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NUCLEAR POWER

WYLFA NEWYDD

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Wylfa Newydd Project

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Horizon Nuclear Power

Wylfa Newydd

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Amec Foster Wheeler Environment & Infrastructure UK Limited

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1. Introduction

1.1 Purpose of this report

This Report for Horizon Nuclear Power Wylfa Ltd has been produced for the purposes of providing the methodology and results associated with the detailed dispersion modelling study to determine the air quality impacts arising from combustion emissions during the main construction phases of the Wylfa Newydd Project on the Isle of Anglesey. The assessment has considered emissions from:

- Non-road mobile machinery (NRMM) deployed across the Wylfa Newydd Development Area during earthworks, major excavations and construction;
- Marine vessels involved in construction of the Marine Offloading facility (MOLF) and in delivering materials and components to the site; and
- Road traffic movements on the A5025 associated with the construction activity.

The aim of this modelling assessment is to provide an indication of which, if any, human and ecological receptors are adversely affected by these stages of the development, and thereby support the impact assessment team to identify if mitigation is required to lessen these effects. Discussion on significance of effects and requirements for mitigation is, however, outside the scope of this report. The report presents a factual account of the modelling methodology and results of the modelling without interpretation or assessment of significance.

Where data has not yet been established at this stage of the design, assumptions based on best practice or typical values have been adopted.

1.2 Terms and definitions

Table 1.1 Terms and definitions

Term	Definition
AADT	Annual Average Daily Traffic
AAHT	Annual Average Hourly Traffic
ADMS	Atmospheric Dispersion Modelling System
AERMIC	American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee
AMS	American Meteorological Society
APIS	Air Pollution Information System
AOD	Above Ordnance Datum
AQO	Air Quality Objective
CBL	Convective Boundary Layer
CERC	Cambridge Environmental Research Consultants
CO	Carbon Monoxide
CURED	Calculator Using Realistic Emissions for Diesels
Defra	Department for Environment, Food and Rural Affairs

Term	Definition
EFT	Emissions Factor Toolkit
GIS	Geographical Information System
LAQM	Local Air Quality Management
MOLF	Marine Offloading Facility
NO_x	Oxides of Nitrogen
NO_2	Nitrogen Dioxide
NRMM	Non-Road Mobile Machinery
NWP	Numerical Weather Prediction
O3	Ozone
OS	Ordnance Survey
PBL	Planetary Boundary Layer
PC	Process Contribution
PEC	Predicted Environmental Concentration
$PM_{2.5}$	Particulate matter less than 2.5 micrometres in diameter
PM_{10}	Particulate matter less than 10 micrometres in diameter
SO_2	Sulphur Dioxide
USEPA	United States Environmental Protection Agency

2. Methodology

2.1 Air pollutants considered

The construction plant will emit a number of pollutants of concern, including oxides of nitrogen (NOx, consisting of nitrogen monoxide (NO) and nitrogen dioxide (NO_2)), particulates (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2) and carbon monoxide (CO) and these pollutants are the focus of this assessment. NOx and SO_2, in turn, contribute to nitrogen and acid deposition with the assessment aiming to quantify the additional contribution to background deposition levels as a result of additional emissions of these specific pollutants.

2.2 Selection of dispersion model

Modelling of emissions from NRMM and marine plant

There are two primary dispersion models which have been used extensively throughout the UK for assessing the air quality impacts arising from developments of this nature and which are accepted as appropriate air quality modelling tools by regulators and local planning authorities alike:

- The ADMS model, developed in the UK by Cambridge Environmental Research Consultants (CERC) in collaboration with the Meteorological Office, National Power and the University of Surrey; and
- The AERMOD model, developed in the United States by the American Meteorological Society (AMS)/United States Environmental Protection Agency (USEPA) Regulatory Model Improvement Committee (AERMIC).

Both models are termed 'new generation' models, parameterising stability and turbulence in the planetary boundary layer (PBL) by the Monin-Obukhov length[1] and the boundary layer depth[2]. This approach allows the vertical structure of the PBL to be more accurately defined than by the stability classification methods of earlier Gaussian-type dispersion models such as R91[3] or ISC[4]. Like R91 and ISC, ADMS and AERMOD adopt a symmetrical Gaussian profile of the concentration distribution in the vertical and crosswind directions in neutral and stable conditions. However, unlike R91 or ISC, the ADMS and AERMOD vertical concentration profile in convective conditions adopts a skewed Gaussian distribution to take account of the heterogeneous nature of the vertical velocity distribution in the Convective Boundary Layer (CBL).

Numerous model inter-comparison studies have demonstrated little difference between the output of ADMS and AERMOD, except in certain complex terrain scenarios[5]. For the purposes of this particular study, ADMS (Version 5.2) has been selected as the most appropriate model to use. The justification for this selection is provided below.

ADMS is capable of calculating sub-hourly averaged concentrations based on site-specific meteorological and surface conditions, whereas AERMOD can only produce output down to hourly-averaged values. Therefore, to enable an assessment of impact against the 15-minute mean SO_2 air quality objective (AQO), a standard conversion factor (1.34) must be applied to the hourly output from AERMOD to approximate 15-minute mean concentrations. This factor is taken from Turner (1994)[6] who published estimated ratios of calculated peak and mean concentrations at 3 minutes, 15 minutes, 1 hour, 3 hours and 24 hours from published data on lateral and vertical diffusion coefficients in steady winds as reported by Nonhebel (1960)[7].

[1] A measure of the effects of buoyancy on turbulent flows, particularly in the lower tenth of the atmospheric boundary layer.
[2] The lowest layer of the atmosphere in which turbulent motion, influenced by the earth's surface processes, affects the dispersion and dilution of emitted material.
[3] https://admlc.files.wordpress.com/2014/05/r91.pdf
[4] https://www3.epa.gov/scram001/userg/regmod/isc3v1.pdf
[5] Carruthers et al., 2011. 'Comparison of the complex terrain algorithms incorporated into two commonly used local-scale air pollution dispersion models (ADMS and AERMOD) using a hybrid model.' J. Air Waste Manag. Assoc., 61, 1227-35
[6] Turner, B., 1994. 'Workbook of Atmospheric Dispersion Estimates.'
[7] Nonhebel, G., 1960. 'Recommendations on Heights for Industrial Chimneys.' J. Inst. Fuel 33, 479-513

What is important to note here is that these estimates were based upon calculated dispersion coefficients, rather than monitoring results. Furthermore, Turner (1994) cautions that:

"...*ratios of peak to mean data depend also on the stability of the atmosphere and the type of terrain that the plume is passing over*."

Therefore, application of a standard, non-site specific conversion factor that does not have its basis in monitored data would significantly increase the uncertainty in modelled 15-minute mean values obtained from AERMOD. This limitation is not present in ADMS, which uses site-specific meteorological and surface conditions to directly calculate sub-hourly averaged concentrations.

For incorporation of terrain effects, AERMOD adopts a basic treatment of topographical effects on pollutant dispersion, using a dividing streamline approach, with the receptor concentration being a weighted average of the contribution from a horizontal plume and a terrain following-plume. ADMS, however, through its FLOWSTAR sub-routine, explicitly calculates the 3-dimensional flow field over terrain, allowing more advanced treatment of dispersion in areas of complex terrain. The overly-pessimistic approach of AERMOD in areas of complex terrain has been discussed by Carruthers et al (2011) who concluded:

"...where there is plume impaction AERMOD has a tendency to overestimate concentrations and, therefore, may act as a screening model in this case, whereas ADMS may predict more realistic concentrations."

Although Carruthers et al (2011) acknowledge that both models appeared to perform reasonably when compared to measurements at the six specific monitoring sites in one of the case studies reviewed (the Clifty Creek case), they also state that:

"…although both models appear to perform reasonably, the comparisons provide relatively little insight into how well the two models are taking account of the impacts of the complex terrain because other factors such as differences in input meteorology arising from the two meteorological pre-processors may cause the model differences between the data and model predictions."

Furthermore, as stated in Carruthers et al (2011), only ADMS could replicate the higher predicted concentrations as a result of the reduction in speed and streamline divergence across the valley, with associated increase in speed and streamline convergence towards the downwind edge of the valley, demonstrated in field studies of air flow by Wiggs et al (2002)[8] and Mason (1987)[9].

Modelling emissions from road traffic

This study uses the ADMS Roads version 4.1.1 model, with version 7.0 of the Emission Factors Toolkit (EFT) [10] supported by the Calculator Using Realistic Emissions for Diesels (CURED)[11] version 2A to quantify the contribution from on-road vehicles on the A5025. Emission from on-road vehicles have been explicitly modelled for those receptors within 200 m of the A5025 and in close proximity to the Wylfa Newydd Development Area in order to more accurately predict the combined impacts of construction plant and on-road vehicle emissions at these receptors during operation of the Wylfa Newydd Project.

Further information on the methodology for modelling vehicle emissions from traffic on the A5025 can be found in appendix C4-01 of the Environmental Statement.

2.3 Emissions and assessment scenarios

Wylfa Newydd Development Area

Construction work on the Wylfa Newydd Development Area is programmed to last several years. Major activities include construction of a MOLF to facilitate import of materials and equipment, deep excavations and earth moving, and building construction. Sources of emissions to air associated with construction activities include exhaust emissions from NRMM, marine construction plant and marine vessels on site,

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[8] Wiggs, G.F.S.; Bullard, J.E.; Garvey, B. and Castro, I., 2002. 'Interactions between Airflow and Valley Topography with Implications for Aeolian Sediment Transport' Phys. Geogr. 23, 366-380.
[9] Mason, P.J., 1987. 'Diurnal Variations in Flow over a Succession of Ridges and Valleys' Q. J. R. Meteorol. Soc. 113, 1117-1140.
[10] https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html
[11] http://www.aqconsultants.co.uk/News/August-2016/Updated-CURED-to-V2A.aspx

related road traffic (both transporting plant and materials and worker commuting) and fugitive dust emissions from exposed ground. Fugitive dust emissions from construction activities are not considered in this report: an assessment of these can be found in Chapter D5 of the Environmental Statement.

Two stages of the construction activity have been assessed, each lasting twelve months:

- The period October 2019–September 2020[12] which represents the peak earth-moving and excavation phase; and
- The period January–December 2023 which represents the peak construction phase.

These scenarios have been chosen based on best available information provided by Horizon regarding likely timescales and activities that are due to take place.

Road traffic – A5025

Information on the assessment scenarios for road traffic emissions can be found in appendix C4-01 of the Environmental Statement.

2.4 Emission calculation methodology

NRMM

Emission limits for NRMM depend on the age of the equipment, with regulations specifying tighter standards as new plant items enter into service. Stage IIIB standards, as specified in the Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) Regulations 1999, as amended, were enacted for new plant in the UK between January 2011 and January 2013, depending upon engine power rating, and the Stage IV standards were enacted in January and October 2014 for new plant. These standards provide limits on emissions for carbon monoxide, nitrogen oxides and particulate matter. It is not yet clear what the age structure of the construction plant complement will be at the time construction activities take place in 2019/2020 and 2023, so two bounding cases have been modelled which do not take into account the practicalities (i.e. availability of plant) or cost of deploying such plant for the Wylfa Newydd Project:

- All plant is assumed to meet Stage IIIB standards; and
- All plant is assumed to meet Stage IV standards.

For the Stage IV calculations, engines with power ratings between 37 kW and 56 kW were assumed to meet the appropriate Stage IIIB standards (there are no new Stage IV standards for this power range). Engines with power ratings above 560 kW were assumed to meet the standard for 560 kW engines. Emission factors for sulphur emissions were calculated using the Stage IIIB standards for specific fuel consumption[13] and the sulphur content of the diesel fuel, assumed to be ultra-low sulphur diesel (10 ppm or 0.001% sulphur w/w).

Further information on construction phase input information can be found in Appendix A.

The construction data provided by Horizon gave a list of plant items with their power ratings, their daily hours of use (including breaks), the number of plant items in use in each month, and the work areas in which they would be operating. The work areas were defined on drawings provided by Horizon (see data in Appendix A and Figure A1). It was assumed that emissions are spread uniformly across each work area. For modelling in ADMS, it was necessary to divide each work area into a number of convex polygons; this entailed slightly simplifying the shape of the work areas, but care was taken to ensure that the boundary was accurately captured close to sensitive receptors or, to ensure conservatism, the boundary was slightly closer to receptors than the actual working area. These polygons are shown in Figure 2.1.

[12] Strictly speaking, annual mean concentrations for assessment against air quality limit values should be based on calendar years. However, in this case, the split year covers the period of greatest activity, according to the programme, and is therefore a worst case.
[13] http://www.bafu.admin.ch/publikationen/publikation/01003/index.html?lang=en (pg 126)

Emissions were calculated for each of the convex polygons within each work area, for each hour of the year. The procedure may be represented by the following pseudocode[14] (Box 1):

Box 1 Emissions Calculation Procedure

For each emissions standard (Stage IIIB or Stage IV):

  For each convex polygon:

    For each day of the year:

      For each hour of the day:

        For each plant item:

          If this plant item operates within the work area containing this convex polygon, during the month containing this day of the year, and during this hour of the day, then:

            Emission rate (g m^{-2} s^{-1}) = operating power (kW) × emission factor (g kWh^{-1}) × number of plant items / 3600 (s h^{-1}) / area of work area (m^2).

        Sum over all plant items and output total emission rate for this convex polygon for this hour of the year.

In the above algorithm, the operating power is calculated from the rated power by assuming that equipment is working at 80% full power (working load) for a fraction of its working hours (ranging from 10% of working hours to 100% of working hours dependent on the type of equipment and activity) and at 20% full power (idle load) for the remainder of its working hours (ranging from 0% of working hours to 90% of working hours dependent on the type of equipment and activity). The fraction of hours spent at working load is contained within the data provided by Horizon.

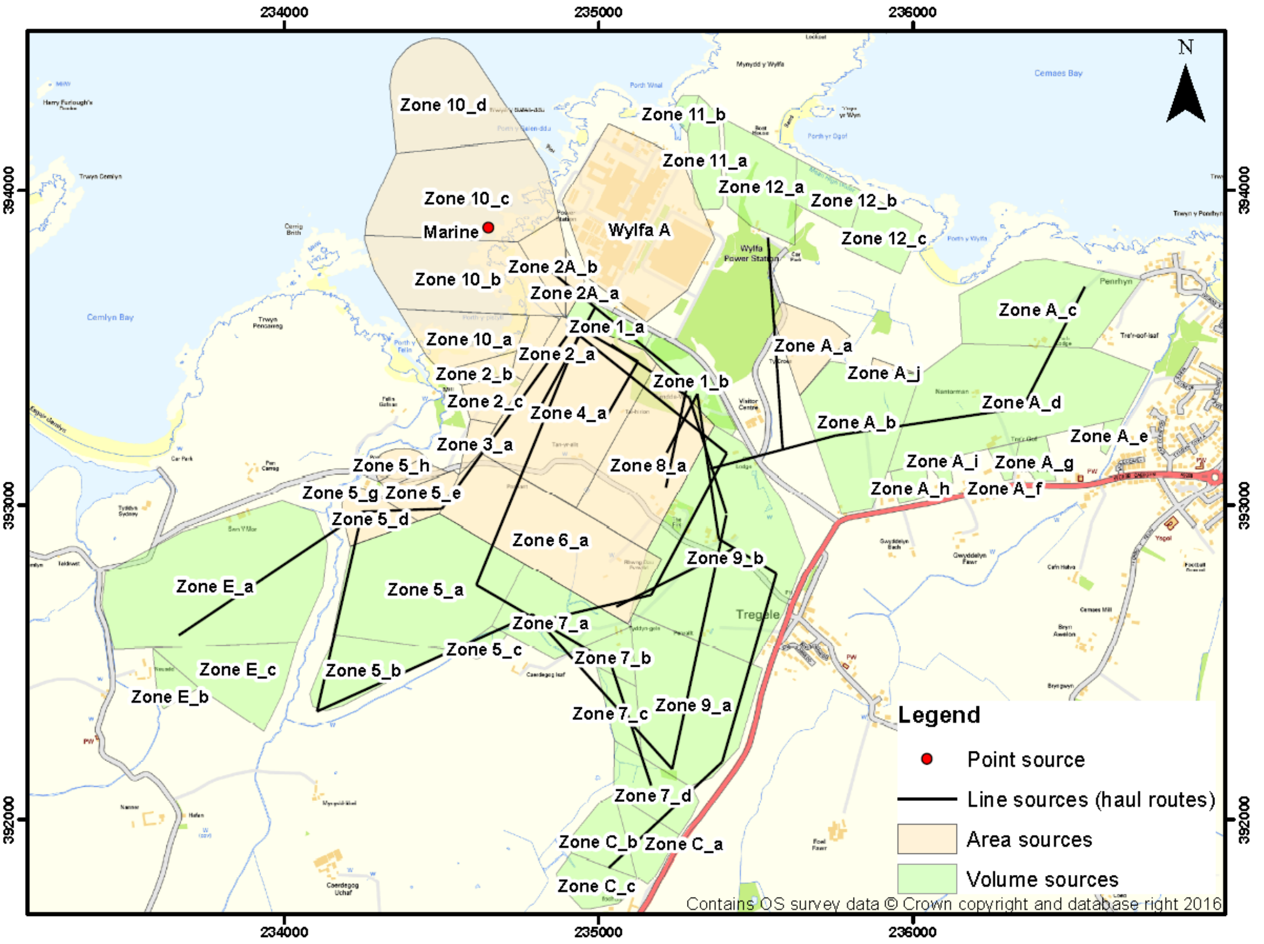
The emission rates thus calculated, for each convex polygon and each hour of the year, were entered directly into ADMS by use of a time-varying emissions (or "var") file. This allows the full spatial and temporal variation in the emissions to be captured by the dispersion modelling.

The emissions within the convex polygons are entered into ADMS as either volume or area sources. For the volume sources, the area emission rate as calculated by the procedure in Box 1 has been divided by the vertical dimension of the source to calculate a volume-based emission rate. Volume sources have a marginal advantage for modelling these type of emissions as they capture the initial mixing in the vertical dimension but, due to limitations in the number of sources of different types that ADMS can model, some sources (those more remote from receptors) have been treated as area sources; this is not expected to make a material difference to the output at any off-site receptor. The distribution of volume and area sources is such that the volume sources have been placed nearer to the largest groups of receptors. This does mean that the smaller number of receptors to the east of Cemlyn Bay, which are adjacent to certain area sources, are likely to experience a marginally greater predicted impact than that which would have resulted if applying a volume source approach to all modelled construction areas was possible. This is considered to be a robust assumption, erring on the side of caution, given that these receptors have the highest predicted off-site impact.

The release height for the volume sources was set to 3 m and the vertical dimension of the volume sources was set at 6 m. These are standard assumptions which have been made on numerous other assessments of NRMM emissions. These assumptions and this approach are broadly consistent with recommendations made by the US EPA for modelling the impact of haul road emissions[15]. For activity on haul routes, the same approach was taken, but treating them in ADMS as line sources of width 10 m.

[14] Pseudocode is an informal high-level description of the operating principle of a computer program or other algorithm.
[15] US EPA, 2012. 'Haul Road Workgroup Final Report Submission to EPA-OAQPS'

Figure 2.1 Visualisation of construction sources included in the model



Note: These areas and haul routes do not fully correspond to the labelled areas and routes detailed in Appendix A due to the requirement to convert the actual area in to a convex form which can be accepted by the model and due to reaching the limitation on the maximum number of line sources which may be accepted by ADMS.

Emissions during construction of the MOLF and operation of the MOLF

Horizon provided the number of marine vessels/types and MOLF construction plant on a monthly basis for each of the 2020 (when the MOLF is undergoing construction) and 2023 (when the MOLF is operational) construction years. Some vessels, such as jack-up barges and dredgers, which are primarily used during the construction of the MOLF only, were included in the NRMM and other construction plant data described above, and so do not feature in the “marine” point source in Figure 2.1. Emissions from these particular vessels are modelled using the NRMM approach described in the preceding sub-section with their emissions distributed equally over the relevant area sources.

Vessels within the marine point source, which represents emissions during operation of the MOLF, include bulk carriers, vessels for abnormal integral loads, and unpowered barges with tugs. Power ratings for the engines for each vessel type were determined by Amec Foster Wheeler from public information[16]. Each shipping movement was assumed to entail 2 hours operating the main engines at 20% of their rated power (representing manoeuvring and docking) and 22 hours operating the auxiliary engines at 80% of their rated power (representing time docked and loading/unloading). Emission factors were derived from Defra’s UK Ship Emissions Inventory report[17].

Movement numbers and the assumed 24-hour turnaround time per movement suggest that approximately two vessels will be present at any time during MOLF operation. In view of this, marine vessel emissions during MOLF operation were modelled as a single continuous point source located in the MOLF area with

[16] www.fleetmon.com, www.marinetraffic.com, www.workboatsinternational.com
[17] Entec (2010), Defra UK Ship Emissions Inventory. Doc Reg No 21897-01.

typical values for the stack height, diameter, temperature and velocity parameters. The emission rates for the point source were derived from the total annual emission calculated for each of the various types of vessel and numbers of associated movements at the MOLF in that particular year.

Wylfa A decommissioning

Concurrent with the 2023 peak construction scenario of the Wylfa Newydd Project, the existing Wylfa A Magnox station will be in its "preparation for care and maintenance" phase. During this phase, some plant and buildings will be removed and remaining structures will be put into a passively safe and secure state. Emissions from this activity have been added to the model and added to the baseline concentration. These emissions are relatively low and are not expected to make a significant contribution to concentrations at receptors, so a fairly simple, conservative approach, such as assuming operation takes place 365 days of the year, has been taken.

The Environmental Statement for the Wylfa A decommissioning contains a list of equipment proposed for these works, with a fractional running time. Power ratings for each equipment type were determined by Amec Foster Wheeler from public information. Equipment was assumed to operate for 8 hours per day, factored by the fractional running time given in the Environmental Statement, and for 365 days per year. Emission factors were based on Stage IIIB standards.

Emissions were then assigned to an area source covering the Wylfa A Magnox site.

Road traffic

Information on the methodology for quantifying the contribution from road traffic emissions can be found in appendix C4-01 of the Environmental Statement.

2.5 Predicting the combined impacts of construction/marine plant and road traffic emissions

In order to estimate the combined impact of construction/marine plant and road traffic emissions, the long-term baseline/background concentration used in the assessment of construction/marine plant emissions takes a value of the total modelled annual mean concentration from the roads model i.e. local roads contribution plus background after verification, before the long-term process contribution from the construction/marine plant emissions is added. Analogous to NRW's '*Air emissions risk assessment for your environmental permit*' guidance[18], the short-term baseline/background concentration used in the assessment of construction/marine plant emissions takes a value of twice the total modelled annual mean concentration from the roads model before the relevant percentile process contribution from the construction/marine plant emissions source is added.

Due to the non-linearity in the NO_x:NO_2 relationship (section 2.10 provides further explanation), a more appropriate method would perhaps be to consider the combined modelled NO_x road source and construction/marine plant contribution for each hour before calculating the combined long-term and short-term NO_2 impacts using Defra's NO_x to NO_2 calculator [19]. However, use of the proposed method is considered appropriate in this instance due to the following factors:

- The fraction of primary NO_2 in construction/marine plant and road traffic emissions is likely to be different which increases the uncertainty in the fraction of primary NO_2 estimate in methods such as Defra's NO_x to NO_2 calculator;
- Accurate predictions of the road contribution for each hour would require a diurnal profile of traffic flows which are not always readily available; and

[18] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit
[19] https://laqm.defra.gov.uk/documents/no2tonox9_ja-forweb_june2016.xls

- Experience suggests use of the NO_x:NO_2 conversion factors from the Environment Agency's Air Quality Modelling and Assessment Unit (AQMAU) guidance[20] generally results in a more conservative prediction of impact for construction plant and marine vessel emissions and therefore provides a precautionary approach for these particular emission sources.

2.6 Meteorology

For meteorological data to be suitable for ADMS dispersion modelling purposes, a number of meteorological parameters need to be measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of sites in the UK where the required meteorological measurements are made. The nearest synoptic station to the Wylfa Newydd Development Area that records these parameters in a format suitable for the model is RAF Valley, located approximately 20 km to the south-west of the Wylfa Newydd Development Area on the southern coast of Anglesey.

However, due to the distance and potential localised influences of topographical/coastal effects, it may not necessarily be the case that data from RAF Valley is completely representative of the conditions more local to the development site. Therefore, this assessment has used interpolated meteorological data from the UK Meteorological Office ('Met Office') Numerical Weather Prediction (NWP) models for the latitude and longitude of the Wylfa Newydd Development Area during the period 2007-2016. Wind rose figures illustrating the frequency of wind speed and direction from the NWP data for each year over this period can be found in Appendix B.

NWP models, such as the Unified Model (UM), are now used operationally by the Met Office for weather forecasting and to model climate change. These models are run on large supercomputers and input observations from ground stations, buoys at sea, radiosondes, aircraft and satellites. The models integrate the governing equations forward in time to move from a current view of the weather to some future state (the "Forecast"). The starting point of NWP forecasts is a set of data (the "Analysis") that combines the currently available observations measured all over the globe with an initial state taken from the previous NWP model run.

Versions of the Unified Model include the global and mesoscale models. These cover various domains and grid resolutions. The mesoscale model covers a limited area focussed on the UK. In 2006, the North Atlantic & European (NAE) model replaced the mesoscale model. It covers a larger area but has the same resolution as the immediately preceding version of the mesoscale model.

When generating data suitable for the ADMS model, the NWP Analysis data for the chosen year from the UM mesoscale model is retrieved from storage and then processed using multi-linear interpolation in all three dimensions and in time to get the effective values of each variable at the station position (latitude & longitude). The raw NWP data are, strictly speaking, Analysis data at each assimilation step in the mesoscale model run, mixed with Forecast data for the intervening hours. Data before 2004 are interpolated from older versions of the UM mesoscale model with a 60 km resolution, whilst data from 2004 to 2006 are interpolated at 12 km resolution and data between 2007 to 2012 at a 4 km resolution, whilst, from 2013 onwards, model resolution is at 1.5 km.

Gaussian plume models, such as ADMS, cannot, as standard, model calm weather conditions, since this results in a discontinuity produced by a 'divide by zero' calculation. Most Gaussian plume models simply skip lines of meteorological data where calm conditions occur. Met lines will also be skipped where any of the required meteorological input parameters are missing. If there are a significant number of calm conditions or missing data, this can result in an equally significant number of met lines being discounted and an unrepresentative prediction of modelled impact, particularly for annual mean or percentile based concentrations. The generally accepted best practice requirement is to ensure that no more than 10% of meteorological data is omitted from the model run. Table 2.1 demonstrates that this requirement is satisfied for all modelled years of NWP meteorological data for the Wylfa Newydd Development Area.

[20] AQMAU, undated. 'Conversion ratios for NOx and NO_2'
http://webarchive.nationalarchives.gov.uk/20140328084622/http:/www.environment-agency.gov.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf

Table 2.1 Meteorological data capture

Year	Number of met lines used	Percentage of lines not used
2007	8727	0.4%
2008	8747	0.4%
2009	8725	0.4%
2010	8717	0.5%
2011	8716	0.5%
2012	8744	0.5%
2013	8700	0.7%
2014	8712	0.5%
2015	8705	0.6%
2016	8731	0.6%

ADMS does possess an additional sub-routine, allowing estimates of modelled contributions during calm conditions to be made. However, validation of this method of calculating concentrations has never been carried out and, consequently, this sub-routine was not used as part of these model runs.

2.7 Model domain and receptors

Modelled grid

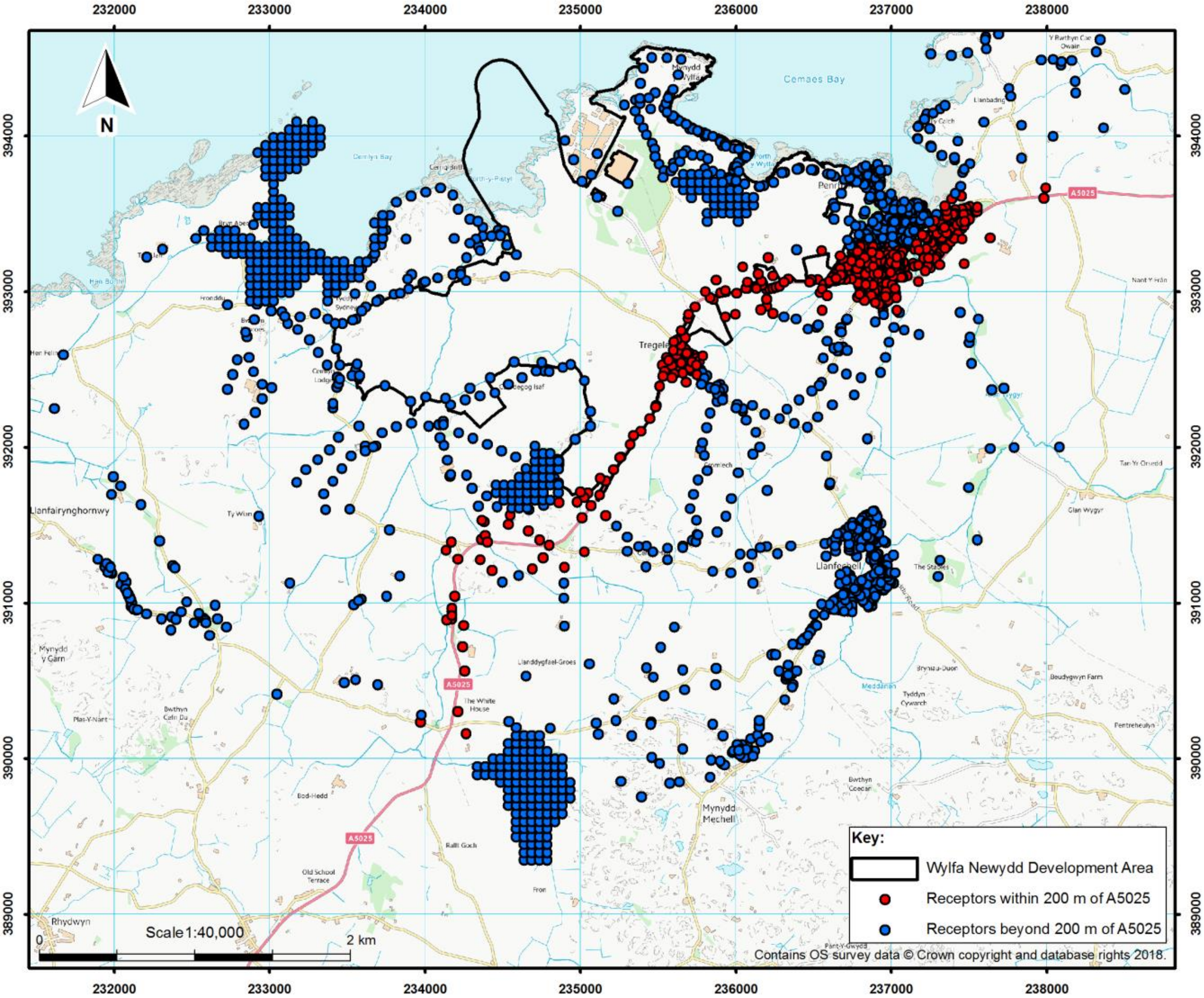
The model incorporates a 6 km x 6 km Cartesian grid, centred on the Wylfa Newydd Development Area, with a receptor resolution of 60 m, to assess the impact of atmospheric emissions during construction on local air quality. The Cartesian grid was used for the purposes of generating concentration isopleths/contour plots indicating process contributions from construction plant and marine vessels.

Specific receptors

Guidance from the UK Government and Devolved Administrations makes it clear that exceedances of the human health based objectives should only be assessed at outdoor locations where members of the general public are regularly present over the averaging time of the objective. The receptors considered were chosen based on places where people may be located, judged in terms of the likely duration of their exposure to pollutants and their proximity to the Wylfa Newydd Development Area boundary (all relevant human receptors within 2 km of the Wylfa Newydd Development Area were considered). Model predictions are made at a height of 1.6 m above ground level, representative of the typical human breathing zone height. Ecological receptors within 2 km (all designated sites) and 15 km (European designated sites only) of the Wylfa Newydd Development Area have been considered in the assessment with predictions for these receptors made at ground level.

Details of the locations of the receptors considered in the assessment are provided in Appendix C and those within 2 km of the Wylfa Newydd Development Area presented in Figure 2.2.

Figure 2.2 Model receptors within 2 km of the Wylfa Newydd Development Area



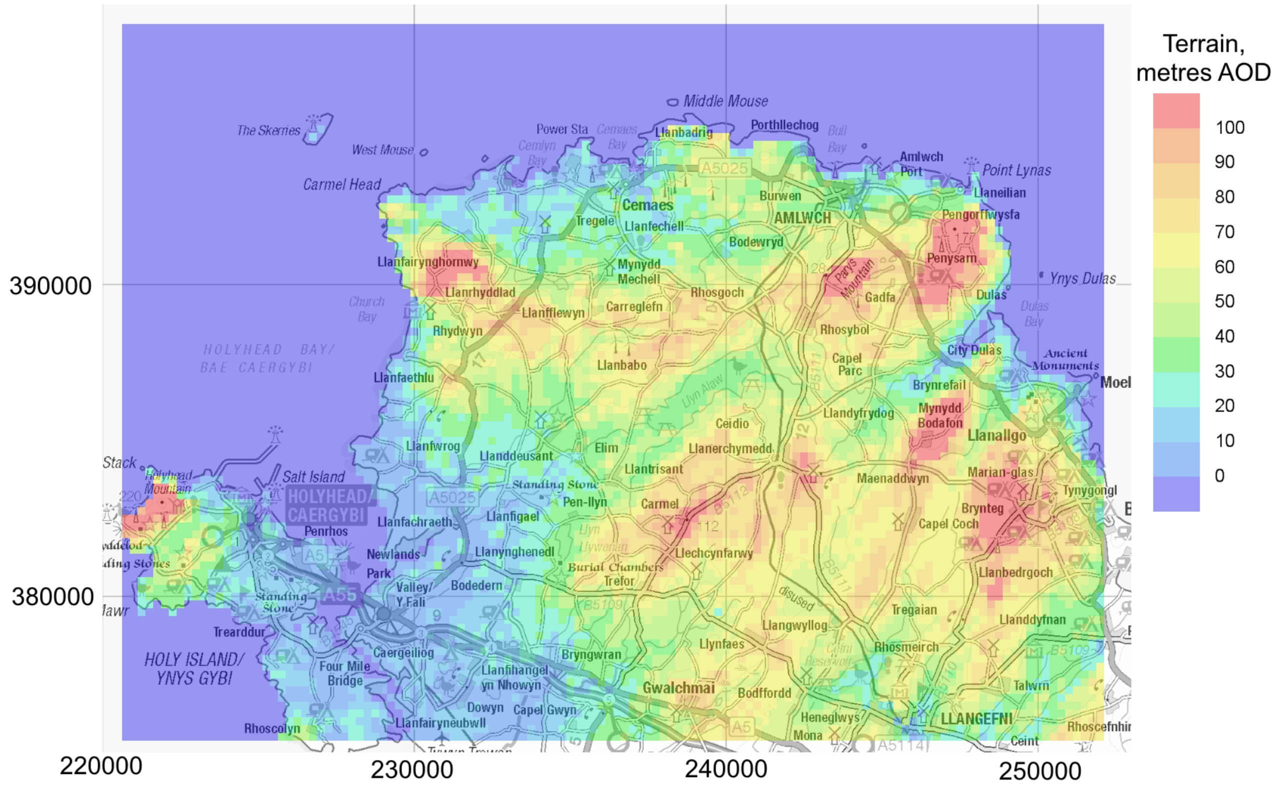
Notes: Red dots indicate those receptors within 200m of the A5025, blue dots indicate those receptors further than 200m of the A5025. Please refer to Section 2.16 for an explanation of this distinction.

2.8 Terrain

The ground level concentrations of pollutants arising from emissions in areas of complex terrain differ from those found in simple, level terrain due to a number of topographical-induced effects on the three-dimensional flow and turbulent fields over the terrain. These effects are most pronounced when terrain gradients are steeper than 1 in 10. The terrain in the model domain approaches or exceeds this criterion and, consequently, digitally mapped terrain data has been included in the model set up.

Within the Wylfa Newydd Development Area, construction works will change the landform due to the creation of level platforms for the main reactor island area, and mounds made from the extracted spoil. Clearly, these will change during the course of the construction phase. Horizon provided drawings of the landform corresponding to various stages of construction (called Reference Points). Reference Point 3, corresponding to main construction through to first nuclear construction, was used for modelling both scenarios, representing an indicative terrain profile during the middle point of the construction schedule. Sensitivity analysis indicated a negligible effect on predicted concentrations with terrain profiles for the different Reference Points so this approach represents a pragmatic solution. Heights of the platforms and mounds were extracted from the drawing and gridded for input into ADMS, combined with OS Terrain 50 data for the wider landscape. The resulting terrain file covered a region of 31 km × 22 km, in order to cover all the modelled receptors, and is illustrated in Figure 2.3.

Figure 2.3 Illustration of terrain used as model input



2.9 Surface characteristics

The predominant surface characteristics and land use in a model domain have an important influence in determining turbulent fluxes and, hence, the stability of the boundary layer and atmospheric dispersion. Factors pertinent to this determination are discussed below.

Surface roughness

The surface roughness length represents the aerodynamic effects of surface friction and is defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing in the boundary layer.

The surface roughness length is typically related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas. Oke[21] and CERC[22] suggest typical roughness lengths for various land use categories (Table 2.2).

[21] Oke, T.R., 1987. 'Boundary Layer Climates' 2nd Edition, Methuen.
[22] CERC, 2003. 'The Met Input Module'. ADMS Technical Specification ADMS 3 P05/01N/03.

Table 2.2 Typical surface roughness lengths for different terrain types

Type of surface	Typical surface roughness length (m)
Ice	0.00001
Smooth snow	0.00005
Smooth sea	0.0002
Lawn grass	0.01
Pasture	0.2
Isolated settlement (farms, trees, hedges)	0.4
Parkland, woodlands, villages, open suburbia	0.5-1.0
Forests/cities/industrialised areas	1.0-1.5
Heavily industrialised areas	1.5-2.0

Increasing surface roughness increases turbulent mixing in the lower boundary layer. With respect to near-ground sources, such as those represented in this modelling of construction and road traffic activity, the overall impact on ground level concentration is correlated with the distance of a receptor from the emission source.

Surface energy budget

One of the key factors governing the generation of convective turbulence is the magnitude of the surface sensible heat flux. This, in turn, is a function of the incoming solar radiation. However, not all solar radiation arriving at the Earth's surface is available to be emitted back to atmosphere in the form of sensible heat. By adopting a surface energy budget approach, it can be identified that, for fixed values of incoming short and long wave solar radiation, the surface sensible heat flux is inversely proportional to the surface albedo and latent heat flux.

The surface albedo is a measure of the fraction of incoming short-wave solar radiation reflected back into the atmosphere by the Earth's surface. This parameter is dependent upon surface characteristics and varies throughout the year. Oke[23] (1987) recommends average surface albedo values of 0.6 for snow covered ground and 0.23 for non-snow covered ground, respectively.

The latent heat flux is dependent upon the amount of moisture present at the surface. The modified Priestly-Taylor parameter can be used to represent the amount of moisture available for evaporation. Areas where moisture availability is greater will experience a greater proportion of incoming solar radiation released back to atmosphere in the form of latent heat, leaving less available in the form of sensible heat and, thus, decreasing convective turbulence. Holstag and van Ulden (1983)[24] suggest modified Priestly-Taylor values of 0.45 and 1.0 for dry grassland and moist grassland respectively.

Selection of appropriate surface characteristic parameters for the model domain

A detailed analysis of the effects of surface characteristics on ground level concentrations by Auld et al. (2002)[25] led them to conclude that, with respect to uncertainty in model predictions:

> *"…the energy budget calculations had relatively little impact on the overall uncertainty"*

[23] T. R. Oke (1987). Boundary Layer Climates. 2nd Edition, Methuen & Co. Ltd, London 435 pp.
[24] A. A. M Holstag & A. P. van Ulden (1983). A Simple Scheme for Daytime Estimates of the Surface Fluxes from Routine Weather Data. J. Clim. App. Met., 22 (4) 517-521.
[25] https://admlc.files.wordpress.com/2014/05/admlc-r2.pdf

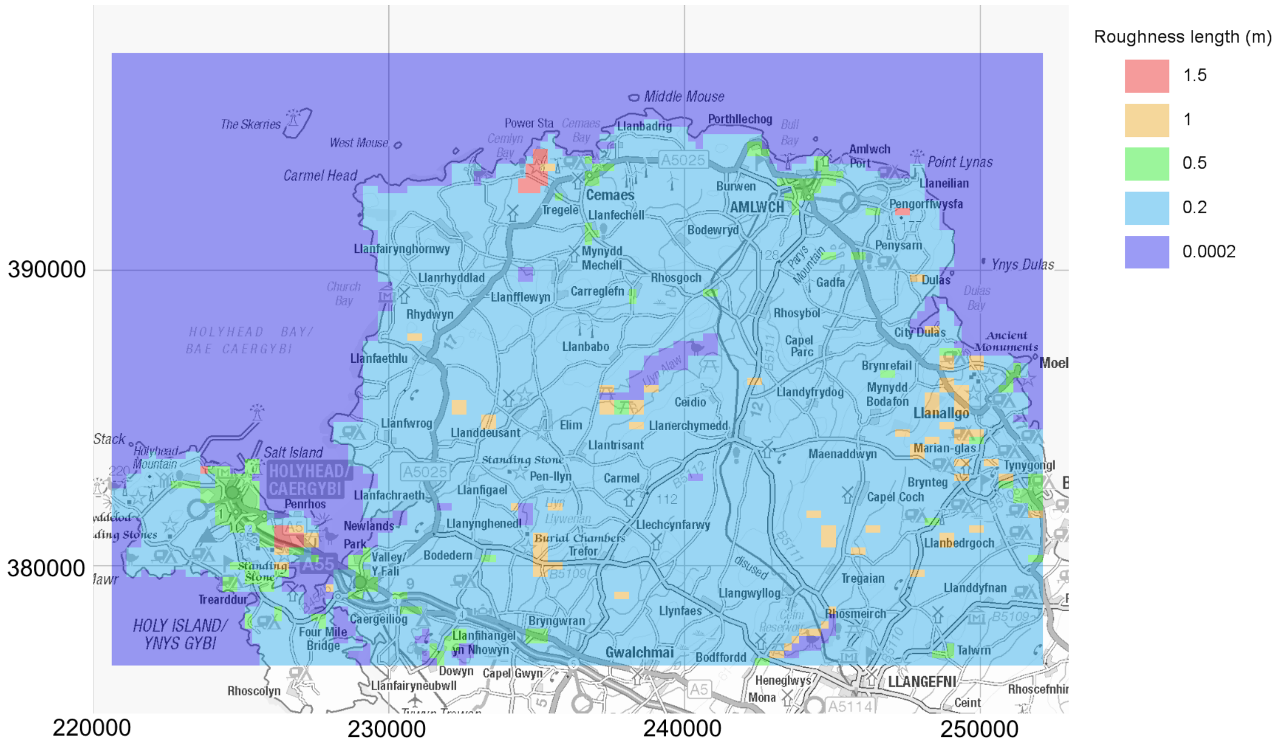
In this regard, it is not considered necessary to vary the surface energy budget parameters, spatially or temporally, and annual averaged values have been adopted throughout the model domain for this assessment.

As snow covered ground is only likely to be present for a small fraction of the year, the surface albedo of 0.23 for non-snow covered ground advocated by Oke[17] has been used, whilst the model default modified Priestly-Taylor parameter value of 1.0 (equivalent of moist vegetation) has also been retained.

However, due to the variability and contrasting nature of land use within the model domain, a spatially varying surface roughness file has been used instead of adopting a uniform surface roughness length throughout the model domain. The surface roughness file, whose varying nature is visualised in Figure 2.4, is composed of the following values and land use categories:

- 0.0002 m - representative of the sea/water;
- 0.2 m - representative of open grass and scrubland;
- 0.5 m - representative of suburbia and isolated settlement;
- 1.0 m - representative of built up areas and woodland; and
- 1.5 m - representative of large industrialised areas.

Figure 2.4 Variable surface roughness length visualisation



Notes: The area covered by construction activity associated with the Wylfa Newydd Project has been assigned an enhanced surface roughness length of 1.5 m to reflect the additional mechanically generated turbulence associated with large numbers of HDVs and NRMM in a concentrated area.

2.10 Conversion of NO to NO_2

Emissions of NO_x from combustion processes are predominantly in the form of NO. Excess oxygen in the combustion gases and further atmospheric reactions cause the oxidation of NO to NO_2. NO_x chemistry in the lower troposphere is strongly interlinked in a complex chain of reactions involving Volatile Organic Compounds (VOCs) and Ozone (O_3). Two of the key reactions interlinking NO and NO_2 are detailed below:

$$NO_2 + O_2 \xrightarrow{hv} NO + O_3 \qquad (R1)$$

$$NO + O_3 \rightarrow NO_2 + O_2 \qquad (R2)$$

Where *hv* is used to represent a photon of light energy (i.e., sunlight).

Taken together, reactions R1 and R2 produce no net change in O_3 concentrations, and NO and NO_2 adjust to establish a near steady state reaction (photo-equilibrium). However, the presence of VOCs and CO in the atmosphere offer an alternative production route of NO_2 for photolysis, allowing O_3 concentrations to increase during the day with a subsequent decrease in the NO_2:NO_x ratio.

However, at night, the photolysis of NO_2 ceases, allowing reaction R2 to promote the production of NO_2, at the expense of O_3, with a corresponding increase in the NO_2:NO_x ratio.

Near to an emission source of NO, the result is a net increase in the rate of reaction R2, suppressing O_3 concentrations immediately downwind of the source, and increasing further downwind as the concentrations of NO begin to stabilise to typical background levels (Gilani and Pliem, 1996)[26].

Given the complex nature of NO_x chemistry, the Environment Agency's Air Quality Modelling and Assessment Unit (AQMAU) has adopted a pragmatic, risk-based approach in determining the conversion rate of NO to NO_2 which dispersion model practitioners can use in detailed assessments. AQMAU guidance advises that the source term should be modelled as NOx (as NO_2) and then suggests a tiered approach when considering ambient NO_2:NOx ratios:

- Screening Scenario: 50% and 100% of the modelled NOx process contributions should be used for short-term and long-term average concentration, respectively. That is, 50% of the predicted NOx concentrations should be assumed to be NO_2 for short-term assessments and 100% of the predicted NOx concentrations should be assumed to be NO_2 for long-term assessments;
- Worst Case Scenario: 35% and 70% of the modelled NOx process contributions should be used for short-term and long-term average concentration, respectively. That is, 35% of the predicted NOx concentrations should be assumed to be NO_2 for short-term assessments and 70% of the predicted NOx concentrations should be assumed to be NO_2 for long-term assessments; and
- Case Specific Scenario: Operators are asked to justify their use of percentages lower than 35% for short-term and 70% for long-term assessments in their application reports.

In line with the AQMAU guidance, this assessment has used the 'Worst Case Scenario' approach in determining the conversion rate of NO to NO_2 from construction plant and marine vessels as a robust assumption. For consideration of emissions from on-road vehicles, Defra's NO_x to NO_2 calculator (version 5.1)[27] has been used. Section 2.5 provides further description on how results from the two types of emission source (i.e. construction/marine and road traffic) have been combined.

2.11 Deposition

The predominant route by which emissions will affect land in the vicinity of an emission source is by deposition of material from the plume. Ecological receptors can potentially be sensitive to the deposition of pollutants, particularly nitrogen and sulphur compounds, which can affect the character of the habitat through eutrophication and acidification.

Deposition processes in the form of dry and wet deposition remove material from a plume and alter the plume concentration. Dry deposition occurs when particles are brought to the surface by gravitational settling and turbulence. They are then removed from the atmosphere by deposition on the land surface or on vegetation. Wet deposition occurs due to rainout (within cloud) scavenging and washout (below cloud) scavenging of the material in the plume. These processes lead to a variation with downwind distance of the

[26] M. V. Gilani & J. E. Pliem (1996) Sub-Grid Scale Features of Anthropogenic Emissions of NOx and VOC in the Context of Regional Eulerian Models. Atmos. Environ. 30, 2043-2059.
[27] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

plume strength and may alter the shape of the vertical concentration profile, as dry deposition only occurs at the surface.

Near to sources of pollutants (< 2 km), dry deposition is generally the predominant removal mechanism for pollutants such as NO_x, SO_2 and NH_3 (Fangmeier et al. 1994)[28]. Dry deposition may be quantified from the near-surface plume concentration and the deposition velocity (Chamberlin and Chadwick, 1953)[29];

$$F_d = v_d C(x, y, 0)$$

Where:

F_d = dry deposition flux (µg m^{-2} s^{-1})

v_d = deposition velocity (m s^{-1})

$C(x, y, 0)$ = ground level concentration (µg m^{-3})

AQTAG06 guidance (AQTAG, 2014)[30] recommends deposition velocities for various pollutants dependent upon the habitat type (Table 2.3).

Table 2.3 Pollutant specific deposition velocities

Pollutant	Deposition velocity (m s^{-1})	
	Short vegetation	Long vegetation
NO_2	0.0015	0.003
SO_2	0.012	0.024

In order to assess the impacts of deposition, habitat-specific critical loads and critical levels have been developed. These are generally defined as (e.g., Nilsson and Grennfelt, 1988)[31];

"...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"

It is important to distinguish between a critical load and a critical level. The critical load relates to the quantity of a material deposited from air to the ground, whilst critical levels refer to the concentration of a material in air. The UK Air Pollution Information System (APIS[32]) provides critical load data for ecological sites in the UK.

The critical loads used to assess the impact of compounds deposited to land which result in eutrophication and acidification are expressed in terms of kilograms of nitrogen deposited per hectare per year (kg N ha^{-1} y^{-1}) and also as kilo-equivalents deposited per hectare per year (keq ha^{-1} y^{-1}). The unit of 'equivalents' (eq) is used for the purposes of assessing acidification, rather than a unit of mass. The unit eq (1 keq ≡ 1,000 eq) refers to molar equivalent of potential acidity resulting from e.g. sulphur, oxidised and reduced nitrogen, as well as base cations. Essentially, it means 'moles of charge' and is a measure of how acidifying a particular chemical species can be.

To convert the predicted concentration in air the following algorithm is used:

$$DR_i = C_i v_{d_i} f_i$$

[28] A. Fangmeier et al. (1994) Effects of Atmospheric Ammonia on Vegetation – A Review. Environ. Pollution, 86 278-291.
[29] A. C. Chamberlin & R. C. Chadwick (1953) Deposition of Airborne Radioactive Vapour. Nucleonics 11 22-25.
[30] AQTAG06 (2014). 'Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air'
[31] J. Nilsson & P. Grennfelt (1988) Critical Loads for Sulphur and Nitrogen. Miljorapport 1988:15, Nordic Council of Ministers, Copenhagen.
[32] http://www.apis.ac.uk/

Where:

DR_i = annual deposition of N or S (kg N ha^{-1} y^{-1} or kg S ha^{-1} y^{-1})

C_i = annual mean concentration of the *i*th chemical species (µg m^{-3})

v_{d_i} = deposition velocity of *i*th species

f_i = factor to convert from µg m^{-2} s^{-1} to kg ha^{-1} y^{-1} for the *i*th species

Table 2.4 provides the relevant conversion factors.

Table 2.4 Deposition rate conversion factors

From	Conversion factor (µg m^{-2} s^{-1} to kg ha^{-1} y^{-1} for the *i*th species)	
	Convert to	**Factor**
NO_2	N	96
SO_2	S	157.7

In order to convert deposition of N to acid equivalents, the following relationships can be used:

- 1 keq ha^{-1} y^{-1} = 14 kg N ha^{-1} y^{-1}; and
- 1 keq ha^{-1} y^{-1} = 16 kg S ha^{-1} y^{-1}.

With respect to wet deposition, AQTAG06 states:

"*It is considered that wet deposition of SO_2, NO_2 and NH_3 is not significant within a short range*"

Therefore, the assessment only considers dry deposition of nitrifying and acidifying N and S compounds.

2.12 Background contributions

Background concentrations are summarised in the baseline air quality report prepared by Jacobs[33]. In summary, the following data sources have been used to quantify background concentrations:

- NO_x and NO_2: For receptors more than 200 m from the A5025, 2013 data from Defra background maps is used to obtain the background concentration for the grid squares containing individual receptors. For receptors within 200 m of the A5025, the contribution from the A5025 has been explicitly modelled for each receptor and added to the 2013 background mapped value after removal of the mapped roads contribution;
- SO_2 and CO: 2001 data from Defra background maps for the grid squares containing individual receptors; and
- PM_{10} and $PM_{2.5}$: Uniform concentrations based on monitored data collected by IACC in the vicinity of the Wylfa Newydd Development Area in 2013/2014 and 2016 (PM_{10} = 14.9 µg m^{-3}; $PM_{2.5}$ = 7.8 µg m^{-3}) for receptors more than 200 m from the A5025. For receptors within 200 m of the A5025 the contribution from the A5025 has been explicitly modelled for each receptor and added to the uniform concentration based on the monitored data.

Conservatively, no reduction in background concentrations in future years is assumed, except for the explicitly modelled roads contribution, where concentrations associated with road traffic emissions have been calculated from emission factors relevant for that specific year.

[33] Jacobs, 2017. 'Baseline Data Synopsis Report – Air Quality' WN03.03.01-S5-PAC-REP-00017

Short-term background/baseline concentrations have been derived from annual mean background/baseline concentrations by applying a factor of 2 to the annual mean data, in accordance with information contained within the Environment Agency's guidance[34]. Section 2.5 provides further description on how results from the two types of emission source (i.e. construction/marine and road traffic) have been combined.

2.13 Sensitivity analysis and model uncertainty

Emissions have been modelled using the standard steady state algorithms in ADMS to determine the impact on local human and ecological receptors. In order to model atmospheric dispersion using standard Gaussian methods, the following assumptions and limitations have to be made and appreciated:

- Conservation of mass – the entire mass of emitted pollutant remains in the atmosphere and no allowance is made for loss due to chemical reactions or deposition processes (although the standard Gaussian model can be modified to include such processes, as is the case with ADMS). Portions of the plume reaching the ground are assumed to be dispersed back away from the ground by turbulent eddies (eddy reflection);
- Steady state emissions – emission rates are assumed to be constant and continuous over the time averaging period of interest, apart from where time-varying emissions are explicitly modelled (see Section 2.4 above); and
- Steady state meteorology – no variations in wind speed, direction or turbulent profiles occur during transport from the source to the receptor. This assumption is reasonable within a few kilometres of a source but may not be valid for receptor distances in the order of tens of kilometres. For example, for a receptor 50 km from a source and with a wind speed of 5 m s^{-1} it will take nearly three hours for the plume to travel this distance, during which time many different processes may change (e.g., the sun may rise or set and clouds may form or dissipate, affecting the turbulent profiles). For this reason, Gaussian models are practically limited to predicting concentrations within ~20 km of a source.

Another area of uncertainty arises from using historical meteorological data to estimate future concentrations. The key limiting assumption here is that conditions in the future will be the same as in the past; however, in reality, no two years are the same. Defra's Technical Guidance LAQM.TG(16)[35] reviews a number of studies examining inter-annual variability of meteorological data and the effect on dispersion model output; it is suggested that variability in source contribution should be no more than 30% between any two years.

As a result of the above, and in combination with other factors, not least attempting to replicate stochastic processes (e.g., turbulence) by deterministic methods, dispersion modelling is inherently uncertain, but is nonetheless a useful tool in the prediction of ground level concentrations. The use of dispersion models has been widely applied in the UK for both regulatory and compliance purposes for a number of years and is an accepted approach for this type of assessment.

This assessment has incorporated a number of worst-case assumptions which should result in an over-estimation of the predicted ground level concentrations. Attempts to minimise uncertainty have been made by undertaking verification of the modelled roads output, assuming no reduction in background concentrations in future assessment years and uplifting the NOx emission factors in the EFT using the CURED tool. As a result of these worst-case assumptions, the predicted results should be considered the upper limit of model uncertainty for a scenario where the actual site impact is determined. In addition, the peak number of construction workers has been taken to be 9,000 and it is expected that the true number will be lower than this.

Given the above, the results provided by this assessment are considered to be robust.

[34] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit
[35] https://laqm.defra.gov.uk/documents/LAQM-TG16-April-16-v1.pdf

3. Modelling results

3.1 Tabulated results

Results tables providing the construction/marine plant process contribution (PC), predicted environmental concentration with construction/marine plant contribution only (PEC(C))[36] and PEC with total Wylfa Newydd Project contribution (PEC(T))[37] for each receptor and each scenario, including a numerical comparison against the relevant AQO, are presented in appendix D. These results are the highest concentrations predicted for individual receptors obtained from any year of meteorological data.

3.2 Concentration isopleths

Annual mean NO_2, PM_{10}/$PM_{2.5}$ and short-term NO_2 process contribution isopleths only are provided in Appendix E, as these are considered to be the pollutants/averaging time periods of greatest importance.

[36] PEC(C) = PC + baseline concentration without additional Wylfa Newydd Project operational traffic contribution
[37] PEC(T) = PC + baseline concentration with additional Wylfa Newydd Project operational traffic contribution

Appendix A
Construction model inputs and emission standards

Table A.1 summarises the plant data used. Here, the numbers of plant are presented as averages for brevity, but in the original data the number of plant units active in each month was supplied, and this more detailed month-by-month data was used in the emissions calculation.

Table A.1 Construction supplementary information

Vehicle ID	Description	Work-ing hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
EX75	Tracked Excavator:75t:352kW:Cat374FLME: 5000lt bucket:Mass excavation	07:00-19:00	1	80%	355	1,2,3,4,6	1.58	0
EX75	Tracked Excavator:75t:352kW:Cat374FLME: 5000lt bucket:Mass excavation	07:00-19:00	1	80%	355	1,2,3,4,6	1.5	0
BD442	Tractor:Track:442kW:Caterpillar D10T:Ripper	07:00-19:00	1	80%	482	1,2,3,4,6	1.5	0
ADT40	Artic Dump Truck:39.5t:365kW:6x6:Caterpillar 740B	07:00-19:00	1	80%	365	Haul 1, 2, 3, 4, 6 to E	15.88	0
BD228	Tractor:Track:228kW:D8T	07:00-19:00	1	80%	268	5, E	2.75	0
RO16	Roller:Steel/Rubber:16t:129kW:Cate rpillar CS74B	07:00-19:00	1	80%	129.5	5, E	2.42	0
CO32	Compactor:32t:Caterpillar 825G	07:00-19:00	1	80%	254	5, E	2.08	0
BD123	Tractor:Track:123kW:Caterpillar D6T LGP	07:00-19:00	1	80%	171	5, E	0.67	0
EX50	Tracked Excavator:50t:317kW:Cat349ELME: 3500lt Bucket:Mass Excavation	07:00-19:00	1	80%	295	1,2,3,4,6	1.33	0
GD26	Grader:26t:222kW:Caterpillar 16M Artic	07:00-19:00	1	80%	243	Haul road	1.67	0
EX75	Tracked Excavator:75t:352kW:Cat374FLME: 5000lt bucket:Mass excavation	07:00-19:00	1	80%	355	6, 7, 8, 9	1.58	0
EX75	Tracked Excavator:75t:352kW:Cat374FLME: 5000lt bucket:Mass excavation	07:00-19:00	1	80%	355	6, 7, 8	0.75	0
BD442	Tractor:Track:442kW:Caterpillar D10T:Ripper	07:00-19:00	1	80%	482	6, 7, 8	0.75	0
ADT40	Artic Dump Truck:39.5t:365kW:6x6:Caterpillar 740B	07:00-19:00	1	80%	365	Haul 6, 7, 8 to A, B, C	9.88	0

Vehicle ID	Description	Working hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
BD228	Tractor:Track:228kW:D8T	07:00-19:00	1	80%	268	A,C	2.33	0
RO16	Roller:Steel/Rubber:16t:129kW:Caterpillar CS74B	07:00-19:00	1	80%	129.5	A,C	2.33	0
CO32	Compactor:32t:Caterpillar 825G	07:00-19:00	1	80%	254	A,C	2.33	0
BD123	Tractor:Track:123kW:Caterpillar D6T LGP	07:00-19:00	1	80%	171	A,C	1	0
EX50	Tracked Excavator:50t:317kW:Cat349ELME: 3500lt Bucket:Mass Excavation	07:00-19:00	1	80%	295	6, 7, 8, 9	0.67	0
GD26	Grader:26t:222kW:Caterpillar 16M Artic	07:00-19:00	1	80%	243	Haul roads	1.33	0
BD442	Tractor:Track:442kW:Caterpillar D10T:Ripper	07:00-19:00	1	80%	482	2, 4, 6	3	0
DR1100	Drill Rig:Quarry Drifter:CHA 1100	07:00-19:00	1	80%	224	4	14	0
R34	ANFO Mixer Truck:3t:4x4	07:00-19:00	1	80%	202	4	2	0
R24	Explosives Transport Truck:6t:4x4	07:00-19:00	1	80%	202	4	2	0
DR1100	Drill Rig	07:00-19:00	1	80%	224	4	21	0
DR1100	Drill Rig	07:00-19:00	1	80%	224	4	9	0
C30	Crane:All Terrain: 30t	07:00-19:00	1	80%	275	4	2	0
EX75	Tracked Excavator:75t:352kW:Cat374FLME: 5000lt bucket:Mass excavation 3.8m3 bucket	07:00-19:00	1	80%	355	2, 4, 6	11.67	0
EX50	Tracked Excavator:50t:317kW:Cat349ELME: 3500lt Bucket:Mass excavation 3.2m3 bucket	07:00-19:00	1	80%	295	2, 4, 6	3	0
ADT40	Artic Dump Truck:39.5t:365kW:6x6:Caterpillar 740B 24m3 Hopper	07:00-19:00	1	80%	365	Haul 4 to E	41.75	0
ADT40	Artic Dump Truck:39.5t:365kW:6x6:Caterpillar 740B 24m3 Hopper	07:00-19:00	1	80%	365	Haul 4 to E	30.5	0
A60H	Artic Dump Truck:55t:470kW:6x6:Volvo A60H	07:00-19:00	1	80%	470	Haul 4 to E	11	0
EX190	Excavator: EX1900-6 190t 810kW (1086hp) (12m3 bucket/11m3 shovel)	07:00-19:00	1	80%	810	4	9	0

Vehicle ID	Description	Working hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
EX250	Excavator:EX2500 (Specs for EX2600 260t 1119kW) (17m3 bucket/15m3 shovel)	07:00-19:00	1	80%	1119	4	3	0
BD442	Tractor:Track:442kW:Caterpillar D10T:Ripper	07:00-19:00	1	80%	482	8	3	0
BD228	Tractor:Track:228kW:D8T	07:00-19:00	1	80%	268	9	2	0
RO16	Roller:Steel/Rubber:16t:129kW:Caterpillar CS74B	07:00-19:00	1	80%	129.5	9	2	0
CO32	Compactor:32t:Caterpillar 825G	07:00-19:00	1	80%	254	9	2	0
DR1100	Drill Rig:Quarry Drifter:CHA 1100	07:00-19:00	1	80%	224	8	13	0
R34	ANFO Mixer Truck:3t:4x4	07:00-19:00	1	80%	202	8	2	0
R24	Explosives Transport Truck:6t:4x4	07:00-19:00	1	80%	202	8	2	0
DR1100	Drill Rig	07:00-19:00	1	80%	224	8	20	0
DR1100	Drill Rig	07:00-19:00	1	80%	224	8	8.67	0
EX75	Tracked Excavator:75t:352kW:Cat374FLME: 5000lt bucket:Mass excavation 3.8m3 bucket	07:00-19:00	1	80%	355	8	11.67	0
EX50	Tracked Excavator:50t:317kW:Cat349ELME: 3500lt Bucket:Mass excavation 3.2m3 bucket	07:00-19:00	1	80%	295	8	3	0
ADT40	Artic Dump Truck:39.5t:365kW:6x6:Caterpillar 740B 24m3 Hopper	07:00-19:00	1	80%	365	Haul 8, 9 to A	28.33	0
ADT40	Artic Dump Truck:39.5t:365kW:6x6:Caterpillar 740B 24m3 Hopper	07:00-19:00	1	80%	365	Haul 8, 9 to A	13.33	0
EX190	Excavator: EX1900-6 190t 810kW (1086hp) (12m3 bucket/11m3 shovel)	07:00-19:00	1	80%	810	8	9.33	0
EX250	Excavator:EX2500 (Specs for EX2600 260t 1119kW) (17m3 bucket/15m3 shovel)	07:00-19:00	1	80%	1119	8	3	0
CS400	Crusher and Screen:400t/hr:Mobile:Jaw:Powerscreen Premiertrac 400:Diesel	07:00-19:00	1	80%	300	2	1	0
LD966K	Loader:Wheel:Caterpillar 966K:199kW:3300-4100lt bucket	07:00-19:00	1	80%	199	2	2	0

Vehicle ID	Description	Work-ing hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
ADT23	Artic Dump Truck:22.7t:6x6:725C	07:00-19:00	1	80%	239	2	3	0
SG300	Screen:Simba Grid 300	07:00-19:00	1	80%	277	2	2	0
LD980	Loader:Wheel:980K:Quarry spec.:5300-5700lt bucket	07:00-19:00	1	80%	274	2	2	0
EX50	Tracked Excavator:50t:317kW:Cat349ELME: 3500lt Bucket:Mass Excavation	07:00-19:00	1	80%	295	2	2	0
ADT23	Artic Dump Truck:22.7t:6x6:725C	07:00-19:00	1	80%	239	2	4	0
CS400	Crusher and Screen:400t/hr:Mobile:Jaw:Powerscreen Premiertrac 400:Diesel	07:00-19:00	1	80%	300	6	2	1
LD966K	Loader:Wheel:Caterpillar 966K:199kW:3300-4100lt bucket	07:00-19:00	1	80%	199	6	2	1
ADT23	Artic Dump Truck:22.7t:6x6:725C	07:00-19:00	1	80%	239	6	4	1
SG300	Screen:Simba Grid 300	07:00-19:00	1	80%	277	6	2	1
R32	Bowser:Fuel:Truck Mounted:12,000lt:4X2	07:00-19:00	1	80%	160	1-9, A-C	2	2
R32	Mobile Workshop/ Lubrication Truck:4x4:inc welder & compressor	07:00-19:00	1	80%	160	1-9, A-C	1	1
R21	Tyre Truck:4x4:5t Crane	07:00-19:00	1	80%	50	1-9, A-C	1	1
DT820	1 x Twin mast drilling jumbo (Sandvik DT820 or similar)	07:30-07:30	16 hours	100%	110	11, 1	2	0
MEWP	2 x Basket lifter (MEWP) (Normet Himec 1125B or similar)	07:30-07:30	12 hours	100%	96	11	4	0
ITC312	1 x Tunnel Excavator/Loader per tunnel (Terex Shaeff ITC 312 or similar)	07:30-07:30	20 hours	100%	165	11	2	0
ADT23	1 x Articulated dump truck per tunnel (e.g. Volvo / Hydrema / Bell / Paus or simlar) Assumed small 23t tunnel dumper	07:30-07:30	20 hours	100%	239	11	2	0
SRMP	1 x Shotcrete robot per tunnel (e.g. Meyco Potenza / Normet or similar)	07:30-07:30	20 hours	100%	74	11	2	0
CN35	4 x Concrete remixer trucks per tunnel (e.g. Carmix or similar)	07:30-07:30	20 hours	100%	83	11	8	0
EX30	Tracked Excavator >30T (eg: Cat330D2?)	07:30-07:30	3 Hours	80%	157	11, 1	7.5	0

Vehicle ID	Description	Working hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
ADT30	Artic Dump Truck >30T (Assumed Cat 730C)	07:30-07:30	3 Hours	50%	274	Haul from 11, 1 to rock processing (6) - assume max of 0.5 day working	3	0
BD442	Tractor:Track:442kW:Caterpillar D10T:Ripper	07:00-19:00	1	80%	482	11, 1	1.25	0
P2	Diesel Generator (assumed 500kVa)	07:30-07:30	0 hours	100%	433	11	1.67	0
LD950	Loader:Wheel:Caterpillar 950K:172kW:2500-3300lt bucket:	07:30-07:30	3 Hours	80%	172	11	2	0
CC150	Tracked Mobile Crawler Crane (eg:Manitowoc MLC165-1)	07:30-07:30	3 Hours	60%	242	11	1	0
LR35	Telescopic Leader Rig (Hydraulic vibratory hammer)(eg; ABI TM13/16SL on SR35)	07:30-07:30	3 Hours	60%	390	11	1	0
R61	Tractor (assumed Agri Tractor:7760:89kW)	07:30-07:30	3 Hours	60%	89	11	1	0
EX60	Rock wheel cutter, 60T excavator, on spud leg barge	07:30-07:30	3 Hours	60%	433	11	0.83	0
P2A	Generator (1MVA)	07:30-07:30	3 hours	100%	866	11	1	0
R33	Truck Mixer: 8m3	07:30-07:30	3 hours	80%	201	11	3	0
EX110	110 tonne long reach excavator (eg;Leibherr 9100 110T Excavator)	7:00-18:00	1 Hour	60%	565	2, 10	0.83	0
BMD	Backhoe dredger (Eg; NordicGiant or Liebherr P955)	07:30-07:30	3 Hours	60%	1600	2, 10	0.83	0
P5	Jack Up Barge 1 (Deckmounted 100kVa generator)	6:00-19:00	2 Hours	60%	103	2, 10	0.5	0
P5	Jack Up Barge 2 (Deckmounted 100kVa generator)	6:00-19:00	2 Hours	60%	103	2, 10	0.25	0
EX75	70 tonne Excavator (eg; Cat 374)	7:00-18:00	2 Hours	60%	355	2, 10	3.33	0
ADT40	40 Tonne ADT	7:00-18:00	2 Hours	60%	365	2, 10	12.17	0
RD01	BG 42 Rotary Drill	7:00-18:00	2 Hours	60%	570	2, 10	0.33	0
P5	Jack Up Barge 3 ((Deckmounted 100kVa generator)	7:00-18:00	2 Hours	60%	103	2, 10	0.33	0
EX45	45 Tonne Excavator (eg: Cat 345	7:00-18:00	2 Hours	60%	295	2, 10	1.83	0

Vehicle ID	Description	Working hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
EX60	60 Tonne Excavator (eg: Cat365)	7:00-18:00	2 Hours	60%	433	2, 10	1.83	0
CC251	250 Tonne Crawler Crane (eg: Kobelco CKE 2500: 247kW) 24hr	07:30-07:30	2 Hours	50%	247	2, 10	1.67	0
CC251	250 Tonne Crawler Crane (eg: Kobelco CKE 2500: 247kW) 10hr	0700-18:00	1 Hour	50%	247	2, 10	1.67	0
CC150	150 Tonne Crawler Crane (eg:Manitowoc MLC165-1)	7:00-18:00	2 Hours	60%	242	2, 10	2	0
CC90	90 tonne crawler crane	7:00-18:00	2 Hours	60%	247	2, 10	1.42	0
CC300	300 Tonne Crawler Crane (eg: Leibherr LR1300)	7:00-18:00	2 Hours	60%	336	2, 10	0.83	0
DR1100	Drill and blast rig 1	7:00-18:00	2 Hours	60%	224	2, 10	3.58	0
EX35	35 Tonne Excavator (eg: Cat335)	7:00-18:00	2 Hours	60%	225	2, 10	3.92	0
ADT30	30 Tonne DT	7:00-18:00	2 Hours	60%	274	2, 10	2.33	0
EX60	60 tonne excavator	7:00-18:00	2 Hours	60%	433	2, 10	0.42	0
CC70	70 tonne Crawler Crane	7:00-18:00	2 Hours	60%	213	2, 10	0.42	0
LR35	Leader rig inc opp (eg; ABI TM13/16SL on SR35)	7:00-18:00	2 Hours	60%	390	2, 10	0.08	0
DR1100	Drilling Rig (eg; CHA 1100)	7:00-18:00	2 Hours	60%	224	2, 10	0.08	0
M01	Tug Holyhead Towing - 24 hour working but only on site for 6 hours out of 72 for each barge	7:30-7:30	2 Hours	60%	4200	2, 10	2.5	0
VS500	Vibratory Screen (eg; CMB BX500B)	7:00-18:00	2 Hours	60%	103	2, 10	0.67	0
LD938	Loader: Wheeled:Cat938M 2.5-5m3 bucket	7:00-18:00	2 Hours	60%	172	2, 10	0.67	0
RIB	Safety Boat (assumed to be Standard 6m Rigid Inflatable Boat ~110hp 80kW)	07:30-07:30	2 Hours	10%	80	2, 10	0.67	0
M12	Multicat MTS Vector: 2x 600hp CAT C18 engine	07:30-07:30	2 Hours	30%	900	2, 10	1.33	0
M02	Split Hopper Barge (eg; Jan de Nul Arent class 2x1850kW)	07:30-07:30	2 Hours	60%	1850	2, 10	2.83	0
P4	MEWP	7:00-18:00	2 Hours	30%	35	2, 10	1.25	0

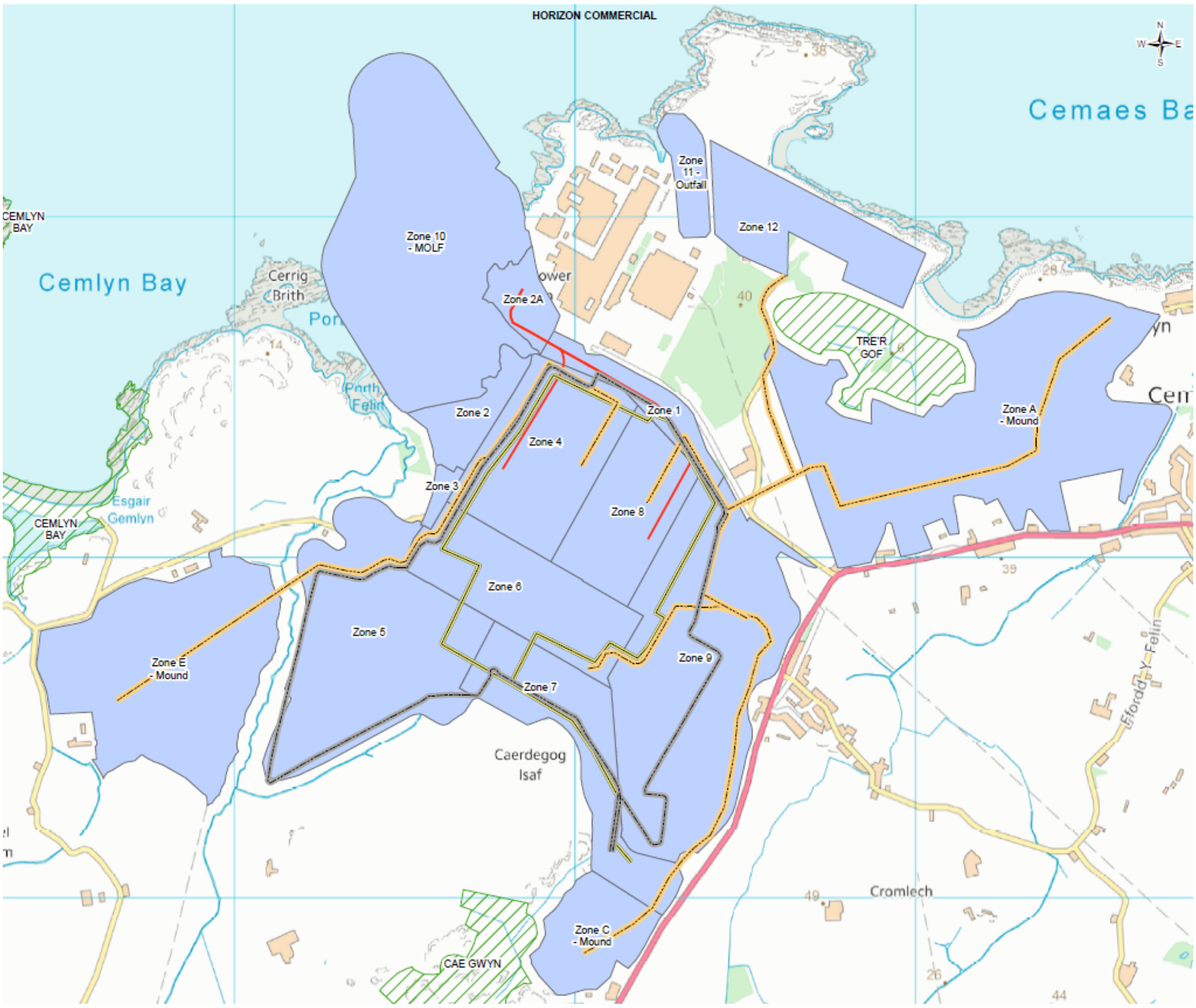
Vehicle ID	Description	Working hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
R35	Mobile Concrete Pump 25m3 - Boom Truck Pump for Anti-Collision Barrier and Top of MOLF	7:00-18:00	2 Hours	30%	231	2, 10	0.67	0
R61	Tractor and Trailer (Assumed tractor andtrailerfordust mitigation spraying)	07:30-07:30	3 Hours	60%	89	2, 10	2	0
P5	Jackup Split barge / barge	07:30-07:30	3 Hours	60%	103	2, 10	4.25	0
BMD	Backhoe dredger (Eg; NordicGiant or Liebherr P955)	07:30-07:30	3 Hours	60%	1600	2, 10	1	0
P1	Diesel Generators 50kVa for Lighting (Diesel worst case, could be mains powered or Hydrogen Fuel Cell if required)	07:30-07:30	0 Hours	100%	45.5	2, 10	4	0
CSD	Cutter Suction Dreger	07:30-07:30	0 Hours	100%	24702	2, 10	0.08	0
P2A	Generator (1MWe) to power 40m3 batching plant and then standby for full batching plant	07:30-07:30	3 hours	100%	866	2A	0.25	0
LD966G	Loader:Wheel:966G:(3300-4100lt)	07:30-07:30	3 hours	80%	160	2A	0.25	1
R33	Truck Mixer: 8m3	07:30-07:30	3 hours	80%	201	4, 6, 8	0.5	4
R33	Truck Mixer: 8m3	07:30-07:30	3 hours	80%	201	2-9	0.5	3
R33	Concrete Pump:Truck: 34m Boom; Max output 90m3/hr plus	07:30-07:30	3 hours	80%	201	4, 6, 8	0.25	2
P1	Compressor:180cfm(5m3/m):Diesel	07:30-07:30	3 hours	80%	45.5	4, 6, 8	0.5	3
R30	Tractor Unit:56t GCW:Tows Low loader with 30t capacity	07:00-19:00	1	80%	89	4, 6, 8	0.33	4
CC100	Crane:Crawler:100t:Manitowoc MTW12000:Lattice boom	07:30-07:30	3 Hours	80%	247	4	0	0
CC100	Crane:Crawler:100t:Manitowoc MTW12000:Lattice boom	07:30-07:30	3 Hours	80%	247	4	0.5	2.08
CC100	Crane:Crawler:100t:Manitowoc MTW12000:Lattice boom	07:30-07:30	3 Hours	80%	247	4	0.25	1.08
C90	Crane: Rough Terrain:90t:Grove RT9130E-2	07:30-07:30	3 Hours	80%	239	4	0.5	1
C30	Crane: All Terrain: 30t	07:30-07:30	3 Hours	80%	275	4	1.83	4
CC100	Crane:Crawler:100t:Manitowoc MTW12000:Lattice boom	07:30-07:30	3 Hours	80%	247	8	0	3
CC100	Crane:Crawler:100t:Manitowoc MTW12000:Lattice boom	07:30-07:30	3 Hours	80%	247	8	0	2

Vehicle ID	Description	Working hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
CC100	Crane:Crawler:100t:Manitowoc MTW12000:Lattice boom	07:30-07:30	3 Hours	80%	247	8	0	2
C90	Crane: Rough Terrain:90t:Grove RT9130E-2	07:30-07:30	3 Hours	80%	239	8	0	8
C30	Crane: All Terrain: 30t	07:30-07:30	3 Hours	80%	275	8	0	8
P4	Access Platform:20m:Telescopic:RT:Genie model S65	07:30-07:30	3 Hours	80%	35	4, 8	0.25	2
P4	Access Platform:13m:Scissor:Slab:680kg - Genie model 4390 RT 2WD	07:30-07:30	3 Hours	80%	35	4, 8	0.25	2
R50	Workman's Bus:60 Seat	06:00	20:00	50%	210	From N security plaze to Site Campus	7.25	10
R50	Workman's Bus:60 Seat	06:00	20:00	50%	210	Haul / site roads	8	24
R23	Pick Up:4x2:Diesel:2415GVW:1090kg Payload:Toyota	06:00	20:00	50%	132	Haul / site roads	3.67	12
R22	Van:Diesel:1.9t GVW:675kg Payload:Escort	06:00	20:00	50%	80	Haul / site roads	3.67	12
R50	Workman's Bus:60 Seat	20:00	06:00	50%	210	Haul / site roads	1	3.5
FL3	Forklift:Rough Terrain: 3.0t:JCB930 - 4	06:00	20:00	50%	55	Haul / site roads	1	22
TH4C	Telehandler:4t:17m Up:12m Out:Rough Terrain:Caterpillar TH417C AC	06:00	20:00	50%	75	Haul / site roads	1	22
R61	Agri Tractor:7760:89kW	06:00	20:00	50%	89	Haul / site roads	1	8
R31	Flat Truck:30,000kg:18tm Crane:4x4:	06:00	20:00	50%	50	Haul / site roads	1	22
R32	Bowser:Water:Truck mounted:10,000lt:4x2	06:00	20:00	50%	160	Haul / site roads	2	2
R32	Road Sweeper:Truck Mounted:Vacuum	06:00	20:00	50%	160	Haul / site roads	2	4
CC300	300 Tonne Crawler Crane (eg: Leibherr LR1300)	7:00-18:00	2 Hours	80%	336	12	1	0

Vehicle ID	Description	Working hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
EX35	3x 35 Tonne Excavator (eg: Cat335)	7:00-18:00	2 Hours	80%	225	12	2.25	0.25
CO32	compactor:32t:Caterpillar 825G	07:00-19:00	1	80%	254	12	1.5	0
GD26	Grader:26t:222kW:Caterpillar 16M Artic	7:00-18:00	2 Hours	80%	243	12	1.5	0.25
P1	2x Compressor, Diesel	07:00-19:00	1	80%	45.5	12	2	0.5
R35	2x Concrete Pump:Truck: 34m Boom; Max output 90m3/hr plus	07:00-19:00	1	80%	231	12	1.75	0
C30	Crane: All Terrain, 30T	7:00-18:00	2 Hours	80%	275	12	0.75	0
C50	Crane: All Terrain, 50T	07:00-19:00	1	80%	280	12	0.58	0.08
C90	Crane: Rough Terrain:90t:Grove RT9130E-2	07:00-19:00	1	80%	239	12	0	0
ADT23	4 x Articulated dump trucks (e.g. Volvo / Hydrema / Bell / Paus or simlar)	7:00-18:00	2 Hours	80%	239	12	4	0.17
R32	Road Sweeper:Truck Mounted:Vacuum	07:00-19:00	1	80%	160	12	1	0.25
R22	2x Van:Diesel: Payload:Escort	7:00-18:00	2 Hours	80%	80	12	2	0.5
TH3	2x Telehandler:3t:Rough Terrain:Merlo ROTO 38.16K:Tunnel Rib Handler:Access Basket	07:00-19:00	1	80%	74.9	12	1	0.5
R31	4x Flat Truck:30,000kg:18tm Crane:4x4:	7:00-18:00	2 Hours	80%	50	12	2.25	0.67
P2	3x Generator 500 kVA	07:00-19:00	1	80%	433	12	2.75	0.5
R33	6x Truck Mixer	07:00-19:00	1	80%	201	12	5	1
R32	Bowser:Water:Truck mounted:10,000lt:4x2	7:00-18:00	2 Hours	80%	160	12	1	0.33
EX75	Tracked Excavator:75t:352kW:Cat374FLME: 5000lt bucket:Mass excavation	07:00-19:00	1	80%	355	A	0	0
ADT40	Artic Dump Truck:39.5t:365kW:6x6:Caterpillar 740B	07:00-19:00	1	80%	365	9, A	0	0
BD228	Tractor:Track:228kW:D8T	07:00-19:00	1	80%	268	9, A	0	0
RO16	Roller:Steel/Rubber:16t:129kW:Caterpillar CS74B	07:00-19:00	1	80%	129.5	9, A	0	0

Vehicle ID	Description	Work-ing hours	Breaks	% of shift under load	Engine size (kW)	Work areas	2019–2020 average plant	2023 average plant
CO32	Compactor:32t:Caterpillar 825G	07:00-19:00	1	80%	254	9, A	0	0
BD123	Tractor:Track:123kW:Caterpillar D6T LGP	07:00-19:00	1	80%	171	9, A	0	0
EX35	35 Tonne Excavator (eg: Cat335)	0	1	80%	225	9	0	0
GD26	Grader:26t:222kW:Caterpillar 16M Artic	07:00-19:00	1	80%	243	9, A	0	0
EX75	Tracked Excavator:75t:352kW:Cat374FLME:5000lt bucket:Mass excavation	07:00-19:00	1	80%	355	E	0	0
ADT40	Artic Dump Truck:39.5t:365kW:6x6:Caterpillar 740B	07:00-19:00	1	80%	365	5, E	0	0
BD228	Tractor:Track:228kW:D8T	07:00-19:00	1	80%	268	E, 5	0	0
RO16	Roller:Steel/Rubber:16t:129kW:Caterpillar CS74B	07:00-19:00	1	80%	129.5	E, 5	0	0
CO32	Compactor:32t:Caterpillar 825G	07:00-19:00	1	80%	254	E, 5	0	0
EX35	35 Tonne Excavator (eg: Cat335)	0	1	80%	225	5	0	0
BD123	Tractor:Track:123kW:Caterpillar D6T LGP	07:00-19:00	1	80%	171	E, 5	0	0
GD26	Grader:26t:222kW:Caterpillar 16M Artic	07:00-19:00	1	80%	243	5, E	0	0

Figure A1 Construction Work Areas



Appendix B
Meteorological data wind roses

Figure B1 2007 wind rose

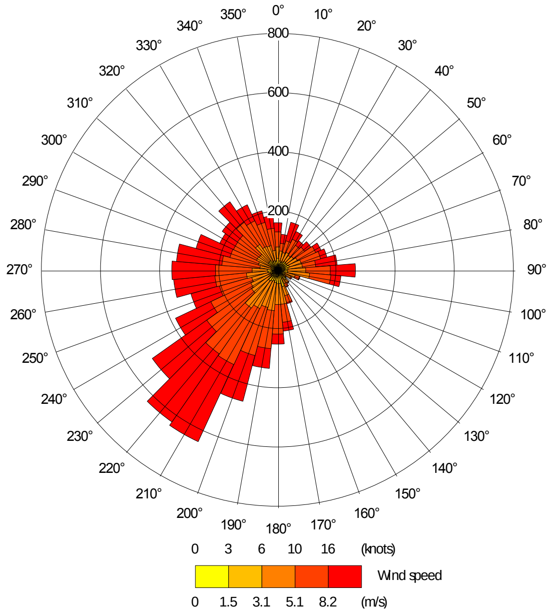


Figure B2 2008 wind rose

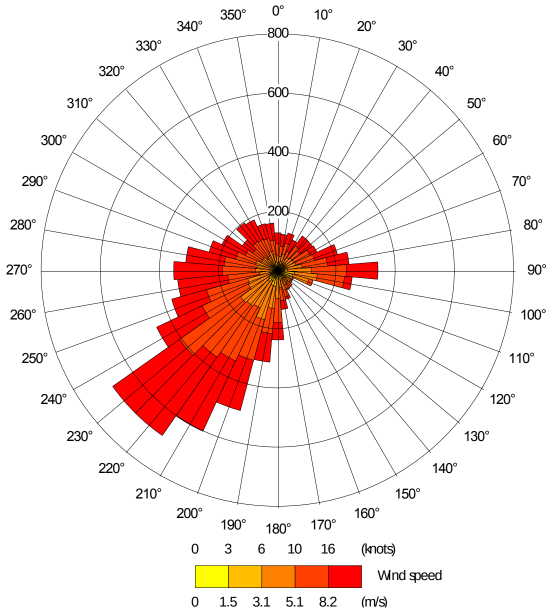


Figure B3 2009 wind rose

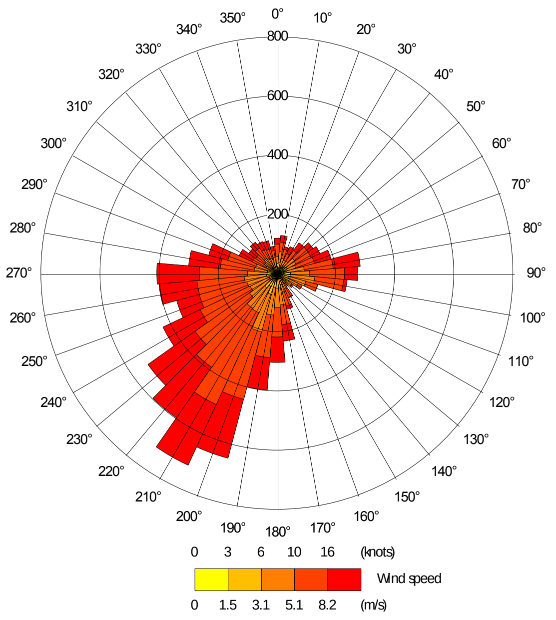


Figure B4 2010 wind rose

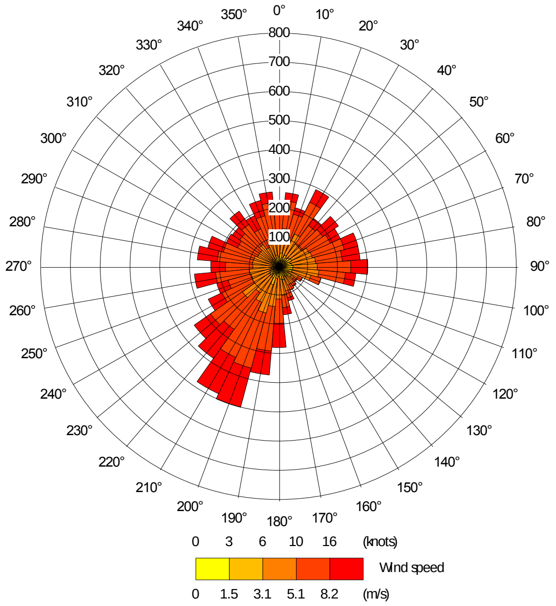


Figure B5 2011 wind rose

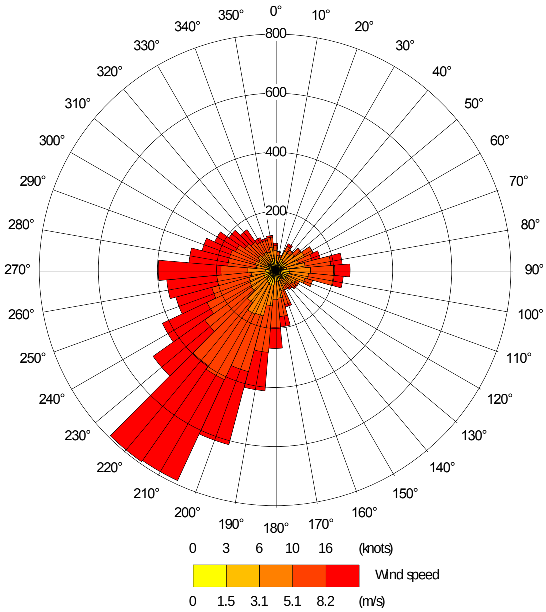


Figure B6 2012 wind rose

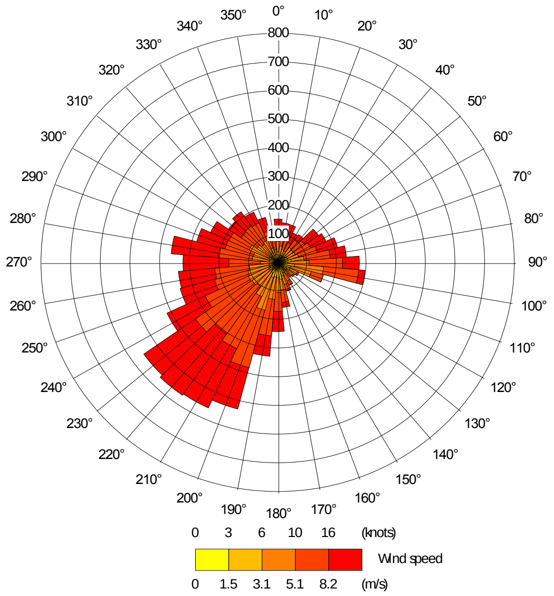


Figure B7 2013 wind rose

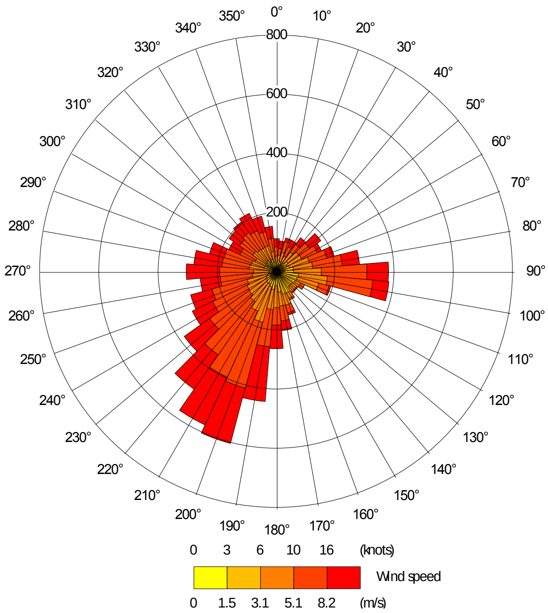


Figure B8 2014 wind rose

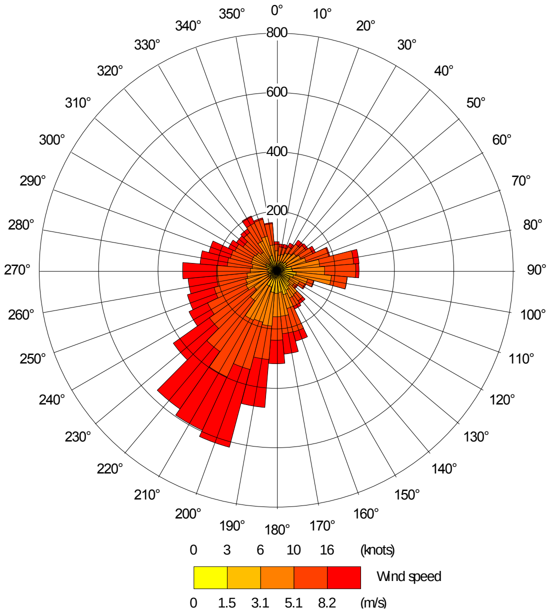


Figure B9 2015 wind rose

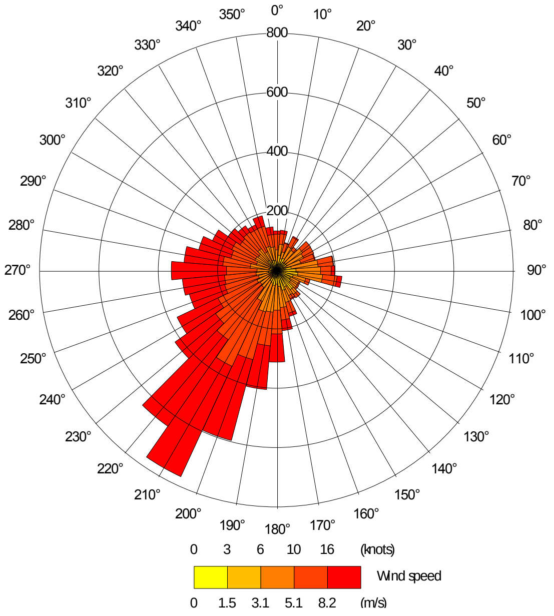
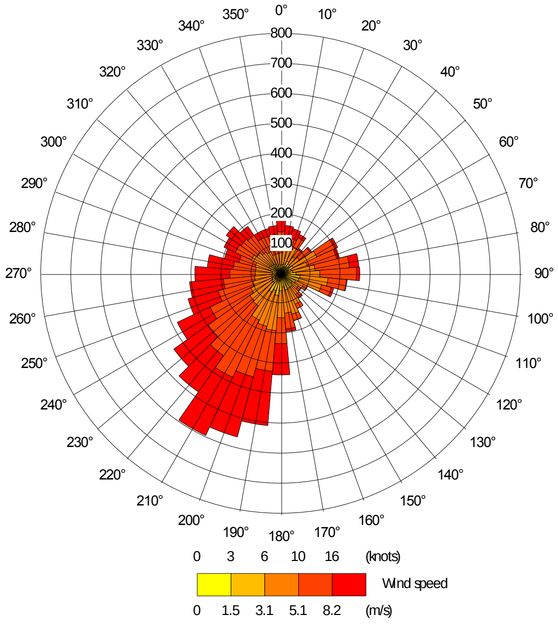


Figure B10 2016 wind rose



Appendix C
Human and ecological receptor locations

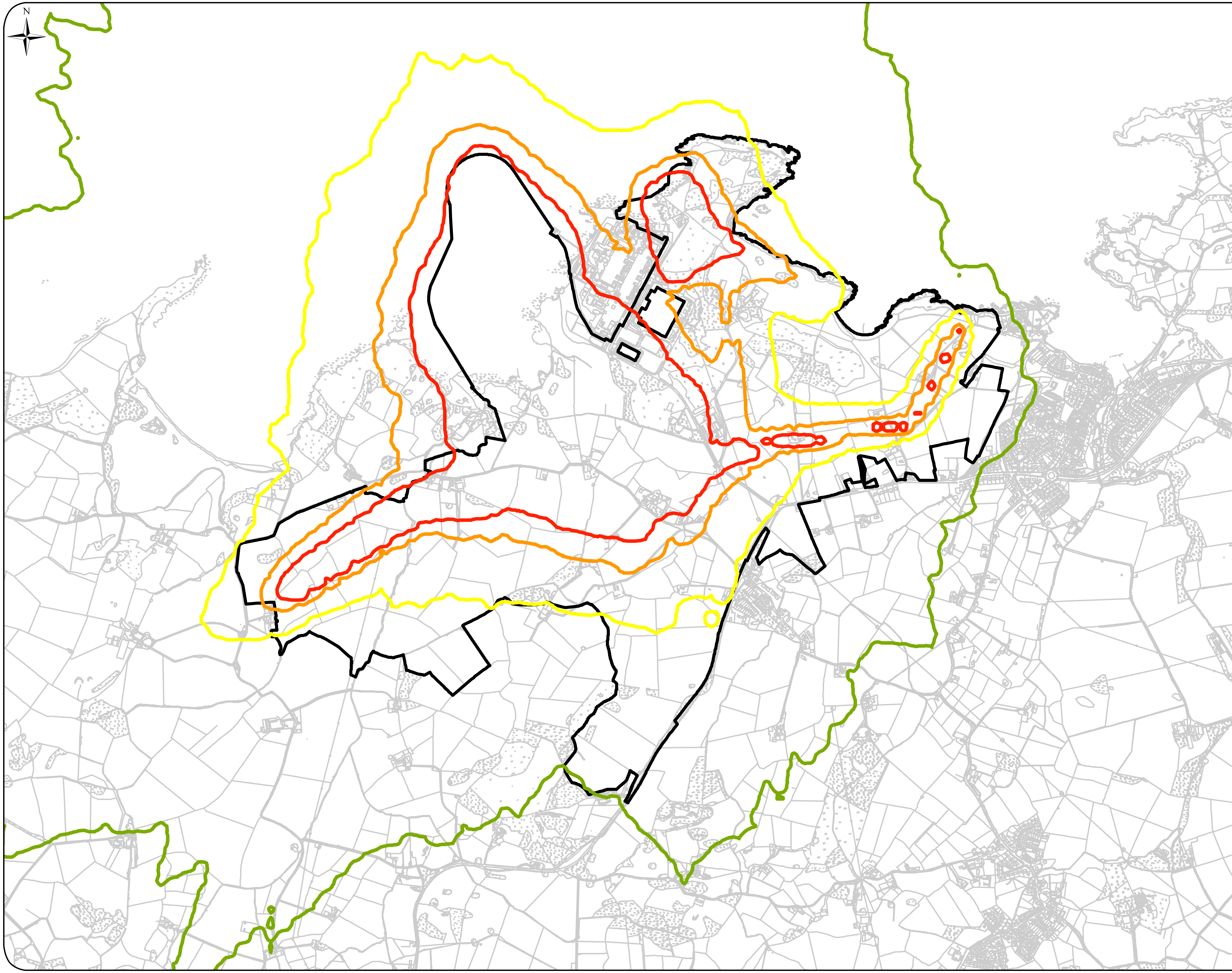
Excel file:

[This appendix will not be shown in the hard copy and only available electronically due to the size of the appendix]

Appendix D
Model results

[This appendix will not be shown in the hard copy and only available electronically due to the size of the appendix]

Appendix E
Concentration isopleths



LEGEND

Wylfa Newydd Development Area

One Hour Mean Process Contribution for NO_2 (µg/m^3)

20

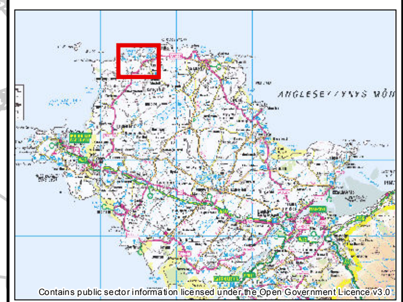
50

100

150

200

Construction Plant (2020, Stage IIIB) 99.79th Percentile 1-hour Mean NO_2 Process Contribution



Scale: 1:15,000

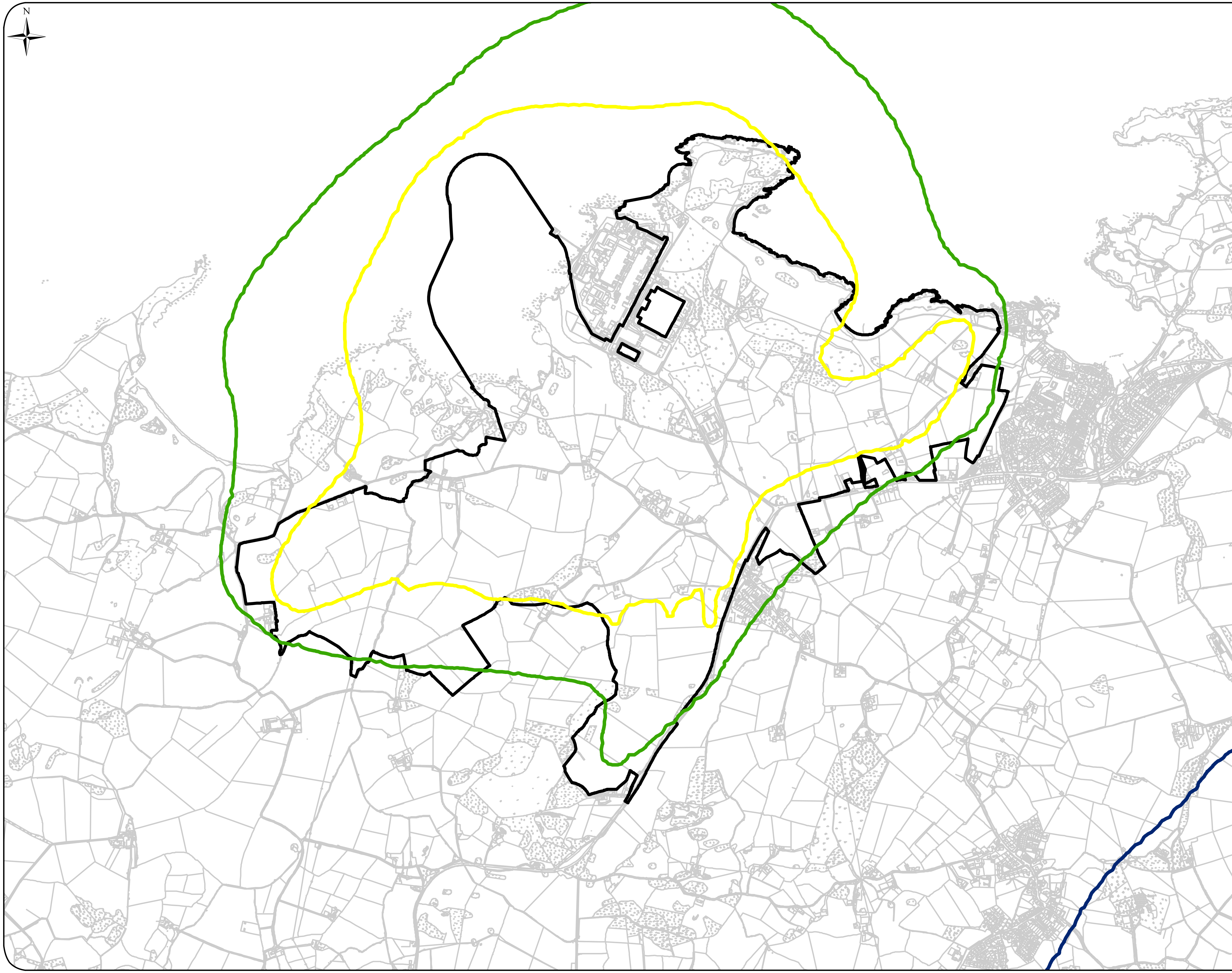
When printed at A3

0 150 300 450 M

HORIZON NUCLEAR POWER

NOT PROTECTIVELY MARKED

35989-Lon602 Hourly Mean NO2 Process Contribution 2020 Stage IIIB



LEGEND

Wylfa Newydd Development Area

Annual Mean Process Contribution for NO_2 ($\mu g/m^3$)

0.4

1

5

10

Construction Plant (2020, Stage IIIB) Annual Mean NO_2 Process Contribution

Scale: 1:15,000

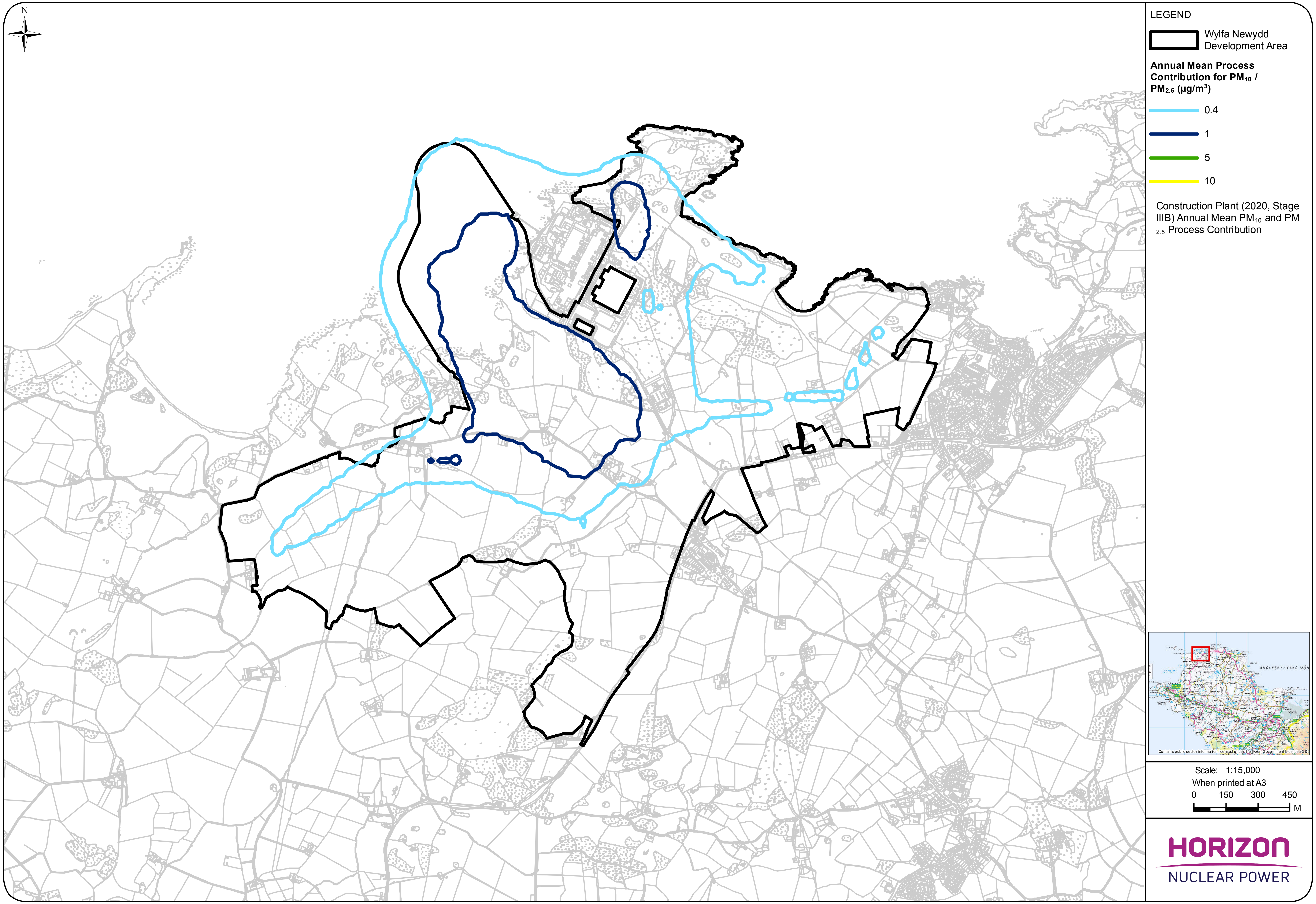
When printed at A3

0 150 300 450 M

HORIZON

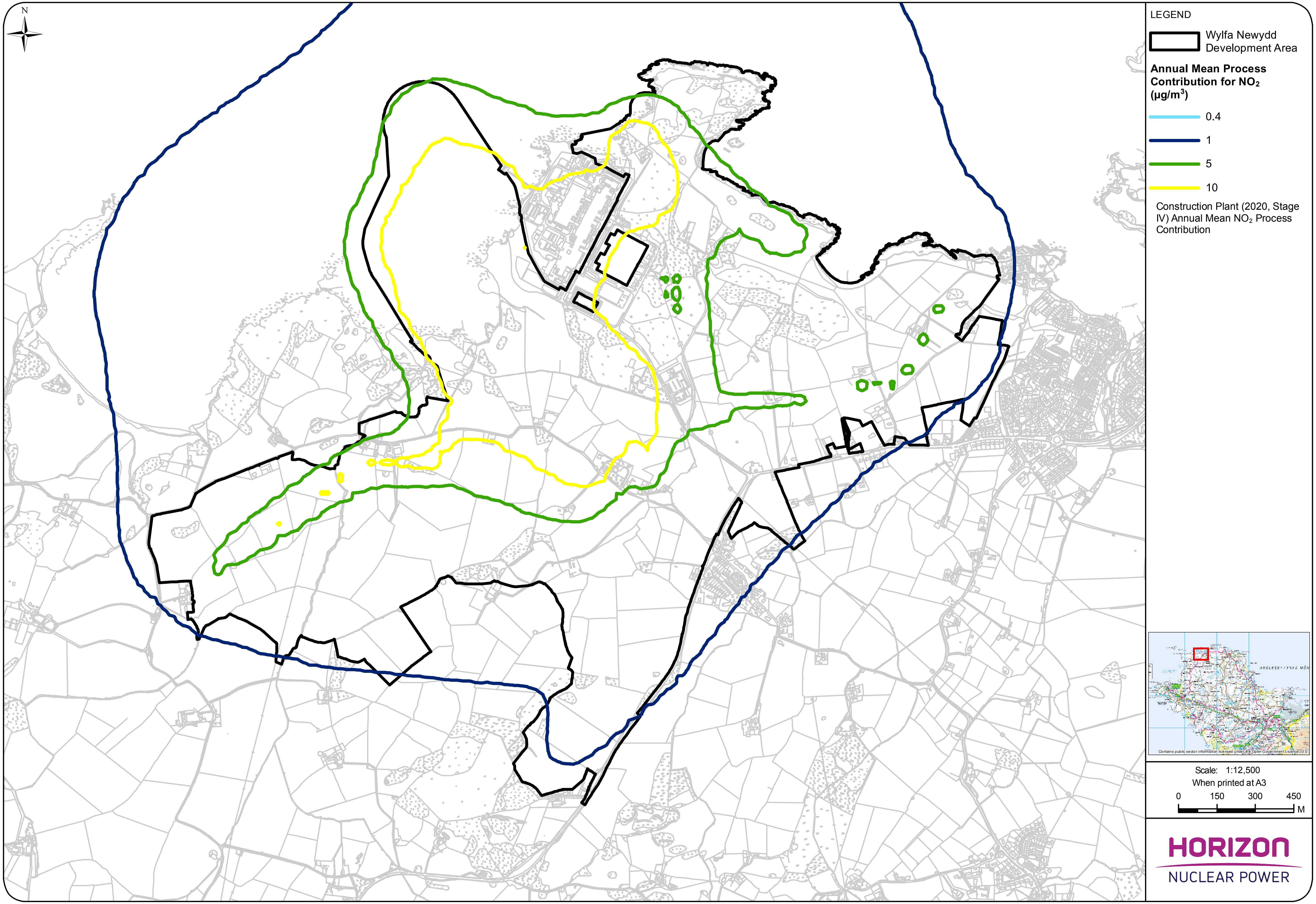
NUCLEAR POWER

NOT PROTECTIVELY MARKED



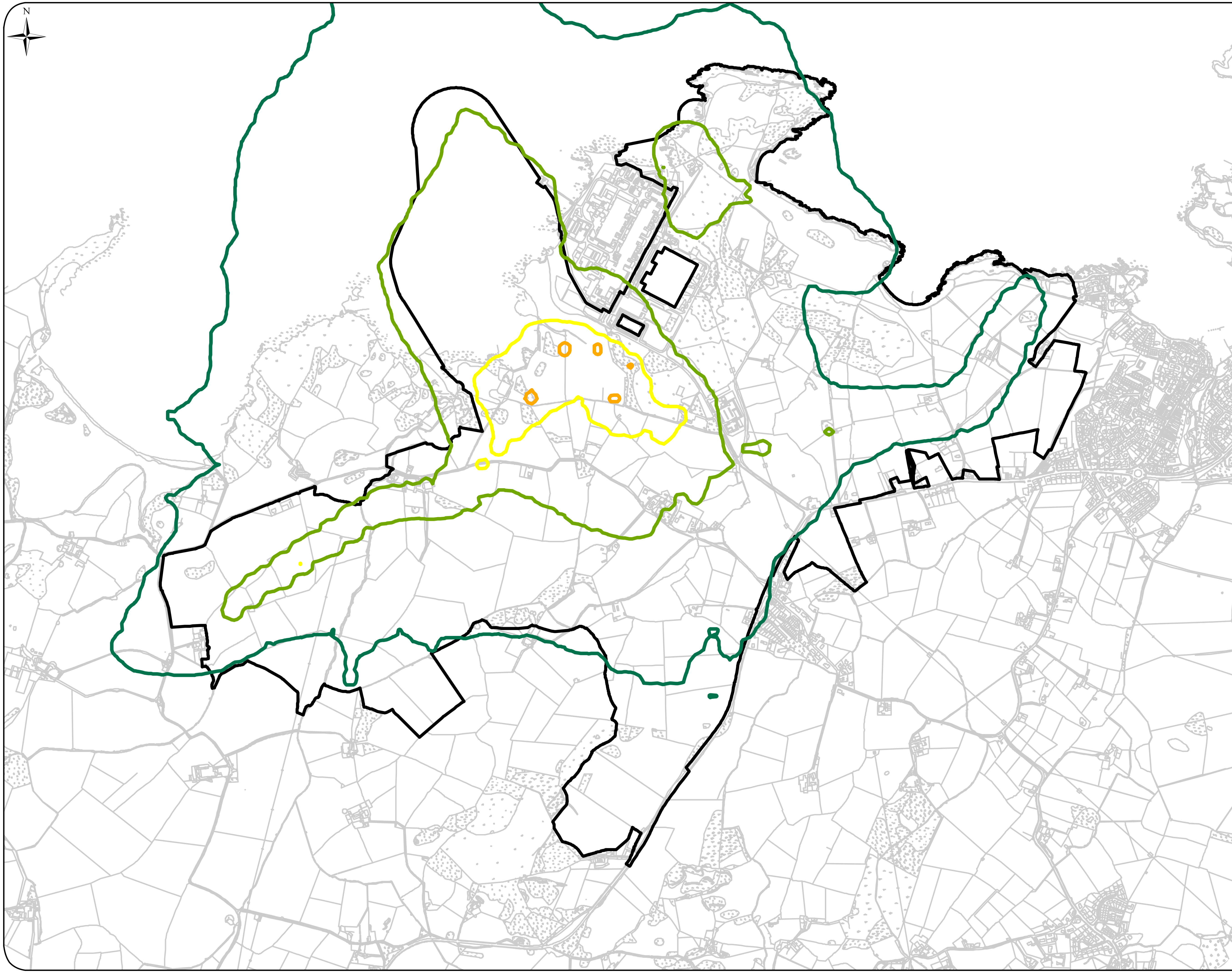
NOT PROTECTIVELY MARKED

35989-Lon604 Annual Mean PM10PM2.5 Process Contribution 2020 Stage IIIB



NOT PROTECTIVELY MARKED

35989-Lon605 Annual Mean NO2 Process Contribution 2020 Stage IV



LEGEND

Wylfa Newydd Development Area

Hourly Mean Process Contribution for NO_2 ($\mu g/m^3$)

- 20
- 50
- 100
- 150
- 200

Construction Plant (2020, Stage IV) 99.79th Percentile 1-hour Mean NO_2 Process Contribution

Scale: 1:12,500
When printed at A3

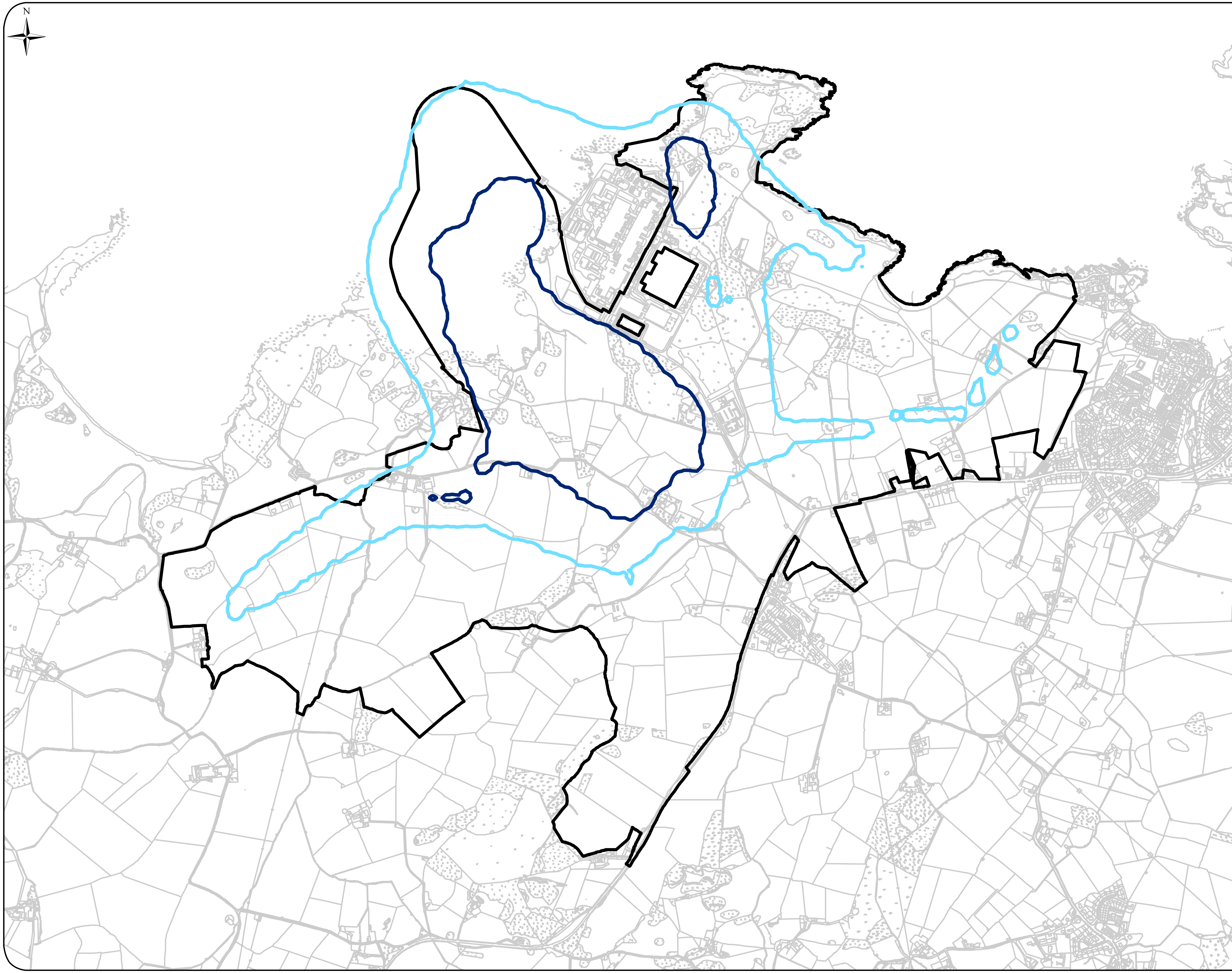
0 150 300 450 M

HORIZON
NUCLEAR POWER

Licence information for additional legend items can be found at the end of this Volume

NOT PROTECTIVELY MARKED

35989-Lon606 Hourly Mean NO2 Process Contribution 2020 Stage IV



LEGEND

Wylfa Newydd Development Area

Annual Mean Process Contribution for PM_{10} / $PM_{2.5}$ ($\mu g/m^3$)

CONTOUR

- 0.4
- 1
- 5
- 10

Construction Plant (2020, Stage IV) Annual Mean PM_{10} and $PM_{2.5}$ Process Contribution

Scale: 1:12,500

When printed at A3

0 150 300 450 M

HORIZON

NUCLEAR POWER

NOT PROTECTIVELY MARKED

35989-Lon607 Annual Mean PM10PM2.5 Process Contribution 2020 Stage IV