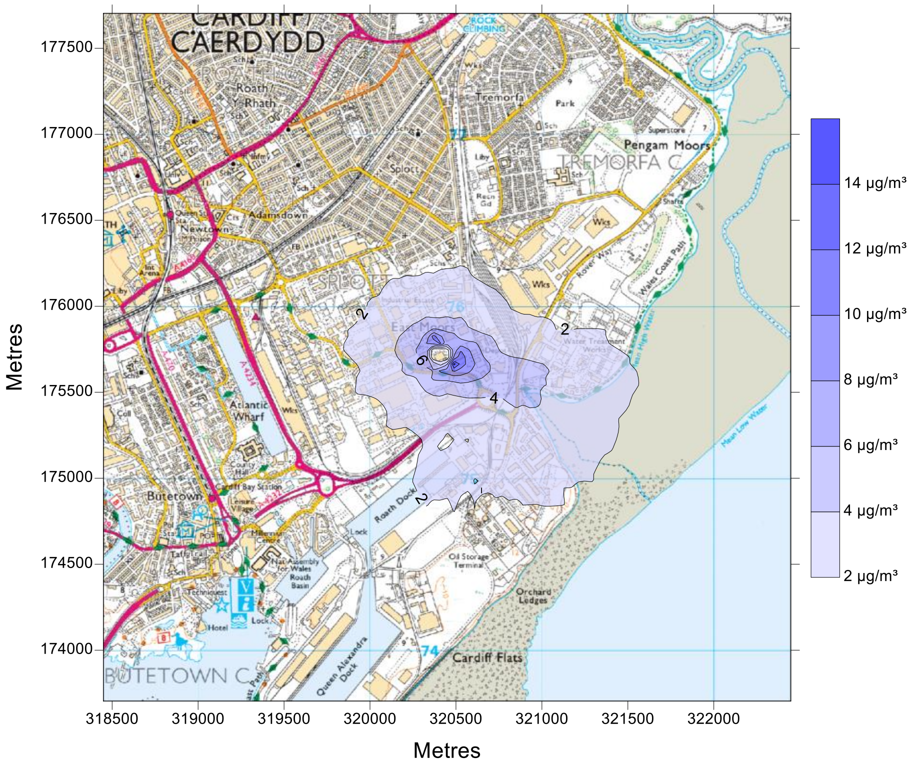
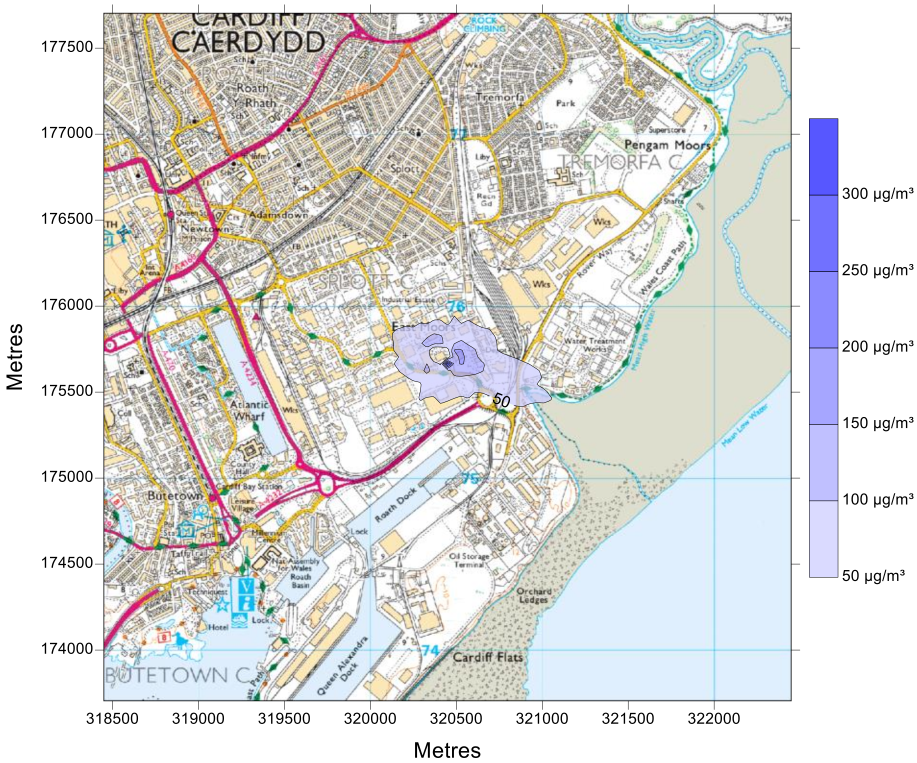


**Figure 12: Isopleth for CO, Met Year 2019**






ECL Ref: ECL.046.01.01/ADM
August 2020
Issue: 1(a)

# 5. ASSESSMENT OF AIR QUALITY IMPACTS AT POTENTIALLY SENSITIVE HUMAN RECEPTOR LOCATIONS

## 5.1. Human Health Impacts at the Specified Receptors

5.1.1. This part of the assessment considers emissions from the Site for emissions of $NO_X$ as $NO_2$ and CO at potentially sensitive human receptor locations.

5.1.2. The PCs from the one existing and the one proposed boilers for each sensitive receptor considered, for the worst case met year for each pollutant and averaging period, are presented in Table 18.

5.1.3. In Table 18, any PCs that are above the significance criteria (outlined in Section 2.17.) are indicated in bold type.

**Table 18: Comparison of Maximum PCs with AQS at Sensitive Receptor Locations**

| Pollutant | | $NO_2$ (annual mean) | $NO_2$ (99.79$^{th}$ %ile) | CO (8hour) |
|---|---|---|---|---|
| **AQS (µg/m$^3$)** | | 40 | 200 | 10,000 |
| **Maximum PC (µg/m$^3$)** | | 0.316 | 2.51 | 37.8 |
| **Max PC as % of AQS** | | 0.79% | 1.25% | 0.38% |
| HSR1 | Industrial estate | 0.107 | 2.51 | 37.8 |
| HSR2 | Mary Price Court | 0.0789 | 1.76 | 25.9 |
| HSR3 | Moorland Primary School | 0.0840 | 1.80 | 21.0 |
| HSR4 | Industrial estate | 0.316 | 2.35 | 29.3 |
| HSR5 | Youth club and sporting grounds | 0.0954 | 1.58 | 21.4 |
| HSR6 | Apartments, Bute East Dock | 0.108 | 1.14 | 20.3 |
| HSR7 | Holiday Inn | 0.102 | 1.03 | 12.4 |
| HSR8 | Willows High School | 0.0448 | 0.904 | 10.8 |
| HSR9 | St Cuthbert's School | 0.0746 | 0.859 | 9.70 |
| HSR10 | Travellers' site | 0.0339 | 0.642 | 6.89 |
| AQMA1 | Stephenson Court AQMA | 0.0269 | 0.736 | 8.58 |
| AQMA2 | Cardiff City Centre AQMA | 0.0219 | 0.538 | 7.48 |

5.1.4. It can be seen from the results in Table 18 that all pollutants screen out (in accordance with the criteria outlined in Section 2.17.) for both the specified potentially sensitive human receptors and the AQMA locations considered. Consequently, no further assessments are required.

# 6. ASSESSMENT OF AIR QUALITY IMPACTS AT SENSITIVE ECOLOGICAL RECEPTOR LOCATIONS

## 6.1. Comparison of Maximum Predicted Ground Level Concentrations with Critical Levels for the Protection of Vegetation and Ecosystems - $NO_x$

6.1.1. This part of the assessment considers emissions from the Site for emissions of $NO_X$ at the designated ecological receptors within the relevant search criteria.

6.1.2. A summary of the results of the maximum predicted GLCs of oxides of nitrogen, at the identified sensitive ecological sites, are presented in Table 19. In accordance with the H1 guidance (and as stated in Section 2.18.1) the significance of the impacts has been determined using the 1% and 10% criteria for long and short-term predictions, respectively, for SPAs, SACs, Ramsar sites and SSSIs. As outlined in Section 2.18.2., the 100% criteria for long and short-term predictions has been used for the local nature sites. Any potentially significant PCs have been indicated in bold type.

**Table 19: Comparison of Maximum Predicted $NO_x$ PCs with Critical Levels at Sensitive Ecological Sites**

| ADMS Ref. | Long Term PC (µg/m³) | Long Term Critical Level (CL) (µg/m³) | Long Term PC as a % of the CL (µg/m³) | Short Term PC (µg/m³) | Short Term Critical Level (CL) (µg/m³) | Short Term PC as a % of the CL (µg/m³) | Worst Case Met Year for Long-Term PCs | Worst Case Met Year for Short-Term PCs |
|---|---|---|---|---|---|---|---|---|
| SE1 | **0.360** | 30 | **1.20%** | 2.59 | 75 | 3.45% | 2017 | 2019 |
| SE2 | 0.0588 | | 0.20% | 0.916 | | 1.22% | 2018 | 2018 |
| SE3 | 0.0616 | | 0.21% | 0.491 | | 0.65% | 2015 | 2015 |
| CBW1 | 0.00241 | | 0.01% | 0.0698 | | 0.09% | 2019 | 2019 |
| LNR1 | 0.0518 | | 0.17% | 0.709 | | 0.95% | 2018 | 2019 |
| LWS1 | 0.881 | | 2.94% | 6.12 | | 8.16% | 2017 | 2019 |
| LWS2 | 0.141 | | 0.47% | 3.21 | | 4.28% | 2019 | 2019 |
| LWS3 | 0.167 | | 0.56% | 1.97 | | 2.62% | 2017 | 2015 |
| LWS4 | 0.0466 | | 0.16% | 0.590 | | 0.79% | 2017 | 2016 |
| LWS5 | 0.0575 | | 0.19% | 0.885 | | 1.18% | 2018 | 2018 |
| LWS6 | 0.0445 | | 0.15% | 0.582 | | 0.78% | 2018 | 2019 |

6.1.3. It can be seen from the data in Table 19 that, for the sites with one or all of the following designations: SAC, SPA, SSSI and Ramsar - i.e. SE1-SE3 and CBW1; the annual mean oxides of nitrogen PCs are less than 1% of the critical level for all sites except SE1. Similarly, daily mean oxides of nitrogen PCs are all less than 10% of the critical level at these sites, and are therefore not significant (refer to Section 2.18.1.).

6.1.4. For the remaining sites (i.e. the local wildlife sites) the results in Table 19 show that the PCs are all less than 100% of the long-term and short-term critical levels (refer to Section 2.18.2.) and consequently no further assessment is required.

6.1.5. For the worst-case long-term PC on SE1, the impact is potentially significant. Consequently, for this ecological site, the PEC will need to be calculated. As displayed in Table 6 of Section 2.7.1, the background $NO_X$ concentration at SE1 is 21.89 µg/m$^3$ – the PEC would therefore be 22.25 µg/m$^3$ (or 74.17% of the critical level). In accordance with the IAQM impact descriptors displayed in Table 12 of Section 2.17.4.4., the significance of the long-term $NO_X$ PC on the critical level can therefore be categorised as 'Negligible'. Subsequently, no further assessments are required.

# 7. ASSESSMENT OF AIR QUALITY IMPACTS - IMPACT ON HABITAT SITES – DEPOSITION

## 7.1. Comparison of Maximum Predicted Nutrient Nitrogen Deposition Rates with Critical Loads

7.1.1. A summary of maximum predicted total (wet and dry) nutrient nitrogen deposition rates at the identified habitat sites are presented in Table 20. It should be noted that due to the number of ecological sites and the number of habitats being considered, the habitat with the lowest lower critical load has been selected.

7.1.2. Where the nitrogen deposition rate is significant - i.e. greater than 1% of the maximum critical load, it is highlighted in bold.

Table 20: Comparison of Maximum Predicted Nutrient Nitrogen Deposition Rates with Critical Loads at Sensitive Habitat Sites

| ADMS Ref. | Description | Habitat Type | Deposition Rate Used | Critical Load (kgN/Ha/yr)) | | Nutrient Nitrogen Deposition Rate (kgN/Ha/yr)[a] | Percentage of Critical Load (%) | |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower | Upper | | Lower | Upper |
| SE1 | Severn Estuary - Ramsar | Coastal saltmarsh / Estuaries | Grassland | 20 | 30 | 0.0620 | 0.31% | 0.21% |
| SE2 | | | | | | 0.0104 | 0.05% | 0.03% |
| SE3 | | | | | | 0.0185 | 0.09% | 0.06% |
| SE1 | Severn Estuary - SAC | Atlantic Salt Meadows / Estuaries | Grassland | 20 | 30 | 0.0620 | 0.31% | 0.21% |
| SE2 | | | | | | 0.0104 | 0.05% | 0.03% |
| SE3 | | | | | | 0.0185 | 0.09% | 0.06% |
| SE1 | Severn Estuary – SPA | Common Shelduck, Common Redshank, Greater White-Fronted Goose | Grassland | 20 | 30 | 0.0620 | 0.31% | 0.21% |
| SE2 | | | | | | 0.0104 | 0.05% | 0.03% |
| SE3 | | | | | | 0.0185 | 0.09% | 0.06% |
| SE1 | Severn Estuary - SSSI | Fed, Marsh and Swamp | Grassland | 15 | 30 | 0.0620 | 0.41% | 0.21% |
| SE2 | | | | | | 0.0104 | 0.07% | 0.03% |
| SE3 | | | | | | 0.0185 | 0.12% | 0.06% |
| CBW1 | Cardiff Beech Woods - SAC | Fagus Woodland | Woodland | 10 | 20 | 0.00126 | 0.01% | 0.01% |

Note to Table 20

(a) Total process contribution to acid deposition is derived from the sum of the contribution due to $NO_2$.

7.1.3. It can be seen from the data in Table 20, that the maximum nutrient nitrogen deposition rates due to process emissions do not exceed 1% of the lower or upper critical load for all ecological sites considered. Consequently, no further assessment is required.

## 7.2. Comparison of Maximum Predicted Acid Deposition Rates with Critical Loads

7.2.1. A summary of maximum predicted acid deposition rates at the relevant identified habitat sites are presented in Table 21. It should be noted that due to the number of ecological sites and the number of habitats being considered, the habitat with the lowest maximum critical load has been selected.

7.2.2. Where the acid deposition rate is potentially significant (i.e. greater than 1% of the maximum critical load) it is highlighted in bold.

**Table 21: Comparison of Maximum Predicted Acid Deposition Rates with the Maximum Critical Load at Sensitive Habitat Sites**

| Habitat Ref. [a] | Deposition Rate Used [b] | Acid Deposition (kEq/ha/yr) PC N | CL Min N (kEq/ha/yr) | CL Max N (kEq/ha/yr) | CL Max S (kEq/ha/yr) | PEC N (kEq/ha/yr) [c] | Total PC as a Percentage of the Critical Load Function[d] |
|---|---|---|---|---|---|---|---|
| SE1 – SE3 - Ramsar | Habitat not sensitive to acidification | | | | | | |
| SE1 – SE3 - SAC | Habitat not sensitive to acidification / or no critical loads set | | | | | | |
| SE1 – SE3 - SPA | Habitat not sensitive to acidification / no expected negative impact | | | | | | |
| SE1 - SSSI | Grassland | 0.00584 | 0.223 | 1.06 | 0.840 | 0.946 | 0.55% |
| SE2- SSSI | | 0.000978 | | | | 0.941 | 0.09% |
| SE3- SSSI | | 0.00175 | | | | 0.942 | 0.16% |
| CBW1 - SAC | Forest | 0.000119 | 0.142 | 1.43 | 1.29 | 1.51 | 0.01% |

Note to Table 21

(a) Refer to Table 2 in Section 2.4. for receptor names and designations.
(b) Refer to Table 8 in Section 2.8.2. for deposition parameters.
(c) Refer to Table 7 in Section 2.7.2. for the site-specific acid deposition background concentrations.
(d) Total PC to acid deposition is derived from the sum of PC N (where PC N is the sum of $NO_2$ deposition).

7.2.3. The data is Table 21 shows, that where the habitat is sensitive to acid deposition, the maximum predicted acid deposition rate, as a result of emissions from the two boiler stacks at the Site (i.e. the one existing the one proposed boiler), does not exceed 1% of the critical load function. Consequently, no further assessments are required.

# 8. CONCLUSIONS

8.1.1. Detailed air quality modelling using the ADMS dispersion model has been undertaken to predict the impacts associated with stack emissions from Princes Cardiff. This has been carried out for both the one existing boiler and the one proposed boiler operating simultaneously.

8.1.2. A detailed screening assessment has been carried out to derive conservative assumptions for the assessment and to determine the optimum discharge stack heights for the existing and the proposed boiler flues. It has been considered that 20m high stacks for both boiler flues (i.e. for the one existing and the one proposed boiler) will facilitate both adequate dispersion of the combustion emissions as well as affording a level of future-proofing of the proposed stack heights, should Princes look to add one additional emission point (i.e. another identical boiler to the one currently proposed) in the vicinity of the boiler house (it is anticipated that, in such an event, the impact of the cumulative emissions would need to be investigated via means of further air quality assessments).

8.1.3. The assessment at maximum predicted GLCs (PCs), at boiler stack heights of 20m, showed that the long-term $NO_2$ PC would see the impact regarded as 'Moderate' and that the short-term $NO_2$ and CO PCs could be considered insignificant.

8.1.4. The assessment at the potentially sensitive human receptor locations has demonstrated that the impact of the predicted PCs can be considered insignificant for all the pollutants considered at all of the human receptors and AQMA sites assessed.

8.1.5. For the potentially sensitive ecological sites, the assessment has demonstrated that the impact from the Site is unlikely to result in a breach of the relevant Critical Levels or Critical Loads, or have a detrimental effect on local habitat sites. Where further screening was carried out (i.e. for SE1, Severn Estuary) it has been demonstrated that the impact could be regarded as 'Negligible'.

8.1.6. It should be emphasised that the emissions rates have been calculated at a worst-case scenario basis of being emitted from the two boiler stacks twenty-four hours a day, 365 days of the year. This represents a conservative assessment which assumes both emission points assessed will release to atmosphere at the maximum proposed ELVs continuously throughout the year.

8.1.7. In reality during normal operation, and when scheduled and unscheduled maintenance is taken into account, it is considered the predicted mean pollutant concentrations for each pollutant assessed would be smaller. Consequently, during normal day to day operation, maximum GLCs are likely to be less and the significance of the impact lower as a result.

8.1.8. In summary, therefore, it can be concluded that emissions arising from the existing and the proposed boiler flues at Princes, Cardiff, will not have a detrimental impact on local air quality, human health, sensitive habitat sites or on the AQMAs assessed.