CHAPTER 6 – AIR QUALITY

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List of Acronyms

AAD	Ambient Air Directive
ADMS	Atmospheric Dispersion Modelling System
APIS	Air Pollution Information System
AQA	Air Quality Assessment
AQDD	Air Quality Daughter Directive
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQS	Air Quality Standard
BAT	Best Available Techniques
Bref	Best Available Techniques Reference Document
Broad Energy	Broad Energy (Wales) Limited
cSAC	Candidate Special Areas of Conservation
DEFRA	Department for Environment, Food and Rural Affairs
Development	All activities within the red line planning boundary (see Drawing ECL-BQ-000 in Technical Appendix TA1-1)
Development Site	The physical site on which the Development is to be located as defined by the red line planning boundary (see Drawing ECL-BQ-000 in Technical Appendix TA1-1)
DNS	Development of National Significance
DT	Diffusion Tube
EA	Environment Agency
ECL	Environmental Compliance Ltd
EIA	Environmental Impact Assessment
ELV	Emission Limit Value
EP	Environmental Permit
EPR	Environmental Permitting Regulations
EPUK	Environmental Protection UK
EPAQS	Expert Panel on Air Quality Standards
ERF	Energy Recovery Facility
EQS	Environmental Quality Standard
GLC	Ground Level Concentration
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IAQM	Institute of Air Quality Management
IED	Industrial Emissions Directive
LDV	Light Duty Vehicle
LDP	Local Development Plan
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NRW	Natural Resources Wales
NWP	Numerical Weather Prediction
PC	Process Contribution
PEC	Predicted Environmental Concentration
PM_{10}	Particulate Matter (with a diameter of 10 µm or less)
$PM_{2.5}$	Particulate Matter (with a diameter of2.5 µm or less)
PPW	Planning Policy Wales
Ramsar	Ramsar Convention on Wetlands of International Importance

List of Acronyms (cont)

SAC	Special Areas of Conservation
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Areas
SSSI	Site of Special Scientific Interest
The Installation	Buttington Energy Recovery Facility
WHO	World Health Organisation

List of Amendments

- A Dust Assessment for the construction phase has been undertaken and the results provided as Technical Appendix 6-3. Reference to the Dust Assessment has been made in the Construction Effects (Section 6.4) section of this chapter.
- An assessment of the construction phase traffic on ecological sites has been undertaken and is provided in the Construction Effects (Section 6.4) section of this chapter and Technical Appendix 6.2.
- A section on Temperature Inversions has been added to the Operational Effects (Section 6.4) section of this Chapter.
- A cumulative assessment of construction phase traffic together with emissions from the main ERF stack has been undertaken and is provided in the Section on the Development in Combination with Other Developments (Section 6.4).
- A cumulative assessment of ERF together with emissions from an Intensive Livestock Unit has been undertaken and is provided in the Section on the Development in Combination with Other Developments (Section 6.4

6. AIR QUALITY

6.1. Introduction

6.1.1. This chapter sets out the likely effects that would result from the proposed Buttington Energy Recovery Facility ("ERF") in relation to Air Quality.

6.1.2. This chapter is supported by Technical Appendix 6-1 which contains the detailed Air Quality Assessment ("AQA") including Stack Height Screening Assessment, and Technical Appendix 6-2 which contains the Air Quality Assessment of Road Emissions.

6.1.3. This chapter contains the relevant aspects of the AQA from an environmental impact assessment perspective and has been prepared by ECL.

6.2. Relevant Legislation

6.2.1. The relevant planning documents, from an air quality perspective, at a National level are Planning Policy Wales 2018 Edition 10[i] ("PPW"), the National Air Quality objectives contained within the Air Quality (Wales) Regulations 2000[ii] (as amended), and the Industrial Emissions Directive ("IED")[iii]. Local planning requirements are set out in the Adopted Powys Local Development Plan 2011-2026[iv] ("Powys LDP").

National Air Quality Policies

6.2.2. PPW 10 states at Paragraph 6.1.32 that "*When considering a scheme of enabling development, planning permission should be granted only where all of the following can be applied….the enabling development does not give rise to significant risks for example residential development in the floodplain or significantly impact on air quality or soundscape*".

6.2.3. It should be noted that at Paragraph 6.72, National air quality objectives are not "safe" levels of air pollution. Rather they represent a pragmatic threshold above which government considers the health risks associated with air pollution are unacceptable. Air just barely compliant with these objectives is not clean and still carries long-term population health risks". This application will seek to demonstrate that emissions from the ERF are substantially lower than the air quality objectives. To demonstrate this, and assist the decision making, a technical air quality assessment undertaken by a suitably qualified person has been undertaken in accordance with PPW10 (Paragraph 6.77).

National Air Quality Objectives

6.2.4. As described above, the national air quality objectives for Wales represent pragmatic thresholds which have been set for the protection of human health. These are set out in the Air Quality (Wales) Regulations 2000 (and subsequent amendments). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland[v] also details Air Quality

Strategy Objectives for a range of pollutants, including a number that are directly relevant to this study.

6.2.5. In addition, the 4th Air Quality Daughter Directive[vi] ("AQDD") details Target Values for arsenic, cadmium and nickel, and the Expert Panel on Air Quality Standards ("EPAQS"), which advises the UK Government on air quality, has also set recommended Guideline Values for arsenic, chromium VI and nickel. Where the values differ, the lowest of these values have been taken into account in this study.

6.2.6. In the case of hydrogen chloride, hydrogen fluoride, chromium (VI) and arsenic, EPAQS has set recommended Guideline Values which have been taken into account in this study.

6.2.7. Environmental Quality Standards ("EQSs") have been assigned by NRW (by the use of the Environment Agency's ("EA") environmental quality standards ("EQS")) to a number of the other pollutants assessed in the modelling study; these are detailed (where assigned) in the EA's online guidance; and have been derived from a variety of published UK and international sources (including the World Health Organisation ("WHO")).

6.2.8. For ease of description, the generic term Air Quality Standard ("AQS") is used to refer to any of the above objectives/target values/EQS. All values used are detailed in Section 2 of the AQA in Technical Appendix 6.1.

Vehicle Emissions

6.2.9. The IAQM guidance document Land-Use Planning and Development Control[vii] provides indicative criteria to determine if an air quality assessment is required. The relevant criteria (see Table 6.2 of the IAQM guidance) to this assessment are provided in Table 6-1.

Table 6-1: Criteria for Air Quality Assessment

The development will:	Indicative criteria
Cause a significant change in Light Duty Vehicle (LDV) traffic flows on local roads with relevant receptors. (LDV = cars and small vans)	A change of LDV flows of: - more than 100 AADT within or adjacent to an AQMA - more than 500 AADT elsewhere.
Cause a significant change in Heavy Duty Vehicle (HDV) flows on local roads with relevant receptors. (HDV = goods vehicles + buses >3.5t gross vehicle weight).	A change of HDV flows of: - more than 25 AADT within or adjacent to an AQMA - more than 100 AADT elsewhere.
Realign roads, i.e. changing the proximity of receptors to traffic lanes.	Where the change is 5m or more and the road is within an AQMA
Introduce a new junction or remove an existing junction near to relevant receptors.	Applies to junctions that cause traffic to significantly change vehicle accelerate/decelerate, e.g. traffic lights, or roundabouts.

Table6-1: Criteria for Air Quality Assessment (cont)

The development will:	Indicative criteria
Have one or more substantial combustion processes, where there is a risk of impacts at relevant receptors. NB. this includes combustion plant associated with standby emergency generators (typically associated with centralised energy centres) and shipping.	Typically, any combustion plant where the single or combined NOx emission rate is less than 5 mg/sec is unlikely to give rise to impacts, provided that the emissions are released from a vent or stack in a location and at a height that provides adequate dispersion. In situations where the emissions are released close to buildings with relevant receptors, or where the dispersion of the plume may be adversely affected by the size and/or height of adjacent buildings (including situations where the stack height is lower than the receptor) then consideration will need to be given to potential impacts at much lower emission rates. Conversely, where existing nitrogen dioxide concentrations are low, and where the dispersion conditions are favourable, a much higher emission rate may be acceptable.

Industrial Emissions Directive

6.2.10. The IED has imposed extremely stringent controls on all installations that thermally treat most types of waste, and prescribe emission limit values that must be complied with. In addition to this, the EU publish Best Available Techniques reference documents ("BREFs"). These are a series of reference documents that cover most industrial processes, they describe various operations condition and emission rates. The BREFs are used by NRW to set emission limits for processes such as the ERF. The ELVs set by the IED are currently higher than the BREF limits, however, to ensure that the Buttington ERF is operating in accordance with the best performing plants, the ELVs used in the modelling study are aligned with the limits set in the BREF. These are lower than the current legal requirements, particularly in the case of nitrogen dioxide, where a limit 120µg/m^3 is proposed compared to the current IED limit of 200µg/m^3

Powys Local Development Plan 2011-2026

6.2.11. The Adopted Powys LDP states at Policy DM14 – Air Quality Management:

> Development proposals will only be permitted where any resultant air pollution does not cause or lead to an unacceptable risk of harm to human health or the natural environment.
> Proposals will need to demonstrate that measures can be taken to overcome any significant adverse risk, with particular attention being paid to:
> 1. National Air Quality Strategy objective and Air Quality Management Areas.
> 2. The critical levels for the protection of habitat and species within a European site or Site of Special Scientific Interest in accordance with Policy DM2.

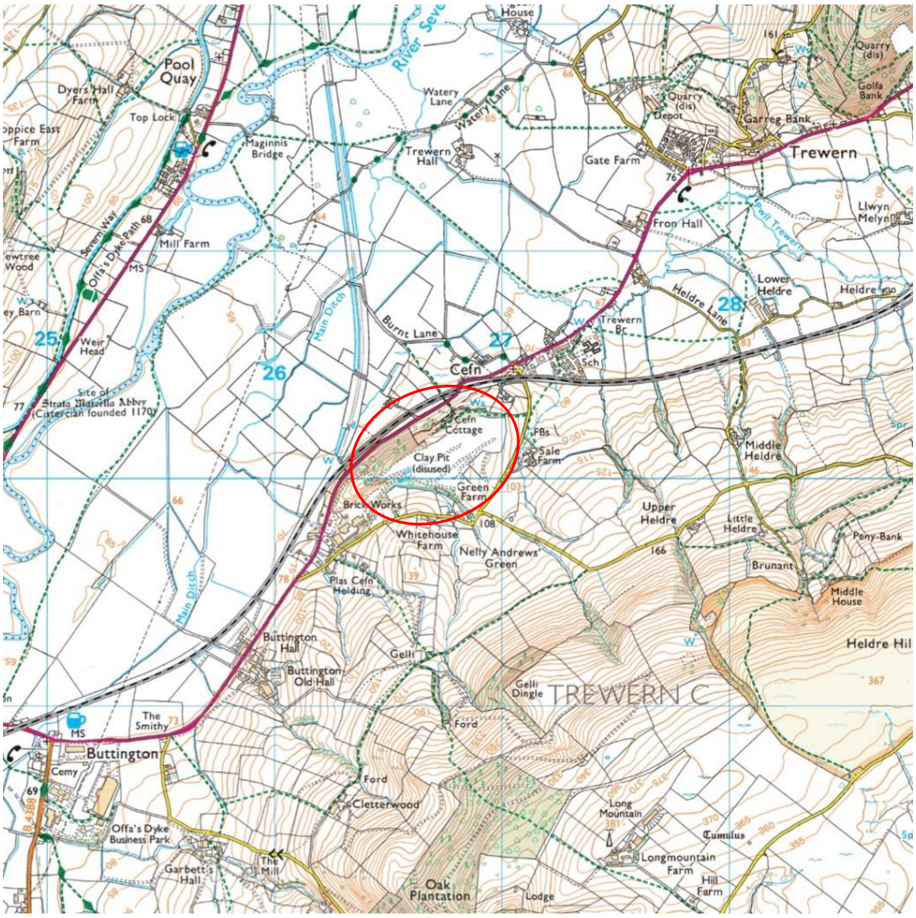
6.2.12. As discussed in Section 6.2.3. this assessment seeks to demonstrate that there is no significant risk to air quality objectives. The ERP is remote from air quality management areas, therefore will not impact on any such areas within Powys. An assessment of the impact on various ecological sites is provided in the AQA in Technical Appendix 6.1.

6.3. The Existing Environment

Environmental Assessment Boundary

6.3.1. The approximate site location is shown on the Site Location Map, outlined in red, which is presented as Figure 1.

Figure 6-1: Site Location Map



6.3.2. The study will predict maximum ground level concentrations ("GLCs") over a 4km by 4km grid (the extents of the area shown in Figure 6-1).

6.3.3. In addition, there are seventy five potentially sensitive human receptors considered in the assessment (up to a distance of 15km from the main stack). A large number of receptors were included to ensure that all receptors considered across technical disciplines for the Environmental Impact Assessment ("EIA") were assessed. They include the potentially noise sensitive receptors as well as all viewpoints considered in the Landscape and visual assessment. Details of these receptors are provided in Table 1 of ADMA in Technical Appendix 6.1, and are provided visually in Figures 6-2 to 6-3 to provide an indication of the locations.

Figure 6-2: Potentially Sensitive Human Receptors up to 3km

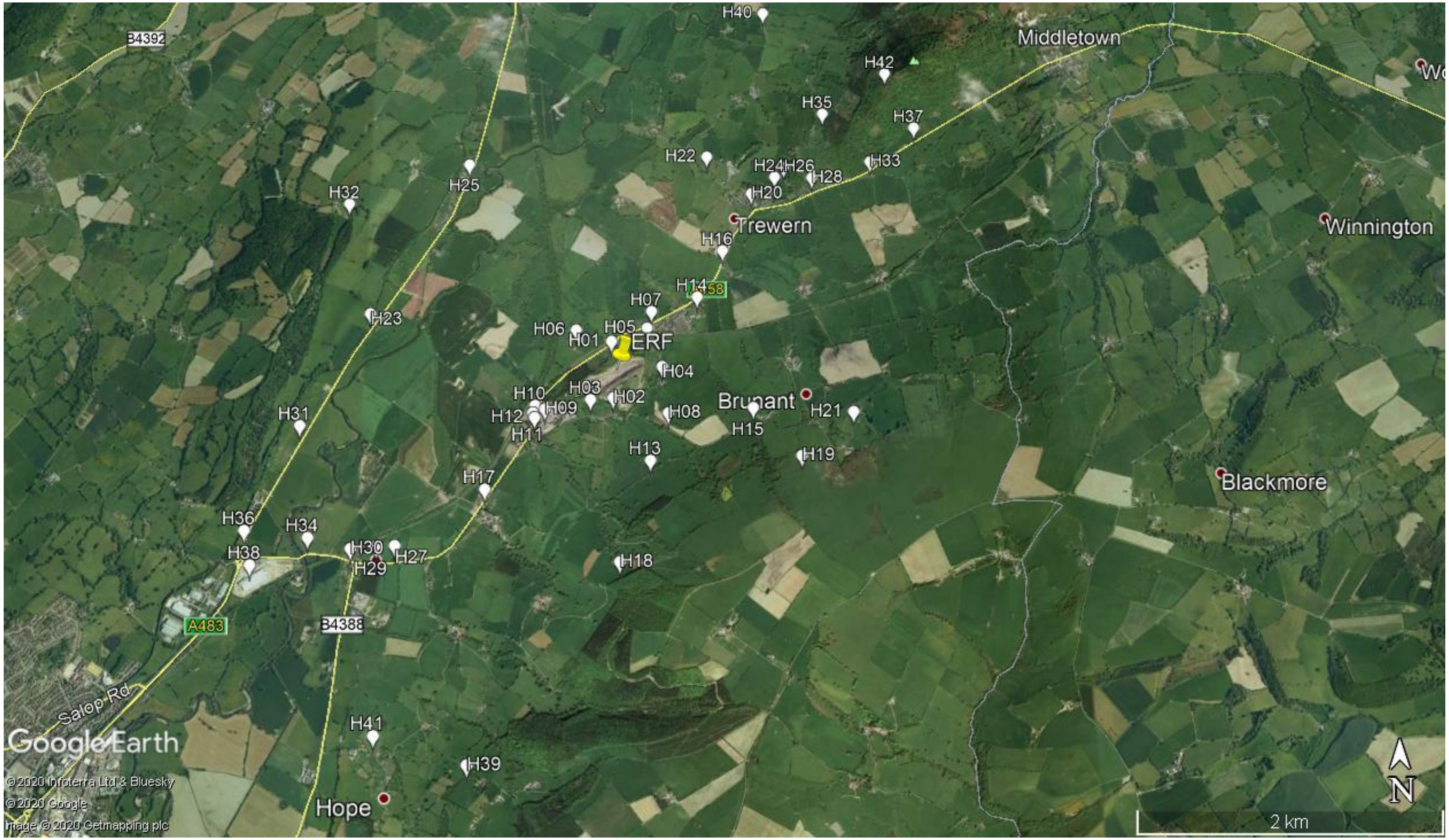
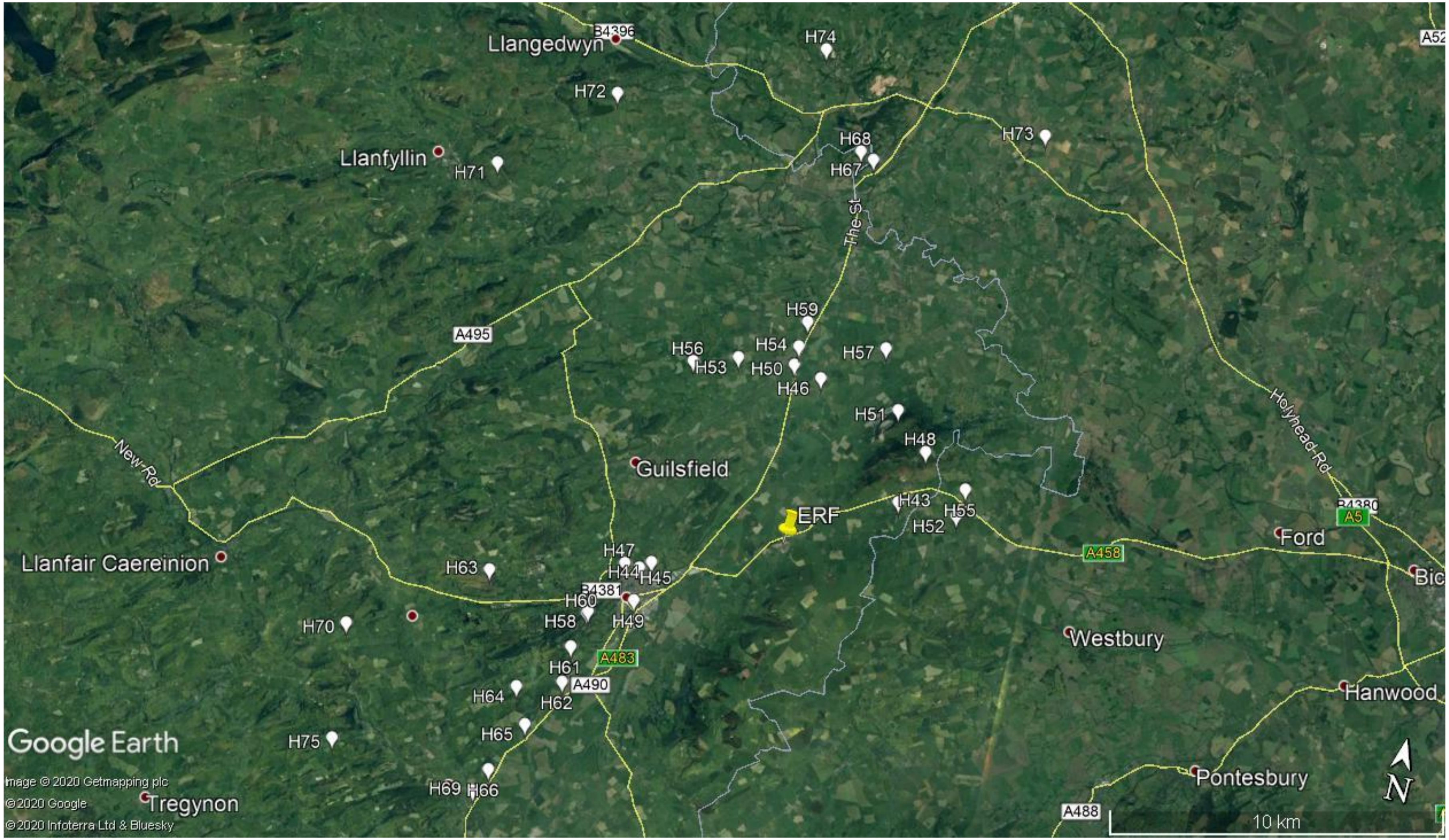


Figure 6-3: Potentially Sensitive Human Receptors 3-15km



6.3.4. The impact of emissions to air on vegetation and ecosystems from the ERF has been assessed for the following sensitive environmental receptors within 10km of the proposed discharge stack:

- Special Areas of Conservation ("SACs") and candidate SACs ("cSACs");
- Special Protection Areas ("SPAs") and potential SPAs; and
- Ramsar Sites.

6.3.5. The impact of emissions to air on vegetation and ecosystems from the installation has been assessed for the following sensitive environmental receptors within 2km of the discharge stack:

- Sites of Special Scientific Interest ("SSSI");
- Ancient woodland; and
- local nature sites (ancient woodland, local wildlife sites and national and local nature reserves).

6.3.6. The ecological sites to be considered in the assessment were all agreed in advance with PINS via the Scoping Request, additional receptors, such as Moel-y-Golfa were included as requested. The sites considered are listed in full in the ADMA in Technical Appendix 6-1, however in summary are listed as follows:

- Midland Meres and Mosses – Phase 1 and 2 – RAMSAR;
- Buttington Brickworks -SSSI;
- Montgomery Canal – SSSI;
- Granllyn – SSSI; and
- eleven Ancient Woodland sites.

Base Line Conditions

6.3.7. To assess the impact of a number of pollutants, baseline air quality data was obtained. It should be noted that baseline data for all pollutants was not needed as most were screened out as not significant at the during the initial phases of the air quality assessment, see Section 4.1.3. of Technical Appendix 6-1.

6.3.8. Background air quality data was obtained from several sources. Powys County Council ("PCC") undertake diffusion tube monitoring for nitrogen dioxide at a number of locations throughout the county, however, all locations were considered too far from the site. Consequently, diffusion tube monitoring was undertaken on Sale Lane, and the A458 to obtain site specific background data. It should be noted that reference was made to PCC Air Quality Progress Report 2018 for background data. However, diffusion tube monitoring data was only available at locations considered to be too remote from the site. Consequently, site specific diffusion tube monitoring data was used.

6.3.9. As there is no suitable measured data available for particulate matter, no volatile organic compounds, DEFRA mapped data was used.

6.3.10. Full details for the background air quality for the assessment on human receptors may be found in Section 4.4 of the AQA in Technical Appendix 6.1.

6.3.11. For the assessment on the ecologically protected sites, site specific baseline nutrient nitrogen and acid deposition and habitat site specific baseline airborne concentrations for rates were obtained from APIS (see Sections 2.7 and 2.8 of the AQA in Technical Appendix 6.1).

Likely Future Conditions

6.3.12. If the development does not proceed, then the quarrying operations are likely to continue which could result in increased dust (particulate matter) emissions. Traffic movements, particularly HGVs, would substantially increase causing a greater increase in emissions of oxides of nitrogen compared to the proposed ERF.

6.3.13. In addition, as the site is allocated in the local plan for employment use, once quarried out to a flat development platform additional small to medium industrial units would be constructed. The potential uses for these units is unknown, therefore any industrial emissions associated with them are unknown, however, it is likely road traffic emissions would increase above that proposed by the ERF.

6.4. Environmental Effects Assessment

Construction – Effects

6.4.1. The likely effect on air quality from the construction phase will be from dust (particulates) during construction and site clearance operations.

6.4.2. Within the Development site, the main sources of dust will arise from materials handling and removal, construction and road traffic passing over exposed soil surfaces, site excavations for foundations and groundwork and batching of concrete on site (if required).

6.4.3. The effects of construction dust are likely to be limited to areas downwind within 100m of dust generating activities, and are predicted to remain within the boundary of the Buttington Quarry site. Elevated concentrations of dust are most likely to occur on dry windy days and areas downwind of the prevailing wind direction will be affected more frequently. The construction activities will be well contained within the quarry void thus potential effects are not expected beyond the planning application boundary.

6.4.4. A Dust Assessment has been undertaken and is provided as Technical Appendix 6-3. The dust impact assessment considered two types of emissions:

- Large deposited particles, commonly referred to as 'dust', which have the potential to cause annoyance, disamenity, or ecological harm due to the deposition of dust onto surfaces; and
- Small particulate matter, with a cross-sectional diameter of less than 10 micrometres (PM_{10}), which are inhalable, and therefore pose a risk to human health.

6.4.5. Regarding deposited dust, the detailed assessment results in an assessment of the magnitude of the likely residual dust effects for each individual receptor; a Negligible effect was predicted for all sensitive receptors.

6.4.6. Regarding PM_{10} health effects, the site is not close to an Air Quality Management Area ("AQMA"), and the annual average background levels of PM_{10} are relatively low. The fact that the quarry will be extracting mudstone with no processing means that high Process Contributions are unlikely.

6.4.7. Taking into account the outcomes of the dust assessment, and all of the factors considered during the assessment process, including mitigation measures and cumulative impacts, it is concluded that the overall dust impacts are not significant. A Dust Management Plan is therefore not considered to be required provided that the measures described in the CEMP are implemented

6.4.8. Emissions from diesel construction equipment will be confined to the construction area. This will increase levels of pollutants within a localised area, however, will be rapidly dispersed in the atmosphere.

6.4.9. There is the potential for pollution associated with construction vehicle exhausts. Construction phase vehicle movements are fully described in Chapter 8 – Highways and Transport. The daily traffic levels attracted to the development for the construction phase is provided in Table 6-2.

Table 6-2:Daily Traffic Levels Attracted During Development Phases

Phase	Level of Daily Traffic Attracted			
	Cars		HGVs	
	Arrivals	Departures	Arrivals	Departures
Construction Phase enabling stage (6 months)	108	108	141	141
Construction Phase worst case (2 months only)	384	384	13	13
Construction Phase average	108	108	13	13

6.4.10. At the height of the construction phase there will be 384 LGV movements in and out of the Development. Based on the IAQM criteria in Table 6-1 this is less than the screening threshold of 500 so does not require a detailed assessment. The HGV movements, whilst in excess of 100 for a 6 month period, the AADT would be 69, therefore would screen out. However, in the interest of a conservative assessment and in order to account for the construction phase enabling period, a detailed air quality assessment of vehicle emissions has been undertaken.

6.4.11. ADMS roads has been used to assess the impact of construction phase vehicles emissions (from nitrogen dioxide (NO_2) and particulate matter (as PM_{10} and $PM_{2.5}$)) and the full report may be found in Technical Appendix 6-2. A summary of the results at the point of maximum ground level concentration ("GLC"), also expressed as a percentage of the relevant air quality standard ("AQS") is provided in Table 6-3. For the purposes of this assessment it is assumed that construction is undertaken 2022 (the construction period is a 3 year process, however as emissions from road transport is predicted to improve year on year, then 2022 would be the worst case year from the construction period).

Table 6-3: Construction Phase Vehicle Emissions Modelling Results

Pollutant	Baseline (2022)		Baseline + Construction Traffic		Impact	
	µg/m³	%of AQS	µg/m³	%of AQS	µg/m³	%of AQS
NO_2	20.54	51.35%	20.95	52.38%	**0.410**	**1.03%**
PM_{10}	2.78	6.94	2.80	7.00	0.0255	0.06
$PM_{2.5}$	1.68	6.71	1.69	6.77	0.0153	0.06

6.4.12. The results of the modelling showed that during the construction phase, the impact will be less than 1% of the air quality standard for particulate matter (PM_{10} and $PM_{2.5}$) and is described as not significant using Environment Agency screening criteria (see Section 2.12 of Technical Appendix 6-2). For the predicted nitrogen dioxide ("NO_2") process contribution, the effect of construction phase traffic could be considered potentially significant and therefore the predicted environmental concentration (the sum of the predicted process contribution and the ambient background concentration) ("PEC") needed to be calculated. The results of the PEC assessment demonstrated that the NO_2 impact, in accordance with the EPUK and IAQM guidance (2017), could be categorised as 'negligible'.

6.4.13. For emissions of particulate matter (PM_{10} and $PM_{2.5}$), impacts at sensitive receptors were less than 1% of the long term AQS. Therefore, the impact is considered not significant. Where further screening was required for NO_2, the impact could be categorised as 'slight' for potentially sensitive human receptor H34, A458, Buttington Bridge, and 'negligible' for the remaining human receptor locations with potentially significant development contributions. As the impact is substantially lower than the National Air Quality Objectives, it is considered that this therefore satisfies the requirements of National Air Quality Policies.

6.4.14. The impact of oxides of nitrogen ("NO_x") from construction traffic was also considered for ecological receptors. This concluded that the predicted annual average concentrations were less than 1% of the AQS and daily averages were less than 10% of the AQS. Therefore, the impact is considered not significant and no further assessment is required.

6.4.15. A detailed environmental effects analysis of the construction phase is provided in Table 6-9.

Construction – Mitigation

6.4.16. The mitigation measures specific to air quality during the construction phase will form part of the construction environmental management plan ("CEMP") to be secured by planning condition in accordance with standard practice. A detailed CEMP will be produced by the Engineering, Procurement and Construction Contractor for approval by the Council pursuant to planning condition. An Outline CEMP has been produced (see Technical Appendix 4-2), and will be used as a basis for the CEMP to be produced by the EPC Contractor[viii]. Mitigation measures in terms of air quality will include:

- the Buttington Brickworks SSSI will be fenced off and construction activities will be set back from the area;
- site access roads will be watered as necessary using a water bowser and surfaces kept in good order and cleaned as required;
- all vehicles carrying loose aggregate and workings will be sheeted at all times;
- dampening of exposed soil and loose material stock piles will be carried out as necessary;
- observation of wind speed and direction will be carried out to determine the potential for dust nuisance to occur at sensitive receptors to the east of the proposed facility prior to conducting potential dust-generating activities; potential dust-generating activities will be avoided during periods of high winds;
- stockpiles of soils and materials will be located in sheltered areas of the site, where practicable;
- windbreak netting will be placed around stockpiles of material sensitive to wind disturbance;
- the use of construction equipment designed to minimise dust generation;
- establishment and enforcement of an appropriate speed limits on roads carrying construction vehicles to minimise dust emissions;
- frequent washdown of roads and made surfaces;
- regular inspection of local highways will take place to monitor the deposition of dust leaving the site;
- wheel washing facilities for vehicles leaving the site if required;
- drop-heights for friable materials will be minimised;
- completed earthworks will be vegetated as soon as practicable.

6.4.17. Details of the proposed methodologies for the above measures will be set out in the CEMP and held on site. These provisions will ensure that risks to human health are managed and minimised for construction related activities.

Operation – Effects

6.4.18. Prior to operation, the Installation will be required to obtain an Environmental Permit ("EP"). The application for the EP is being submitted to Natural Resources Wales ("NRW") in tandem with the DNS application. The EP contains a list of conditions which the Installation will have to comply with, for example implementation of a management system and compliance with emission limit values ("ELVs"). As part of the planning process, planning decision-makers are entitled to assume that the strict controls under the Environmental Permit regime will operate effectively. The Installation will comply with all permit conditions and will operate to Best Available Techniques ("BAT") as required by the BAT conclusions document[ix]. It should be noted that as part of the EP the site will be operated in an environmentally sound manner to ensure that all emissions, either those from the stack, fugitive dust and odour are controlled to ensure there is no impact beyond the site boundary.

6.4.19. All operations at the Installation will be undertaken within enclosed buildings, with vehicles unloading the waste within the confines of the waste reception hall. The waste reception hall is maintained under negative pressure with the extracted air being used as combustion air. Any odour compounds in this air stream would be destroyed as a result of the high temperatures within the combustion chamber, and consequently there would be no release of odour from the main stack. Using the extracted air in this manner also prevents the release of odour, and any dust generated from the tipping process, from the building when the roller shutter doors are used for entry and egress of vehicles.

6.4.20. Residual waste is only stored within the waste bunker for a limited period (up to 4 days) to prevent any decay of waste which would lead to the formation of odour. No waste would be stored outside of the building. In addition, the bunker will be provided with humidifier sprays for dust control and for the introduction of a deodoriser. The humidifier spray will be equipped with appropriate fine atomisation and a means of introducing deodoriser during outage periods

6.4.21. In the event of a planned shutdown, the incoming waste would be managed to ensure that the majority of waste within the waste bunker would be processed with minimal remaining. In the event of an un-planned shutdown, the bunker would be back loaded and the waste removed off site for processing/disposal at alternative facilities.

Potential Odour Effects

6.4.22. It should be noted that further to discussion with Powys Council Council's Environmental Health Officer and a site visit to a similar Installation in Kidderminster it was confirmed that "there were no unpleasant odours detectable at the site boundary" and "a qualitative assessment [of odour] would be acceptable"[x]. In accordance with the IAQM Odour Guidance (2018)[xi] an estimation of the effect of odour has been undertaken considering the risk of odour exposure and receptor sensitivity.

6.4.23. The nearest sensitive receptor (Cefn Cottage) is 182m north of the Installation (downwind). Under calm conditions, odour would remain within the site boundary due to the nature of the quarry void, however, during turbulent conditions odour would be moved away from the Installation and would gradually dissipate. When considering the wind roses for the numerical weather prediction data (See Section 2.12. of Technical Appendix 6.1.), the winds are generally from the south west, which is in keeping with local knowledge of the site where the wind in known to funnel up the valley. Thus the nearest downwind receptor Cefn Cottage, would have the most effective odour pathway, whilst all other receptors to the north and north east would have a less effective odour pathway. It is considered that due to the topography of the location of the Installation, i.e. it is situated within the quarry void, it would require turbulent conditions for any potential odour to be dispersed beyond the site boundary, consequently the pathway effectiveness is considered moderate. Receptors located upwind are considered to have an ineffective pathway.

6.4.24. As described above the Installation has been designed in accordance with BAT to ensure that there is no odour beyond the site boundary, consequently the magnitude of the odour release is considered to be small.

6.4.25. Therefore, impact descriptors contained within the IAQM Odour Guidance, for a moderately effective pathway, with a small odour potential, the risk of odour exposure at the nearest sensitive receptor is considered Negligible Risk.

6.4.26. The final step in the assessment is to consider the sensitivity of the receptors. The majority of the receptors in the vicinity of the site are considered high sensitivity receptors, as they are predominantly residential, receptors are considered to expect a high level of amenity and are expected to the present, if not continuously, but certainly for a large period of time.

6.4.27. Consequently, based on the negligible risk of odour exposure and the high receptor sensitivity, the likely magnitude of odour effect at the nearest sensitive receptor location is classed as having a negligible effect in accordance with the IAQM Odour Guidance.

Potential Effects from Emissions from Operational Phase Traffic

6.4.28. Vehicle movement associated with the operational phase of the ERF are provided in Table 6-4.

Table 6-4: Operational Phase Traffic Movements

Phase	Level of Daily Traffic Attracted			
	Cars		HGVs	
	Arrivals	Departures	Arrivals	Departures
Operational Phase	22	22	40	40

6.4.29. During the operational phase there will be 22 LGV movements in and out of the Development. Based on the IAQM criteria in Table 6-1 this is less than the screening threshold of 500 so does not require a detailed assessment. As the HGV movements will also be less than the criteria in Table 6-1 (i.e. less than 100 HGV), then a detailed air quality assessment of vehicle emissions for the operation phase is not required. In accordance with the IAQM guidance, if the vehicle movements are less than the screening criteria the Development is not expected to cause a significant change in air quality and the effect can be classed as negligible.

Potential Effects from Emissions from the Main Stack

6.4.30. To determine the impact of the ERF on air quality, air dispersion modelling has been undertaken. This included both an assessment of the most appropriate stack height for the Installation, together a series of assessments on both human receptors and protected ecological sites. The full assessment may be found in Technical Appendix 6.1. The operational effects of the development are summarised in this section. It should be noted that where significance is discussed in this section, reference is being made to the Environment Agency ("EA") screening criteria[xii] (used by Natural Resources Wales ("NRW"), and the Institute of Air Quality Management assessment criteria[xiii]. In terms of this ES, the significance criteria, as required by the methodology in Chapter 2, is provided in Section 6.5. together with the overall assessment of significance.

6.4.31. The study was undertaken using ADMS modelling software - 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.

6.4.32. Several assumptions were made including that the Installation was operational 24 hours a day 7 days a week at the maximum permitted ELV which is considered to be an overestimate of actual emissions thus providing a conservative assessment.

6.4.33. The stack emission parameters used in the study are presented in Table 6-5 for the main stack (designated A1). The ELVs assumed for each pollutant and the pollutant mass emission rate for the study are presented in Table 6-6. These are the assumed daily ELVs used for the modelling assessment. Emissions parameters were provided by HZI.

Table 6-5: Stack Emission Parameters

Parameter	A1
Stack Height (m)	TBC (50-95m)
Stack Exit Diameter (m)	1.6
Stack Gas Discharge Velocity (actual) (m/s)	19
Stack Gas Discharge Temperature (°C)	135
Stack Centre Co-ordinates	326807, 310086
Oxygen Concentration in Stack Emission (%)	8.24
Moisture Concentration in Stack Emission (%)	20
Actual Volumetric Flowrate (m^3/s)	38.2
Normalised Volumetric Flowrate (Nm^3/s)[b]	26.01
Mass of H_2O (kg/kg)	0.149

Notes to Table
(a) Referenced to 273K, 1 atm, dry and 11% O_2.

Table 6-6: Pollutant Emission Rates

Pollutant	ELV[a][c] (mg/Nm^3)	A1 (g/s)
Nitrogen dioxide	120	3.12
Sulphur dioxide	50	1.301
Carbon monoxide	50	1.301
PM10[b]	10	0.260
PM2.5[b]	10	0.260
VOCs (as Benzene)	10	0.260
Hydrogen chloride	10	0.260
Hydrogen fluoride	1	0.0260
Cadmium/thallium	0.05	0.00130
Mercury	0.05	0.00130
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.5	0.0130
Ammonia	10	0.260
Dioxins and Furans	0.00000004	0.00000000104
PAH (as benzo[a]pyrene)[d]	0.0001	0.00000260
Polychlorinated biphenyls[e]	0.00001	0.000000260

Notes to Table

(a) Concentrations are at reference conditions i.e. 273K, 1 atmosphere, 11% oxygen, dry.
(b) It has been assumed that all particulate matter can be present as PM_{10} or $PM_{2.5}$
(c) Unless stated otherwise, pollutant ELVs are as stated in the IED.
(d) There is no ELV for B[a]P. Consequently, an appropriate ELV for the purposes of the modelling study was required. The BREF for the waste incineration sector quotes emission levels for B[a]P ranging from 0.004ng/Nm3 to 1µg/Nm3. Actual emissions testing from another plant (FCC Millerhill) using the same HZI technology gave results of between 0.0147µg/m3 and 0.0179µg/m3. As the BREF document uses data from older as well as more modern incineration plant, it is considered that a limit of 1µg/Nm3 would be overly conservative and would not provide realistic results. It is also approximately 70 times that of the actual emissions observed. Consequently, for the purposes of this modelling study a value of 0.1µg/Nm3 has been used for emissions of B[a]P. This is still some 7 times greater than the actual emissions observed, however still retains a degree of conservatism for the assessment.
(e) ELV provided by HZI.

6.4.34. All other input parameters are described in Section 2 of the air dispersion modelling report in Technical Appendix 6.1.

Stack Height Screening

6.4.35. A stack height assessment was initially undertaken to determine the optimum height for releases to air. This is a height at which increasing the stack any further would not provide any further material environmental benefit. The modelling study showed that as the stack height increased the ground level concentrations of the various pollutants decreased. The results of the stack height screening assessment demonstrated that there is an environmental benefit of stack heights 60m and above, however, beyond this there is no clear point of inflection at which an appropriate stack height can be determined. Consequently, the impact on the environment of stack heights 50m – 95m was considered.

Assessment at the Maximum Point of Impact

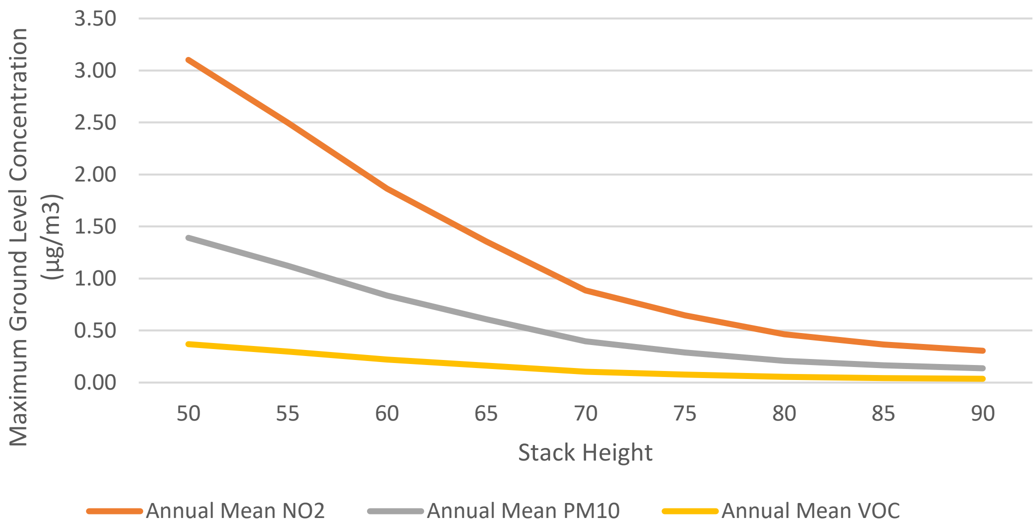
6.4.36. Section 4 of the Air Quality Assessment in Technical Appendix 6-1 shows that that the impact of the Installation varies depending on the pollutant considered, however, for the majority of pollutants assessed, the impact of the proposed facility is not significant for stack heights of 55m and above. However, the stack height screening study demonstrated that that there is an environmental benefit of a stack which is 60m or higher. Therefore, for stack heights of 60 and above, the potentially significant impacts, are for the long-term (annual):

- nitrogen dioxide,
- PM_{10} and $PM_{2.5}$;
- VOC (as benzene),
- arsenic,
- cadmium,
- chromium VI,
- cobalt,
- lead, and
- nickel.

6.4.37. The next stage in the assessment is to consider the impact of the predicted environmental concentration ("PEC"), which is the process contribution plus the existing background. When the PECs were calculated, the results showed that the impact of all metals (As, Cd, Cr(VI), Co, Pb and Ni) were not significant, and no further assessment was required.

6.4.38. For the remaining pollutants, the PECs were again calculated, and the impacts can be described as negligible, or screen out. Consequently, stack heights of 60m and above would be suitable. However, on further inspection of the data, there is a significant drop in process contributions from 60 to 65m (27% reduction) and from 65 to 70m (a further 25% reduction). The reduction in process contributions is then not as pronounced from 70m upwards. This can be seen in Figure 6-4 for the remaining pollutants (NO_2, PM_{10} and VOC).

Figure 6-4: Reduction in Actual Max GLC with Increasing Stack Height



6.4.39. Based on the above graph, a stack height of 70m is proposed. At this height, most pollutants have process contributions (“PCs”) which are less than 1% of the air quality standards (“AQS”), therefore in accordance with NRW (which make use of EA) guidelines are considered not significant. For those pollutants which are greater than 1% of the AQS, the predicted environmental concentrations (“PECs”) are calculated. The PEC is the sum of the PCs plus the existing background concentrations of the various pollutants. The PECs of annual mean NO_2 and VOC are classed as having a negligible impact on the environment. Consequently, it is considered that as the PCs are substantially lower than National Air Quality Objectives, the impact of the ERF on air quality satisfies the requirements of National Air Quality Policies (see Section 6.2.3.).

Impact at Potentially Sensitive Human Receptors

6.4.40. As mentioned in Section 6.3. of this report, the impact of the Installation on 75 potentially sensitive human receptors was also considered. The results from this assessment demonstrated that the impact at all sensitive receptors, for all pollutants, at a stack height of 70m can be considered not significant, with the exception of long term impacts of NO_2 and VOC (as benzene) at 3 locations. When PECs at the 3 potentially sensitive locations were calculated, they were classed as negligible, consequently no further assessment was required (full results are provided in Technical Appendix 6-1).

Impact at Potentially Sensitive Ecological Receptors

6.4.41. Likewise, the impact of the Installation on sensitive ecological sites was assessed. The maximum ground level concentrations of oxides of nitrogen ("NO_x"), sulphur dioxide ("SO_2"), ammonia ("NH_3") and hydrogen fluoride ("HF") were compared with the critical levels set for the protection of sensitive habitat sites. The results showed that the impact of all pollutants at all sites can be considered not significant.

6.4.42. A comparison of the maximum predicted nutrient nitrogen deposition rates was also undertaken. For the local nature sites, i.e. the ancient woodland sites, the process contributions were only a maximum of 2.78% of the lower critical load and 1.39% of the upper critical load. Consequently, the Installation will not cause significant pollution.

6.4.43. Both RAMSAR sites have PCs less than 1% of the critical loads, therefore the impact is considered not significant and consequently no further assessment is required. A shadow Habitats Regulations Assessment ("sHRA") has been undertaken and is provided with the DNS application. The sHRA concludes that the ERF is not likely to have a significant effect on the RAMSAR sites.

6.4.44. The maximum nutrient nitrogen deposition rates due to process emissions are greater than 1% at the Montgomery Canal and Moel y Golfa, and due to the large background concentrations, all PECs are also in excess of 100% of the upper and lower critical loads. Further detailed assessment of these two sites was undertaken in consultation with BSG Ecology. In the case of the Montgomery Canal, the process contribution compared to the critical load for nitrogen deposition is equivalent to 2.96% of the lower CL and 0.89% of the upper CL. The lower CL is intended for boreal and alpine lakes, thus is not relevant to this site. The process contribution when compared to the upper CL falls below 1% of the long-term environmental standard and so can be considered not significant and no further assessment is required. For Moel y Golfa, the Process Contribution is 0.13 kgN/ha/yr, which is 0.88% of the upper critical load and 2.63% of the lower critical load, i.e. the PC when compared to the upper CL is below the 1% screening threshold and so a significant effect is unlikely. It is important to note, although the PC is above the 1% threshold when compared to the lower CL, this is only a screening threshold and does not by default mean that a significant effect is likely. Modelling of deposition rates at different elevations within the SSSI indicates that there is likely to be widespread variability depending on the elevation. In the absence of the proposed development, there will still be exceedance of the nitrogen deposition critical level for woodland, which is mainly attributable to agricultural and other sources. If the assumed Conservation Objective (of reducing nitrogen deposition to below the critical level for woodland habitat) is to be achieved, this will require policy intervention at Government level. The required changes are of such a magnitude that the predicted minor process contribution (which is only 0.13 kgN/ha/yr) is unlikely to affect the ability to achieve the Conservation Objective.

6.4.45. The maximum predicted acid deposition rates at the identified nature sites (which are sites other than European sites) was also predicted. The maximum acid deposition rates due to process emissions are less than 100% of critical loads function at these habitat sites. However, again, due to the large background concentrations, all PECs are currently in excess of 100% of the critical loads at six of the ancient woodland sites considered. However, in accordance with the EA guidance, if the PCs are less than 100% of the appropriate environmental criterion then there will be no significant pollution.

Potential Effects from Emissions from the Main Stack in Combination with Construction Phase Traffic

6.4.46. An assessment construction phase traffic was undertaken with the addition of the emissions associated with the proposed ERF. This was undertaken in the interest of assessing the hypothetical worst-case predicted cumulative impact of the emissions associated with traffic using the A483 and A458 and the operation of the ERC main stack (designated 'A1') for the 2022 construction phase scenario. This was undertaken as an absolute worst case scenario to cover a period where construction activities may still be being undertaken whilst the main stack could be operational, for example, during Hot Commissioning. This is an unlikely scenario, however in the interests of a conservative assessment has been undertaken.

6.4.47. Ground level concentrations of NO_2, PM_{10} and $PM_{2.5}$ were calculated on an area covering the development and nearby potentially affected roads. The results are provided in Table 6-7.

Table 6-7: Construction Phase Vehicle Emissions + A1 Modelling Results

Pollutant	Baseline (2022) No Construction Traffic		Baseline (2022) + Construction Traffic + A1		Impact	
	µg/m³	%of AQS	µg/m³	%of AQS	µg/m³	%of AQS
NO_2	20.54	51.35	21.34	53.35	**0.799**	**2.00**
PM_{10}	2.78	6.94	2.81	7.02	0.0309	0.08
$PM_{2.5}$	1.68	6.71	1.69	6.78	0.0165	0.07

6.4.48. The results in Table 6-7 clearly demonstrate that the effect of the construction phase traffic and the operation of A1 can be considered not significant at the maximum point of impact for PM_{10} and $PM_{2.5}$ as the difference in concentrations of pollutants are less than 1% of the AQS. For the predicted NO_2 process contribution, the effect of construction phase traffic could be considered potentially significant and therefore the PEC needed to be calculated. The results of the PEC assessment demonstrated that the NO_2 impact, in accordance with the EPUK and IAQM guidance (2017), could be categorised as 'negligible'.

6.4.49. For emissions of particulate matter (PM_{10} and $PM_{2.5}$), impacts at sensitive receptors were less than 1% of the long term AQS (with the exception of at H16, Heldre Lane, Trewern) and, therefore, the impacts could be considered not significant. Further screening for PM_{10} at H16 demonstrated the impact could be regarded as 'negligible'. Where further screening was required for NO_2, the impact could be categorised as 'slight' for potentially sensitive human receptor H34, A458, Buttington Bridge, and 'negligible' for the remaining human receptor locations with potentially significant development contributions

Plume Visibility

6.4.50. The potential visible plume impacts from the Installation's stack were modelled. A plume will become visible when water vapour in the plume condenses to form small particles in the form of water droplets.

6.4.51. The results of the plume visibility assessment concluded that for 40% of all hours, no visible plume is forecast to occur. When visible, the plume length is predicted to be short, with a plume length of around 4m for 30% of daylight hours. The plume is forecast to extend to a length of up to 107m for only 5% of the time and therefore would remain within the site boundary for 95% of the time (the site boundary being a minimum distance of 113m boundary from the stack location). A visual representation of the average visible plume is provided in Figure 6-5.

Figure 6-5: Visual Representation of the Average Visible Plume

Abnormal Emissions

6.4.52. In order to assess the impact of the plant under abnormal operating conditions, two scenarios have been considered:

- with emissions at the half-hourly emission limits prescribed in Annex VI of the IED;
- and to take account of short-term abnormal conditions permitted under Article 46(6) of the IED

6.4.53. The conditions referred to in Paragraph 6.4.42. refer to emissions concentration based on half hourly concentrations of a limited number of pollutants, which can be emitted by the installation for a maximum of 4 hours at any one time. The cumulative duration of operation in this manner cannot exceed a cumulative period of more than 60 hours. These pollutant concentrations are higher concentrations that the daily emission limits and are set for a limited number of pollutants as described in paragraphs 6.4.46. and 6.4.47.

6.4.54. The assessment with emissions at the half hourly limits considered the Installation operating at the half-hourly emission limits continuously for 24 hours a day, 365 days a year. In practice this would not occur, however, as it was unknown which met conditions would produce the maximum GLC, all 7 years of met data were used. This therefore represents a robust, worst case scenario.

6.4.55. For the short term abnormal conditions, this was based on the Installation operating at the half hourly emission limit values for 60 hours per year, and daily emission limit values for the remaining 8700 hours per year.

6.4.56. For emissions at the half-hourly emission limits, with the exception of nitrogen dioxide, predicted PCs under these worst-case conditions are all less than 10% of their respective AQSs and would be assessed as being not significant. For NO_2, the maximum predicted short term concentration is 10.93%. This is only just above the short-term significance criterion, and represents the very worst case conditions i.e. this is the highest process contribution predicted assuming the facility emits at the half-hourly average for the entire year and therefore, combines the maximum emission with the worst case hour of meteorological data. Furthermore, these are the maximum concentrations predicted at any location within the model area. Accordingly, it is considered that, in practice, releases of NO_2 dioxide will not be significant. However, even at this concentration, using the IAQM methodology, the impact would be described as small. Predicted concentrations at the sensitive human receptors will be substantially lower than this, and, accordingly, will not be significant.

6.4.57. For abnormal emissions, the process contributions of PM_{10}, HCl, HF, SO_2 and CO can be considered to be not significant as long term GLCs are less than 1% of the long-term AQS and short term GLCs are less than 10% of the short-term AQS. For nitrogen dioxide, maximum predicted annual mean process contribution in excess of 1% of the long-term AQS, and the short term is in excess of 10% of the short-term AQS. Stage 2 screening has, therefore, also been undertaken and the PEC classed as slight impact under the IAQM methodology. The short term concentration at 10.93% of the AQS is also classed as slight under the IAQM methodology. This is only just above the short-term significance criterion, and represents the very worst case conditions. Furthermore, these are the maximum concentrations predicted at any location within the model area. Accordingly, it is considered that, in practice, releases of NO_2 will not be significant.

Temperature Inversions

6.4.58. It was requested by Powys County Council that the air quality modelling should also account for "the local phenomenon of significant temperature inversions which are common in the River Severn Valley and which can trap emissions if the stack design is not capable of dispersing the plume above the inversion ceiling". The modelling takes inversions into account and the following sections seek to demonstrate that the stack design is appropriate.

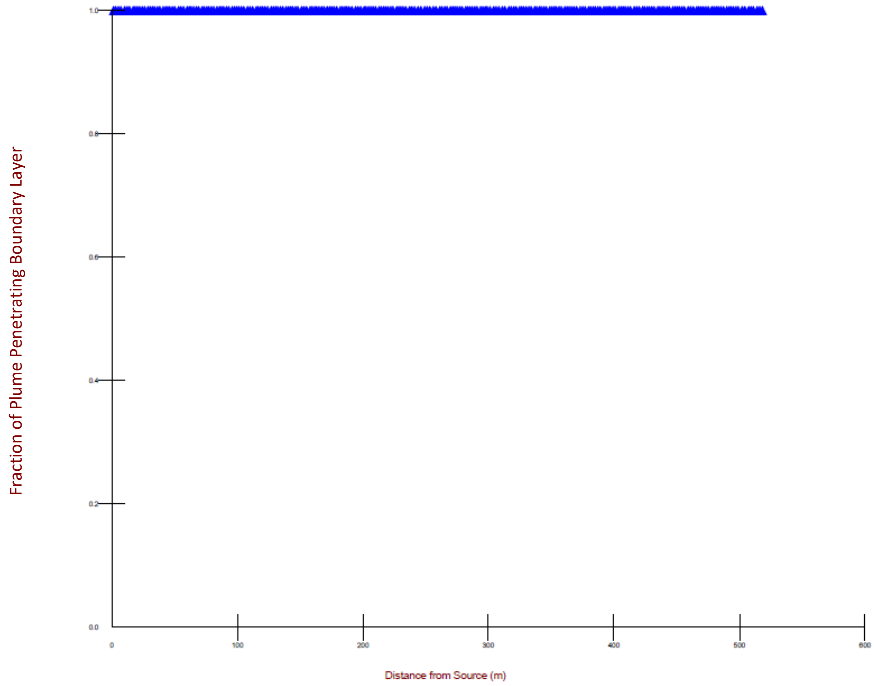
6.4.59. The met data used in the model was for Shawbury, and Numerical Weather Prediction ("NWP") data based on the location of the stack coordinates (see Section 2.12. of Technical Appendix 6-1). Consequently, this section considers only the NWP data only as this met data is based on the conditions at the location of the ERF, and specifically 2019 as this gave the highest process contributions for the majority of pollutants.

6.4.60. A Capping inversion can occur at the top of the boundary layer. The dispersion model models these effects by including extra terms in the plume concentration algorithms to allow for the reflection of material below the boundary layer top. An inversion will always be present in convective and neutral conditions, but only present in stable conditions if there is a temperature jump at the boundary layer. From the 2019 NWP data, the temperature jump occurs 2,701 times (approximately 31% of the time), thus capping inversions will have been modelled for convective, neutral and stable conditions.

6.4.61. Within the boundary layer, temperature inversions are expected to occur in during stable conditions. Stable conditions within the boundary layer are indicted when the model calculated boundary layer depth divided by the Monon-Obukhov length is greater than 1. Using the 2019 NWP data as an example, this occurs 3,423 times (approximately 39% of the time), and the boundary layer height varies from 50m to 1,036m. Note within the 2018 met data expected temperature inversions were more frequent (circa 56% of the time, however, 2019 gave higher predicted ground level pollutant concentrations).

6.4.62. To demonstrate that the plume is able to penetrate the inversion, the dispersion modelling software is also able to plot the fraction of the plume that penetrates the inversion layer. For example, on the 3rd October 2019 at 7am, the model predicts stable conditions, and a boundary layer height of 50m. The fraction of the plume penetrating the inversion layer can then be plotted and is shown in Figure 6-6. These plot outputs are produced directly by the ADMS 5 line plotter.

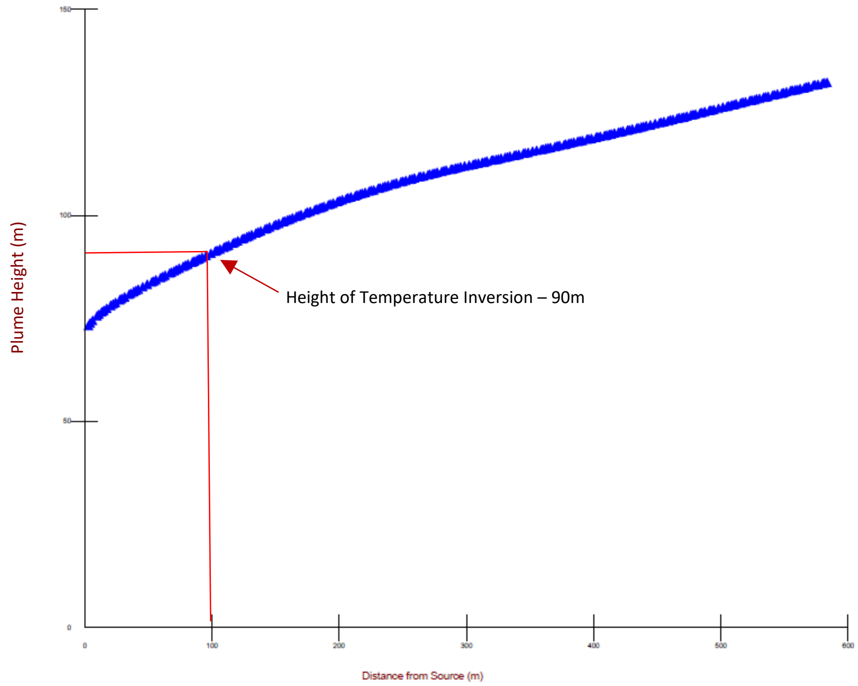
Figure 6-6: Fraction of Plume Penetrating 50m High Temperature Inversion



6.4.63. Figure 6-6 demonstrates that the whole plume penetrates the inversion. However, in this case, the height of the inversion (50m) is lower than the height of the stack (70m). Consequently, a boundary height of 90m was also considered – i.e. a height 20m above the height of the stack.

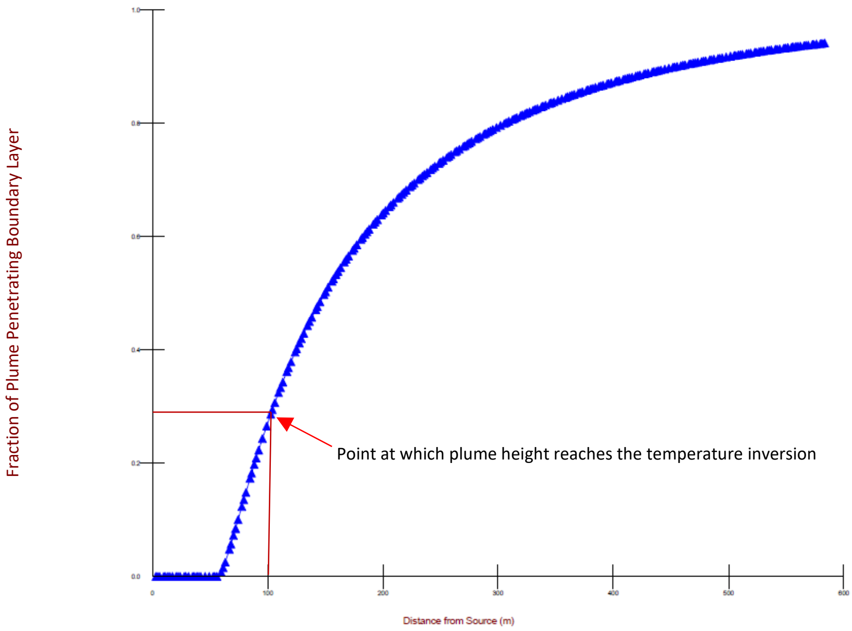
6.4.64. On the 5th January at 7am the model predicts stable conditions, and a boundary layer height of 90m. As the height of the stack is 70m, the plume height must also be considered and is shown for 5th January at 7am in Figure 6-7. The height at which the temperature inversion occurs has been added to the ADMS plot for ease of viewing.

Figure 6-7: Plume Height at 7am, 5th January 2019 (NWP)



6.4.65. As shown in Figure 6-7, the plume will not actually reach the height of the temperature inversion (90m) until it is around 100m from the stack. The fraction of the plume penetrating the 90m inversion layer has now been plotted and is shown in Figure 6-8.

Figure 6-8: Fraction of Plume Penetrating 90m High Temperature Inversion



6.4.66. Figure 6-8 clearly demonstrates that as the height of the plume reaches the inversion the plume penetrates the inversion rapidly, demonstrating that the stack design is capable of dispersing the plume above the inversion.

Operation - Mitigation

6.4.67. Three are many measures that are incorporated into the design of the ERF to ensure that there are no unacceptable impacts on air quality during its operational phase. These are a combination of design measures and management and operational procedures. No additional mitigation is required beyond that incorporated into the design of the installation and as required to meet BAT.

Management and Staffing Arrangements

6.4.68. The ERF would have an appropriate management structure in place and would be suitably staffed. An integrated management system ("IMS") would be developed which will be based on the requirements of:

- international quality management standard ISO9001;
- international environmental management standard ISO14001; and
- international occupational health and safety standard IHSAS18001.

These measures will ensure that the ERF is managed and operated to the highest standards at all times with all operational procedures documented and staff highly trained to ensure that the plant is operated in an appropriate manner at all times.

Process Control Measures

6.4.69. The ERF will be subject to strict controls under the Environmental Permit that will be required for the Installation to operate and will be regulated by Natural Resources Wales. The planning and environmental permit regime are separate but complementary. As part of the planning process, planning decision-makers are entitled to assume that the strict controls under the Environmental Permit regime will operate effectively.

6.4.70. All aspects of the ERF would be controlled by a series of sophisticated computer control systems which would provide feedback to the plant operators on the operational status of the plant at all times. All elements of the ERF meet the requirements of the Industrial Emissions Directive ("IED")[xiv].

6.4.71. The Installation will incorporate a selective non-catalytic reduction ("SNCR") system to ensure that NO_x are reduced to a level that ensure that the emissions meet the requirements of the IED.

6.4.72. A flue gas treatment stage will be installed to remove acid gases and particulate matter from the gas stream before discharge to atmosphere; this comprises a lime and activated carbon injection system and a high specification bag filtration system; again, these arrangements would ensure that IED requirements would be met in relation to emissions of particulate matter, sulphur dioxide, hydrogen chloride and hydrogen fluoride.

6.4.73. A comprehensive range of continuous monitoring devices will be installed to ensure that the plant operators are fully aware of the status of the emissions from the plant at all times. These systems would monitor: particulate matter, carbon monoxide, oxides of nitrogen (nitrogen monoxide ("NO") and nitrogen dioxide ("NO_2") expressed as NO_2), ammonia, sulphur dioxide, volatile organic compounds, hydrogen chloride, oxygen, moisture, temperature, pressure and velocity and flow. The continuous emissions monitoring data generated by these devices would enable the operators to adjust and / or shut down the ERF if necessary.

6.4.74. The Installation would be equipped with a comprehensive series of alarms and interlock systems throughout; these would provide an indication of any potential or actual system faults and would, if necessary, automatically close the Installation down

Decommissioning Phase - Effects

6.4.75. The decommissioning phase of the Buttington ERF will be similar to the construction phase. The main effects on air quality will be from dust (particulates) which may be generated during any demolition of buildings and site clearance operations.

6.4.76. As with the construction phase, it is likely that the effects of dust will be limited to areas downwind within 200m of dust generating activities, and are predicted to remain within the wider quarry boundary. Elevated concentrations of dust are most likely to occur on dry windy days and areas downwind of the prevailing wind direction will be affected more frequently.

6.4.77. Mobile plant used will also produce emissions which may temporarily increase levels of pollutants within a localised area, however, will be rapidly dispersed in the atmosphere.

6.4.78. Vehicle emissions associated with the decommissioning phase are again expected to be similar to those during the construction phase.

Decommissioning Phase – Mitigation

6.4.79. A Decommissioning Environmental Management Plan ("DEMP") will be written for the Installation and will be required to maintained and updated regularly in accordance with the Installation's Environmental Permit. The DEMP will encompass 10 key steps:

1. staged shut down of all processes;
2. maintenance of safe waste and chemical storage conditions;
3. confirm inventory of all materials held on site;
4. transfer of documentation to management team supervising decommissioning/demolition process;
5. sale and transport of any remaining raw materials off site;

6. emptying of all storage tanks and cleaning of all tanks, pipework and process equipment;
7. dismantling of process equipment and sale or scrap;
8. survey of site structures and buildings;
9. demolition of buildings; and
10. geoenvironmental investigation of ground to ensure the site is in a satisfactory state to surrender Environmental Permit.

6.4.80. Of the stages of the Decommissioning Plan, those that have the potential to impact on air quality are the demolition of buildings. The DEMP will include mitigation measures identical to those proposed in the CEMP (See Paragraph 6.4.6 of this Chapter). These provisions will ensure that risks to human health are managed and minimised for decommissioning and demolition related activities.

The Development Overall

6.4.81. The main effect of the ERF on the environment would be the potential to change local air quality, however, the mitigation measures, implemented at both the design stage, and the operational stage are considered sufficient ensure that process contributions are substantially lower than air quality objectives, therefore satisfying the policy requirements of National Air Quality Policies. The Development will also not cause nuisance to the wider environment.

The Development in Combination with Other Developments

6.4.82. At time of writing, there was only one development which could have potential cumulative effects in the area, namely an Intensive Livestock Unit (“ILU”) located approximately 3.8km south of the ERF. The ILU relates to planning application P/2018/0474 – Application for a Proposed Free Range Egg Laying Chicken Houses at Trelystan, near Leighton in Powys. A detailed assessment may be found in Chapter 10 of the Air Quality Assessment provided as Technical Appendix 6.1. As both facilities emit ammonia an assessment of cumulative ammonia emissions (and nutrient nitrogen deposition) was undertaken.

6.4.83. An assessment of ammonia emissions from the ILU together with those at the maximum point of ground level concentration of the ERF concluded that the impact of the ILU and the ERF at the maximum point of impact of the ERF would be 0.096% of the AQS for ammonia. Also considered was the impact on the Montgomery canal, both in terms of ammonia concentration and nitrogen deposition. The results showed that the impact for ammonia is less than 1% of the critical level, however nitrogen deposition rates are greater than 1%. The Apis website[xv] states that the critical load should only be applied to oligotrophic waters with low alkalinity with no significant agricultural or other human inputs. The ILU is by nature a significant agricultural input, and given that the stronghold for the species is wholly artificial and receives relatively high levels of management[xvi] it is considered that the critical load should not be applied in this case.

6.4.84. The cumulative assessment also considered the impact at Moel Y Golfa SSSI. The cumulative impact was 1.5% of the critical level for ammonia, however where contributions are just over 1% a degree of professional judgment should be applied with regard to the theoretical risk. Modelling has been undertaken on the assumption that the ERF is operating 24 hours a day, 7 days a week and emitting ammonia at the ELV concentration of 10mg/Nm^3. Actual emissions monitoring data from a similar plant demonstrate actual levels some twenty times lower that the value used in the modelling study. Therefore, in reality the process concentration at Moel Y Golfa would be significantly less than 1% of the Critical Level, and therefore insignificant.

6.4.85. Whist the 1% and 70% criteria referred to by NRW are appropriate for the screening stage, the cumulative assessment undertaken constitutes a detailed ammonia modelling assessment, and has used a combination of NRW/EA/IAQM and professional judgment to conclude that emissions from the ERF will not be significant at Moel Y Golfa.

6.4.86. In terms of emissions from transport, only developments that have planning permission and have been implemented (regardless of the state of completion) are considered to form the baseline (i.e. committed developments). Other developments that are being determined (at time the Transport Impact Assessment ("TIA") was undertaken, February 2019), or that have planning permission, but are not yet implemented, are considered to form the part of cumulative assessment. Traffic growth factors have been applied within the TIA which provided the numbers of vehicles for the assessment of the impact of road traffic on air quality. Consequently, it is considered that this forms a cumulative assessment.

6.4.87. Cumulative impacts from other developments were considered by virtue of the use of existing background air quality data. The background air quality data used both in assessment of human health impact and impact on ecological sites made use of existing background data which would encompass other existing developments. It is therefore considered that predicted environmental concentrations take account of existing other developments.

Interactive Effects

6.4.88. Consideration must be given to the interactive effects associated with the Development in terms of the relationship between the various KEAs considered. Likely interactive effects are discussed in Table 6-8.

Table 6-8 : Interactive Effects on KEA

KEA Interaction	Interactive Effects
Air Quality and Ecology	A change in air quality has the potential to impact on potentially sensitive ecological sites. Air Dispersion Modelling of the impact of the emissions from the Installation has been undertaken. The results of the assessment may be found the Technical Appendix 6.1. An assessment of the significance of the impact is provided in Section 6.5 of this Chapter.
Air Quality and Health Impact Assessment	A change in air quality has the potential to impact on human health. Air Dispersion Modelling of the impact of the emissions from the installation has been undertaken. The results of the assessment may be found the Technical Appendix 6.1. An assessment of the significance of the impact is provided in Section 6.5 of this Chapter. A Health Impact Assessment has also been undertaken, the results of which are discussed in Chapter 7 – Health Impact.
Air Quality and Transport	Increased traffic movements have the potential to impact on air quality. Air Dispersion Modelling of the impact of emissions from the transport associated with the ERF has been undertaken. The results of the assessment may be found the Technical Appendix 6.2. An assessment of the significance of the impact is provided in Section 6.5 of this Chapter.
Air Quality and Landscape	Under certain circumstances, there is the potential for a visible plume to be produced from the Installation. Air Dispersion Modelling of plume visibility has been undertaken. The results of the assessment may be found the Technical Appendix 6.1. An assessment of the significance of the impact is provided in Section 6.5 of this Chapter and in Chapter 9 – Landscape and Visual Impact.

6.5. Environmental Effects Analysis

6.5.1. Based on the Environmental Effect Assessment for all Development phases discussed in Section 6.4, a detailed environmental effects analysis is provided in Table 6-10 to 6-12.

6.5.2. The significance criteria provided in Table 6-9 are considered relevant in respect of the impact of the Development on air quality within the study area and have been used to describe the effects.

Table 6-9 : Environmental Effects Assessment Evaluation Criteria

Criteria	Description
Magnitude of Impact (Mg)	• Unknown - there is insufficient evidence to indicate the magnitude of the effect; • Nil- there will be no change to background air quality levels or there will be no visible plume. • Low – Process contributions are less than 10% of short term air quality objectives or 1% of long term air quality objectives or a visible plume does not extend beyond the site boundary for more than 5% of the time; • Medium – Predicted environmental concentrations are less than 70% of air quality objectives or a visible plume extends beyond the site boundary for 50% of the time; • High - Predicted environmental concentrations exceed air quality objectives or a plume is visible beyond the site boundary permanently.
Geographic Extent of Impact (GE)	• Within ERF Boundary – 0km • Up to 2km from ERF • Up to 10km from ERF • Over 10km from ERF
Frequency of Impact (F)	• Single event • Potentially annual activity • Monthly occurrence • Continuous activity • Variable depending on weather conditions
Duration of Impact (D)	• 0-6 hours • 1 day • Up to 60 hours • 1 week • 1 month • 2-6 months • 6-12 months • 12-36 months • Over 36 months
Reversibility of Impact (R)	• Unknown - there is insufficient research/experience to indicate whether the environmental effect is reversible • High - previous research/experience indicates the environmental effect is reversible • Medium - previous research/experience indicates the environmental effect may be reversible • Low - previous research/ experience indicates that there is a small likelihood that the environmental effect is reversible • Nil - previous research/ experience indicates that the environmental effect is irreversible
Ecological, Cultural and Socio-economic Context of Impact (ESC)	• Relatively pristine area not adversely affected by human activity • Evidence of human activity • High level of human activity

Table 6-10 : Environmental Effects Analysis – Air Quality: Construction

Activity	Potential Effect	Evaluation Criteria					
		Mg	GE	F	D	R	ESC
Site Development	Reduced air quality due to generation of dust	Low	0km	Cont	12-36M	High	High
	Conclusion: The environmental impact of the development of the site is considered to be not significant. Any dust generated will be confined to the site boundary, and if required water suppression will be used. Notwithstanding the above some mitigation is proposed as outlined below.						
	Mitigation: A Construction Environmental Management Plan ("CEMP") has been prepared. This will be updated by the EPC Contractor and will be agreed with the Local Authority pursuant to planning condition in advance of construction activities. This will detail measures, such as those proposed in Section 6.4.6. of this chapter, to ensure there is no detrimental impact on air quality.						
Construction Traffic on Local Road Network	Reduced air quality due to additional vehicles	Low	<10 km	Cont	12-36M	High	High
	Conclusion: The environmental impact of the development of the site is considered to be not significant. Changes to the background air quality will be negligible.						
	Mitigation: None.						
Construction Vehicles within Development Area	Reduced air quality due to additional vehicles	Un-known	0 km	Cont	12-36M	High	High
	Conclusion: The impact of construction vehicles within the development area is not significant. Vehicles will be correctly serviced and maintained and if hydrogen fuelled excavators are commercially available their use will be considered. Notwithstanding the above – mitigation measures will be incorporated into the CEMP.						
	Mitigation: A Construction Environmental Management Plan ("CEMP") has been prepared. This will be updated by the EPC Contractor and will be agreed with the Local Authority in advance of construction activities. This will detail measures, such as those proposed in Section 6.4.6. of this chapter, to ensure there is no detrimental impact on air quality.						

Table 6-11 : Environmental Effects Analysis – Air Quality: Operation

Activity	Potential Effect	Evaluation Criteria					
		Mg	**GE**	**F**	**D**	**R**	**ESC**
Tipping of Waste into Bunker	Reduced air quality due to generation of dust	Low	0km	Cont	>36 M	High	High
	Conclusion: There will be no impact from the tipping of waste as the operation is undertaken within the confines of the waste reception hall. The waste reception hall will be kept under negative pressure. Fast acting roller shutter doors will be installed to the waste reception hall and will remain closed when not in use. The mitigation is incorporated into the design of the building and the operational procedures.						
	Mitigation: No further mitigation.						
Tipping and Storage of Waste	Odour generation	Low	0km	Cont	>36 M	High	High
	Conclusion: There will be no significant impact from the tipping or storage of waste. Operations are undertaken within the confines of the waste reception hall. The waste reception hall will be kept under negative pressure with extracted air used as combustion air to destroy any odour causing compounds. Fast acting roller shutter doors will be installed to the waste reception hall and will remain closed when not in use. The mitigation is incorporated into the design of the building and the operational procedures.						
	Mitigation: No further mitigation.						
Operation of incinerator	Emission of pollutants from the main stack at the maximum point of impact	Low - Med	<2km	Cont	>36 M	High	High
	Conclusion: Emissions of pollutants from the main stack are considered to be not significant overall. The predicted maximum ground level concentrations are well within both the short and long term air quality objectives and are also assessed as not significant (less than 1% long term or 10% short term of the relevant air quality standards) for most pollutants assessed, and for those of potential significance, further assessment has demonstrated that predicted environmental concentrations will be significantly lower than any and impacts can be described as negligible in accordance with the Institute of Air Quality Modelling guidance. The mitigation is incorporated into the design of the 70m high stack and the operational procedures.						
	Mitigation: No further mitigation.						

Table 6-10 : Environmental Effects Analysis – Air Quality: Operation (cont)

Activity	Potential Effect	Evaluation Criteria					
		Mg	GE	F	D	R	ESC
Operation of incinerator	Emission of pollutants from the main stack at potentially sensitive human receptors	Low-Med	<10km	Cont	>36 M	High	High
	Conclusion: Emissions of pollutants from the main stack are considered to be not significant at the locations of all sensitive receptors considered. The predicted maximum ground level concentrations are well within both the short and long term air quality objectives and are also assessed as not significant (less than 1% long term or 10% short term of the relevant air quality standards) for most pollutants assessed, and for those of potential significance, further assessment has demonstrated that predicted environmental concentrations will be significantly lower than any AQSs and impacts can be described as negligible in accordance with the Institute of Air Quality Modelling guidance. The mitigation is incorporated into the design of the 70m high stack and the operational procedures.						
	Mitigation: No further mitigation.						
Operation of incinerator	Emission of pollutants from the main stack at ecological receptors	Low	<10km	Cont	>36 M	High	High
	Conclusion: The overall impact of emissions from the Installation can be considered not significant at all ecological receptors. There will be no exceedances of the critical levels set for the protection of ecosystems at either European Protected site or all other ecological sites. Nutrient nitrogen deposition critical loads will not be exceeded at the that majority of local nature sites, and will not cause significant pollution at one of the ancient woodland sites. There are slight exceedances at Moel-y Golfa and the Montgomery Canal. However, the magnitude of change for Moel-y-Golfa is so small with respect to the background levels that significant impacts are not expected. For the Montgomery Canal, the lower critical load specified is not applicable, and as the process contribution is less than 1% of the upper critical load the impact can be considered not significant. PCs on both RAMSAR sites considered are less than 1% consequently are not significant. For acid deposition, the process contributions are all less than 100% at the local nature sites, and less than 1% at the SSSIs, SACs and RAMSAR sites. The mitigation is incorporated into the design of the 70m high stack and the operational procedures.						
	Mitigation No further mitigation.						

Table 6-10 : Environmental Effects Analysis – Air Quality: Operation (cont)

Activity	Potential Effect	Evaluation Criteria					
		Mg	**GE**	**F**	**D**	**R**	**ESC**
Operation of incinerator	Plume Visibility	Low	<0km	Var	0-6 hours	High	High
	Conclusion: The plume will only be visible for 40% of all hours, and when visible the length is predicted to be short (4m) for 30% of daylight hours. A visible plume would only extend to 107m for 5% of the time, thus would remain within the site boundary. Consequently, plume visibility can be considered not significant. The mitigation is incorporated into the design of the 70m high stack and the operational procedures.						
	Mitigation: No further mitigation.						
Operation of incinerator	Abnormal Emissions	Med	<2km	Annual	Up to 60h	High	High
	Conclusion: The impact of abnormal emissions from the Installation is considered to be not significant. Short term impacts of pollutants under extreme worst case scenario conditions are less than 10% of the air quality standards, the exception being NO_2 which at a process contribution of 10.93% can be described as a small impact. Long term impacts also are considered not significant, or can be classed slight on further screening. The mitigation is incorporated into the design of the 70m high stack and the operational procedures.						
	Mitigation: No further mitigation.						

Table 6-12 : Environmental Effects Analysis – Air Quality: Decommissioning

Activity	Potential Effect	Evaluation Criteria					
		Mg	GE	F	D	R	ESC
Site Demolition	Reduced air quality due to generation of dust	Low	0km	Cont	>36	High	High
	Conclusion: The environmental impact of the development of the site is considered to be not significant. Any dust generated will be confined to the site boundary, and if required water suppression will be used. Notwithstanding the above some mitigation is proposed as outlined below.						
	Mitigation: A Decommissioning Plan will be prepared and maintained in accordance with the Installation's. This will be agreed with the Local Authority in advance of construction activities. This will detail measures, such as those proposed in Section 6.4.6. of this chapter, to ensure there is no detrimental impact on air quality.						
Decommissioning Demolition Traffic on Local Road Network	Reduced air quality due to additional vehicles	Low	<10 km	Cont	12-36M	High	High
	Conclusion: Decommissioning traffic is likely to be similar to the construction phase, consequently it is assumed that the environmental impact of the decommissioning will not significant. Changes to the background air quality will be negligible.						
	Mitigation: None.						
Decommissioning Demolition Traffic Vehicles within Development Area	Reduced air quality due to additional vehicles	Un-known	0 km	Cont	12-36M	High	High
	Conclusion: The impact of decommissioning vehicles within the development area is not significant. Notwithstanding the above – mitigation measures will be incorporated into the Decommissioning Environmental Management Plan ("DEMP").						
	Mitigation: A DEMP will be prepared. This will be similar in nature to the CEMP (Technical Appendix 4-1) and will be agreed with the Local Authority in advance of decommissioning activities. This will detail measures, such as those proposed in Section 6.4.55. of this chapter, to ensure there is no detrimental impact on air quality.						

6.6. Residual Environmental Effects

6.6.1. This section considers the residual environmental effect of the Buttington ERF, i.e. those effects which remain after the application of mitigation or engineering design.

6.6.2. In addition to the above significance rating the nature/type and duration of the impacts will be assessed using the following criteria:

- Major (significant) residual environmental effect = the predicted environmental concentration of potential pollutants from the facility frequently exceeds air quality objectives; or
- Moderate (significant) residual environmental effect = the predicted environmental concentration of potential pollutants from the facility occasionally exceeds of the air quality objectives; or
- Minor (not significant) residual environmental effect = the predicted environmental concentration of potential pollutants from the facility is 70% or less than the air quality objectives; or
- Negligible (not significant) residual environmental effect = the process contribution of potential pollutants from the facility is 10% or less of the short term air quality objective or 1% of the long term air quality objective.

6.6.3. The type of impact will also be defined according to the following criteria:

- Direct Impact – Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors.
- Indirect Impact - Impacts that result from other activities that are encouraged to happen as a consequence of the Project.

6.6.4. Residual adverse environmental effects for the Project are provided in Table 6-13.

Table 6-13 : Summary of Residual Adverse Environmental Effects – Air Quality

Development Phase	Residual Adverse Environmental Effect	Significance	Likely Effect on the Environment
Construction	Reduced air quality due to generation of dust	Negligible **Not Significant** Direct Impact	Anticipated effects are small and may not be detectable and would not be permanent
	Reduced air quality due to construction traffic on road network	Negligible **Not Significant** Direct Impact	
	Reduced air quality due to construction vehicles within Development area	Negligible **Not Significant** Direct Impact	
Operation	Reduced air quality due to generation of dust	Negligible **Not Significant** Direct Impact	Anticipated effects are small and may not be detectable.
	Odour Generation	Negligible **Not Significant** Direct Impact	
	Reduced air quality due to generation of pollutants from the main stack	Negligible to Minor **Not Significant** Direct Impact	Residual adverse environmental effects will not result in noticeable ecosystem changes.
	Plume Visibility	Negligible **Not Significant** Direct Impact	Anticipated effects are small and will be temporary.
	Reduced air quality due to generation of pollutants from vehicle emissions	Negligible **Not Significant**	Residual adverse environmental effects will not result in noticeable ecosystem changes.
Decommissioning	Reduced air quality due to generation of dust	Negligible **Not Significant** Direct Impact	Anticipated effects are small and may not be detectable and would not be permanent
	Reduced air quality due to construction traffic on road network	Negligible **Not Significant** Direct Impact	
	Reduced air quality due to construction vehicles within Development area	Negligible **Not Significant** Direct Impact	

6.7. Summary

6.7.1. An assessment has been carried out to determine the local air quality impacts associated with the emissions from the proposed Buttington ERF from both the Installation and the associated vehicle emissions. In addition, a dust assessment and a qualitative assessment of odour impact has been undertaken.

6.7.2. As a worst-case, emissions from the Installation's stack have been assumed to be at the maximum emission limit values which represents a conservative assessment of the impact as the actual emissions from the site are likely to be significantly lower.

6.7.3. A detailed screening assessment confirmed that the optimum stack height for the Installation would be 70m.

6.7.4. Predicted maximum GLCs ("PCs") are within the short and long term air quality objectives and are assessed as not significant (less than 1% of the AQS/EAL) for most pollutants assessed, and for those of potential significance, further assessment has demonstrated that the predicted environmental concentrations have a negligible impact on the environment or human health at the maximum point of ground level concentration and at potentially significant human receptors locations.

6.7.5. For the sensitive habitat sites, there will be no significant effects. It has been demonstrated that the impact from the proposed Installation is unlikely to result in a breach of the relevant Critical Loads or Critical Levels or have a detrimental effect on local habitat sites.

6.7.6. An assessment of plume visibility was also undertaken, which concluded that visible plumes would only occur around 30% of the time, and for 95% of the time, any visible plumes would remain within the site boundary.

6.7.7. An assessment was also made of the impact of the proposed plant when operating under the abnormal conditions permitted under Article 46(6) of the IED. The results of the assessment indicated that it would be unlikely that any AQSs would be exceeded under such abnormal operating conditions.

6.7.8. The impact of road traffic associated with the Installation, in all phases of the development can also be classed as not significant for the majority of pollutants and receptors assessed. Where further screening was required, the impact was described as 'slight' (i.e., NO_2 at H34, A458, Buttington Bridge) and 'negligible' for the remaining specified human receptor locations.

6.7.9. The odour assessment also confirmed that the Installation will have a negligible effect on the nearest sensitive receptors.

6.7.10. In summary, therefore, it can be concluded that the proposed Buttington EFR will not have a significant impact on local air quality, human health or sensitive habitat sites, nor give rise to any significant odour impacts.

6.8. References

[i] Planning Policy Wales, Edition 10, December 2018 – Welsh Government

[ii] The Air Quality (Amendment)(Wales) Regulations 2002, Welsh Government, 31st December 2002

[iii] Directive 2010/75/EU on Industrial Emissions, European Parliament, 24th November 2010

[iv] Adopted Powys Local Development Plan 2011-2016, Powys County Council, April 2018.

[v] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1), July 2007

[vi] Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air, 15th December 2004.

[vii] https://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

[viii] The requirement for a "Pre-CEMP" was discussed and agreed with NRW via email on 12.12.2018.

[ix] Commission Implementing Decision (EU) 2019/2010 of 12th November 2019 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for waste incineration.

[x] Email from Powys CC to ECL 22nd March 2019

[xi] Institute of Air Quality Management, Guidance on the Assessment of Odour for Planning, Version 1.1 – July 2018

[xii] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#screen-out-insignificant-pcs

[xiii] https://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

[xiv] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN

[xv] http://www.apis.ac.uk/srcl/select-a-feature?site=UK0030213&SiteType=SAC&submit=Next

[xvi] https://en.powys.gov.uk/media/2721/Float-water-plantain/pdf/float_water_plantain_bi_01.pdf?m=1520524558407

Technical Appendix 6-1
Air Quality Assessment

ECL Ref: ECL.001.01.02/ES
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AIR DISPERSION MODELLING ASSESSMENT OF RELEASES FROM THE ENERGY RECOVERY CENTRE AT BUTTINGTON QUARRY

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AIR DISPERSION MODELLING REPORT OF RELEASES FROM THE ENERGY RECOVERY CENTRE AT BUTTINGTON QUARRY

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ACRONYMS / TERMS USED IN THIS REPORT

AAD	Ambient Air Directive
ADMS	Atmospheric Dispersion Modelling System
APIS	Air Pollution Information System
AQAL	Air Quality Assessment Level
AQDD	Air Quality Daughter Directive
AQMA	Air Quality Management Area
AQMAU	Air Quality Modelling Assessment Unit
AQMRAT	Air Quality Modelling and Risk Assessment Team
AQO	Air Quality Objective
AQS	Air Quality Standard
As	Arsenic
B[a]P	Benzo[a]Pyrene
BAT	Best Available Techniques
Bref	Best Available Techniques Reference Document
Broad Energy	Broad Energy (Wales) Limited
Cd	Cadmium
CERC	Cambridge Environmental Research Consultants
CO	Carbon monoxide
Co	Cobalt
CrIII	Chromium III
CrVI	Chromium VI
cSAC	Candidate Special Areas of Conservation
Cu	Copper
DEFRA	Department for Environment, Food and Rural Affairs
DNS	Development of National Significance
DT	Diffusion Tube
EA	Environment Agency
ECL	Environmental Compliance Ltd
EIA	Environmental Impact Assessment
ELV	Emission Limit Value
EP	Environmental Permit
EPAQS	Expert Panel on Air Quality Standards
EPR	Environmental Permitting Regulations
EPUK	Environmental Protection UK
ERF	Energy Recovery Facility
GLC	Ground Level Concentration
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
Hg	Mercury
IAQM	Institute of Air Quality Management
IED	Industrial Emissions Directive
ILU	Intensive Livestock Unit
LNR	Local Nature Reserve
Met Data	Meteorological Data
Met Office	Meteorological Office
Mn	Manganese
N	Nitrogen

ACRONYMS / TERMS USED IN THIS REPORT

NH_3	Ammonia
Ni	Nickel
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NRW	Natural Resources Wales
NWP	Numerical Weather Prediction
PAH	Polyaromatic Hydrocarbons
Pb	Lead
PC	Process Contribution
PCB	Polychlorinated Biphenyls
PCDD/Fs	Polychlorobenzodioxins / Polychlorodibenzofurans
PEC	Predicted Environmental Concentration
PM_{10}	Particulate Matter (with a diameter of 10 µm or less)
$PM_{2.5}$	Particulate Matter (with a diameter of2.5 µm or less)
Ramsar	Ramsar Convention on Wetlands of International Importance
S	Sulphur
SAC	Special Areas of Conservation
Sb	Antimony
SEPA	Scottish Environment Protection Agency
SO_2	Sulphur Dioxide
SPA	Special Protection Areas
SSSI	Site of Special Scientific Interest
Tl	Thallium
The Installation	Buttington Energy Recovery Facility
V	Vanadium
VOC	Volatile Organic Compounds
WHO	World Health Organisation

LIST OF AMMENDMENTS

- Conclusions moved to Section 11
- New Section 10 added – an in-combination assessment added to include an in-combination assessment of the ERF with a proposed ILU

1. INTRODUCTION

1.1. The Study

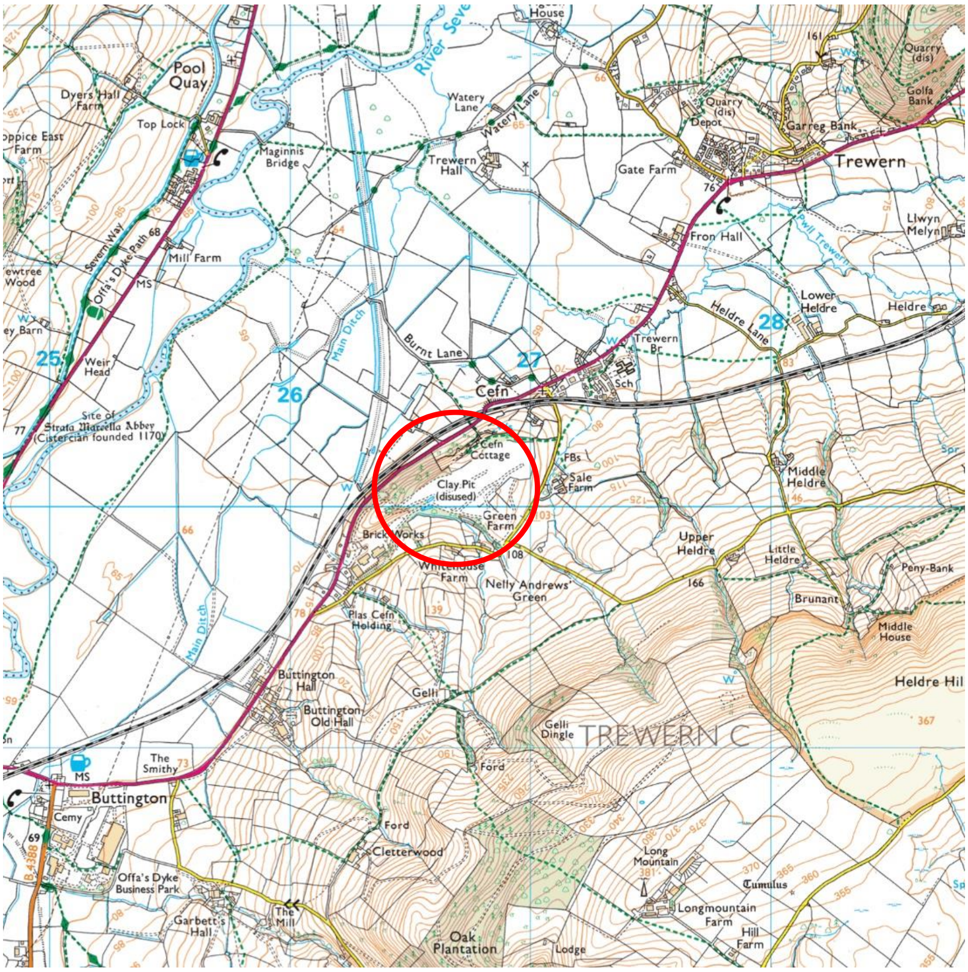
1.1.1. Environmental Compliance Ltd (“ECL”) was commissioned by Broad Energy (Wales) Limited (“Broad Energy”) to undertake an air quality assessment of releases from the proposed Energy Recovery Facility (“ERF”) at Buttington Quarry (“the Installation”), Powys in support of both a Development of National Significance (“DNS”) application to the welsh Ministers and an Environmental Permit (“EP”) Application to Natural Resources Wales (“NRW”).

1.1.2. The study was conducted to determine the impact of emissions to air from the proposed Installation on both human health and local environmentally sensitive sites.

1.1.3. The study was undertaken using the ADMS modelling package, which is one of the models recognised as being suitable for this type of study.

1.1.4. The approximate site location is shown on the Site Location Map, outlined in red, 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 a suitable discharge stack height for the proposed Installation by undertaking a stack height screening assessment;
- to determine the maximum ground level concentrations ("GLCs") arising from the emission of pollutants from the Installation's discharge stack; the pollutants are assumed to be released from the Installation at the Emission Limit Values ("ELVs") defined in Annex VI of the Industrial Emissions Directive ("IED") [1] - *Technical provisions relating to waste incineration plants and waste co-incineration plants;* GLCs have been determined with the plant operating normally and abnormally;
- to determine the 'actual' maximum GLCs arising from the emission of pollutants from the proposed Installation; based on emissions from a similar plant in Edinburgh, which is essentially of the same design;
- to assess the impact of emissions from the facility on existing local air quality in relation to human health at a range of potentially sensitive receptors by comparison with relevant air quality standards ("AQSs");
- to assess the impact of emissions from the facility on potentially sensitive ecological receptors and compare these to the Critical Levels set for the protection of Ecosystems;
- to predict deposition rates of acids and nutrient nitrogen from the modelled emissions and compare these with relevant Critical Loads at a range of sensitive habitat sites; and
- to assess plume visibility.

1.3. Scope of the Study

1.3.1. The first part of the study comprised a screening assessment to determine a suitable height for the Installation's discharge stack. The impact of the facility on human health and sensitive habitats was assessed for a range of stack heights between 50m and 95m.

1.3.2. The main study determined the maximum predicted GLCs of the following pollutants:

- nitrogen oxides (NO_x and NO_2);
- total fine particles (PM_{10} and $PM_{2.5}$);
- carbon monoxide;
- gaseous and vaporous organic substances ("VOCs"), expressed as total organic carbon and assumed to comprise entirely of benzene (in accordance with the guidance provided in SEPA Horizontal Guidance Note H1 *Environmental Assessment and Appraisal of BAT* ("H1"), specifically Module 2, *Emissions Inventory - Grouping air pollutants*, which indicates that, where characterisation of VOCs has not been undertaken, a precautionary approach is taken and all VOCs are assumed to present as benzene);
- sulphur dioxide;
- hydrogen chloride;
- hydrogen fluoride;

(1) Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast)

- ammonia;
- mercury and its compounds;
- cadmium and thallium and their compounds;
- antimony, arsenic, chromium, cobalt, copper, lead, manganese, nickel, vanadium and their compounds (note for ease of reporting, this group of nine metals and their compounds are hereinafter referred to as "Group 3 metals and their compounds";
- dioxins and furans;
- polychlorinated biphenyls and
- PAH, as benzo[a]pyrene (the AQS for PAH is expressed as benzo[a]pyrene, and, accordingly, for the purposes of the assessment, all PAH are assumed to be present as benzo[a]pyrene).

1.3.3. Modelling was carried out using the appropriate ELVs as specified in the IED. However, it is noted that the Best Available Techniques ("BAT") Reference Document ("Bref")[2] has recommended lower limits for certain pollutants. As this document has been issued, Broad Energy has taken the decision to adopt the limits specified in this document to demonstrate its commitment to ensuring the minimum impact on the environment possible, and to be in keeping with the principles of the Well-being of Future Generations (Wales) Act[3].

1.3.4. Daily ELVs were used for the main assessment as the frequency with which the half hourly limit can be exceeded is limited by the provisions of Annex VI of the IED. Consequently, it would be unreasonable to assume that the Installation operates continually at the half hour limits, even for the prediction of short-term concentrations. Half-hourly ELVs, where such limits have been assigned, were used for assessing abnormal releases.

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

1.3.6. The maximum predicted pollutant ground level concentrations ("GLCs") - also known as the process contributions ("PCs") - for each of the releases were compared with the relevant AQSs.

1.3.7. For the purposes of determining the 'actual' maximum GLCs arising from the emission of pollutants from the Installation, actual monitoring data - both continuous and periodic - from a similar HZI plant at Edinburgh has been used. Data for these assessments was kindly provided by FCC Environmental.

1.3.8. 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.

1.3.9. The maximum predicted annual mean GLCs of NO_x, sulphur dioxide ("SO_2"), hydrogen fluoride ("HF") and ammonia ("NH_3") were compared with the Critical Levels for the

[2] Best Available Techniques (BAT) Reference Document for Waste Incineration, Joint research Centre, Directorate B – Growth and Innovation Circular Economy and Industrial Leadership Unit European IPPC Bureau, (December 2019)
[3] Well-being of Future Generations (Wales) Act 2015, April 2015.

Protection of Ecosystems or Vegetation detailed in the Environment Agency's online guidance[4].

1.3.10. The maximum predicted pollutant GLCs at seventy-five human receptors were also compared to the relevant AQSs. There are no declared Air Quality Management Areas ("AQMAs") in Powys (Powys did have one AQMA, however this was revoked on 15th March 2017). Consequently, the assessment of impact on AQMAs is not required.

1.3.11. Using ADMS, the rates of deposition for acids (nitrogen and sulphur, as kilo-equivalents) and nutrient nitrogen were predicted for all relevant habitat sites (eighteen in number; one geological site has been included in the list of sites for completeness, but has not been assessed). These rates were then compared to the appropriate critical loads for the type and location of each habitat.

1.3.12. Abnormal operating conditions were also considered in the study to take account of short-term abnormal conditions permitted under Article 46(6) of the IED.

1.3.13. In relation to the cumulative effects, it is known that, at the time of writing, that there are no potential developments within a 15km radius that require cumulative assessment for impact to air.

[4] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

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 (model version 5.2.4.0).

2.1.2. ADMS 5.2 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 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 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, and, for most pollutants, considerably so; 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 as referenced in AQTAG06[5];
- all of the particulate releases will be present as $PM_{2.5}$ and also as PM_{10}; this enables direct comparison with the particle AQSs, which are expressed in terms of $PM_{2.5}$

[5] AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air (April 2014);

and PM_{10}; in practice, this will not be the case as some of the particles present will be larger than PM_{10}; 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 seventy-five potentially sensitive human receptors considered in the assessment (up to a distance of 15km from the main stack). A large number of receptors were included to ensure that all receptors considered across technical disciplines for the Environmental Impact Assessment ("EIA") were assessed. They include the potentially noise sensitive receptors as well as all viewpoints considered in the Landscape and visual assessment. Details of these receptors are provided in Table 1 and a visual representation as Figure 2 for receptors up to 3km from the Installation and Figure 3 for receptors 3-15km from the installation. All receptors are assumed to be at ground level.

Table 1: Sensitive Human Receptors

ADMS Ref.	Description	Easting	Northing	Distance from Stack (m)	Heading (degrees)
H01	Cefn Cottage	326773	310265	182	349
H02	Green Farm Heldre Lane	326783	309854	234	186
H03	Whitehouse Farm	326624	309845	303	217
H04	Sale Farm - House Off Sale Lane	327129	310072	322	93
H05	Cefn Farm - House Off Sale Lane	327026	310357	348	39
H06	Lower Cefn	326523	310355	391	313
H07	Methodist Church, Buttington	327059	310480	467	33
H08	Heldre Lane	327168	309736	503	134
H09	Speed Welshpool	326305	309785	586	239
H10	Brookside	326236	309813	633	244
H11	Border Hardcore Offices	326221	309760	671	241
H12	York House	326233	309726	678	238
H13	Footpath south of Nelly Andrews' Green	327039	309402	723	161
H14	Buttington Trewern Primary School	327386	310580	761	50
H15	Upper Heldre	327763	309759	1011	109
H16	Heldre Lane, Trewern	327576	310925	1138	43
H17	Farm Buildings off A458	325894	309228	1253	227

Table 1: Sensitive Human Receptors (cont)

ADMS Ref.	Description	Easting	Northing	Distance from Stack (m)	Heading (degrees)
H18	Footpath between Gelli and Longmountain Farm	326822	308704	1383	179
H19	Footpath west of Middle House	328091	309410	1451	118
H20	Criggion Lane, Trewern,	327796	311358	1611	38
H21	Pen-y-Bank	328464	309713	1699	103
H22	Criggion Lane, Trewern	327478	311654	1705	23
H23	A483, Strat Marcella Abbey	325058	310512	1800	284
H24	Trewern, Garreg Bank (lower)	327970	311483	1817	40
H25	Offas Dyke Path, Pool Quay	325741	311635	1880	325
H26	Trewern, Garreg Bank (upper)	328039	311560	1921	40
H27	A458, Buttington and west of The Smithy	325286	308853	1958	231
H28	Trewern, near monument	328241	311471	1993	46
H29	Buttington	325160	308852	2058	233
H30	Buttington Church	324984	308840	2208	236
H31	A483 Pool Quay Straight	324596	309709	2243	260
H32	Coppice East Farm	324875	311351	2309	303
H33	The Old Shop Cottage	328672	311586	2393	51
H34	A458, Buttington Bridge	324689	308923	2417	241
H35	Shepherd’s Lane, Moel y Golfa	328340	311975	2432	39
H36	A483, Buttington Cross	324252	308983	2783	247
H37	A458 between Middletown and Trewern	329009	311847	2819	51
H38	Trailhead Fine Foods/ Welshpool Livestock Sales A483	324304	308746	2839	242
H39	Footpath at Buttington View, Hope	325807	307396	2870	200
H40	Criggion Lane, Old Mills	327926	312807	2942	22
H41	Hope Road	325185	307598	2970	213
H42	Moel y Golfa Wood and Footpath	328818	312289	2983	42
H43	Oak Grange, Middletown	330031	311675	3594	64
H44	Gungrog Hill, Welshpool	323159	308319	4054	244
H45	Borfa Green, Welshpool	322838	308077	4449	243
H46	Rhyd-Esgyn Lane	326950	314820	4736	2
H47	Adelaide Drive, Welshpool	322382	308122	4841	246
H48	Middletown Hill (Cefn y Castell)	330520	313330	4930	49

Table 1: Sensitive Human Receptors (cont)

ADMS Ref.	Description	Easting	Northing	Distance from Stack (m)	Heading (degrees)
H49	Bridge over A483, Welshpool and National Cycle Route 81	322890	307087	4934	233
H50	A483, New Cut	326081	315052	5018	352
H51	Rodney's Pillar, Breidden Hill	329440	314382	5038	32
H52	Footpath west of Rose and Crown	331826	311643	5255	73
H53	Pen-y-coed, Ardleen	324383	314905	5394	333
H54	A483 at Trederwyn Lane	326096	315620	5579	353
H55	A458 between Plas-y-Court and Wollaston	331928	312482	5654	65
H56	Lane west of Bugdin, Ardleen	323069	314499	5783	320
H57	From Severn Way Footpath, south of Gwern-y-go	328685	316127	6326	17
H58	Powys Castle north-east terrace	321616	306469	6327	235
H59	A483 at Trederwen Fweibion Gwnwas	326199	316402	6345	355
H60	Powys Castle, south-east terrace	321593	306403	6384	235
H61	Footpath south of Dyserth Hall	321341	305331	7245	229
H62	A483 by The Moat Farm	321318	304246	8015	223
H63	Trig point and footpath at Y Golfa golf course	318444	307052	8896	250
H64	Pound Lane, Llwynderw	320007	303820	9247	227
H65	A483 by Wernllwyd	320505	302774	9653	221
H66	A483 junction with B4390 to Berriew	319733	301229	11336	219
H67	A483, Pant	327092	321651	11568	1
H68	Llanymynech Golf Course and footpath	326666	321821	11735	359
H69	A483 north of bridge at Berriew	319414	300515	12094	218
H70	Footpath between Cefn Crin and Ashton	314587	304571	13407	246
H71	Green Hall Hill, Llanfyllin	315949	319110	14118	310
H72	East of Mynydd Jaram Bodynfoel Wood	319045	321969	14193	327
H73	Rolly Bank near Osbaston	332037	323502	14399	21
H74	Offas Dyke Path, Nantmawr	324968	324649	14678	353
H75	From Lane near Belan, west of Berriew	314942	301136	14862	233

Figure 2: Potentially Sensitive Human Receptors up to 3km

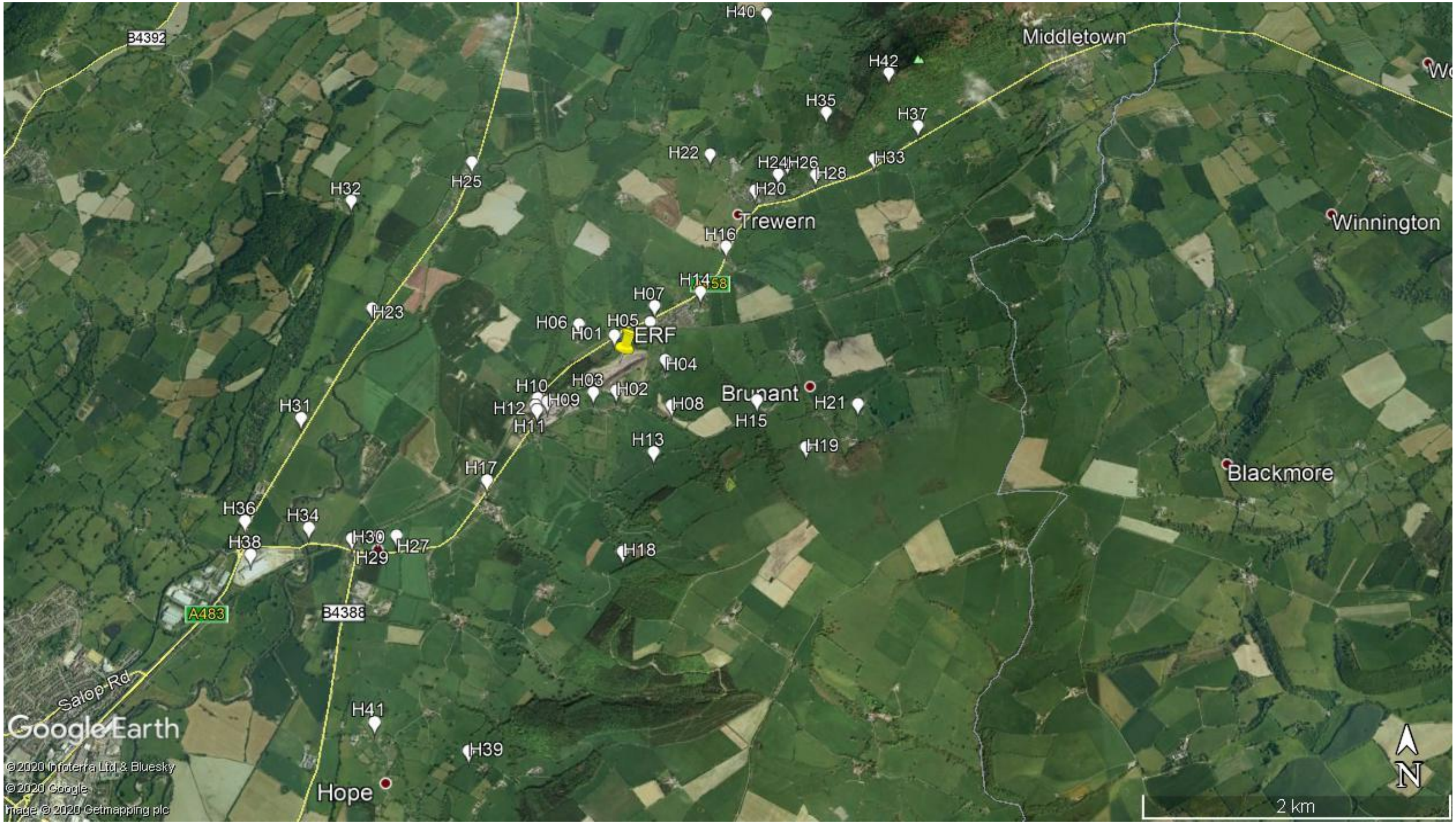
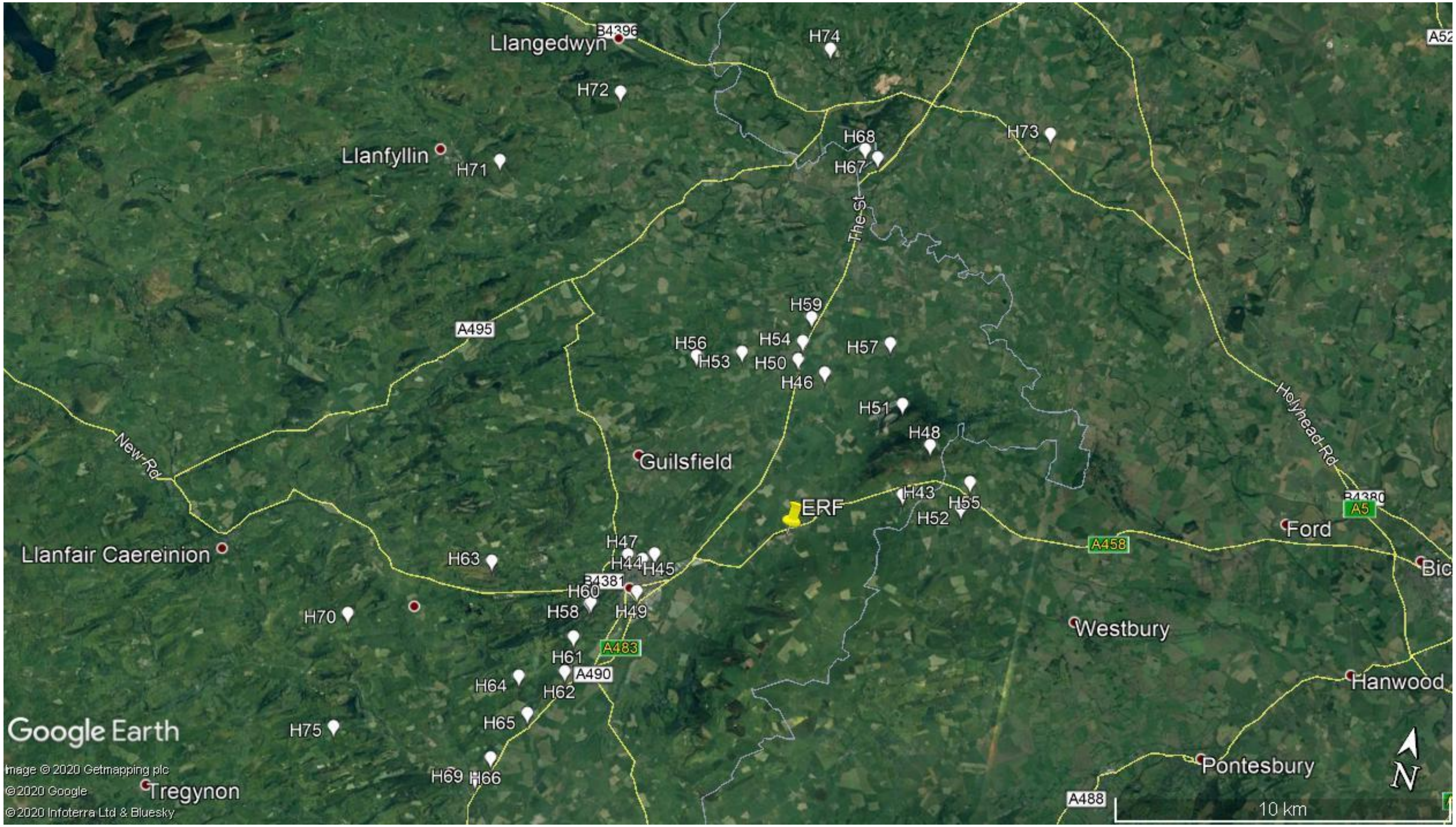


Figure 3: Potentially Sensitive Human Receptors 3-15km



2.4. Sensitive Ecological Receptors

2.4.1. The impact of emissions to air on vegetation and ecosystems from the proposed facility has been assessed for the following sensitive environmental receptors within 10km of the proposed discharge stack:

- Special Areas of Conservation ("SACs") and candidate SACs ("cSACs") designated under the EC Habitats Directive (6);
- Special Protection Areas ("SPAs") and potential SPAs designated under the EC Birds Directive (7);
- SACs and SPAs are included in an EU-wide network of protected sites called Natura 2000 (8). The EC Habitats Directive and Wild Birds Directive have been transposed into UK law by the Habitats Regulations (9).
- Ramsar Sites designated under the Convention on Wetlands of International Importance (10);

2.4.2. In addition, the impact of emissions to air on vegetation and ecosystems from the installation has been assessed for the following sensitive environmental receptors within 2km of the discharge stack:

- Sites of Special Scientific Interest ("SSSI") established by the 1981 Wildlife and Countryside Act;
- Ancient woodland; and
- local nature sites (ancient woodland, local wildlife sites and national and local nature reserves).

2.4.3. For dispersion modelling purposes, the specified habitat co-ordinates are a precautionary approach, and are those located at the boundary of the protected site closest to the proposed Installation. All receptors are assumed to be at ground level. The details of the Habitat sites are provided in Table 2, and a visual representation provided in Figure 4 for all sites excluding the Ramsar sites, and Figure 5 for the two Ramsar sites.

(6) Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora
(7) Council Directive 79/409/EEC on the conservation of wild birds
(8) www.natura.org
(9) The Conservation (Natural Habitats, &c.) Regulations 1994. The Conservation (Natural Habitats, &c.) (Amendment) Regulations 1997 (Statutory Instrument 1997 No. 3055), The Conservation (Natural Habitats, &c.) (Amendment) (England) Regulations 2000 (Statutory Instrument 2000 No. 192)
(10) The Convention of Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, Iran,1971)

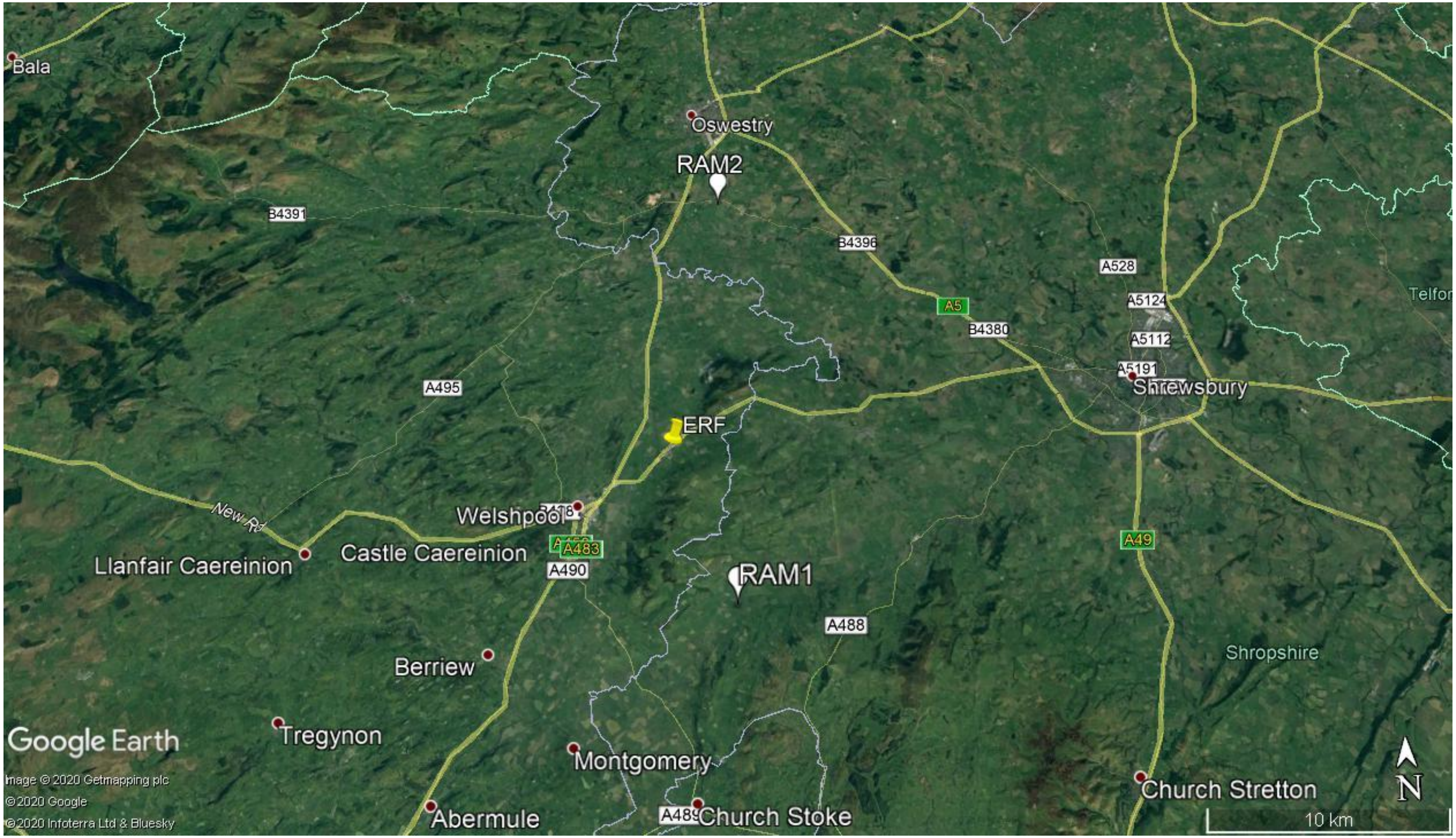
Table 2: Specific Sensitive Habitat Receptors Considered for the Assessment

ADMS Ref.	Location	Type of Receptor	Easting (X)	Northing (Y)	Distance from Source (m)	Heading (Degrees)
RAM1	Midland Meres and Mosses – Phase 1 – Marton Pool	Ramsar	329510	302730	7837	160
RAM2	Midland Meres and Mosses – Phase 2	Ramsar	330008	323857	14,138	13
SSSI1	Buttington Brickworks	SSSI	326980	310222	220	52
SSSI2	Montgomery Canal	SSSI	324911	310297	1,908	276
SSSI3	Moel y Golfa	SSSI	328426	311640	2,244	46
SAC1	Montgomery Canal	SAC	324911	310297	1908	276
SAC2	Granllyn	SAC	322501	311267	4465	285
AW01	Ancient Woodland - 33254	Cat 1 - AW	326365	310248	471	290
AW02	Ancient Woodland - 33255	Cat 1 - AW	326312	310244	520	288
AW03	Ancient Woodland - 47343	Cat 3 - AW	327442	310141	637	85
AW04	Ancient Woodland - 26045	Cat 1 - AW	327683	310276	896	78
AW05	Ancient Woodland - 27762	Cat 1 - AW	327370	309339	936	143
AW06	Ancient Woodland - 33238	Cat 1 - AW	326717	309109	982	185
AW07	Ancient Woodland - 27222	Cat 1 - AW	327761	309658	1046	114
AW08	Ancient Woodland - 28973	Cat 2 - AW	327692	309306	1180	131
AW09	Ancient Woodland - 35167	Cat 2 - AW	328187	310137	1381	88
AW10	Ancient Woodland - 27086	Cat 1 - AW	326285	308794	1394	202
AW11	Ancient Woodland - 27223	Cat 1 - AW	328256	309896	1461	97

Note to Table 2
AW = Ancient Woodland
Cat = Category

Figure 4: Potentially Sensitive Ecological Receptors – Excluding Ramsars

Figure 5: Potentially Sensitive Ecological Receptors – Ramsars



2.5. Air Quality Standards for the Protection of Human Health

2.5.1. The national air quality objectives for Wales represent pragmatic thresholds which have been set for the protection of human health. These are set out in the Air Quality (Wales Regulations [11] 2000, No 1940 (Wales) 138) and Air Quality (Amendment) (Wales) Regulations 2002, No 3182 (Wales 298). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland[12] also details Air Quality Strategy Objectives for a range of pollutants, including a number that are directly relevant to this study.

2.5.2. In addition, the 4th Air Quality Daughter Directive[13] ("AQDD") details Target Values for arsenic, cadmium and nickel. The Expert Panel on Air Quality Standards ("EPAQS"), which advises the UK Government on air quality, has set recommended Guideline Values for arsenic, chromium VI and nickel; the EPAQS Guideline Value for nickel is the same as the AQDD Target Value, but the EPAQS Guideline Value for arsenic is half that of the AQDD value. The lowest of these values have been taken into account in this study.

2.5.3. In the case of hydrogen chloride, hydrogen fluoride, chromium (VI) and arsenic, EPAQS has set recommended Guideline Values which have been taken into account in this study. Environmental Quality Standards ("EQSs") have been assigned by NRW (by the use of the EA's EQS) to a number of the other pollutants assessed in the modelling study; these are detailed (where assigned) in the EA's online guidance; these have been derived from a variety of published UK and international sources (including the World Health Organisation ("WHO")).

2.5.4. In this report, the generic term Air Quality Standard ("AQS") is used to refer to any of the above values. The various AQSs - Air Quality Objectives, Target Values, EPAQS Guideline Values and EALs - 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.

[11] Air Quality (Wales Regulations 2000, No 1940 (Wales) 138) and Air Quality (Amendment) (Wales) Regulations 2002, No 3182 (Wales 298).

[12] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1), July 2007

[13] Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air, 15th December 2004.

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

Pollutant	Averaging Period	AQS (µg/m³)	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
Sulphur Dioxide (SO_2)	24-hour	125	UK AQO, not to be exceeded more than 3 times per annum, equivalent to the 99.18th percentile of 24-hour means
	1-hour	350	UK AQO, not to be exceeded more than 24 times per annum, equivalent to the 99.73rd percentile of 1-hour means
	15-minute	266	UK AQO, not to be exceeded more than 35 times per annum, equivalent to the 99.9th percentile of 15-minute means
Particulate Matter, as PM_{10}	annual	40	UK AQO
	24-hour	50	UK AQO, not to be exceeded more than 35 times per annum, equivalent to the 94.01st percentile of 24 hour means
Particulate Matter, as $PM_{2.5}$	annual	25	EU Limit Value
Carbon Monoxide (CO)	8-hour	10,000	UK AQO and ADD Limit
VOC (as benzene)	Annual	5	ADD Limit and AQS Objective
Ammonia	Annual	180	EAL derived from long-term occupational exposure limits
	1-hour	2,500	EAL derived from long-term occupational exposure limits as no short-term limit exists
Hydrogen chloride	1-hour	750	EPAQS Guideline Value
Hydrogen Fluoride (HF)	Annual	16	EPAQS Guideline Values
	1-hour	160	

Table 3: Air Quality Standards for the Protection of Human Health (Cont)

Pollutant	Averaging Period	AQS (µg/m³)	Comments
Antimony (Sb)	annual	5	EAL derived from long-term occupational exposure limits
	1-hour	150	EAL derived from long-term occupational exposure limits as no short-term limit exists
Arsenic (As)	annual	0.003	EPAQS Guideline Value
Cadmium (Cd)	annual	0.005	AQDD Target Value/EPAQS Guideline Value
Chromium III (CrIII)	annual	5	EAL derived from long-term occupational exposure limits
	1-hour	150	EAL derived from long-term occupational exposure limits as no short-term limit exists
Chromium VI (CrVI)	annual	0.0002	EPAQS Guideline Value
Cobalt (Co)	annual	0.2	EAL derived from long-term occupational exposure limits
	1-hour	6	EAL derived from short-term occupational exposure limits
Copper (Cu)	annual	10	EAL derived from short-term occupational exposure limits
	1-hour	200	EAL derived from long-term occupational exposure limits
Lead (Pb)	annual	0.25	UK AQO
Manganese (Mn)	annual	1	WHO Guideline Value
	1-hour	1500	EAL derived from long-term occupational exposure limits as no short-term limit exists
Mercury (Hg)	annual	0.25	EAL derived from long-term occupational exposure limits
	1-hour	7.5	EAL derived from long-term occupational exposure limits as no short-term limit exists

Table 3: Air Quality Standards for the Protection of Human Health (Cont)

Pollutant	Averaging Period	AQS ($\mu g/m^3$)	Comments
Nickel (Ni)	annual	0.02	AQDD Target Value/EPAQS Guideline Value
Thallium (Tl)	Annual	1	EAL derived from long-term occupational exposure limits
	1-hour	30	EAL derived from short-term occupational exposure limits
Vanadium (V)	annual	5	EAL derived from long-term occupational exposure limits
	24-hour	1	WHO Guideline Value
Benzo[a]pyrene	annual	0.00025	UK AQO
PCBs	annual	0.2	EAL
	1-hour	6	EAL
Dioxins and Furans	No Standard Applies		

2.6. Assessment Criteria for the Protection of Sensitive Habitat Sites and Ecosystems - Critical Levels

2.6.1. 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.

2.6.2. The 2008 Air Quality Directive[14] 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.

[14] Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe, 21st May 2008

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

Pollutant	Averaging Period	Critical Level (µg/m³)	Comments
Nitrogen Oxides (as NO_2)	annual	30	Air Quality Objective
	daily	75	(a)
Sulphur Dioxide (SO_2)	annual	10	sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity (a)
	annual	20	Air Quality Objective
	winter mean	20	Air Quality Objective
Ammonia (NH_3)	annual	1	sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity (b)
	annual	3	All other ecosystems (b)
Hydrogen Fluoride (HF)	daily	5	(c)
	weekly	0.5	(c)

Notes to Table 4
(a) WHO (2000) Air Quality Guidelines for Europe; 2nd Edition. WHO Regional Publications, European Series, No. 91.
(b) UN Economic & Social Council, Executive Body for the Convention on Long-Range Transboundary Air Pollution, ECE/EB.AIR/WG.5/2007/3.
(c) Mc Cune, DC (1969a): Fluoride criteria for vegetation reflect the diversity of the plant kingdom. In a symposium: The technical significance of air quality standards. Environmental Science & Technology. 3: 720-735.

2.7. Assessment Criteria for the Protection of Sensitive Habitat Sites and Ecosystems - Critical Loads

2.7.1. 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"[15].

2.7.2. 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[(16)] are assigned to habitat classes of the European Nature Information System[(17)] in units of kgN/ha/yr.

(15) From http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm
(16) From http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm
(17) See http://eunis.eea.europa.eu/ for details

2.7.3. 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/m²/s × (14/46)[18] *× 315.36*[19]

2.7.4. 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[20].

2.7.5. 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[16] in units of keq/ha/yr.

2.7.6. 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/m²/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/m2/s × (14/46) × 315.36) ÷ 14(21)
- sulphur (keq) =([SO_2]µg/m2/s × (32/64) × 315.36) ÷ 16(22.

2.7.7. Emissions of ammonia ("NH_3") and hydrogen chloride ("HCl") from the Installation will also contribute to the total acidification rate.

2.7.8. 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.

2.7.9. Table 5 list the site-specific critical loads for nutrient nitrogen deposition and acid deposition. Features are as indicated on the Air Pollution Information System ("APIS") website (for SAC's) or directly from the SSSI citation. Where a primary feature identified in the SSSI 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[23]. The Critical Load values for acidification were based on the grid reference for the ecological receptor as stated in Table 2.

2.7.10. A summary of site-specific baseline nutrient nitrogen and acid deposition rates, as provided by APIS, is also presented in Table 5. 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.

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(18) Ratio of atomic weight(of nitrogen to molecular weight of nitrogen dioxide
(19) Conversion factor from g/m² to kg/ha.
(20) From http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm#_Toc279788052
(21)14kg nitrogen/ha/yr = 1keq nitrogen/ha/yr
(22)16kg sulphur/ha/yr= 1keq sulphur/ha/yr
(23) http:/www.apis.ac.uk/habitat_table.html

Table 5: Critical Loads for Deposition

ADMS Receptor Reference	Site	Habitat Interest	Nutrient Nitrogen Deposition			Acidity			Acidity Background		
			Lower Critical Load (N) (kgN/ha/yr)	Upper Critical Load (N) (kgN/ha/yr)	Background Concentration (kgN/ha/yr)	CL MaxN	CL MinN	CL MaxS	Total (keq/ha/yr)	N (keq/ha/yr)	S (keq/ha/yr)
RAM1	Midland Meres and Mosses – Phase 1	Open Water Bodies, Reed Swamps, Fen, carr and damp pasture	10	15	19.46	Habitat not sensitive to Acidity			1.41	1.39	0.13
RAM1	Midland Meres and Mosses – Phase 2	Nutrient rich open water bodies with fringing habitats of reed, swamp, fen, carr and damp pasture.	10	15	18.2	Habitat not sensitive to Acidity			1.3	1.3	0.12
SSSI1	Buttington Brickworks	Geological SSSI									
SSSI2	Montgomery Canal	Aquatic, emergent and marginal plant communities including floating water plantain	3	10	13.86	No Critical Loads Set for Freshwater			1.22	0.99	0.23
SSSI3	Moel y Golfa	Semi-Natural Broadleaved Woodland with mature trees and well-developed shrub. The canopy has been modified by planting and includes many coniferous trees.	5	15	30.52	2.825	0.357	2.468	2.12	2.18	0.16
SAC1	Montgomery Canal SAC	Aquatic, emergent and marginal plant communities including floating water plantain		10	14.5	No critical loads are available for this feature			1.33	1.34	0.15
SAC2	Granllyn SAC	Triturus cristatus - Great crested newt	No comparable habitat		12.2	No critical loads are available for this feature			1.33	1.34	0.15

Table 5: Critical Loads for Deposition (cont)

ADMS Receptor Reference	Site	Habitat Interest	Nutrient Nitrogen Deposition			Acidity			Acidity Background		
			Lower Critical Load (N) (kgN/ha/yr)	Upper Critical Load (N) (kgN/ha/yr)	Background Concentration (kgN/ha/yr)	CL MaxN	CL MinN	CL MaxS	Total (keq/ha/yr)	N (keq/ha/yr)	S (keq/ha/yr)
AW01	33254	Ancient Woodland	10	15	30.52	2.828	0.357	2.471	2.12	2.18	0.16
AW02	33255	Ancient Woodland	10	15	30.52	2.828	0.357	2.471	2.12	2.18	0.16
AW03	47343	Ancient Woodland	10	15	30.52	2.83	0.357	2.473	2.12	2.18	0.16
AW04	26045	Ancient Woodland	10	15	30.52	2.83	0.357	2.473	2.12	2.18	0.16
AW05	27762	Ancient Woodland	10	15	34.16	1.684	0.142	1.542	2.37	2.44	0.2
AW06	33238	Ancient Woodland	10	15	34.16	1.684	0.142	1.542	2.37	2.44	0.2
AW07	27222	Ancient Woodland	10	15	34.16	1.684	0.142	1.542	2.37	2.44	0.2
AW08	28973	Ancient Woodland	10	15	34.16	2.37	2.44	0.2	1.684	0.142	1.542
AW09	35167	Ancient Woodland	10	15	30.52	2.83	0.357	2.473	2.12	2.18	0.16
AW10	27086	Ancient Woodland	10	15	34.16	1.684	0.142	1.542	2.37	2.44	0.2
AW11	27223	Ancient Woodland	10	15	34.16	1.684	0.142	1.542	2.37	2.44	0.2

2.8. Habitat Site Specific Baseline Concentrations

2.8.1. A summary of site-specific baseline concentrations of NO_x, SO_2 and NH_3, 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 NOx, SO_2 and NH_3

ADMS Receptor Reference	Description	Background Concentration[a]			
		NO_x (µg/m³)		SO_2 (µg/m³)	NH_3 (µg/m³)
		Annual Mean	24 Hour Mean[b]	Annual Mean	Annual Mean
RAM1	Midland Meres and Mosses – Phase 1	4.39	5.18	0.72	2.23
RAM1	Midland Meres and Mosses – Phase 2	5.44	6.42	0.8	2.33
SSSI1	Buttington Brickworks	n/a			
SSSI2	Montgomery Canal	0.15	5.43	6.41	0.78
SSSI3	Moel y Golfa	0.16	5.78	6.82	0.86
SAC1	Montgomery Canal	0.15	5.43	6.41	0.78
SAC2	Granllyn	0.15	2.09	2.47	0.75

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.

(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.

2.9. Deposition Parameters - Sensitive Habitats

2.9.1. Deposition of nitrogen and acids at designated habitats sites was also included in the assessment. This focused on sites within 10km of the Installation as detailed in Section 2.4.3. The pollutant deposition rates are presented in Table 7. These parameters are detailed in AQTAG06. Since woodland sites have a greater surface area, higher deposition velocities are adopted for these sites.

2.9.2. For acidification impacts, the deposition of oxides of nitrogen, ammonia, sulphur dioxide and hydrogen chloride are considered. For nutrient nitrogen, the deposition of the oxides of nitrogen and ammonia are included.

Table 7: Acid/Nitrogen Deposition Parameters[(a)]

Pollutant	Dry Deposition Velocity for Grassland (m/s)	Dry Deposition Velocity for Woodland (m/s)
Sulphur Dioxide	0.012	0.024
Oxides of Nitrogen (as NO_2)	0.0015	0.003
Ammonia	0.02	0.03
Hydrogen Chloride	0.025	0.06

Note to Table 7

(a) As detailed in AQTAG06.

2.10. Background Air Quality

2.10.1. Background air quality data has been obtained for all pollutants, where relevant, so that the PECs for all pollutants can be calculated. Where background concentrations were needed, the source and concentrations used are discussed in the relevant sections of this report (sections 4.2 and 4.4).

2.10.2. It should be noted, that there are, at time of writing, no automatic monitoring sites within Powys County Council.

2.11. Stack Emission Parameters

2.11.1. The stack emission parameters used in the study are presented in Table 8 for the main stack (designated A1). The ELVs assumed for each pollutant and the pollutant mass emission rate for the study are presented in Table 9. These are the assumed daily ELVs used for the modelling assessment. Emissions parameters were provided by HZI.

Table 8: Stack Emission Parameters

Parameter	A1
Stack Height (m)	TBC (50-95m)
Stack Exit Diameter (m)	1.6
Stack Gas Discharge Velocity (actual) (m/s)	19
Stack Gas Discharge Temperature (°C)	135
Stack Centre Co-ordinates	326807, 310086
Oxygen Concentration in Stack Emission (%)	8.24
Moisture Concentration in Stack Emission (%)	20
Actual Volumetric Flowrate (m^3/s)	38.2
Normalised Volumetric Flowrate (Nm^3/s)[(a)]	26.01
Mass of H_2O (kg/kg)	0.149

Notes to Table 8

(a) Referenced to 273K, 1 atm, dry and 11% O_2.

Table 9: Pollutant Emission Rates

Pollutant	ELV(a)(c) (mg/Nm^3)	A1 (g/s)
Nitrogen dioxide	120	3.12
Sulphur dioxide	50	1.301
Carbon monoxide	50	1.301
PM10(b)	10	0.260
PM2.5(b)	10	0.260
VOCs (as Benzene)	10	0.260
Hydrogen chloride	10	0.260
Hydrogen fluoride	1	0.0260
Cadmium/thallium	0.05	0.00130
Mercury	0.05	0.00130
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.5	0.0130
Ammonia	10	0.260
Dioxins and Furans	0.00000004	0.00000000104
PAH (as benzo[a]pyrene)(d)	0.0001	0.00000260
Polychlorinated biphenyls(e)	0.00001	0.000000260

Notes to Table 9

(a) Concentrations are at reference conditions i.e. 273K, 1 atmosphere, 11% oxygen, dry.

(b) It has been assumed that all particulate matter can be present as PM_{10} or $PM_{2.5}$

(c) Unless stated otherwise, pollutant ELVs are as stated in the IED.

(d) There is no ELV for B[a]P. Consequently, an appropriate ELV for the purposes of the modelling study was required. The BREF for the waste incineration sector quotes emission levels for B[a]P ranging from 0.004ng/Nm3 to 1µg/Nm3. Actual emissions testing from another plant (FCC Millerhill) using the same HZI technology gave results of between 0.0147µg/m3 and 0.0179µg/m3. As the BREF document uses data from older as well as more modern incineration plant, it is considered that a limit of 1µg/Nm3 would be overly conservative and would not provide realistic results. It is also approximately 70 times that of the actual emissions observed. Consequently, for the purposes of this modelling study a value of 0.1µg/Nm3 has been used for emissions of B[a]P. This is still some 7 times greater than the actual emissions observed, however still retains a degree of conservatism for the assessment.

(e) ELV provided by HZI.

2.12. Meteorological (Met) Data

2.12.1. Further to advice from the Met Office it is considered that modelling will be undertaken using data from Shawbury for 2015 – 2019 as this is the closest site to the ERC.

2.12.2. It should be noted that this location is in excess of 30km northeast of the ERF (located at 355280, 322106). However, feedback from an earlier public consultation indicated that local residents have concerns around plume grounding on Long Mountain. Numerical Weather Predication ("NWP") data is available from the Met Office which would provide modelled site-specific weather conditions. NWP data is used by the Met Office for weather forecasting and to model climate change. The models are run on large supercomputers and input observations from ground stations, buoys at sea, radiosondes, aircraft and satellites[24]. The data supplied by the Met Office is at a resolution of 1.5km. The Met Office

[24] User Guide to NWP Mett Data for Dispersion Modelling, Met Office, 10th March 2009.

have investigated the terrain surrounding the site and believe that the 1.5km resolution is the appropriate model to use[25]. Two years of NWP data has been used in the assessment, 2018 and 2019.

2.12.3. It should be noted that the NWP data contains additional meteorological variables to observed data, including the sensible heat flux and boundary layer depth which can then be used directly in the model, rather than ADMS using the met pre-processor to estimate heat flux, boundary layer depth and stability using the cloud amount. However, the Met Office state that it may be desirable with the NWP data to run ADMS in the same way as it would be run with observed data, i.e. without the additional parameters. *This approach may give more consistent results in comparison with ADMS runs using observations (but not necessarily more accurate results*[25]). Consequently, a sensitivity analysis has been undertaken based on unitised emission rates for a 70m stack, using an output grid 4km x 4km with 101 points in each direction, i.e. a grid spacing of 40m. All other variables were the same as the main modelling study. The met year 2019 was used in the assessment as it contained more usable hours (see paragraph 2.12.9). The results are provided in Table 10.

Table 10: Met Pre-Processor Screening (met year 2019)

Met Data	Maximum Predicted Annual Mean GLC (PC) (µg/m^3)	Maximum (100th percentile) Predicted 1 hour Mean GLC (PC) (µg/m^3)	Maximum Predicted 99.79 percentile of 1 hour Mean GLC (PC) (µg/m^3)
NWP with all Variables	0.25	26.90	4.02
NWP without Sensible Heat Flux and Boundary Layer Depth	0.35	13.69	3.76
2019 Observed Met Data	0.13	18.39	3.55

2.12.4. It can be seen from Table 10 that there are differences in the predicted PCs for the annual mean, 100th percentile and 99.79th percentiles, however, the differences are not consistent with different met data providing the highest process contributions.

2.12.5. To assess the impact of these differences, the actual emission rates were considered. The actual emission rate for NO_2 is 3.12g/s (NO_2 was chosen as an example as the air quality standard has both an annual and short term (99.79th percentile) averaging period), and the emissions rate for ammonia is 0.26g/s which was used as an example for the 100th percentile. Table 11 and 12 show the difference in actual pollutant concentrations for NO_2 for both the long term (annual) and short term (99.79th percentile) air quality standard (NO_x to NO_2 conversion rates, as detailed in Section 2.26 have been accounted for), and Table 13 shows the difference in actual pollutant concentrations for ammonia for the short term (100th percentile) air quality standard.

[25] Email from Met Office to ECL 19th July 2019.

Table 11: Met Pre-Processor Screening- Comparison with NO_2 Long Term AQS

Met Data	Maximum Predicted Annual Mean GLC (PC) (µg/m³)	AQS	Maximum Predicted Annual Mean GLC (PC) as a % of AQS
NWP with all Variables	0.554	40	1.38%
NWP without Sensible Heat Flux and Boundary Layer Depth	0.771		1.93%
2019 Observed Met Data	0.277		0.69%

Table 12: Met Pre Processor Screening – Comparison with NO_2 Short Term AQS

Met Data	Maximum Predicted 99.79th Percentile GLC (PC) (µg/m³)	AQS	Maximum Predicted 99.79th Percentile GLC (PC) as a % of AQS
NWP with all Variables	4.39	200	2.19%
NWP without Sensible Heat Flux and Boundary Layer Depth	4.11		2.06%
2019 Observed Met Data	3.88		1.94%

Table 13: Met Pre Processor Screening – Comparison with Ammonia Short Term AQS

Surface Roughness	Maximum Predicted 100th Percentile GLC (PC) (µg/m³)	AQS	Maximum Predicted Annual Mean GLC (PC) as a % of AQS
NWP with all Variables	6.99	2,500	0.28%
NWP without Sensible Heat Flux and Boundary Layer Depth	3.56		0.14%
2019 Observed Met Data	4.78		0.19%

2.12.6. The data in Tables 11-13 show that the difference in the PCs, would be significant for the long term (i.e. greater than 1% of the long-term AQS), but not significant for the short term standard (i.e. less than 10% of the short term AQS)

2.12.7. The Met Office note that *'it may be more desirable with NWP data to run ADMS in the same way with heat flux, boundary layer depth and stability calculated by the ADMS pre-processor using the NWP cloud amount*[26]*.'* Furthermore, the Met Office note that this approach *'may give more consistent results in comparison with ADMS runs using observations (but not necessarily more accurate results)*.

2.12.8. Consequently, as there is no clear guidance and as the results from the screening study are not conclusive, the modelling be undertaken using data from the observed meteorological station (in accordance with NRW/EA guidance), non-modified NWP data for 2018 and 2019, and NWP data for 2018 and 2019 with the sensible heat flux and boundary layer depth turned off. Thus, a total of 9 years of met data will be used to obtain worst case.

2.12.9. Wind roses for the data are presented in Figure 5; these show that the prevailing winds are predominantly westerly / south-westerly.

2.12.10. Over the five years of meteorological data used (43,824 hours), ADMS reported that 117 hours contained inadequate data, 104 hours were calm and 1,606 hours were non-calm met data lines with a wind speed less than the minimum value (0.75 m/s). These represent 0.3%, 0.2% and 3.7% of the data respectively.

2.12.11. For 2018 NWP Met data, 8293 lines were used with 467 lines as non-calm met data lines with a wind speed less than the minimum value. For 2018 NWP Met data, 8487 lines were used with 273 lines as non-calm met data lines with a wind speed less than the minimum value.

[26] User Guide to NWP Met Data for Dispersion Modelling, Met Office, 10th March 2019

Figure 6: Wind Roses - Met Years 2015-2019

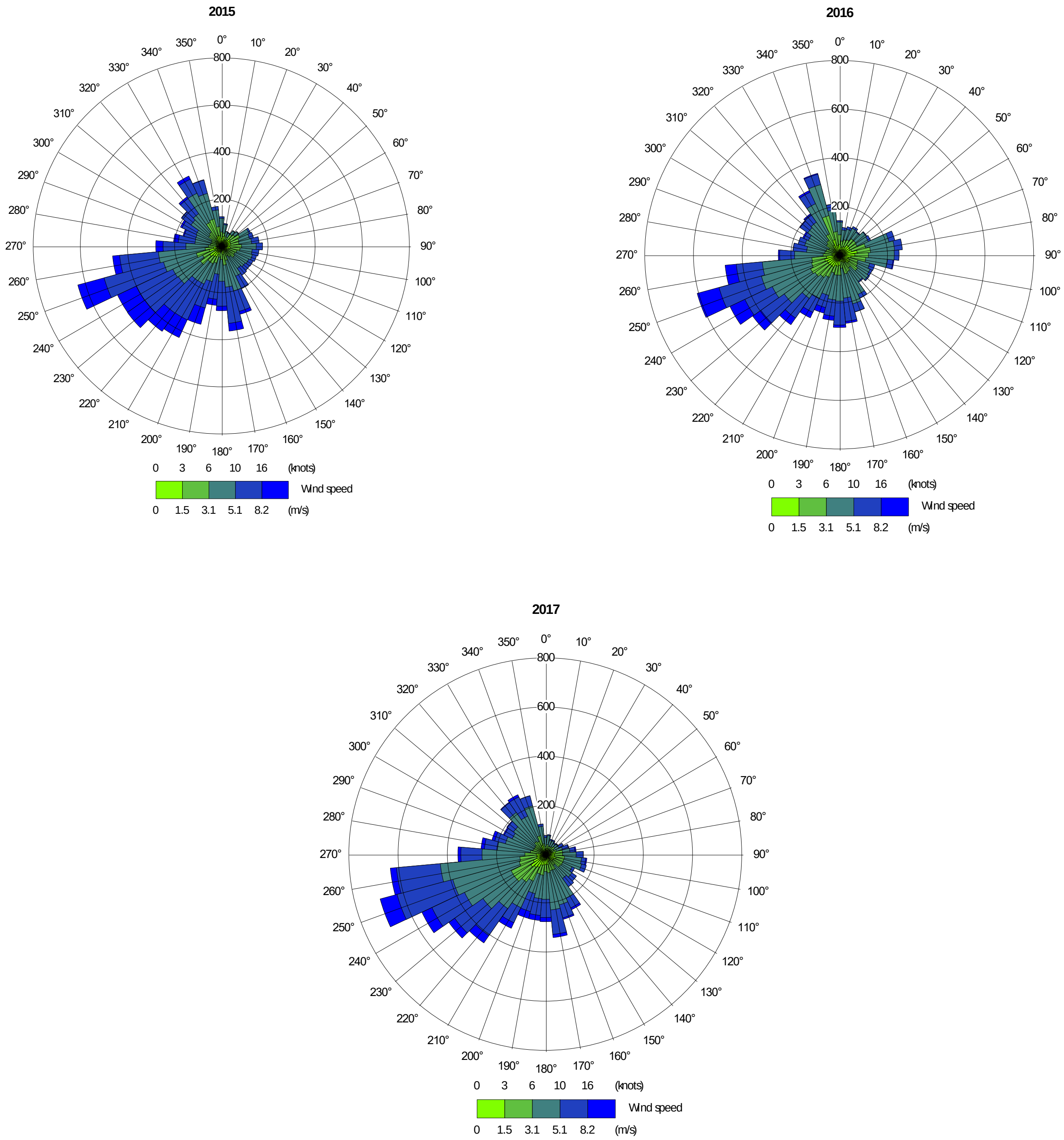
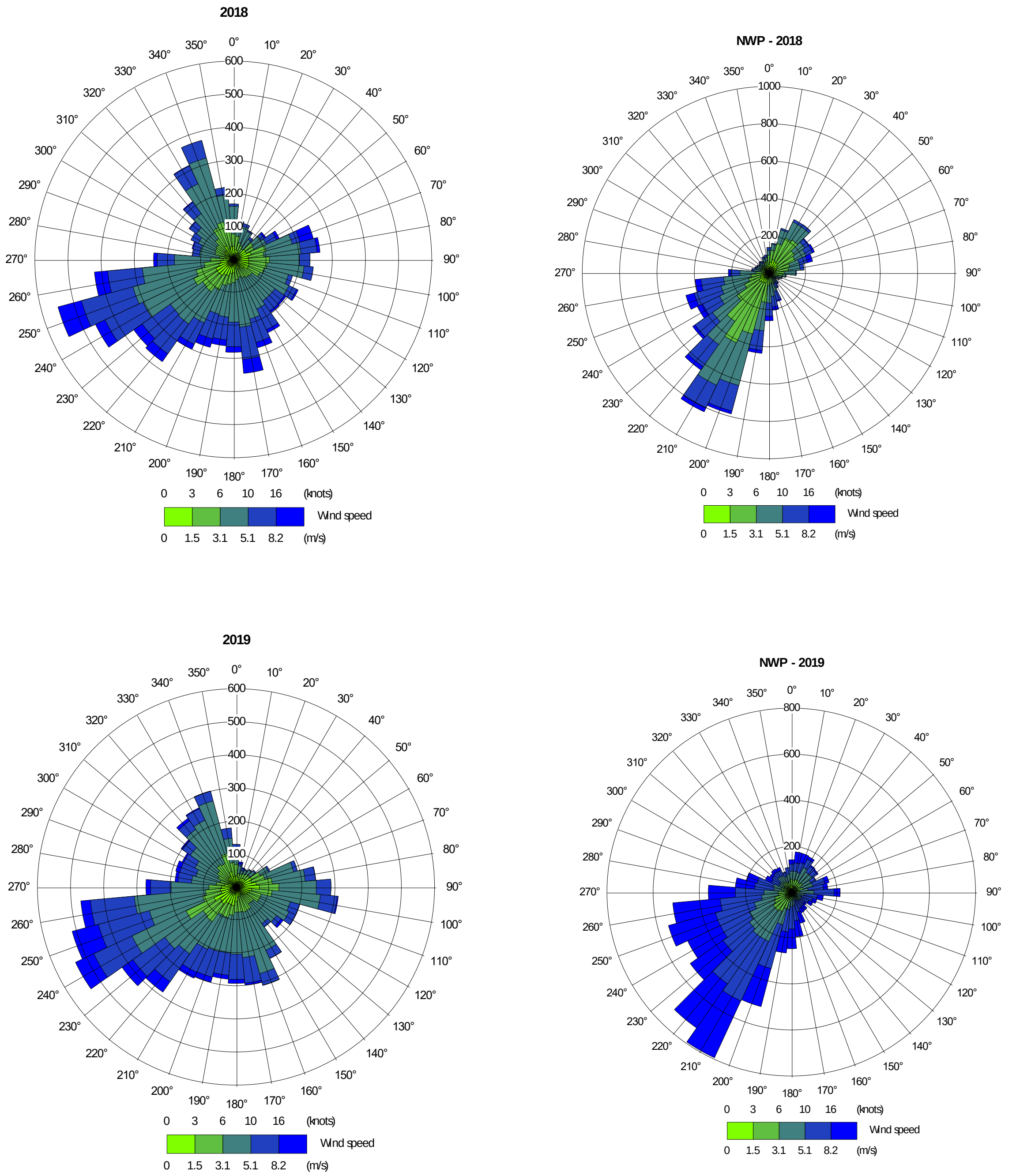


Figure 6: Wind Roses - Met Years 2014-2019 (cont)



2.12.12. The wind roses for the NWP data, compared to the observed data are markedly different. The NWP data shows that the winds blew from the south west for a significantly greater period of time than the observed data. This is more in keeping with local knowledge of the site where it has been observed that the wind does funnel up the valley. Whilst there does not appear to be much difference in wind speed between 2018 observed and 2018 NWP, the winds from the 2019 NWP are much faster.

2.12.13. These differences will therefore have a significant impact on dispersion modelling, consequently all seven years of met data will be used in the modelling assessment and impacts will be based on the worst case met year regardless of observed or NWP.

2.13. Surface Albedo

2.13.1. The surface albedo is the ratio of reflected to incident shortwave solar radiation at the surface of the earth[27]. ADMS allows the user to set this value between 0 and 1. A value of 0.40-0.95 would be considered representative of snow covered ground where a large proportion of the light is reflected, soils from 0.05-0.40, agricultural crops 0.18-0.25, and grass would be 0.16 – 0.26 depending on length[28]. A value of 0.23 is an average value for non-snow-covered surfaces and is the default value used in the model. This value is considered appropriate for the rural setting of the dispersion site.

2.14. Priestley-Taylor Parameter

2.14.1. The Priestly Taylor parameter is a parameter representing the surface moisture available for evaporation[27]. This parameter must be set between 0 and 3 where 0 would be classed as dry bare earth, 0.45 as dry grassland, 1 as moist grassland and a value of 3 is suggested for a saturated forest surrounded by forest[29]. The value of 1 was considered to be appropriate for the rural setting of the dispersion site.

2.15. Minimum Monin-Obukhov Length

2.15.1. The Monin-Obukhov length provides a measure of the stability of the atmosphere. For example, in urban areas the air is affected by heat generated from buildings and traffic which prevents the atmosphere from becoming stable. In rural areas the atmosphere would be more stable. The minimum Monin-Obukhov length can be set between 1 and 200m. Typical values would be[27]:

- large conurbations >1 million = 100m;
- cities and large towns = 30m;
- mixed urban/industrial = 30m;
- small towns <50,000 = 10m; and
- rural areas = 1m.

2.15.2. A value of 1m, which is the model default value was used as this value is considered appropriate for the rural setting of the dispersion site.

2.16. Buildings Data

2.16.1. The building parameters utilised for the study are detailed in Table 14, a plan view is provided as Figure 7 and 3D visualisation in Figure 8.

[27] ADMS5 User Guide, CERC, V5, Nov 2012
[28] TR Oke, Buondary Layer Climates, 2nd Edition 1987
[29] J P Lhomme, A Theorestivl Basis for the Priestley-Taylor Coefficient, February 1997.

Table 14: On-Site Building Parameters

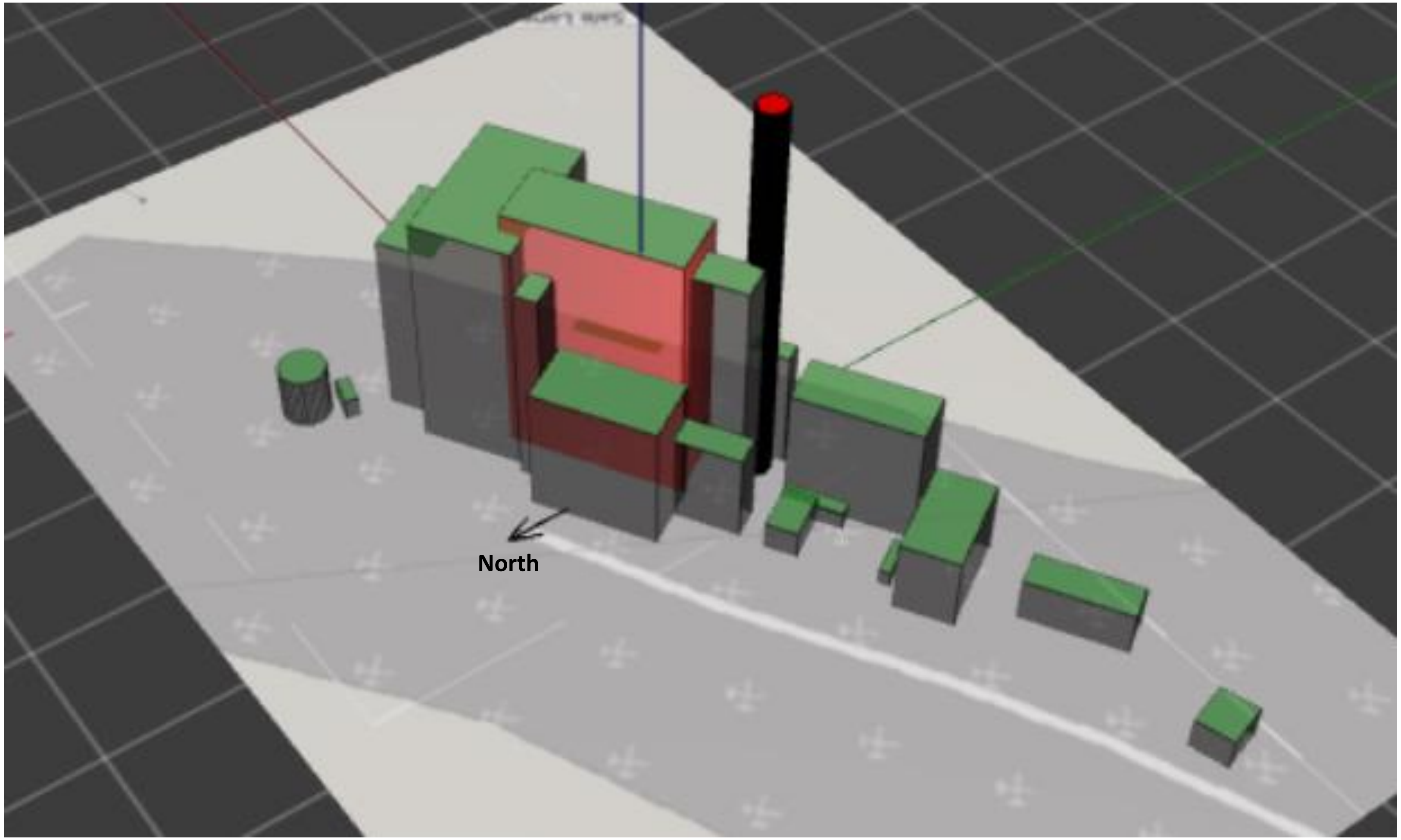
Building	X (a)	Y (a)	Angle (°) (b)	Height (m) (c)	Length/ Diameter (m) (c)	Width (m) (c)
Weighbridge In and Out	326662	310050	73.9	5.8	11.4	13.2
Office/Mess	326712	310052	59.6	8	30.4	10.4
Workshop /Warehouse	326745	310071	59.6	13.4	17.042	30.129
Air Cooled Condenser	326780	310071	59.6	22	37.6	15.6
Electrical Building	326783	310084	59.6	3.2	17.9	4.75
Substation	326755	310080	59.6	2.8	3.1	12.3
Transformer	326781	310094	59.6	5	9.4	14.6
Turbine Building	326821	310126	59.6	23.1	37.3	20.5
Electrical Houses	326800	310107	59.6	16	20.9	9.1
Flue Gas Treatment	326808	310097	59.6	43	16.1	11.2
Chemical Silos	326810	310079	59.6	22	11.75	5.6
Boiler Hall	326839	310113	59.6	46	52.2	20.9
IBA Out Building	326849	310103	59.6	15.1	26.3	4.6
Stair/Lift Core	326843	310134	59.6	37	7	10.1
Bunker and Crane Building	326871	310126	59.6	43	29.6	46.5
Tipping Hall	326888	310139	59.6	33.6	16.9	26.2
Sprinkler Pump Building	326894	310166	14.6	3.8	3.9	9.1
Sprinkler Tank	326900	310176	n/a	9.3	13.7	n/a

Notes to Table 14

(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 Race Cottam Architects.

Figure 7: Buildings Layout – Plan View

Figure 8: Buildings Layout – 3D View



2.17. Terrain Data – Grid Resolution

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

2.17.2. In total, four different terrains were used as follows:

- an area 8km by 8km – this was used to model the maximum ground level concentrations within 2km of the main stack initially, however, was later discounted (see Section 3 of this report);
- an area 11km by 11km – this was used to model the maximum ground level concentrations within 2km of the main stack and potentially sensitive receptors up to a maximum distance of 5km of the main stack;
- an area 7.5km north, 6km east, 8.5km south and 9.5km west of the main stack – this was used to model potentially sensitive receptors up to a maximum distance of 10km of the main stack; and
- an area 16km north, 11km east, 21km south and 17.5km west of the main stack – this was used to model potentially sensitive receptors within a distance of 10km to 25km of the main stack.

2.17.3. Each of the terrain files created gave different grid spacings. The terrain files created within ADMS do not interpolate and simply extract the data. Consequently, for the 8km x 8km terrain file, the grid spacing would be expected to be approximately 125m, however, as the data is provided in a 50m resolution, ADMS will alternate between 100m and 150m. It is considered that there is no difference between regular and irregular spacing, as ADMS will interpolate to a regular spaced grid for the flow filed. There is the potential for important terrain features to be lost, however, this is also a potential issue for regular spaced data when the resolution of the terrain file for ADMS is lower that the data used to make the file.

2.17.4. The terrain files were created by compiling the data from the relevant Ordnance Survey tiles. The terrain data file was created using an ADMS input terrain grid resolution of 64 x 64. The grid resolution was also set to 64 x 64 to match the input data. It should be noted that this grid resolution can be increased to 128 x 128 or even 256 x 256 and the model therefore will attempt to improve the resolution of the terrain. To test this, a screening assessment was undertaken, altering the grid resolution. The results for the annual mean, 100^{th} percentile hourly percentile and the 99.79^{th} percentile are provided in Table 15 for a unitised emission rate for a 70m high stack, based on 2019 met data. The screening was undertaken using the 8km x 8km terrain file only.

Table 15: Grid Resolution Screening (met year 2019)

Grid Resolution	Maximum Predicted Annual Mean GLC (PC) (µg/m^3)	Maximum (100th percentile) Predicted 1 hour Mean GLC (PC) (µg/m^3)	Maximum Predicted 99.79 percentile of 1 hour Mean GLC (PC) (µg/m^3)
64 x 64	0.13	18.84	3.61
128 x 128	0.14	17.49	4.30
256 x 256	0.17	16.63	5.44

2.17.5. It can be seen from Table 15 that there is variation to the predicted PCs for the annual mean and for the 100th percentile and 99.79th percentile of 1 hour means.

2.17.6. To put this into context actual emission rates have been used to compare the results with the various AQS. Again, NO_2 and ammonia have been used. Table 16 and 17 show the difference in actual pollutant concentrations for NO_2 for both the long term and short-term air quality standard (NO_x to NO_2 conversion rates, as detailed in Section 2.26 have been accounted for), and Table 18 provides the actual concentrations for the 100th percentile.

Table 16: Grid Resolution Screening – Comparison with Long Term AQS NO_2

Grid Resolution	Maximum Predicted Annual Mean GLC (PC) (µg/m^3)	AQS	PC as a % of AQS
64 x 64	0.277	40	0.69%
128 x 128	0.316		0.79%
256 x 256	0.366		0.91%

Table 17: Grid Resolution Screening – Comparison with Short Term AQS NO_2

Grid Resolution	Maximum Predicted 99.79th GLC (PC) (µg/m^3)	AQS	PC as a % of AQS
64 x 64	3.94	200	1.97%
128 x 128	4.70		2.35%
256 x 256	5.94		2.97%

Table 18: Grid Resolution Screening – Comparison with Short Term AQS – NH_3

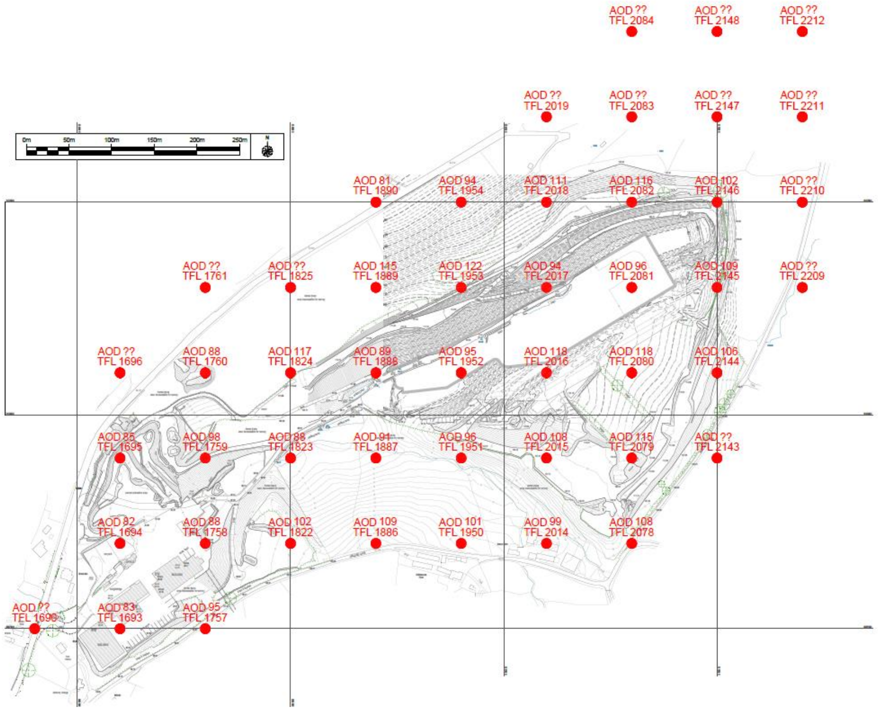
Grid Resolution	Maximum Predicted 99.79th GLC (PC) (μg/m³)	AQS	PC as a % of AQS
64 x 64	4.90	2,500	0.20%
128 x 128	4.55		0.18%
256 x 256	4.32		0.17%

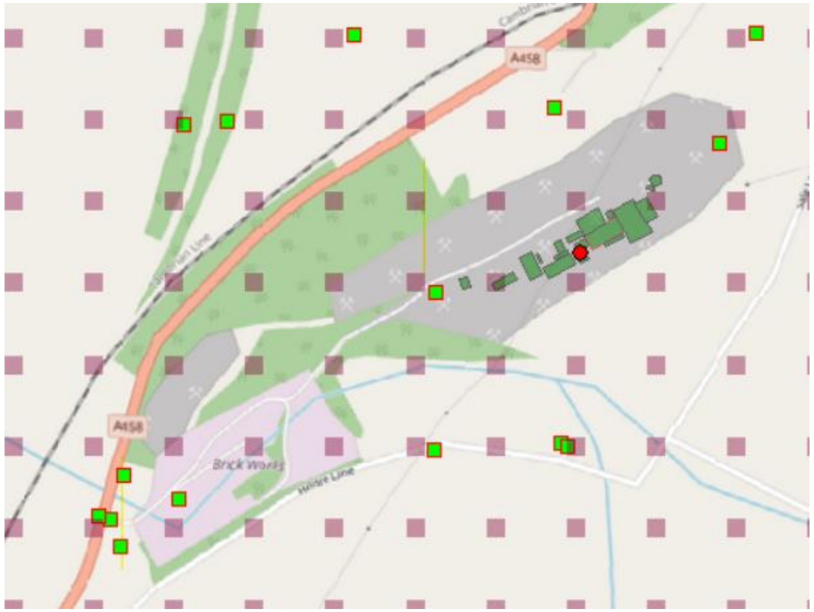
2.17.7. The data in Tables 16-18 show that the difference in the PCs, when expressed as a percentage of the air quality standard is not significant (i.e. the long-term PC are less than 1% of the AQS and the short term PCs are less than 10% of the short term AQS). . Consequently, a grid resolution of 64 x 64 will be used for the modelling assessment.

2.18. Terrain Data – Terrain Height Modification

2.18.1. In addition to creating the terrain files, it was also necessary to modify the terrain files. The heights of the data provided in ordnance survey files do not accurately reflect the final site levels due to existing (at time of writing) quarrying operations and the final pre-construction site levels. The ADMS mapper tool was used to visualise the terrain points for each file. Grid coordinates that then fell within the site boundary could then be obtained and checked with the post development contours. Visualisations from the ADMS mapper together with corresponding post development contours are provided on Figures 9-12 and Table 19 provides the terrain file line numbers that have been altered together with their original and post construction AOD heights.

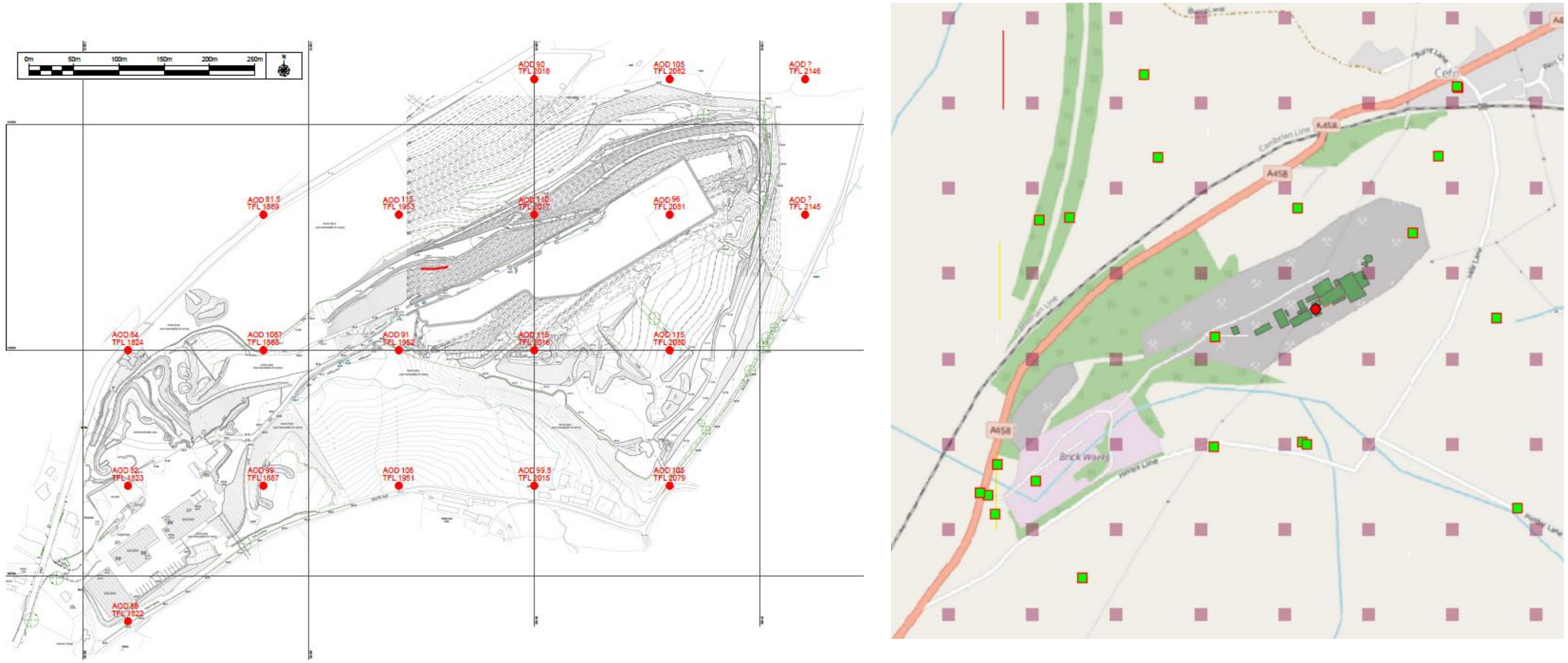
Figure 9: 8km x 8km Terrain Adjustment





Key
AOD = Above ordnance datum height
TFL = Terrain File Line Number
?? = height outside of site
Purple squares indicate the location of the terrain height points
Green squares indicate the location of potentially sensitive receptors

Figure 10: 11km x 11km Terrain Adjustment

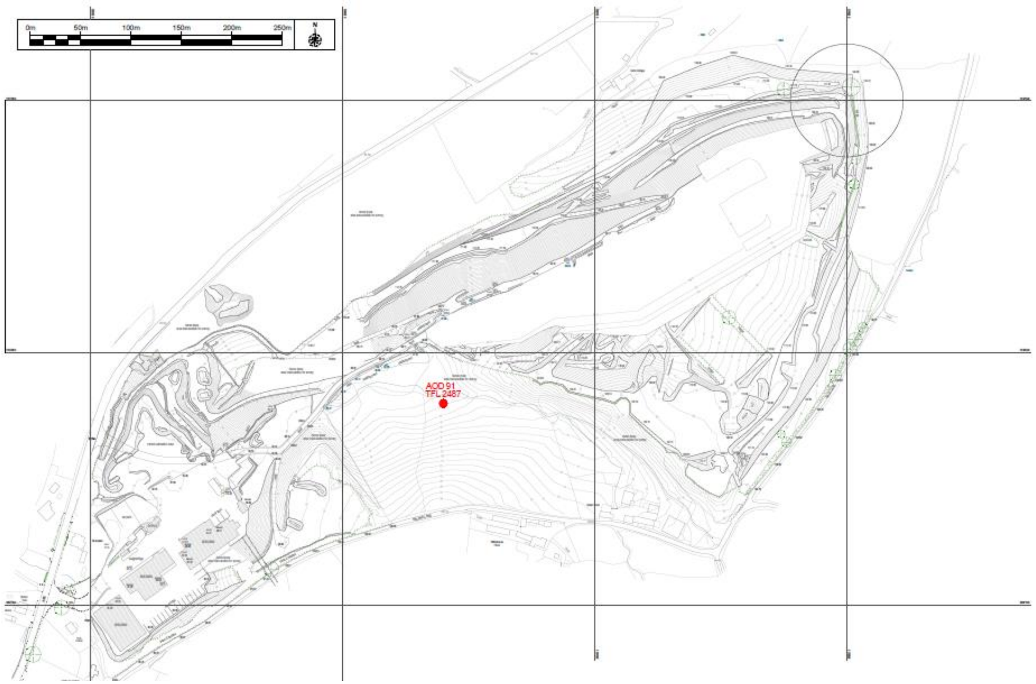


Key
AOD = Above ordnance datum height
TFL = Terrain File Line Number
?? = height outside of site
Purple squares indicate the location of the terrain height points
Green squares indicate the location of potentially sensitive receptors

Figure 11: 7.5km North by 6km East by 8.5km south by 9.5km west Terrain Adjustment

Key
AOD = Above ordnance datum height
TFL = Terrain File Line Number
?? = height outside of site
Purple squares indicate the location of the terrain height points
Green squares indicate the location of potentially sensitive receptors

Figure 12: 16.5km North by 11km East by 21km south by 17.5km west Terrain Adjustment



Key
AOD = Above ordnance datum height
TFL = Terrain File Line Number
?? = height outside of site
Purple squares indicate the location of the terrain height points
Green squares indicate the location of potentially sensitive receptors

Table 19: Terrain File Adjustment

Terrain File	Terrain File Line Number	X Coordinate	Y Coordinate	mAOD from Ordnance Survey Tiles	mAOD post development
8km x 8km	1693	326300	309750	83	83
	1694	326300	309850	86	82
	1695	326300	309950	98	85
	1757	326400	309750	95	95
	1758	326400	309850	88	88
	1759	326400	309950	99	98
	1760	326400	310050	98	88
	1822	326500	309850	100	102
	1823	326500	309950	85	88
	1824	326500	310050	117	117
	1886	326600	309850	103	109
	1887	326600	309950	86	91
	1888	326600	310050	122	89
	1889	326600	310150	105	115
	1890	326600	310250	78	81
	1950	326700	309850	98	101
	1951	326700	309950	101	96
	1952	326700	310050	122	95
	1953	326700	310150	118	122
	1954	326700	310250	93	94
	2014	326800	309850	99	99
	2015	326800	309950	114	108
	2016	326800	310050	122	118
	2017	326800	310150	118	94
	2018	326800	310250	108	111
	2078	326900	309850	103	105
	2079	326900	309950	110	115
	2080	326900	310050	116	118
	2081	326900	310150	115	96
	2082	326900	310250	110	116
	2144	327000	310050	101	106
	2145	327000	310150	103	109
	2146	327000	310250	101	102

Table 19: Terrain File Adjustment (cont)

Terrain File	Terrain File Line Number	X Coordinate	Y Coordinate	mAOD from Ordnance Survey Tiles	mAOD post development
11km x 11km	1822	326300	309700	86	88
	1823	326300	309850	86	82
	1824	326300	310000	86	84
	1887	326450	309850	96	99
	1888	326450	310000	113	108
	1889	326450	310150	80	81.5
	1951	326600	309850	103	108
	1952	326600	310000	106	91
	1953	326600	310150	105	115
	2015	326750	309850	97	99.5
	2016	326750	310000	118	115
	2017	326750	310150	119	110
	2018	326750	310300	90	90
	2079	326900	309850	103	105
	2080	326900	310000	114	115
	2081	326900	310150	115	96
	2082	326900	310300	101	105
7.5km North 6km East 8.5km South 9.5km West	2337	326300	309800	80	82
	2338	326300	310050	77	82
	2401	326500	309800	104	102
	2402	326500	310050	117	117
	2466	326700	310050	122	88.75
	2467	326700	310300	80	81.7
	2529	326900	309800	105	105
	2530	326900	310050	116	117
	2531	326900	310300	101	105.33
16.5km North 11km East 21km South 17.5km west	2487	326600	309950	86	91

2.18.2. Figures 13 -16 show visual representations of each terrain file. The location of the site is shown by the red circle. The arrows on each figure represent north, north is off set in Figures 13 and 14, however Figures 15 and 16 are north up.

Figure 13: 8km x 8 km Terrain File

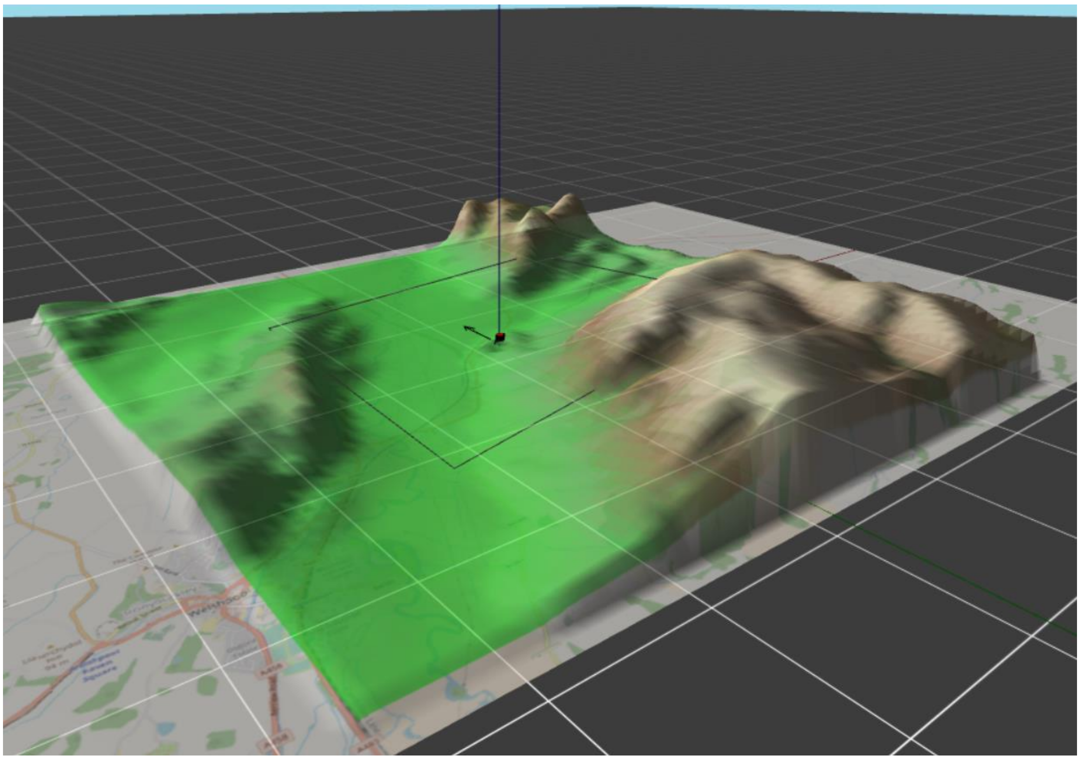


Figure 14: 11km x 11 km Terrain File

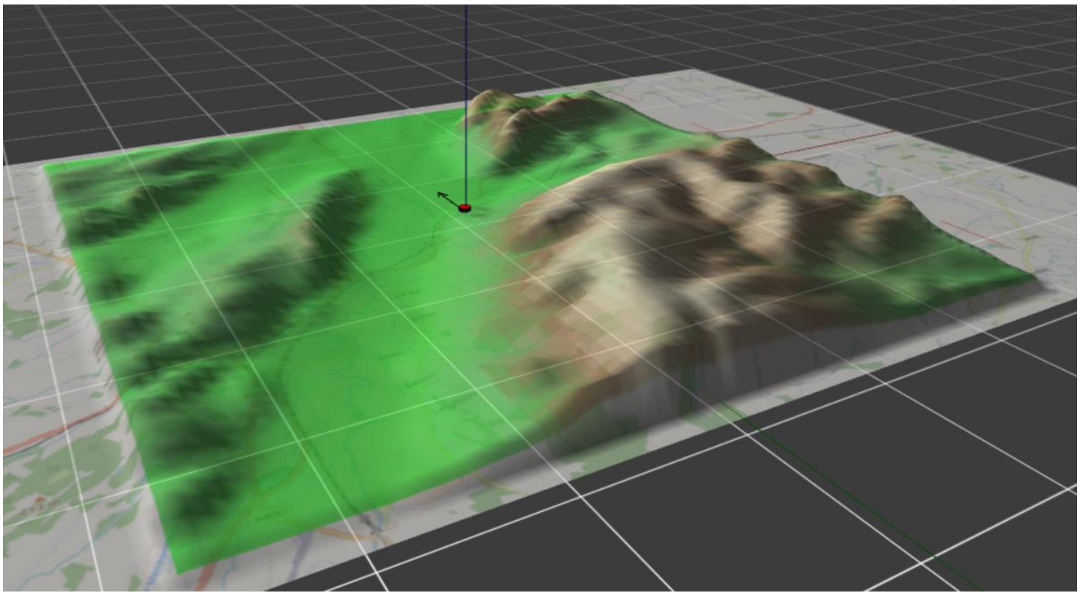


Figure 15: 7.5km North by 6km East by 8.5km south by 9.5km west Terrain File

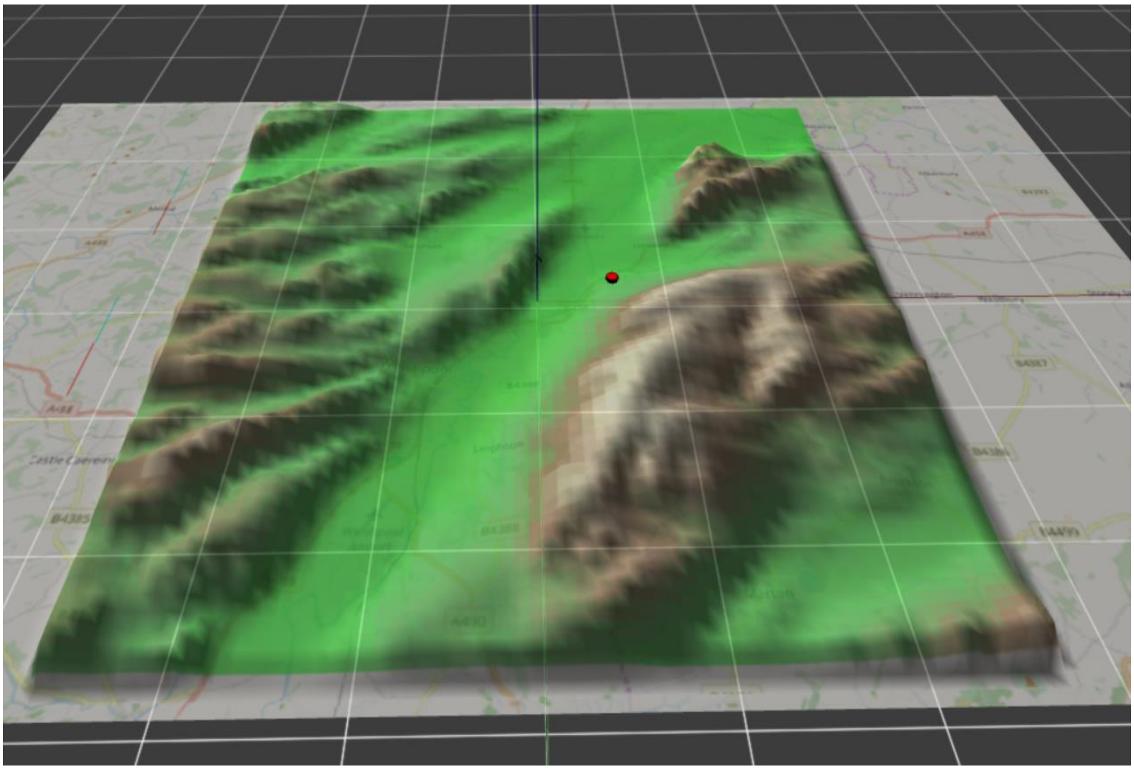
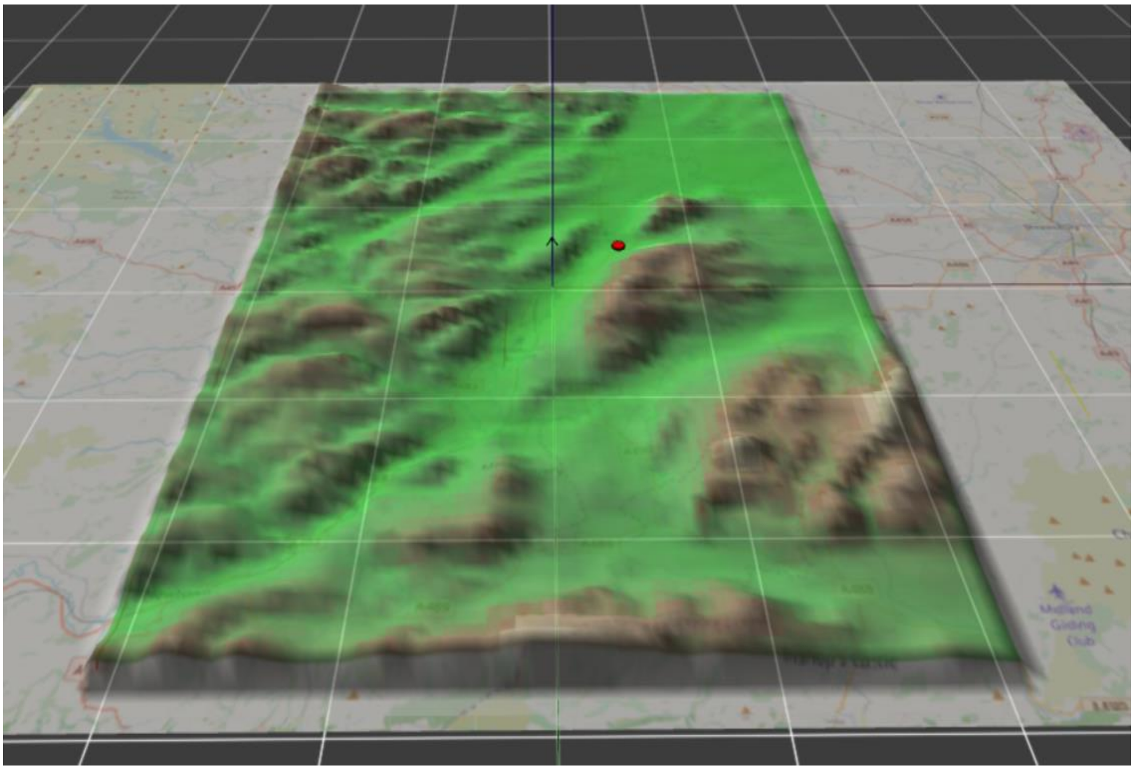


Figure 16: 15.5km North by 11km East by 21km south by 17.5km west Terrain File



2.19. Roughness Length

2.19.1. 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, agricultural areas are classed as 0.2m, parkland and open suburbia is classed as 0.5m and cities and woodlands are classed as 1.0m.

2.19.2. Based on a review of the terrain, following a site visit, and knowledge of the intended end use of both the site and surrounding area, the most appropriate surface roughness was considered to be 0.3m and was used for the 'Dispersion site' (indicative of agricultural crops) and a value of 0.2m was used for the 'met measurement site' (indicative of agricultural crops). The met measurement site is located within Shawbury Airport – there is a mix of open grass land, some areas of longer grass, more akin to agricultural areas, and some housing down wind.

2.19.3. When the model is run with the NWP data the roughness length was again set to 0.3m for both the dispersion site and the met site.

2.19.4. To test is this was the most appropriate roughness length, three surface lengths were tested. The model was run using values of 0.005m (short grass), 0.2m (agricultural areas min), 0.3m (agricultural areas max), and 0.5m (parkland and open suburbia) on unitised (1g/s) emission rates for the annual mean, the 1-hour mean and the 99.79th percentile of 1-hour means. The results are provided in Table 20. The met year 2019 was used as this is the latest year available. A stack height of 70m was used for the assessment.

Table 20: Surface Roughness Screening (met year 2019)

Surface Roughness (m)	Maximum Predicted Annual Mean GLC (PC) (µg/m^3)	Maximum Predicted 100th Percentile of hourly Mean GLC (PC) (µg/m^3)	Maximum Predicted 99.79 percentile of 1 hour Mean GLC (PC) (µg/m^3)
0.005	0.063	5.04	3.32
0.2	0.116	17.1	3.60
0.3	0.127	18.8	3.61
0.5	0.144	25.2	3.62

2.19.5. It can be seen from the data in Table 20, that as the surface roughness increases, the PCs also increase. It could be considered that using a surface roughness value of 0.5m would be the most conservative approach, however, whilst there are small villages in the area, the surface is dominated by agricultural areas. The value of 0.005 is indicative of short grass, would not be representative of the area under consideration, and has therefore been discounted from further assessment.

2.19.6. To put the surface roughness figures into context, the figures in Table 20 are based on a unitised emissions rate (i.e. 1g/s), however, the actual emission rate for ammonia (for example) is 0.260g/s. Ammonia was chosen as an example as the air quality standard has both an annual and short term (100th percentile) averaging period. The results for the 99.79th percentile have not been further considered as there is very little difference between the surface roughness. Table 21 and 22 show the difference in actual pollutant concentrations for ammonia for both the long term and short term air quality standards.

Table 21: Surface Roughness Screening – Comparison with Long Term AQS

Surface Roughness (m)	Maximum Predicted Annual Mean GLC (PC) (µg/m³)	AQS	Maximum Predicted Annual Mean GLC (PC) as a % of AQS
0.2	0.030	180	0.017%
0.3	0.033		0.018%
0.5	0.038		0.021%

Table 22: Surface Roughness Screening – Comparison with Short Term AQS

Surface Roughness (m)	Maximum Predicted Annual Mean GLC (PC) (µg/m³)	AQS	Maximum Predicted Annual Mean GLC (PC) as a % of AQS
0.2	4.44	2,500	0.18%
0.3	4.90		0.20%
0.5	6.55		0.26%

2.19.7. The data in Tables 25 and 26 shown that the difference in the PCs, when expressed as a percentage of the air quality standard, is not significant. It could be considered that using a surface roughness value of 0.5m would be the most conservative approach, however, whilst there are small villages in the area, the surface is dominated by agricultural areas. A surface roughness of 0.5m would be indicative of parkland and open suburbia, whereas 0.3m would be agricultural areas (max).

2.19.8. The request for a scoping opinion (ECL Document ECL.001.01.02/RFS, August 2018) proposed a surface roughness value of 0.3m. Natural Resources Wales response to that document was that "*we acknowledge and agree with the AQ* [Air Quality] *scope outlined in this section*"[30]. Consequently, to maintain consistency with the approach outlined in the scoping document, a value of 0.3m was used for the dispersion site.

2.19.9. It should be noted that a spatially varying surface roughness file could be used, however, as there is no clear delineation of surface roughness, it was considered that a screening study for surface roughness was sufficient to characterise the surface roughness. This approach was discussed and approved by CERC.

[30] NRW Reference CAS-67232-N2D6, 6th September 2018 – Letter Response to PINS regarding a Potential DNS Application.

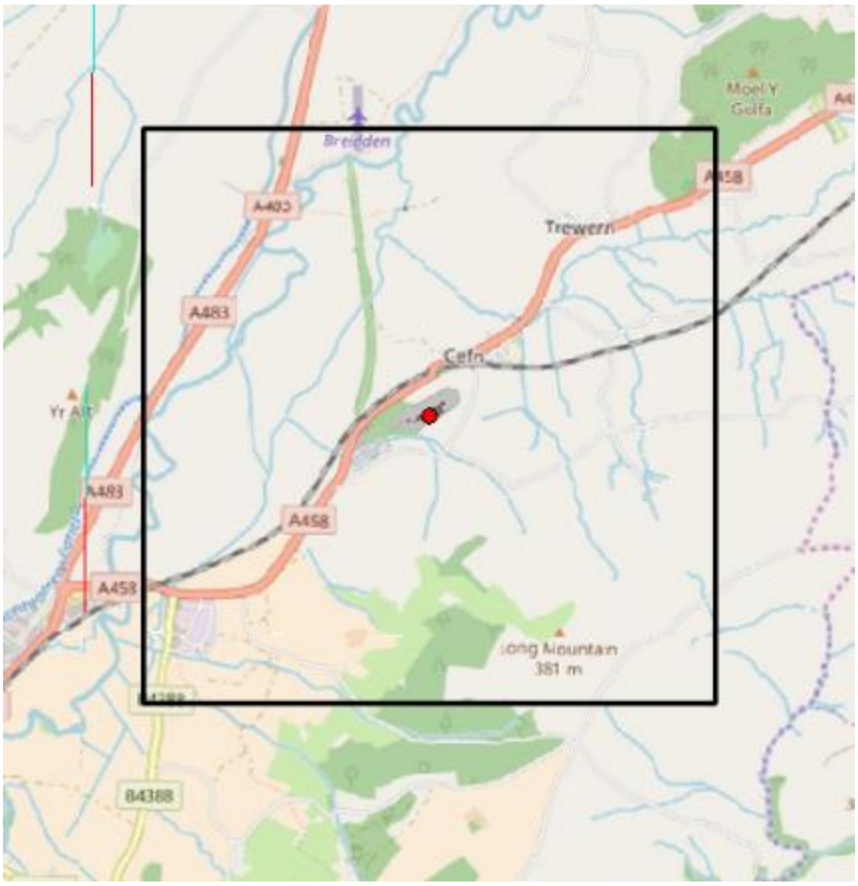
2.20. Model Output Parameters

2.20.1. 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.

2.20.2. 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.

2.20.3. For assessing the maximum point of impact, a grid sizing 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 = 324807 to 328807 and Y = 308086 to 312086, with 400 nodes along each axis i.e. a grid spacing of 10m. The extent of the output grid is outlined in black on Figure 17.

Figure 17: Extent of Output File for Maximum GLC



2.20.4. For assessing the impact of emissions on human health the grid references of each were included as specified points within the ADMS model. Also, for assessing ecological sites, the grid reference of the ecological sites' boundary closest to the stack location was used.

2.21. Scenarios Modelled

2.21.1. The modelling study assessed the following scenarios:

- emissions from the facility for all pollutants based on IED ELVs for the maximum GLC;
- emissions from the facility for all pollutants based on IED ELVs for the previously agreed human sensitive receptors;
- emissions from the facility for NO_x, SO_2, NH_3 and HF (at IED ELVs) at the previously agreed ecological habitat sites;
- modelled deposition rates (acid and nitrogen) at IED ELVs at the previously agreed ecological habitat sites;
- plume visibility; and
- abnormal emissions as detailed in IED.

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

2.22.1. Both the EA online guidance (which NRW state should be used) and IAQM[31] 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.

2.22.2. 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.

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

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

2.22.4. Consequently, significance will be judged based on the site-specific circumstances and on the EPUK and IAQM methodology as described in Sections 2.22.5 to 22.22.12.

Long-Term Impacts

2.22.5. 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 two scrubber stacks will be assessed in accordance with the latest guidance produced by EPUK and IAQM in January 2017.

2.22.6. 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.

[31] IAQM guidance, January 2017 (Land-Use Planning & Development Control: Planning for Air Quality')

2.22.7. 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.

2.22.8. The impact descriptors for individual receptors are presented in Table 23.

Table 23: 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

Short-Term Impacts

2.22.9. 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."*

2.22.10. 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.

2.22.11. 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'.

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

2.23. Assessment of Significance of Impact Guidelines – Ecological Receptors

2.23.1. 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.

2.23.2. 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 23. If the short-term PC exceeds the screening criteria then further modelling needs to be undertaken.

2.23.3. When there are local nature sites within the specified distance the EA online guidance state 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.

2.23.4. If the above criteria are met, then no further assessment is required.

2.24. Assessment of Significance of Impact Guidelines – Ecological Receptors, Critical Levels and/or Loads

2.24.1. EA Operational Instruction 67_12[32] states that a detailed assessment is required where modelling predicts that the long-term PC is greater than:

- 1% for European sites and SSSIs; or
- 100% for NNR, LNR, LWS and ancient woodlands.

And, the PEC is greater than:

- 70% for European sites and SSSIs; or
- 100% for NNR, LNR, LWS and ancient woodlands.

[32] EA Operational Instruction 67_12 Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation, V2, 27.3.15

2.24.2. For short-term emissions, modelling is required at European site and SSSI's where the PC is greater than 10% of the critical level, or 100% for NNR, LNR, LWS and ancient woodland.

2.24.3. Following detailed assessment, if the PEC is less than 100% of the appropriate environmental criterion, then it can be assumed there will be no adverse effect for European Sites and SSSI's.

2.24.4. However, for NNR, LNR, LWS or ancient woodland, if the PC is less than 100% of the appropriate environmental criterion, then it can be assumed there will be no significant pollution.

2.25. Assessment of Significance Guidelines for Trace Metals

2.25.1. For the Group 3 metals there is an additional guideline indicated in the EA Guidance for Group 3 Metals (see below) that states that the environmental standard is unlikely to be exceeded if:

- the long-term and short-term PEC is <100% of the long-term and short-term environmental standard (as appropriate)

(where the short-term PEC is the sum of the short-term PC and twice the long-term pollutant background concentration).

2.25.2. For trace metals, Annex VI of the IED assigns ELVs for three groups. Group 1 comprises cadmium (Cd) and thallium (Tl), Group 2 comprises mercury (Hg) and Group 3 comprises antimony (Sb), arsenic (As), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), lead (Pb), nickel (Ni) and vanadium (V). The ELVs are the total for the combined emissions, and it would not be reasonable to assume that each metal emits at the maximum ELV for the group. In this regard, the EA has provided guidance on the steps required for assessing the impact of such metal emissions, namely Releases from Waste Incinerators[33].

2.25.3. Step 1 of the guidance is to assume that all emissions are at the maximum ELV for the group. For example, all of the Group 3 metals would be assumed to be emitted at a concentration of 0.5mg/Nm^3.

2.25.4. Where the release is considered to be potentially significant, Step 2 of the guidance allows the applicant to use the maximum emissions data listed in Appendix A of the guidance to revise predictions, and consider each pollutant as a percentage of the Group 3 ELVs.

2.26. NO_x to NO_2 conversion Rates

2.26.1. 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.

[33] Releases from Waste Incinerators, Environment Agency, V4

2.26.2. However, further to detailed discussion with both NRW and the EA 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 should be used in all detailed modelling assessments. The conversion rates, as provided in section 2.26.1., should only be used for screening assessments.

3. IDENTIFICATION OF APPROPRIATE STACK HEIGHT

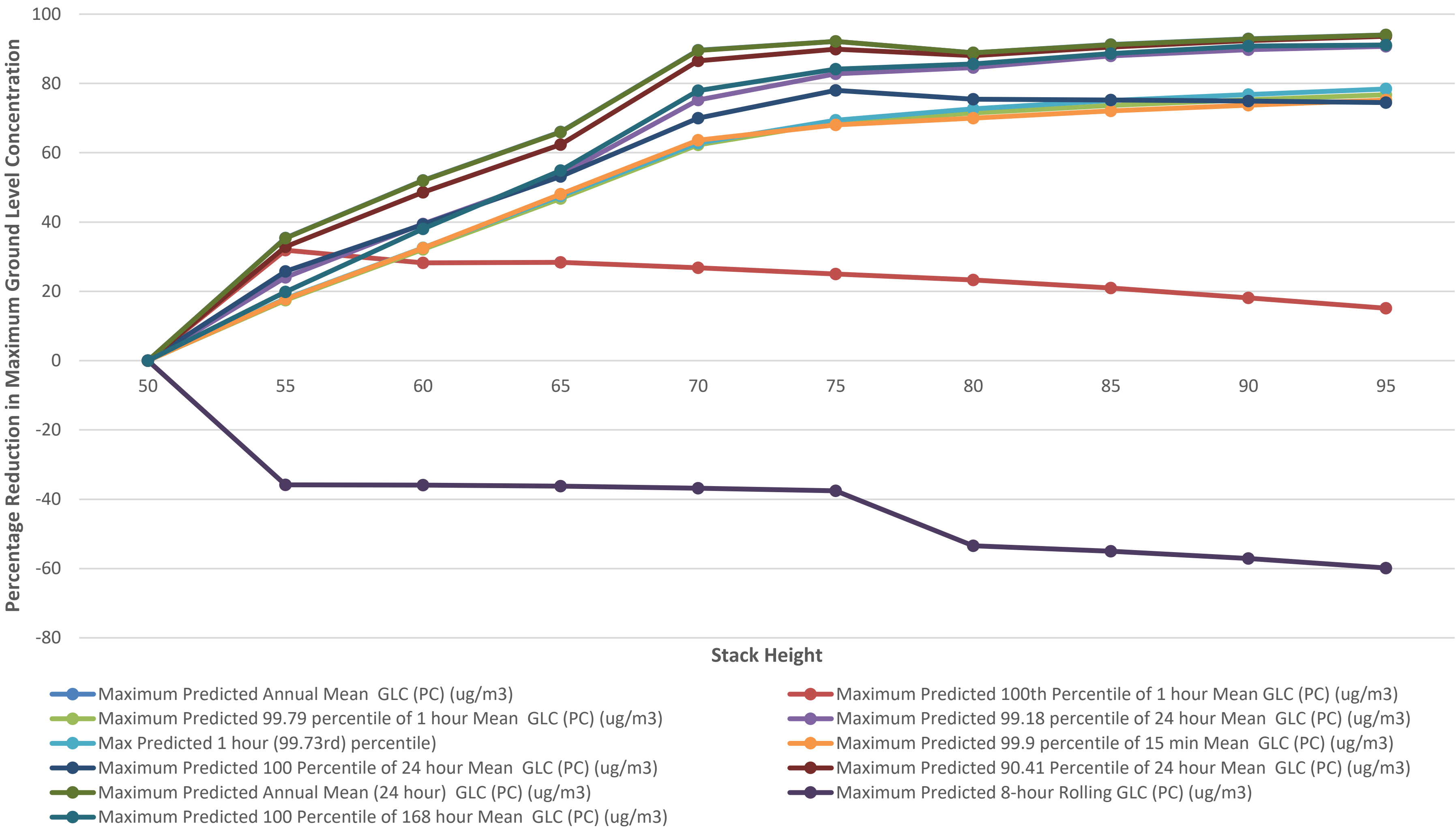
3.1. Assessment based on Unitised (1g/s) Release Rates

3.1.1. This assessment considered the effect of stack height on all relevant averaging periods required to complete the main modelling assessment. For the screening study, the modelling was undertaken with the following settings:

- buildings effects were included;
- complex terrain (post construction) was included at a distance of 4km from the stack, at a resolution of 64x64;
- emission rates for pollutants were based on 1g/s;
- no account was made for NO_x to NO_2 conversion rates;
- stack heights from 50 – 95m were considered;
- a surface roughness of 0.3m was used for the dispersion site and 0.2m for the met measurement site;
- 5 years of hourly sequential meteorological data from Shawbury for 2015 – 2019 inclusive was used;
- 2018 NWP data and 2019 NWP for the stack location at a resolution of 1.5km with terrain effects was used;
- 2018 NWP data and 2019 NWP with the surface heat flux and boundary layer parameters both turned off for the stack location at a resolution of 1.5km with terrain effects was used;
- an output grid 2km in each direction from the stack was used, with 400 points in each direction giving a resolution of 10m; and
- only the maximum ground level concentration was considered for the stack height screening.

3.1.2. The results of this assessment are shown in Figure 18.

Figure 18:Effect of Stack Height on Ground Level Concentrations



3.1.3. Figure 18 clearly indicates that increasing the stack height has the effect of decreasing the modelled maximum ground level concentrations (GLCs), for the majority of the averaging periods considered. There is a substantial reduction in GLCs up to 70m, (for most percentiles at least a 60% reduction), however, heights greater than 70m do not provide much more environmental benefit.

3.1.4. However, for the maximum predicted 1 hour mean, 100th percentile, and the 8-hour rolling, 100th percentile, as the stack height increases the predicted maximum ground level concentration actually increases for the 8-hour rolling, and for the 1 hour mean, there is an initial decrease, followed by an increase in PCs from 60m and above. This is the reverse of what would be expected to be the case. This unusual result was therefore discussed with CERC.

3.1.5. Looking first at the 1 hour mean, the results obtained for the unitised emission rate are provided in Table 24.

Table 24: Stack Height Screening – 1 hour mean (1 g/s)

Stack height (m)	Met Year	Maximum Predicted 1 hour Mean 100th percentile GLC (µg/m^3)
50	NWP 2019 Heat and Boundary Off	35.81
55	NWP - 2018	25.45
60	NWP - 2019	26.63
65	NWP - 2019	26.81
70	NWP - 2019	26.98
75	NWP - 2019	27.16
80	2017	27.48
85	2017	28.29
90	2017	29.31
95	2017	30.40

3.1.6. As shown in Table 24, the max GLCs increase with increasing stack height. On seeking clarification with CERC, they have commented that the 2019NWP data is more reliable if the boundary layer depth is removed from the met file. For a number of hours in 2019, the value of the boundary layer depth is inconsistent with other parameters in the met file. For example, for met line 40 removing the boundary layer height in the met file and allowing the model to calculate the boundary layer height itself gives a boundary layer height of 140m rather than the provided 50m in the met file. As CERC consider that removing the boundary layer depth from the met file will provide more reliable results this approach has been adopted and NWP data will only be used with the boundary layer and surface heat flux removed. The results for the screening assessment for the 1-hour mean, for the five years of observed met data, and the two years of NWP data with surface heat flux and boundary layer height removed (switched off) are shown in Table 25.

Table 25: Stack Height Screening – 1 hour mean (1 g/s)

Stack height (m)	Met Year	Maximum Predicted 1 hour Mean 100th percentile GLC (µg/m^3)
50	NWP 2019 Heat and Boundary Off	35.81
55	2017	24.39
60	2017	25.70
65	2017	25.64
70	2017	26.22
75	2017	26.85
80	2017	27.48
85	2017	28.29
90	2017	29.31
95	2017	30.40

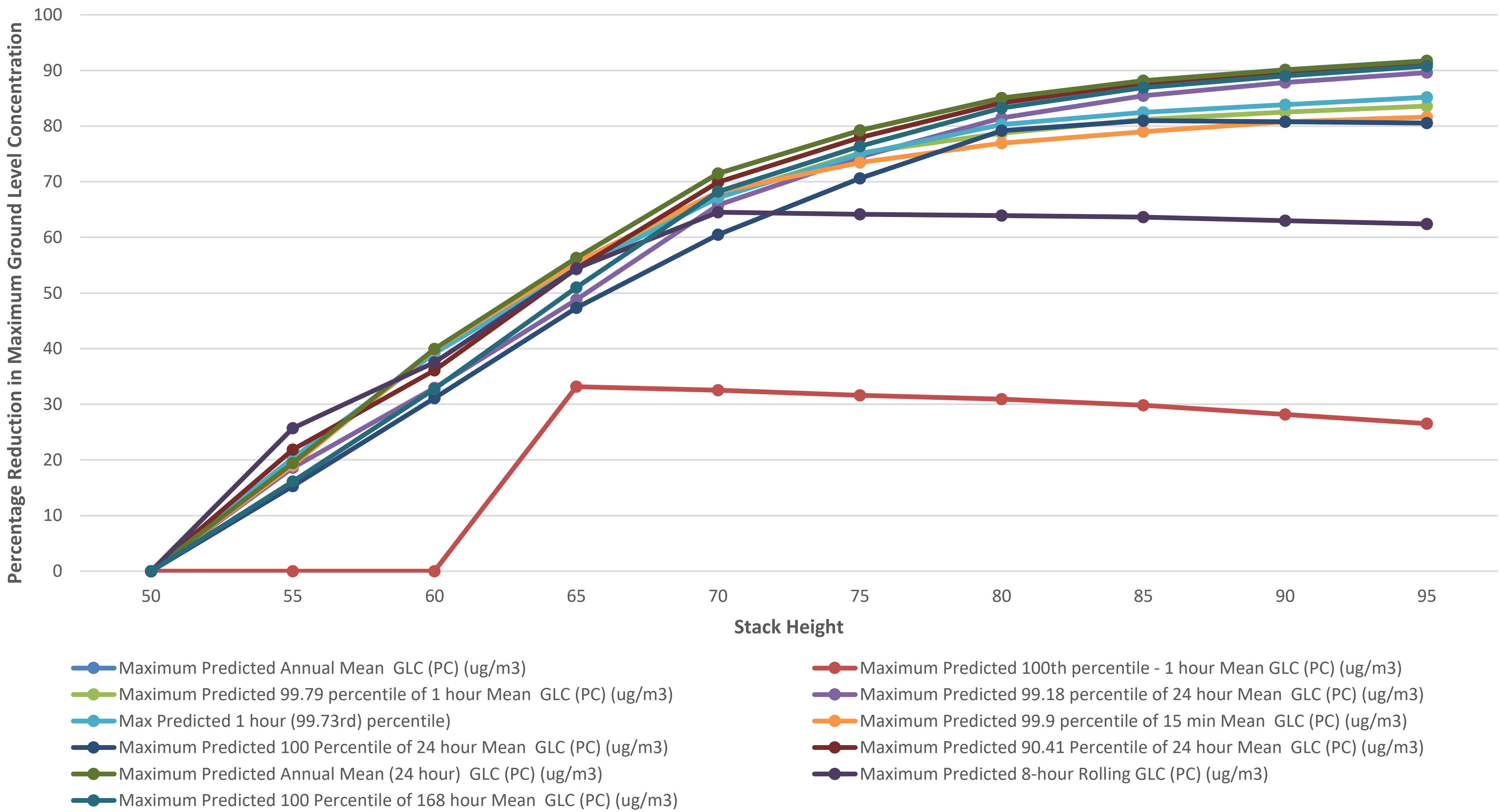
3.1.7. The results in Table 25 again show that increasing the stack height, again increases the maximum ground level concentrations, however, the worst case met year is now 2017 (observed data).

3.1.8. A further recommendation from CERC was to run the model with a larger terrain extent. The terrain to the east and south comprises a number of hills. In modelling, where possible CERC advise to avoid having the edge of the terrain grid in the middle of a large hill. This is usually more important for the upwind edge as the model assumes that the upwind flow is unaffected by the terrain, but also the downwind edges can also have some effect.

3.1.9. Figure 12 (Section 2.18.2) which shows the extent of the 8x8km terrain file for the screening study, shows the terrain file ending in the middle of the hills to the north and again in the middle of the hills to the south. Figure 14 shows a larger terrain file (11x11km) which was used for assessing receptors beyond 2km of the Installation. This terrain file ends beyond the hills to the north, and also encompasses more of the terrain to the south. Consequently, the screening assessment was re-run with this larger terrain file. To decrease model run time, a courser output grid resolution was used – 81 x 81 points (to give a grid spacing of 50m). All other parameters remained the same. This screening study was undertaken using met years 2017, and 2019 NWP data with the surface heat flux and boundary layer turned off as these two met years were providing the worst-case results.

3.1.10. The results of this assessment are shown in Figure 19.

Figure 19:Effect of Stack Height on Ground Level Concentrations – 11km x 11km Terrain File



3.1.11. Figure 19 again clearly indicates that increasing the stack height has the effect of decreasing the modelled maximum ground level concentrations (GLCs), for the majority of the averaging periods considered. There is a substantial reduction in GLCs up to 70m, (for most). It is again the 100th percentile of both the 1 hour mean and 8-hour rolling that shows some slightly different results. For the 1 hour mean, the results are constant for stack heights of 50, 55 and 60m. PCs then decrease for the 65m stack, but then increase as the stack height increases, however, not to the extent shown with a smaller terrain file.

3.1.12. Considering first the 8-hour rolling averages, and considering all met years, further discussion with CERC was undertaken. It was noted that the 8-hour rolling was giving very high maximums and was due to skipped lines in the model run. The maximum for 2019 is from a period of 14 hours with one valid model output; the other hours in the period are skipped by the model due to calm conditions. Therefore, there are a number of 8-hour rolling averages with the same value as the average is just from the one hour. In accordance with guidance from DEFRA[34], these hours should not be considered valid as they do not meet the validity threshold of 75% i.e. 6 hours, these values should therefore be ignored. Validity thresholds were therefore applied using the comprehensive output file processor of ADMS.

3.1.13. A stack height screening study was therefore run, with 2019 met data and with the 75% data validity threshold. The results of this are shown in Table 26.

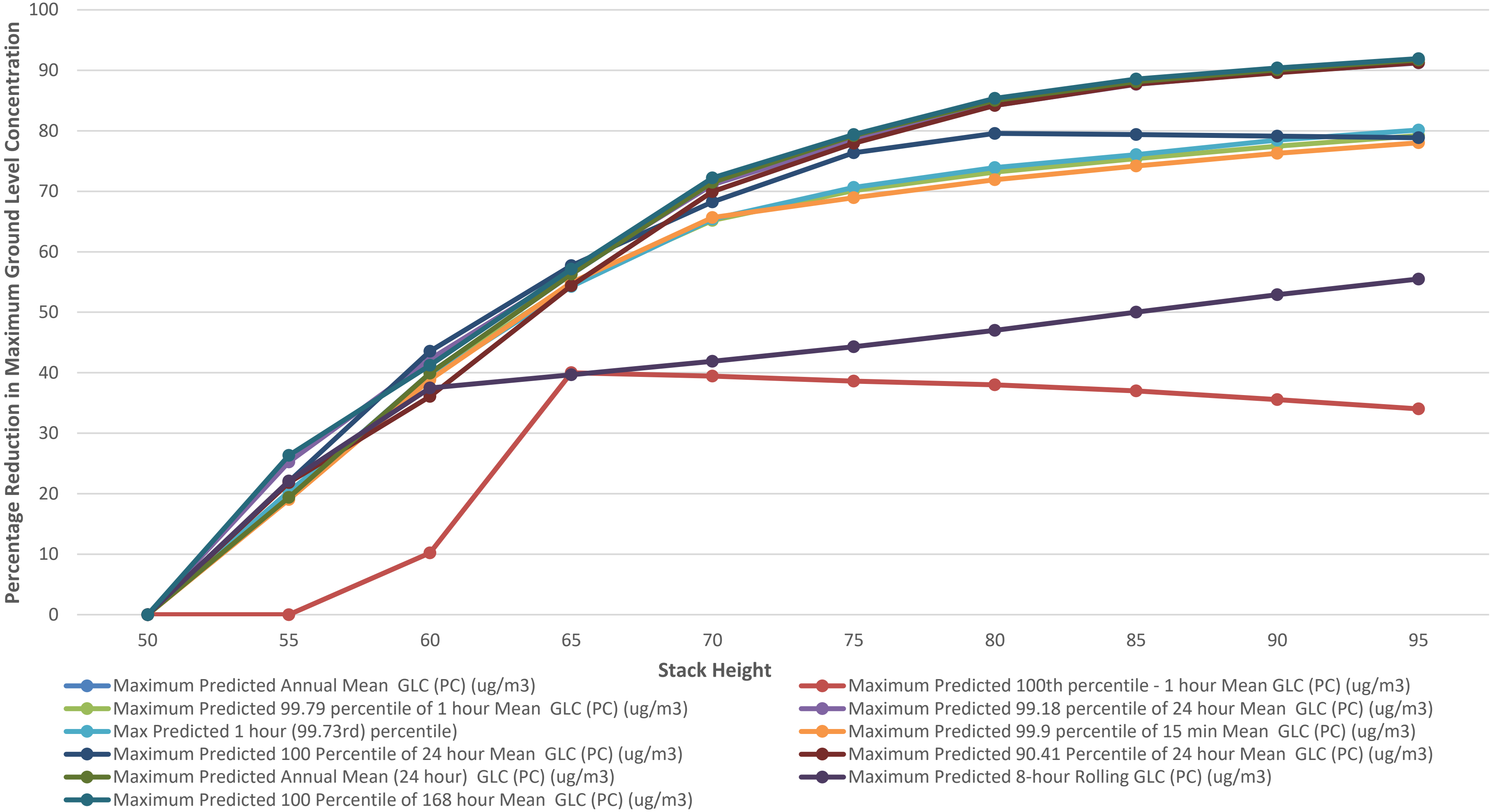
Table 26: 8-hour Rolling with 75% Data Validity Threshold – 2019 Met Data

Stack Height (m)	Met Year	Validity Threshold	Maximum Predicted 8-hour Rolling GLC (PC) (μg/m³)
50	2019	75%	10.71
55	2019	75%	7.35
60	2019	75%	5.25
65	2019	75%	3.80
70	2019	75%	2.72
75	2019	75%	2.59
80	2019	75%	3.56
85	2019	75%	3.61
90	2019	75%	3.71
95	2019	75%	3.81

3.1.14. The data in Table 26 clearly demonstrates that increasing the stack height decreases the maximum GLC, up to a height of 80m, however there is a slight increase for 85-95m inclusive. The values for 2019 for the 8-hour rolling average were then included with the results from all met years to provide the results shown in Figure 20.

[34] https://uk-air.defra.gov.uk/air-pollution/faq?question=20

Figure 20: Effect of Stack Height on Ground Level Concentrations – 11km x 11km Terrain File, and 75% validity for 2019 met data for 8-hour rolling average



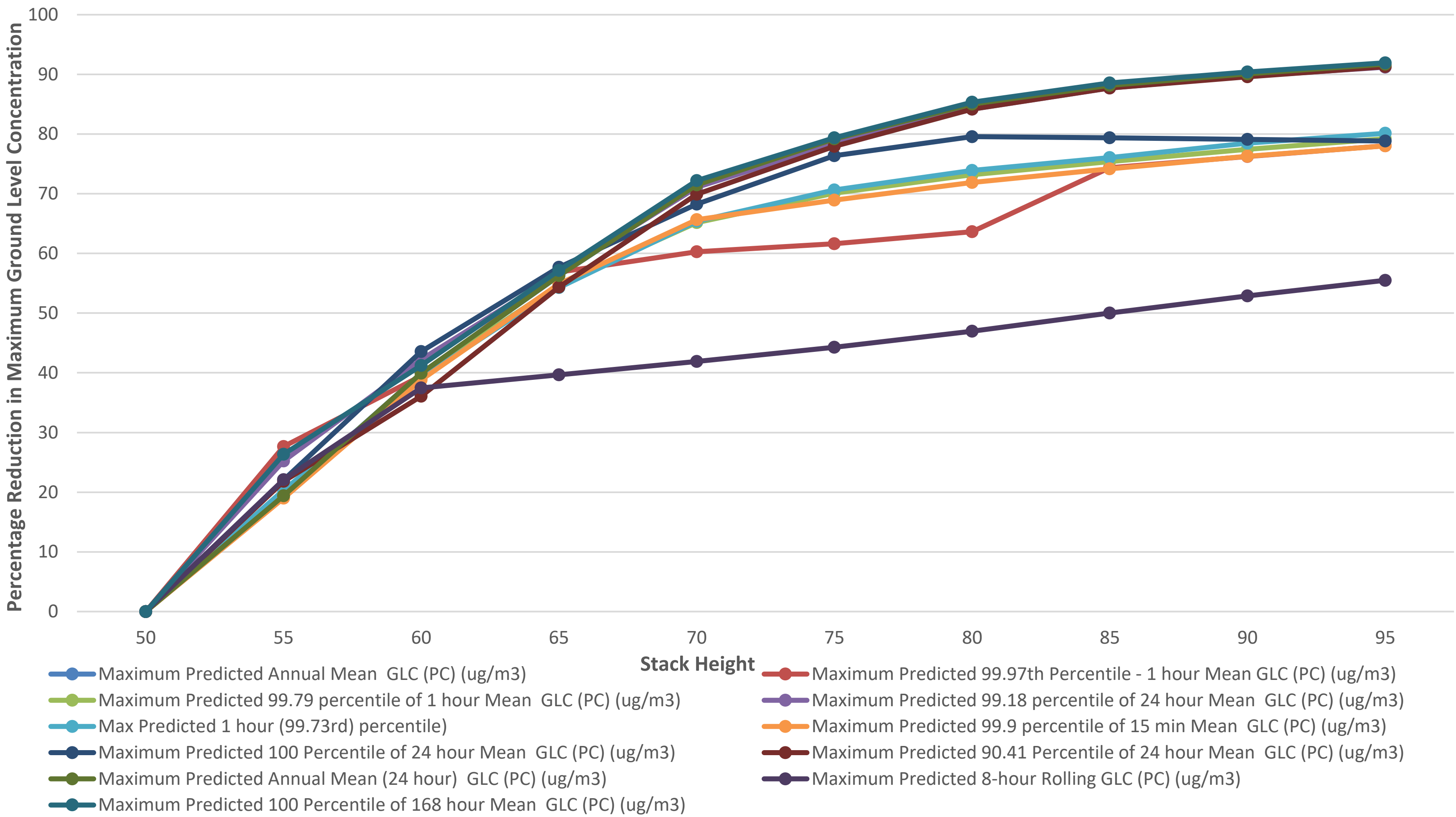
3.1.15. Figure 20 again clearly indicates that increasing the stack height has the effect of decreasing the modelled maximum ground level concentrations (GLCs), for the majority of the averaging periods considered. The maximum predicted 8-hour rolling average, is now shown as would be expected with the ground level concentrations decreasing as stack height is increased. It should be noted that the worst case met year has changed from 2019 to 2018 for 50m, 2018 NWP with surface heat flux and boundary layer turned off for 55m, and then 2016 for stack heights of 60m and above.

3.1.16. However, the issue with the maximum predicted 100th percentile of 1 hour means still requires further investigation. Again, further discussion was held with CERC. From their investigations, the met lines giving the maximum concentrations have similar plume behaviours. The plumes from the various stack heights all start above the boundary layer and are eventually brought down into the boundary layer due to the complex flow field, with the initially higher plumes having smaller spread and thus producing higher ground level concentrations when the plumes reach the ground. CERC further commented that for the conditions giving the maximums, they were not convinced that mechanisms that lead to the higher initial plumes having less plume spread at ground-level make sense physically. The higher plumes understandably have less initial spread, because the air is more stable with increasing altitude, and because the model calculates faster downward velocities from the higher heights, the higher plumes give higher concentrations at ground levels. CERC's view was that a lower percentile – the 99.97th should be used in place of the 100th percentile. As this was a deviation from the normal method of air dispersion modelling, NRW was consulted. CERC provided a technical note on this issue to explain the 100th percentile concentrations and their suggested approach. This was submitted to NRW for comment. NRW's response was that "*it would not be appropriate to confirm an approach at the pre-application stage, but that the applicant needs to provide justification in their application if it differs from a common approach. If the justification is reasonable, it will be accepted*[35]." The technical note from CERC, is included in Appendix 1 of this report. It is considered that as this advice and technical note came from the modelling software providers, it is a reasonable justification.

3.1.17. Consequently, the 99.97th percentile was used in place of the 100th percentile for the 1 hour average. It should be noted that the CERC investigation focused on the 2019 met data only, the stack height screening study was undertaken using the worst case met year obtained from the stack height screening assessment using the 11km x 11km terrain; 2018 met data for 50 and 55m, 2019 NWP with heat and boundary off for 60m and 2017 for 65m and above. The results are provided in Figure 21.

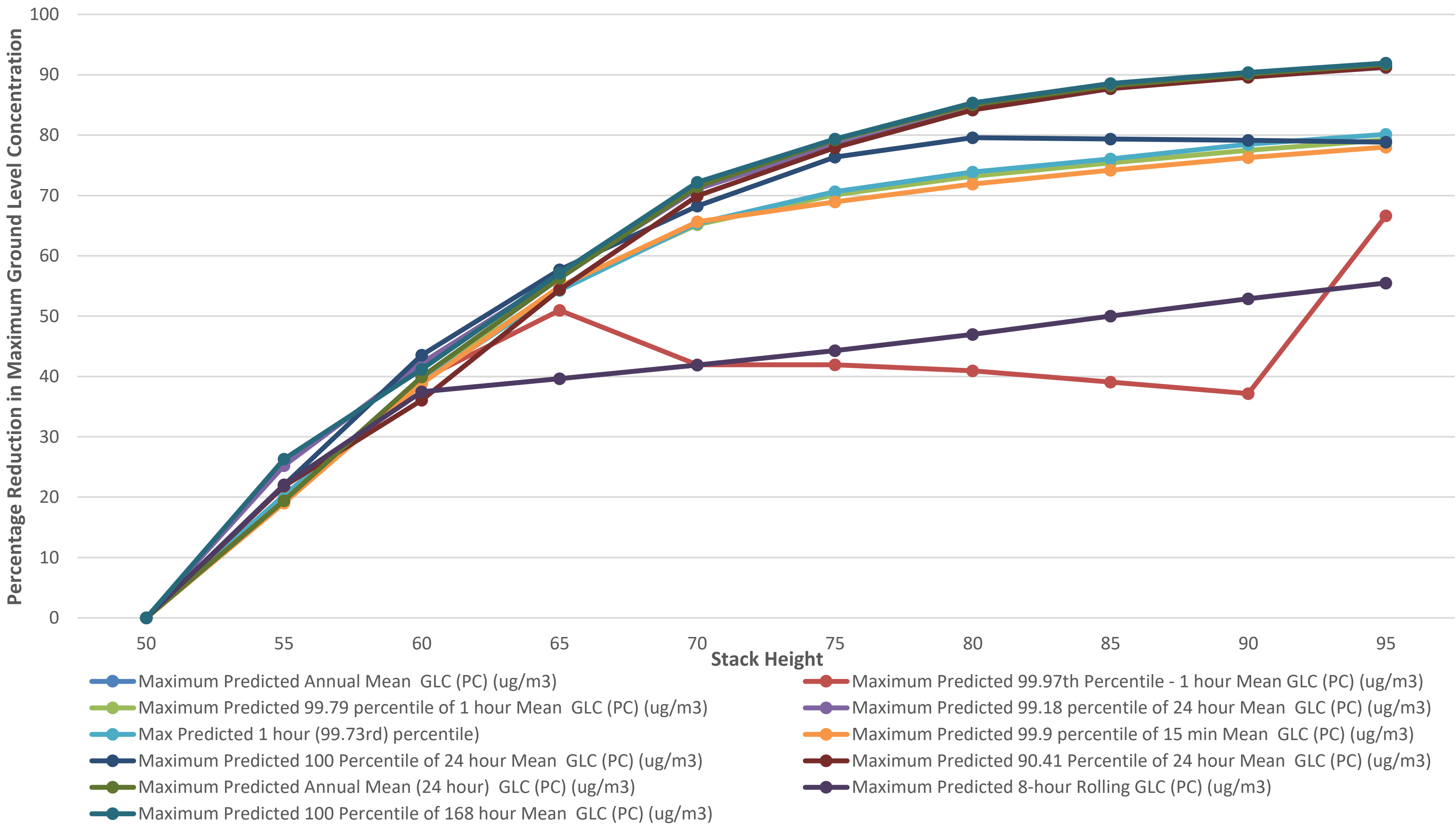
[35] Email from NRW to ECL 21.5.2020

Figure 21: Effect of Stack Height on Ground Level Concentrations – 11km x 11km Terrain File, and 75% validity for 2019 met data for 8-hour rolling average with 99.97th Percentile in place of 100th Percentile for 1 hour averaging period for the worst case met years



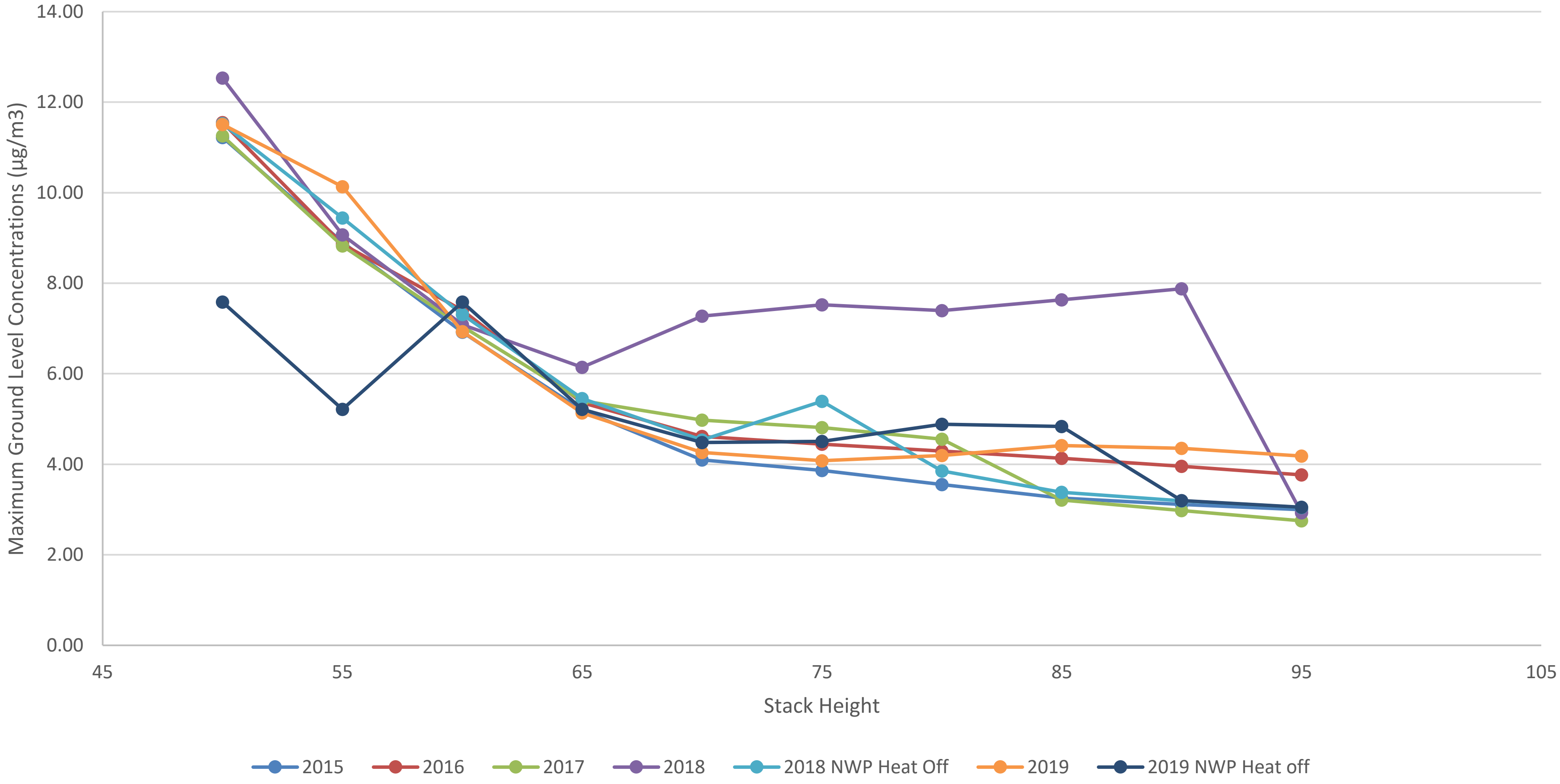
3.1.18. Figure 21 now clearly indicates, that for all pollutants increasing the stack height has the effect of decreasing the modelled maximum ground level concentrations (GLCs). To ensure that the worst case met years remained constant when all met years were considered, further modelling was undertaken to obtain the 99.97^{th} percentile, for each met year, for each stack height. The results of this assessment are provided in Figure 22.

Figure 22: Effect of Stack Height on Ground Level Concentrations – 11km x 11km Terrain File, and 75% validity for 2019 met data for 8-hour rolling average with 99.97th Percentile in place of 100th Percentile for 1 hour averaging period for all met years



3.1.19. Figure 22 again demonstrates that for most pollutants the results are as expected, however again for the 99.97th (used in place of the 100th percentile) the results have no clear trend. What the results do confirm is the model uncertainty at very high percentiles. To investigate this further, the maximum GLCs for each year were graphed and are provided in Figure 23.

Figure 23: Effect of Stack Height on Ground Level Concentrations – 11km x 11km Terrain File, with 99.97th Percentile in place of 100th Percentile for 1-hour averaging period for individual met years



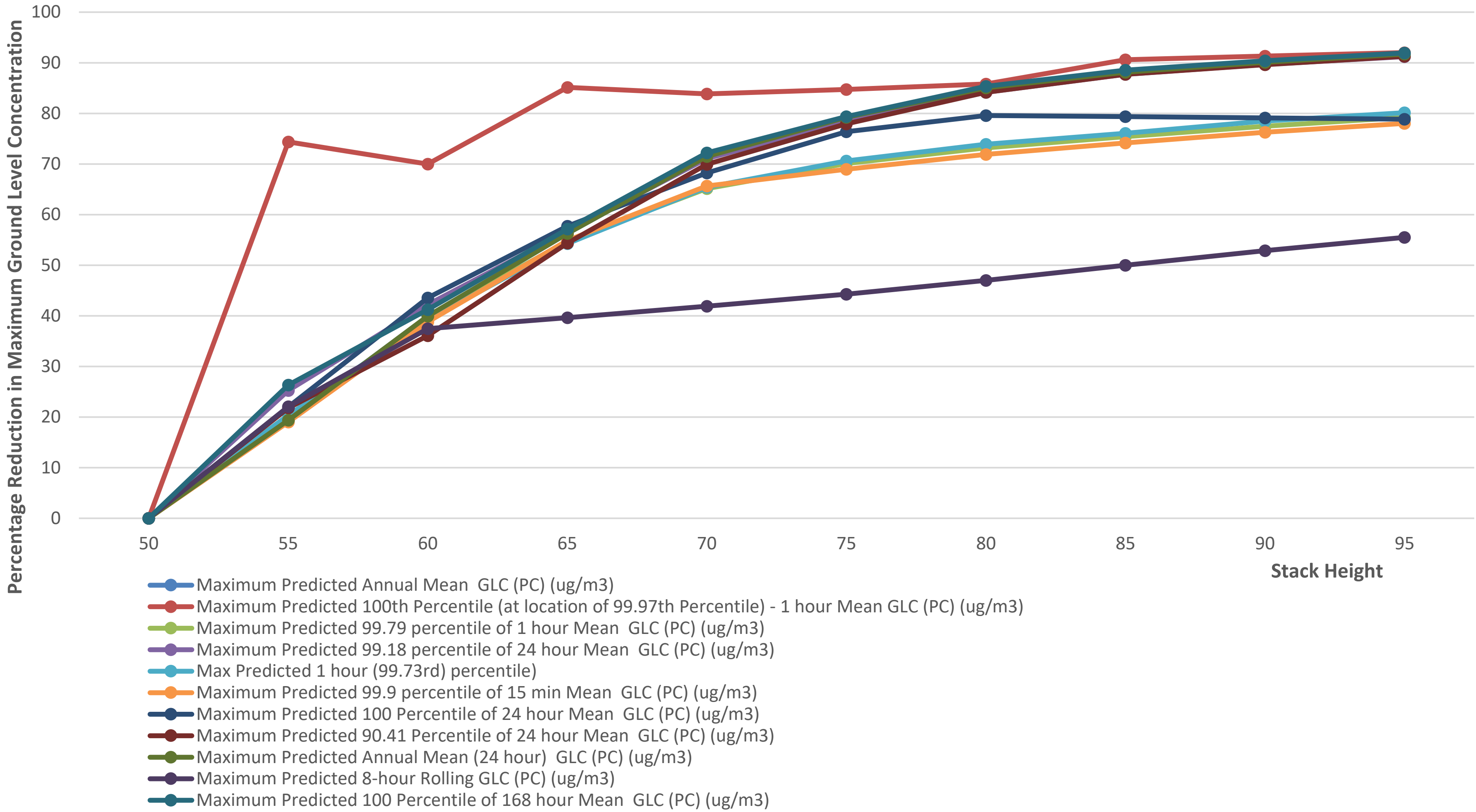
3.1.20. Figure 23 demonstrates that for most met years results are as expected – the maximum GLC decreases with increasing stack height. Plotting the stack height results for the seven individual met years being considered on the same graph indicates that the 2018 results are very much an outlier, and further to discussion with CERC, may not be the best results to use.

3.1.21. A further approach recommended by CERC was to take the 100th percentile results at the location of the 99.97th percentile which would also provide a robust high concentration for this model set up. This study was undertaken using 2018 met data for 50 and 55m, 2019 NWP with heat and boundary off for 60m and 2017 for 65m and above (the original worst case met years). The difference in concentrations are shown in Table 27 and in Figure 24.

Table 27: Maximum GLCs for the 99.97th Percentile compared to the Maximum GLCs for the 100th Percentile at the Location of the 99.97th Percentile (1g/s emission rate)

Stack Height (m)	Location of 99.97th Percentile (x)	Location of 99.97th Percentile (y)	Concentration of 99.97th Percentile (µg/m³)	Concentration of 100th Percentile at Location of 99.97th Percentile (µg/m³)
50	326657	309986	12.53	37.14
55	326707	309986	9.07	9.51
60	326607	309886	7.58	11.15
65	325007	308086	5.40	5.52
70	326657	310786	4.98	6.00
75	326657	310786	4.81	5.66
80	326607	310286	4.55	5.27
85	326507	309886	3.21	3.49
90	324857	308086	2.98	3.23
95	324857	308086	2.75	2.97

Figure 24: Effect of Stack Height on Ground Level Concentrations – 11km x 11km Terrain File, and 75% validity for 2019 met data for 8-hour rolling average with 100th Percentile at the location of the 99.97th Percentile for 1 hour averaging period



3.1.22. The data in Table 27 shows that using the 100th percentile at the location of the 99.97th percentile does provide higher concentrations at a stack height of up to 60m, however above this the concentrations are similar. Consequently, further to much refinement of the model, it is clear that the results do demonstrate the model uncertainty at very high percentiles. Based on the above, it is considered that:

- the 100th percentile results at the location of the 100th percentile results should not be relied upon;
- using the 99.97th percentile in place of the 100th percentile provide more consistent results, however, results from 2018 are considered to be significant outliers;
- using the 100th percentile results at the location of the 99.97th percentile demonstrates slightly higher results for stack heights of 65m and above.

3.1.23. Following refinement of the model, the results of the stack height screening study show that there is significant environmental benefit of a stack which is 60m or higher, however, beyond this there is no clear point of inflection based on a unitised emission rate. Consequently, the impact of the actual emissions on the environment must be considered.

3.1.24. The next step of the assessment, will be conducted as follows:

- only NWP met data which has the surface heat flux and boundary layer options turned off will be used;
- a terrain which is 11km in each direction of the main stack will be used, see Figures 10 and 14;
- for the 8-hour rolling average, the 75% data validity condition has been applied to the 2019 met data results; and
- for the 1-hour mean, the 100th percentile results will be used at the location of the 99.97th percentile results to provide a robust assessment.

4. ASSESSMENT OF AIR QUALITY IMPACTS AT THE MAXIMUM GROUND LEVEL CONCENTRATIONS

4.1. Comparison of Maximum Predicted Pollutant Ground Level Concentrations with Air Quality Standards

4.1.1. The predicted PCs for each of the pollutants considered in the assessment at the maximum point of impact have been extracted and presented in Table 28. The data is based on the worst case met data year. It should be noted that the location of the maximum impact may not be in an area where there is a relevant public exposure. The maximum predicted PCs are also compared to their respective AQSs in the table.

4.1.2. Maximum concentrations are considered potentially significant if the long-term prediction is greater than 1% of the long-term AQS. For short-term predictions, a potentially significant concentration would be greater than 10% of the short-term AQS. In Table 28, any PCs that are above these significance criteria are indicated in bold type. The acronym HBO after the met data year denotes that the surface heat flux and boundary layer options have been switched off.

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m^3)	AQS (µg/m^3)	PC as a % of AQS
NO_2 (annual mean)	50	NWP - 2019 HBO	3.10	40	**7.75%**
	55	NWP - 2019 HBO	2.50		**6.24%**
	60	NWP - 2019 HBO	1.864		**4.66%**
	65	NWP - 2019 HBO	1.357		**3.39%**
	70	NWP - 2019 HBO	0.885		**2.21%**
	75	NWP - 2019 HBO	0.645		**1.61%**
	80	NWP - 2019 HBO	0.464		**1.16%**
	85	NWP - 2019 HBO	0.367		0.92%
	90	NWP - 2019 HBO	0.306		0.76%
	95	NWP - 2019 HBO	0.256		0.64%
NO_2 (1 hour, 99.79th percentile)	50	NWP - 2019 HBO	12.06	200	6.03%
	55	NWP - 2018 HBO	9.73		4.86%
	60	NWP - 2018 HBO	7.29		3.65%
	65	NWP - 2019 HBO	5.46		2.73%
	70	NWP - 2018 HBO	4.20		2.10%
	75	NWP - 2018 HBO	3.60		1.80%
	80	NWP - 2018 HBO	3.23		1.62%
	85	NWP - 2018 HBO	2.97		1.48%
	90	NWP - 2018 HBO	2.72		1.36%
	95	NWP - 2018 HBO	2.51		1.25%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
SO_2 (24 hour, 99.18th percentile)	50	NWP - 2018 HBO	10.43	125	8.34%
	55	NWP - 2018 HBO	7.80		6.24%
	60	NWP - 2018 HBO	6.02		4.82%
	65	NWP - 2019 HBO	4.52		3.61%
	70	NWP - 2019 HBO	3.02		2.41%
	75	NWP - 2019 HBO	2.26		1.80%
	80	NWP - 2018 HBO	1.65		1.32%
	85	NWP - 2019 HBO	1.28		1.03%
	90	NWP - 2019 HBO	1.07		0.86%
	95	NWP - 2019 HBO	0.92		0.73%
SO_2 (1 hour, (99.73th percentile)	50	NWP - 2019 HBO	14.18	350	4.05%
	55	NWP - 2019 HBO	11.30		3.23%
	60	NWP - 2019 HBO	8.63		2.46%
	65	NWP - 2019 HBO	6.49		1.85%
	70	NWP - 2018 HBO	4.91		1.40%
	75	NWP - 2018 HBO	4.17		1.19%
	80	NWP - 2018 HBO	3.70		1.06%
	85	NWP - 2018 HBO	3.40		0.97%
	90	NWP - 2018 HBO	3.05		0.87%
	95	NWP - 2018 HBO	2.82		0.81%
SO_2 (15min, 99.9th Percentile)	50	NWP - 2019 HBO	16.00	266	6.01%
	55	NWP - 2019 HBO	12.95		4.87%
	60	NWP - 2018 HBO	9.79		3.68%
	65	NWP - 2018 HBO	7.21		2.71%
	70	NWP - 2018 HBO	5.50		2.07%
	75	NWP - 2018 HBO	4.97		1.87%
	80	NWP - 2018 HBO	4.49		1.69%
	85	NWP - 2018 HBO	4.13		1.55%
	90	NWP - 2018 HBO	3.80		1.43%
	95	NWP - 2018 HBO	3.52		1.32%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
PM_{10} (annual)	50	NWP - 2019 HBO	0.362	40	0.90%
	55	NWP - 2019 HBO	0.292		0.73%
	60	NWP - 2019 HBO	0.217		0.54%
	65	NWP - 2019 HBO	0.158		0.40%
	70	NWP - 2019 HBO	0.103		0.26%
	75	NWP - 2019 HBO	0.075		0.19%
	80	NWP - 2019 HBO	0.054		0.14%
	85	NWP - 2019 HBO	0.043		0.11%
	90	NWP - 2019 HBO	0.036		0.09%
	95	NWP - 2019 HBO	0.030		0.07%
PM_{10} (90.41th, Percentile 24hour)	50	NWP - 2019 HBO	1.051	50	2.10%
	55	NWP - 2019 HBO	0.822		1.64%
	60	NWP - 2019 HBO	0.672		1.34%
	65	NWP - 2019 HBO	0.480		0.96%
	70	NWP - 2019 HBO	0.316		0.63%
	75	NWP - 2019 HBO	0.232		0.46%
	80	NWP - 2019 HBO	0.166		0.33%
	85	NWP - 2019 HBO	0.1290		0.26%
	90	NWP - 2019 HBO	0.1093		0.22%
	95	NWP - 2019 HBO	0.0916		0.18%
$PM_{2.5}$ (annual)	50	NWP - 2019 HBO	0.362	25	**1.45%**
	55	NWP - 2019 HBO	0.292		**1.17%**
	60	NWP - 2019 HBO	0.217		0.87%
	65	NWP - 2019 HBO	0.158		0.63%
	70	NWP - 2019 HBO	0.103		0.41%
	75	NWP - 2019 HBO	0.075		0.30%
	80	NWP - 2019 HBO	0.0542		0.22%
	85	NWP - 2019 HBO	0.0429		0.17%
	90	NWP - 2019 HBO	0.0358		0.14%
	95	NWP - 2019 HBO	0.0300		0.12%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
CO (8 hour)	50	2018	14.0	10,000	0.14%
	55	NWP - 2018 HBO	10.9		0.11%
	60	2016	8.77		0.088%
	65	2016	8.47		0.085%
	70	2016	8.15		0.082%
	75	2016	7.82		0.078%
	80	2016	7.44		0.074%
	85	2016	7.01		0.070%
	90	2016	6.61		0.066%
	95	2016	6.24		0.062%
VOC (annual)	50	NWP - 2019 HBO	0.369	5	**7.39%**
	55	NWP - 2019 HBO	0.297		**5.95%**
	60	NWP - 2019 HBO	0.2219		**4.44%**
	65	NWP - 2019 HBO	0.1615		**3.23%**
	70	NWP - 2019 HBO	0.1053		**2.11%**
	75	NWP - 2019 HBO	0.0767		**1.53%**
	80	NWP - 2019 HBO	0.0552		**1.10%**
	85	NWP - 2019 HBO	0.0437		0.87%
	90	NWP - 2019 HBO	0.0364		0.73%
	95	NWP - 2019 HBO	0.0305		0.61%
NH_3 (annual)	50	NWP - 2019 HBO	0.369	180	0.205%
	55	NWP - 2019 HBO	0.297		0.165%
	60	NWP - 2019 HBO	0.2219		0.123%
	65	NWP - 2019 HBO	0.1615		0.090%
	70	NWP - 2019 HBO	0.1053		0.059%
	75	NWP - 2019 HBO	0.0767		0.043%
	80	NWP - 2019 HBO	0.0552		0.031%
	85	NWP - 2019 HBO	0.0437		0.024%
	90	NWP - 2019 HBO	0.0364		0.0202%
	95	NWP - 2019 HBO	0.0305		0.0169%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m^3)	AQS (µg/m^3)	PC as a % of AQS
NH_3 (1-hour)	50	2018	9.66	2500	0.386%
	55	2018	2.47		0.099%
	60	2019 NWP HO	2.90		0.116%
	65	2017	1.44		0.057%
	70	2017	1.56		0.062%
	75	2017	1.47		0.059%
	80	2017	1.37		0.055%
	85	2017	0.91		0.036%
	90	2017	0.84		0.034%
	95	2017	0.77		0.031%
HCl (1-hour)	50	2018	9.66	750	1.29%
	55	2018	2.47		0.33%
	60	2019 NWP HO	2.90		0.39%
	65	2017	1.44		0.19%
	70	2017	1.56		0.21%
	75	2017	1.47		0.20%
	80	2017	1.37		0.18%
	85	2017	0.91		0.12%
	90	2017	0.84		0.11%
	95	2017	0.77		0.10%
HF (annual)	50	NWP - 2019 HBO	0.0369	16	0.231%
	55	NWP - 2019 HBO	0.0297		0.186%
	60	NWP - 2019 HBO	0.02219		0.139%
	65	NWP - 2019 HBO	0.01615		0.101%
	70	NWP - 2019 HBO	0.01053		0.066%
	75	NWP - 2019 HBO	0.00767		0.048%
	80	NWP - 2019 HBO	0.00552		0.035%
	85	NWP - 2019 HBO	0.00437		0.027%
	90	NWP - 2019 HBO	0.00364		0.023%
	95	NWP - 2019 HBO	0.00305		0.019%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
HF (1-hour)	50	2018	0.966	160	0.604%
	55	2018	0.247		0.155%
	60	2019 NWP HO	0.290		0.181%
	65	2017	0.144		0.090%
	70	2017	0.156		0.098%
	75	2017	0.147		0.092%
	80	2017	0.137		0.086%
	85	2017	0.091		0.057%
	90	2017	0.084		0.052%
	95	2017	0.077		0.048%
Sb (annual)	50	NWP - 2019 HBO	0.0185	5	0.369%
	55	NWP - 2019 HBO	0.01486		0.297%
	60	NWP - 2019 HBO	0.01109		0.222%
	65	NWP - 2019 HBO	0.00808		0.162%
	70	NWP - 2019 HBO	0.00527		0.105%
	75	NWP - 2019 HBO	0.00384		0.077%
	80	NWP - 2019 HBO	0.00276		0.055%
	85	NWP - 2019 HBO	0.00218		0.044%
	90	NWP - 2019 HBO	0.001821		0.036%
	95	NWP - 2019 HBO	0.001525		0.030%
Sb (1-hour)	50	2018	0.483	150	0.322%
	55	2018	0.124		0.082%
	60	2019 NWP HO	0.145		0.097%
	65	2017	0.072		0.048%
	70	2017	0.078		0.052%
	75	2017	0.074		0.049%
	80	2017	0.069		0.046%
	85	2017	0.045		0.030%
	90	2017	0.042		0.028%
	95	2017	0.039		0.026%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
As (annual)	50	NWP - 2019 HBO	0.0185	0.003	**615%**
	55	NWP - 2019 HBO	0.01486		**495%**
	60	NWP - 2019 HBO	0.01109		**370%**
	65	NWP - 2019 HBO	0.00808		**269%**
	70	NWP - 2019 HBO	5.27E-03		**176%**
	75	NWP - 2019 HBO	0.00384		**128%**
	80	NWP - 2019 HBO	0.00276		**92%**
	85	NWP - 2019 HBO	0.00218		**73%**
	90	NWP - 2019 HBO	0.001821		**61%**
	95	NWP - 2019 HBO	0.001525		**51%**
Cd (annual)	50	NWP - 2019 HBO	0.00185	0.005	**37%**
	55	NWP - 2019 HBO	0.001486		**30%**
	60	NWP - 2019 HBO	0.001109		**22%**
	65	NWP - 2019 HBO	0.000808		**16.2%**
	70	NWP - 2019 HBO	0.000527		**10.5%**
	75	NWP - 2019 HBO	0.000384		**7.7%**
	80	NWP - 2019 HBO	0.000276		**5.5%**
	85	NWP - 2019 HBO	0.000218		**4.4%**
	90	NWP - 2019 HBO	0.0001821		**3.6%**
	95	NWP - 2019 HBO	0.0001525		**3.0%**
Cr (annual)	50	NWP - 2019 HBO	0.0185	5	0.37%
	55	NWP - 2019 HBO	0.01486		0.30%
	60	NWP - 2019 HBO	0.01109		0.22%
	65	NWP - 2019 HBO	0.00808		0.162%
	70	NWP - 2019 HBO	0.00527		0.105%
	75	NWP - 2019 HBO	0.00384		0.077%
	80	NWP - 2019 HBO	0.00276		0.055%
	85	NWP - 2019 HBO	0.00218		0.044%
	90	NWP - 2019 HBO	0.001821		0.036%
	95	NWP - 2019 HBO	0.001525		0.030%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Cr (1-hour)	50	2018	0.483	150	0.322%
	55	2018	0.124		0.082%
	60	2019 NWP HO	0.145		0.097%
	65	2017	0.072		0.048%
	70	2017	0.078		0.052%
	75	2017	0.074		0.049%
	80	2017	0.069		0.046%
	85	2017	0.045		0.030%
	90	2017	0.042		0.028%
	95	2017	0.039		0.026%
Cr VI (annual)	50	NWP - 2019 HBO	0.0185	0.0002	**9232%**
	55	NWP - 2019 HBO	0.0149		**7432%**
	60	NWP - 2019 HBO	0.0111		**5547%**
	65	NWP - 2019 HBO	0.0081		**4038%**
	70	NWP - 2019 HBO	0.00527		**2633%**
	75	NWP - 2019 HBO	0.00384		**1919%**
	80	NWP - 2019 HBO	0.00276		**1380%**
	85	NWP - 2019 HBO	0.00218		**1092%**
	90	NWP - 2019 HBO	0.00182		**911%**
	95	NWP - 2019 HBO	0.00152		**762%**
Co (annual)	50	NWP - 2019 HBO	0.0185	0.2	**9.2%**
	55	NWP - 2019 HBO	0.01486		**7.4%**
	60	NWP - 2019 HBO	0.01109		**5.5%**
	65	NWP - 2019 HBO	0.00808		**4.0%**
	70	NWP - 2019 HBO	0.00527		**2.6%**
	75	NWP - 2019 HBO	0.00384		**1.92%**
	80	NWP - 2019 HBO	0.00276		**1.38%**
	85	NWP - 2019 HBO	0.00218		**1.09%**
	90	NWP - 2019 HBO	0.001821		0.91%
	95	NWP - 2019 HBO	0.001525		0.76%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Co (1-hour)	50	2018	0.483	6	8.05%
	55	2018	0.124		2.06%
	60	2019 NWP HO	0.145		2.42%
	65	2017	0.072		1.20%
	70	2017	0.078		1.30%
	75	2017	0.074		1.23%
	80	2017	0.069		1.14%
	85	2017	0.045		0.76%
	90	2017	0.042		0.70%
	95	2017	0.039		0.64%
Cu (annual)	50	NWP - 2019 HBO	0.0185	10	0.18%
	55	NWP - 2019 HBO	0.01486		0.149%
	60	NWP - 2019 HBO	0.01109		0.111%
	65	NWP - 2019 HBO	0.00808		0.081%
	70	NWP - 2019 HBO	0.00527		0.053%
	75	NWP - 2019 HBO	0.00384		0.038%
	80	NWP - 2019 HBO	0.00276		0.028%
	85	NWP - 2019 HBO	0.00218		0.022%
	90	NWP - 2019 HBO	0.001821		0.0182%
	95	NWP - 2019 HBO	0.001525		0.0152%
Cu (1-hour)	50	2018	0.483	200	0.24%
	55	2018	0.124		0.06%
	60	2019 NWP HO	0.145		0.07%
	65	2017	0.072		0.04%
	70	2017	0.078		0.04%
	75	2017	0.074		0.04%
	80	2017	0.069		0.03%
	85	2017	0.045		0.02%
	90	2017	0.042		0.02%
	95	2017	0.039		0.02%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Pb (annual)	50	NWP - 2019 HBO	0.0185	0.25	**7.4%**
	55	NWP - 2019 HBO	0.01486		**5.9%**
	60	NWP - 2019 HBO	0.01109		**4.4%**
	65	NWP - 2019 HBO	0.00808		**3.2%**
	70	NWP - 2019 HBO	0.00527		**2.11%**
	75	NWP - 2019 HBO	0.00384		**1.53%**
	80	NWP - 2019 HBO	0.00276		**1.10%**
	85	NWP - 2019 HBO	0.00218		0.87%
	90	NWP - 2019 HBO	0.001821		0.73%
	95	NWP - 2019 HBO	0.001525		0.61%
Mn (annual)	50	NWP - 2019 HBO	0.0185	1	**1.85%**
	55	NWP - 2019 HBO	0.01486		**1.49%**
	60	NWP - 2019 HBO	0.01109		**1.11%**
	65	NWP - 2019 HBO	0.00808		0.81%
	70	NWP - 2019 HBO	0.00527		0.53%
	75	NWP - 2019 HBO	0.00384		0.38%
	80	NWP - 2019 HBO	0.00276		0.28%
	85	NWP - 2019 HBO	0.00218		0.22%
	90	NWP - 2019 HBO	0.00182		0.18%
	95	NWP - 2019 HBO	0.00152		0.15%
Mn (1-hour)	50	2018	0.483	1500	0.032%
	55	2018	0.124		0.008%
	60	2019 NWP HO	0.145		0.010%
	65	2017	0.072		0.005%
	70	2017	0.078		0.005%
	75	2017	0.074		0.005%
	80	2017	0.069		0.005%
	85	2017	0.045		0.003%
	90	2017	0.042		0.003%
	95	2017	0.039		0.003%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Hg (annual)	50	NWP - 2019 HBO	0.00185	0.25	0.74%
	55	NWP - 2019 HBO	0.001486		0.59%
	60	NWP - 2019 HBO	0.001109		0.44%
	65	NWP - 2019 HBO	0.000808		0.32%
	70	NWP - 2019 HBO	0.000527		0.211%
	75	NWP - 2019 HBO	0.000384		0.153%
	80	NWP - 2019 HBO	0.000276		0.110%
	85	NWP - 2019 HBO	0.000218		0.087%
	90	NWP - 2019 HBO	0.000182		0.073%
	95	NWP - 2019 HBO	0.000152		0.061%
Hg (1-hour)	50	2018	0.0483	7.5	0.64%
	55	2018	0.0124		0.16%
	60	2019 NWP HO	0.0145		0.19%
	65	2017	0.0072		0.10%
	70	2017	0.0078		0.10%
	75	2017	0.0074		0.10%
	80	2017	0.0069		0.09%
	85	2017	0.0045		0.06%
	90	2017	0.0042		0.06%
	95	2017	0.0039		0.05%
Ni (annual)	50	NWP - 2019 HBO	0.0185	0.02	**92%**
	55	NWP - 2019 HBO	0.01486		**74%**
	60	NWP - 2019 HBO	0.01109		**55%**
	65	NWP - 2019 HBO	0.00808		**40%**
	70	NWP - 2019 HBO	0.00527		**26.3%**
	75	NWP - 2019 HBO	0.00384		**19.2%**
	80	NWP - 2019 HBO	0.00276		**13.8%**
	85	NWP - 2019 HBO	0.00218		**10.9%**
	90	NWP - 2019 HBO	0.00182		**9.1%**
	95	NWP - 2019 HBO	0.00152		**7.6%**

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m^3)	AQS (µg/m^3)	PC as a % of AQS
Tl (annual)	50	NWP - 2019 HBO	0.00185	1	0.18%
	55	NWP - 2019 HBO	0.001486		0.149%
	60	NWP - 2019 HBO	0.001109		0.111%
	65	NWP - 2019 HBO	0.000808		0.081%
	70	NWP - 2019 HBO	0.000527		0.053%
	75	NWP - 2019 HBO	0.000384		0.038%
	80	NWP - 2019 HBO	0.000276		0.028%
	85	NWP - 2019 HBO	0.000218		0.022%
	90	NWP - 2019 HBO	0.0001821		0.0182%
	95	NWP - 2019 HBO	0.0001525		0.0152%
Tl (1-hour)	50	2018	0.0483	30	0.161%
	55	2018	0.0124		0.041%
	60	2019 NWP HO	0.0145		0.048%
	65	2017	0.0072		0.024%
	70	2017	0.0078		0.026%
	75	2017	0.0074		0.025%
	80	2017	0.0069		0.023%
	85	2017	0.0045		0.015%
	90	2017	0.0042		0.014%
	95	2017	0.0039		0.013%
V (annual)	50	NWP - 2019 HBO	0.0181	5	0.36%
	55	NWP - 2019 HBO	0.01458		0.29%
	60	NWP - 2019 HBO	0.01087		0.217%
	65	NWP - 2019 HBO	0.00791		0.158%
	70	NWP - 2019 HBO	0.00516		0.103%
	75	NWP - 2019 HBO	0.00376		0.075%
	80	NWP - 2019 HBO	0.00271		0.054%
	85	NWP - 2019 HBO	0.002145		0.043%
	90	NWP - 2019 HBO	0.001790		0.036%
	95	NWP - 2019 HBO	0.001499		0.030%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
V (24-hour)	50	NWP - 2018 HBO	0.119	1	**11.9%**
	55	NWP - 2018 HBO	0.0927		9.3%
	60	NWP - 2018 HBO	0.0671		6.7%
	65	NWP - 2019 HBO	0.0503		5.0%
	70	NWP - 2019 HBO	0.0378		3.8%
	75	NWP - 2019 HBO	0.0281		2.8%
	80	2019	0.0243		2.4%
	85	2019	0.0245		2.5%
	90	2019	0.0248		2.5%
	95	2019	0.0252		2.5%
B[a]P (annual)	50	NWP - 2019 HBO	0.0000037	0.00025	**1.48%**
	55	NWP - 2019 HBO	0.0000030		**1.19%**
	60	NWP - 2019 HBO	0.00000222		0.89%
	65	NWP - 2019 HBO	0.00000162		0.65%
	70	NWP - 2019 HBO	0.00000105		0.42%
	75	NWP - 2019 HBO	0.00000077		0.31%
	80	NWP - 2019 HBO	0.00000055		0.22%
	85	NWP - 2019 HBO	0.00000044		0.17%
	90	NWP - 2019 HBO	0.00000036		0.15%
	95	NWP - 2019 HBO	0.00000030		0.12%
PCBs (annual)	50	NWP - 2019 HBO	0.000000369	0.2	0.00018%
	55	NWP - 2019 HBO	0.000000297		0.000149%
	60	NWP - 2019 HBO	0.0000002219		0.000111%
	65	NWP - 2019 HBO	0.0000001615		0.000081%
	70	NWP - 2019 HBO	0.0000001053		0.000053%
	75	NWP - 2019 HBO	0.0000000767		0.000038%
	80	NWP - 2019 HBO	0.0000000552		0.000028%
	85	NWP - 2019 HBO	0.0000000437		0.000022%
	90	NWP - 2019 HBO	0.0000000364		0.000018%
	95	NWP - 2019 HBO	0.0000000305		0.000015%

Table 28: Comparison of Predicted Maximum Ground Level Process Contributions with Air Quality Standards (cont)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
PCBs (1-hour)	50	2018	0.0000097	6	0.00016%
	55	2018	0.00000247		0.000041%
	60	2019 NWP HO	0.00000290		0.00005%
	65	2017	0.00000144		0.000024%
	70	2017	0.00000156		0.000026%
	75	2017	0.00000147		0.000025%
	80	2017	0.00000137		0.000023%
	85	2017	0.00000091		0.000015%
	90	2017	0.00000084		0.000014%
	95	2017	0.00000077		0.000013%
Dioxins (annual)	50	NWP - 2019 HBO	0.000000001477	No Standard Applies	
	55	NWP - 2019 HBO	0.000000001189		
	60	NWP - 2019 HBO	0.000000000888		
	65	NWP - 2019 HBO	0.000000000646		
	70	NWP - 2019 HBO	0.000000000421		
	75	NWP - 2019 HBO	0.000000000307		
	80	NWP - 2019 HBO	0.0000000002208		
	85	NWP - 2019 HBO	0.0000000001746		
	90	NWP - 2019 HBO	0.0000000001457		
	95	NWP - 2019 HBO	0.0000000001220		

4.1.3. It can be seen from the data in Table 28, that the impact of the Installation varies depending on the pollutant considered, however, for the majority of pollutants assessed, the impact of the proposed facility is not significant for stack heights of 55m and above. However, the stack height screening study demonstrated that that there is significant environmental benefit of a stack which is 60m or higher (see Section 3.1.21). Therefore, for stack heights of 60m and above, the potentially significant impacts, are for the long-term (annual):

- nitrogen dioxide,
- VOC (as benzene),
- arsenic,
- cadmium,
- chromium VI,
- cobalt,
- lead, and
- nickel.

4.1.4. It is important to note that the metals have, at this step of the assessment, each been modelled at their respective ELVs (see Section 2.25 of this report).

4.1.5. However, it would not be reasonable to assume that each Group 3 metal emits at the maximum ELV for the group. In this regard, the EA has provided guidance (which NRW have approved the use of) on the steps required for assessing the impact of metals emissions (see Section 2.25. of this report). If any of the Group 3 metals exceed 1% of a long-term standard, then the PEC should be compared against the AQS. If the PEC is greater than 100% of the AQS then case specific screening is required. Consequently, background concentrations for arsenic, chromium VI, cobalt, lead and nickel are required. Cadmium will also be considered with the Group 3 Metals.

4.2. Background Air Concentrations of Group 2 and Group 3 Metals

4.2.1. Monitoring of trace elements has been undertaken by DEFRA since 1976. Currently, monitoring of twelve metals is carried out at locations throughout the UK, predominantly in urban locations. In addition, concentrations of As, Cd, and Ni are monitored at a further ten rural locations.

4.2.2. The closest location to the application site is the rural site at Cwmystwyth (NGR 277138, 274242), approximately 61km to the west of the site. Although this is some distance from the site, it is classed as a rural background monitoring site, therefore is considered to be appropriate to be used in the assessment.

4.2.3. For CrVI, it has been assumed that the background concentration is 20% of the total Cr concentration (as indicated in the EPAQS report *Guidelines for metals and metalloids in ambient air for the protection of human health*, May 2009).

4.2.4. Background concentrations for 2019 are provided in Table 29.

Table 29: Annual Mean Trace Metal Concentrations

Metal	Annual Mean Concentration (ng/m^3)
Arsenic (As)	0.224
Cadmium (Cd)	0.0496
Total Chromium (Cr)	0.65
Hexavalent Chromium (Cr VI)	0.13[(c)]
Cobalt (Co)	0.025
Lead (Pb)	1.47
Nickel (Ni)	0.314

Notes to Table 29
(d) Cr VI assumed to be 20% of total Cr

4.3. Step 1 and 2 Screening of Group 2 and 3 Metals

4.3.1. Using the background concentrations in Section 4.2, PECs for the potentially significant Group 2 and Group 3 pollutants are provided in Table 30. Any PECs greater than 100% of the AQS are highlighted in bold.

Table 30: PECs of Group 2 and Group 3 Metals – Step 1 Screening

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS	Background Concentration (µg/m³)	Maximum PEC (µg/m³)	PEC as a % of AQS
Arsenic (annual)	60	NWP - 2019 HBO	0.01109	0.003	370%	0.000224	0.01132	**377%**
	65	NWP - 2019 HBO	0.00808		269%		0.00830	**277%**
	70	NWP - 2019 HBO	0.00527		176%		0.00549	**183%**
	75	NWP - 2019 HBO	0.00384		128%		0.00406	**135%**
	80	NWP - 2019 HBO	0.00276		92%		0.00298	99%
	85	NWP - 2019 HBO	0.00218		73%		0.00241	80%
	90	NWP - 2019 HBO	0.001821		61%		0.00205	68%
	95	NWP - 2019 HBO	0.001525		51%		0.00175	58%
Cadmium (annual)	60	NWP - 2019 HBO	0.001109	0.005	22%	0.0000496	0.001333	27%
	65	NWP - 2019 HBO	0.000808		16.2%		0.001032	21%
	70	NWP - 2019 HBO	0.000527		10.5%		0.000751	15.0%
	75	NWP - 2019 HBO	0.000384		7.7%		0.000608	12.2%
	80	NWP - 2019 HBO	0.000276		5.5%		0.000500	10.0%
	85	NWP - 2019 HBO	0.000218		4.4%		0.000442	8.8%
	90	NWP - 2019 HBO	0.0001821		3.6%		0.000406	8.1%
	95	NWP - 2019 HBO	0.0001525		3.0%		0.000376	7.5%

Table 30: PECs of Group 2 and Group 3 Metals – Step 1 Screening (cont)

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS	Background Concentration (µg/m³)	Maximum PEC (µg/m³)	PEC as a % of AQS
Chromium VI (annual)	60	NWP - 2019 HBO	0.0022	0.0002	1109%	0.00013	0.00235	**1174%**
	65	NWP - 2019 HBO	0.0016		808%		0.00175	**873%**
	70	NWP - 2019 HBO	0.00105		527%		0.00118	**592%**
	75	NWP - 2019 HBO	0.00077		384%		0.00090	**449%**
	80	NWP - 2019 HBO	0.00055		276%		0.00068	**341%**
	85	NWP - 2019 HBO	0.00044		218%		0.00057	**283%**
	90	NWP - 2019 HBO	0.00036		182%		0.00049	**247%**
	95	NWP - 2019 HBO	0.00030		152%		0.000435	**217%**
Cobalt (annual)	60	NWP - 2019 HBO	0.01109	0.2	5.5%	0.000025	0.01112	5.6%
	65	NWP - 2019 HBO	0.00808		4.0%		0.00810	4.1%
	70	NWP - 2019 HBO	0.00527		2.6%		0.00529	2.6%
	75	NWP - 2019 HBO	0.00384		1.92%		0.00386	1.93%
	80	NWP - 2019 HBO	0.00276		1.38%		0.00279	1.39%
	85	NWP - 2019 HBO	0.00218		1.09%		0.00221	1.10%
	90	NWP - 2019 HBO	0.001821		0.91%		0.001846	0.92%
	95	NWP - 2019 HBO	0.001525		0.76%		0.001550	0.77%

Table 30: PECs of Group 2 and Group 3 Metals – Step 1 Screening (cont)

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS	Background Concentration (µg/m³)	Maximum PEC (µg/m³)	PEC as a % of AQS
Lead(annual)	60	NWP - 2019 HBO	0.01109	0.25	4.4%	0.00147	0.01256	5.0%
	65	NWP - 2019 HBO	0.00808		3.2%		0.00955	3.8%
	70	NWP - 2019 HBO	0.00527		2.11%		0.00674	2.7%
	75	NWP - 2019 HBO	0.00384		1.53%		0.00531	2.1%
	80	NWP - 2019 HBO	0.00276		1.10%		0.00423	1.69%
	85	NWP - 2019 HBO	0.00218		0.87%		0.00365	1.46%
	90	NWP - 2019 HBO	0.001821		0.73%		0.00329	1.32%
	95	NWP - 2019 HBO	0.001525		0.61%		0.00299	1.20%
Nickel (annual)	60	NWP - 2019 HBO	0.01109	0.02	55%	0.000314	0.0114	57%
	65	NWP - 2019 HBO	0.00808		40%		0.0084	42%
	70	NWP - 2019 HBO	0.00527		26.3%		0.0056	28%
	75	NWP - 2019 HBO	0.00384		19.2%		0.0042	20.8%
	80	NWP - 2019 HBO	0.00276		13.8%		0.0031	15.4%
	85	NWP - 2019 HBO	0.00218		10.9%		0.0025	12.5%
	90	NWP - 2019 HBO	0.00182		9.1%		0.0021	10.7%
	95	NWP - 2019 HBO	0.00152		7.6%		0.0018	9.2%

4.3.2. The data in Table 30 indicates that, although for the majority of pollutants the PECs can be screened out, further screening is required for long-term As at stack heights 60-75m and for Cr(VI) at all stack heights.

4.3.3. Step 2 screening indicates that where the PC exceeds 1% of the long standard, the maximum emissions data in Appendix A of the EA's Group 3 metals assessment guidance can be used to revise the predictions, and the PEC then compared against the AQS. The guidance states that As comprises 5% of the Group 3 metals, and Cr(VI) 0.03%. Consequently, the PCs for each have been recalculated based on these percentages. The results may be found in Table 31.

Table 31: PECs of Group 3 Metals – Step 2 Screening

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m^3)	AQS (µg/m^3)	PC as a % of AQS	Background Concentration (µg/m^3)	Maximum PEC (µg/m^3)	PEC as a % of AQS
Arsenic (annual)	60	NWP - 2019 HBO	0.000555	0.003	18.5%	0.000224	0.00078	26%
	65	NWP - 2019 HBO	0.000404		13.5%		0.00063	21%
	70	NWP - 2019 HBO	0.000263		8.8%		0.00049	16%
	75	NWP - 2019 HBO	0.000192		6.4%		0.00042	14%
	80	NWP - 2019 HBO	0.000138		4.6%		0.00036	12%
	85	NWP - 2019 HBO	0.000109		3.6%		0.00033	11%
	90	NWP - 2019 HBO	0.000091		3.0%		0.00032	11%
	95	NWP - 2019 HBO	0.000076		2.5%		0.00030	10%
Chromium VI (annual)	60	NWP - 2019 HBO	0.00000333	0.0002	1.7%	0.00013	0.00013	66%
	65	NWP - 2019 HBO	0.00000242		1.2%		0.00013	66%
	70	NWP - 2019 HBO	0.00000158		0.8%		0.00013	65%
	75	NWP - 2019 HBO	0.00000115		0.6%		0.00013	65%
	80	NWP - 2019 HBO	0.00000083		0.4%		0.00013	65%
	85	NWP - 2019 HBO	0.00000065		0.3%		0.00013	65%
	90	NWP - 2019 HBO	0.00000055		0.3%		0.00013	65%
	95	NWP - 2019 HBO	0.00000046		0.2%		0.00013	65%

4.3.4. The data in Table 31 indicates that for both As and Cr(VI) the PECs can be screened out, at all stack heights. Consequently, no further assessment is required for the metals.

4.3.5. The long-term impacts of NO_2, and VOC still require further assessment. The next stage of the Step 2 impact significance screening process is to compare the long-term pollutant PECs with the criteria outlined in Section 2.22 of this report. Consequently, the background concentrations of the pollutants are required.

4.4. Background Concentrations of NO_2, and VOC

Nitrogen Dioxide (NO_2)

4.4.1. PCC undertake NO_2 diffusion tube monitoring at seven sites. These sites all operate within, or in the vicinity of the former Newtown AQMA, and are located approximately 24km south west of the Installation. These are all roadside locations and, mainly due to the distance from the site, would not be representative of local air quality in the Buttington area.

4.4.2. SLR Consulting undertook diffusion tube monitoring for NO_2 from August 2015 to January 2016 at the following locations:

- Parc Caradog (AQ1);
- Cefn Chapel (AQ2);
- Buttington (AQ3);
- Green Farm (AQ4); and
- Sale Farm (AQ5).

4.4.3. The locations of the diffusion tubes are shown on Figure 25 and the results of the monitoring are provided in Table 32.

Figure 25: Diffusion Tube Monitoring Locations

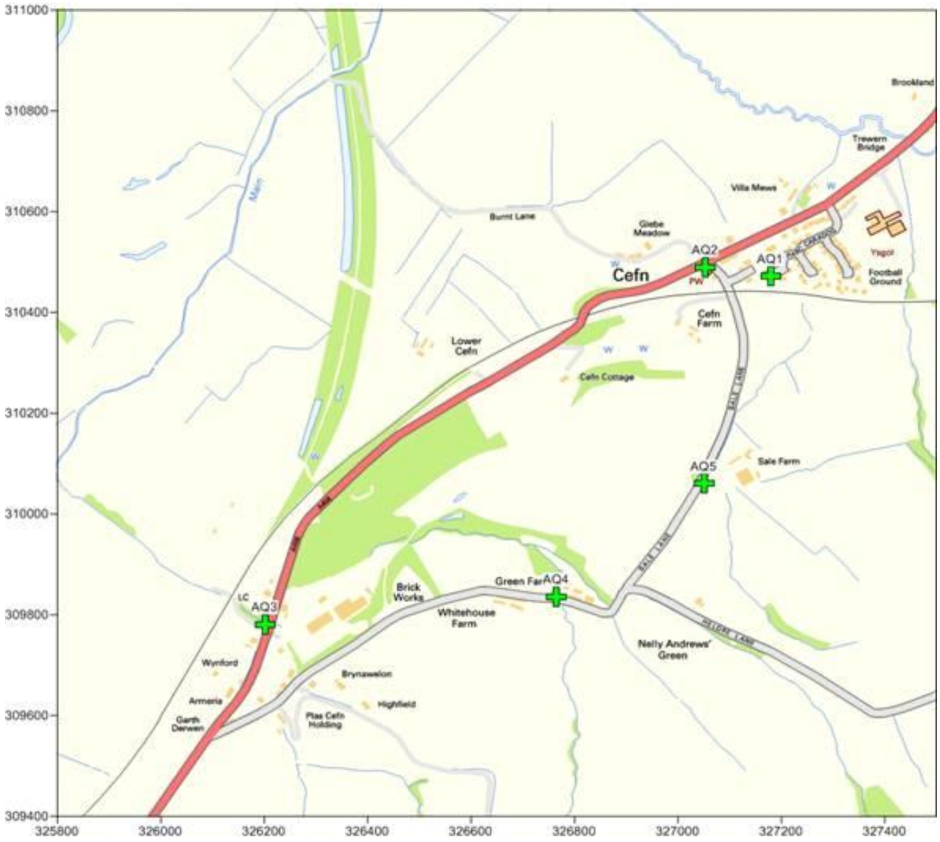


Table 32: Local Diffusion Tube Monitoring Data

Tube No.	Location	Dates of Sampling (Results in μg/m³ – Raw Data)						Mean Conc*1. (μg/m³)
		3.8.15–26.8.15	26.8.15-30.9.15	30.9.15-28.10.15	28.10.15-2.12.15	2.12.15-6.1.16	6.1.16-3.2.16	Average
AQ1A	Parc Caradog	6.86	8.41	10.60	7.81	7.35	8.73	6.76
AQ1B		6.88	9.13	12.54	7.55	7.27	9.49	
AQ2A	Cefn Chapel	26.91	25.10	25.75	23.78	18.30	n/a	18.87
AQ2B		26.63	26.59	23.59	22.68	19.54	n/a	
AQ3A	Buttington	11.94	18.03	22.44	11.64	14.24	15.56	12.51
AQ3B		12.08	17.53	24.85	12.53	14.81	14.32	
AQ4A	Green Farm	6.23	8.23	10.69	5.39	5.42	6.4	5.51
AQ4B		6.21	7.31	10.20	5.61	5.81	6.26	
AQ5A	Sale Farm	4.89	5.43	8.30	5.18	5.37	6.42	4.72
AQ5B		5.19	5.72	8.16	5.34	4.86	6.89	

Notes to Table 32

*1 - A bias adjustment figure of 0.79 was used to maintain consistency with the 2015 Bias adjustment factor used by PCC in their Air Quality Progress Report 2017.

n/a: data not available

4.4.4. The DEFRA mapped NO_2 concentration[36] for the area surrounding the Installation for the year 2018 (latest available) at NGR 326500, 310500 is 3.56µg/m^3. This location is 515m west of the Installation.

4.4.5. For the stack height screening assessment, the highest concentration of NO_2 will be used – 18.87µg/m^3.

Volatile Organic Compounds (as Benzene)

4.4.6. As there is no suitable measured data for VOC as benzene the DEFRA mapped data will be used. The DEFRA mapped concentration for the area surrounding the Installation for the year 2018 (latest available) at NGR 326500, 310500 is 0.17µg/m^3. This location is 516m west of the Installation, thus will be used as a background concentration in this assessment.

4.5. Step 2 Screening of Remaining Pollutants

4.5.1. Using the background data in section 4.4., PECs will now be calculated for the long-term impacts of NO_2 and VOC. For this section of the assessment, only stack heights of 60m and above will be considered. The criteria used to determine the significance of the impact of PECs is provided in Section 2.22 of this report.

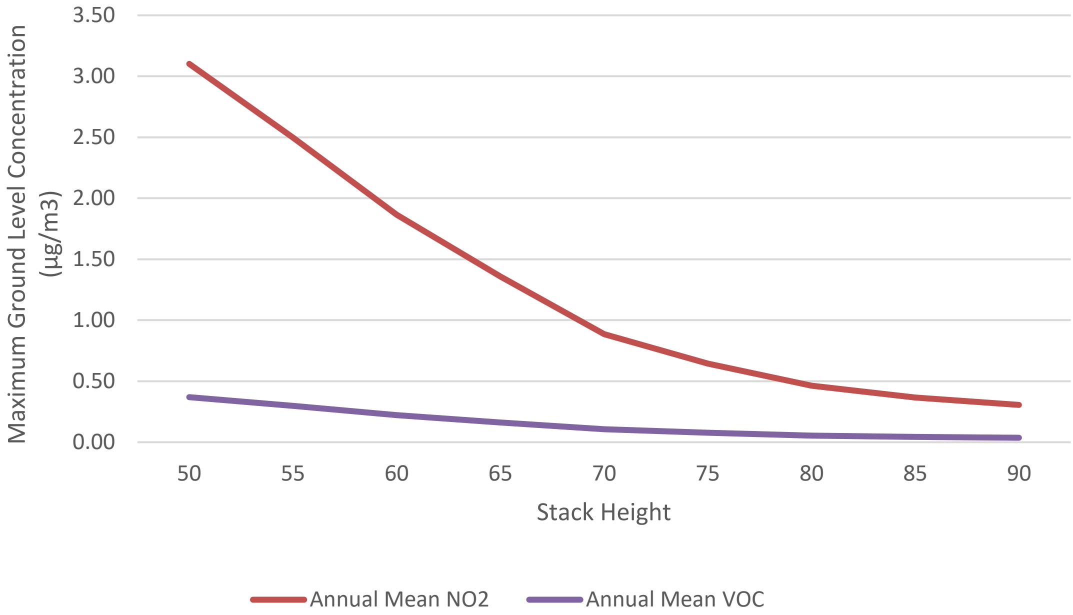
[36] https://uk-air.defra.gov.uk/data/pcm-data

Table 33: Long term impacts of NO_2, PM_{10}, $PM_{2.5}$ and VOC – Step 2 Screening

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS	Background Concentration (µg/m³)	Maximum PEC (µg/m³)	PEC as a % of AQS	Impact Descriptor
NO_2 (annual mean)	60	NWP - 2019 HBO	1.864	40	4.66%	18.87	20.73	52%	Negligible
	65	NWP - 2019 HBO	1.357		3.39%		20.23	51%	Negligible
	70	NWP - 2019 HBO	0.885		2.21%		19.75	49%	Negligible
	75	NWP - 2019 HBO	0.645		1.61%		19.51	49%	Negligible
	80	NWP - 2019 HBO	0.464		1.16%		19.33	48%	Negligible
	85	NWP - 2019 HBO	0.367		0.92%		19.24	48%	Screens out at Step 1
	90	NWP - 2019 HBO	0.306		0.76%		19.18	48%	Screens out at Step 1
	95	NWP - 2019 HBO	0.256		0.64%		19.13	48%	Screens out at Step 1
VOC (annual)	60	NWP - 2019 HBO	0.2219	5	4.44%	0.17	0.392	7.8%	Negligible
	65	NWP - 2019 HBO	0.1615		3.23%		0.332	6.6%	Negligible
	70	NWP - 2019 HBO	0.1053		2.11%		0.275	5.5%	Negligible
	75	NWP - 2019 HBO	0.0767		1.53%		0.247	4.9%	Negligible
	80	NWP - 2019 HBO	0.0552		1.10%		0.225	4.5%	Negligible
	85	NWP - 2019 HBO	0.0437		0.87%		0.214	4.3%	Screens out at Step 1
	90	NWP - 2019 HBO	0.0364		0.73%		0.206	4.1%	Screens out at Step 1
	95	NWP - 2019 HBO	0.0305		0.61%		0.200	4.0%	Screens out at Step 1

4.5.2. The data in Table 33 indicates that for all pollutants the impact on the environment can be classed as negligible or screens out at higher stack heights. Consequently, stack heights of 60m and above would be suitable. However, on further inspection of the data, there is a significant drop in GLCs from 60 to 65m (27% reduction) and from 65 to 70m (a further 25% reduction). The reduction in GLC is then not as pronounced from 70m upwards. This can be seen in Figure 26.

Figure 26: Reduction in Actual Max GLC with Increasing Stack Height



4.5.3. Based on the above graph, a stack height of 70m is proposed. At this height, all pollutants screen out at Stage 1 screening with the exception of annual mean NO_2 and VOC which at Stage 2 screening have a negligible impact on the environment; and arsenic and chromium VI which both screen out at Stage 2 screening.

4.6. Isopleths

4.6.1. Isopleths have been prepared for every pollutant with an AQS. These are provided as Figures 27-47.

4.6.2. For the 100th percentile isopleths, the 100th percentile concentration was plotted. However, where the 100th percentile was at a greater concentration than the maximum predicted 100th percentile at the location of the 99.97th percentile (i.e. the value used in the assessment), the concentration of the 99.97th percentile was used.

Figure 27: NO_2 Annual Mean Isopleth

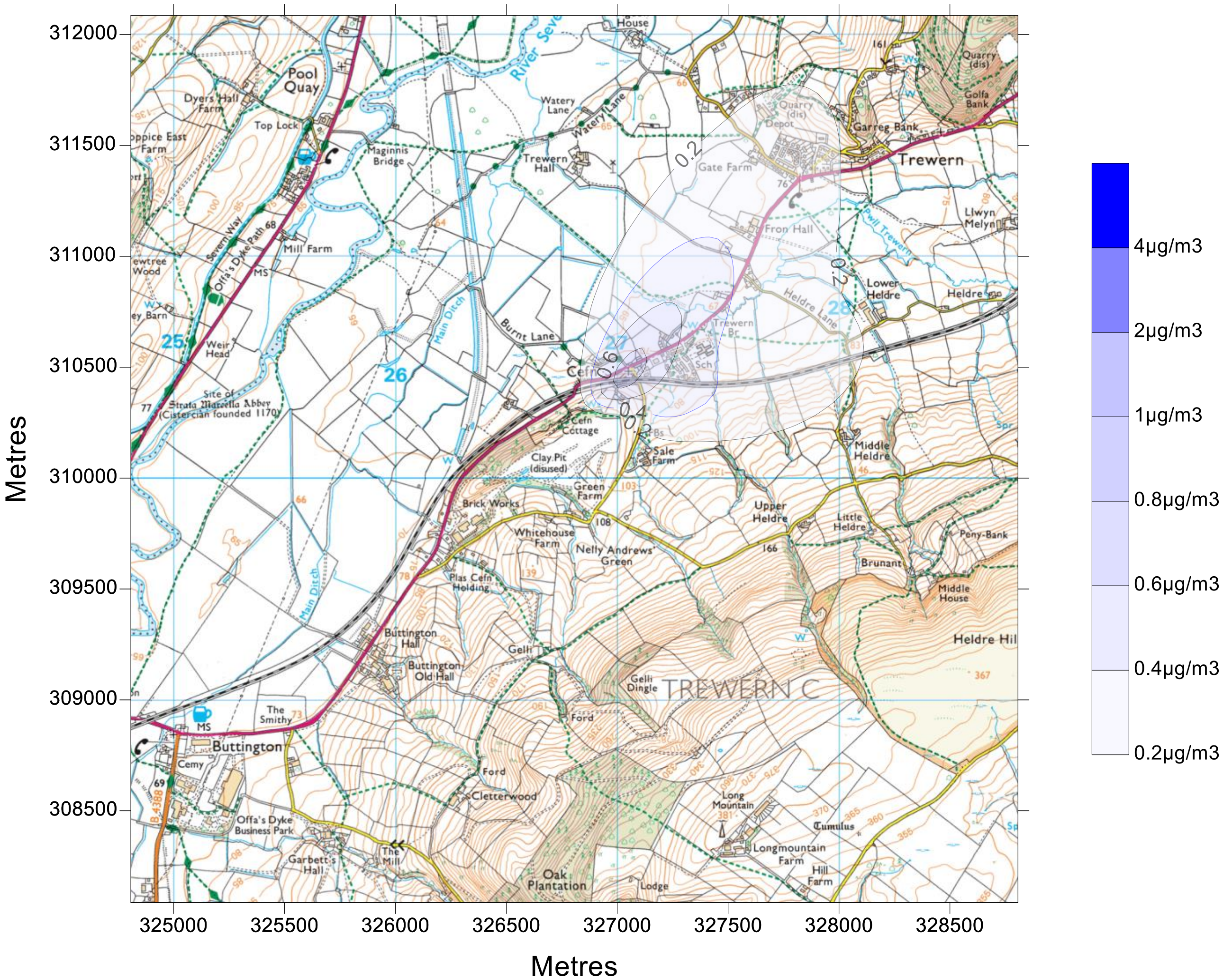


Figure 28: NO_2 99.79th Percentile

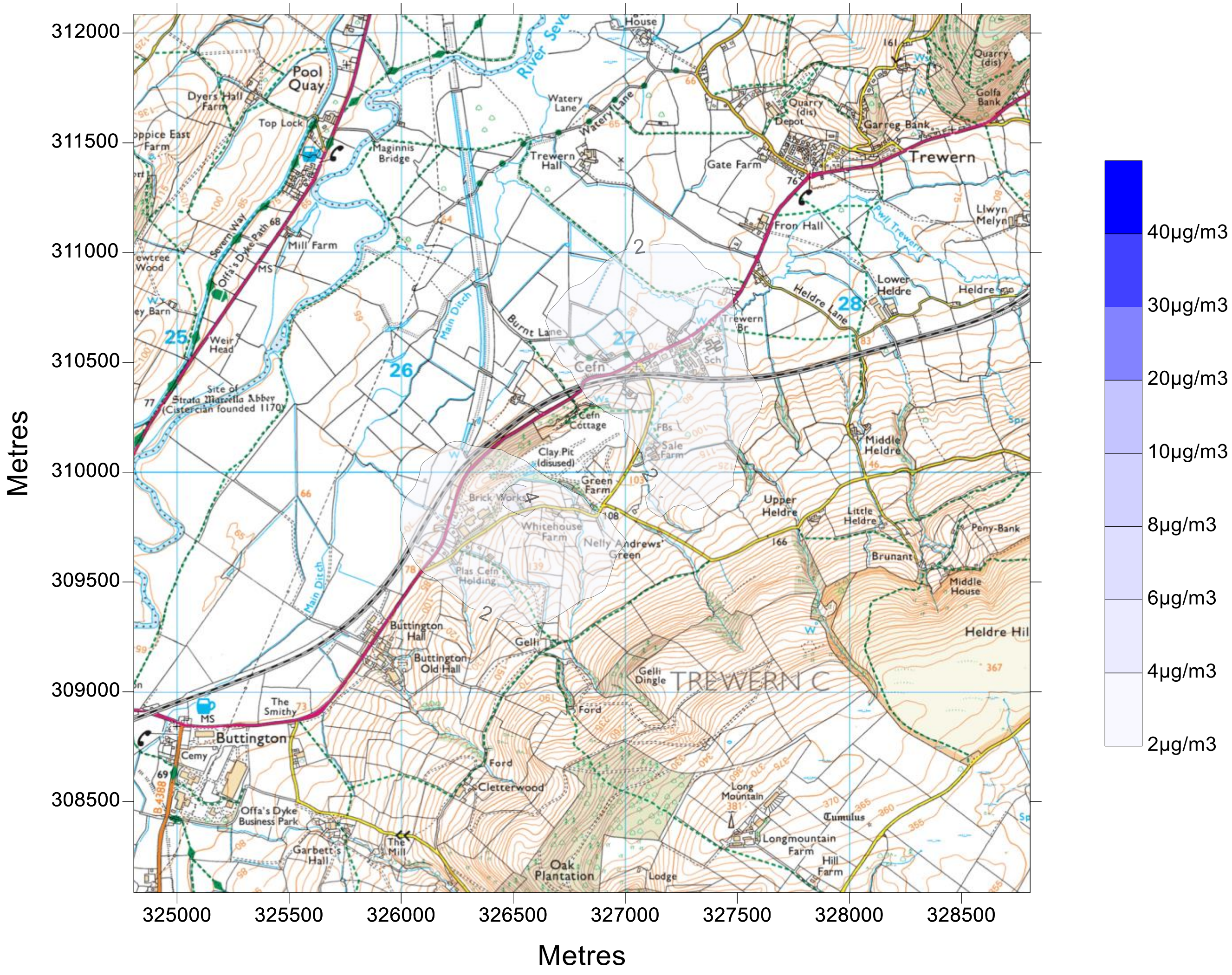


Figure 29: SO_2 99.18th Percentile

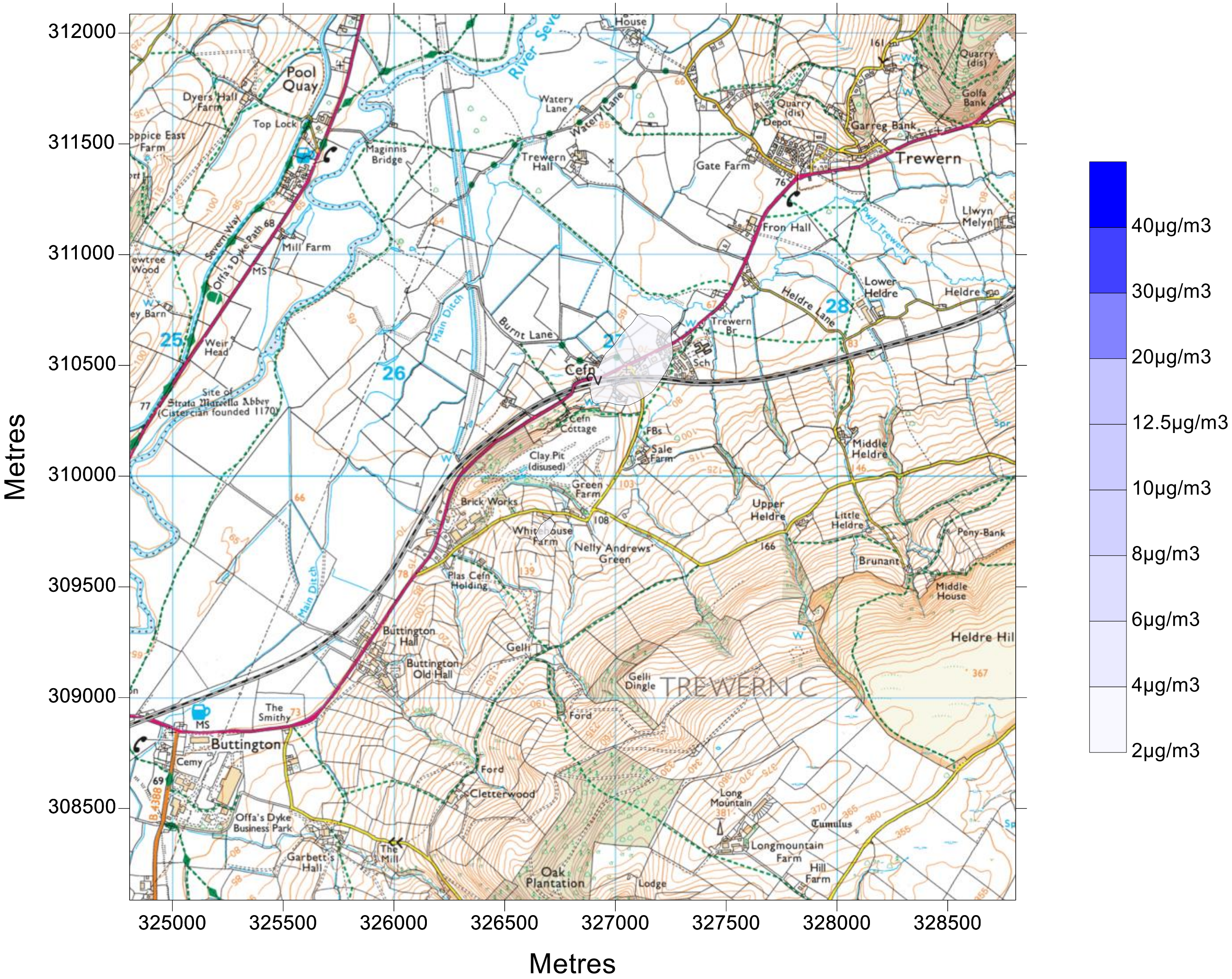


Figure 30: SO_2 99.73rd Percentile

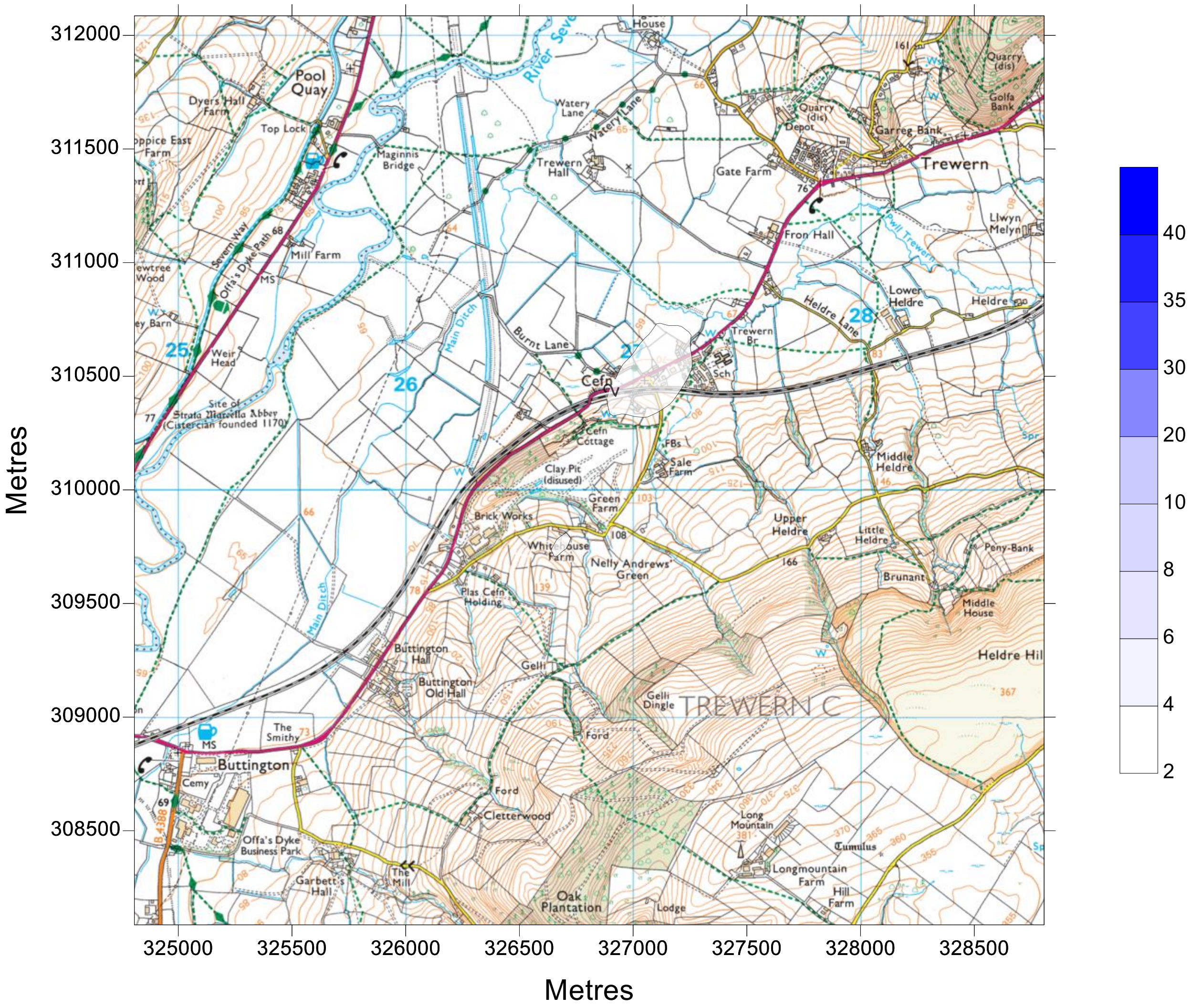


Figure 31: SO_2 99.9th Percentile

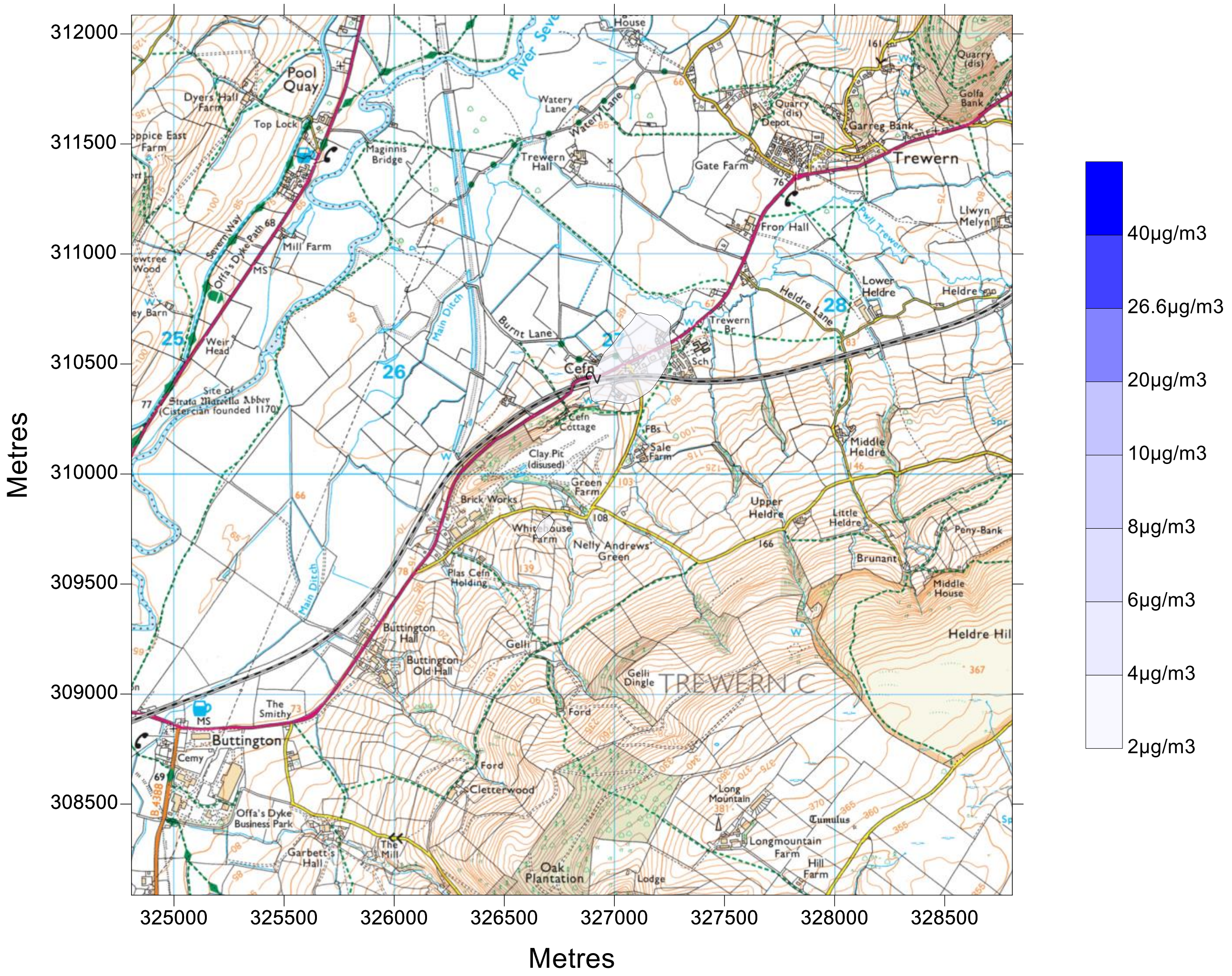


Figure 32: PM$_{10}$, PM$_{2.5}$, NH3 and VOC Annual Mean

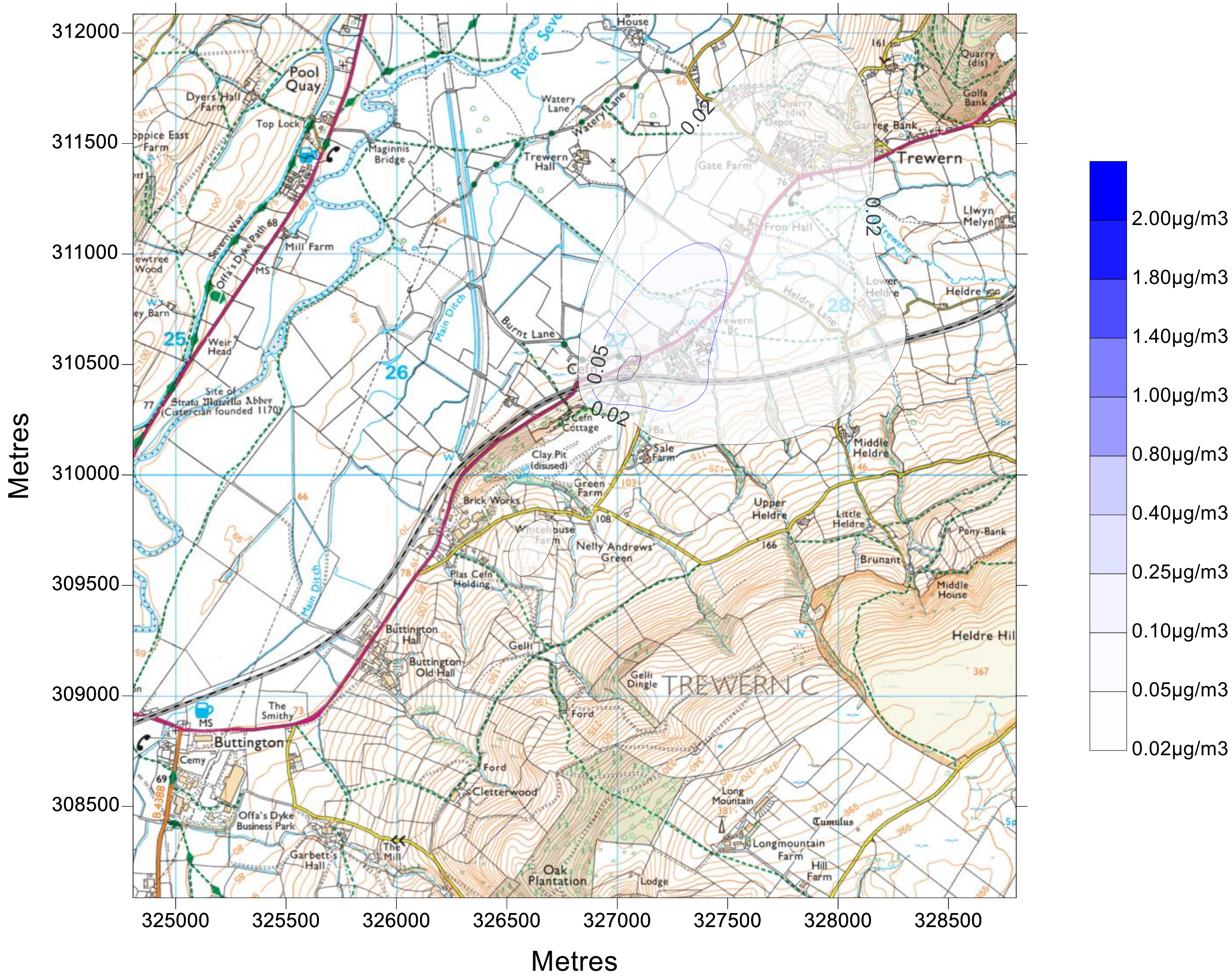


Figure 33: 100th Percentile NH_3 and HCl

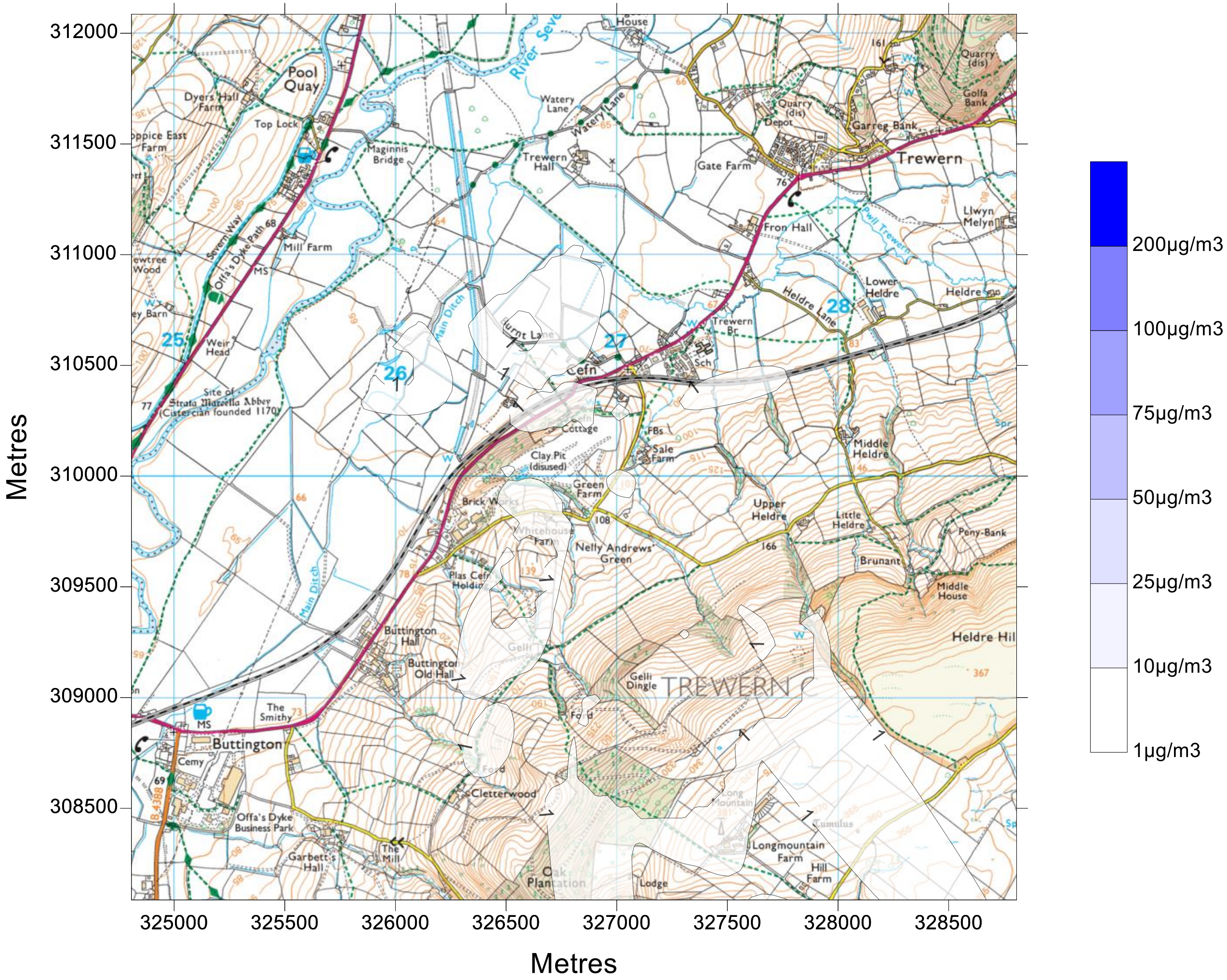


Figure 34: Annual Mean HF

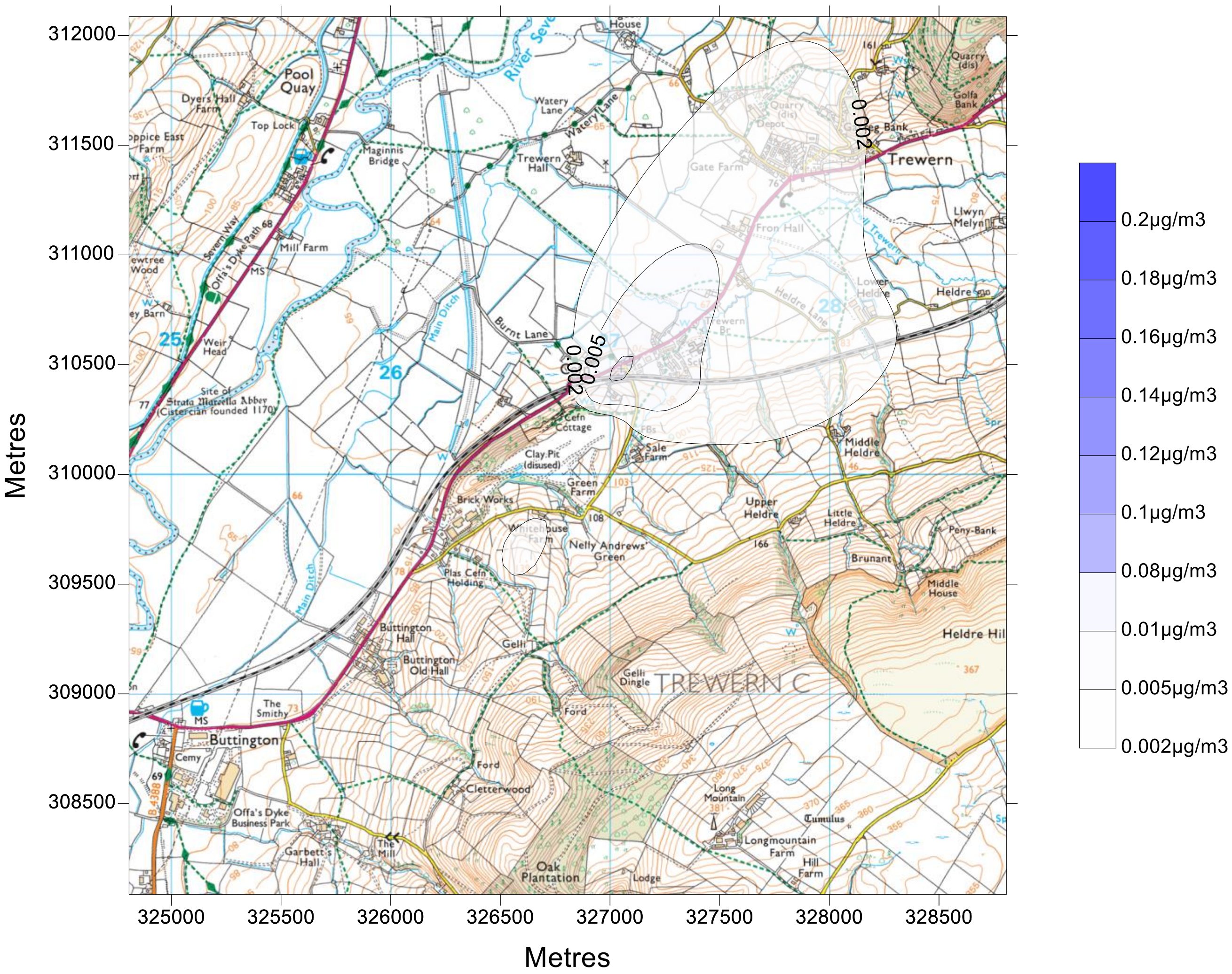


Figure 35: 100th Percentile HF

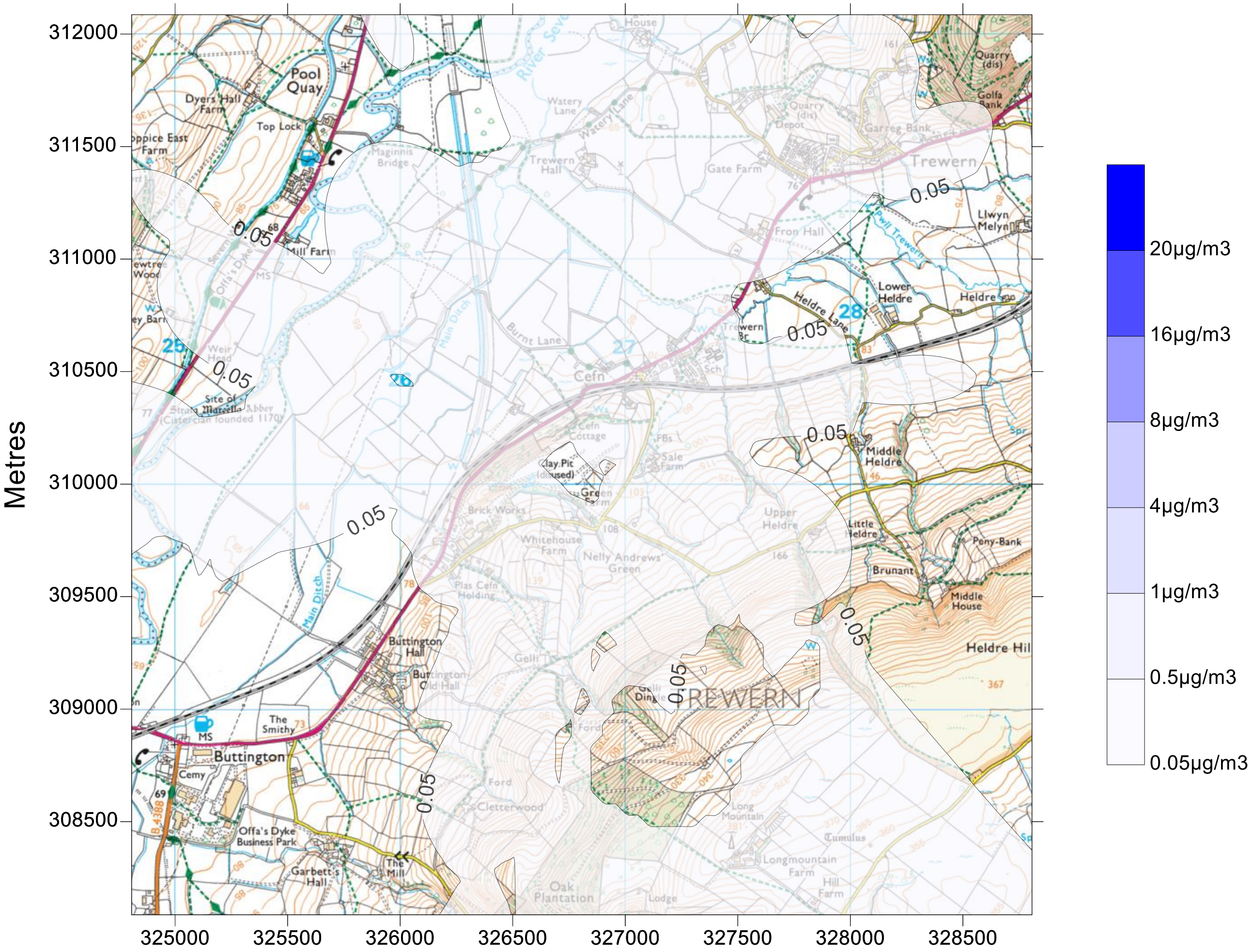


Figure 36: 90.4th Percentile PM_{10}

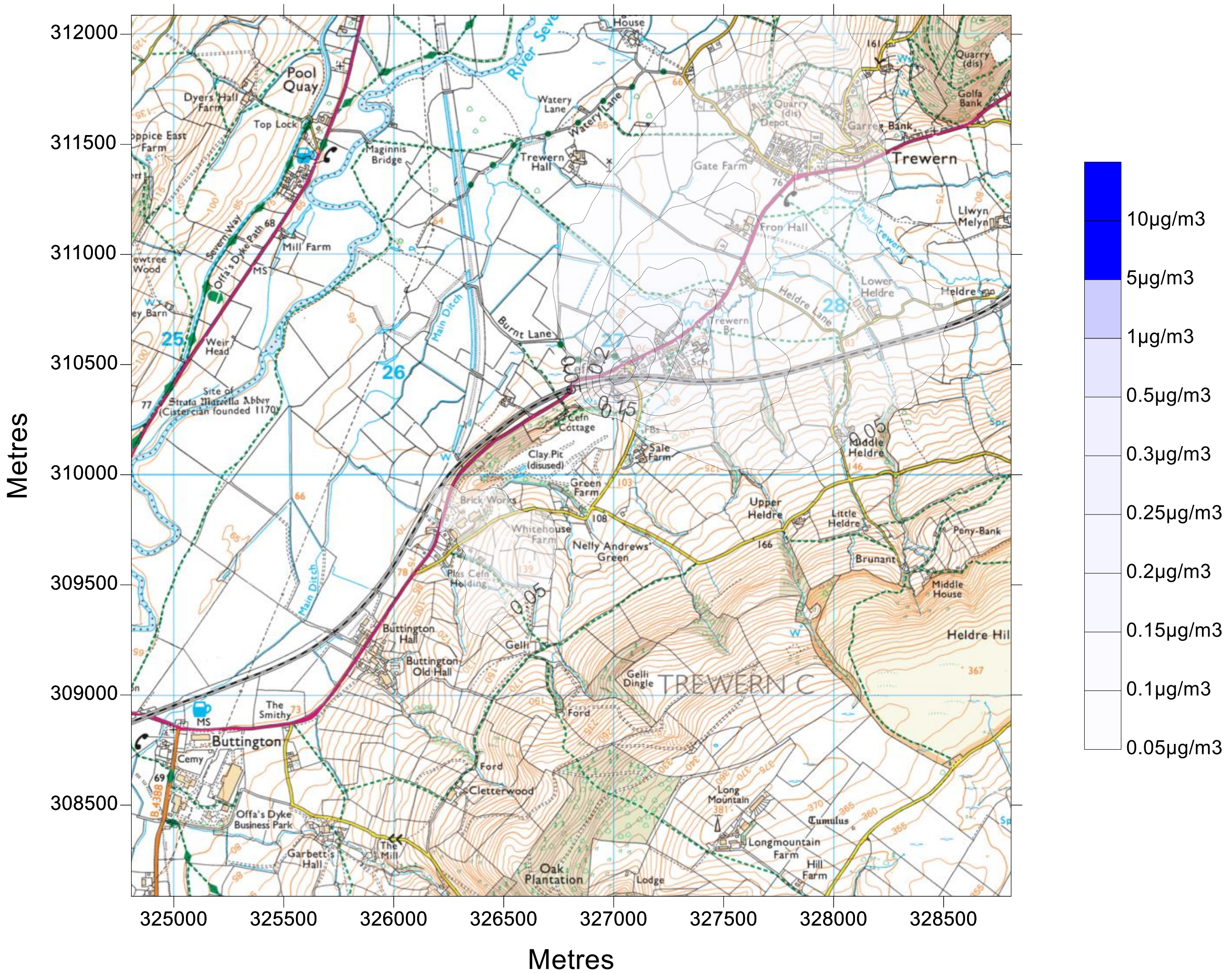


Figure 37: 100th Percentile CO

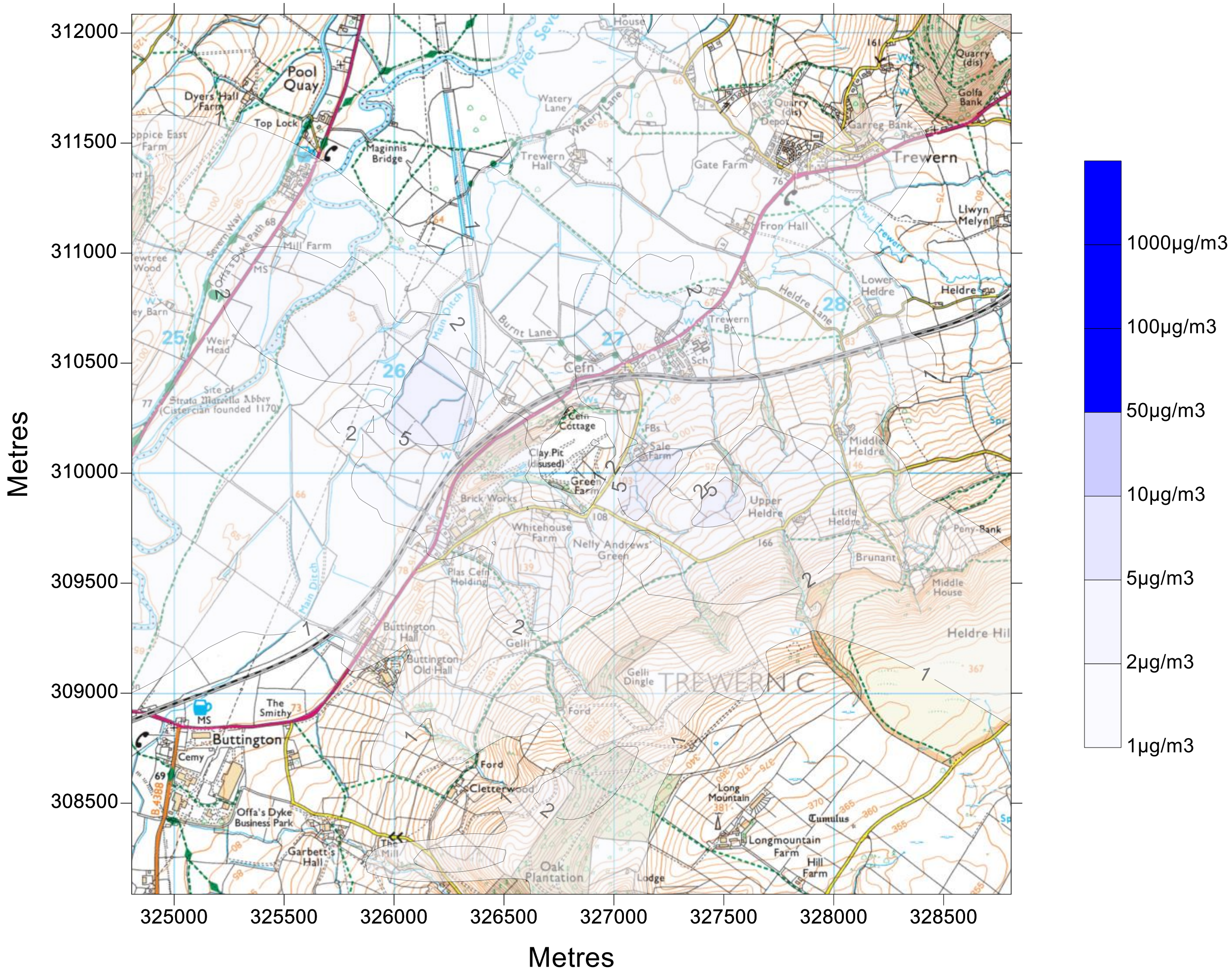


Figure 38: Annual Mean Sb, Cr, Co, Cu, Pb, Mn, Ni, V

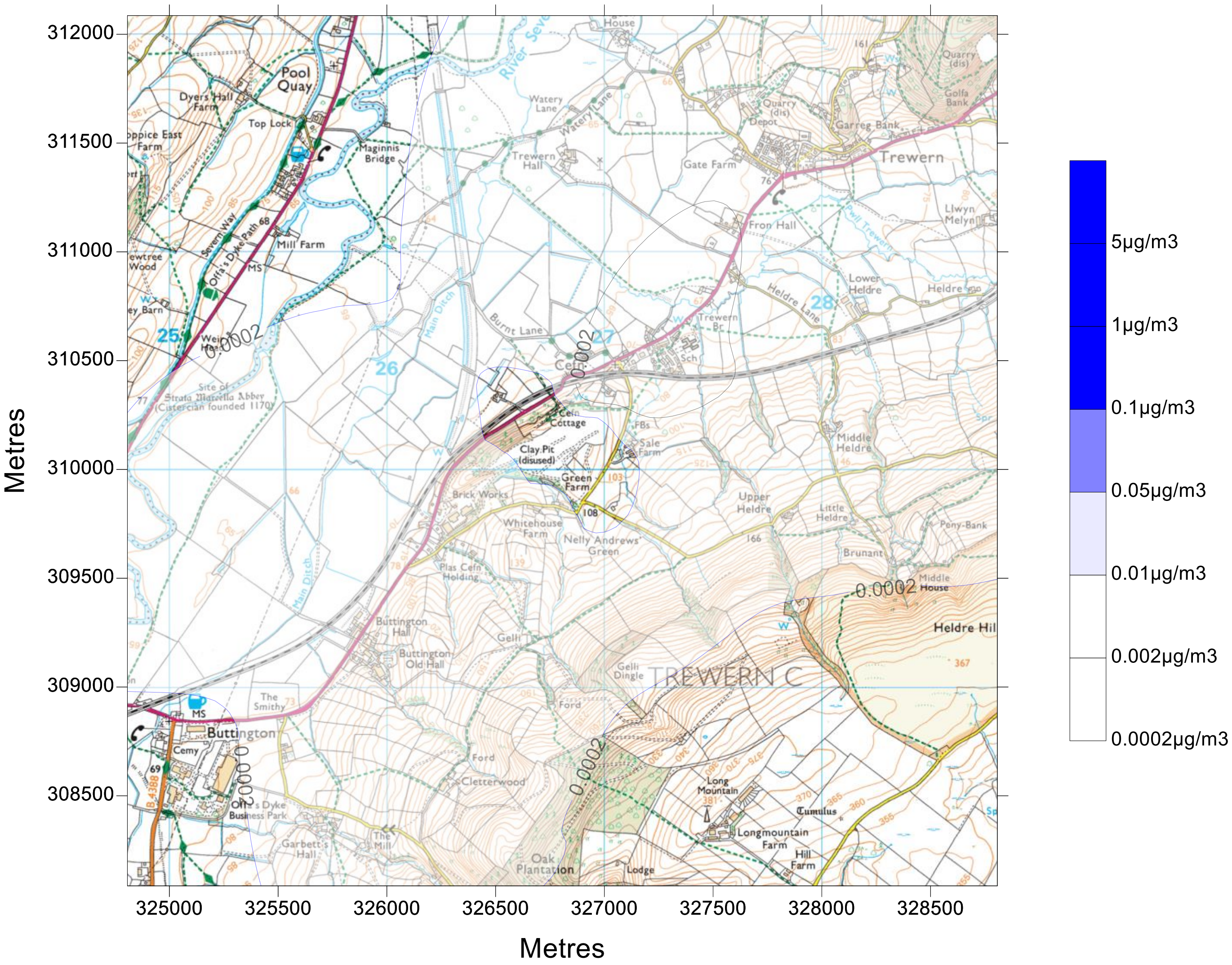


Figure 39: 100th Percentile Sb, Cr, Co, Cu, Mn

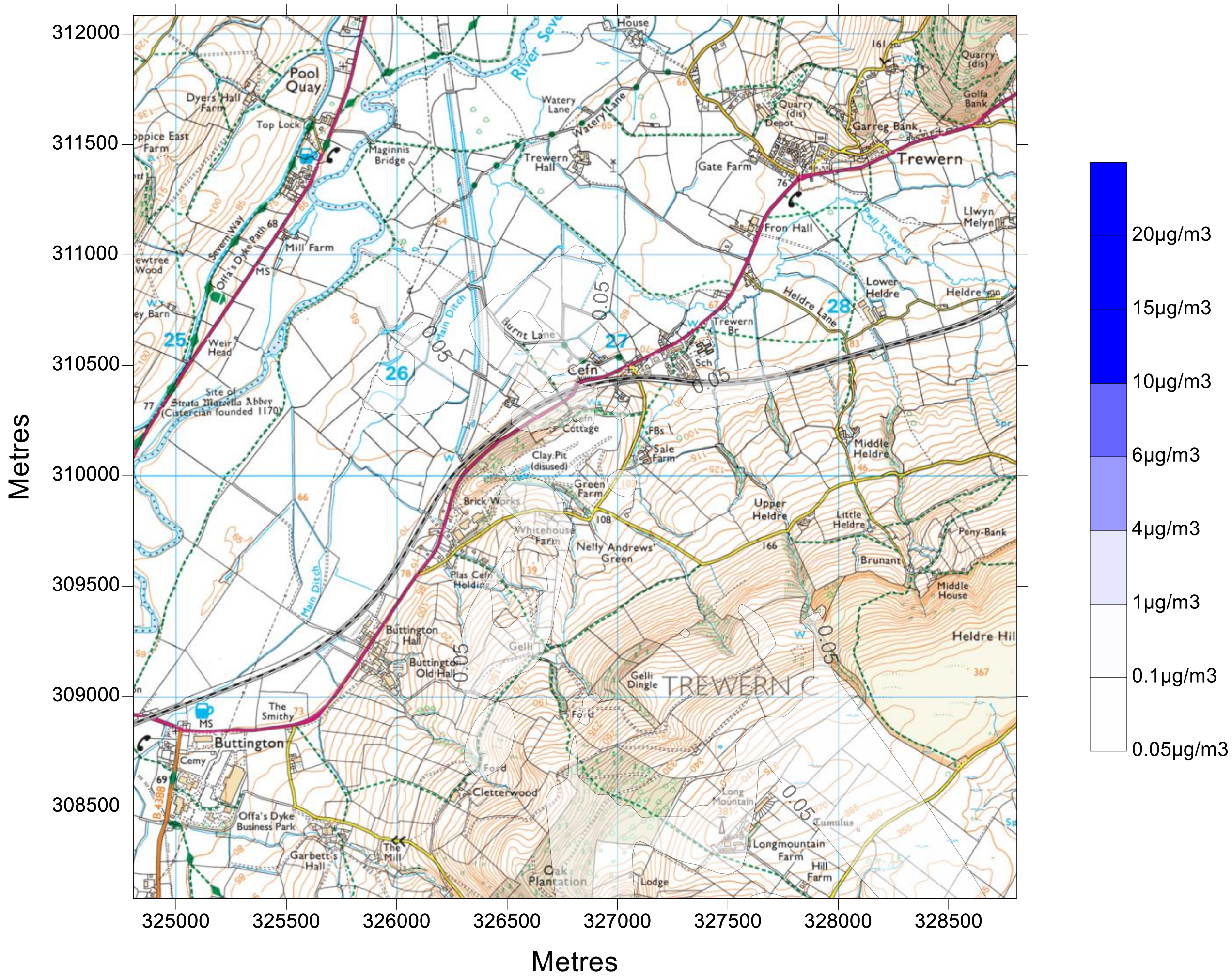


Figure 40: Annual Mean Cd, Tl and Hg

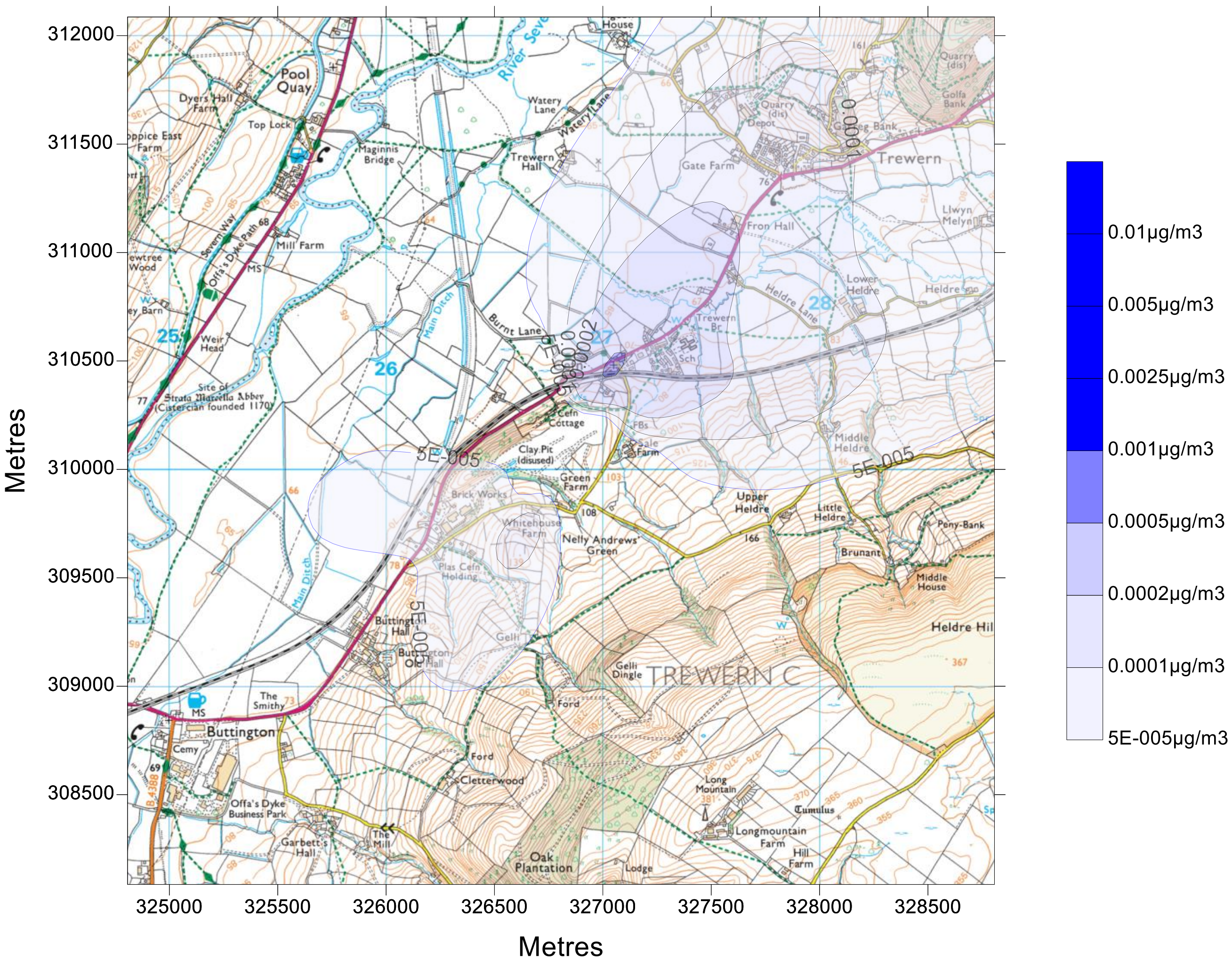


Figure 41: Annual Mean As

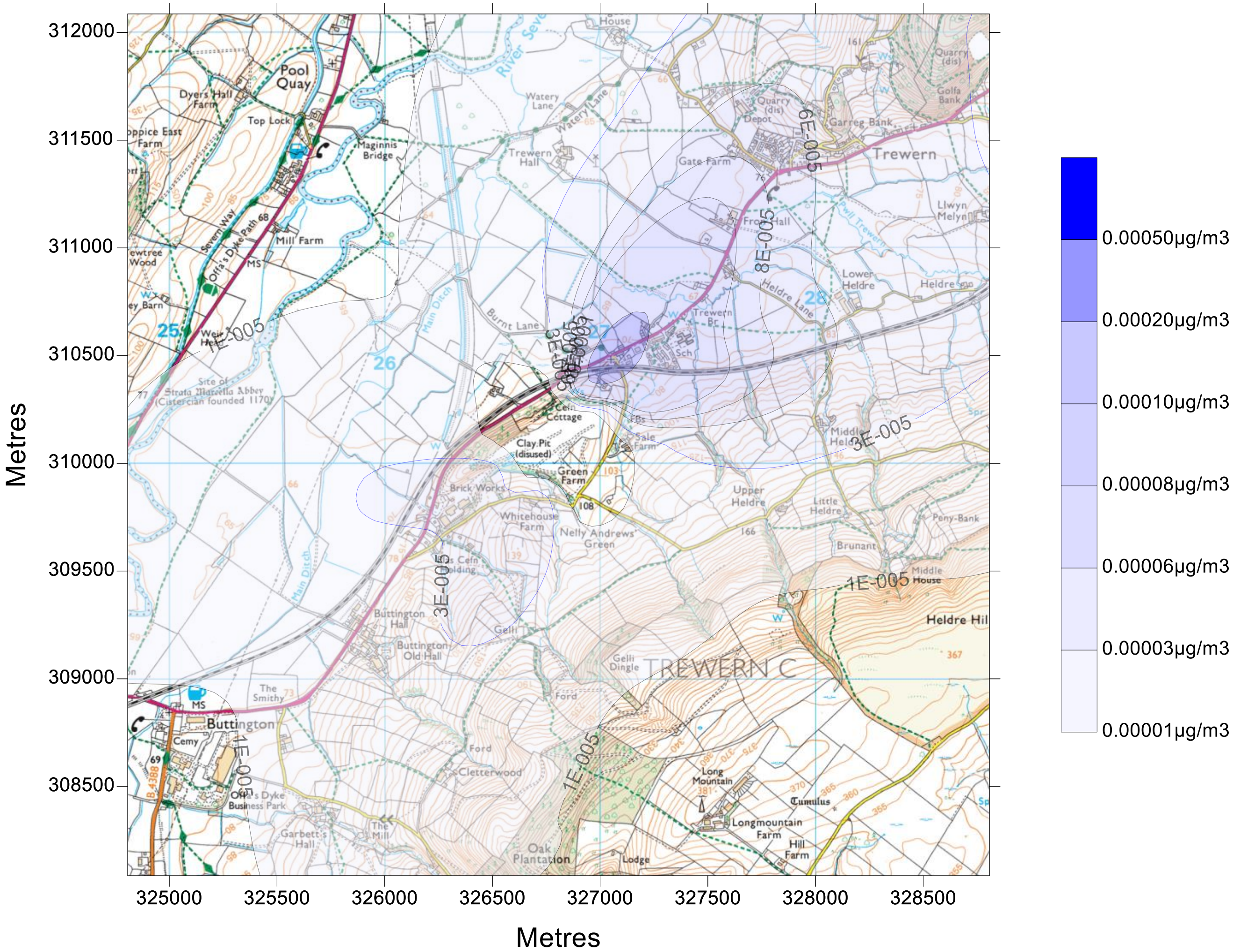


Figure 42: Annual Mean Cr(VI)

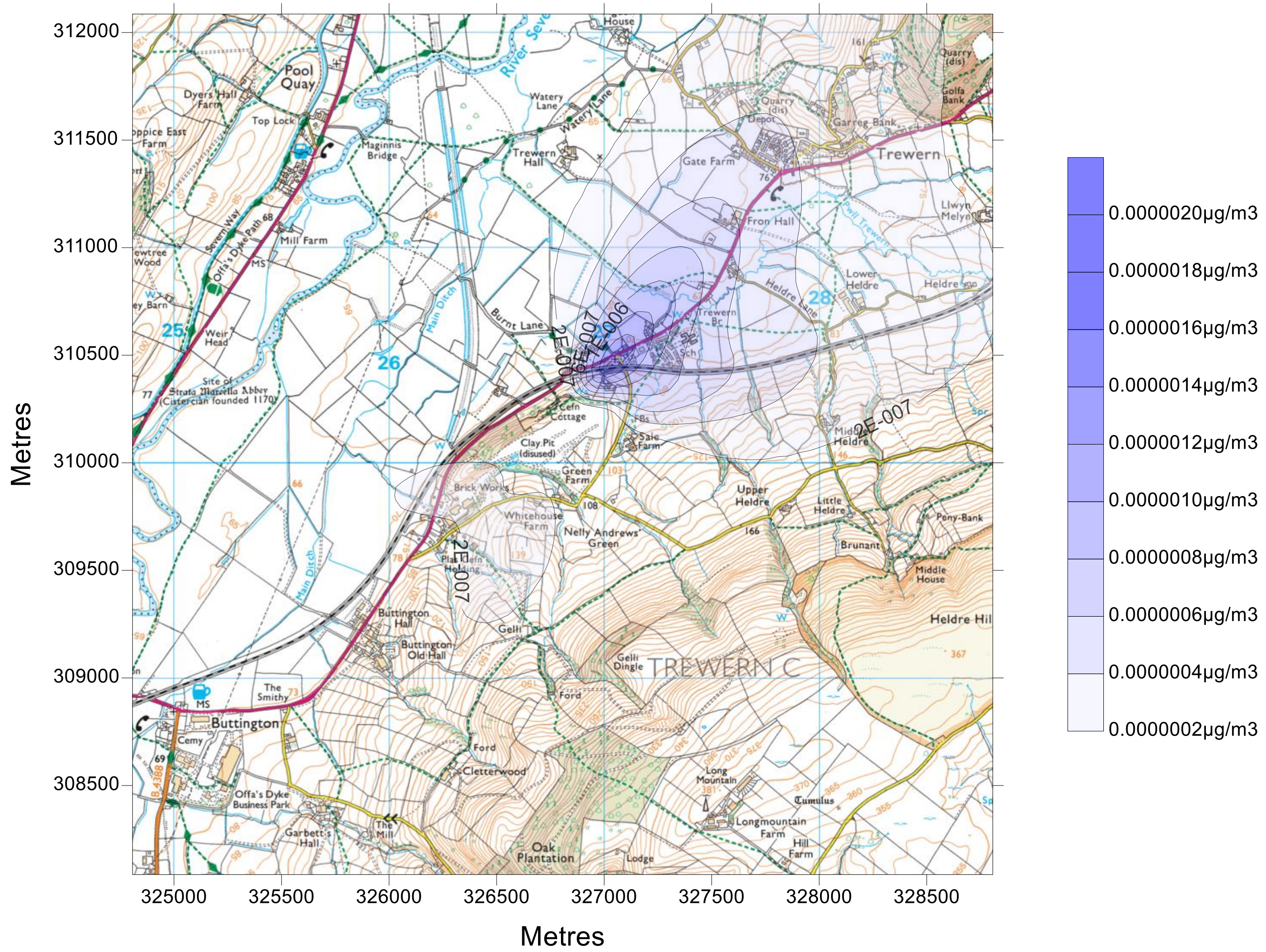


Figure 43: 100th Percentile Hg and Tl

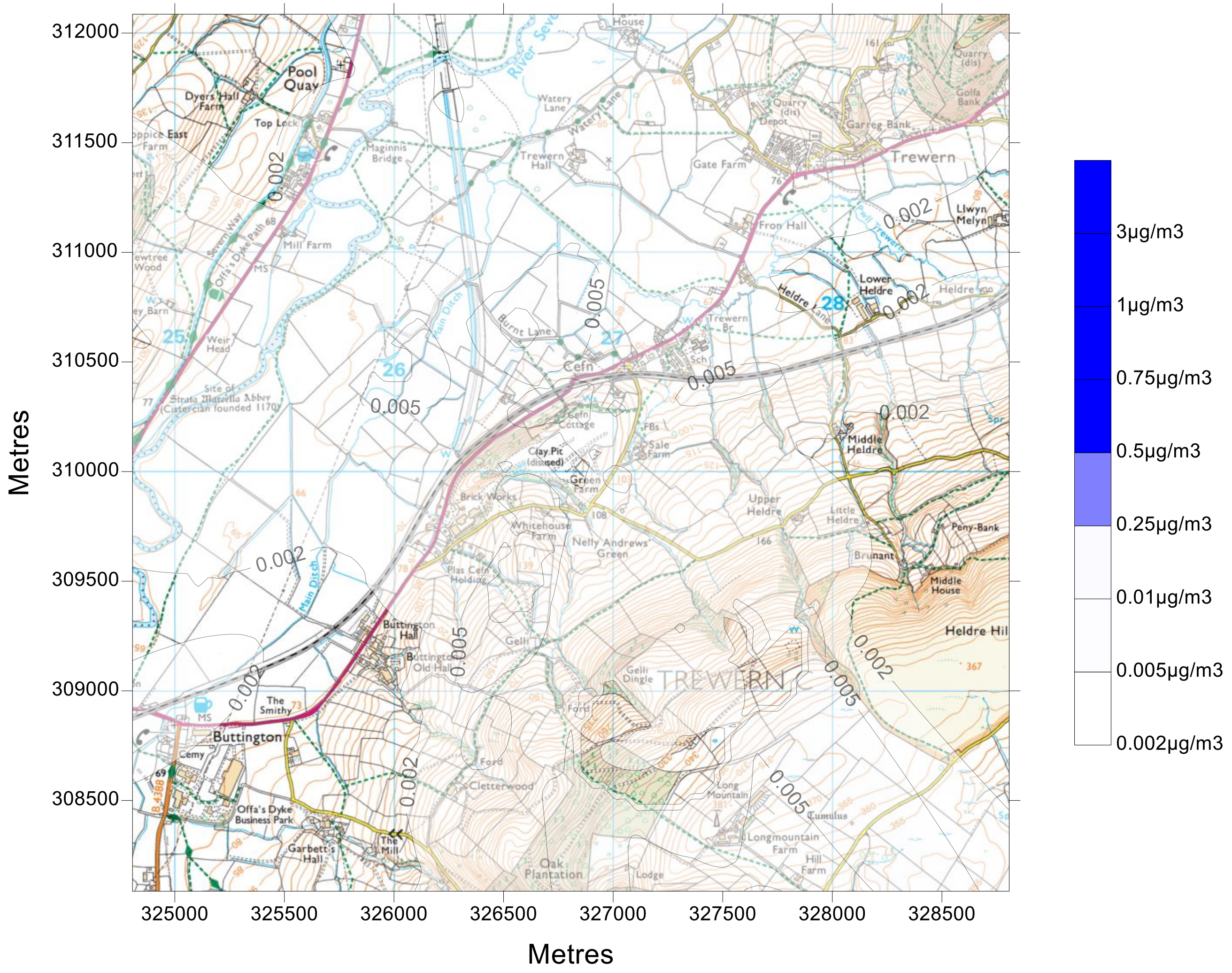


Figure 44: 100th Percentile V

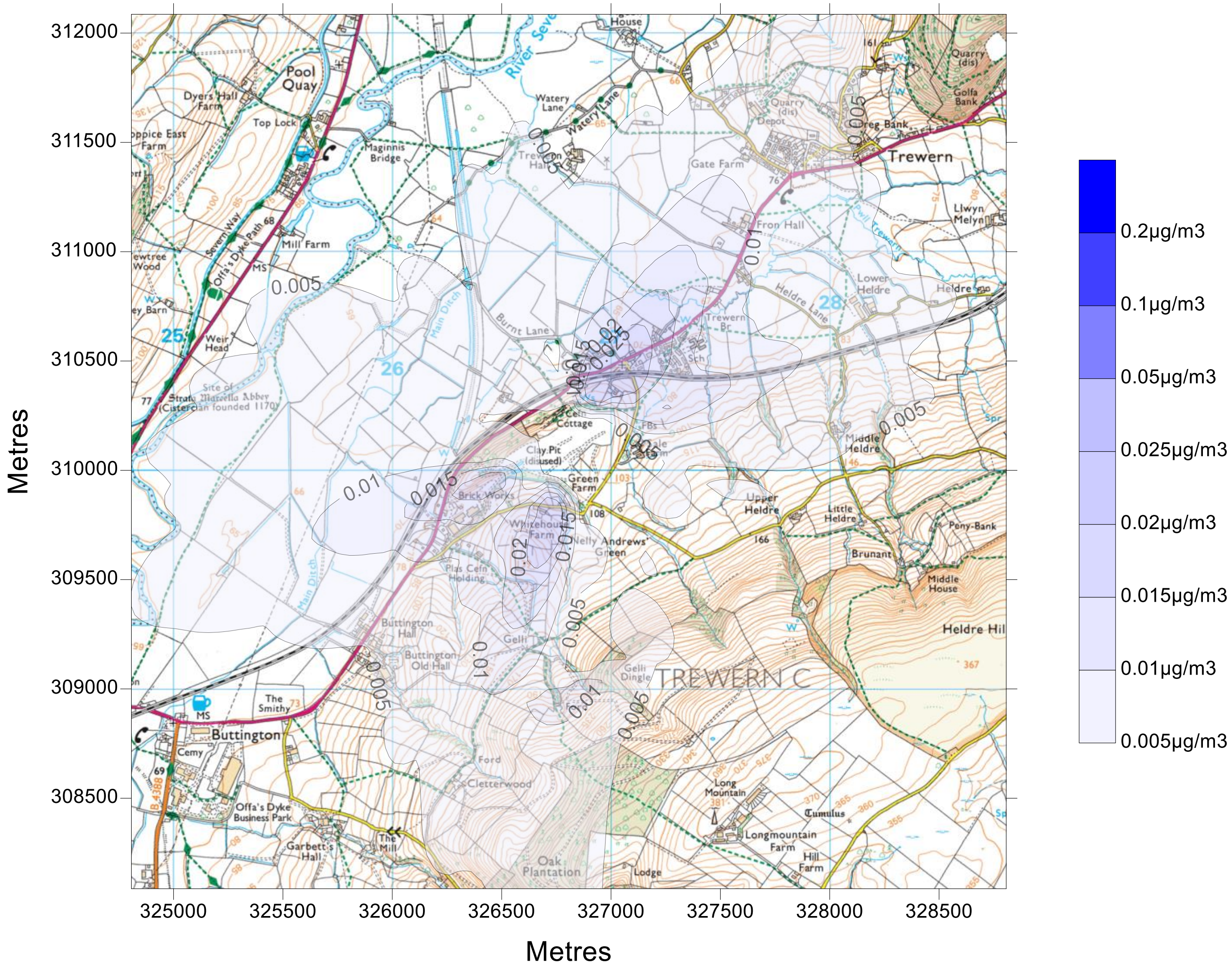


Figure 45: Annual Mean B[a]P

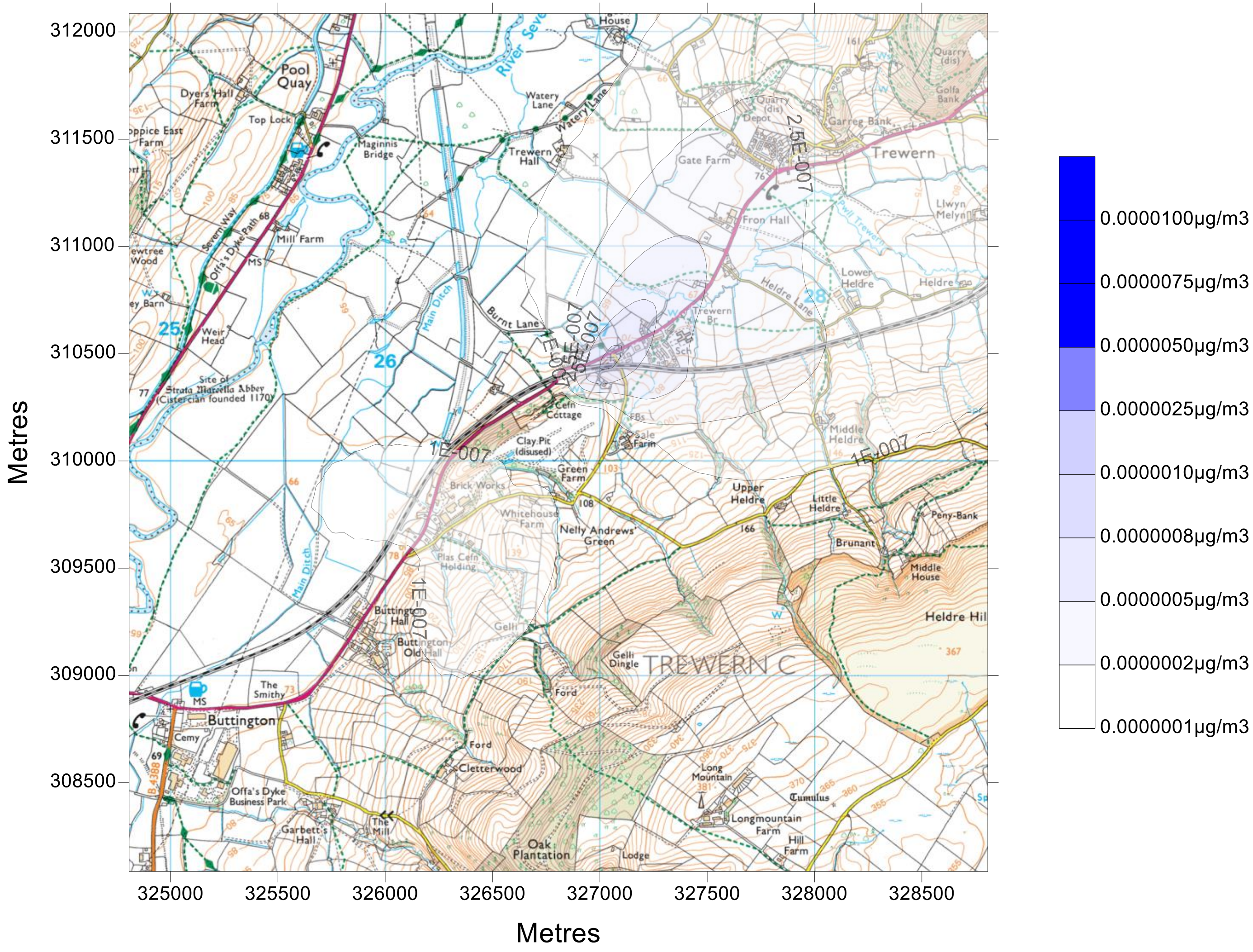


Figure 46: Annual Mean PCBs

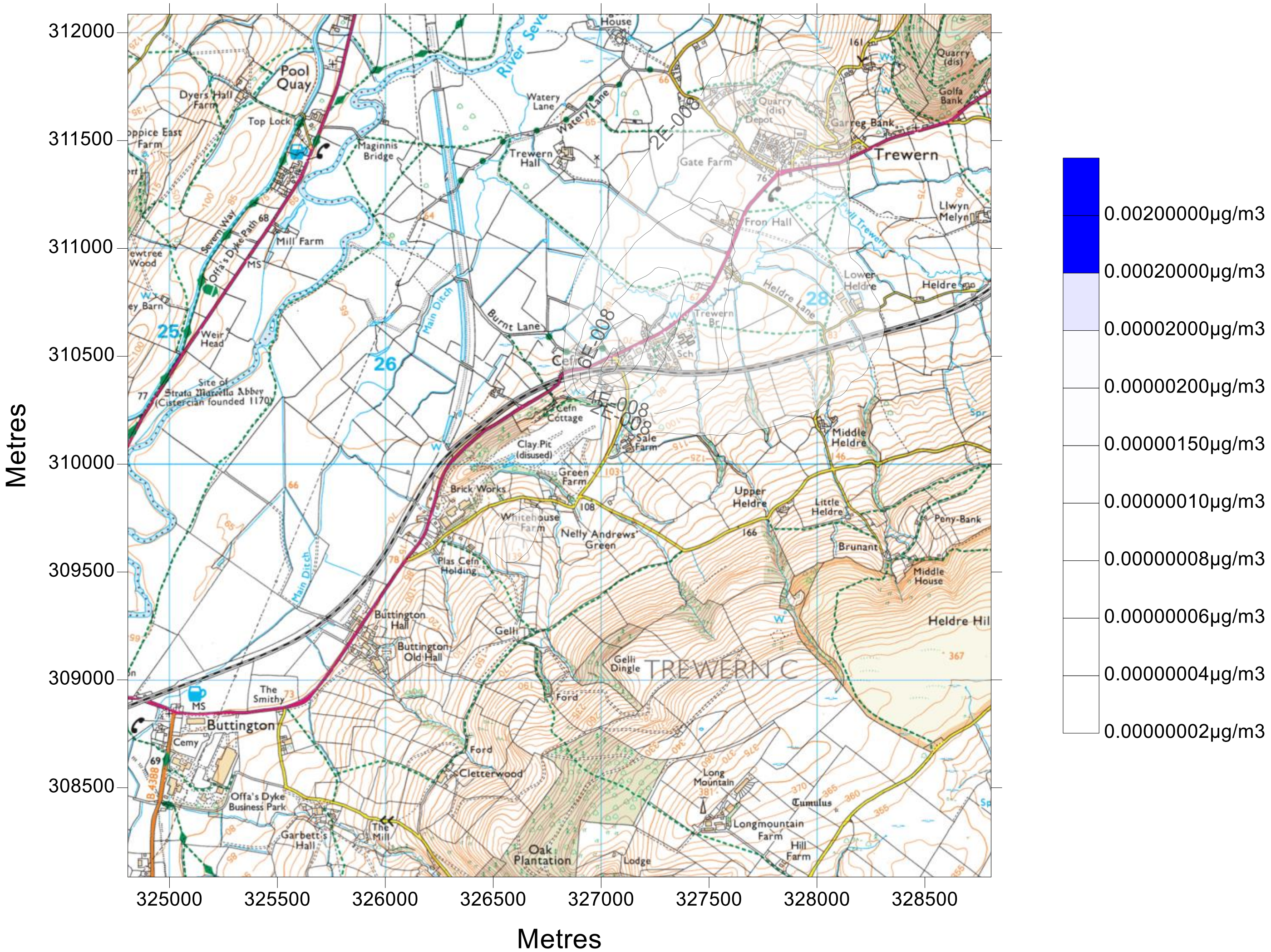
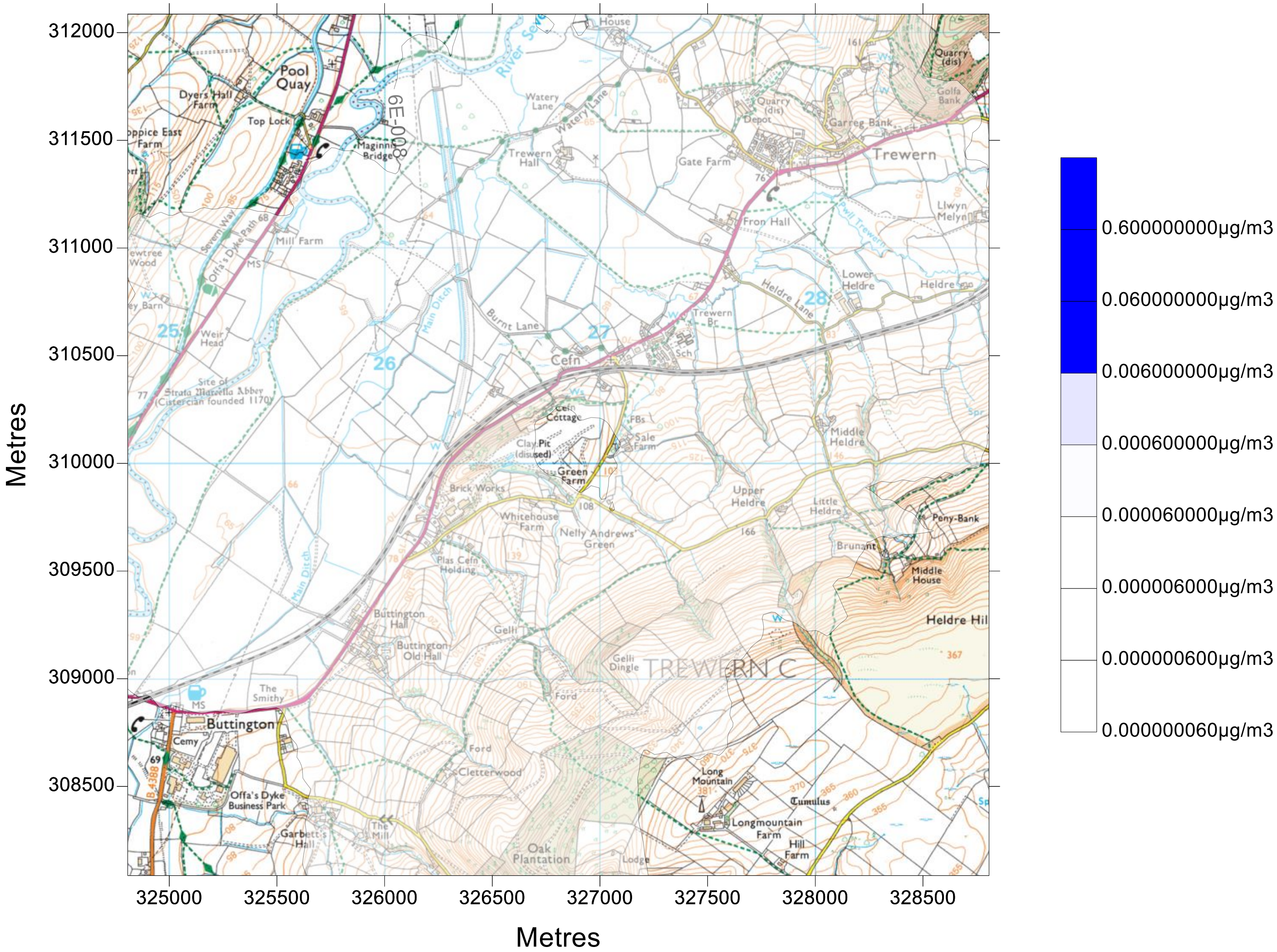


Figure 47: Annual Mean PCBs



312000
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327500
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328500
Metres
Metres
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0.006000000µg/m3
0.000600000µg/m3
0.000060000µg/m3
0.000006000µg/m3
0.000000600µg/m3
0.000000060µg/m3

4.7. Proposed Stack Height

4.7.1. Based on the results of the stack height screening assessment detailed above, a 70m discharge stack height is proposed.

5. ASSESSMENT OF AIR QUALITY IMPACTS - SENSITIVE HUMAN RECEPTOR LOCATION

5.1. Model Setup

5.1.1. This assessment considered the effect of emissions from the Installation on potentially sensitive human receptors identified in Table 2. Modelling was undertaken with the following settings:

- buildings effects were included;
- emission rates for pollutants were based on actual emission rates;
- NO_x to NO_2 conversion rates were used;
- the proposed stack height of 70m was considered;
- a surface roughness of 0.3m was used for the dispersion site and 0.2m for the met measurement site;
- 5 years of hourly sequential meteorological data from Shawbury for 2015 – 2019 inclusive was used;
- 2018 NWP data and 2019 NWP with the surface heat flux and boundary layer parameters both turned off for the stack location at a resolution of 1.5km with terrain effect was used;
- complex terrain (post construction) for an area 11km by 11km was used to model the potentially sensitive receptors up to a maximum distance of 5km of the main stack;
- complex terrain (post construction) of an area 7.5km north, 6km east, 8.5km south and 9.5km west of the main stack was used to model potentially sensitive receptors up to a maximum distance of 10km of the main stack; and
- complex terrain (post construction) of an area 16km north, 11km east, 21km south and 17.5km west of the main stack was used to model potentially sensitive receptors within a distance of 10km to 25km of the main stack.

5.2. Results – Group 1, 2 and 3 Metals

5.2.1. Due to the number of potentially sensitive human receptors, and the varying screening methodology, the results have been split into two sections. This section focuses on Group 1, 2 and 3 metals only, the remaining pollutants are discussed in Section 5.3.

5.2.2. Based on Stage 1 screening (i.e. long term PCs are greater than 1% and short term PCs are greater than 10%), all metals with short-term averaging periods screened out, the metals with potentially significant impacts were long terms impacts of As, Cd, Cr(VI), Co, Pb and Ni. Consequently, PECs were considered for these metals.

5.2.3. Following calculation of the PECs, all metals with the exception of long-term As and Cr(VI) screened out. Step 2 screening indicates that where the PC exceeds 1% of the long standard, the maximum emissions data in Appendix A of the EA's Group 3 metals assessment guidance can be used to revise the predictions, and the PEC then compared against the AQS. The guidance states that As comprises 5% of the Group 3 metals, and Cr(VI) 0.03%.

5.2.4. Following Step 2 screening, all Group 1, 2 and 3 Metals screen out as being not-significant at all potentially sensitive human receptors for a 70m stack. The results of this assessment may be found in Table 34.

Table 34: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for Group 1, 2 and 3 Metals

	Pollutant	Sb (annual)	Sb(1-hour)	As (annual)	Cd (annual)	Cr (annual)	Cr (1-hour)	Cr VI (annual)	Co (annual)	Co (1-hour)	Cu (annual)	Cu (1-hour)
	AQS (µg/m^3)	5	150	0.003	0.005	5	150	0.0002	0.2	6	10	200
	Emission Rate	0.0130	0.0130	0.0130	0.00130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130
	Multiplication Factor	1	1	0.05	1	1	1	0.0003	1	1	1	1
	Maximum PC (µg/m^3)	0.005	0.223	0.000	0.001	0.005	0.223	0.0000016	0.0052	0.223	0.005	0.223
	Max PC as % of AQS	0.10%	0.15%	**8.7%**	**10.50%**	0.10%	0.15%	0.79%	**2.62%**	3.72%	0.052%	0.11%
	Background Concentration (µg/m^3)	n/a	n/a	0.000224	0.00005	n/a	n/a	0.00013	0.000025	n/a	n/a	n/a
	Max PEC as % of AQS	n/a	n/a	16%	11.49%	n/a	n/a	66%	2.64%	n/a	n/a	n/a
H01	Cefn Cottage	0.000074	0.073	0.0000037	0.0000074	0.00007	0.073	0.000000022	0.00007	0.073	0.00007	0.073
H02	Green Farm Heldre Lane	0.000437	0.080	0.0000218	0.0000437	0.00044	0.080	0.000000131	0.00044	0.080	0.00044	0.080
H03	Whitehouse Farm	0.000932	0.058	0.0000466	0.0000932	0.00093	0.058	0.000000280	0.00093	0.058	0.00093	0.058
H04	Sale Farm - House Off Sale Lane (2)	0.000253	0.223	0.0000126	0.0000253	0.00025	0.223	0.000000076	0.00025	0.223	0.00025	0.223
H05	Cefn Farm - House Off Sale Lane (1)	0.003701	0.049	0.0001851	0.0003701	0.00370	0.049	0.000001110	0.00370	0.049	0.00370	0.049
H06	Lower Cefn	0.000239	0.066	0.0000120	0.0000239	0.00024	0.066	0.000000072	0.00024	0.066	0.00024	0.066
H07	Methodist Church, Buttington	0.005249	0.042	0.0002624	0.0005249	0.00525	0.042	0.000001575	0.00525	0.042	0.00525	0.042
H08	Heldre Lane	0.000500	0.038	0.0000250	0.0000500	0.00050	0.038	0.000000150	0.00050	0.038	0.00050	0.038
H09	Speed Welshpool	0.001413	0.039	0.0000706	0.0001413	0.00141	0.039	0.000000424	0.00141	0.039	0.00141	0.039
H10	Brookside	0.001272	0.035	0.0000636	0.0001272	0.00127	0.035	0.000000382	0.00127	0.035	0.00127	0.035
H11	Border Hardcore Offices	0.001252	0.033	0.0000626	0.0001252	0.00125	0.033	0.000000376	0.00125	0.033	0.00125	0.033
H12	York House	0.001252	0.033	0.0000626	0.0001252	0.00125	0.033	0.000000376	0.00125	0.033	0.00125	0.033
H13	Footpath south of Nelly Andrews' Green	0.000600	0.052	0.0000300	0.0000600	0.00060	0.052	0.000000180	0.00060	0.052	0.00060	0.052
H14	Buttington Trewern Primary School	0.002558	0.030	0.0001279	0.0002558	0.00256	0.030	0.000000768	0.00256	0.030	0.00256	0.030
H15	Upper Heldre	0.000361	0.152	0.0000180	0.0000361	0.00036	0.152	0.000000108	0.00036	0.152	0.00036	0.152
H16	Heldre Lane, Trewern	0.002171	0.030	0.0001085	0.0002171	0.00217	0.030	0.000000651	0.00217	0.030	0.00217	0.030
H17	Farm Buildings off A458	0.000690	0.023	0.0000345	0.0000690	0.00069	0.023	0.000000207	0.00069	0.023	0.00069	0.023
H18	Footpath between Gelli and Longmountain Farm	0.000315	0.152	0.0000158	0.0000315	0.00032	0.152	0.000000095	0.00032	0.152	0.00032	0.152
H19	Footpath west of Middle House	0.000260	0.155	0.0000130	0.0000260	0.00026	0.155	0.000000078	0.00026	0.155	0.00026	0.155
H20	Criggion Lane, Trewern,	0.001505	0.040	0.0000753	0.0001505	0.00151	0.040	0.000000452	0.00151	0.040	0.00151	0.040
H21	Pen-y-Bank	0.000279	0.049	0.0000139	0.0000279	0.00028	0.049	0.000000084	0.00028	0.049	0.00028	0.049
H22	Criggion Lane, Trewern	0.001117	0.032	0.0000559	0.0001117	0.00112	0.032	0.000000335	0.00112	0.032	0.00112	0.032
H23	A483, Strat Marcella Abbey	0.000245	0.028	0.0000122	0.0000245	0.00024	0.028	0.000000073	0.00024	0.028	0.00024	0.028
H24	Trewern, Garreg Bank (lower)	0.001233	0.036	0.0000616	0.0001233	0.00123	0.036	0.000000370	0.00123	0.036	0.00123	0.036
H25	Offas Dyke Path, Pool Quay	0.000233	0.024	0.0000116	0.0000233	0.00023	0.024	0.000000070	0.00023	0.024	0.00023	0.024
H26	Trewern, Garreg Bank (upper)	0.001143	0.033	0.0000571	0.0001143	0.00114	0.033	0.000000343	0.00114	0.033	0.00114	0.033
H27	A458, Buttington and west of The Smithy	0.000425	0.027	0.0000213	0.0000425	0.00043	0.027	0.000000128	0.00043	0.027	0.00043	0.027
H28	Trewern, near monument	0.000918	0.036	0.0000459	0.0000918	0.00092	0.036	0.000000275	0.00092	0.036	0.00092	0.036
H29	Buttington	0.000396	0.025	0.0000198	0.0000396	0.00040	0.025	0.000000119	0.00040	0.025	0.00040	0.025

Table 34: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for Group 1, 2 and 3 Metals (cont)

	Pollutant	Sb (annual)	Sb(1-hour)	As (annual)	Cd (annual)	Cr (annual)	Cr (1-hour)	Cr VI (annual)	Co (annual)	Co (1-hour)	Cu (annual)	Cu (1-hour)
	AQS (µg/m³)	5	150	0.003	0.005	5	150	0.0002	0.2	6	10	200
	Emission Rate	0.0130	0.0130	0.0130	0.00130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130
	Multiplication Factor	1	1	0.05	1	1	1	0.0003	1	1	1	1
	Maximum PC (µg/m³)	0.005	0.223	0.000	0.001	0.005	0.223	0.0000016	0.0052	0.223	0.005	0.223
	Max PC as % of AQS	0.10%	0.15%	**8.7%**	**10.50%**	0.10%	0.15%	0.79%	**2.62%**	3.72%	0.052%	0.11%
	Background Concentration (µg/m³)	n/a	n/a	0.000224	0.00005	n/a	n/a	0.00013	0.000025	n/a	n/a	n/a
	Max PEC as % of AQS	n/a	n/a	16%	11.49%	n/a	n/a	66%	2.64%	n/a	n/a	n/a
H30	Buttington Church	0.000357	0.023	0.0000178	0.0000357	0.00036	0.023	0.000000107	0.00036	0.023	0.00036	0.023
H31	A483 Pool Quay Straight	0.000266	0.039	0.0000133	0.0000266	0.00027	0.039	0.000000080	0.00027	0.039	0.00027	0.039
H32	Coppice East Farm and ancient monument	0.000157	0.026	0.0000078	0.0000157	0.00016	0.026	0.000000047	0.00016	0.026	0.00016	0.026
H33	The Old Shop Cottage	0.000625	0.027	0.0000313	0.0000625	0.00063	0.027	0.000000188	0.00063	0.027	0.00063	0.027
H34	A458, Buttington Bridge	0.000303	0.026	0.0000151	0.0000303	0.00030	0.026	0.000000091	0.00030	0.026	0.00030	0.026
H35	Shepherd's Lane, Moel y Golfa	0.000803	0.027	0.0000402	0.0000803	0.00080	0.027	0.000000241	0.00080	0.027	0.00080	0.027
H36	A483, Buttington Cross	0.000239	0.023	0.0000119	0.0000239	0.00024	0.023	0.000000072	0.00024	0.023	0.00024	0.023
H37	A458 between Middletown and Trewern	0.000525	0.023	0.0000262	0.0000525	0.00052	0.023	0.000000157	0.00052	0.023	0.00052	0.023
H38	Trailhead Fine Foods/ Welshpool Livestock Sales A483	0.000248	0.023	0.0000124	0.0000248	0.00025	0.023	0.000000074	0.00025	0.023	0.00025	0.023
H39	Footpath at Buttington View, Hope	0.000167	0.081	0.0000083	0.0000167	0.00017	0.081	0.000000050	0.00017	0.081	0.00017	0.081
H40	Criggion Lane, Old Mills	0.000619	0.022	0.0000309	0.0000619	0.00062	0.022	0.000000186	0.00062	0.022	0.00062	0.022
H41	Hope	0.000243	0.016	0.0000121	0.0000243	0.00024	0.016	0.000000073	0.00024	0.016	0.00024	0.016
H42	Moel y Golfa Wood and Footpath	0.000966	0.057	0.0000483	0.0000966	0.00097	0.057	0.000000290	0.00097	0.057	0.00097	0.057
H43	Oak Grange, Middletown	0.000412	0.034	0.0000206	0.0000412	0.00041	0.034	0.000000124	0.00041	0.034	0.00041	0.034
H44	Gungrog Hill, Welshpool	0.000159	0.017	0.0000080	0.0000159	0.00016	0.017	0.000000048	0.00016	0.017	0.00016	0.017
H45	Borfa Green, Welshpool	0.000147	0.014	0.0000074	0.0000147	0.00015	0.014	0.000000044	0.00015	0.014	0.00015	0.014
H46	Rhyd-Esgyn Lane	0.000116	0.024	0.0000058	0.0000116	0.00012	0.024	0.000000035	0.00012	0.024	0.00012	0.024
H47	Adelaide Drive, Welshpool	0.000134	0.013	0.0000067	0.0000134	0.00013	0.013	0.000000040	0.00013	0.013	0.00013	0.013
H48	Middletown Hill (Cefn y Castell)	0.000972	0.043	0.0000486	0.0000972	0.00097	0.043	0.000000291	0.00097	0.043	0.00097	0.043
H49	Bridge over A483, Welshpool and National Cycle Route 81	0.000134	0.013	0.0000067	0.0000134	0.00013	0.013	0.000000040	0.00013	0.013	0.00013	0.013
H50	A483, New Cut	0.000110	0.033	0.0000055	0.0000110	0.00011	0.033	0.000000033	0.00011	0.033	0.00011	0.033
H51	Rodney's Pillar, Breidden Hill	0.000944	0.028	0.0000472	0.0000944	0.00094	0.028	0.000000283	0.00094	0.028	0.00094	0.028
H52	Footpath west of Rose and Crown	0.000263	0.056	0.0000131	0.0000263	0.00026	0.056	0.000000079	0.00026	0.056	0.00026	0.056
H53	Pen-y-coed, Ardleen	0.000083	0.010	0.0000041	0.0000083	0.00008	0.010	0.000000025	0.00008	0.010	0.00008	0.010
H54	A483 at Trederwyn Lane	0.000099	0.014	0.0000049	0.0000099	0.00010	0.014	0.000000030	0.00010	0.014	0.00010	0.014
H55	A458 between Plas-y-Court and Wollaston	0.000266	0.042	0.0000133	0.0000266	0.00027	0.042	0.000000080	0.00027	0.042	0.00027	0.042

Table 34: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for Group 1, 2 and 3 Metals (cont)

	Pollutant	Sb (annual)	Sb(1-hour)	As (annual)	Cd (annual)	Cr (annual)	Cr (1-hour)	Cr VI (annual)	Co (annual)	Co (1-hour)	Cu (annual)	Cu (1-hour)
	AQS (µg/m³)	5	150	0.003	0.005	5	150	0.0002	0.2	6	10	200
	Emission Rate	0.0130	0.0130	0.0130	0.00130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130
	Multiplication Factor	1	1	0.05	1	1	1	0.0003	1	1	1	1
	Maximum PC (µg/m³)	0.005	0.223	0.000	0.001	0.005	0.223	0.0000016	0.0052	0.223	0.005	0.223
	Max PC as % of AQS	0.10%	0.15%	**8.7%**	**10.50%**	0.10%	0.15%	0.79%	**2.62%**	3.72%	0.052%	0.11%
	Background Concentration (µg/m³)	n/a	n/a	0.000224	0.00005	n/a	n/a	0.00013	0.000025	n/a	n/a	n/a
	Max PEC as % of AQS	n/a	n/a	16%	11.49%	n/a	n/a	66%	2.64%	n/a	n/a	n/a
H56	Lane west of Bugdin, Ardleen	0.000061	0.008	0.0000030	0.0000061	0.00006	0.008	0.000000018	0.00006	0.008	0.00006	0.008
H57	From Severn Way Footpath, south of Gwern-y-go	0.000213	0.012	0.0000107	0.0000213	0.00021	0.012	0.000000064	0.00021	0.012	0.00021	0.012
H58	Powys Castle north-east terrace	0.000094	0.013	0.0000047	0.0000094	0.00009	0.013	0.000000028	0.00009	0.013	0.00009	0.013
H59	A483 at Trederwen Fweibion Gwnwas	0.000080	0.017	0.0000040	0.0000080	0.00008	0.017	0.000000024	0.00008	0.017	0.00008	0.017
H60	Powys Castle, south-east terrace	0.000092	0.012	0.0000046	0.0000092	0.00009	0.012	0.000000028	0.00009	0.012	0.00009	0.012
H61	Footpath south of Dyserth Hall	0.000079	0.010	0.0000039	0.0000079	0.00008	0.010	0.000000024	0.00008	0.010	0.00008	0.010
H62	A483 by The Moat Farm	0.000077	0.008	0.0000038	0.0000077	0.00008	0.008	0.000000023	0.00008	0.008	0.00008	0.008
H63	Trig point and footpath at Y Golfa golf course	0.000101	0.013	0.0000050	0.0000101	0.00010	0.013	0.000000030	0.00010	0.013	0.00010	0.013
H64	Pound Lane, Llwynderw	0.000056	0.005	0.0000028	0.0000056	0.00006	0.005	0.000000017	0.00006	0.005	0.00006	0.005
H65	A483 by Wernllwyd	0.000064	0.006	0.0000032	0.0000064	0.00006	0.006	0.000000019	0.00006	0.006	0.00006	0.006
H66	A483 junction with B4390 to Berriew	0.000080	0.009	0.0000040	0.0000080	0.00008	0.009	0.000000024	0.00008	0.009	0.00008	0.009
H67	A483, Pant	0.000040	0.008	0.0000020	0.0000040	0.00004	0.008	0.000000012	0.00004	0.008	0.00004	0.008
H68	Llanymynech Golf Course and footpath	0.000039	0.007	0.0000020	0.0000039	0.00004	0.007	0.000000012	0.00004	0.007	0.00004	0.007
H69	A483 north of bridge at Berriew	0.000081	0.009	0.0000040	0.0000081	0.00008	0.009	0.000000024	0.00008	0.009	0.00008	0.009
H70	Footpath between Cefn Crin and Ashton	0.000079	0.009	0.0000039	0.0000079	0.00008	0.009	0.000000024	0.00008	0.009	0.00008	0.009
H71	Green Hall Hill, Llanfyllin	0.000020	0.003	0.0000010	0.0000020	0.00002	0.003	0.000000006	0.00002	0.003	0.00002	0.003
H72	East of Mynydd Jaram Bodynfoel Wood	0.000021	0.004	0.0000011	0.0000021	0.00002	0.004	0.000000006	0.00002	0.004	0.00002	0.004
H73	Rolly Bank near Osbaston	0.000121	0.009	0.0000061	0.0000121	0.00012	0.009	0.000000036	0.00012	0.009	0.00012	0.009
H74	Offas Dyke Path, Nantmawr	0.000031	0.004	0.0000015	0.0000031	0.00003	0.004	0.000000009	0.00003	0.004	0.00003	0.004
H75	From Lane near Belan, west of Berriew	0.000059	0.006	0.0000030	0.0000059	0.00006	0.006	0.000000018	0.00006	0.006	0.00006	0.006

Table 34: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for Group 1, 2 and 3 Metals (cont)

	Pollutant	Pb (annual)	Mn (annual)	Mn (1-hour)	Hg (annual)	Hg (1-hour)	Ni (annual)	Tl (annual)	Tl (1-hour)	V (annual)	V (24-hour)
	AQS (µg/m³)	0.25	1	1500	0.25	7.5	0.02	1	30	5	1
	Emission Rate	0.0130	0.0130	0.0130	0.00130	0.00130	0.0130	0.00130	0.00130	0.0130	0.0130
	Multiplication Factor	1	1	1	1	1	1	1	1	1	1
	Maximum PC (µg/m³)	0.0052	0.005	0.223	0.001	0.022	0.005	0.001	0.022	0.005	0.031
	Max PC as % of AQS	**2.10%**	0.52%	0.015%	0.21%	0.30%	**26.2%**	0.052%	0.074%	0.10%	3.09%
	Background Concentration (µg/m³)	0.00147	n/a	n/a	n/a	n/a	0.000314	n/a	n/a	n/a	n/a
	Max PEC as % of AQS	2.69%	n/a	n/a	n/a	n/a	27.8%	n/a	n/a	n/a	n/a
H01	Cefn Cottage	0.00007	0.00007	0.073	0.000007	0.0073	0.000074	0.000007	0.00731	0.000074	0.0099
H02	Green Farm Heldre Lane	0.00044	0.00044	0.080	0.000044	0.0080	0.000437	0.000044	0.00797	0.000437	0.0217
H03	Whitehouse Farm	0.00093	0.00093	0.058	0.000093	0.0058	0.000932	0.000093	0.00576	0.000932	0.0194
H04	Sale Farm - House Off Sale Lane (2)	0.00025	0.00025	0.223	0.000025	0.0223	0.000253	0.000025	0.02233	0.000253	0.0112
H05	Cefn Farm - House Off Sale Lane (1)	0.00370	0.00370	0.049	0.000370	0.0049	0.003701	0.000370	0.00488	0.003701	0.0289
H06	Lower Cefn	0.00024	0.00024	0.066	0.000024	0.0066	0.000239	0.000024	0.00658	0.000239	0.0113
H07	Methodist Church, Buttington	0.00525	0.00525	0.042	0.000525	0.0042	0.005249	0.000525	0.00422	0.005249	0.0309
H08	Heldre Lane	0.00050	0.00050	0.038	0.000050	0.0038	0.000500	0.000050	0.00380	0.000500	0.0101
H09	Speed Welshpool	0.00141	0.00141	0.039	0.000141	0.0039	0.001413	0.000141	0.00386	0.001413	0.0247
H10	Brookside	0.00127	0.00127	0.035	0.000127	0.0035	0.001272	0.000127	0.00349	0.001272	0.0244
H11	Border Hardcore Offices	0.00125	0.00125	0.033	0.000125	0.0033	0.001252	0.000125	0.00334	0.001252	0.0217
H12	York House	0.00125	0.00125	0.033	0.000125	0.0033	0.001252	0.000125	0.00334	0.001252	0.0214
H13	Footpath south of Nelly Andrews' Green	0.00060	0.00060	0.052	0.000060	0.0052	0.000600	0.000060	0.00521	0.000600	0.0092
H14	Buttington Trewern Primary School	0.00256	0.00256	0.030	0.000256	0.0030	0.002558	0.000256	0.00302	0.002558	0.0185
H15	Upper Heldre	0.00036	0.00036	0.152	0.000036	0.0152	0.000361	0.000036	0.01522	0.000361	0.0076
H16	Heldre Lane, Trewern	0.00217	0.00217	0.030	0.000217	0.0030	0.002171	0.000217	0.00301	0.002171	0.0119
H17	Farm Buildings off A458	0.00069	0.00069	0.023	0.000069	0.0023	0.000690	0.000069	0.00234	0.000690	0.0086
H18	Footpath between Gelli and Longmountain Farm	0.00032	0.00032	0.152	0.000032	0.0152	0.000315	0.000032	0.01521	0.000315	0.0077
H19	Footpath west of Middle House	0.00026	0.00026	0.155	0.000026	0.0155	0.000260	0.000026	0.01553	0.000260	0.0194
H20	Criggion Lane, Trewern,	0.00151	0.00151	0.040	0.000151	0.0040	0.001505	0.000151	0.00396	0.001505	0.0090
H21	Pen-y-Bank	0.00028	0.00028	0.049	0.000028	0.0049	0.000279	0.000028	0.00485	0.000279	0.0048
H22	Criggion Lane, Trewern	0.00112	0.00112	0.032	0.000112	0.0032	0.001117	0.000112	0.00322	0.001117	0.0087
H23	A483, Strat Marcella Abbey	0.00024	0.00024	0.028	0.000024	0.0028	0.000245	0.000024	0.00277	0.000245	0.0047
H24	Trewern, Garreg Bank (lower)	0.00123	0.00123	0.036	0.000123	0.0036	0.001233	0.000123	0.00359	0.001233	0.0074
H25	Offas Dyke Path, Pool Quay	0.00023	0.00023	0.024	0.000023	0.0024	0.000233	0.000023	0.00239	0.000233	0.0054
H26	Trewern, Garreg Bank (upper)	0.00114	0.00114	0.033	0.000114	0.0033	0.001143	0.000114	0.00334	0.001143	0.0070
H27	A458, Buttington and west of The Smithy	0.00043	0.00043	0.027	0.000043	0.0027	0.000425	0.000043	0.00267	0.000425	0.0060
H28	Trewern, near monument	0.00092	0.00092	0.036	0.000092	0.0036	0.000918	0.000092	0.00359	0.000918	0.0053
H29	Buttington	0.00040	0.00040	0.025	0.000040	0.0025	0.000396	0.000040	0.00250	0.000396	0.0057

Table 34: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for Group 1, 2 and 3 Metals (cont)

	Pollutant	Pb (annual)	Mn (annual)	Mn (1-hour)	Hg (annual)	Hg (1-hour)	Ni (annual)	Tl (annual)	Tl (1-hour)	V (annual)	V (24-hour)
	AQS (µg/m³)	0.25	1	1500	0.25	7.5	0.02	1	30	5	1
	Emission Rate	0.0130	0.0130	0.0130	0.00130	0.00130	0.0130	0.00130	0.00130	0.0130	0.0130
	Multiplication Factor	1	1	1	1	1	1	1	1	1	1
	Maximum PC (µg/m³)	0.0052	0.005	0.223	0.001	0.022	0.005	0.001	0.022	0.005	0.031
	Max PC as % of AQS	**2.10%**	0.52%	0.015%	0.21%	0.30%	**26.2%**	0.052%	0.074%	0.10%	3.09%
	Background Concentration (µg/m³)	0.00147	n/a	n/a	n/a	n/a	0.000314	n/a	n/a	n/a	n/a
	Max PEC as % of AQS	2.69%	n/a	n/a	n/a	n/a	27.8%	n/a	n/a	n/a	n/a
H30	Buttington Church	0.00036	0.00036	0.023	0.000036	0.0023	0.000357	0.000036	0.00232	0.000357	0.0047
H31	A483 Pool Quay Straight	0.00027	0.00027	0.039	0.000027	0.0039	0.000266	0.000027	0.00392	0.000266	0.0048
H32	Coppice East Farm and ancient monument	0.00016	0.00016	0.026	0.000016	0.0026	0.000157	0.000016	0.00258	0.000157	0.0034
H33	The Old Shop Cottage	0.00063	0.00063	0.027	0.000063	0.0027	0.000625	0.000063	0.00267	0.000625	0.0041
H34	A458, Buttington Bridge	0.00030	0.00030	0.026	0.000030	0.0026	0.000303	0.000030	0.00260	0.000303	0.0042
H35	Shepherd’s Lane, Moel y Golfa	0.00080	0.00080	0.027	0.000080	0.0027	0.000803	0.000080	0.00269	0.000803	0.0049
H36	A483, Buttington Cross	0.00024	0.00024	0.023	0.000024	0.0023	0.000239	0.000024	0.00229	0.000239	0.0044
H37	A458 between Middletown and Trewern	0.00052	0.00052	0.023	0.000052	0.0023	0.000525	0.000052	0.00232	0.000525	0.0030
H38	Trailhead Fine Foods/ Welshpool Livestock Sales A483	0.00025	0.00025	0.023	0.000025	0.0023	0.000248	0.000025	0.00234	0.000248	0.0035
H39	Footpath at Buttington View, Hope	0.00017	0.00017	0.081	0.000017	0.0081	0.000167	0.000017	0.00808	0.000167	0.0043
H40	Criggion Lane, Old Mills	0.00062	0.00062	0.022	0.000062	0.0022	0.000619	0.000062	0.00224	0.000619	0.0045
H41	Hope	0.00024	0.00024	0.016	0.000024	0.0016	0.000243	0.000024	0.00161	0.000243	0.0028
H42	Moel y Golfa Wood and Footpath	0.00097	0.00097	0.057	0.000097	0.0057	0.000966	0.000097	0.00574	0.000966	0.0095
H43	Oak Grange, Middletown	0.00041	0.00041	0.034	0.000041	0.0034	0.000412	0.000041	0.00342	0.000412	0.0030
H44	Gungrog Hill, Welshpool	0.00016	0.00016	0.017	0.000016	0.0017	0.000159	0.000016	0.00172	0.000159	0.0027
H45	Borfa Green, Welshpool	0.00015	0.00015	0.014	0.000015	0.0014	0.000147	0.000015	0.00144	0.000147	0.0023
H46	Rhyd-Esgyn Lane	0.00012	0.00012	0.024	0.000012	0.0024	0.000116	0.000012	0.00242	0.000116	0.0017
H47	Adelaide Drive, Welshpool	0.00013	0.00013	0.013	0.000013	0.0013	0.000134	0.000013	0.00135	0.000134	0.0022
H48	Middletown Hill (Cefn y Castell)	0.00097	0.00097	0.043	0.000097	0.0043	0.000972	0.000097	0.00427	0.000972	0.0079
H49	Bridge over A483, Welshpool and National Cycle Route 81	0.00013	0.00013	0.013	0.000013	0.0013	0.000134	0.000013	0.00134	0.000134	0.0016
H50	A483, New Cut	0.00011	0.00011	0.033	0.000011	0.0033	0.000110	0.000011	0.00332	0.000110	0.0017
H51	Rodney’s Pillar, Breidden Hill	0.00094	0.00094	0.028	0.000094	0.0028	0.000944	0.000094	0.00280	0.000944	0.0068
H52	Footpath west of Rose and Crown	0.00026	0.00026	0.056	0.000026	0.0056	0.000263	0.000026	0.00558	0.000263	0.0031
H53	Pen-y-coed, Ardleen	0.00008	0.00008	0.010	0.000008	0.0010	0.000083	0.000008	0.00099	0.000083	0.0012
H54	A483 at Trederwyn Lane	0.00010	0.00010	0.014	0.000010	0.0014	0.000099	0.000010	0.00141	0.000099	0.0015
H55	A458 between Plas-y-Court and Wollaston	0.00027	0.00027	0.042	0.000027	0.0042	0.000266	0.000027	0.00416	0.000266	0.0025

Table 34: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for Group 1, 2 and 3 Metals (cont)

	Pollutant	Pb (annual)	Mn (annual)	Mn (1-hour)	Hg (annual)	Hg (1-hour)	Ni (annual)	Tl (annual)	Tl (1-hour)	V (annual)	V (24-hour)
	AQS (μg/m³)	0.25	1	1500	0.25	7.5	0.02	1	30	5	1
	Emission Rate	0.0130	0.0130	0.0130	0.00130	0.00130	0.0130	0.00130	0.00130	0.0130	0.0130
	Multiplication Factor	1	1	1	1	1	1	1	1	1	1
	Maximum PC (μg/m³)	0.0052	0.005	0.223	0.001	0.022	0.005	0.001	0.022	0.005	0.031
	Max PC as % of AQS	**2.10%**	0.52%	0.015%	0.21%	0.30%	**26.2%**	0.052%	0.074%	0.10%	3.09%
	Background Concentration (μg/m³)	0.00147	n/a	n/a	n/a	n/a	0.000314	n/a	n/a	n/a	n/a
	Max PEC as % of AQS	2.69%	n/a	n/a	n/a	n/a	27.8%	n/a	n/a	n/a	n/a
H56	Lane west of Bugdin, Ardleen	0.00006	0.00006	0.008	0.000006	0.0008	0.000061	0.000006	0.00083	0.000061	0.0014
H57	From Severn Way Footpath, south of Gwern-y-go	0.00021	0.00021	0.012	0.000021	0.0012	0.000213	0.000021	0.00117	0.000213	0.0015
H58	Powys Castle north-east terrace	0.00009	0.00009	0.013	0.000009	0.0013	0.000094	0.000009	0.00127	0.000094	0.0012
H59	A483 at Trederwen Fweibion Gwnwas	0.00008	0.00008	0.017	0.000008	0.0017	0.000080	0.000008	0.00171	0.000080	0.0013
H60	Powys Castle, south-east terrace	0.00009	0.00009	0.012	0.000009	0.0012	0.000092	0.000009	0.00125	0.000092	0.0012
H61	Footpath south of Dyserth Hall	0.00008	0.00008	0.010	0.000008	0.0010	0.000079	0.000008	0.00100	0.000079	0.0011
H62	A483 by The Moat Farm	0.00008	0.00008	0.008	0.000008	0.0008	0.000077	0.000008	0.00083	0.000077	0.0010
H63	Trig point and footpath at Y Golfa golf course	0.00010	0.00010	0.013	0.000010	0.0013	0.000101	0.000010	0.00125	0.000101	0.0013
H64	Pound Lane, Llwynderw	0.00006	0.00006	0.005	0.000006	0.0005	0.000056	0.000006	0.00053	0.000056	0.0007
H65	A483 by Wernllwyd	0.00006	0.00006	0.006	0.000006	0.0006	0.000064	0.000006	0.00062	0.000064	0.0007
H66	A483 junction with B4390 to Berriew	0.00008	0.00008	0.009	0.000008	0.0009	0.000080	0.000008	0.00087	0.000080	0.0009
H67	A483, Pant	0.00004	0.00004	0.008	0.000004	0.0008	0.000040	0.000004	0.00078	0.000040	0.0010
H68	Llanymynech Golf Course and footpath	0.00004	0.00004	0.007	0.000004	0.0007	0.000039	0.000004	0.00071	0.000039	0.0009
H69	A483 north of bridge at Berriew	0.00008	0.00008	0.009	0.000008	0.0009	0.000081	0.000008	0.00094	0.000081	0.0010
H70	Footpath between Cefn Crin and Ashton	0.00008	0.00008	0.009	0.000008	0.0009	0.000079	0.000008	0.00088	0.000079	0.0012
H71	Green Hall Hill, Llanfyllin	0.00002	0.00002	0.003	0.000002	0.0003	0.000020	0.000002	0.00027	0.000020	0.0005
H72	East of Mynydd Jaram Bodynfoel Wood	0.00002	0.00002	0.004	0.000002	0.0004	0.000021	0.000002	0.00037	0.000021	0.0004
H73	Rolly Bank near Osbaston	0.00012	0.00012	0.009	0.000012	0.0009	0.000121	0.000012	0.00090	0.000121	0.0009
H74	Offas Dyke Path, Nantmawr	0.00003	0.00003	0.004	0.000003	0.0004	0.000031	0.000003	0.00044	0.000031	0.0005
H75	From Lane near Belan, west of Berriew	0.00006	0.00006	0.006	0.000006	0.0006	0.000059	0.000006	0.00061	0.000059	0.0008

5.3. Results – Remaining Pollutants

5.3.1. Due to the number of potentially sensitive human receptors, and the varying screening methodology, the results have been split into two sections. This section focuses on all pollutants excluding the Group 1, 2 and 3 Metals which are discussed in Section 5.2.

5.3.2. Based on Stage 1 screening (i.e. long-term PCs are greater than 1% and short-term PCs are greater than 10%), all pollutants with short-term averaging periods screened out all locations. Potentially significant impacts were observed at only 3 locations for long term impacts of NO_2 and VOC (as benzene). Consequently, PECs were considered for these pollutants. It should be noted, that to ensure a robust assessment for NO_2, the background concentrations identified in Section 4.4 was used.

5.3.3. Following calculation of the PECs, impacts of NO_2 and VOC at the 3 potentially sensitive locations were classed as negligible, consequently, no further assessment was required.

5.3.4. The results of this assessment may be found in Table 35.

Table 35: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for All Remaining Pollutants

	Pollutant	NO_2 (annual mean)	NO_2 (99.79th %ile)	SO_2 (99.18th %ile)	SO_2 (99.73rd %ile)	SO_2 (99.90th %ile)	$PM_{2.5}$ (annual)	PM_{10} (annual)	PM_{10} (90.41st %ile)	CO (8hour)	VOC (annual)
	AQS (µg/m³)	40	200	125	350	266	25	40	50	10000	5
	Emission Rate	3.12	3.12	1.30	1.30	1.30	0.260	0.260	0.260	1.301	0.260
	Multiplication Factor	0.7	0.35	1	1	1	1	1	1	1	1
	Maximum PC (µg/m³)	0.882	3.939	2.952	4.498	7.150	0.105	0.105	0.313	0.514	0.105
	Max PC as % of AQS	**2.20%**	1.97%	2.36%	1.29%	2.69%	0.42%	0.26%	0.63%	0.0051%	**2.10%**
	Background Concentration (µg/m³)	18.87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.17
	Max PEC as % of AQS	**49.38%**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**5.50%**
	Impact Descriptor	**Negligible**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**Negligible**
H01	Cefn Cottage	0.013	0.932	0.399	0.864	2.538	0.0015	0.0015	0.0004	0.0090	0.0015
H02	Green Farm Heldre Lane	0.073	2.526	1.364	2.810	4.418	0.0087	0.0087	0.0190	0.0446	0.0087
H03	Whitehouse Farm	0.157	3.939	1.369	4.498	5.329	0.0186	0.0186	0.0615	0.0966	0.0186
H04	Sale Farm - House Off Sale Lane (2)	0.042	2.282	0.527	2.219	4.075	0.0051	0.0051	0.0145	0.0277	0.0051
H05	Cefn Farm - House Off Sale Lane (1)	0.622	3.073	2.416	3.646	4.260	0.0740	0.0740	0.2448	0.3626	0.0740
H06	Lower Cefn	0.040	2.702	0.575	2.746	4.218	0.0048	0.0048	0.0123	0.0266	0.0048
H07	Methodist Church, Buttington	0.882	3.332	2.952	3.911	4.361	0.1050	0.1050	0.3134	0.5141	0.1050
H08	Heldre Lane	0.084	2.675	0.651	2.916	3.621	0.0100	0.0100	0.0435	0.0496	0.0100
H09	Speed Welshpool	0.237	3.050	2.226	3.577	3.969	0.0283	0.0283	0.1059	0.1400	0.0283
H10	Brookside	0.214	2.735	1.931	3.217	3.598	0.0254	0.0254	0.0875	0.1254	0.0254
H11	Border Hardcore Offices	0.210	2.616	1.941	3.098	3.499	0.0250	0.0250	0.0915	0.1238	0.0250
H12	York House	0.210	2.606	1.790	3.066	3.468	0.0250	0.0250	0.1002	0.1242	0.0250
H13	Footpath south of Nelly Andrews' Green	0.101	2.060	0.859	2.403	2.777	0.0120	0.0120	0.0466	0.0608	0.0120
H14	Buttington Trewern Primary School	0.430	2.319	1.350	2.736	3.081	0.0512	0.0512	0.1525	0.2514	0.0512
H15	Upper Heldre	0.061	1.381	0.443	1.544	1.964	0.0072	0.0072	0.0286	0.0352	0.0072
H16	Heldre Lane, Trewern	0.365	1.758	1.140	2.079	2.511	0.0434	0.0434	0.1213	0.2140	0.0434
H17	Farm Buildings off A458	0.116	1.419	0.626	1.652	2.044	0.0138	0.0138	0.0613	0.0698	0.0138
H18	Footpath between Gelli and Longmountain Farm	0.053	1.209	0.429	1.375	2.350	0.0063	0.0063	0.0248	0.0319	0.0063
H19	Footpath west of Middle House	0.044	1.034	0.308	1.133	1.770	0.0052	0.0052	0.0209	0.0366	0.0052
H20	Criggion Lane, Trewern,	0.253	1.364	0.685	1.562	2.327	0.0301	0.0301	0.0795	0.1490	0.0301
H21	Pen-y-Bank	0.047	0.825	0.278	0.940	1.275	0.0056	0.0056	0.0206	0.0275	0.0056
H22	Criggion Lane, Trewern	0.188	1.209	0.633	1.428	2.185	0.0223	0.0223	0.0656	0.1108	0.0223
H23	A483, Strat Marcella Abbey	0.041	0.916	0.366	1.016	1.384	0.0049	0.0049	0.0167	0.0245	0.0049
H24	Trewern, Garreg Bank (lower)	0.207	1.312	0.567	1.524	2.445	0.0247	0.0247	0.0639	0.1223	0.0247
H25	Offas Dyke Path, Pool Quay	0.039	0.765	0.291	0.881	1.168	0.0047	0.0047	0.0182	0.0239	0.0047
H26	Trewern, Garreg Bank (upper)	0.192	1.317	0.524	1.510	2.546	0.0229	0.0229	0.0587	0.1135	0.0229
H27	A458, Buttington and west of The Smithy	0.071	0.974	0.401	1.129	1.565	0.0085	0.0085	0.0372	0.0430	0.0085

Table 35: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for All Remaining Pollutants (cont)

	Pollutant	NO_2 (annual mean)	NO_2 (99.79th %ile)	SO_2 (99.18th %ile)	SO_2 (99.73rd %ile)	SO_2 (99.90th %ile)	$PM_{2.5}$ (annual)	PM_{10} (annual)	PM_{10} (90.41st %ile)	CO (8hour)	VOC (annual)
	AQS (µg/m³)	40	200	125	350	266	25	40	50	10000	5
	Emission Rate	3.12	3.12	1.30	1.30	1.30	0.260	0.260	0.260	1.301	0.260
	Multiplication Factor	0.7	0.35	1	1	1	1	1	1	1	1
	Maximum PC (µg/m³)	0.882	3.939	2.952	4.498	7.150	0.105	0.105	0.313	0.514	0.105
	Max PC as % of AQS	**2.20%**	1.97%	2.36%	1.29%	2.69%	0.42%	0.26%	0.63%	0.0051%	**2.10%**
	Background Concentration (µg/m³)	18.87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.17
	Max PEC as % of AQS	**49.38%**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**5.50%**
	Impact Descriptor	**Negligible**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**Negligible**
H28	Trewern, near monument	0.154	1.326	0.464	1.448	2.435	0.0184	0.0184	0.0492	0.0916	0.0184
H29	Buttington	0.067	0.920	0.376	1.059	1.611	0.0079	0.0079	0.0345	0.0400	0.0079
H30	Buttington Church	0.060	0.838	0.358	0.959	1.457	0.0071	0.0071	0.0288	0.0359	0.0071
H31	A483 Pool Quay Straight	0.045	0.887	0.369	0.942	1.673	0.0053	0.0053	0.0249	0.0267	0.0053
H32	Coppice East Farm and ancient monument	0.026	0.659	0.288	0.751	1.179	0.0031	0.0031	0.0112	0.0160	0.0031
H33	The Old Shop Cottage	0.105	1.183	0.327	1.284	2.724	0.0125	0.0125	0.0334	0.0628	0.0125
H34	A458, Buttington Bridge	0.051	0.774	0.353	0.859	1.828	0.0061	0.0061	0.0271	0.0302	0.0061
H35	Shepherd’s Lane, Moel y Golfa	0.135	1.195	0.352	1.325	2.396	0.0161	0.0161	0.0408	0.0802	0.0161
H36	A483, Buttington Cross	0.040	0.745	0.297	0.811	1.398	0.0048	0.0048	0.0200	0.0236	0.0048
H37	A458 between Middletown and Trewern	0.088	1.097	0.258	1.209	2.230	0.0105	0.0105	0.0295	0.0531	0.0105
H38	Trailhead Fine Foods/ Welshpool Livestock Sales A483	0.042	0.689	0.289	0.729	1.518	0.0050	0.0050	0.0207	0.0247	0.0050
H39	Footpath at Buttington View, Hope	0.028	0.757	0.200	0.820	1.402	0.0033	0.0033	0.0125	0.0174	0.0033
H40	Criggion Lane, Old Mills	0.104	0.771	0.348	0.902	1.440	0.0124	0.0124	0.0365	0.0608	0.0124
H41	Hope	0.041	0.853	0.264	0.878	1.678	0.0049	0.0049	0.0197	0.0250	0.0049
H42	Moel y Golfa Wood and Footpath	0.162	3.000	0.554	3.483	7.150	0.0193	0.0193	0.0512	0.1003	0.0193
H43	Oak Grange, Middletown	0.069	0.637	0.218	0.693	1.322	0.0082	0.0082	0.0226	0.0406	0.0082
H44	Gungrog Hill, Welshpool	0.027	0.505	0.203	0.579	1.060	0.0032	0.0032	0.0122	0.0159	0.0032
H45	Borfa Green, Welshpool	0.025	0.461	0.181	0.538	0.924	0.0029	0.0029	0.0114	0.0147	0.0029
H46	Rhyd-Esgyn Lane	0.020	0.458	0.123	0.469	1.046	0.0023	0.0023	0.0087	0.0116	0.0023
H47	Adelaide Drive, Welshpool	0.022	0.435	0.172	0.503	0.986	0.0027	0.0027	0.0109	0.0135	0.0027
H48	Middletown Hill (Cefn y Castell)	0.163	3.067	0.687	3.586	6.502	0.0194	0.0194	0.0588	0.1036	0.0194
H49	Bridge over A483, Welshpool and National Cycle Route 81	0.022	0.468	0.136	0.482	0.923	0.0027	0.0027	0.0108	0.0136	0.0027
H50	A483, New Cut	0.018	0.379	0.127	0.395	0.678	0.0022	0.0022	0.0086	0.0113	0.0022
H51	Rodney’s Pillar, Breidden Hill	0.159	2.080	0.434	2.458	4.485	0.0189	0.0189	0.0495	0.0954	0.0189
H52	Footpath west of Rose and Crown	0.044	0.437	0.136	0.470	0.874	0.0053	0.0053	0.0150	0.0264	0.0053

Table 35: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for All Remaining Pollutants (cont)

	Pollutant	NO_2 (annual mean)	NO_2 (99.79th %ile)	SO_2 (99.18th %ile)	SO_2 (99.73rd %ile)	SO_2 (99.90th %ile)	$PM_{2.5}$ (annual)	PM_{10} (annual)	PM_{10} (90.41st %ile)	CO (8hour)	VOC (annual)
	AQS (μg/m³)	40	200	125	350	266	25	40	50	10000	5
	Emission Rate	3.12	3.12	1.30	1.30	1.30	0.260	0.260	0.260	1.301	0.260
	Multiplication Factor	0.7	0.35	1	1	1	1	1	1	1	1
	Maximum PC (μg/m³)	0.882	3.939	2.952	4.498	7.150	0.105	0.105	0.313	0.514	0.105
	Max PC as % of AQS	**2.20%**	1.97%	2.36%	1.29%	2.69%	0.42%	0.26%	0.63%	0.0051%	**2.10%**
	Background Concentration (μg/m³)	18.87	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.17
	Max PEC as % of AQS	**49.38%**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**5.50%**
	Impact Descriptor	**Negligible**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**Negligible**
H53	Pen-y-coed, Ardleen	0.014	0.288	0.085	0.326	0.634	0.0017	0.0017	0.0066	0.0084	0.0017
H54	A483 at Trederwyn Lane	0.017	0.321	0.105	0.336	0.593	0.0020	0.0020	0.0076	0.0101	0.0020
H55	A458 between Plas-y-Court and Wollaston	0.045	0.568	0.131	0.641	0.873	0.0053	0.0053	0.0137	0.0275	0.0053
H56	Lane west of Bugdin, Ardleen	0.010	0.276	0.068	0.317	0.522	0.0012	0.0012	0.0047	0.0062	0.0012
H57	From Severn Way Footpath, south of Gwern-y-go	0.036	0.400	0.119	0.400	0.839	0.0043	0.0043	0.0122	0.0211	0.0043
H58	Powys Castle north-east terrace	0.016	0.313	0.098	0.353	0.836	0.0019	0.0019	0.0081	0.0095	0.0019
H59	A483 at Trederwen Fweibion Gwnwas	0.013	0.280	0.075	0.295	0.576	0.0016	0.0016	0.0062	0.0082	0.0016
H60	Powys Castle, south-east terrace	0.016	0.314	0.097	0.350	0.822	0.0018	0.0018	0.0073	0.0093	0.0018
H61	Footpath south of Dyserth Hall	0.013	0.324	0.079	0.333	0.602	0.0016	0.0016	0.0063	0.0080	0.0016
H62	A483 by The Moat Farm	0.013	0.280	0.071	0.312	0.637	0.0015	0.0015	0.0066	0.0079	0.0015
H63	Trig point and footpath at Y Golfa golf course	0.017	0.564	0.106	0.620	1.301	0.0020	0.0020	0.0087	0.0107	0.0020
H64	Pound Lane, Llwynderw	0.009	0.217	0.060	0.210	0.443	0.0011	0.0011	0.0049	0.0058	0.0011
H65	A483 by Wernllwyd	0.011	0.240	0.055	0.259	0.450	0.0013	0.0013	0.0056	0.0066	0.0013
H66	A483 junction with B4390 to Berriew	0.013	0.351	0.068	0.368	0.504	0.0016	0.0016	0.0066	0.0090	0.0016
H67	A483, Pant	0.007	0.171	0.041	0.180	0.370	0.0008	0.0008	0.0030	0.0041	0.0008
H68	Llanymynech Golf Course and footpath	0.007	0.144	0.043	0.158	0.330	0.0008	0.0008	0.0029	0.0040	0.0008
H69	A483 north of bridge at Berriew	0.014	0.380	0.069	0.431	0.471	0.0016	0.0016	0.0064	0.0091	0.0016
H70	Footpath between Cefn Crin and Ashton	0.013	0.592	0.098	0.665	1.155	0.0016	0.0016	0.0068	0.0083	0.0016
H71	Green Hall Hill, Llanfyllin	0.003	0.101	0.039	0.115	0.211	0.0004	0.0004	0.0014	0.0021	0.0004
H72	East of Mynydd Jaram Bodynfoel Wood	0.004	0.103	0.027	0.115	0.229	0.0004	0.0004	0.0017	0.0022	0.0004
H73	Rolly Bank near Osbaston	0.020	0.307	0.054	0.323	0.609	0.0024	0.0024	0.0066	0.0122	0.0024
H74	Offas Dyke Path, Nantmawr	0.005	0.102	0.029	0.117	0.204	0.0006	0.0006	0.0023	0.0032	0.0006
H75	From Lane near Belan, west of Berriew	0.010	0.348	0.073	0.358	0.644	0.0012	0.0012	0.0044	0.0062	0.0012

Table 35: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for All Remaining Pollutants (cont)

	Pollutant	NH_3 (annual)	NH3 (1-hour)	HCl (1 hour)	HF (annual)	HF (1 hour)	B[a]P (annual)	PCB (annual)	PCB (24hour)	Dioxins (annual)
	AQS (µg/m³)	180	2500	750	16	160	0.00025	0.2	6	n/a
	Emission Rate	0.260	0.260	0.2601	0.02601	0.02601	0.00000260	0.000000260	0.000000260	0.00000000104
	Multiplication Factor	1	1	1	1	1	1	1	1	1
	Maximum PC (µg/m³)	0.105	4.465	4.465	0.010	0.447	0.000	0.000	0.000	0.000
	Max PC as % of AQS	0.058%	0.18%	0.60%	0.066%	0.279%	0.42%	0.000052%	0.0000103%	n/a
	Background Concentration (µg/m³)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Max PEC as % of AQS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Impact Descriptor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
H01	Cefn Cottage	0.0015	1.462	1.462	0.00015	0.146	0.00000001	0.000000001	0.000000199	0.0000000000060
H02	Green Farm Heldre Lane	0.0087	1.594	1.594	0.00087	0.159	0.00000009	0.000000009	0.000000434	0.0000000000349
H03	Whitehouse Farm	0.0186	1.153	1.153	0.00186	0.115	0.00000019	0.000000019	0.000000387	0.0000000000745
H04	Sale Farm - House Off Sale Lane (2)	0.0051	4.465	4.465	0.00051	0.447	0.00000005	0.000000005	0.000000223	0.0000000000202
H05	Cefn Farm - House Off Sale Lane (1)	0.0740	0.977	0.977	0.00740	0.098	0.00000074	0.000000074	0.000000578	0.0000000002961
H06	Lower Cefn	0.0048	1.316	1.316	0.00048	0.132	0.00000005	0.000000005	0.000000225	0.0000000000191
H07	Methodist Church, Buttington	0.1050	0.845	0.845	0.01050	0.084	0.00000105	0.000000105	0.000000619	0.0000000004199
H08	Heldre Lane	0.0100	0.760	0.760	0.00100	0.076	0.00000010	0.000000010	0.000000201	0.0000000000400
H09	Speed Welshpool	0.0283	0.773	0.773	0.00283	0.077	0.00000028	0.000000028	0.000000495	0.0000000001130
H10	Brookside	0.0254	0.698	0.698	0.00254	0.070	0.00000025	0.000000025	0.000000487	0.0000000001018
H11	Border Hardcore Offices	0.0250	0.668	0.668	0.00250	0.067	0.00000025	0.000000025	0.000000434	0.0000000001002
H12	York House	0.0250	0.667	0.667	0.00250	0.067	0.00000025	0.000000025	0.000000429	0.0000000001002
H13	Footpath south of Nelly Andrews' Green	0.0120	1.042	1.042	0.00120	0.104	0.00000012	0.000000012	0.000000184	0.0000000000480
H14	Buttington Trewern Primary School	0.0512	0.604	0.604	0.00512	0.060	0.00000051	0.000000051	0.000000370	0.0000000002047
H15	Upper Heldre	0.0072	3.044	3.044	0.00072	0.304	0.00000007	0.000000007	0.000000152	0.0000000000289
H16	Heldre Lane, Trewern	0.0434	0.602	0.602	0.00434	0.060	0.00000043	0.000000043	0.000000237	0.0000000001737
H17	Farm Buildings off A458	0.0138	0.468	0.468	0.00138	0.047	0.00000014	0.000000014	0.000000171	0.0000000000552
H18	Footpath between Gelli and Longmountain Farm	0.0063	3.042	3.042	0.00063	0.304	0.00000006	0.000000006	0.000000153	0.0000000000252
H19	Footpath west of Middle House	0.0052	3.107	3.107	0.00052	0.311	0.00000005	0.000000005	0.000000388	0.0000000000208
H20	Criggion Lane, Trewern,	0.0301	0.792	0.792	0.00301	0.079	0.00000030	0.000000030	0.000000180	0.0000000001204
H21	Pen-y-Bank	0.0056	0.970	0.970	0.00056	0.097	0.00000006	0.000000006	0.000000096	0.0000000000223
H22	Criggion Lane, Trewern	0.0223	0.645	0.645	0.00223	0.064	0.00000022	0.000000022	0.000000174	0.0000000000894
H23	A483, Strat Marcella Abbey	0.0049	0.553	0.553	0.00049	0.055	0.00000005	0.000000005	0.000000093	0.0000000000196
H24	Trewern, Garreg Bank (lower)	0.0247	0.718	0.718	0.00247	0.072	0.00000025	0.000000025	0.000000149	0.0000000000986
H25	Offas Dyke Path, Pool Quay	0.0047	0.477	0.477	0.00047	0.048	0.00000005	0.000000005	0.000000108	0.0000000000186
H26	Trewern, Garreg Bank (upper)	0.0229	0.667	0.667	0.00229	0.067	0.00000023	0.000000023	0.000000139	0.0000000000914
H27	A458, Buttington and west of The Smithy	0.0085	0.534	0.534	0.00085	0.053	0.00000009	0.000000009	0.000000121	0.0000000000340
H28	Trewern, near monument	0.0184	0.718	0.718	0.00184	0.072	0.00000018	0.000000018	0.000000107	0.0000000000735

Table 35: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for All Remaining Pollutants (cont)

	Pollutant	NH_3 (annual)	NH3 (1-hour)	HCl (1 hour)	HF (annual)	HF (1 hour)	B[a]P (annual)	PCB (annual)	PCB (24hour)	Dioxins (annual)
	AQS (µg/m^3)	180	2500	750	16	160	0.00025	0.2	6	n/a
	Emission Rate	0.260	0.260	0.2601	0.02601	0.02601	0.00000260	0.000000260	0.000000260	0.00000000104
	Multiplication Factor	1	1	1	1	1	1	1	1	1
	Maximum PC (µg/m^3)	0.105	4.465	4.465	0.010	0.447	0.000	0.000	0.000	0.000
	Max PC as % of AQS	0.058%	0.18%	0.60%	0.066%	0.279%	0.42%	0.000052%	0.0000103%	n/a
	Background Concentration (µg/m^3)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Max PEC as % of AQS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Impact Descriptor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
H29	Buttington	0.0079	0.500	0.500	0.00079	0.050	0.00000008	0.000000008	0.000000113	0.0000000000317
H30	Buttington Church	0.0071	0.464	0.464	0.00071	0.046	0.00000007	0.000000007	0.000000095	0.0000000000285
H31	A483 Pool Quay Straight	0.0053	0.785	0.785	0.00053	0.078	0.00000005	0.000000005	0.000000096	0.0000000000213
H32	Coppice East Farm and ancient monument	0.0031	0.516	0.516	0.00031	0.052	0.00000003	0.000000003	0.000000067	0.0000000000125
H33	The Old Shop Cottage	0.0125	0.535	0.535	0.00125	0.053	0.00000013	0.000000013	0.000000083	0.0000000000500
H34	A458, Buttington Bridge	0.0061	0.520	0.520	0.00061	0.052	0.00000006	0.000000006	0.000000085	0.0000000000242
H35	Shepherd's Lane, Moel y Golfa	0.0161	0.538	0.538	0.00161	0.054	0.00000016	0.000000016	0.000000098	0.0000000000643
H36	A483, Buttington Cross	0.0048	0.458	0.458	0.00048	0.046	0.00000005	0.000000005	0.000000088	0.0000000000191
H37	A458 between Middletown and Trewern	0.0105	0.463	0.463	0.00105	0.046	0.00000010	0.000000010	0.000000061	0.0000000000420
H38	Trailhead Fine Foods/ Welshpool Livestock Sales A483	0.0050	0.468	0.468	0.00050	0.047	0.00000005	0.000000005	0.000000069	0.0000000000198
H39	Footpath at Buttington View, Hope	0.0033	1.615	1.615	0.00033	0.162	0.00000003	0.000000003	0.000000086	0.0000000000133
H40	Criggion Lane, Old Mills	0.0124	0.448	0.448	0.00124	0.045	0.00000012	0.000000012	0.000000090	0.0000000000495
H41	Hope	0.0049	0.322	0.322	0.00049	0.032	0.00000005	0.000000005	0.000000056	0.0000000000194
H42	Moel y Golfa Wood and Footpath	0.0193	1.148	1.148	0.00193	0.115	0.00000019	0.000000019	0.000000190	0.0000000000773
H43	Oak Grange, Middletown	0.0082	0.685	0.685	0.00082	0.068	0.00000008	0.000000008	0.000000059	0.0000000000329
H44	Gungrog Hill, Welshpool	0.0032	0.344	0.344	0.00032	0.034	0.00000003	0.000000003	0.000000053	0.0000000000127
H45	Borfa Green, Welshpool	0.0029	0.287	0.287	0.00029	0.029	0.00000003	0.000000003	0.000000046	0.0000000000118
H46	Rhyd-Esgyn Lane	0.0023	0.484	0.484	0.00023	0.048	0.00000002	0.000000002	0.000000033	0.0000000000093
H47	Adelaide Drive, Welshpool	0.0027	0.270	0.270	0.00027	0.027	0.00000003	0.000000003	0.000000045	0.0000000000107
H48	Middletown Hill (Cefn y Castell)	0.0194	0.854	0.854	0.00194	0.085	0.00000019	0.000000019	0.000000158	0.0000000000777
H49	Bridge over A483, Welshpool and National Cycle Route 81	0.0027	0.269	0.269	0.00027	0.027	0.00000003	0.000000003	0.000000033	0.0000000000107
H50	A483, New Cut	0.0022	0.663	0.663	0.00022	0.066	0.00000002	0.000000002	0.000000035	0.0000000000088
H51	Rodney's Pillar, Breidden Hill	0.0189	0.561	0.561	0.00189	0.056	0.00000019	0.000000019	0.000000137	0.0000000000755
H52	Footpath west of Rose and Crown	0.0053	1.115	1.115	0.00053	0.112	0.00000005	0.000000005	0.000000063	0.0000000000210
H53	Pen-y-coed, Ardleen	0.0017	0.197	0.197	0.00017	0.020	0.00000002	0.000000002	0.000000023	0.0000000000066
H54	A483 at Trederwyn Lane	0.0020	0.282	0.282	0.00020	0.028	0.00000002	0.000000002	0.000000031	0.0000000000079
H55	A458 between Plas-y-Court and Wollaston	0.0053	0.832	0.832	0.00053	0.083	0.00000005	0.000000005	0.000000051	0.0000000000213

Table 35: Predicted Maximum Ground Level Pollutant Concentrations (PCs) at Sensitive Human Receptors for All Remaining Pollutants (cont)

	Pollutant	NH_3 (annual)	NH3 (1-hour)	HCl (1 hour)	HF (annual)	HF (1 hour)	B[a]P (annual)	PCB (annual)	PCB (24hour)	Dioxins (annual)
	AQS (µg/m³)	180	2500	750	16	160	0.00025	0.2	6	n/a
	Emission Rate	0.260	0.260	0.2601	0.02601	0.02601	0.00000260	0.000000260	0.000000260	0.00000000104
	Multiplication Factor	1	1	1	1	1	1	1	1	1
	Maximum PC (µg/m³)	0.105	4.465	4.465	0.010	0.447	0.000	0.000	0.000	0.000
	Max PC as % of AQS	0.058%	0.18%	0.60%	0.066%	0.279%	0.42%	0.000052%	0.0000103%	n/a
	Background Concentration (µg/m³)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Max PEC as % of AQS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Impact Descriptor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
H56	Lane west of Bugdin, Ardleen	0.0012	0.167	0.167	0.00012	0.017	0.00000001	0.000000001	0.000000028	0.0000000000049
H57	From Severn Way Footpath, south of Gwern-y-go	0.0043	0.233	0.233	0.00043	0.023	0.00000004	0.000000004	0.000000030	0.0000000000170
H58	Powys Castle north-east terrace	0.0019	0.254	0.254	0.00019	0.025	0.00000002	0.000000002	0.000000023	0.0000000000075
H59	A483 at Trederwen Fweibion Gwnwas	0.0016	0.341	0.341	0.00016	0.034	0.00000002	0.000000002	0.000000025	0.0000000000064
H60	Powys Castle, south-east terrace	0.0018	0.249	0.249	0.00018	0.025	0.00000002	0.000000002	0.000000023	0.0000000000074
H61	Footpath south of Dyserth Hall	0.0016	0.201	0.201	0.00016	0.020	0.00000002	0.000000002	0.000000023	0.0000000000063
H62	A483 by The Moat Farm	0.0015	0.166	0.166	0.00015	0.017	0.00000002	0.000000002	0.000000019	0.0000000000061
H63	Trig point and footpath at Y Golfa golf course	0.0020	0.250	0.250	0.00020	0.025	0.00000002	0.000000002	0.000000026	0.0000000000081
H64	Pound Lane, Llwynderw	0.0011	0.107	0.107	0.00011	0.011	0.00000001	0.000000001	0.000000015	0.0000000000045
H65	A483 by Wernllwyd	0.0013	0.124	0.124	0.00013	0.012	0.00000001	0.000000001	0.000000013	0.0000000000051
H66	A483 junction with B4390 to Berriew	0.0016	0.174	0.174	0.00016	0.017	0.00000002	0.000000002	0.000000018	0.0000000000064
H67	A483, Pant	0.0008	0.156	0.156	0.00008	0.016	0.00000001	0.000000001	0.000000019	0.0000000000032
H68	Llanymynech Golf Course and footpath	0.0008	0.141	0.141	0.00008	0.014	0.00000001	0.000000001	0.000000017	0.0000000000031
H69	A483 north of bridge at Berriew	0.0016	0.188	0.188	0.00016	0.019	0.00000002	0.000000002	0.000000020	0.0000000000064
H70	Footpath between Cefn Crin and Ashton	0.0016	0.176	0.176	0.00016	0.018	0.00000002	0.000000002	0.000000025	0.0000000000063
H71	Green Hall Hill, Llanfyllin	0.0004	0.055	0.055	0.00004	0.005	0.00000000	0.000000000	0.000000009	0.0000000000016
H72	East of Mynydd Jaram Bodynfoel Wood	0.0004	0.074	0.074	0.00004	0.007	0.00000000	0.000000000	0.000000007	0.0000000000017
H73	Rolly Bank near Osbaston	0.0024	0.180	0.180	0.00024	0.018	0.00000002	0.000000002	0.000000018	0.0000000000097
H74	Offas Dyke Path, Nantmawr	0.0006	0.088	0.088	0.00006	0.009	0.00000001	0.000000001	0.000000010	0.0000000000024
H75	From Lane near Belan, west of Berriew	0.0012	0.121	0.121	0.00012	0.012	0.00000001	0.000000001	0.000000016	0.0000000000048

6. ASSESSMENT OF AIR QUALITY IMPACTS - IMPACT ON HABITAT SITES, EMISSIONS AT IED EMISSION LIMIT VALUES

6.1. Comparison of Maximum Predicted Pollutant Ground Level Concentrations with Critical Levels for the Protection of Vegetation and Ecosystems - Oxides of Nitrogen

6.1.1. A summary of maximum predicted GLCs of oxides of nitrogen at the identified sensitive habitat sites is presented in Table 36 and 37. In accordance with the H1 guidance, the significance of the impacts has been determined using the 100% long and short term screening criteria for local nature sites, and 1% and 10% criteria for long and short-term predictions, respectively for SPAs, SACs, Ramsars and SSSIs (see Section 2.23. of this document). Any significant impacts are highlighted in bold.

Table 36: Comparison of Maximum Predicted Oxides of Nitrogen Ground Level Concentrations (PCs) with Critical Levels at Sensitive Habitat Sites – Local Nature Sites

	Pollutant	**NO_x (annual mean)**	**NO_x (24-hour Mean)**
	Critical Level	30	75
	Maximum PC (µg/m^3)	0.320	3.013
	Max PC as % of Critical Level	1.07%	4.02%
AW01	Ancient Woodland - 33254	0.076	3.013
AW02	Ancient Woodland - 33255	0.087	2.808
AW03	Ancient Woodland - 47343	0.218	2.087
AW04	Ancient Woodland - 26045	0.320	2.302
AW05	Ancient Woodland - 27762	0.125	1.801
AW06	Ancient Woodland - 33238	0.095	1.960
AW07	Ancient Woodland - 27222	0.084	1.825
AW08	Ancient Woodland - 28973	0.091	1.335
AW09	Ancient Woodland - 35167	0.157	1.237
AW10	Ancient Woodland - 27086	0.100	1.722
AW11	Ancient Woodland - 27223	0.096	1.076

Table 37: Comparison of Maximum Predicted Oxides of Nitrogen Ground Level Concentrations (PCs) with Critical Levels at Sensitive Habitat Sites – SPAs, SACs, Ramsars and SSSIs

	Pollutant	NO_x (annual mean)	NO_x (24-hour Mean)
	Critical Level	30	75
	Maximum PC (µg/m³)	0.181	2.120
	Max PC as % of Critical Level	0.60%	2.83%
RAM1	Midland Meres and Mosses Phase 1 - Marton Pool	0.025	0.285
RAM2	Midland Meres and Mosses Phase 2	0.012	0.177
SAC1	Montgomery Canal	0.066	1.059
SAC2	Granllyn	0.022	0.346
SSSI1	Buttington Brickworks	0.044	2.120
SSSI2	Montgomery Canal	0.066	1.059
SSSI3	Moel y Golfa	0.181	1.025

6.1.2. It can be seen from the data in Table 36 that the annual mean and daily mean oxides of nitrogen PCs are all less than 100% of the critical level and therefore, are not significant at all of the local nature sites considered.

6.1.3. Similarly, it can be seen from the data in Table 37 that the annual mean and daily mean oxides of nitrogen PCs are all less than 1% or 10% of their respective critical levels and therefore, are not significant at all SACs, Ramsars and SSSI's considered.

6.2. Comparison of Maximum Predicted Pollutant Ground Level Concentrations with Critical Levels for the Protection of Vegetation and Ecosystems - Sulphur Dioxide

6.2.1. A summary of maximum predicted GLCs of sulphur dioxide at the identified sensitive habitat sites are presented in Tables 38 and 39. In accordance with the H1 guidance, the significance of the impacts has been determined using the 100% long and short term screening criteria for local nature sites, and 1% and 10% criteria for long and short-term predictions, respectively for SPAs, SACs, Ramsars and SSSIs (see Section 2.23. of this document). Any significant impacts are highlighted in bold.

Table 38: Comparison of Maximum Predicted Sulphur Dioxide Ground Level Concentrations (PCs) with Critical Levels at Sensitive Habitat Sites – Local Nature Sites

Pollutant		SO_2 (annual mean) - Crops	SO_2 (annual mean) - Forests and Natural Vegetation	SO_2 (annual mean) - Sensitive Lichens
Critical Level		30	20	10
Maximum PC (µg/m³)		0.133	0.133	0.133
Max PC as % of Critical Level		0.44%	0.67%	1.33%
AW01	Ancient Woodland - 33254	0.032	0.032	0.032
AW02	Ancient Woodland - 33255	0.036	0.036	0.036
AW03	Ancient Woodland - 47343	0.091	0.091	0.091
AW04	Ancient Woodland - 26045	0.133	0.133	0.133
AW05	Ancient Woodland - 27762	0.052	0.052	0.052
AW06	Ancient Woodland - 33238	0.040	0.040	0.040
AW07	Ancient Woodland - 27222	0.035	0.035	0.035
AW08	Ancient Woodland - 28973	0.038	0.038	0.038
AW09	Ancient Woodland - 35167	0.066	0.066	0.066
AW10	Ancient Woodland - 27086	0.042	0.042	0.042
AW11	Ancient Woodland - 27223	0.040	0.040	0.040

Table 39: Comparison of Maximum Predicted Sulphur Dioxide Ground Level Concentrations (PCs) with Critical Levels at Sensitive Habitat Sites – SPAs, SACs, Ramsars and SSSIs

Pollutant		SO_2 (annual mean) - Crops	SO_2 (annual mean) - Forests and Natural Vegetation	SO_2 (annual mean) - Sensitive Lichens
Critical Level		30	20	10
Maximum PC (µg/m³)		0.075	0.075	0.075
Max PC as % of Critical Level		0.25%	0.38%	0.75%
RAM1	Midland Meres and Mosses Phase 1 - Marton Pool	0.010	0.010	0.010
RAM2	Midland Meres and Mosses Phase 2	0.005	0.005	0.005
SAC1	Montgomery Canal	0.027	0.027	0.027
SAC2	Granllyn	0.009	0.009	0.009
SSSI1	Buttington Brickworks	0.018	0.018	0.018
SSSI2	Montgomery Canal	0.027	0.027	0.027
SSSI3	Moel y Golfa	0.075	0.075	0.075

6.2.2. It can be seen from the data in Table 38 that the annual mean sulphur dioxide PCs are all less than 100% of the critical level and therefore, are not significant at all of the local nature sites considered.

6.2.3. Similarly, it can be seen from the data in Table 39 that the annual mean sulphur dioxide PCs are all less than 1% of the critical levels and therefore, are not significant at all SACs, Ramsars and SSSI's considered.

6.3. Comparison of Maximum Predicted Pollutant Ground Level Concentrations with Critical Levels for the Protection of Vegetation and Ecosystems - Ammonia

6.3.1. A summary of maximum predicted GLCs of ammonia at the identified sensitive habitat sites are presented in Tables 40 and 41. In accordance with the H1 guidance, the significance of the impacts has been determined using the 100% long and short term screening criteria for local nature sites, and 1% and 10% criteria for long and short-term predictions, respectively for SPAs, SACs, Ramsars and SSSIs (see Section 2.23. of this document). Any significant impacts are highlighted in bold.

Table 40: Comparison of Maximum Predicted Ammonia Ground Level Concentrations (PCs) with Critical Levels at Sensitive Habitat Sites – Local Nature Sites

Pollutant		NH_3 (annual mean) - Lichens and Bryophytes	NH_3 (annual mean) - Other Vegetation
Critical Level		1	3
Maximum PC (µg/m³)		0.0266	0.0266
Max PC as % of Critical Level		2.66%	0.89%
AW01	Ancient Woodland - 33254	0.0064	0.0064
AW02	Ancient Woodland - 33255	0.0072	0.0072
AW03	Ancient Woodland - 47343	0.0182	0.0182
AW04	Ancient Woodland - 26045	0.0266	0.0266
AW05	Ancient Woodland - 27762	0.0104	0.0104
AW06	Ancient Woodland - 33238	0.0079	0.0079
AW07	Ancient Woodland - 27222	0.0070	0.0070
AW08	Ancient Woodland - 28973	0.0076	0.0076
AW09	Ancient Woodland - 35167	0.0131	0.0131
AW10	Ancient Woodland - 27086	0.0084	0.0084
AW11	Ancient Woodland - 27223	0.0080	0.0080

Table 41: Comparison of Maximum Predicted Ammonia Ground Level Concentrations (PCs) with Critical Levels at Sensitive Habitat Sites – SPAs, SACs, Ramsars and SSSIs

Pollutant		NH_3 (annual mean) - Lichens and Bryophytes	NH_3 (annual mean) - Other Vegetation
Critical Level		1	3
Maximum PC (µg/m³)		0.0151	0.0151
Max PC as % of Critical Level		1.51%	0.50%
RAM1	Midland Meres and Mosses Phase 1 - Marton Pool	0.0021	0.0021
RAM2	Midland Meres and Mosses Phase 2	0.0010	0.0010
SAC1	Montgomery Canal	0.0055	0.0055
SAC2	Granllyn	0.0018	0.0018
SSSI1	Buttington Brickworks	0.0037	0.0037
SSSI2	Montgomery Canal	0.0055	0.0055
SSSI3	Moel y Golfa	0.0151	0.0151

6.3.2. It can be seen from the data in Table 40 that the annual mean ammonia PCs are all less than 100% of the critical level and therefore, are not significant at all of the local nature sites considered.

6.3.3. Similarly, it can be seen from the data in Table 41 that the annual mean ammonia PCs are all less than 1% of the critical levels and therefore, are not significant at all SACs, Ramsars and SSSI's considered with the exception of Moel Y Golfa. The PC at Moel y Golfa is 1.51% of the annual mean of the AQS set, when there are sensitive lichens and bryophytes. From a review of the citation there is no mention of scarce bryophytes or lichens as a feature of the SSSI. However, the Landscape Character Assessment for the Shropshire Hills outliers, produced by NRW, states however:

Further north, overlooking the Severn Valley, are the Long Mountain, Breidden Hill and Moel Y Golfa. the latter two being extensively wooded and SSSIs. Shallow soils susceptible to drought have limited the spread of woody species and enable less competitive plants such as rock cinquefoil and bloody cranesbill to survive, as well as the whitebeam amongst the tree population. Much of the woodland scrub has developed on stabilised screes, along with important lichen and moss communities. Moel Y Golfa is the largest semi-natural broadleaved woodland ……"

6.3.4. Consequently, the lower AQS has been considered. However, it should be noted that the PC is only just over 1% when the Installation is operating at the maximum ELV, 24 hours a day, seven days a week, in reality emissions are likely to be significantly lower and are unlikely to have a significant impact on the SSSI. A further assessment of ammonia has been undertaken in combination and may be found in Section 10.5. of this report.

6.4. Comparison of Maximum Predicted Pollutant Ground Level Concentrations with Critical Levels for the Protection of Vegetation and Ecosystems - Hydrogen Fluoride

6.4.1. A summary of maximum predicted GLCs of hydrogen fluoride at the identified sensitive habitat sites are presented in Tables 42 and 43. In accordance with the H1 guidance, the significance of the impacts has been determined using the 100% long and short term screening criteria for local nature sites, and 1% and 10% criteria for long and short-term predictions, respectively for SPAs, SACs, Ramsars and SSSIs (see Section 2.23. of this document). Any significant impacts are highlighted in bold.

Table 42: Comparison of Maximum Predicted Hydrogen Fluoride Ground Level Concentrations (PCs) with Critical Levels at Sensitive Habitat Sites – Local Nature Sites

Pollutant		HF (Weekly Mean)	HF (Daily mean)
Critical Level		0.5	3
Maximum PC (µg/m³)		0.0096	0.025
Max PC as % of Critical Level		1.92%	0.84%
AW01	Ancient Woodland - 33254	0.0076	0.025
AW02	Ancient Woodland - 33255	0.0086	0.023
AW03	Ancient Woodland - 47343	0.0082	0.017
AW04	Ancient Woodland - 26045	0.0096	0.019
AW05	Ancient Woodland - 27762	0.0052	0.015
AW06	Ancient Woodland - 33238	0.0066	0.016
AW07	Ancient Woodland - 27222	0.0031	0.015
AW08	Ancient Woodland - 28973	0.0039	0.011
AW09	Ancient Woodland - 35167	0.0055	0.010
AW10	Ancient Woodland - 27086	0.0049	0.014
AW11	Ancient Woodland - 27223	0.0032	0.009

Table 43: Comparison of Maximum Predicted Hydrogen Fluoride Ground Level Concentrations (PCs) with Critical Levels at Sensitive Habitat Sites – SPAs, SACs, Ramsars and SSSIs

Pollutant		HF (Weekly Mean)	HF (Daily mean)
Critical Level		0.5	3
Maximum PC (µg/m³)		0.00575	0.01766
Max PC as % of Critical Level		**1.15%**	0.59%
RAM1	Midland Meres and Mosses Phase 1 - Marton Pool	0.00084	0.00238
RAM2	Midland Meres and Mosses Phase 2	0.00038	0.00147
SAC1	Montgomery Canal	0.00440	0.00883
SAC2	Granllyn	0.00133	0.00289
SSSI1	Buttington Brickworks	0.00575	0.01766
SSSI2	Montgomery Canal	0.00440	0.00883
SSSI3	Moel y Golfa	0.00391	0.00854

6.4.2. It can be seen from the data in Table 42 that the weekly and daily mean HF PCs are all less than 100% of the critical level and therefore, are not significant at all of the local nature sites considered.

6.4.3. Similarly, it can be seen from the data in Table 42 that the weekly and daily mean ammonia PCs are all less than 1% of the critical levels and therefore, are not significant at all SACs, Ramsars and most of SSSI's considered. The weekly mean of HF is greater than 1% at the Buttington Brickworks, however, considering that the SSSI is designated as a geological SSSI, there will be do detrimental ecological impacts. However, for the sake of completeness, a background concentration[1] of 0.0005µg/m^3, together with the PC of 0.00575µg/m^3 would give a PEC of 0.00625µg/m^3, which is 1.25% of the AQS and therefore not significant in accordance with the guidance set out in Section 2.23 of this report.

[1] EPAQS (February 2006) Guidelines for Halogen and Hydrogen Halides in Ambient Air for Protecting Human Health Against Acute Irritancy Effects

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

7.1. Comparison of Maximum Predicted Nutrient Nitrogen Deposition Rates with Critical Loads – Local Nature Sites

7.1.1. A summary of maximum predicted nutrient nitrogen deposition rates at the identified Local Nature sites (i.e. ancient woodland) are presented in Table 44. It should be noted that the habitat with the lowest lower and upper critical load has been selected. Habitat Interests considered are as specified in Table 2.

7.1.2. PCs greater than 100% of the critical load and PECs greater than 100% of the critical load are highlighted in bold.

Table 44: Comparison of Maximum Predicted Nutrient Nitrogen Deposition Rates with Critical Loads at Sensitive Habitat Sites – Local Sites

ADMS Ref.	Site ID	Deposition Velocity	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Process Contribution (kgN/ha/yr)	PC as a Percentage of Lower Critical Load	PC as a Percentage of Upper Critical Load	Background Concentration (kgN/ha/yr)	PEC (kgN/ha/yr)	PEC as a Percentage of Lower Critical Load	PEC as a Percentage of Upper Critical Load
AW01	33254	Forest	10	20	0.061	0.61%	0.30%	30.52	30.58	**306%**	**153%**
AW02	3255	Forest	10	20	0.069	0.69%	0.34%	30.52	30.59	**306%**	**153%**
AW03	47343	Forest	10	20	0.19	1.92%	0.96%	30.52	30.71	**307%**	**154%**
AW04	26045	Forest	10	20	0.28	2.78%	1.39%	30.52	30.80	**308%**	**154%**
AW05	27762	Forest	10	20	0.094	0.94%	0.47%	34.16	34.25	**343%**	**171%**
AW06	33238	Forest	10	20	0.072	0.72%	0.36%	34.16	34.23	**342%**	**171%**
AW07	27222	Forest	10	20	0.063	0.63%	0.32%	34.16	34.22	**342%**	**171%**
AW08	28973	Forest	10	20	0.067	0.67%	0.34%	34.16	34.23	**342%**	**171%**
AW09	35167	Forest	10	20	0.12	1.21%	0.61%	30.52	30.64	**306%**	**153%**
AW10	27086	Forest	10	20	0.076	0.76%	0.38%	34.16	34.24	**342%**	**171%**
AW11	7223	Forest	10	20	0.073	0.73%	0.36%	34.16	34.23	**342%**	**171%**

7.1.3. It can be seen from the data in Table 44 that the maximum nutrient nitrogen deposition rates, due to process emissions, are less than 100% of both the upper and lower critical loads at all habitat sites. However, due to the large background concentrations, all PECs are in excess of 100% of the upper and lower critical loads.

7.1.4. It should be noted that, and in accordance with the EA guidance, if the PCs are less than 100% of the appropriate environmental criterion, then there will be no significant pollution. Consequently, it can be concluded that, as the highest PC is only 2.78% of the lower critical load and 1.39% of the upper critical load, the Installation will not cause significant pollution.

7.2. Comparison of Maximum Predicted Nutrient Nitrogen Deposition Rates with Critical Loads – European Sites and SSSIs

7.2.1. A summary of maximum predicted nutrient nitrogen deposition rates at the identified European Sites and SSSIs are presented in Table 45. It should be noted that the habitat with the lowest lower and upper critical load has been selected. Habitat Interests considered are as specified in Table 2.

7.2.2. PCs greater than 1% of the critical load and PECs greater than 70% of the critical load are highlighted in bold.

Table 45: Comparison of Maximum Predicted Nutrient Nitrogen Deposition Rates with Critical Loads at Sensitive Habitat Sites – European Sites and SSSIs

ADMS Ref.	Site	Deposition Velocity	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Process Contribution (kgN/ha/yr)	PC as a % of Lower Critical Load	PC as a % of Upper Critical Load	Background Conc (kgN/ha/yr)	PEC (kgN/ha/yr)	PEC as % of Lower Critical Load	PEC as a% of Upper Critical Load
RAM1	Midland Meres and Mosses – Phase 1	Grassland	10	15	0.025	0.24%	0.16%	19.46	19.48	**195%**	**130%**
RAM2	Midland Meres and Mosses – Phase 2	Grassland	10	15	0.013	0.13%	0.08%	18.2	18.21	**182%**	**121%**
SSSI1	Buttington Brickworks	Geological SSSI									
SSSI2	Montgomery Canal	Grassland	3	10	0.086	**2.96%**	0.89%	13.86	13.95	**465%**	**139%**
SSSI3	Moel y Golfa	Forest	5	15	0.13	**2.63%**	0.88%	30.52	30.76	**613%**	**204%**
SAC1	Montgomery Canal SAC	Grassland	3	10	0.086	**2.86%**	0.86%	14.5	14.59	**486%**	**146%**
SAC2	Granllyn SAC	n/a	No comparable habitat		0.03	n/a	n/a	12.2	12.23	n/a	n/a

7.2.3. It can be seen from the data in Table 45 that the maximum nutrient nitrogen deposition rates, due to process emissions, are greater than 1% at the Montgomery Canal and Moel-y-Golfa. Also due to the large background concentrations, all PECs are in excess of 100% of the upper and lower critical loads.

7.2.4. It is considered that, as both the Ramsar sites have PCs less than 1% of the critical loads, no further assessment is required.

7.2.5. Further investigation of the Montgomery Canal and Moel-y-Golfa is required. BSG Ecology have investigated both sites, and have provided the following assessment for each.

Montgomery Canal

7.2.6. The Montgomery Canal is described as 'permanent oligotrophic water' with a Critical Load (CL) for Nitrogen deposition of 3-10 kg N/ha/yr[1]. Site levels are reported to be 12.2 kg N/ha/yr (average), with a range of 10.8 kg N/ha/yr (minimum) to 14.5 kg N/ha/yr (maximum), which means that the upper Critical Load is already being exceeded for nitrogen.

7.2.7. APIS advises that the application of the CL for Nitrogen in any assessment should be subject to the following considerations:

'*Important Note: Seek site specific advice for site value. This critical load only applies if the interest feature is associated with softwater oligotrophic or dystrophic lakes at the site. If the feature is not depending on these lake types, there is no comparable critical load available. The critical load for C1.1 and C1.4 is 3-10 kgNha-1yr-1. The lower end of the range is intended for boreal and alpine lakes, and the higher end of the range for Atlantic softwaters. Site specific advice should be sought from the conservation agencies as to which part of the range is relevant. Note that the critical load should only be applied to oligotrophic waters with low alkalinity with no significant agricultural or other human inputs*.'

7.2.8. The conservation objectives for the SSSI include an interim total phosphorus target for the whole canal of <40µg L^{-1} Total Phosphorus. No target is required for other elements, which indicates that P is considered to be the rate limiting nutrient. The interim total phosphorus target for the whole canal of <40µg L^{-1} indicates that it should be treated as being at the upper end of the mesotrophic[2] range.

7.2.9. Source attribution data[1] indicate that the current baseline exceedance is heavily influenced by agricultural sources. The APIS data (total Nitrogen deposition expressed as Kg N/ha/yr from sources by Region) indicate that the main sources are livestock 45.80% (Wales and England combined), road transport 8.91%, fertiliser 6.95% (Wales and England combined), shipping 5.28%, and European sources 14.35% (total 81.29%).

7.2.10. The process contribution from the ERF will be 0.09 kg N/ha/yr, which is not significant in terms of the overall levels of nitrogen compared to the current levels. When the PC is compared to the CL for Nitrogen deposition it is equivalent to 2.96% of the lower CL and 0.89% of the upper CL. As noted above, the lower CL is intended for boreal and alpine lakes; the PC when

[1] http://www.apis.ac.uk, accessed 22 May 2020

[2] OECD (1982) defines freshwater trophic categories as follows: oligotrophic = mean total P <10 µg l^{-1}; mesotrophic = mean total P 10-35 µg l^{-1}; eutrophic mean total P >35 µg l^{-1}

compared to the upper CL falls below 1% of the long-term environmental standard and so can be screened out.

Moel y Golfa

7.2.11. The SSSI is the largest remaining area of semi-natural broadleaved woodland in Montgomeryshire, with many mature trees and a well-developed shrub and ground layer in parts. The site is particularly notable for its breeding birds, with 48 breeding species recorded.

7.2.12. The citation notes that the composition of the woodland canopy is complex and has been modified by the planting of conifers. The ground flora of the site is variable and includes common species in many areas; however, there are also wetter areas and glades that support heath vegetation, which increase the diversity. In some areas basic igneous intrusions support notable calcicolous plants.

7.2.13. Standing and felled timber provide habitats for a wide range of fungi. The scarce liverwort Ptilidium pulcherrimum is reported to be present (but no reference is made to any other lower plants).

7.2.14. The list of Potentially Damaging Operations for the SSSI does not specifically consider aerial deposition or more general pollution; however, the following is included:

- application of manure, fertilisers and lime; and
- dumping, spreading or discharging of any materials.

7.2.15. Whilst these are considered to apply to agricultural activities and illegal activities such as fly-tipping, a broad interpretation could potentially include aerial deposition of nutrients.

7.2.16. The Site Management Statement for the SSSI also does not make reference to the effects of aerial deposition.

7.2.17. There are no published Conservation Objectives for the SSSI and so it has been assumed for the purposes of the assessment that a Conservation Objective is to preserve the existing habitat structure (or facilitate habitat restoration if required) by reducing Nitrogen deposition to below the Critical Load for woodland habitat. Currently baseline N-deposition is 30.52 kgN/ha/yr, which is almost double the upper end of the CL range (which is 5-15 kgN/ha/yr).

7.2.18. Source attribution data provided by APIS (http://www.apis.ac.uk/, accessed 22 May 2020) indicate that the current baseline exceedance is heavily influenced by agricultural and other sources. The APIS data (total Nitrogen deposition, expressed as Kg N/ha/yr, from sources by Region) indicate that the main sources are livestock 47.49% (Wales and England combined), road transport 8.72%, fertiliser 6.15% (Wales and England combined), shipping 5.56%, and European sources 14.54% (total 82.46%).

7.2.19. The Process Contribution is 0.13 kgN/ha/yr, which is 0.88% of the upper CL and 2.63% of the lower CL, i.e. the PC when compared to the upper CL is below the 1% screening threshold and so a significant effect is unlikely. Although the PC is above the 1% threshold when compared to the lower CL, this is only a screening threshold and does not by default mean that a significant effect is likely.

7.2.20. Modelling of deposition rates at different elevations within the SSSI indicate that there is likely to be widespread variability. The PC as a percentage of the upper CL ranges from 0.086% at 400 m Above Ordnance Datum (AOD) to 0.13% at 100 m AOD. The PC as a percentage of the lower CL ranges from 1.72% at 400 m AOD to 2.58% at 100 m AOD.

7.2.21. In the absence of the proposed development, there will still be exceedance of the N-deposition CL for woodland, which is mainly attributable to agricultural and other sources. If the assumed Conservation Objective (of reducing Nitrogen deposition to below the CL for woodland habitat) is to be achieved, this will require policy intervention at the Government level. The required changes are of such a magnitude that the predicted PC (which is 0.13 kgN/ha/yr) is unlikely to affect the ability to achieve the Conservation Objective.

7.3. Comparison of Maximum Predicted Acid Deposition Rates with Critical Loads – Local Nature Sites

7.3.1. A summary of maximum predicted acid deposition rates at the identified Local Nature sites (i.e. ancient woodland) are presented in Table 46. Habitat Interests considered are as specified in Table 2, and the forest deposition rate was used for all sites.

7.3.2. PCs and PECs greater than 100% of the critical load are highlighted in bold.

Table 46: Comparison of Maximum Predicted Acid Deposition Rates with Critical Loads at Sensitive Habitat Sites – Local Sites

Ref	Site	PC N (keq/Ha/yr)	BG N (keq/ha/yr)	PC S (keq/Ha/yr)	BG S (keq/ha/yr)	CL MinN (keq/ha/yr)	CLMaxN (keq/ha/yr)	CLMaxS (keq/ha/yr)	PEC N (keq/Ha/yr)	PEC S (keq/Ha/yr)	PC as % of CL	Total PEC (keq/ha/yr)	PEC as & of CL
AW01	33254	0.0048	2.18	0.002	0.16	0.357	2.828	2.471	2.18	0.16	0.24%	2.35	83%
AW02	33255	0.0054	2.18	0.001	0.16	0.357	2.828	2.471	2.19	0.16	0.23%	2.35	83%
AW03	47343	0.0151	2.18	0.040	0.16	0.357	2.83	2.473	2.20	0.20	1.96%	2.40	85%
AW04	26045	0.0220	2.18	0.037	0.16	0.357	2.83	2.473	2.20	0.20	2.07%	2.40	85%
AW05	27762	0.0074	2.44	0.052	0.2	0.142	1.684	1.542	2.45	0.25	3.51%	2.70	**160%**
AW06	33238	0.0057	2.44	0.061	0.2	0.142	1.684	1.542	2.45	0.26	3.98%	2.71	**161%**
AW07	27222	0.0050	2.44	0.022	0.2	0.142	1.684	1.542	2.45	0.22	1.62%	2.67	**158%**
AW08	28973	0.0054	2.44	0.020	0.2	0.142	1.684	1.542	2.45	0.22	1.53%	2.67	**158%**
AW09	35167	0.0096	2.18	0.016	0.16	0.357	2.83	2.473	2.19	0.18	0.91%	2.37	84%
AW10	27086	0.0060	2.44	0.015	0.2	0.142	1.684	1.542	2.45	0.22	1.26%	2.66	**158%**
AW11	27223	0.0058	2.44	0.026	0.2	0.142	1.685	1.543	2.45	0.23	1.88%	2.67	**159%**

Notes to Table 46

PC N = Process contribution from nitrogen (dry deposition only)

PC S = Process contribution from sulphur (dry deposition) and hydrogen chloride (wet and dry deposition)

PEC = Predicted environmental concentration

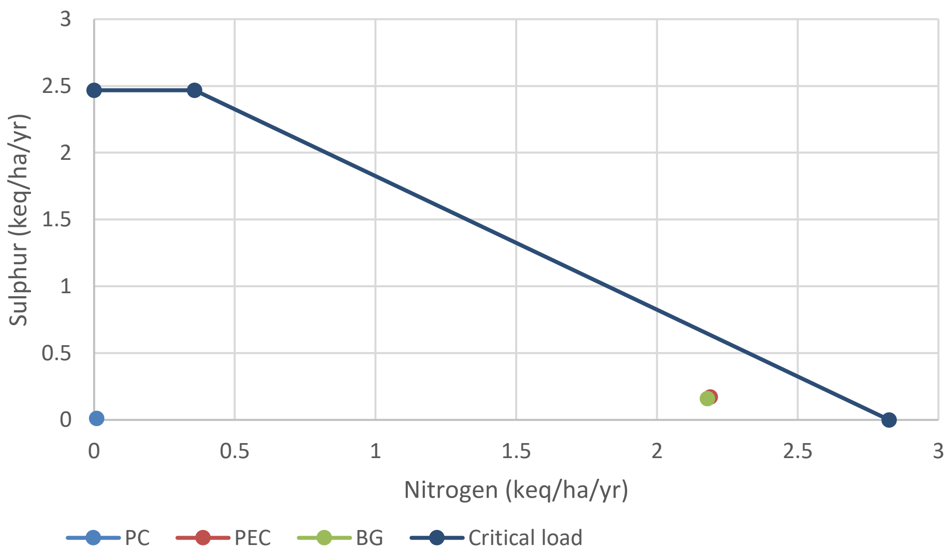
BG = Background concentration

CL = Critical Load

7.3.3. It can be seen from the data in Table 46 that the maximum acid deposition rates due to process emissions are less than 100% of the critical loads function at all habitat sites. However, due to the large background concentrations, all PECs are in excess of 100% of the critical loads at six of the sites considered. It should be noted that, and in accordance with the EA guidance, if the PCs are less than 100% of the appropriate environmental criterion then there will be no significant pollution.

7.3.4. The critical load function, for the site with the highest CL, AW06, has also been graphed using the APIS critical load function tool. The results are shown in Figure 48.

Figure 48: Comparison with Critical Load Function for Ancient Woodland Site 33238



7.3.5. The graph clearly shows that the exceedance is due to the background and not process contributions. Consequently, it can be concluded that, as the highest PC is only 4% of the critical load, the Installation will not cause significant pollution.

7.4. Comparison of Maximum Predicted Acid Deposition Rates with Critical Loads – European Sites and SSSIs

7.4.1. A summary of maximum predicted acid deposition rates at the identified European Sites and SSSIs are presented in Table 47. Habitat Interests considered are as specified in Table 2, and the forest deposition rate was used for all sites.

7.4.2. PCs greater than 1% of the critical load, and PECs greater than 70% of the critical load are highlighted in bold.

Table 47: Comparison of Maximum Predicted Nutrient Nitrogen Deposition Rates with Critical Loads at Sensitive Habitat Sites – European Sites and SSSIs

ADMS Ref.	Site	PC N (keq/Ha/yr)	BG N (keq/ha/yr)	PC S (keq/Ha/yr)	BG S (keq/ha/yr)	CL MinN (keq/ha/yr)	CLMaxN (keq/ha/yr)	CLMaxS (keq/ha/yr)	PEC N (keq/ha/yr)	PEC S (keq/ha/yr)	PC as % of CL	Total PEC (keq/ha/yr)	PEC as % of CL
RAM1	Midland Meres and Mosses – Phase 1	Habitat not sensitive to Acidity											
RAM1	Midland Meres and Mosses – Phase 2	Habitat not sensitive to Acidity											
SSSI1	Buttington Brickworks	Habitat not sensitive to Acidity											
SSSI2	Montgomery Canal	No Critical Loads Set for Freshwater											
SSSI3	Moel y Golfa	0.010	2.180	0.011	0.16	0.357	2.825	2.468	2.19	0.17	0.77%	2.36	**83.60%**
SAC1	Montgomery Canal SAC	No critical loads are available for this feature											
SAC2	Granllyn SAC	No critical loads are available for this feature											

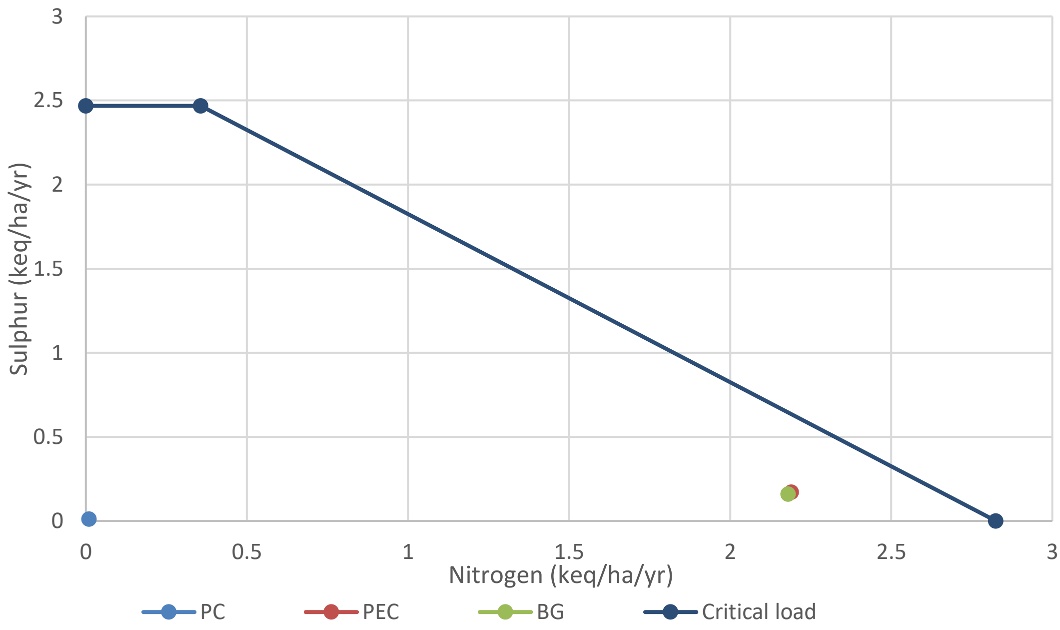
Notes to Table 47
PC N = Process contribution from nitrogen (dry deposition only)
PC S = Process contribution from sulphur (dry deposition) and hydrogen chloride (wet and dry deposition)
PEC = Predicted environmental concentration
BG = Background concentration
CL = Critical Load

7.4.3. It can be seen from the data in Table 47 that the maximum acid deposition rates due to process contributions are less than 1% at the Moel-y-Golfa. All other European sites or SSSI's are either not sensitive to acidity or have no critical loads available.

7.4.4. However, due to the large background concentrations, the PECs are in excess of 70%. Therefore, further investigation was required.

7.4.5. The critical load function, for Moel-y-Golfa was graphed using the APIS critical load function tool. The results are shown in Figure 49.

Figure 49: Comparison with Critical Load Function for Moel-y-Golfa



7.4.6. The graph clearly shows that there is no exceedance of the critical load and also demonstrates the high PEC is attributable to the existing background concentration.

7.4.7. In accordance with the EA guidance, if the PECs are less than 100% of the appropriate environmental criterion then there will be no adverse effect.

7.4.8. It can be seen from the data in Table 47 that, where the habitat is sensitive to acid deposition, the maximum predicted acid deposition rate as a result of emissions from the proposed facility is less than 1% of the critical load and, therefore, is insignificant.

8. ASSESSMENT OF AIR QUALITY IMPACTS - PLUME VISIBILITY

8.1. Forecast Visible Plumes

8.1.1. This section of the report describes the potential visible plume impacts from the Installation's stack. A plume will become visible when water vapour in the plume condenses to form small particles in the form of water droplets. A plume is defined as "visible" if the liquid water content of the plume at the centreline exceeds 0.000015 kg/kg, and is defined to have grounded if the vertical spread of the plume is larger than the plume centreline height.

8.1.2. In addition to the input parameters for the model used thus far, the initial mixing ration of the plume in kg/kg (i.e. the mass of water vapour per unit mass of dry release at the source) is also required. This value was provided by HZI and is 0.149 kg/kg.

8.1.3. Plume visibility for the main stack was assessed for the 5 years of observed met data and the two years of NWP met data with the surface heat flux and boundary layer off. All met files include the relative humidity and temperature required for plume visibility calculation.

8.1.4. The modelled lengths of visible vapour plumes are provided in Table 48 for all hours. No visible groundings were observed for any of the met years.

Table 48: Forecast Visible Plumes during Daylight Hours

	2015	2016	2017	2018	2018 NWP - Heat Off	2019	2019 NWP - Heat Off
Number of Met Lines Used	8406	8341	8398	8459	8293	8390	8293
Number of Visible Plumes	2232	2590	2135	2682	2475	2512	2891
Percentage of Visible Plumes	27%	31%	25%	32%	30%	30%	35%
Average length of visible plumes (m)	33.14	35.48	41.75	44.22	41.59	39.48	54.81
Max Length of visible plume (m)	351.62	297.41	350.31	359.21	513.67	281.53	370.16

8.1.5. The results of the plume visibility assessment concluded that visible plumes will only occur for a maximum of 35% of the hours in a year. The maximum length of a visible plume from the installation is 513.67m. However, on average visible plumes would be 55m (54.81m) in length.

8.1.6. It is also important to consider how often the plumes of varying length will be present for. Table 49 provides the 10-100th Percentile plume lengths for each met year considered. All figures are in meters.

Table 49: 10-100th Percentile Plume Lengths

Percentile	2015	2016	2017	2018	2018 NWP (HBO)	2019 NWP (HBO)
10th Percentile Plume Length	0	0	0	0	0	0
20th Percentile Plume Length	0	0	0	0	0	0
30th Percentile Plume Length	0	0	0	0	0	0
40th Percentile Plume Length	0	0	0	0	0	0
50th Percentile Plume Length	0	0	0	0	0	0
60th Percentile Plume Length	0	0	0	0	0	0
70th Percentile Plume Length	0	0	0	0	0	4
80th Percentile Plume Length	8	15	8	0	14	29
90th Percentile Plume Length	31	39	39	50	41	72
95th Percentile Plume Length	53	65	67	80	68	107
98th Percentile Plume Length	92	101	109	124	117	149
99th Percentile Plume Length	117	123	139	162	172	180
100th Percentile Plume Length	352	297	350	359	514	370

8.1.7. The results in Table 49 show that for 40% of all hours, no visible plume is forecast to occur. When visible, the plume length is predicted to be short, with a plume length of around 4m for 30% of daylight hours (i.e. 70th Percentile) as shown in Table 49. The plume is forecast to extend to only to a length of up to 107m for 5% of the time (95th Percentile) and therefore would remain within the site boundary (113m from the stack location).

8.1.8. The nearest sensitive receptor considered in the assessment would be H01 – Cefn Cottage, a distance of 182m from the Installation stack. The plume would only extent to this distance for 1% of the time, as demonstrated by the 99th Percentile in Table 49.

8.1.9. In the absence of NRW specific guidance on plume visibility, SEPA's H1 guidance[1], has been used to assess the impact of plume visibility. The screening criteria used is provided in Table 50.

[1] IPPC Environmental Assessment and Appraisal of BAT, V6, July 2003

Table 50: Screening Criteria for Plume Visibility

Impact	Quantitative Description
Zero	• No visible impacts resulting from operation of process
Insignificant	• Regular small impact from operation of process • Plume length exceeds boundary less than 5% of daylight hours per year • No sensitive local receptors
Low	• Regular small impact from operation of process • Plume length exceeds boundary less than 5% of daylight hours per year • Sensitive local receptors
Medium	• Regular large impact from operation of process • Plume length exceeds boundary for more than 5% of daylight hours per year • Sensitive local receptors
High	• Continuous large impact from operation of process • Plume length exceeds boundary more than 25% of daylight hours per year • Local sensitive receptors

8.1.10. Based on the SEPA criteria the impact would be classed as low; as the plume length exceeds the average site boundary distance for less than 5% of hours per year (i.e. the 95th Percentile) and there are sensitive local receptors. It should be noted that the SEPA criteria refers to daylight hours, however, this assessment considers all hours.

8.1.11. Consequently, it can be concluded that the impact of visible plumes is low. A visual representation of the average visible plume is provided in Figure 50.

Figure 50: Visual Representation of the Average Visible Plume

9. ASSESSMENT OF AIR QUALITY IMPACTS - ABNORMAL EMISSIONS

9.1. Scenarios Considered

9.1.1. In order to assess the impact of the plant under abnormal operating conditions, two scenarios have been considered:

- with emissions at the half-hourly emission limits prescribed in Annex VI of the IED,
- and to take account of short-term abnormal conditions permitted under Article 46(6) of the IED.

9.2. Emissions at Half-hourly Emission Limit Values

9.2.1. The dispersion modelling results presented below are based on the facility operating for all hours in the year with the pollutant concentrations at the daily ELVs prescribed by Annex VI of the IED. This is an extreme assumption, especially for long term predictions, since the facility could never operate with release rates as high as this in practice. Annex VI of the IED also prescribes short-term ELVs for some pollutants based on half hourly average concentrations. However, the frequency with which these limits can be applied are very limited (i.e. for the majority of pollutants with half hourly limits the daily limit value must be complied with for 97% of the time).

9.2.2. Half-hourly limit values apply to total dust (30mg/Nm^3), volatile organic compounds (as benzene), (20mg/Nm^3), hydrogen chloride (60mg/Nm^3), hydrogen fluoride (4mg/Nm^3), sulphur dioxide (200mg/Nm^3) and oxides of nitrogen (as nitrogen dioxide) (400mg/Nm^3).

9.2.3. Short-term peak concentrations may arise if the facility emits some pollutants that are at concentrations within the half hourly limit values prescribed in Annex VI of the IED but greater than the daily limit values used for the dispersion modelling. The probability of such occasions occurring at the same time as the meteorological conditions that produce the highest one-hour mean GLCs is remote. However, in the event that this does occur, then the maximum one-hour mean GLCs for these pollutants would be as provided in Table 51. Please note that in accordance with the findings of the screening study, the value used for the 100th percentile of hourly meant for this assessment is the 100th percentile at the location of the 99.97th percentile in order to ensure consistency of approach.

Table 51: Maximum Predicted One-hour Concentrations (PCs) for Emissions at the Half- hourly IED Emission Limit Values

Pollutant	Maximum Predicted Hourly Mean GLC (PC) (µg/m^3) (b)	Short-term AQS (µg/m^3)	PC as a %age of Short-term AQS
Particulate Matter, as PM_{10}	4.69	No hourly standard	n/a
VOCs (as Benzene)	3.12	No hourly standard	n/a
Hydrogen Chloride	9.37	750	1.25%
Hydrogen Fluoride	0.625	160	0.39%
Sulphur Dioxide	31.24	350	8.92%
Nitrogen Dioxide (a)	21.87	200	10.93%

Notes to Table 51
Assuming 35% of NO_x is oxidised to NO_2 (see Section 2.26. of this document).
Maximum predicted hourly concentration for all hours of the meteorological data set.

9.2.4. With the exception of nitrogen dioxide, predicted PCs under these worst-case conditions are all less than 10% of their respective AQSs and, in accordance with the short-term significance criterion detailed in Section 2.22. of this document, would be assessed as being not significant.

9.2.5. For nitrogen dioxide, the maximum predicted short term concentrations is 10.93%. This is only just above the short-term significance criterion, and represents the very worst case conditions i.e. this is the highest PC predicted assuming the facility emits at the half-hourly average for the entire year and therefore, combines the maximum emission with the worst case hour of meteorological data. Furthermore, these are the maximum concentrations predicted at any location within the model area. Accordingly, it is considered that, in practice, releases of nitrogen dioxide will not be significant. However, even at this concentration, using the IAQM methodology, the impact would be described as small.

9.2.6. Predicted concentrations at the sensitive human receptors will be substantially lower than this, and, accordingly, will not be significant.

9.3. Emissions Under Abnormal Operating Conditions

9.3.1. Results presented in Section 5 of this report are based on normal operating conditions and using daily emission limits where daily and half-hourly values are provided. Article 46(6) of the IED allows abnormal operation, where the ELVs can be exceeded for certain periods, without being in contravention of the Environmental Permit for the plant. This part of the assessment quantifies the impacts on air quality as a result of changes in emissions during abnormal events.

9.3.2. In the event of any process disruption or mechanical failure, the operator would assess the situation to determine if these abnormal conditions can be remedied without resulting in elevated emissions; this would avoid shutting down the process unnecessarily. Where this is not the case, the operator would reduce/cease fuel loading and commence a controlled shutdown of the combustion plant.

9.3.3. The dispersion modelling assessment for abnormal emissions has been adapted to consider short-term impacts during periods of abnormal operation, assuming abatement plant failure. Article 46(6) of the IED specifies that abatement plant or monitoring failure may not occur for longer than four hours whilst the plant is operating. Therefore, if it is likely that the problem cannot be rectified within four hours then a controlled shut down would be implemented as soon as possible. In addition, the total allowable period in a year for abnormal releases must not exceed sixty hours.

9.3.4. Accordingly, the maximum time period for which a failure can occur is four hours. For carbon monoxide and total organic carbon - VOCs (pollutant indicators of poor combustion conditions) are not allowed to exceed their respective ELVs. Therefore, a four hour exceedance of the ELVs only applies to total dust (maximum concentration of 150mg/Nm^3, expressed as a half-hourly average), hydrogen chloride, hydrogen fluoride, sulphur dioxide and oxides of nitrogen.

9.3.5. For assessing short-term air quality impacts resulting from abnormal operation, it has been assumed that the plant operates for four hours continuously at the maximum emission concentration (i.e. half-hourly limit or abnormal emission limit). Abnormal emission limits apply to carbon monoxide (100mg/Nm^3) and to total dust (150mg/Nm^3).

9.3.6. For assessing long-term impacts - annual mean GLCs - it has been assumed that the plant operates at sixty hours per year at the maximum permissible emission 3% of the time at the half hour limit where these apply and the remainder at the daily emission limit. On this basis an annual average emission limit has been derived to determine annual average concentrations.

9.3.7. Emission concentrations for the assessment of abnormal emissions on short-term and long-term predicted concentrations are presented in Table 52. Predicted maximum GLCs are compared to the relevant AQSs in Table 53.

Table 52: Short-term and Long-term Emission Concentrations for Abnormal Releases

Pollutant	Half Hour Limit (mg/Nm^3)	Normal Emission Concentration (mg/Nm^3)	Maximum Emission Concentration (mg/Nm^3)	Assumed Short-term Abnormal Emission (mg/Nm^3)	Assumed Long-term Abnormal Emission Concentration (mg/Nm^3)
Particulate Matter, as PM_{10}	30	10	150	33.3[(a)]	11.0[(b)]
Hydrogen Chloride	60	10	-	60	No Long-term AQS
Hydrogen Fluoride	4	1	-	4	1.02[(c)]
Sulphur Dioxide	200	50	-	200	No Long-term AQS
Nitrogen Dioxide [(d)]	400	120	-	400	121.92[(c)]
Carbon Monoxide	100	50	150 [(e)]	100	No Long-term AQS

Notes to Table 52

(a) 4 hours at $150mg/Nm^3$ and 20 hours at the normal emissions concentration ($10mg/Nm^3$) for comparison with daily mean AQS.

(b) 60 hours at $150mg/Nm^3$ and the remainder of hours at the normal emission concentration of $10mg/Nm^3$.

(c) 60 hours at half hour limit and the remainder at the normal emissions concentration.

(d) Assuming 35% of NOx is oxidised to NO_2.

(e) Ten minute average.

Table 53: Comparison of Maximum Predicted Pollutant Ground Level Concentrations (PCs) with Air Quality Standards for Abnormal Emissions

Pollutant	Averaging Period	Maximum Predicted GLC (PC) (µg/m³)	AQS (µg/m³)	PC as a %age of AQS
Particulate Matter, as PM_{10}	annual	0.115	40	0.29%
	24-hour	0.179	50	0.36%
Hydrogen Chloride	1-hour	9.371	750	1.25%
Hydrogen Fluoride	annual	0.413	16	2.58%
	1-hour	0.625	160	0.39%
Sulphur Dioxide	24-hour	11.65	125	9.32%
	1-hour	19.63	350	5.61%
	15-minute	21.98	266	8.26%
Nitrogen Dioxide	annual	0.899	40	2.25%
	1-hour	21.87	200	10.93%
Carbon Monoxide	8-hour	16.31	10,000	0.16%

9.3.8. It is evident from the data in Table 53, that PCs of PM_{10}, hydrogen chloride, hydrogen fluoride, sulphur dioxide and carbon monoxide can be considered to be not significant as long term GLCs are less than 1% of the long-term AQS and short term GLCs are less than 10% of the short-term AQS.

9.3.9. For nitrogen dioxide, the maximum predicted annual mean GLC is in excess of 1% of the long-term AQS, and the short term is in excess of 10% of the short-term AQS. Stage 2 screening has, therefore, also been undertaken. The PEC for the long-term would be 19.77µg/m³, 49% of the AQS and therefore classed as a slight impact under the IAQM methodology. The short-term concentration, at 10.93% of the AQS, is also classed as slight under the IAQM methodology. This is only just above the short-term significance criterion, and represents the very worst-case conditions Furthermore, these are the maximum concentrations predicted at any location within the model area. Accordingly, it is considered that, in practice, releases of nitrogen dioxide will not be significant.

10. INCOMBINATION ASSESSMENT

10.1. Introduction

10.1.1. During the statutory pre-application consultation process for the ERF, NRW made a number of comments which required further assessment. NRW requested a total of 8 requirements to be met and a number of planning conditions. Three of the requirements were in in relation to air quality, and are as follows:

- Requirement 1 – an amended Air Quality Impact Assessment;
- Requirement 2 – Submission of a detailed ammonia and nitrogen assessment for the Montgomery Canal SAC and SSSI
- Requirement 3 – Submission of a detailed ammonia modelling assessment for the Moel Y Golfa SSSI.

10.1.2. Requirement 1 requires an Air Quality Impact Assessment which considers the cumulative impacts of other development (namely a proposed intensive livestock unit ("ILU") 3.5km south of the site) and includes an assessment of transport impacts on protected sites. This will be addressed as follows:

i. the ADMS Roads Assessment (ECL report ECL.001.01.02/ADM Roads – Technical Appendix 6.2 of the ES) will be updated to include the impact of the highways movements associated with the ERF on protected ecological sites;
ii. the ADMS Roads Assessment (ECL report ECL.001.01.02/ADM Roads – Technical Appendix 6.2 of the ES) will be updated to include the impact of the highways movements associated with the ERF and the impact of emissions from the A1 stack at the maximum point of ground level concentration, human sensitive receptor locations and protected ecological sites;
iii. ADMS 5 will be used to model the impact of the ERF and the ILU on airborne ammonia concentrations at the maximum point of impact of the ERF.

10.1.3. Requirement 2 requires submission of detailed ammonia and nitrogen assessment for the Montgomery Canal SAC/SSSI. ADMS 5 will be used to model the impact of the ERF and the ILU, process contributions obtained from the ADMS Roads assessment on the ecological sites (point i) will then be added to the ADMS 5 output to obtain the total impact from the emission sources for nitrogen deposition. The output of the ERF and ILU with be used for the ammonia assessment. The results will be presented within this report.

10.1.4. Requirement 3 requires submission of a detailed ammonia assessment for Moel Y Golfa SSSI. ADMS 5 will again be used to model the impact from the ERF and the ILU at this site. The results will be presented within this report.

10.2. Data Availability

10.2.1. ES Chapter 16 of the DNS Application for the ERF (ECL Report ECL.001.01.02/ES) presents a table of developments in the area which may have a cumulative impact with the ERF. In their response to the Pre-Application Consultation, NRW commented that this ILU should be considered in combination with the ERF as the development is known to contribute ammonia and nitrogen to protected sites. The ILU relates to planning application P/2018/0474 – Application for a Proposed Free Range Egg Laying Chicken Houses at Trelystan, near Leighton in Powys. The ILU is located 3.88km south east of the ERF.

10.2.2. Included in the application submission documents for P/2018/0474 is "A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Free Range Egg Laying Chicken Houses at Trelystan, near Leighton in Powys" produced by AS Modelling & Data Limited in August 2017 (a copy may be found in Appendix 2 of this report). The data contained within this report has been used to inform the cumulative assessment.

10.2.3. The agent for this development was contacted to ascertain if it was possible to obtain the input modelling files for this study, however, at time of writing, no response had been made. The information for the cumulative assessment is therefore based only on the information contained within the AS Modelling & Data Limited report. It is therefore restricted to relevant specified receptors and process contributions obtained from isopleths (which are approximate) contained within the AS Modelling & Data report

10.2.4. In the absence of the ADMS input files being available, it is considered that there is insufficient information available to accurately recreate the model produced by AS Modelling Limited, however, the report provides the results for the Buttington Brick Works SSSI and the Montgomery Canal. Process Contributions for Moel y Golfa will be obtained from the isopleths.

10.3. In-combination Ammonia Emissions at Max GLC (Requirement 1 Part iii)

10.3.1. The location used for the Buttington Brickworks SSSI in the AS Modelling Report is 326976, 310143. This point is 352m south east of the maximum ground level concentration obtained from the modelling study. In the absence of being able to re-create the model, it is considered that this point would be an over estimate of the ammonia concentrations at the max GLC location of the ERF and therefore could be used as a worst case concentration.

10.3.2. The concentration of ammonia from the ILU at the Buttington Brickworks varies from 0.068µg/m^3 to 0.022µg/m^3, or 0.04 – 0.01% of the AQS for ammonia. The concentration of ammonia at the maximum GLC for the ERF is 0.1053µg/m^3 or 0.06% of the AQS. A worst case in-combination concentration at the point of maximum GLC would be around 0.1733µg/m^3 or 0.096% of the AQS for ammonia. Consequently, it is considered that there is no significant impact from the cumulative impacts of both the ILU and the ERF at the maximum point of impact for the ERF.

10.3.3. No data is provided for the maximum point of impact from the ILU therefore an assessment at the maximum point of impact for the ILU cannot be assessed.

10.4. Assessment of the Montgomery Canal (Requirement 2)

10.4.1. As mentioned in section 10.2.3. the input file for the AS Modelling & Data Limited Report could not be obtained. However, the report does provide the maximum annual mean ammonia concentrations, and maximum annual nitrogen deposition rates at a number of points within the Montgomery Canal SAC. Therefore these points were added to the ECL modelling studies to allow process concentrations at a common location to be combined.

10.4.2. The point for the Montgomery Canal for the in-combination assessment are provided in Table 54. For ease of reference the receptor number from the AS Modelling & Data Limited Report has been used.

Table 54: Montgomery Canal Assessment Locations

ADMS Ref.	Location	Type of Receptor	Easting (X)	Northing (Y)	Distance from Source (m)	Heading (Degrees)
MC36	Montgomery Canal from AS Modelling	SAC/SSSI	323643	308242	3662	240
MC37			324192	309027	2821	248
MC38			324865	310242	1948	275
MC39			322294	306086	6031	228
MC40			325683	311762	2018	326

10.4.3. A summary of maximum predicted GLCs of ammonia at the locations identified within the Montgomery Canal are presented in Tables 55 for the ERF, the ILU and the total.

Table 55: Maximum Predicted Ammonia Ground Level Concentrations (PCs) from the ERF and ILU at the Montgomery Canal

Pollutant		PC from ERF (µg/m^3)	PC from ILU(1) (µg/m^3)	Total PC (µg/m^3)
MC36	Montgomery Canal from AS Modelling	0.0030	0.024	0.0270
MC37		0.0036	0.020	0.0236
MC38		0.0048	0.013	0.0178
MC39		0.0018	0.018	0.0198
MC40		0.0036	0.011	0.0146

Note to Table

(1) Obtained from AS Modelling & Data Limited Report – Table 6a

10.4.4. For ammonia concentrations the critical level for higher plants is 3µg/m^3 as an annual mean and for floating water plantain the critical level for the SAC is 3µg/m^3 again as an annual mean. A comparison with these critical levels is provided in Table 56.

Table 56: Comparison of Maximum Predicted Ammonia Ground Level Concentrations (PCs) with Critical Levels at the Montgomery Canal for the EFR in-combination with the ILU

Location		Maximum PC (µg/m^3)	Critical Level	Max PC as % of Critical Level
MC36	Montgomery Canal from AS Modelling	0.0270	3	0.90%
MC37		0.0236		0.79%
MC38		0.0178		0.59%
MC39		0.0198		0.66%
MC40		0.0146		0.49%

10.4.5. It can be seen from the data in Table 56 that the in-combination impacts for the higher vegetation including Floating Water-plantain, can be considered not significant at all points considered. Consequently, in-combination effects from both the ERF and the ILU on the Montgomery Canal can be considered insignificant.

10.4.6. A summary of maximum predicted nutrient nitrogen deposition rates at locations identified within the Montgomery Canal are presented in Tables 57 for the ERF, the ILU and the total. A comparison with the Critical Loads is provided in Table 58.

Table 57: Maximum Predicted Nitorgen Deposition from the ERF and ILU at the Montgomery Canal

Pollutant		PC from ERF (kgN/ha/yr)	PC from ILU(1) (kgN/ha/yr)	Total PC (kgN/ha/yr)
MC36	Montgomery Canal from AS Modelling	0.020	0.190	0.210
MC37		0.029	0.150	0.179
MC38		0.046	0.100	0.146
MC39		0.012	0.140	0.152
MC40		0.044	0.080	0.124

Note to Table

(1) Obtained from AS Modelling & Data Limited Report – Table 6a

Table 58: Comparison of Maximum Predicted Nutrient Nitrogen Deposition Rates with Critical Loads

ADMS Ref.	Habitat Interest	Deposition Velocity	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Process Contribution (kgN/ha/yr)	PC as a % of Lower Critical Load	PC as a % of Upper Critical Load	Background Conc (kgN/ha/yr)	PEC (kgN/ha/yr)	PEC as % of Lower Critical Load	PEC as a% of Upper Critical Load
MC36	Floating Water Plantain	Grassland	3	10	0.210	7.02%	2.10%	14.5(1)	14.71	490%	147%
MC37					0.179	5.98%	1.79%		14.68	489%	147%
MC38					0.146	4.87%	1.46%		14.65	488%	146%
MC39					0.152	5.07%	1.52%		14.65	488%	147%

Notes to Table
(1) Obtained from APIS 23.11.2020

10.4.7. It can be seen from the data in Table 57 that the maximum nutrient nitrogen deposition rates, due to process emissions, are greater than 1% at the Montgomery Canal. Also due to the large background concentrations, all PECs are in excess of 100% of the upper and lower critical loads.

10.4.8. Further investigation of the Montgomery Canal is required. BSG Ecology have investigated the site and have provided an assessment based on the ERF only in Section 7.2.6. of this report.

10.4.9. It should however be noted that in addition to the comments in Section 7.2.6. the Apis website[41] states that the critical load should only be applied to oligotrophic waters with low alkalinity with no significant agricultural or other human inputs. The ILU is by nature a significant agricultural input, and given that the stronghold for the species is wholly artificial and receives relatively high levels of management[42] it is considered that the critical load should not be applied in this case.

10.5. Assessment of Moel Y Golfa (Requirement 3)

10.5.1. Moel Y Golfa is not assessed in the AS Modelling and Data Limited Report as the site is approximately 5.5km north of the ILU. However, the report does provide the maximum annual mean ammonia concentrations in the form of an isopleth (Figure 6a – See Appendix 2 of this report). Moel y Golfa is shown on the isopleth, however it is beyond the lowest contour (0.01µg/m^3 or 1% of the Critical Level of 1µg/m^3). Therefore PCs from the ILU are considered to be not significant and cannot be assessed further.

10.5.2. The process contribution from the ERF is 0.0151µg/m^3, or 1.51% of the Critical Level (1µg/m^3). This is above 1% of the Critical Level therefore cannot be screened out as insignificant. However, at the detailed modelling stage there are no criteria to determine whether PCs are significant, or if PECs are insignificant or not[43]. Consequently the significance or otherwise, so determined, must be explained.

10.5.3. Further guidance is available within the IAQM – "A guide to the assessment of air quality impacts on designated nature conservation sites". This seeks to clarify the use of the 1% criterion for the determination of "insignificant" effects. It states that "*crucially, the 1% screening criterion is not a threshold of harm and exceeding this threshold does not, of itself, imply damage to a habitat".* The guidance then suggests that the information should be passed to an ecologist for their opinion. BSG have provided their opinion in Section 7.2 of this report in relation to ammonia.

10.5.4. Furthermore, if the impacts are well above 1% then this should be regarded as potentially significant, however, where the impacts are just slightly greater – i.e. 1.5% - then a degree of profession judgment should be applied with regard to the theoretical risk.

10.5.5. It should also be noted that the modelling has been undertaken on the assumption that the ERF is operating 24 hours a day, 7 days a week and emitting ammonia at the ELV concentration of 10mg/Nm^3. Actual emissions monitoring data was kindly provided by FCC

[41] http://www.apis.ac.uk/srcl/select-a-feature?site=UK0030213&SiteType=SAC&submit=Next
[42] https://en.powys.gov.uk/media/2721/Float-water-plantain/pdf/float_water_plantain_bi_01.pdf?m=1520524558407
[43] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports#carry-out-impact-assessment

Environment for their Millerhill Resource and Energy Recovery Centre (“Millerhill RERC”) in Edinburgh. The Millerhill RERC is almost identical to the ERF, albeit slightly larger (24 tonne per hour compared to the ERF at 19 tonnes per hour). The ammonia emission concentrations obtained in September 2019, and January 2020 were 0.50mg/Nm^3 and 0.35mg/Nm^3 respectively. This is twenty times lower that the value used in the modelling study. Therefore, in reality the process concentration at Moel Y Golfa would be 0.000754µg/m^3 or 0.075% of the Critical Level, and therefore insignificant.

10.5.6. Whist the 1% and 70% criteria referred to by NRW are appropriate for the screening stage, this assessment constitutes a detailed ammonia modelling assessment, and has used a combination of NRW/EA/IAQM and professional judgment to conclude that emissions from the ERF will not be significant at Moel Y Golfa.

11. CONCLUSIONS

11.1.1. An assessment has been carried out to determine the local air quality impacts associated with the emissions from the proposed Buttington ERF.

11.1.2. Detailed air quality modelling using the ADMS dispersion model has been undertaken to predict the impacts associated with stack emissions from the Installation. As a worst-case, emissions from the Installation's stack have been assumed to be at the maximum ELV. This represents a conservative assessment of the impact since the actual emissions from the site are likely to be significantly lower.

11.1.3. A detailed screening assessment has been carried out to derive conservative assumptions for the assessment and to determine the optimum discharge stack height for the facility. The stack height so determined was 70m.

11.1.4. Predicted maximum GLCs ("PCs") are within the short and long term air quality objectives and are assessed as not significant (less than 1% of the AQS/EAL) for most pollutants assessed, and for those that are potentially significant, further screening has demonstrated that it is unlikely that any AQSs will be exceeded as a result of emissions from the proposed Installation at the maximum point of GLC or at any of the potentially significant human receptors.

11.1.5. For the sensitive habitat sites, it has again been demonstrated that the impact from the proposed Installation is unlikely to result in a breach of the relevant Critical Loads or Critical Levels or have a detrimental effect on local habitat sites.

11.1.6. An assessment of plume visibility was also undertaken, which concluded that visible plumes would only occur around 30% of the time, and for 95% of the time, any visible plumes would remain within the site boundary.

11.1.7. An assessment was also made of the impact of the proposed plant when operating under the abnormal conditions permitted under Article 46(6) of the IED. The results of the assessment indicated that it would be unlikely that any AQSs would be exceeded under such abnormal operating conditions.

11.1.8. In summary, therefore, it can be concluded that the proposed Buttington EFR will not have a significant impact on local air quality, human health or sensitive habitat sites.

APPENDIX 1
CERC Technical Briefing Note

ECL Ref: ECL.001.01.02/ADM
November 2020
Issue: Final

Helpdesk #16391 technical note: 100th percentile concentrations

CERC, 7 May 2020

As part of the ADMS helpdesk service, CERC investigated ECL's model set-up that was leading to higher 1-hour maximum (100th percentile) ground-level concentrations with increasing stack height for a small number of the user's runs (one year of met data per run).

For each of those years, it was found that one particular met line was giving the maximum concentrations for all stack heights, and that each of these met lines exhibited similar behaviour. The model predicts a large reverse flow region within the valley, with the plumes travelling over it above the boundary layer with little mixing before being brought down into the turbulent boundary layer due to the complex flow field. This is a very complicated situation to model accurately, and the CERC development team are presently looking into improvements.

In the meantime, CERC advise that the maximum 100th percentile of 1-hour concentrations for this model set-up should not be relied upon. Analysis of model results using 2019 meteorological data indicate that the 99.97th percentile would provide the basis of a more robust maximum concentration. This approach is typical in dispersion modelling, for example a metric called the Robust Highest Concentration (RHC) is often used to mitigate the potential for unusual events leading to unreliable predictions by analysing a set of the largest values (typically between 10 and 25) to determine the highest probable concentration (O'Shaughnessy and Altmaier, 2011, *Atmos. Environ.*, 45(27): 4617-4625).

Figures 1 and 2 show the modelled 100th to 99.95th percentile concentrations at the maximum concentration location for each of these percentiles for the year 2019, for a 55 m and 75m stack height respectively. Both stack heights show similar variations. The maximum modelled concentration (100th percentile) is significantly higher than the second highest concentration (99.98th percentile) at the same location (548% higher for 55 m stack and 811% higher for 75 m stack). When using a full year of hourly meteorological data, such a disparity should not be expected, indicating that the maximum modelled concentration should not be relied upon in this case. This is compared with the concentration profiles at the location of the 99.97th percentile, where the maximum concentration is less than 10% higher than the second highest concentration for both stack heights. It is therefore advised that taking the 99.97th percentile, or the 100th percentile at the location of the 99.97th percentile, would provide a robust highest concentration for this model set-up.

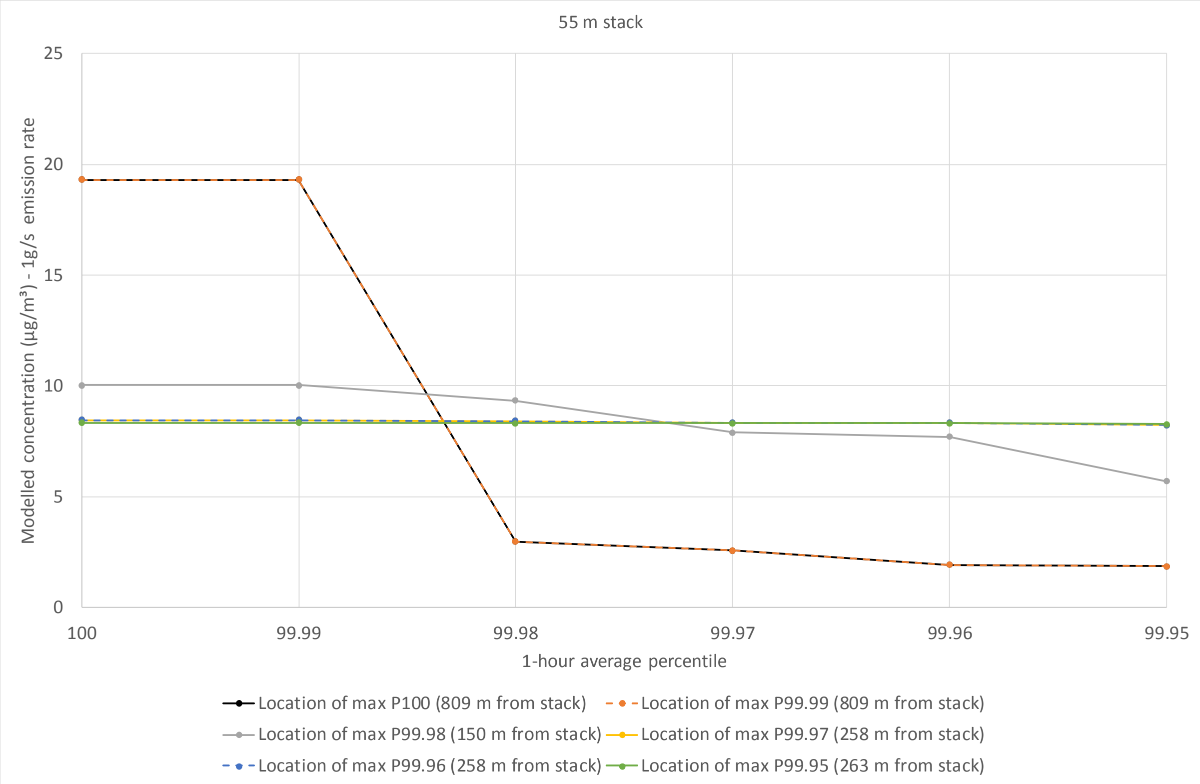


Figure 1: Concentration profiles for the locations of the 100th to 99.95th percentiles of 1-hour average concentrations, 55 m stack

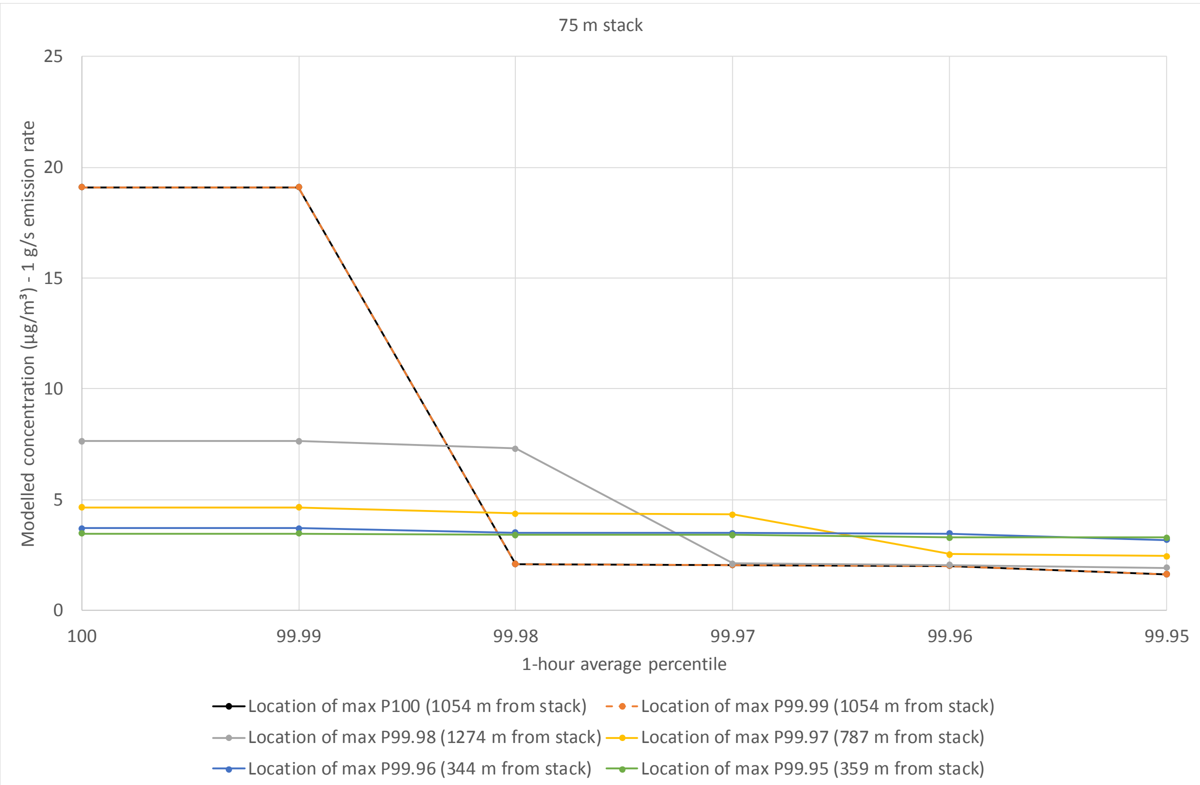


Figure 2: Concentration profiles for the locations of the 100th to 99.95th percentiles of 1-hour average concentrations, 75 m stack

APPENDIX 2
AS Modelling & Data Limited Modelling Report – August 2017

ECL Ref: ECL.001.01.02/ADM
November 2020
Issue: Final

A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Free Range Egg Laying Chicken Houses at Trelystan, near Leighton in Powys

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11th August 2017

1. Introduction

AS Modelling & Data Ltd. has been instructed by Rosina Bloor of Roger Parry & Partners LLP, on behalf of the applicant P E and G R Jones, to use computer modelling to assess the impact of ammonia emissions from the existing and proposed free range egg laying houses at Trelystan, Leighton, Welshpool, Powys. SY21 8JA.

Ammonia emission rates from the existing and proposed poultry houses have been assessed and quantified based upon the Environment Agency's standard ammonia emission factors. Emissions of ammonia from the ranging area have been assessed and quantified based upon figures obtained from the paper "Ammonia emission factors for UK agriculture" (Misselbrook *et al*) and Environment Agency guidance. The ammonia emission rates have then been used as inputs to an atmospheric dispersion and deposition model which calculates ammonia exposure levels and nitrogen and acid deposition rates in the surrounding area.

This report is arranged in the following manner:

- Section 2 provides relevant details of the farm and potentially sensitive receptors in the area.

- Section 3 provides some general information on ammonia; details of the method used to estimate ammonia emissions; relevant guidelines and legislation on exposure limits and where relevant, details of likely background levels of ammonia.

- Section 4 provides some information about ADMS, the dispersion model used for this study and details the modelling procedure.

- Section 5 contains the results of the modelling.

- Section 6 provides a discussion of the results and conclusions.

2. Background Details

The site of the existing and proposed free range egg laying chicken houses at Trelystan are in an isolated rural area, approximately 2.9 km to the east of the village of Leighton in Powys. The surrounding land is used primarily for arable and livestock farming, although there are some areas of semi-natural woodlands and grassland. The site is at an altitude of around 340 m, with the land rising towards mountains to the west and falling towards Brockton Brook to the east.

There are currently two poultry houses at Trelystan, these houses provide accommodation for up to 32,000 egg laying chickens. There are pop holes on the sides of the houses, which provide daytime access to outside ranging areas. The poultry houses are naturally ventilated. The birds' droppings collect within the houses and are removed at the end of each flock cycle, which is approximately once per year.

It is proposed that a new poultry house be constructed on land to the south-east of the existing poultry houses; this house would provide accommodation for an additional 32,000 egg laying chickens. There would be pop holes on the side of the house which would provide daytime access to outside ranging areas. The house would be ventilated by high speed ridge mounted fans. The birds' droppings would be removed by a belt collection system, approximately twice weekly, and transferred directly to a trailer for removal from the site, transferred directly to a manure spreader to be applied to the land locally, or stored temporarily on the farm.

There are several areas designated as Ancient Woodlands (AWs) within 2 km of the site of the poultry houses at Trelystan. There are eight Sites of Special Scientific Interest (SSSIs) that are within 5 km of the site, namely: Gwaun Bryn SSSI; Leighton Bat Roosts SSSI; Marton Pool Chirbury SSSI; Kingswood Meadow SSSI; The Montgomery Canal SSSI; Gungrog Flash SSSI; Bron-y-Buckley Wood SSSI and Buttington Brickworks SSSI. Marton Pool Chirbury SSSI is also designated as part of The Midland Meres and Mosses Ramsar sites, The Montgomery Canal SSSI is also designated as a Special Area of Conservation (SAC) and there is one other SAC, namely Granllyn, within 10 km.

Maps of the surrounding area showing the positions of the poultry unit, the AWs, the SSSIs and the SACs/SPAs are provided in Figures 1a and 1b. Figure 1a is a broad scale view, showing the positions of the SSSIs and SACs/SPAs and Figure 1b is a closer view showing the closer AWs and SSSIs. In these figures, the AWs are shaded in olive, SSSIs are shaded in green, the SACs are shaded in purple, the Ramsar site is shaded in blue and the locations of the existing and proposed poultry houses are outlined in blue.

Figure 1a. The area surrounding Trelystan – concentric circles radii 2.0 km (olive), 5.0 km (green) and 10.0 km (purple)

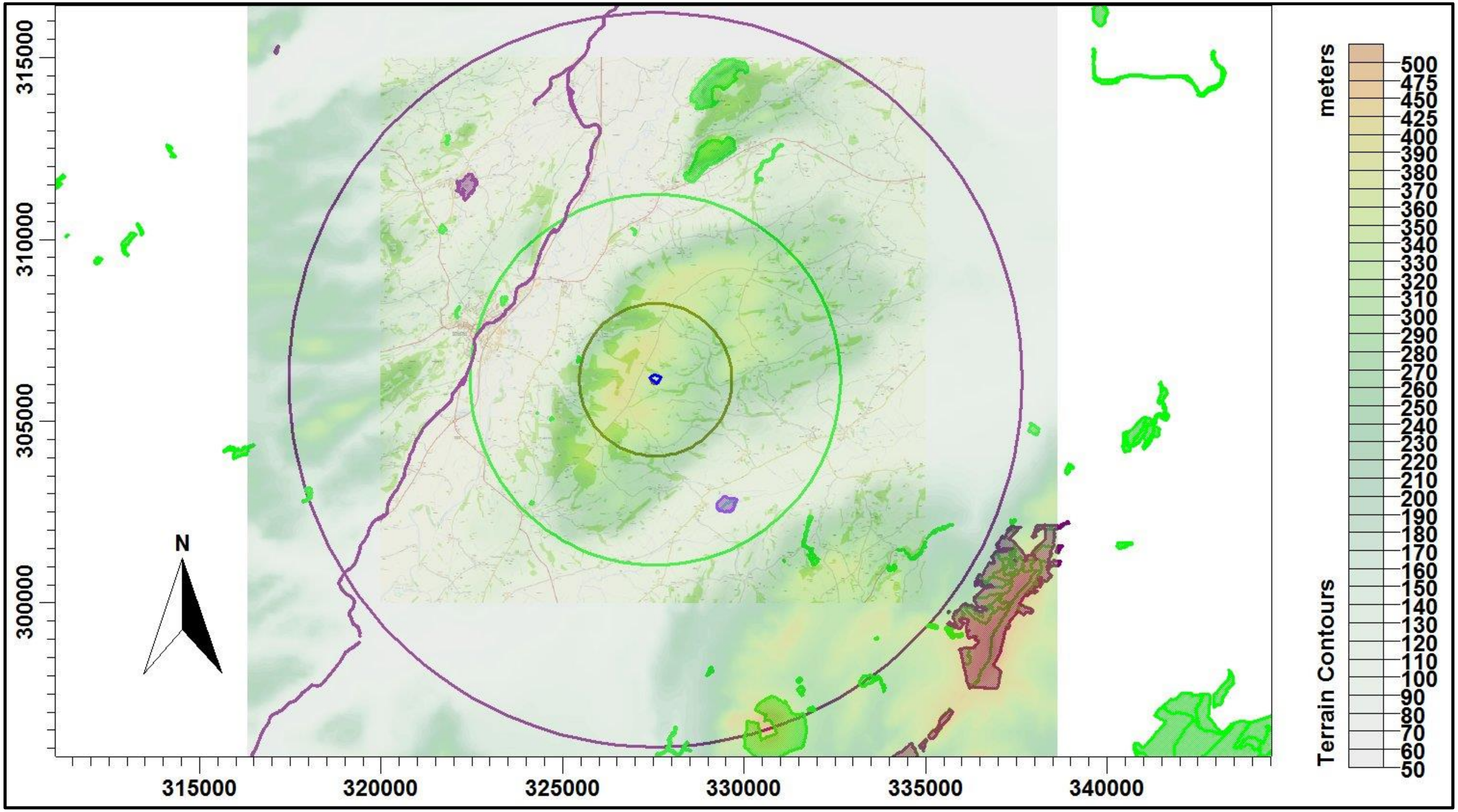
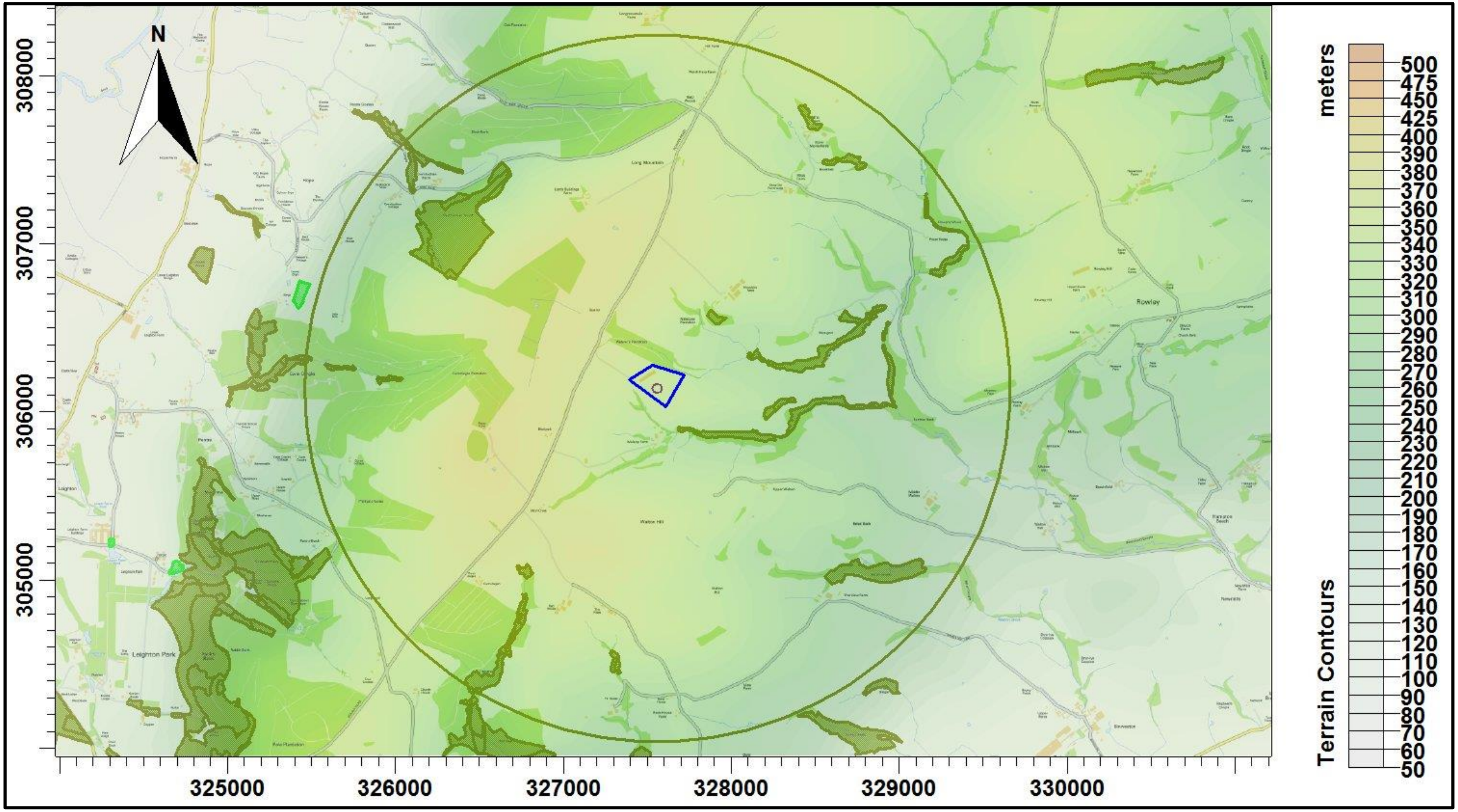


Figure 1b. The area surrounding Trelystan – a closer view



3. Ammonia, Background Levels, Critical Levels & Loads & Emission Rates

3.1 Ammonia concentration and nitrogen and acid deposition

When assessing potential impact on ecological receptors, ammonia concentration is usually expressed in terms of micrograms of ammonia per metre cubed of air (µg-NH_3/m^3) as an annual mean. Ammonia in the air may exert direct effects on the vegetation, or indirectly affect the ecosystem through deposition which causes both hyper-eutrophication (excess nitrogen enrichment) and acidification of soils. Nitrogen deposition, specifically in this case the nitrogen load due to ammonia deposition/absorption, is usually expressed in kilograms of nitrogen per hectare per year (kg-N/ha/y). Acid deposition is expressed in terms of kilograms equivalent (of H^+ ions) per hectare per year (keq/ha/y).

3.2 Background ammonia levels and nitrogen and acid deposition

The background ammonia concentration (annual mean) in the area around Trelystan is 1.77 µg-NH_3/m^3. The background nitrogen deposition rate to woodland is 232.76kg-N/ha/y and to short vegetation is 19.04 kg-N/ha/y. The background acid deposition rate to woodland is 2.44 keq/ha/y and to short vegetation is 1.45 keq/ha/y. The source of these background figures is the Air Pollution Information System (APIS, August 2017).

3.3 Critical Levels & Critical Loads

Critical Levels and Critical Loads are a benchmark for assessing the risk of air pollution impacts to ecosystems. It is important to distinguish between a Critical Level and a Critical Load. The Critical Level is the gaseous concentration of a pollutant in the air, whereas the Critical Load relates to the quantity of pollutant deposited from air to the ground.

Critical Levels are defined as, "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge". (UNECE)

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". (UNECE)

For ammonia concentration in air, the Critical Level for higher plants is 3.0 µg-NH_3/m^3 as an annual mean. For sites where there are sensitive lichens and bryophytes present, or where lichens and bryophytes are an integral part of the ecosystem, the Critical Level is 1.0 µg-NH_3/m^3 as an annual mean.

Critical Loads for nutrient nitrogen are set under the Convention on Long-Range Transboundary Air Pollution. They are based on empirical evidence, mainly observations from experiments and gradient studies. Critical Loads are given as ranges (e.g. 10-20 kg-N/ha/y); these ranges reflect variation in ecosystem response across Europe.

The Critical Levels and Critical Loads at the wildlife sites assumed in this study are provided in Table 1. N.B. Where the Critical Level of 1.0 µg-NH_3/m^3 is assumed, it is usually unnecessary to consider the Critical Load as the Critical Level provides the stricter test. Normally the Critical Load for nitrogen deposition provides a stricter test than the Critical Load for acid deposition.

Table 1. Critical Levels and Critical Loads at the wildlife sites

Site	Critical Level (µg-NH_3/m^3)	Critical Load Nitrogen (kg-N/ha/y)	Critical Load Acid (keq/ha/y)
AWs	1.0 [1]	-	-
Gwaun Bryn SSSI	3.0 [2]	20.0 [5]	-
Gungrog Flash SSSI	3.0 [2]	15.0 [5]	-
Kingswood Meadows SSSI	3.0 [2]	10.0 [2]	-
Leighton Bat Roosts SSSI	n/a [3]	15.0 [5]	n/a [3]
Buttinghton Brickworks SSSI	n/a [3]	n/a [3]	n/a [3]
Midland Meres & Mosses site	1.0 [1]	-	-
Montgomery Canal SAC (bankside) and Granllyn SAC	3.0 [2]	10.0 [2]	-
Montgomery Canal SAC (aquatic)	3.0 [2]	3.0 [2 & 4]	-

1. A precautionary figure used where no details of the ecology of the site are available, or the citation for the sites indicates that sensitive lichens and/or bryophytes are present.
2. Assumed based upon the citation for the site and information from APIS.
3. Site designated for mammalian or geological features
4. The Critical Load for the SAC is for Floating water-plantain, *luronium natans (*N.B. a deposition velocity of 0.005 m/s is assumed*).*
5. Natural Resources Wales.

3.4 Guidance on the Significance of Ammonia Emissions

In March 2017, Natural Resources Wales (Regulation and Permitting Department, EPP) published Operational Guidance Note 41 (OGN 41), "Assessment of ammonia and nitrogen impacts from livestock units when applying for an Environmental Permit or Planning Permission". This guidance was intended to update the way Natural Resources Wales (NRW) assessed emissions, in particular by changing the thresholds of insignificance and the upper threshold process contributions for designated sites. These designated sites include European sites, such as Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites as well as Sites of Special Scientific Interest (SSSIs).

Table 1 in OGN 41 describes the revised screening distance and thresholds for livestock developments; the threshold of insignificant percentage of the designated site Critical Level or Load is given as 1%; the upper threshold percentage of the designated site Critical Level or Load is given as 8%.

Table 2 in OGN 41 describes the possible outcomes of assessment and for detailed modelling of the application alone, where process contributions, considered in isolation, are up to 1% of the designated site Critical Level or Load, then it should be determined that there is no significant environmental effect/no likely significant effect/damage to scientific interest.

Where process contributions, considered in isolation, are between 1% and 8% of the designated site Critical Level or Load, an in-combination assessment is required. Should the in-combination process contributions be between 1% and 8% of the designated site Critical Level or Load then it should be determined that the application would cause no significant environmental effect/likely significant effect/damage to scientific interest.

When considering process contributions, in isolation or in-combination, if they exceed 8% of the designated site Critical Level or Load it is necessary to consider background concentrations and whether the designated site Critical Level or Load is breached and whether additional controls may be necessary. The application will then be determined based on whether there will be significant environmental effect/adverse effect/damage to scientific interest.

Please note that as far as AS Modelling & Data Ltd. is aware, currently, there is no publicly available ledger or database of sites with extant planning permission, or other proposed sites in planning, that would provide sufficient information to make an in-combination modelling assessment. Therefore, if Natural Resources Wales, or the Local Authority concerned do not consider the details of the modelling of ammonia emissions from this site provided by this study as sufficient information to fulfil the requirements of their appropriate assessment, then in most cases, it would not be possible for AS Modelling & Data Ltd. to provide this information.

For Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and Ancient Woodlands (AWs), the current assessment procedure usually applied is based on the Environment Agency's horizontal guidance, H1 Environmental Risks Assessment, H1 Annex B - Intensive Farming. The following are taken from this document.

"An emission is insignificant where Process Contribution (PC) is <50% for local and national nature reserves (LNRs & NNRs), ancient woodland and local wildlife sites." And "Where modelling predicts a process contribution >100% at a NNR, LNR, ancient woodland or local wildlife site, your proposal may not be considered acceptable. In such cases, your assessment should include proposals to reduce ammonia emissions."

This document was withdrawn February 1st 2016 and replaced with a web-page titled "Intensive farming risk assessment for your environmental permit", which contains essentially the same criteria. It is assumed that the upper threshold and lower threshold on the web-page refers to the levels that were previously referred to as levels of insignificance and acceptability in Annex B– Intensive Farming.

Within the range between the lower and upper thresholds, whether or not the impact is deemed acceptable is at the discretion of the Environment Agency. N.B. In the case of LWSs and AWs, the Environment Agency do not usually consider other farms that may act in-combination and therefore a PC of up to 100% of Critical Level or Critical Load is usually deemed acceptable for permitting purposes and therefore the upper and lower thresholds are the same (100%).

3.5 IAQM Position Statement on the use of the 1% criterion

A Position Statement issued by the Institute of Air Quality Management (IAQM) in January 2016 further clarifies the use of the 1% criterion for the determination of an '*insignificant*' effect of air quality impacts on sensitive habitats. The Position Statement states: "*the use of a criterion of 1% of an environmental standard or assessment level in the context of habitats should be used only to screen out impacts that will have an insignificant effect. It should not be used as a threshold above which damage is implied.*" Furthermore, if the impacts are plainly above 1% then this should be regarded as potentially significant; where impacts are just slightly greater than 1% then a degree of professional judgement should be applied with regards to the theoretical risk.

3.6 Quantification of Ammonia Emissions

Ammonia emission rates from poultry houses depend on many factors and are likely to be highly variable. However, the benchmarks for assessing impacts of ammonia and nitrogen deposition are framed in terms of an annual mean ammonia concentration and annual nitrogen deposition rates. To obtain relatively robust figures for these statistics it is not necessary to model short term temporal variations and a steady continuous emission rate can be assumed. In fact, modelling short term temporal variations might introduce rather more uncertainty than modelling continuous emissions.

The Environment Agency provides an Intensive Farming guidance note which lists standard ammonia emission factors for a variety of livestock, including poultry. For free-range egg laying chickens, where manure collects within the house, the Environment Agency figure is 0.29 kg-NH_3/bird place/year. For free-range egg laying chickens, in an aviary system, where manure is removed frequently using a belt system, the Environment Agency figure is 0.08 kg-NH_3/bird place/year.

As the birds in the new egg laying chicken house would have access to outdoor ranging areas, some of the birds' droppings, which is the source of the ammonia, would be deposited on these ranging areas. For modelling purposes, it is assumed that 20% of the droppings are deposited on the ranging areas; this assumption is based upon Environment Agency guidance. To estimate the ammonia emissions from the ranges, it has been assumed that laying hens produce 0.8 kg-N/y (Misselbrook) in their droppings and that 20% of ammoniacal nitrogen is emitted as ammonia (typically 40% to 50% is emitted as ammonia from stored manure, but this has been reduced to allow for mineralisation and leaching due to the contact with mineral soils). This equates to an emission factor of 0.194 kg-NH_3/bird/y, which is rounded up to 0.2 kg-NH_3/bird/y for use in the emission calculations.

Details of the poultry numbers and types, emission factors used and calculated ammonia emission rates are provided in Table 2.

Table 2. Details of poultry numbers and ammonia emission rates

Ammonia source	Animal numbers	Type or weight	Emission factor (kg-NH_3/place/y)	Emission rate (g-NH_3/s)
Existing Housing	32,000 (x0.8)	EA figure for laying chickens – deep pit	0.29	0.235252
Proposed Housing	32,800 (x0.8)	EA figure for laying chickens in aviary system (belt removal)	0.08	0.064897
Existing Ranging	32,000 (x0.2)	AS Modelling & Data Ltd. range emission figure	0.20	0.040561
Proposed Ranging	32,800 (x0.2)	AS Modelling & Data Ltd. range emission figure	0.20	0.040561

4. The Atmospheric Dispersion Modelling System (ADMS) and model parameters

The Atmospheric Dispersion Modelling System (ADMS) ADMS 5 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.

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).

ADMS has a number of model options including: dry and wet deposition; NO_x chemistry; impacts of hills, variable roughness, buildings and coastlines; puffs; fluctuations; odours; radioactivity decay (and γ-ray dose); condensed plume visibility; time varying sources and inclusion of background concentrations.

ADMS has an in-built meteorological pre-processor that allows flexible input of meteorological data both standard and more specialist. Hourly sequential and statistical data can be processed and all input and output meteorological variables are written to a file after processing.

The user defines the pollutant, the averaging time (which may be an annual average or a shorter period), which percentiles and exceedance values to calculate, whether a rolling average is required or not and the output units. The output options are designed to be flexible to cater for the variety of air quality limits, which can vary from country to country and are subject to revision.

4.1 Meteorological data

Computer modelling of dispersion requires hourly sequential meteorological data and to provide robust statistics, the record should be of a suitable length; preferably four years or longer.

The meteorological data used in this study is obtained from assimilation and short term forecast fields of the Numerical Weather Prediction (NWP) system known as the Global Forecast System (GFS).

The GFS is a spectral model and data are archived at a horizontal resolution of 0.25 degrees, which is approximately 25 km over the UK (formerly 0.5 degrees, or approximately 50 km). The GFS resolution adequately captures major topographical features and the broad-scale characteristics of the weather over the UK. Smaller scale topological features may be included in the dispersion modelling by using the flow field module of ADMS (FLOWSTAR). The use of NWP data has advantages over traditional meteorological records because:

- Calm periods in traditional observational records may be over represented, this is because the instrumentation used may not record wind speeds below approximately 0.5 m/s and start up wind speeds may be greater than 1.0 m/s. In NWP data, the wind speed is continuous down to 0.0 m/s, allowing the calms module of ADMS to function correctly.

- Traditional records may include very local deviations from the broad-scale wind flow that would not necessarily be representative of the site being modelled; these deviations are difficult to identify and remove from a meteorological record. Conversely, local effects at the site being modelled are relatively easy to impose on the broad-scale flow and provided horizontal resolution is not too great, the meteorological records from NWP data may be expected to represent well the broad-scale flow.

- Information on the state of the atmosphere above ground level which would otherwise be estimated by the meteorological pre-processor may be included explicitly.

The raw GFS wind speeds are modified by the treatment of roughness lengths (see Section 4.7) and where terrain data is included in the modelling, wind speeds and directions will be further modified. The raw GFS wind rose is shown in Figure 2a and the terrain and roughness length modified wind rose for the site of Trelystan is shown in Figure 2b. Note that elsewhere in the modelling domain the modified wind roses may differ more markedly and that the resolution of the wind field in terrain runs is approximately 340 m in the preliminary modelling and low resolution deposition runs and is 100 m in the high resolution deposition modelling runs.

Figure 2a. The wind rose. GFS derived data, for 52.648 N, 3.072 W, 2013 – 2016

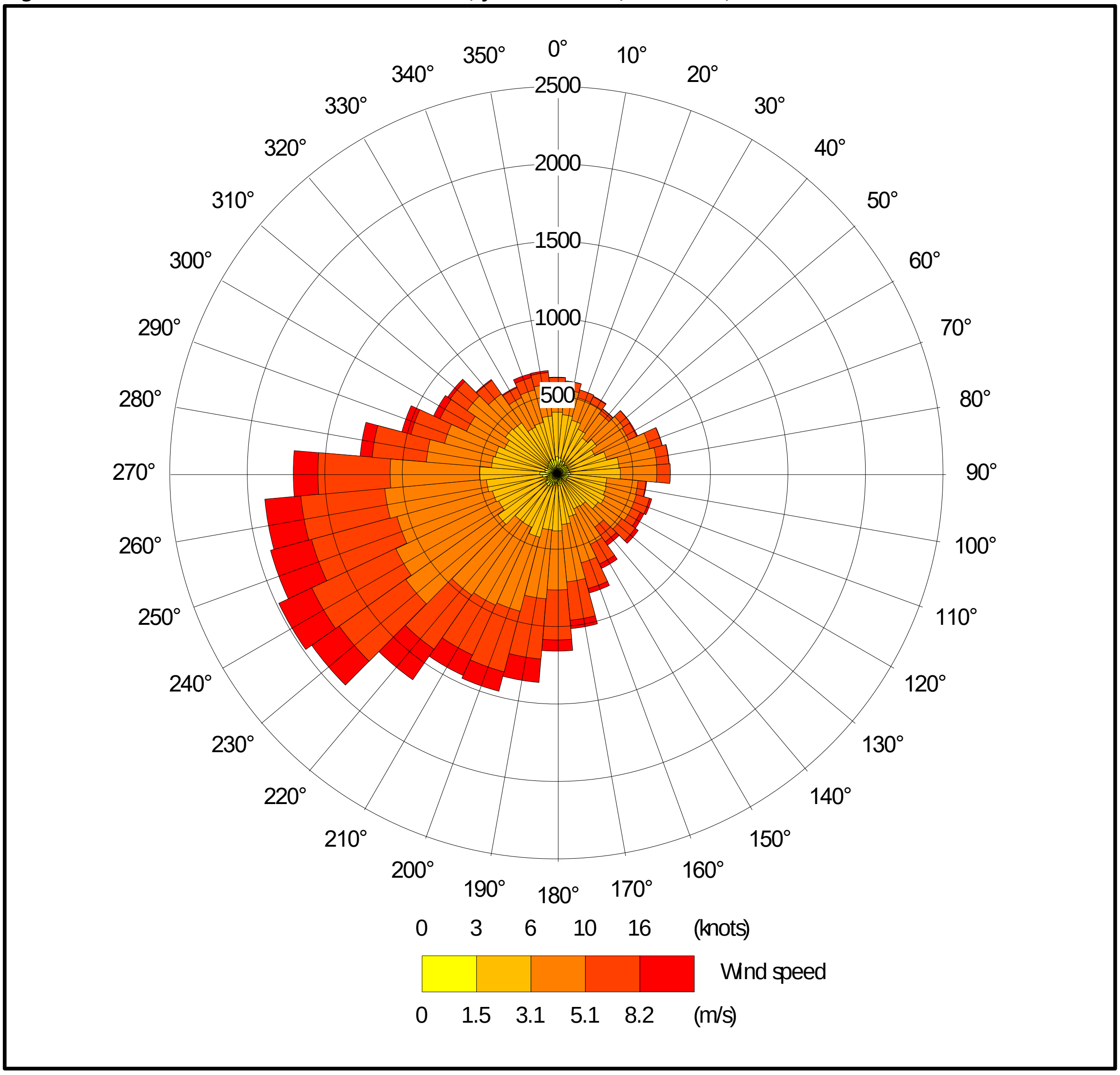
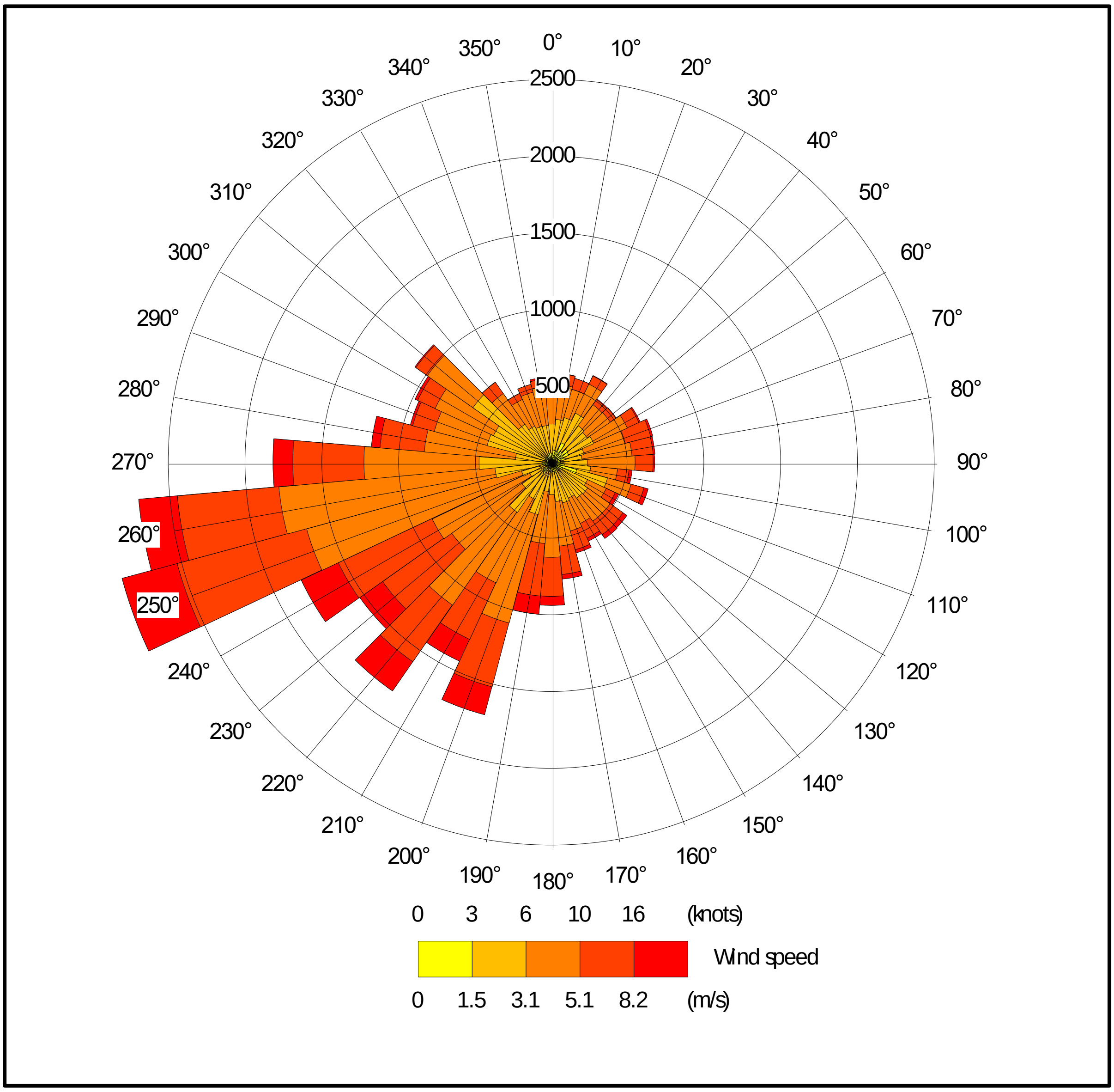


Figure 2b. The wind rose. FLOWSTAR derived data for NGR 327550, 2306150, 2013 - 2016



4.2 Emission sources

Emissions from the naturally ventilated existing poultry houses are represented by a two volume sources per house within ADMS, one representing emissions from the ridge vent on the houses (60% of total emissions) and one representing fugitive emissions from the pop holes and side vents (40% of total emissions). Details of the volume source parameters are shown in Table 3a. The positions of the volume sources may be seen in Figure 3.

Table 3a. Volume source parameters

Source ID	Length (m)	Width (m)	Depth (m)	Base height (m)	Emission temperature (˚C)	Emission rate per source ($g-NH_3/s$)
EX1_ridge and EX2_ridge	110.0	20.0	4.0	0.5	Ambient	0.070576
EX1_fug and EX2_fug	110.0	3.0	1.0	4.0	Ambient	0.047050

Emissions from the uncapped high speed ridge fans that would be used to ventilate the proposed poultry house are represented by three point sources within ADMS (PR1 a, b and c). Details of the point source parameters are shown in Table 3b. The positions of the point sources may be seen in Figure 3.

Table 3b. Point source parameters

Source ID	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (°C)	Emission rate per source ($g-NH_3/s$)
PR1 a, b & c	6	0.8	11	Variable[1]	0.021632

1. Dependent on ambient temperature.

Emissions from the ranging areas are represented by three area sources within ADMS. The area sources cover the parts of the ranges most likely to be used frequently, not the whole ranging area. Details of the area source parameters are shown in Table 3c. The positions of the area sources may be seen in Figure 3.

Table 3c. Area source parameters

Source ID	Height (m)	Area (m^2)	Emission temperature (°C)	Emission rate per source ($g-NH_3/s$)
EX1_range	0.0	12,407.1	Ambient	0.020280
EX2_range	0.0	8,913.8	Ambient	0.020280
PR1_range	0.0	8,655.1	Ambient	0.040561

4.3 Modelled buildings

The structure of the poultry houses may affect the plumes from the point sources. Therefore, the buildings are modelled within ADMS. The positions of the modelled buildings may be seen in Figure 3, where they are marked by grey rectangles.

4.4 Discrete receptors

Forty-seven discrete receptors have been defined: twenty-nine at the AWs (1 to 29), six at the SSSIs (30 to 35) and twelve at the SACs/Ramsar site (36 to 47). These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figures 4a and 4b, where they are marked by enumerated pink rectangles.

4.5 Cartesian grid

To produce the contour plots presented in Section 5 of this report and to define the spatially varying deposition velocity field, two regular Cartesian grids have been defined within ADMS, one at low resolution and one at high resolution. The individual grid receptors are defined at ground level within ADMS. The position of the Cartesian grids may be seen in Figures 4a and 4b, where they are marked by grey lines.

4.6 Terrain data

Terrain has been considered in the modelling. The terrain data are based upon the Ordnance Survey 50 m Digital Elevation Model. A 22.0 km x 22.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS in the preliminary modelling and the low resolution deposition modelling and a 6.4 km x 6.4 km domain has been resampled at 50 m horizontal resolution for use within ADMS in the high resolution deposition modelling. N.B. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field for the terrain runs is approximately 340 m in the preliminary and low resolution deposition modelling runs and is ap100 m in the high resolution deposition modelling runs.

4.7 Roughness Length

A fixed surface roughness length of 0.25 m has been applied over the entire modelling domain. As a precautionary measure, the GFS meteorological data is assumed to have a roughness length of 0.225 m. The effect of the difference in roughness length is precautionary as it increases the frequency of low wind speeds and the stability and therefore increases predicted ground level concentrations.

Figure 3. The positions of modelled buildings & sources

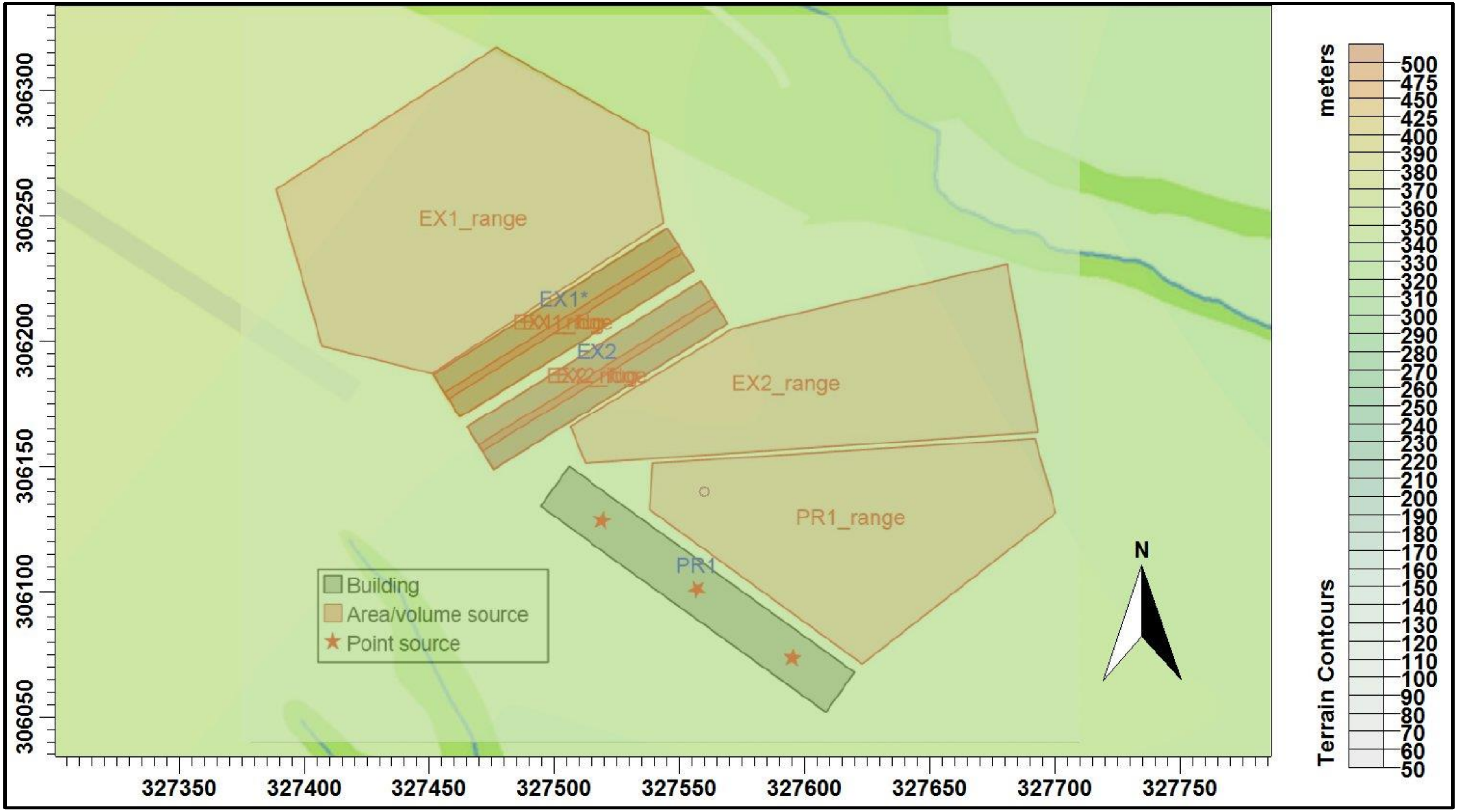


Figure 4a. The discrete receptors and regular Cartesian grids – a broad-scale view

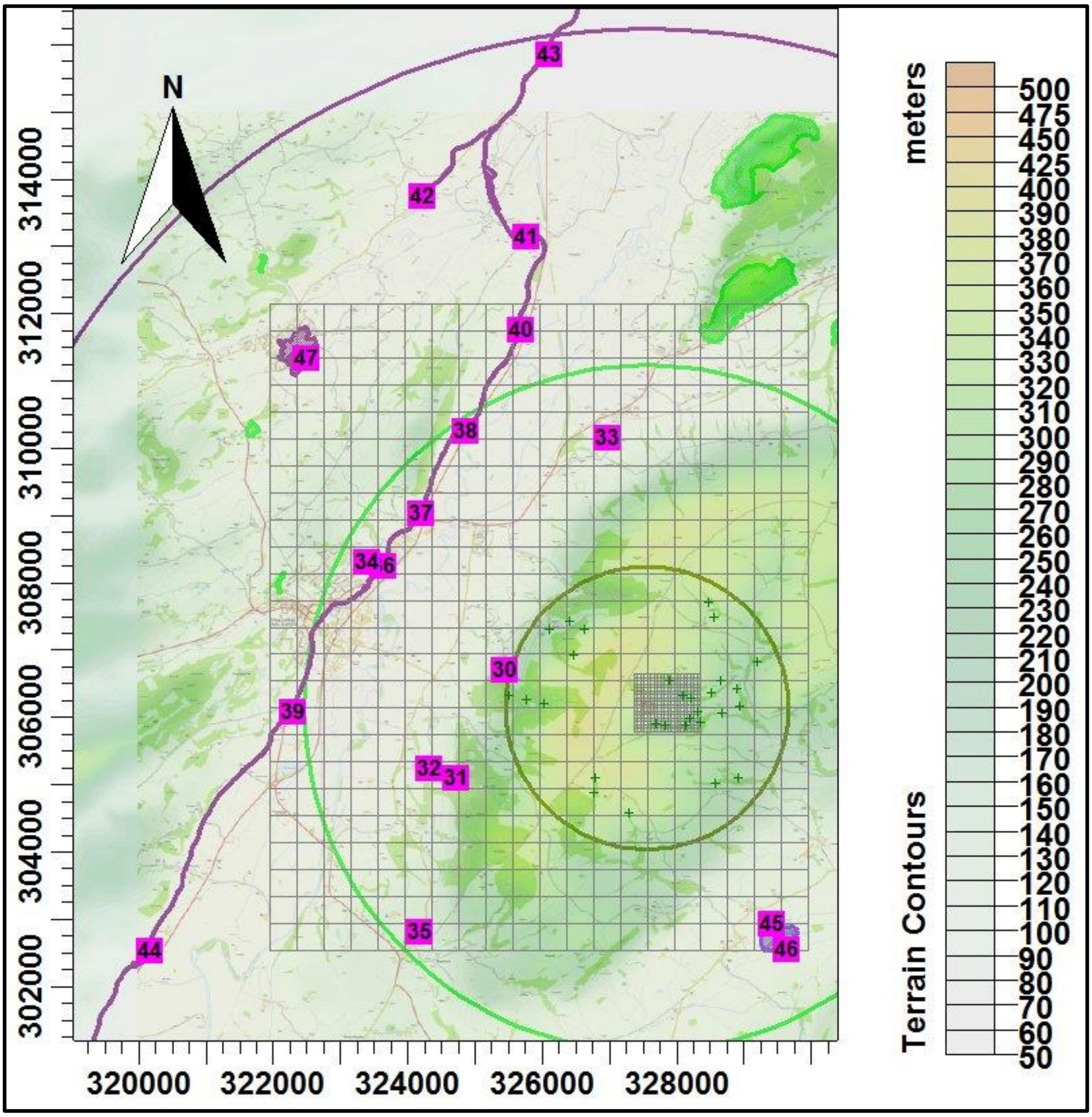
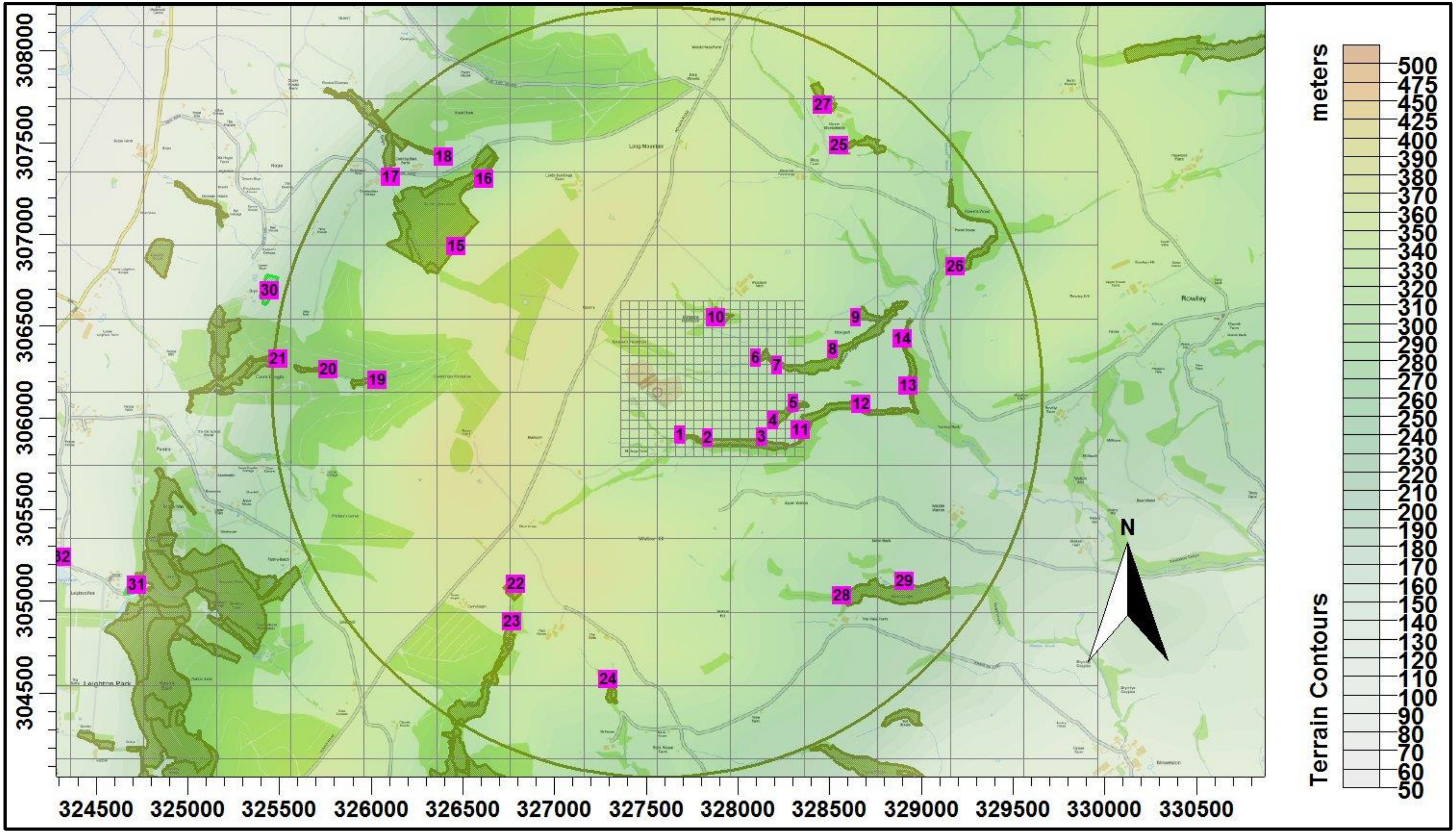


Figure 4b. The regular Cartesian grids and discrete receptors – a closer view



4.8 Deposition

The method used to model deposition of ammonia and consequent plume depletion is based on a document titled "Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming" from the Environment Agency's Air Quality Modelling and Assessment Unit, 22 November 2010. N.B. AS Modelling & Data Ltd. has restricted deposition over arable farmland and areas with rye grass to 0.05 m/s; this is to compensate for possible saturation effects due to fertilizer application and to allow for periods when fields are clear of crops (Sutton). The deposition velocity is also set to 0.002 m/s where grid points are over the poultry housing or ranging areas and 0.015 m/s over heavily grazed grassland.

In summary, the method is as follows:

- A preliminary run of the model without deposition is used to provide an ammonia concentration field.
- The preliminary ammonia concentration field, along with land usage, is used to define a deposition velocity field. The deposition velocities used are provided in Table 4.

Table 4. Deposition velocities

NH_3 concentration (PC + background) (µg/m^3)	< 10	10 - 20	20 - 30	30 – 80	> 80
Deposition velocity – woodland (m/s)	0.03	0.015	0.01	0.005	0.003
Deposition velocity – short vegetation (m/s)	0.02	0.015	0.01	0.005	0.003
Deposition velocity – arable farmland/rye grass (m/s)	0.005	0.005	0.005	0.005	0.003

- The model is then rerun with the spatially varying deposition module.

Contour plots of the spatially varying deposition fields are provided in Figures 5a (low resolution) and 5b (high resolution).

Figure 5a. The spatially varying deposition field – low resolution

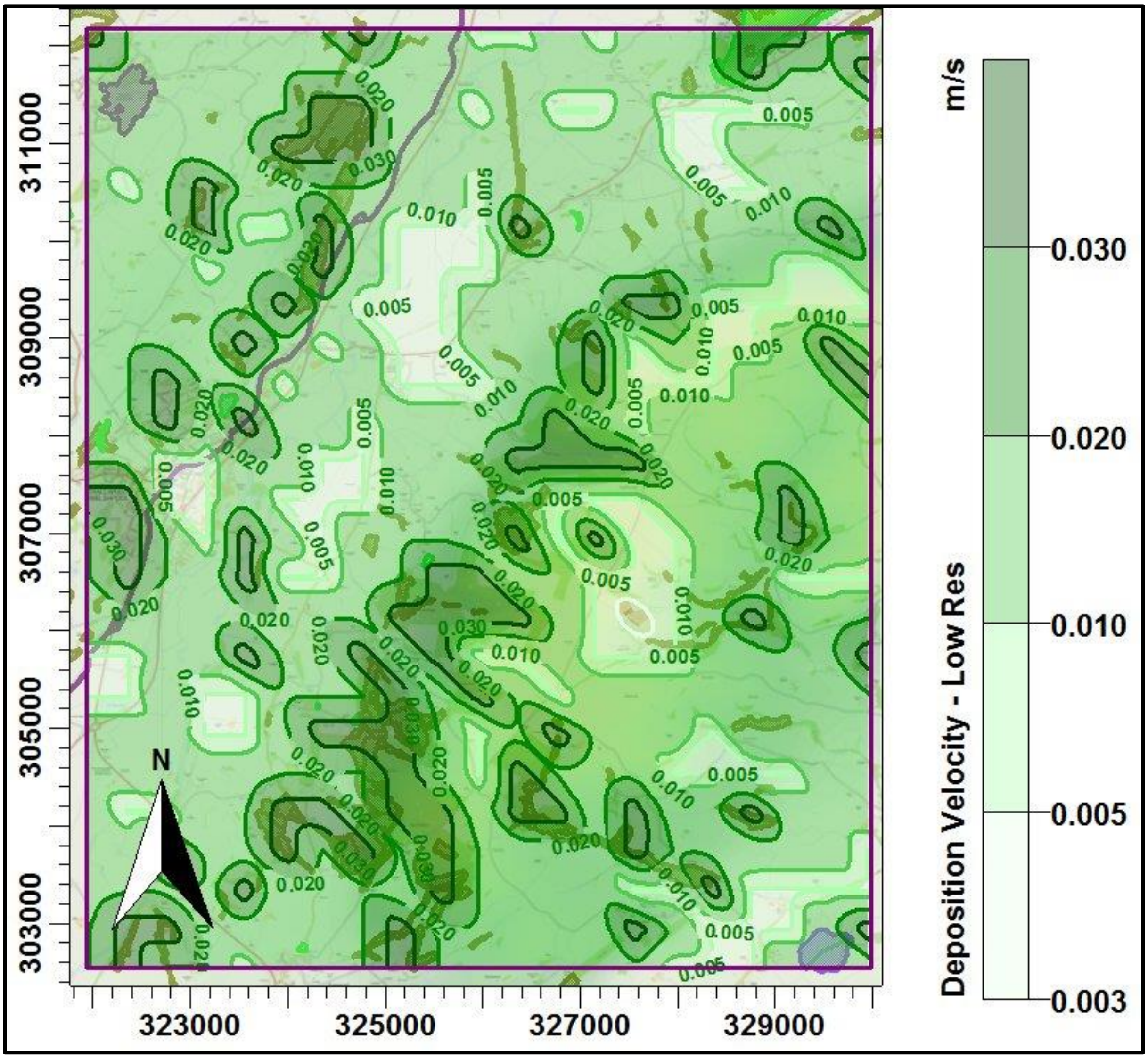
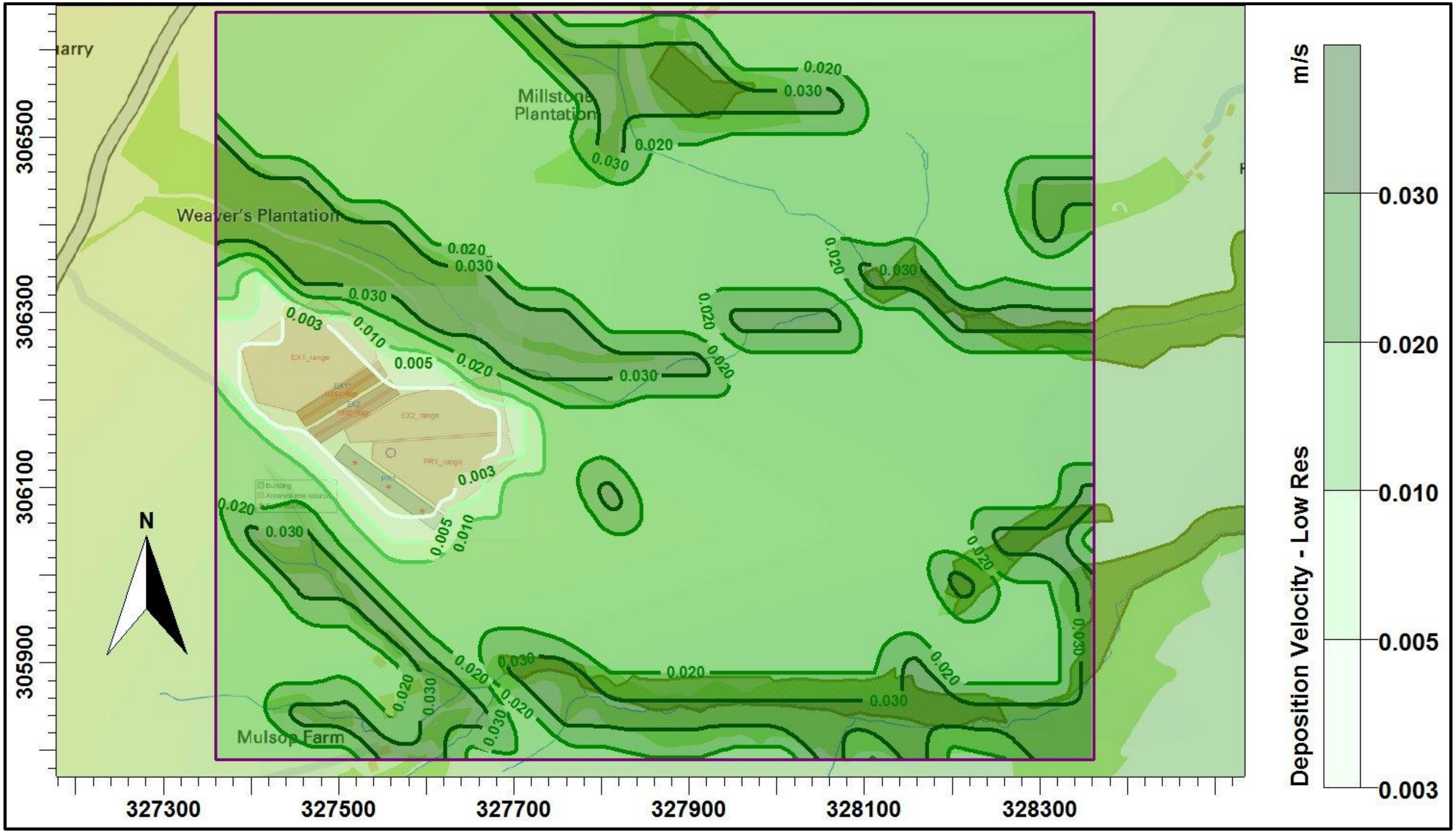


Figure 5b. The spatially varying deposition field – high resolution



5. Details of the Model Runs and Results

5.1 Preliminary modelling and model sensitivity tests

ADMS was run a total of sixteen times, once for each year of the meteorological record, in the following six modes:

- In basic mode without calms, or terrain – GFS data.
- With calms and without terrain – GFS data.
- Without calms and with terrain – GFS data.
- Without calms and terrain, but with a fixed deposition velocity of 0.003 m/s – GFS data.

For each mode, statistics for the maximum annual mean ammonia concentration at each receptor were compiled.

Details of the predicted annual mean ammonia concentrations at each receptor are provided in Table 5. In the Table, predicted ammonia concentrations, including those that would lead to a nitrogen deposition rate, that are in excess of the Natural Resources Wales/Environment Agency's upper threshold (8% of Critical Level or Load for a SAC, Ramsar site and SSSI or 100% of a Critical Level or Load for an AW) are coloured red. Concentrations in the range between the Natural Resources Wales/Environment Agency's upper threshold and lower threshold (1% to 8% for a SAC, Ramsar site or SSSI and 50% [1] to 100% for an AW) are coloured blue. For convenience, cells referring to the AWs are shaded olive, cells referring to the SSSIs are shaded green, cells referring to SACs are shaded purple and cells referring to the Ramsar site are shaded blue.

1. The pre-February 2016 value is used.

Table 5. Predicted maximum annual mean ammonia concentration at the discrete receptors - preliminary modelling

Receptor number	X(m)	Y(m)	Site	Maximum annual mean ammonia concentration - (µg/m³)			
				GFS No Calms No Terrain	GFS Calms No Terrain	GFS No Calms Terrain	GFS No Calms Terrain Fixed depo.
1	327685	305909	AW	4.635	5.078	4.825	2.176
2	327834	305890	AW	2.845	3.143	2.935	1.316
3	328131	305895	AW	1.265	1.495	1.201	0.549
4	328194	305986	AW	1.497	1.698	1.451	0.661
5	328302	306079	AW	1.454	1.609	1.386	0.644
6	328099	306327	AW	2.016	2.247	2.097	1.053
7	328215	306285	AW	1.638	1.816	1.570	0.815
8	328517	306372	AW	0.824	0.924	0.749	0.381
9	328644	306548	AW	0.607	0.671	0.564	0.278
10	327880	306548	AW	2.586	2.833	2.443	1.359
11	328341	305933	AW	1.043	1.191	0.966	0.440
12	328674	306073	AW	0.770	0.854	0.733	0.335
13	328930	306171	AW	0.553	0.612	0.562	0.252
14	328897	306431	AW	0.480	0.539	0.488	0.234
15	326463	306937	AW	0.405	0.467	0.283	0.141
16	326617	307304	AW	0.265	0.316	0.199	0.103
17	326105	307312	AW	0.216	0.253	0.156	0.078
18	326395	307423	AW	0.211	0.252	0.161	0.083
19	326033	306204	AW	0.363	0.407	0.266	0.117
20	325764	306263	AW	0.274	0.308	0.205	0.089
21	325496	306319	AW	0.216	0.243	0.169	0.071
22	326787	305095	AW	0.364	0.424	0.275	0.119
23	326770	304887	AW	0.311	0.356	0.231	0.099
24	327294	304575	AW	0.311	0.344	0.205	0.084
25	328552	307483	AW	0.326	0.366	0.283	0.136
26	329187	306826	AW	0.302	0.333	0.286	0.128
27	328463	307704	AW	0.275	0.312	0.240	0.110
28	328569	305031	AW	0.318	0.358	0.269	0.115
29	328908	305108	AW	0.244	0.277	0.202	0.089
30	325446	306693	Gwaun Bryn SSSI	0.198	0.224	0.159	0.065
31	324725	305089	Leighton Bat Roosts SSSI	0.092	0.106	0.068	0.028
32	324315	305242	Leighton Bat Roosts SSSI	0.089	0.100	0.070	0.028
33	326976	310143	Buttingham Brickworks SSSI	0.056	0.068	0.049	0.022
34	323398	308308	Gungrog Flash SSSI	0.056	0.063	0.087	0.029
35	324170	302802	Kingswood Meadows SSSI	0.042	0.051	0.035	0.013
36	323643	308242	Montgomery Canal SAC	0.061	0.069	0.095	0.033
37	324192	309027	Montgomery Canal SAC	0.048	0.057	0.064	0.024
38	324865	310242	Montgomery Canal SAC	0.034	0.041	0.040	0.015
39	322294	306086	Montgomery Canal SAC	0.046	0.052	0.107	0.030
40	325683	311762	Montgomery Canal SAC	0.028	0.035	0.033	0.013
41	325769	313143	Montgomery Canal SAC	0.022	0.026	0.026	0.010
42	324219	313743	Montgomery Canal SAC	0.015	0.019	0.021	0.006
43	326098	315855	Montgomery Canal SAC	0.014	0.017	0.021	0.007
44	320170	302526	Montgomery Canal SAC	0.019	0.023	0.021	0.006
45	329423	302931	Midland Meres & Mosses	0.069	0.079	0.040	0.020
46	329642	302536	Midland Meres & Mosses	0.058	0.066	0.040	0.019
47	322495	311341	Granllyn SAC	0.020	0.024	0.018	0.007

5.2 Detailed deposition modelling

The detailed modelling was carried out at low resolution over a restricted domain covering the poultry houses and the SSSIs, SACs and the Ramsar Site, where the preliminary modelling indicated that annual mean ammonia concentrations could potentially exceed 100% of the relevant Critical Level or Critical Load for the site. Additionally, detailed modelling was carried out at high resolution over a restricted domain covering the poultry houses and the nearest AWs; the area where the preliminary modelling indicated that annual mean ammonia concentrations could potentially exceed 100% of the precautionary Critical of 1.0 µg-NH_3/m^3.

At other AWs, SSSIs and SACs, the preliminary modelling indicated that ammonia levels (and nitrogen deposition rates) would be at levels below the Environment Agency's lower threshold percentage of Critical Level (or Load) for the designation of the site. Note that for some of the SACs, consideration of deposition (and consequent plume depletion) is required to screen out the sites from the need for detailed modelling and that using a fixed deposition velocity of 0.003 m/s is always precautionary compared to results that would be obtained from a larger spatially varying deposition domain.

The model was run four times once for each year of the meteorological record, using the terrain and spatially varying deposition modules of ADMS. As the calms module of ADMS cannot be used in conjunction with the spatially varying deposition module, the results obtained have been multiplied by a factor of 1.13 (obtained from the average difference between the basic and calms runs in the preliminary modelling) to account for the effects of calms.

The predicted maximum annual mean ground level ammonia concentrations and nitrogen deposition rates at the discrete receptors within the detailed modelling domains are shown in Tables 6a (low resolution modelling) and 6b (high resolution modelling). In these Tables, predicted ammonia concentrations or nitrogen deposition rates that are in excess of the Natural Resources Wales upper threshold (8% of Critical Level or Load for a SAC, Ramsar site or SSSI and 100% of Critical Level or Load for an AW) are coloured red. Concentrations that are in the range between the Natural Resources Wales lower and upper threshold (1% to 8% for a SAC, Ramsar site or SSSI and 50% [1] to 100% for an AW) are coloured blue. The predicted process contributions from the proposed development alone to maximum annual mean ground level ammonia concentrations and nitrogen deposition rates at the discrete receptors within the detailed modelling domains are shown in Tables 7a (low resolution modelling) and 7b (high resolution modelling).

Contour plots of the predicted ground level maximum annual mean ammonia concentration and the maximum nitrogen deposition rate are shown in Figures 6a and 6b, respectively, for the low resolution modelling and Figures 7a and 7b, respectively, for the high resolution modelling.

1. The pre-February 2016 value for the lower threshold is used for non-statutory sites.

Table 6a. Annual ammonia concentration and nitrogen deposition rate at the discrete receptors – low resolution deposition modelling

Receptor number	X(m)	Y(m)	Designation	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m³)	Critical Load (kg/ha)	PC (µg/m³)	%age of Critical Level	PC Existing (kg/ha)	%age of Critical Load
30	325446	306693	Gwaun Bryn SSSI	0.030	3.0	20.0	0.058	**1.9**	0.45	**2.2**
31	324725	305089	Leighton Bat Roosts SSSI	0.030	3.0	15.0	0.024	0.8	0.19	**1.2**
32	324315	305242	Leighton Bat Roosts SSSI	0.030	3.0	15.0	0.023	0.8	0.18	**1.2**
33	326976	310143	Buttingham Brickworks SSSI	0.030	3.0	10.0	0.022	0.7	0.17	**1.7**
34	323398	308308	Gungrog Flash SSSI	0.030	3.0	15.0	0.020	0.7	0.16	**1.0**
35	324170	302802	Kingswood Meadows SSSI	0.030	3.0	10.0	0.010	0.3	0.08	0.8
36	323643	308242	Montgomery Canal SAC	0.030	3.0	10.0	0.024	0.8	0.19	**1.9**
37	324192	309027	Montgomery Canal SAC	0.030	3.0	10.0	0.020	0.7	0.15	**1.5**
38	324865	310242	Montgomery Canal SAC	0.030	3.0	10.0	0.013	0.4	0.10	1.0
39	322294	306086	Montgomery Canal SAC	0.030	3.0	10.0	0.018	0.6	0.14	**1.4**
40	325683	311762	Montgomery Canal SAC	0.030	3.0	10.0	0.011	0.4	0.08	0.8
45	329423	302931	Midland Meres & Mosses	0.030	3.0	10.0	0.023	0.8	0.18	**1.8**
46	329642	302536	Midland Meres & Mosses	0.030	3.0	10.0	0.019	0.6	0.15	**1.5**
47	322495	311341	Granllyn SAC	0.030	3.0	10.0	0.005	0.2	0.04	0.4

Table 6b. Annual ammonia concentration and nitrogen deposition rate at the discrete receptors – high resolution deposition modelling

Receptor number	X(m)	Y(m)	Site	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m³)	Critical Load (kg/ha)	Process Contribution (µg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	327685	305909	Unnamed AW	0.030	1.0	10.0	2.524	**252.4**	19.66	**196.6**
2	327834	305890	Unnamed AW	0.030	1.0	10.0	1.419	**141.9**	11.05	**110.5**
3	328131	305895	Unnamed AW	0.030	1.0	10.0	0.552	**55.2**	4.30	**43.0**
4	328194	305986	Unnamed AW	0.030	1.0	10.0	0.649	**64.9**	5.05	**50.5**
5	328302	306079	Unnamed AW	0.030	1.0	10.0	0.623	**62.3**	4.85	48.5
6	328099	306327	Outrack Dingle AW	0.030	1.0	10.0	1.057	**105.7**	8.23	**82.3**
7	328215	306285	Outrack Dingle AW	0.030	1.0	10.0	0.786	**78.6**	6.12	**61.2**
10	327880	306548	Millstone Plantation AW	0.030	1.0	10.0	1.082	**108.2**	8.43	**84.3**
11	328341	305933	Unnamed AW	0.030	1.0	10.0	0.442	44.2	3.44	34.4

Table 7a. Annual ammonia concentration and nitrogen deposition rate at the discrete receptors – low resolution deposition modelling – proposed development only

Receptor number	X(m)	Y(m)	Designation	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (μg/m³)	Critical Load (kg/ha)	Process Contribution (μg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
30	325446	306693	Gwaun Bryn SSSI	0.030	3.0	20.0	0.015	0.5	0.12	0.6
31	324725	305089	Leighton Bat Roosts SSSI	0.030	3.0	15.0	0.006	0.2	0.05	0.3
32	324315	305242	Leighton Bat Roosts SSSI	0.030	3.0	15.0	0.006	0.2	0.05	0.3
33	326976	310143	Buttingham Brickworks SSSI	0.030	3.0	10.0	0.006	0.2	0.05	0.5
34	323398	308308	Gungrog Flash SSSI	0.030	3.0	15.0	0.005	0.2	0.04	0.3
35	324170	302802	Kingswood Meadows SSSI	0.030	3.0	10.0	0.003	0.1	0.02	0.2
36	323643	308242	Montgomery Canal SAC	0.030	3.0	10.0	0.006	0.2	0.05	0.5
37	324192	309027	Montgomery Canal SAC	0.030	3.0	10.0	0.005	0.2	0.04	0.4
38	324865	310242	Montgomery Canal SAC	0.030	3.0	10.0	0.003	0.1	0.03	0.3
39	322294	306086	Montgomery Canal SAC	0.030	3.0	10.0	0.005	0.2	0.04	0.4
40	325683	311762	Montgomery Canal SAC	0.030	3.0	10.0	0.003	0.1	0.02	0.2
45	329423	302931	Midland Meres & Mosses	0.030	3.0	10.0	0.007	0.2	0.05	0.5
46	329642	302536	Midland Meres & Mosses	0.030	3.0	10.0	0.005	0.2	0.04	0.4
47	322495	311341	Granllyn SAC	0.030	3.0	10.0	0.001	0.0	0.01	0.1

Table 7b. Annual ammonia concentration and nitrogen deposition rate at the discrete receptors – high resolution deposition modelling – proposed development only

Receptor number	X(m)	Y(m)	Designation	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (μg/m³)	Critical Load (kg/ha)	Process Contribution (μg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	327685	305909	Unnamed AW	0.030	1.0	10.0	0.687	**68.7**	5.35	**53.5**
2	327834	305890	Unnamed AW	0.030	1.0	10.0	0.372	37.2	2.90	29.0
3	328131	305895	Unnamed AW	0.030	1.0	10.0	0.147	14.7	1.15	11.5
4	328194	305986	Unnamed AW	0.030	1.0	10.0	0.185	18.5	1.44	14.4
5	328302	306079	Unnamed AW	0.030	1.0	10.0	0.180	18.0	1.40	14.0
6	328099	306327	Outrack Dingle AW	0.030	1.0	10.0	0.219	21.9	1.70	17.0
7	328215	306285	Outrack Dingle AW	0.030	1.0	10.0	0.180	18.0	1.40	14.0
10	327880	306548	Millstone Plantation AW	0.030	1.0	10.0	0.177	17.7	1.38	13.8
11	328341	305933	Unnamed AW	0.030	1.0	10.0	0.126	12.6	0.98	9.8

Figure 6a. Maximum annual ammonia concentration – low resolution modelling

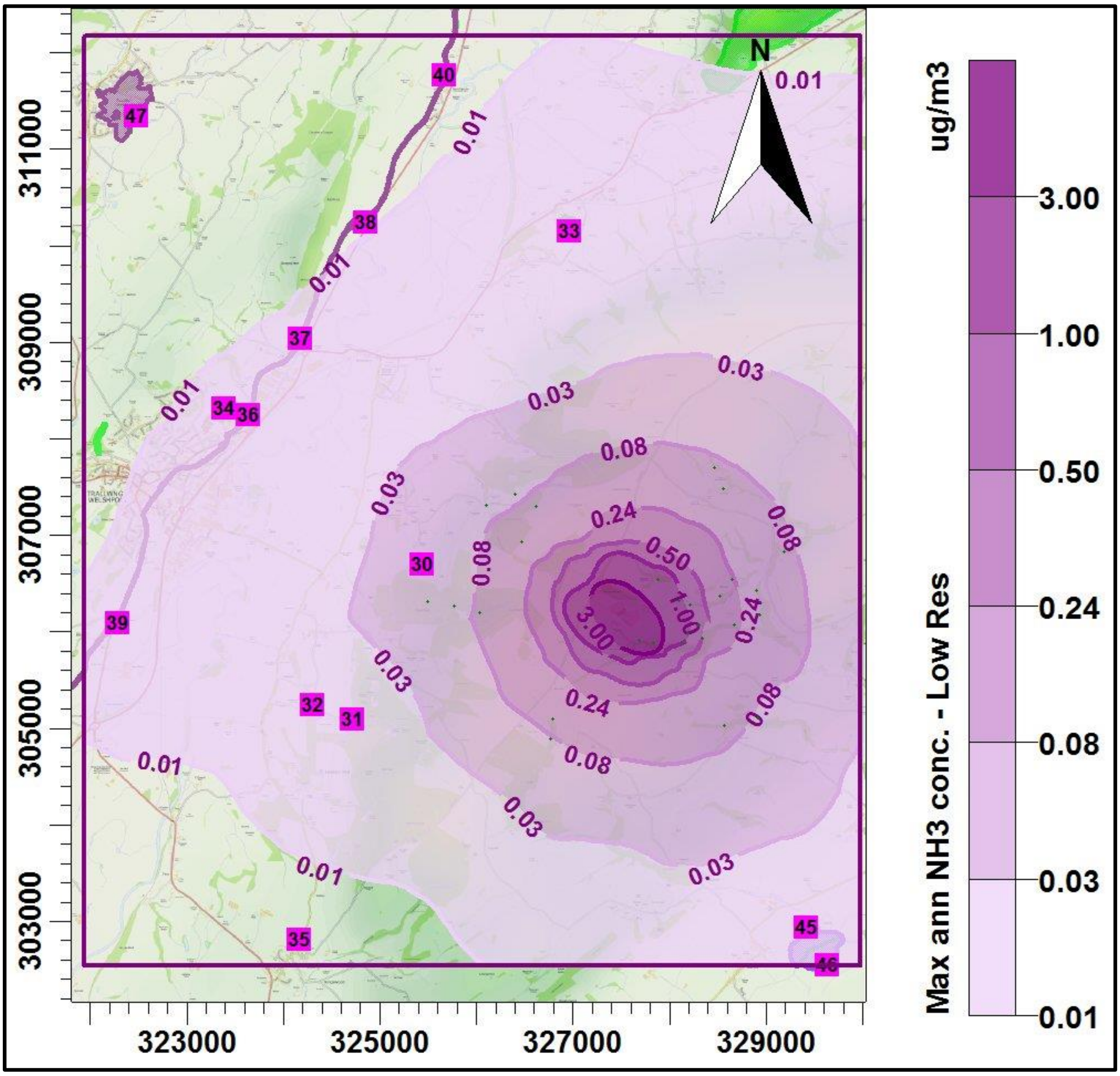


Figure 6b. Maximum annual nitrogen deposition rate – low resolution modelling

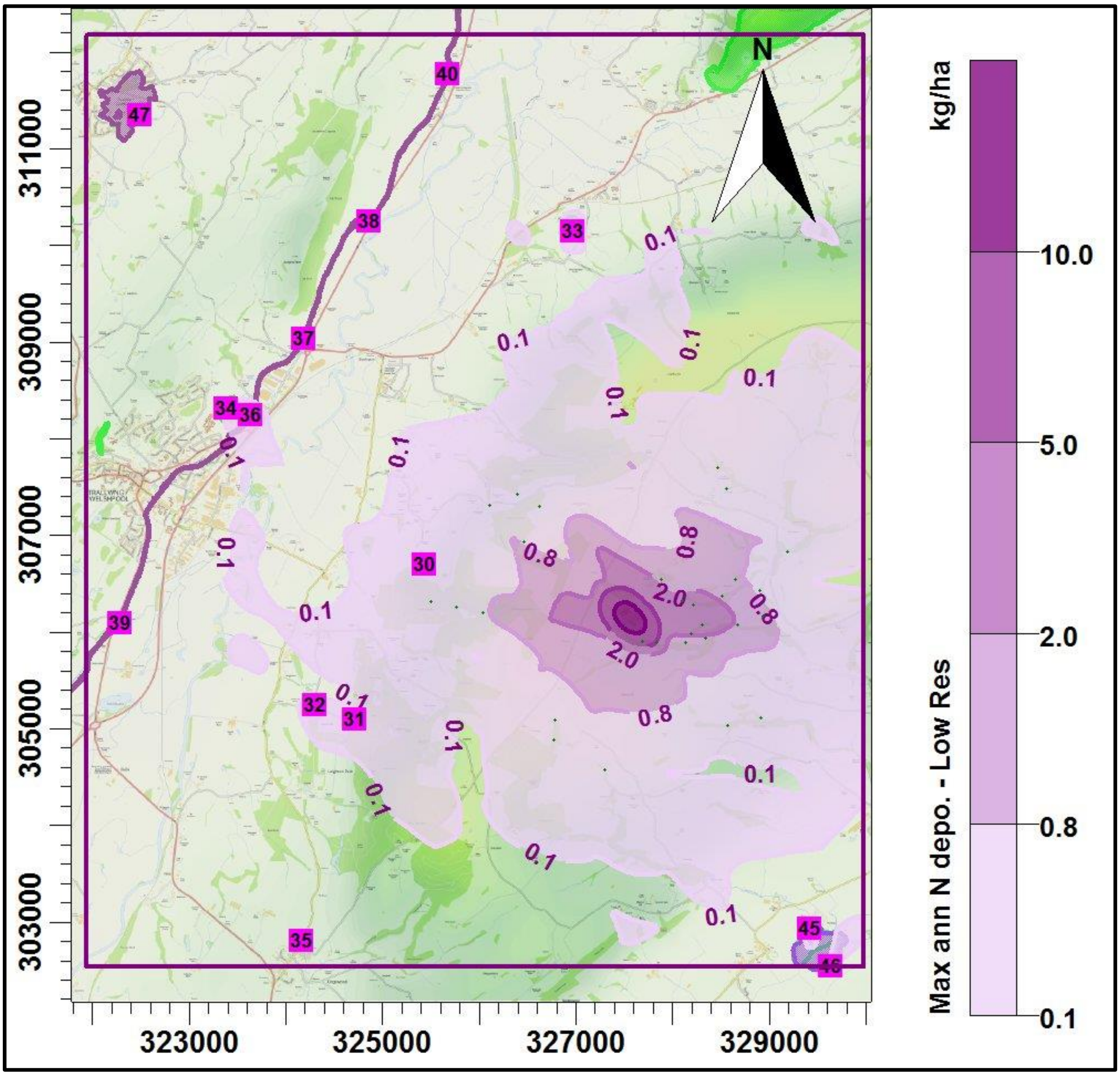


Figure 7a. Maximum annual ammonia concentration – high resolution modelling

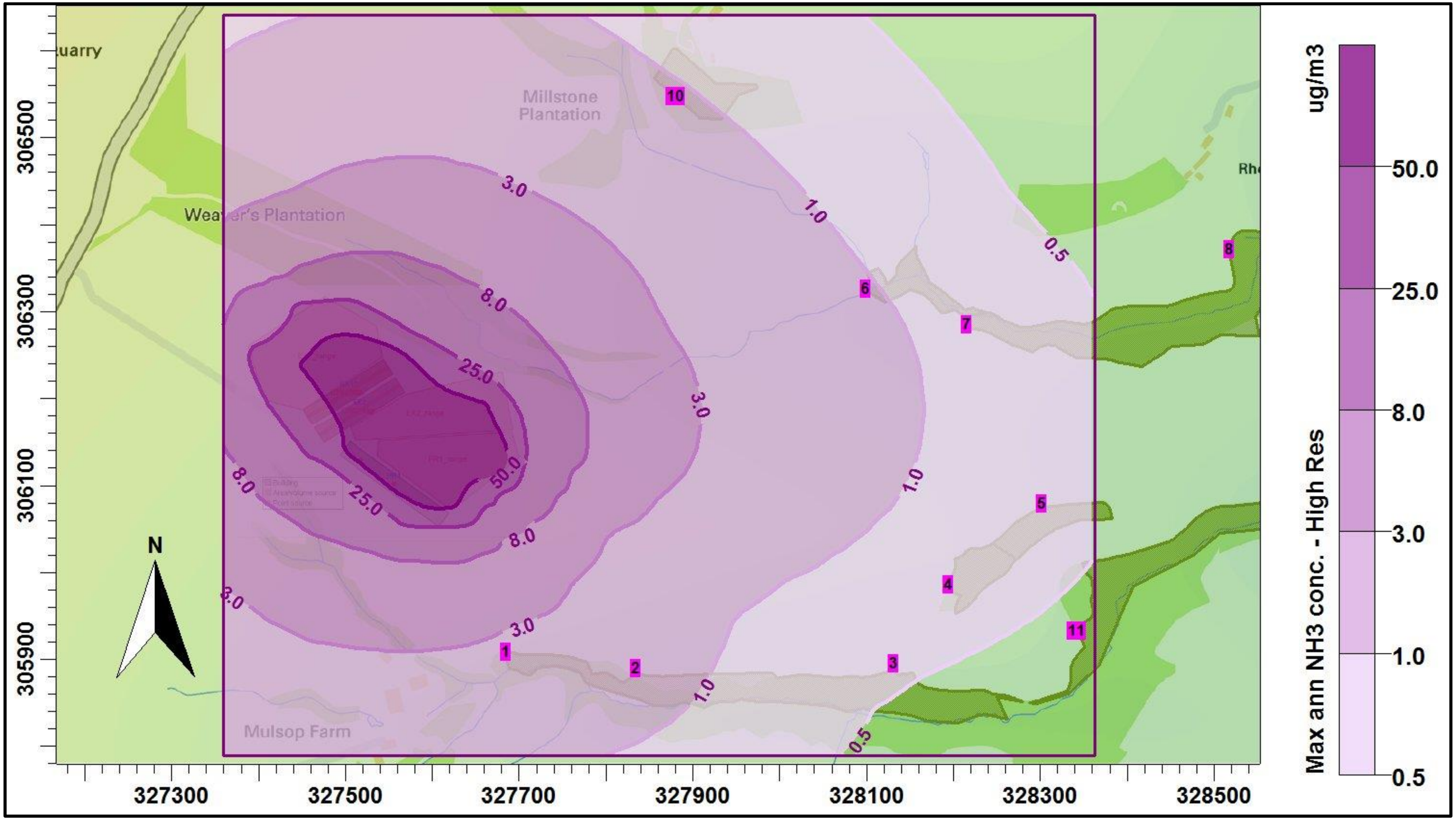
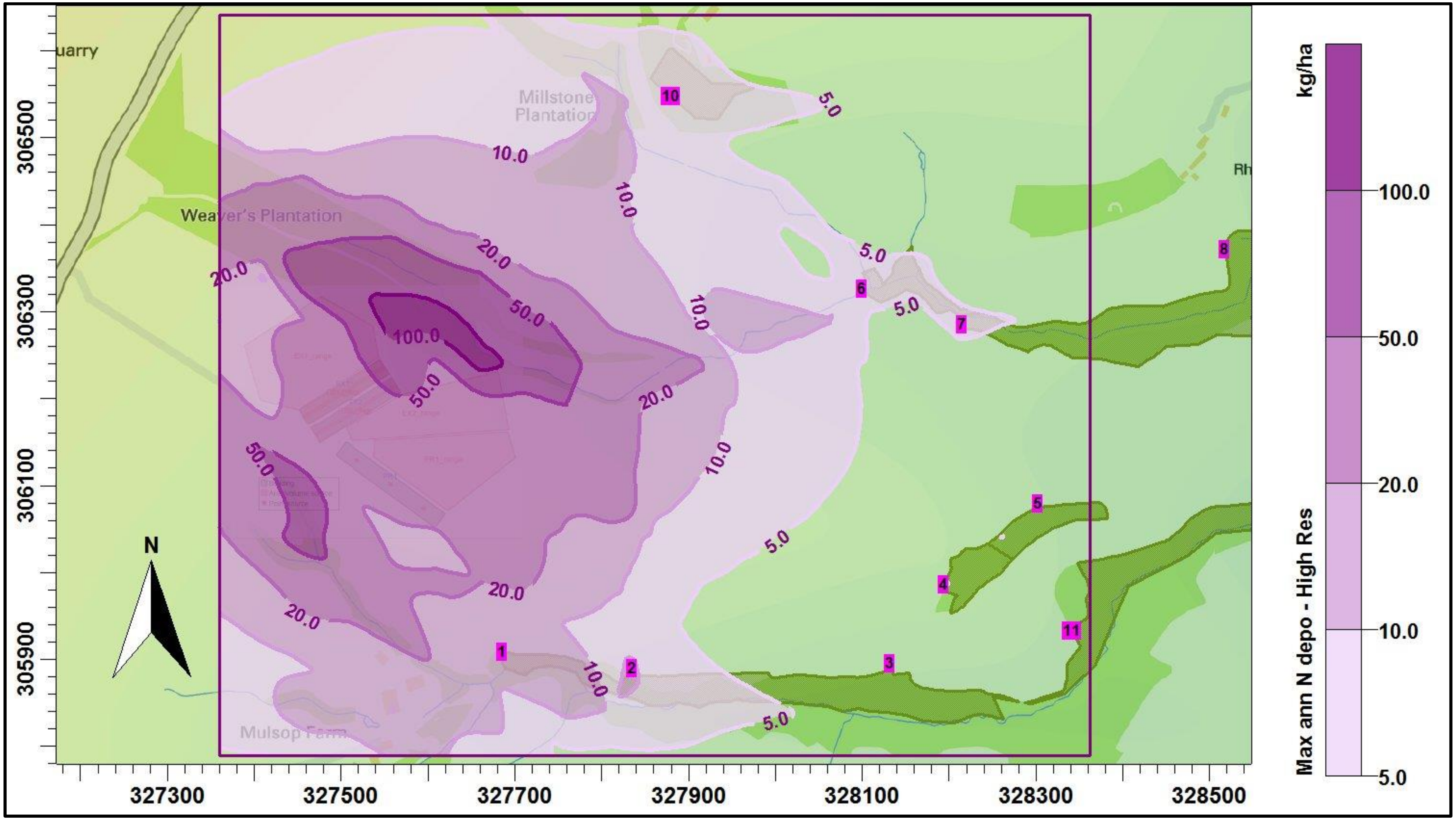


Figure 7b. Maximum annual nitrogen deposition rate – high resolution modelling



6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Rosina Bloor of Roger Parry & Partners LLP, on behalf of the applicant P E and G R Jones, to use computer modelling to assess the impact of ammonia emissions from the existing and proposed free range egg laying houses at Trelystan, Leighton, Welshpool, Powys. SY21 8JA.

Ammonia emission rates from the existing and proposed poultry houses have been assessed and quantified based upon the Environment Agency's standard ammonia emission factors. Emissions of ammonia from the ranging area have been assessed and quantified based upon figures obtained from the paper "Ammonia emission factors for UK agriculture" (Misselbrook *et al*) and Environment Agency guidance. The ammonia emission rates have then been used as inputs to an atmospheric dispersion and deposition model which calculates ammonia exposure levels and nitrogen and acid deposition rates in the surrounding area.

The modelling predicts that should the proposed enlargement of the poultry unit at Trelystan proceed:

- At nearby AWs, assuming the Critical Level of 1.0 µg-NH^3/m^3, which provides the strictest assessment criteria: there would be exceedances of the Environment Agency's lower threshold percentage of the Critical Level (100%) over approximately 0.6 ha of nearby AWs to the north-east and south-east. There are smaller predicted exceedances of the Critical Load of 10 kg-N/ha/y over a small part of the unnamed AW to the south-east.

- At Gwaun Bryn SSSI there would be a small exceedance of Natural resources Wales lower threshold percentage (1%) of the Critical Level of 3.0 µg-NH_3/m^3 and the Critical Load od 20 kg-N/ha/y; however, there would be no exceedances of the upper threshold percentage (8%) of the Critical Level or Critical Load.

- At Gwaun Bryn SSSI, Gungrog Flash SSSI, Leighton Bat Roosts SSSI and parts of The Montgomery Canal SAC and the Midlands Meres and Mosses Ramsar site there would be exceedances of Natural Resources Wales lower threshold percentage (1%) of the Critical Loads for the sites; however, there would be no exceedances of 1% of the Critical Level nor the upper threshold percentage of the Critical Load (8%).

- At all other sites designated as AWs, SSSIs and at the Ramsar site, the process contributions to annual mean ammonia level and the annual nitrogen deposition rate would be at levels below the relevant Environment Agency/Natural Resources Wales lower threshold percentage of Critical Level or Critical Load for the designation of the sites.

Mitigation

Where exceedances of the upper threshold are predicted at an AW, some form of mitigation is usually required. AS Modelling & Data Ltd. would recommend that, if available, to compensate for possible detrimental effects on the nearby AWs, that land of at least a similar area to the exceedance of 100% of the Critical Level is set aside for nature conservation and be planted or seeded with native species. Alternatively, or additionally, buffer zones and corridors could be set up around and between the AWs; such buffer zones and corridors can greatly enhance biodiversity over time.

Where there is a predicted exceedance of the Natural Resources Wales lower threshold percentage of Critical Level or Critical Load at a SSSI, SAC or Ramsar site, but the upper threshold is not exceeded, the proposal may or may not be deemed acceptable, depending on the presence, or not, of other installations that may have in-combination effects, background ammonia concentrations and the sensitivity of the wildlife sites involved.

7. References

Cambridge Environmental Research Consultants (CERC) (website). http://www.cerc.co.uk/environmental-software/ADMS-model.html

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IAQM (January 2016). Position Statement: Use of a Criterion for the Determination of an Insignificant Effect of Air Quality Impacts on Sensitive Habitats.

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Misselbrook. *et al*. Inventory of Ammonia Emissions from UK Agriculture 2011 http://uk-air.defra.gov.uk/assets/documents/reports/cat07/1211291427_nh3inv2011_261112_FINAL_corrected.pdf

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United Nations Economic Commission for Europe (UNECE) (website). http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm

UK Air Pollution Information System (APIS) (website). http://www.apis.ac.uk/

Technical Appendix 6-2
Air Quality Assessment of Road Emissions

AIR QUALITY MODELLING REPORT OF VEHICULAR MOVEMENTS ASSOCIATED WITH A PROPOSED ENERGY RECOVERY FACILITY AT BUTTINGTON QUARRY

Broad Energy (Wales) Limited,
Buttington Quarry,
Buttington,
Welshpool,
Powys.
SY21 8SZ

ECL Ref: ECL.001.01.02/ADM Roads
Issue: 1
February 2021

LIST OF AMENDMENTS

- The ecological receptors considered for ECL report reference ECL.001.01.02/ADM (EIA Chapter TA-6.1) have now been incorporated into the ADM Roads assessment;
- Assessment of significance criteria for ecological sites added;
- DEFRA's NO_X to NO_2 calculator (v8.1) has been used for the purposes of deriving NO_2 from NO_X for road sources (previously the AQTAG06 method (refer to Section 2.16.4., for details) was used for consistency with the reported NO_2 results predicted using the ADMS 5 model);
- Additional scenarios modelled to capture a hypothetical worst-case scenario of the cumulative impact of the development contribution associated with both the construction traffic and the simultaneous operation of emission point A1;
- Update to gridded output to increase the grid resolution at the maximum point of impact (previous grid spacing: X = approximately 549m and Y = approximately 744m, latest grid spacing: X = approximately 165m and Y = approximately 223m);
- Update to the complex terrain file used in order to capture all the ecological receptors. Latest terrain file now 34 km by 34km, 64 x 64 resolution (compared to the previously used 30km by 30km, 64 x 64 resolution);
- Results tables updated and additional figures added to reflect the amendments discussed; and
- Updated introduction and conclusions.

AIR QUALITY MODELLING REPORT OF VEHICULAR MOVEMENTS ASSOCIATED WITH A PROPOSED ENERGY RECOVERY FACILITY AT BUTTINGTON QUARRY

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ACRONYMS / TERMS USED IN THIS REPORT

AAD	Ambient Air Directive
AADT	Annual Average Daily Traffic Figures
ADMS	Atmospheric Dispersion Modelling System
AMS	Automatic Monitoring Station
APIS	Air Pollution Information System
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQAL	Air Quality Acceptance Level
AQS	Air Quality Standard
AW	Ancient Woodland
CERC	Cambridge Environmental Research Consultants
CL	Critical Level(s)
DEFRA	Department for Environment, Food and Rural Affairs
DNS	Development of National Significance
DT	Diffusion Tube
EA	Environment Agency
ECL	Environmental Compliance Limited
EP	Environmental Permit
EPUK	Environmental Protection UK
ERF	Energy Recovery Facility
GLC	Ground Level Concentration
IAQM	Air Quality Management
LNR	Local Nature Reserve
LWS	Local Wildlife Site
Max	Maximum
Met	Meteorological
Met data	Meteorological data
Met Office	Meteorological Office
NNR	National Nature Reserve
NO_x	Oxides of nitrogen
NO_2	Nitrogen dioxide
NRW	Natural Resources Wales
NWP	Numerical Weather Prediction
PC	Process Contribution
PCC	Powys County Council
PEC	Predicted Environmental Concentration
$PM_{2.5}$	Particulate Matter (with a diameter of 2.5 µm or less)
PM_{10}	Particulate Matter (with a diameter of 10 µm or less)
Ramsar	The Ramsar Convention on Wetlands of International Importance
SAC	Special Area of Conservation
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
The Site	Buttington Quarry Energy Recovery Centre
WHO	World Health Organisation

UNITS

km	Kilometre
km/hr	Kilometres per hour
m	Metre
µg/m³	Microgram per cubic metre
X	Easting coordinate
Y	Northing coordinate
Z_0	Surface roughness length (as defined by the modelling software)
%	Percent
%ile	Percentile

1. INTRODUCTION

1.1. The Study

1.1.1. Environmental Compliance Ltd ("ECL") were commissioned by Broad Energy (Wales) Ltd ("Broad Energy") to undertake an air quality assessment of vehicle emissions arising from the construction of a proposed Energy Recovery Facility ("ERF") at Buttington Quarry ("the Site"), Powys. This document is in support of a Development of National Significance ("DNS") application to the welsh Ministers.

1.1.2. At the height of the construction phase the number of LGV movements in and out of the ERF when combined with HGV movements require a detailed air quality assessment of vehicle emissions.

1.1.3. During the operational phase there will be substantially less vehicles and in accordance with the IAQM guidance[1], if the vehicle movements are less than the screening criteria the Development is not expected to cause a significant change in air quality and the effect can be classed as negligible.

1.1.4. Consequently, this report considered the construction phase of the ERF only.

1.1.5. This study has been conducted to determine the impact of increased road traffic on human health at roadside receptor locations and at the specified ecological receptors (see Section 2.4), operating on a worst-case scenario basis, within 13km of the Site, as outlined in the relevant guidance (see Section 2.5). A hypothetical worst-case scenario of the development contribution associated with the construction traffic and the simultaneous operation of the proposed ERF's

1.1.6. The study was undertaken using the ADMS-Roads modelling package, which is one of the models recognised as being suitable for this type of study.

1.1.7. The location of the Application Site is circled in red and central on the Site Location Map, which is presented as Figure 1. The wider area demonstrates the surrounding road network; of interest to this assessment are the A483 and the A458 (refer to Section 1.3. for further details).

[1] https://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

Figure 1: The Application Site Location Map

1.2. Objectives of the Study

1.2.1. The objectives of this study are as follows:

- to determine the maximum ground level concentrations ("GLCs") arising from traffic travelling on main access roads around the Site during the construction phase;
- to assess the impact of traffic emissions at a range of potentially sensitive human and ecological receptors, again during the construction phase;
- to determine the maximum GLCs arising from a hypothetical cumulative impact scenario which incorporated emissions arising from traffic travelling on main access roads around the Site during the construction phase as well as the simultaneous operation of the proposed ERF's main emission point; and
- to assess the cumulative impact of traffic emissions and the operation of the proposed ERF's main emission point at a range of potentially sensitive human and ecological receptors, again during the construction phase.

1.3. Scope of the Study

1.3.1. The following pollutants have been considered in the assessment:

- nitrogen dioxide ("NO_2");
- PM_{10} particulates ("PM_{10}");
- $PM_{2.5}$ particulates ("$PM_{2.5}$"); and
- oxides of nitrogen ("NO_X").

1.3.2. This report spans a number of guidance documents. The Environment Agency ("EA") online guidance[2] was used for assessing if process contributions ("PCs") are insignificant. The Environmental Protection UK ("EPUK") and the Institute of Air Quality Management ("IAQM") guidance 2017[3] was used where applicable (i.e. where PCs exceeded the assessment criteria outlined in the EA online guidance).

1.3.3. The roads considered in the study are a 22 km section of the A483, running in a north to south direction and passing to the west of the site, and a 16 km section of the A458 running in a north east to south west direction and passing to the north of the site.

1.3.4. The impacts of the predicted pollutant GLCs (also referred to as the PCs) were compared with the relevant AQSs and significance criteria at the following:

- at thirty potentially sensitive human receptor sites; and
- at 23 locations for ecological sites (includes multiple designations and co-ordinates for the Montgomery Canal).

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 AQSs. Results are presented as the maximum predicted GLC and the maximum sensitive receptor GLC.

1.3.6. Powys County Council ("PCC") have not declared any Air Quality Management Areas ("AQMAs") in the borough. PCC did have one AQMA, however this was revoked on 15th March 2017. Consequently, the assessment of impact on AQMAs is not required.

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

2. METHOD STATEMENT

2.1. Choice of Model

2.1.1. The ADMS-Roads model has been used in this assessment to predict the air quality impacts from changes in traffic on the local road network. This is a version of the Atmospheric Dispersion Modelling System ("ADMS"), a formally validated model developed in the UK by Cambridge Environmental Research Consultants ("CERC") and widely used in the UK and internationally for regulatory purposes. The current version is ADMS Roads 5.0.0.1.

2.1.2. ADMS-Roads 5.0.0.1 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.

2.1.3. 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).

2.1.4. ADMS-Roads 5.0.0.1 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 Installation will be operating on a 24-hourly basis, 365 days of the year; in practice, taking shutdowns for planned maintenance into account, the plant will not operate for 365 days;
- the highest predicted pollutant GLCs for the meteorological data for the year of 2019 for long-term averaging periods (annual mean, etc.) have been used;
- further to discussions with CERC - concentrations of NO_2 in the emissions from the specified roads have been calculated using the Department for Environment, Food and Rural Affairs ("DEFRA") NO_X to NO_2 calculator[4]. In addition, where the ERF's main stack (i.e., A1) was included in a modelled run (i.e., to assess the predicted hypothetical cumulative impact - refer to Section 2.12., Scenarios Modelled, for details), A1 was grouped separately and a long-term 70% NO_x to NO_2 conversion rate was used; 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.

[4] DEFRA NO_X to NO_2 calculator (v8.1), available online via: https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

2.3. Sensitive Human Receptors

2.3.1. In addition to predicting roadside concentrations over the 22km by 16km grid, there are 30 potentially sensitive human receptors considered in the assessment with the potential for exposure to traffic emissions (being situated in close proximity to both minor and major roads). Details of these receptors are provided in Table 1, with visual representations for these as Figures 2 and 3.

Table 1: Potentially Human Sensitive Receptors

ADMS Ref.	Name	Easting Coordinate (X)	Northing Coordinate (Y)	Distance from Site (m)	Heading (degrees)
H01	Cefn Cottage	326764	310332	248	350
H07	Methodist Church, Buttington	327057	310494	477	30
H10	Brookside	326236	309813	634	243
H11	Border Hardcore Offices	326210	309763	680	240
H12	York House	326207	309740	694	239
H14	Buttington Trewern Primary School	327355	310641	779	44
H16	Heldre Lane, Trewern	327576	310925	1,137	42
H17	Farm Buildings off A458	325883	309232	1,260	226
H20	Criggion Lane, Trewern	327822	311353	1,622	38
H23	A483, Strat Marcella Abbey	325058	310512	1,800	283
H25	Offas Dyke path, Pool Quay	325741	311635	1,879	325
H27	A458, Buttington and west of The Quarry	325286	308853	1,960	230
H28	Trewern, near monument	328241	311471	1,993	45
H29	Buttington	325160	308852	2,060	232
H30	Buttington Church	325006	308845	2,188	234
H31	A483 Pool Quay Straight	324596	309709	2,244	259
H33	The Old Shop Cottage	328661	311615	2,403	50
H34	A458, Buttington Bridge	324689	308923	2,418	240
H36	A483, Buttington Cross	324241	308972	2,799	246
H37	A458 between Middleton and Trewern	329009	311847	2,820	50
H49	Bridge of A483, Welshpool and National Cycle Route 81	322890	307087	4,940	232
H50	A483, New Cut	326081	315052	5,018	351

Table 1: Human Sensitive Receptors (cont.)

ADMS Ref.	Name	Easting Coordinate [(a)] (X)	Northing Coordinate [(a)] (Y)	Distance from Site [(b)] (m)	Heading (degrees)
H54	A483 at Trederwyn Lane	326096	315620	5,580	352
H55	A458 between Plas-y-Court and Wollaston	331928	312482	5,655	64
H59	A483 at Trederwein Fweibion Gwnwas	326199	316402	6,345	354
H62	A483 by Moat Farm	321318	304246	8,020	222
H65	A483 by Wernllwyd	320505	302774	9,657	220
H66	A483 Junction with B4390 to Berriew	319733	301229	11,332	218
H67	A483, Pant	327092	321651	11,570	1
H69	A483 north of the bridge at Berriew	319414	300515	12,100	217

Notes to Table 1
(a) Receptor coordinates are the nearest road side location to the site.
(b) Distances are measured as the crow flies from the defined receptor to the 'Site'. The 'Site' is the term for the ERF (location coordinates: 326807 (X), 310086 (Y).

Figure 2: Location of Potentially Sensitive Human Receptors up to 3km from the Site

Notes to Figure 2
The red circle is the approximate location of the ERF; and
The green squares with the white annotations represent the potentially sensitive human receptor locations specified in Table 1.

Figure 3: Potentially Sensitive Human Receptors 3km to 13km from the Site

Notes to Figure 3
The red circle is the approximate location of the ERF; and
The green squares with the white annotations represent the potentially sensitive human receptor locations specified in Table 1.

2.4. Sensitive Ecological Receptors

2.4.1. The impact of emissions to air on vegetation and ecosystems from the proposed ERF has been assessed for the following sensitive environmental receptors within 10km of the proposed discharge stack:

- Special Areas of Conservation ("SACs") and candidate SACs ("cSACs") designated under the EC Habitats Directive [5];
- Special Protection Areas ("SPAs") and potential SPAs designated under the EC Birds Directive [6];
- SACs and SPAs are included in an EU-wide network of protected sites called Natura 2000 [7]. The EC Habitats Directive and Wild Birds Directive have been transposed into UK law by the Habitats Regulations [8].

(5) Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora
(6) Council Directive 79/409/EEC on the conservation of wild birds
(7) www.natura.org
(8) The Conservation (Natural Habitats, &c.) Regulations 1994. The Conservation (Natural Habitats, &c.) (Amendment) Regulations 1997 (Statutory Instrument 1997 No. 3055), The Conservation (Natural Habitats, &c.) (Amendment) (England) Regulations 2000 (Statutory Instrument 2000 No. 192)

- Ramsar Sites designated under the Convention on Wetlands of International Importance [9];

2.4.2. In addition, the impact of emissions to air on vegetation and ecosystems from the proposed ERF has been assessed for the following sensitive environmental receptors within 2km of the discharge stack:

- Sites of Special Scientific Interest ("SSSI") established by the 1981 Wildlife and Countryside Act;
- Ancient woodland; and
- local nature sites (ancient woodland, local wildlife sites and national and local nature reserves).

2.4.3. For dispersion modelling purposes, the specified habitat co-ordinates are a precautionary approach, and are those located at the boundary of the protected site closest to the proposed ERF. All receptors are assumed to be at ground level.

2.4.4. The details of the Habitat sites are provided in Table 2. Details of these Habitat sites have been extracted from ECL report reference ECL.001.01.02/ADM (EIA Chapter TA-6.1). An additional five points were considered for the Montgomery Canal SAC and SSSI. These were included for completeness as they are considered in Section 10 of ECL Report ECL.001.01.02/ADM. These refer to locations specified in an application for an Intensive Livestock Unit, and are denoted MC36 – MC40 (inclusive). However, it should be noted that there are no common pollutants emitted from the Intensive Livestock Unit and traffic movements.

2.4.5. A visual representation of the Habitat sites is provided in Figure 4 for all sites excluding the Ramsar sites, and Figure 5 for the two Ramsar sites.

(9) The Convention of Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, Iran,1971)

Table 2: Specific Sensitive Habitat Receptors Considered for the Assessment

ADMS Ref.	Name	Type of Receptor	Easting (X)	Northing (Y)	Distance from Source (m)	Heading (°)
RAM1	Midland Meres and Mosses – Phase 1 – Marton Pool	Ramsar	329510	302730	7,837	160
RAM2	Midland Meres and Mosses – Phase 2	Ramsar	330008	323857	14,138	13
SSSI1	Buttington Brickworks	SSSI	326980	310222	220	52
SSSI2	Montgomery Canal	SSSI	324911	310297	1,908	276
SSSI3	Moel y Golfa	SSSI	328426	311640	2,244	46
SAC1	Montgomery Canal	SAC	324911	310297	1,908	276
SAC2	Granllyn	SAC	322501	311267	4,465	285
MC36	Montgomery Canal	SAC, SSSI	323643	308242	3,662	240
MC37			324192	309027	2,821	248
MC38			324865	310242	1,948	275
MC39			322294	306086	6,031	228
MC40			325683	311762	2,018	326
AW01	Ancient Woodland - 33254	Cat 1 - AW	326365	310248	471	290
AW02	Ancient Woodland - 33255	Cat 1 - AW	326312	310244	520	288
AW03	Ancient Woodland - 47343	Cat 3 - AW	327442	310141	637	85
AW04	Ancient Woodland - 26045	Cat 1 - AW	327683	310276	896	78
AW05	Ancient Woodland - 27762	Cat 1 - AW	327370	309339	936	143
AW06	Ancient Woodland - 33238	Cat 1 - AW	326717	309109	982	185
AW07	Ancient Woodland - 27222	Cat 1 - AW	327761	309658	1,046	114
AW08	Ancient Woodland - 28973	Cat 2 - AW	327692	309306	1,180	131
AW09	Ancient Woodland - 35167	Cat 2 - AW	328187	310137	1,381	88
AW10	Ancient Woodland - 27086	Cat 1 - AW	326285	308794	1,394	202

Table 3: Specific Sensitive Habitat Receptors Considered for the Assessment (cont.)

ADMS Ref.	Name	Type of Receptor	Easting (X)	Northing (Y)	Distance from Source (m)	Heading (°)
AW11	Ancient Woodland - 27223	Cat 1 - AW	328256	309896	1,461	97

Notes to Table 2

(a) Distances are measured as the crow flies from the defined receptor to the 'Site'. The 'Site' is the term for the ERF (location coordinates: 326807 (X), 310086 (Y).

Details of these Habitat sites have been extracted from ECL report reference ECL.001.01.02/ADM (EIA Chapter TA-6.1) – with the exception of MC36 – MC40 (which are the five points considered for the Montgomery Canal SAC and SSSI as specified in the Poultry Farm report).

AW = Ancient Woodland

Cat = Category

Figure 4: Potentially Sensitive Ecological Receptors – Excluding Ramsar

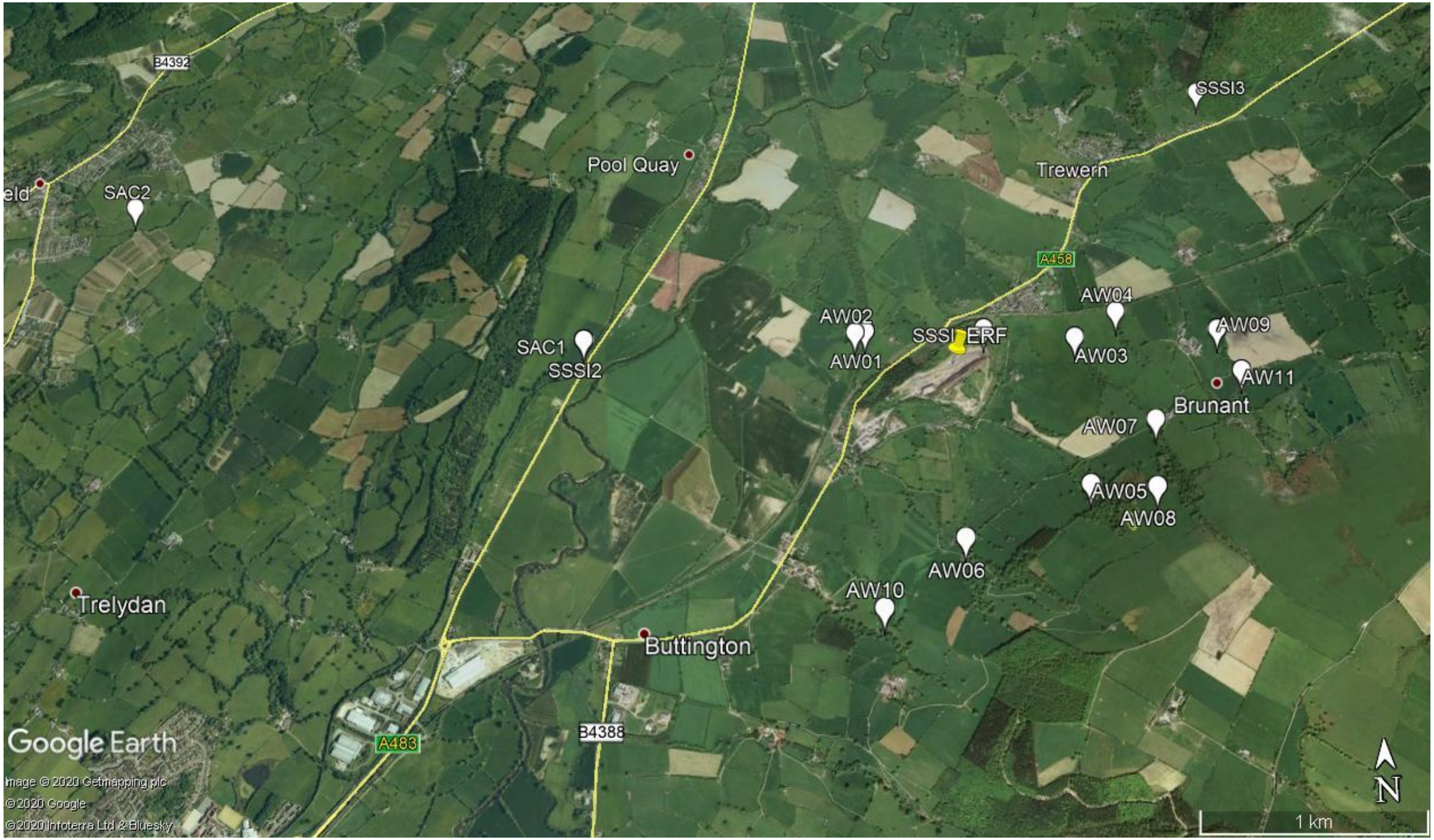
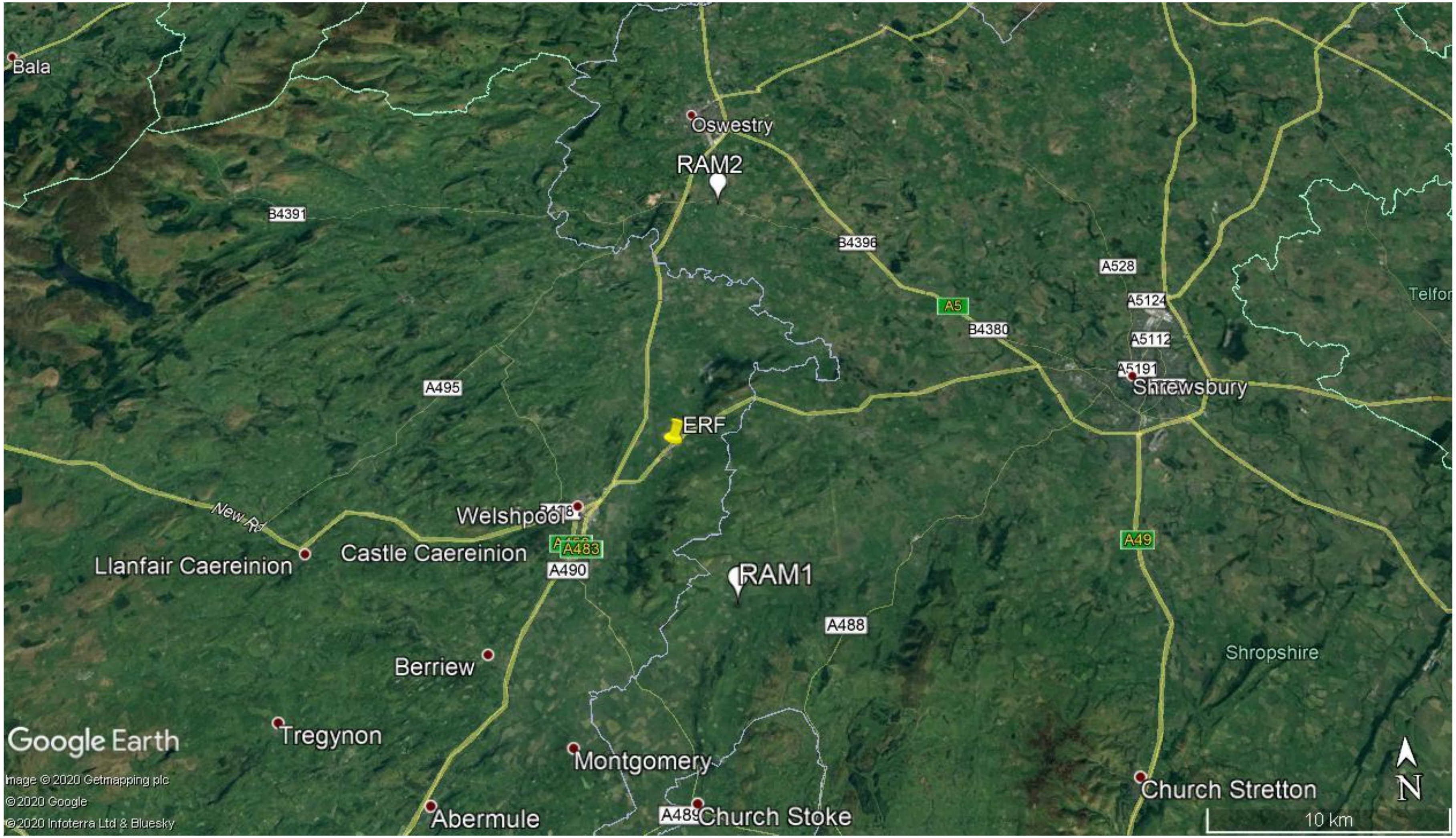


Figure 5: Potentially Sensitive Ecological Receptors – Ramsar



2.5. Air Quality Standards for the Protection of Human Health

2.5.1. The Air Quality Strategy ("AQS") for England, Scotland, Wales and Northern Ireland (2007) details Air Quality Strategy Objectives ("AQO") for a range of pollutants, including a number that are directly relevant to this study, i.e. NO_2, PM_{10} and $PM_{2.5}$. 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 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 AQO and AAD Limit
Particulate Matter, as PM_{10}	annual	40	UK AQO
Particulate Matter, as $PM_{2.5}$	annual	25	EU Limit Value

2.6. Assessment Criteria for the Protection of Sensitive Habitat Sites and Ecosystems - Critical Levels

2.6.1. 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.

2.6.2. The 2008 Air Quality Directive[10] 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.

[10] Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe, 21st May 2008

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

Pollutant	Averaging Period	Critical Level (µg/m³)	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.

2.7. Background Air Quality

2.7.1. Where background air quality data is used in this assessment, it will be discussed in the relevant section of this report.

2.8. Meteorological (Met) Data

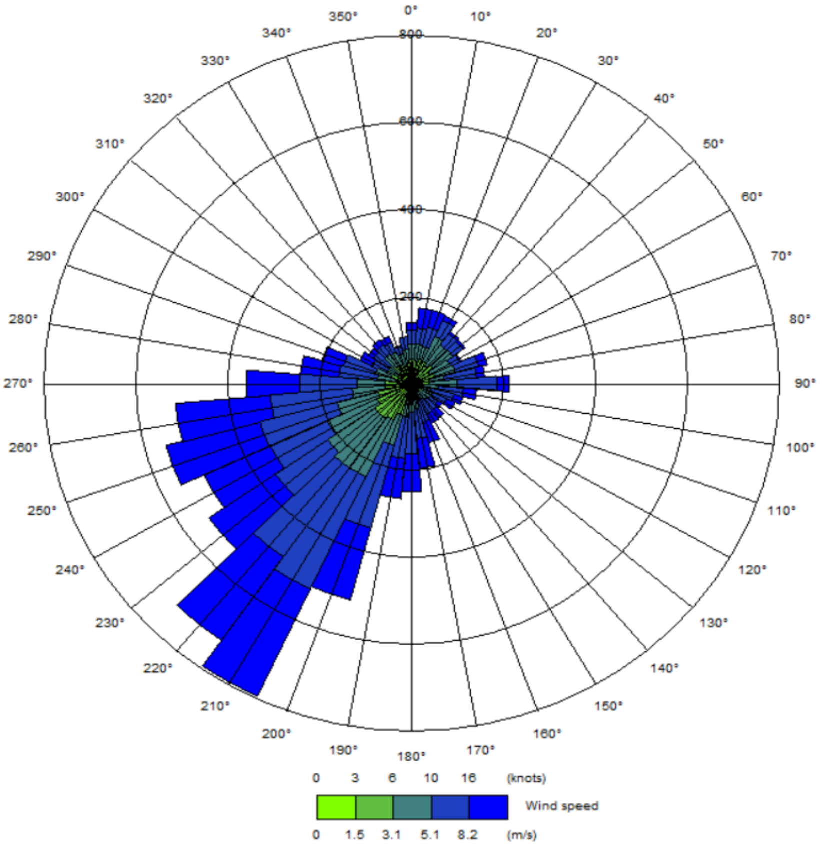
2.8.1. ADMS-Roads has a meteorological pre-processing capability, which calculates the required boundary layer parameters from a variety of data. Meteorological data ("met data") can be utilised in its sequentially analysed form, which estimates the pattern of dispersion through 10° sectors from the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

2.8.2. The nearest suitable met data available from the Meteorological Office ("Met Office") is from Shawbury. It should be noted that this location is in excess of 30km north east of the Site (located at 355280, 322106). Numerical Weather Prediction ("NWP") data is available from the Met Office which would provide modelled site-specific weather conditions. NWP data is used by the Met Office for weather forecasting and to model climate change. The models are run on large supercomputers and input observations from ground stations, buoys at sea, radiosondes, aircraft and satellites[11]. The data supplied by the Met Office is at a resolution of 1.5km. The Met Office have investigated the terrain surrounding the site and believe that the 1.5km resolution is the appropriate model to use[12].

2.8.3. The assessment utilised NWP data from 2019 of hourly sequentially analysed data in sectors of 10°. Refer to Section 2.12. in ECL report reference ECL.001.01.02/ADM (EIA Chapter TA-6.1) for further details regarding the meteorological data. The wind rose for the 2019 NWP data is presented in Figure 6; this shows that the prevailing winds are predominantly south-westerly.

[11] User Guide to NWP Mett Data for Dispersion Modelling, Met Office, 10th March 2009.
[12] Email from Met Office to ECL 19th July 2019.

Figure 6: Wind Rose – NWP Data 2019



2.9. Terrain Data

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

2.9.2. Terrain data was used for an area of 1,156 km^2 (34km by 34 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 potentially sensitive human receptors and ecological sites considered for the assessment. 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.

2.10. Roughness Length

2.10.1. 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-Roads 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 large urban areas are classed as 1.5m.

2.10.2. A surface roughness length of 0.3m was used for the 'Dispersion site' (which is indicative of agricultural crops (max) in the vicinity of which the Site is located). Being site specific NWP data, a surface roughness value of 0.3m was also used for the 'met measurement site'. Screening undertaken for the dispersion modelling report (see ECL Report ECL.001.01.02/ADM) also confirmed the suitability of this roughness length.

2.11. Model Output Parameters

2.11.1. The ADMS-Roads 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 coordinate system. For the purpose of this study the Cartesian system was used.

2.11.2. 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.

2.11.3. For assessing the maximum point of impact, a grid resolution of approximately 16 km by 22 km was utilised in order to capture the values of the predicted pollutant GLCs arising from the modelled pollutants for the extent of the roads assessed. The grid coordinates were X = 316605 to 333063 and Y = 300037 to 322351, with 101 nodes along each axis (i.e. an approximate grid spacing of 165m for X and 223m for Y).

2.11.4. For assessing the impact of emissions on human and ecological health, the grid references of each were included as specified points within the ADMS-Roads model.

2.12. Scenarios Modelled

2.12.1. The following scenarios were modelled:

- To validate the model:
  - impact assessment of vehicle emissions of long-term NO_x as NO_2, PM_{10} and $PM_{2.5}$ at potentially sensitive roadside human receptor locations for the 2019 baseline year; and
  - impact assessment of vehicle emissions of annual and daily NO_x at the ecological sites considered for the assessment for the 2019 baseline year.
- To assess the impact of vehicle movements associated with the construction phase of the ERF only. This scenario is also referred to as 'Roads Only':
  - impact assessment of vehicle emissions of long-term NO_x as NO_2, PM_{10} and $PM_{2.5}$ from increased construction related traffic flows for 2022 at the maximum point of impact;
  - impact assessment of vehicle emissions of long-term NO_x as NO_2, PM_{10} and $PM_{2.5}$ from increased construction related traffic flows for 2022 at potentially sensitive human receptor locations; and
  - impact assessment of vehicle emissions of annual and daily NO_x from increased construction related traffic flows for 2022 at the ecological sites considered for the assessment.
- To assess the impact of vehicle movements associated with the construction phase of the ERF combined with the hypothetical simultaneous operation of the ERF's main stack emission point (designated 'A1'). This scenario is also referred to as 'Cumulative':
  - impact assessment of vehicle and A1 emissions of long-term NO_x as NO_2, PM_{10} and $PM_{2.5}$ from increased construction related traffic flows (and the hypothetical operation of A1) for 2022 at the maximum point of impact;
  - impact assessment of vehicle emissions of long-term NO_x as NO_2, PM_{10} and $PM_{2.5}$ from increased construction related traffic flows (and the hypothetical operation of A1) for 2022 at potentially sensitive human receptor locations; and
  - impact assessment of vehicle emissions of annual and daily NO_x from increased construction related traffic flows (and the hypothetical operation of A1) for 2022 at the ecological sites considered for the assessment.

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

2.13.1. 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.

2.13.2. 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

2.13.3. 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 2.12.4.

2.13.4. **Long-Term Impacts**

2.13.4.1. If the PCs exceed the long-term criteria outlined in the EA online guidance, the potential long-term effects on human receptors from the vehicular traffic will be assessed in accordance with the latest guidance produced by EPUK and IAQM in January 2017.

2.13.4.2. 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.

2.13.4.3. 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 Air Quality Acceptance Level ("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 a 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 individual receptors considered.

2.13.4.4. The impact descriptors for individual receptors are presented in Table 5.

Table 5: 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

2.14. Assessment of Significance of Impact Guidelines – Ecological Receptors

2.14.1. 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.

2.14.2. 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 5. If the short-term PC exceeds the screening criteria then further modelling needs to be undertaken.

2.14.3. When there are local nature sites within the specified distance the EA online guidance state 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.

2.14.4. If the above criteria are met, then no further assessment is required.

2.15. Assessment of Significance of Impact Guidelines – Ecological Receptors, Critical Levels

2.15.1. EA Operational Instruction 67_12[13] states that a detailed assessment is required where modelling predicts that the long-term PC is greater than:

- 1% for European sites and SSSIs; or
- 100% for NNR, LNR, LWS and ancient woodlands.

And, the PEC is greater than:

- 70% for European sites and SSSIs; or
- 100% for NNR, LNR, LWS and ancient woodlands.

2.15.2. For short-term emissions, modelling is required at European site and SSSI's where the PC is greater than 10% of the critical level, or 100% for NNR, LNR, LWS and ancient woodland.

[13] EA Operational Instruction 67_12 Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation, V2, 27.3.15

2.15.3. Following detailed assessment, if the PEC is less than 100% of the appropriate environmental criterion, then it can be assumed there will be no adverse effect for European Sites and SSSI's.

2.15.4. However, for NNR, LNR, LWS or ancient woodland, if the PC is less than 100% of the appropriate environmental criterion, then it can be assumed there will be no significant pollution.

2.16. NO_X to NO_2 conversion Rates

2.16.1. **Emissions from ADMS-Roads: Road sources**

2.16.1.1. Following recent discussions with CERC, it was advised that DEFRA's NO_X to NO_2 calculator should be used for the purposes of deriving NO_2 from NO_X (previously the AQTAG06 method (refer to Section 2.16.4., for details) was used for consistency with the reported NO_2 results predicted using the ADMS 5 model (i.e., ECL report reference ECL.001.01.02/ADM).

2.16.1.2. Consequently, v8.1 of the calculator has now been used in this assessment to determine NO_2 concentrations, based on predicted NO_X concentrations using ADMS-Roads.

2.16.2. **Emissions from ADMS-Roads: Industrial Sources**

2.16.3. 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

2.16.4. However, further to detailed discussion with the EA and Natural Resources Wales ("NRW") on previous studies, a long-term 70% NO to NO_2 conversion rate 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 for industrial sources. The conversion rates as provided in section 2.16.3. should only be used for screening assessment.

2.16.5. Consequently, for modelled runs inclusive of industrial sources (i.e., the ERF's main stack (A1)), the predicted NO_X emissions arising from A1 will be converted using the 70% NO to NO_2 conversion rate – this approach was also discussed with CERC.

3. Vehicle Emissions

3.1. Emission Factors

3.1.1. The ADMS-Roads model has been used in this assessment to predict the air quality impacts from changes in traffic levels on the local road network around the Site.

3.1.2. Concentrations of NO_2, PM_{10} and $PM_{2.5}$ at roadside human receptors were calculated using the modelling system. Modelling was performed using traffic flow data recorded from major roads in the area during a traffic road survey carried out by Intermodal Transportation in January 2019[14].

3.1.3. The model was run using NWP data for the year 2019 to be used for the future scenario modelling. The model was then re-run using predicted increased traffic flows for the year 2022 based on vehicle factor increases provided by Intermodal Transport[6] and increased traffic flow based on construction traffic travelling to and from the Site.

3.2. Traffic Flows

3.2.1. For all major roads in the area, data from a manual traffic survey performed by PCC Traffic Information Consultancy on the 17th January 2019 was used to determine the baseline annual average daily traffic ("AADT") figures.

3.2.2. PCC Traffic Information Consultancy divided motorised traffic into six categories; motorcycles, cars, light goods vehicles, ordinary goods vehicles 1, ordinary goods vehicles 2 and buses[15]. ADMS Roads only contains the traffic categories of light goods vehicles and heavy goods vehicles, therefore, to ensure vehicle emissions are modelled as a worst-case scenario, motorcycles and cars were counted as light goods vehicles and all other vehicles were counted as heavy goods vehicles.

3.2.3. Based on the traffic survey data, baseline traffic flows for 2019 were calculated and are presented in Table 6.

3.2.4. The construction phase is due to take place from 2022-2025. Intermodal Transportation calculated that by 2025 (the assumed operational year) traffic flow on the local road network would increase by a factor of 1.089. Consequently the 2019 traffic flow has been increased by this factor (as a worst-case assessment) to account for the 3 year construction period for the "2022 without development" scenario (see Table 6). The construction phase vehicle movements (again provided by Intermodal Transport) were then added to the 2022 traffic flows to provide the "2022 with development" scenario (see Table 6).

3.2.5. The year 2022 was again used as a worst case year as vehicle emissions in 2025 are predicted to improve, consequently the worst case vehicle emissions year (2022), combined with the worst case growth year (2025) adds conservatism to the model.

[14] Intermodal Report IT1921, Traffic Assessment, August 2020.
[15] Appendix F - Intermodal Report IT1921, Traffic Assessment, August 2020.

Table 6: Traffic Data

Road	Speed (km/hr)	2019 Baseline		2022 With Development		2022 Without Development	
		AADT	HGV%	AADT	HGV%	AADT	HGV%
A483 (South)	80	3180	22%	4179	35%	3463	22%
A483 (J2 to J3)	80	6473	22%	7213	23%	7049	22%
A483 (J1 to J2)	80	7961	21%	8700	21%	8670	21%
A483 (North)	80	1929	21%	2122	21%	2101	21%
A458 (South)	80	3006	15%	3392	18%	3274	15%
A458 (North)	80	2133	19%	2873	34%	2323	19%
A458 Buttington Bridge to Kevin Bridge	80	2133	19%	2873	34%	2323	19%
A483 (South to J3)	20	3180	22%	4179	35%	3463	22%
A458 to J3	20	3006	15%	3392	18%	3274	15%
A483 to J3	20	6473	22%	7213	23%	7049	22%
A458 to J2	20	3006	15%	3392	18%	3274	15%
A483 (J3 to J2)	20	6473	22%	7213	23%	7049	22%
A483 to J2	20	7961	21%	8700	21%	8670	21%
A483 to J1	20	7961	21%	8700	21%	8670	21%
A483 (North to J1)	20	1929	21%	2122	21%	2101	21%
A458 to J1	20	2133	19%	2873	34%	2323	19%
Buttington Bridge	20	2133	19%	2873	34%	2323	19%
Kevin Bridge	20	2133	19%	2873	34%	2323	19%

3.2.6. Outside the development area general assumptions were made for road speed. The traffic speeds on free-flowing sections of the A483 and A458 were assumed to be 80km/hr, speeds within 75m of junctions were reduced to 20km/hr to represent congested traffic at these locations.

4. MODEL VERIFICATION

4.1. Comparison of Measured and Modelled Concentrations

4.1.1. The first stage of a modelling study is to model a current case in order to verify that the input data and the model setup are appropriate for the area by comparing measured and modelled concentrations for the local monitoring locations. For the verification and adjustment of NO_X/NO_2 concentrations, the LAQM.TG16 guidance recommends that the comparison considers a broad spread of automatic and DT monitoring.

4.1.2. PCC does not undertake any diffusion tube ("DT") monitoring for NO_2 within the vicinity of the study area. However, a DT study was performed by SLR Consultancy between August 2015 and January 2016, Table 7 displays the location of the nearest roadside monitoring location to Site (i.e. DT locations within 3km of Site) and the average NO_2 concentration at the location for the monitoring period. It should be noted that although the SLR monitoring included 5 diffusion tube locations, only one (AQ3) was roadside therefore was used for this assessment.

Table 7: Nearest Roadside DT Monitoring Locations to Site – NO_2

Tube Number	Location	NO_2 Conc. (bias corrected) ($\mu g/m^3$)	Easting Coord. (X)	Northing Coord. (Y)	Distance from Site [(b)] (m)	Heading (degrees)
AQ3 [(a)]	Buttington	12.51 [(a)]	326206 [(a)]	309763 [(a)]	682	242

Notes to Table 7

(a) Information obtained from monitoring data provided by SLR Consultants. AQ3 results are calculated from data obtained from AQ3A and AQ3B diffusion tubes (the data is an average of AQ3A's average and AQ3B's average from the results recorded over the period August 2015 to January 2016).

(b) Distances are measured as the crow flies from the DT site to the 'Site'. The 'Site' is the term for the ERF (location coordinates: 326807 (X), 310086 (Y)).

4.1.2.1. It should be noted that the background NO_2 concentrations at AQ3 is 31.3% of the AQS, which is most likely attributable to the roadside location.

4.1.2.2. There are currently no Automatic Monitoring Stations ("AMS") operating within PCC. Consequently, there is no additional observed (i.e. monitored) NO_2 data to supplement the DT concentrations.

4.1.3. Data from AQ3 (see Table 7) has been used to verify the model for this study. It should be noted that, as the diffusion tube data is incomplete (i.e. it does not cover a full calendar year) and the traffic count data and Met data is from 2019 – it is not a like-for-like comparison. However, in the absence of any alternative measured background NO_2 data, for the purposes of this assessment the 2019 baseline year has been used to compare the measured and modelled concentrations of NO_2 at AQ3; the results of the assessment are presented in Table 8 (this has been conducted reporting the maximum predicted concentration in the interest of demonstrating the worst-case scenario PC).

Table 8: Measured and Modelled Average NO_2 Concentrations at the Monitoring Site

Site ID	Measured Concentration (µg/m³)	Modelled Concentration (µg/m³)	% Difference (Modelled vs. Monitored)
AQ3 [a]	12.51 [a]	12.47 [b]	-0.34

Notes to Table 8

(a) Buttington diffusion tube (August 2015 – January 2016 data). Refer to Table 7 for further details.

(b) 100th percentile NO_2, adjusted using the DEFRA NO_X to NO_2 calculator (v8.1) – 2019 baseline year.

4.1.4. Although not a like-for-like comparison, due to the lack of available data, the verification results displayed in Table 8 indicate that the model set-up and emissions are suitable for the situation considered. The verification also lends confidence to the predictions for future concentrations, as the modelled prediction is within 10% of the measured result and well within the +/-25%; beyond which - it is recommended that model inputs and verification should be revisited in order to make improvements or correction factors are required (LAQM.TG16).

5. PREDICTED 2022 CONCENTRATIONS – Roads Only

5.1. Maximum Ground Level Concentrations – Roads Only

5.1.1. Ground level concentrations of NO_2, PM_{10} and $PM_{2.5}$ were calculated on an area covering the development and nearby potentially affected roads. Estimates of vehicle pollutant concentrations at roadside sensitive receptors were predicted and assessed for the baseline year of 2019 prior to construction. Vehicle pollutant concentrations were then reassessed at roadside sensitive receptors for the construction year of 2022, with and without construction having taken place.

5.1.2. Maximum ground level concentrations were determined using NWP data for Met year 2019. This data is presented in Tables 9a and 9b, with a visual representation of the Max PC location provided in Figure 7. Table 9c summarises the impact of the construction phase traffic. In Table 9c, any development contribution that is potentially significant (i.e., greater than 1% of the respective AQS) is highlighted in bold type.

Table 9a: Maximum Ground Level Concentrations – Baseline 2022

Pollutant	Met Year	Max PC (µg/m³)	AQS (µg/m³)	PC as % of AQS	Location of Max PC	
					X Coord	Y Coord
NO_2 (annual)	2019 – NWP data	20.54	40	51.35%	323652	308069
PM_{10} (annual)		2.78	40	6.94%	324202	308746
$PM_{2.5}$ (annual)		1.68	25	6.71%	324202	308746

Table 9b: Maximum Ground Level Concentrations – Baseline & Construction Traffic 2022

Pollutant	Met Year	Max PC (µg/m³)	AQS (µg/m³)	PC as % of AQS	Location of Max PC	
					X Coord	Y Coord
NO_2 (annual)	2019 – NWP data	20.95	40	52.38%	323652	308069
PM_{10} (annual)		2.80	40	7.00%	324202	308746
$PM_{2.5}$ (annual)		1.69	25	6.77%	324202	308746

Table 9c: Construction Phase Vehicle Emissions Modelling Results

Pollutant	Baseline (2022) No Construction Traffic		Baseline (2022) + Construction Traffic		Impact	
	µg/m³	%of AQS	µg/m³	%of AQS	µg/m³	%of AQS
NO_2	20.54	51.35%	20.95	52.38%	**0.410**	**1.03%**
PM_{10}	2.78	6.94%	2.80	7.00%	0.0255	0.06%
$PM_{2.5}$	1.68	6.71%	1.69	6.77%	0.0153	0.06%

Figure 7: Approximate Location of Maximum Pollutant GLCs – Roads Only

Notes to Figure 7
The red icon labelled 'S' is the approximate location of the proposed ERF emission point; and
The green and blue markers in Figure 7 represent the approximate locations of the maximum GLCs specified in Tables 9a and 9b
(Please note that the colour coded icons in Figure 7 correspond to the colour coded coordinates shown in Tables 9a and 9b).

5.1.3. Maximum concentrations for all modelled pollutants occur to the south-west of the site at junctions of the A483 and A485 roads. This is as would be expected as the junctions are on the north-east perimeter of the town of Welshpool which is the most populated region of the area modelled and the prevailing winds for the NWP Met year of 2019 were predominantly from the south-west.

5.1.4. The results in Table 9c clearly demonstrate that the effect of the construction phase traffic can be considered not significant at the maximum point of impact, for $PM_{2.5}$ and PM_{10}, as the difference in concentrations of pollutants are less than 1% of the relevant AQS (see Section 2.13). Consequently, no further assessment is required for these pollutants.

5.1.4.1. For the predicted NO_2 concentration, the results in Table 9c show that the effect of the construction phase traffic can be considered potentially significant (i.e., the difference in the NO_2 concentration is greater than 1% of the respective AQS). Consequently, the PEC must be calculated. As previously discussed, PECs are determined by adding the predicted PC to the ambient background concentration.

5.1.4.2. As PCC do not currently operate any automatic monitoring sites, nor do they operate any DT sites in the vicinity of the study area; DEFRA modelled background pollution maps have been used as the source of background air quality. The background pollution maps make use of a 1x1 km resolution.

5.1.4.3. The nearest most representative (and also the highest) DEFRA modelled background location to the location of is at the following grid coordinates: 323500 (X), 307500 (Y)). The

2022 annual NO_2 concentration at this location is 7.06 µg/m^3 (the background concentration was taken from the future projection local authority maps[16], for PCC for NO_2, developed by DEFRA, for the year 2022 (using 2018 as the reference year for monitoring meteorological data). Making use of a background concentration of 7.06 µg/m^3 the annual NO_2 PEC would be 7.47 µg/m^3 (or 19% of the AQS).

5.1.4.4. It should be noted that, when using the latest available DEFRA modelled background maps[17] for NO_2 (2019 data) the background concentration from the same location (i.e. 323500 (X), 307500 (Y)) is 8.28 µg/m^3 – this would make the NO_2 PEC 8.69 µg/m^3 (or 22% of the AQS).

5.1.4.5. Furthermore, whilst not considered representative background data for the purposes of calculating the NO_2 PEC at the maximum point of impact (due to both the period in which the data was captured and the location of where the data was recorded) - if DT AQ3 was used as the source of the ambient air quality (refer to Table 7 in Section 4., for details) in the interest of reporting the worst-case scenario total NO_2 concentration – the PEC would be 12.92 µg/m^3 (or 32% of the AQS).

5.1.4.6. In accordance with the IAQM impact descriptors laid out in Table 5 of Section 2.13., the significance of all three NO_2 PECs calculated can therefore be regarded as 'negligible' for the potentially significant development contribution at the maximum point of impact. Consequently, no further assessment is required.

5.2. Human Receptor Locations – Roads Only

5.2.1. Nitrogen Dioxide (NO_2)

5.2.1.1. Table 10 presents a summary of the predicted change in long-term NO_2 concentrations at potentially sensitive human receptor sites due to changes in traffic flow associated with the construction phase. Baseline data (2019) is provided for information. The impact of the "2022 no development" and "2022 with development" is then considered at all locations. In Table 10, any development contribution that is potentially significant (i.e., greater than 1% of the AQS for NO_2) is highlighted in bold type.

[16] Available online via: https://uk-air.defra.gov.uk/data/laqm-background-home
[17] Available online via: https://uk-air.defra.gov.uk/data/pcm-data

Table 10: Predicted Annual Average Concentrations of NO_2 at Receptor Locations

ADMS Ref. [a]	NO_2 (µg/m^3)				
	Name	**Baseline 2019**	**2022 No Development**	**2022 With Development**	**Development Contribution (% of AQS) [b]**
H01	Cefn Cottage	4.17	2.93	4.55	**4.05%**
H07	Methodist Church, Buttington	5.17	3.59	5.12	**3.83%**
H10	Brookside	1.68	1.20	1.52	0.80%
H11	Border Hardcore Offices	4.12	2.95	3.70	**1.88%**
H12	York House	2.63	1.88	2.37	**1.23%**
H14	Buttington Trewern Primary School	0.970	0.700	0.910	0.53%
H16	Heldre Lane, Trewern	4.16	2.97	3.72	**1.88%**
H17	Farm Buildings off A458	1.78	1.27	1.60	0.83%
H20	Criggion Lane, Trewern	1.88	1.33	1.68	0.88%
H23	A483, Strat Marcella Abbey	1.56	1.08	1.10	0.05%
H25	Offas Dyke path, Pool Quay	3.82	2.67	2.71	0.10%
H27	A458, Buttington and west of The Quarry	1.53	1.08	1.36	0.70%
H28	Trewern, near monument	2.14	1.52	1.93	**1.03%**
H29	Buttington	1.44	1.02	1.28	0.65%
H30	Buttington Church	1.07	0.760	0.950	0.48%
H31	A483 Pool Quay Straight	1.79	1.25	1.28	0.08%
H33	The Old Shop Cottage	1.62	1.16	1.47	0.78%
H34	A458, Buttington Bridge	7.96	5.50	8.51	**7.53%**
H36	A483, Buttington Cross	8.31	5.68	5.88	0.50%
H37	A458 between Middleton and Trewern	3.48	2.49	3.12	**1.58%**
H49	Bridge of A483, Welshpool and National Cycle Route 81	4.33	3.04	3.13	0.23%
H50	A483, New Cut	2.06	1.45	1.47	0.05%
H54	A483 at Trederwyn Lane	1.03	0.720	0.730	0.03%
H55	A458 between Plas-y-Court and Wollaston	0.660	0.470	0.600	0.33%
H59	A483 at Trederwein Fweibion Gwnwas	3.64	2.54	2.57	0.07%
H62	A483 by Moat Farm	3.12	2.16	2.64	**1.20%**
H65	A483 by Wernllwyd	3.96	2.74	3.34	**1.50%**

Table 10: Predicted Annual Average Concentrations of NO_2 at Receptor Locations (cont.)

ADMS Ref. [(a)]	NO_2 (µg/m³)				
	Name	**Baseline 2019**	**2022 No Development**	**2022 With Development**	**Development Contribution (% of AQS) [(b)]**
H66	A483 Junction with B4390 to Berriew	3.32	2.28	2.79	**1.28%**
H67	A483, Pant	2.26	1.57	1.59	0.05%
H69	A483 north of the bridge at Berriew	1.57	1.09	1.34	0.63%

Notes to Table 10

(a) Refer to Table 1 and Figures 2 and 3, in Section 2.3., for further details on these potentially sensitive human receptor sites.

(b) Refer to Table 3 in Section 2.5., for the relevant air quality standard.

5.2.1.2. The results in Table 10 clearly demonstrate that, with the exception of the development contributions highlighted in bold type, the effect of the construction phase traffic can be considered not significant at the remaining receptor locations as the difference in concentrations of NO_2 is less than 1% of the AQS (see Section 2.13). For the specified human receptor locations with potentially significant impacts (i.e., those with development contributions highlighted in bold type), PECs will need to be calculated.

5.2.1.3. It is worth nothing that, irrespective of the background NO_2 concentration chosen (i.e., whether the concentration comes from the relevant grid square of the future projections local authority background maps for PCC (for the year 2022), from the relevant grid square of the DEFRA backround maps (for the year 2019) or whether the DT concentration from AQ3 (refer to Table 7 in Section 2.4., for details) is used), the significance of the impact of the calculated PECs, in accordance with the IAQM guidance outlined in Table 5 of Section 2.13., can be described as 'slight' for H34, A458, Buttington Bridge, and 'negligible' for the remaining human receptor locations with potentially significant development contributions. Consequently, no further assessment is required.

5.2.2. PM_{10}

5.2.2.1. Table 11 presents a summary of the predicted change in long-term PM_{10} concentrations at sensitive human receptor sites due to changes in traffic flow associated with the construction phase. Baseline data (2019) is provided for information. The impact of the "2022 no development" and "2022 with development" is then considered at all locations.

Table 11: Predicted Annual Average Concentrations of PM_{10} at Receptor Locations

ADMS Ref. [(a)]	PM_{10} (µg/m³)				
	Name	**Baseline 2019**	**2022 No Development**	**2022 With Development**	**Development Contribution (% of AQS) [(b)]**
H01	Cefn Cottage	0.369	0.354	0.570	0.54%

Table 11: Predicted Annual Average Concentrations of PM_{10} at Receptor Locations (Cont.)

ADMS Ref. [(a)]	PM_{10} (µg/m^3)				
	Name	**Baseline 2019**	**2022 No Development**	**2022 With Development**	**Development Contribution (% of AQS) [(b)]**
H07	Methodist Church, Buttington	0.591	0.562	0.888	0.81%
H10	Brookside	0.263	0.257	0.409	0.38%
H11	Border Hardcore Offices	0.654	0.637	1.01	0.93%
H12	York House	0.414	0.404	0.642	0.59%
H14	Buttington Trewern Primary School	0.147	0.145	0.232	0.22%
H16	Heldre Lane, Trewern	0.661	0.642	1.02	0.94%
H17	Farm Buildings off A458	0.280	0.273	0.433	0.40%
H20	Criggion Lane, Trewern	0.296	0.285	0.454	0.42%
H23	A483, Strat Marcella Abbey	0.250	0.239	0.247	0.02%
H25	Offas Dyke path, Pool Quay	0.620	0.597	0.615	0.04%
H27	A458, Buttington and west of The Quarry	0.240	0.232	0.364	0.33%
H28	Trewern, near monument	0.338	0.328	0.523	0.49%
H29	Buttington	0.225	0.218	0.340	0.31%
H30	Buttington Church	0.165	0.160	0.248	0.22%
H31	A483 Pool Quay Straight	0.283	0.273	0.284	0.03%
H33	The Old Shop Cottage	0.255	0.250	0.399	0.37%
H34	A458, Buttington Bridge	0.701	0.661	1.05	0.98%
H36	A483, Buttington Cross	0.737	0.692	0.720	0.07%
H37	A458 between Middleton and Trewern	0.552	0.537	0.852	0.79%
H49	Bridge of A483, Welshpool and National Cycle Route 81	0.712	0.692	0.734	0.11%
H50	A483, New Cut	0.332	0.323	0.333	0.02%
H54	A483 at Trederwyn Lane	0.165	0.159	0.164	0.01%
H55	A458 between Plas-y-Court and Wollaston	0.103	0.101	0.162	0.15%
H59	A483 at Trederwein Fweibion Gwnwas	0.590	0.568	0.584	0.04%
H62	A483 by Moat Farm	0.511	0.492	0.728	0.59%
H65	A483 by Wernllwyd	0.651	0.626	0.927	0.75%
H66	A483 Junction with B4390 to Berriew	0.545	0.520	0.773	0.63%

Table 11: Predicted Annual Average Concentrations of PM_{10} at Receptor Locations (Cont.)

ADMS Ref. [(a)]	PM_{10} (µg/m³)				
	Name	Baseline 2019	2022 No Development	2022 With Development	Development Contribution (% of AQS) [(b)]
H67	A483, Pant	0.365	0.351	0.361	0.02%
H69	A483 north of the bridge at Berriew	0.256	0.248	0.370	0.30%

Notes to Table 11

(a) Refer to Table 1 and Figures 2 and 3, in Section 2.3., for further details on these potentially sensitive human receptor sites.

(b) Refer to Table 3 in Section 2.5., for the relevant air quality standard.

5.2.2.2. The results in Table 11 clearly demonstrate that the effect of the construction phase traffic can be considered not significant at all receptor locations as the difference in concentrations of PM_{10} is less than 1% of the AQS (see Section 2.12). Consequently, no further assessment is required.

5.2.3. $PM_{2.5}$

5.2.3.1. Table 12 presents a summary of the predicted change in long-term $PM_{2.5}$ concentrations at sensitive human receptor sites due to changes in traffic flow associated the construction phase. Baseline data (2019) is provided for information. The impact of the “2022 no development” and “2022 with development” is then considered at all locations.

Table 12: Predicted Annual Average Concentrations of $PM_{2.5}$ at Receptor Locations

ADMS Ref. [(a)]	$PM_{2.5}$ (µg/m³)				
	Name	Baseline 2019	2022 No Development	2022 With Development	Development Contribution (% of AQS) [(b)]
H01	Cefn Cottage	0.238	0.217	0.347	0.52%
H07	Methodist Church, Buttington	0.371	0.336	0.528	0.77%
H10	Brookside	0.161	0.151	0.237	0.35%
H11	Border Hardcore Offices	0.399	0.373	0.586	0.85%
H12	York House	0.253	0.237	0.373	0.54%
H14	Buttington Trewern Primary School	0.0899	0.0850	0.135	0.20%
H16	Heldre Lane, Trewern	0.403	0.376	0.590	0.86%
H17	Farm Buildings off A458	0.171	0.160	0.252	0.37%
H20	Criggion Lane, Trewern	0.181	0.167	0.264	0.39%
H23	A483, Strat Marcella Abbey	0.152	0.140	0.144	0.02%
H25	Offas Dyke path, Pool Quay	0.377	0.349	0.359	0.04%

Table 12: Predicted Annual Average Concentrations of $PM_{2.5}$ at Receptor Locations (cont.)

ADMS Ref. (a)	PM2.5 (µg/m³)				
	Name	Baseline 2019	2022 No Development	2022 With Development	Development Contribution (% of AQS) (b)
H27	A458, Buttington and west of The Quarry	0.146	0.136	0.211	0.30%
H28	Trewern, near monument	0.206	0.192	0.304	0.45%
H29	Buttington	0.137	0.128	0.198	0.28%
H30	Buttington Church	0.101	0.0938	0.144	0.20%
H31	A483 Pool Quay Straight	0.173	0.160	0.166	0.02%
H33	The Old Shop Cottage	0.156	0.146	0.232	0.34%
H34	A458, Buttington Bridge	0.454	0.405	0.643	0.95%
H36	A483, Buttington Cross	0.477	0.424	0.440	0.07%
H37	A458 between Middleton and Trewern	0.337	0.314	0.494	0.72%
H49	Bridge of A483, Welshpool and National Cycle Route 81	0.434	0.404	0.429	0.10%
H50	A483, New Cut	0.202	0.189	0.194	0.02%
H54	A483 at Trederwyn Lane	0.100	0.0931	0.0959	0.01%
H55	A458 between Plas-y-Court and Wollaston	0.0630	0.0591	0.0941	0.14%
H59	A483 at Trederwein Fweibion Gwnwas	0.360	0.332	0.341	0.04%
H62	A483 by Moat Farm	0.311	0.288	0.422	0.54%
H65	A483 by Wernllwyd	0.396	0.366	0.537	0.69%
H66	A483 Junction with B4390 to Berriew	0.332	0.304	0.448	0.58%
H67	A483, Pant	0.222	0.205	0.211	0.02%
H69	A483 north of the bridge at Berriew	0.156	0.145	0.215	0.28%

Notes to Table 12

(a) Refer to Table 1 and Figures 2 and 3, in Section 2.3., for further details on these potentially sensitive human receptor sites.

(b) Refer to Table 3 in Section 2.5., for the relevant air quality standard.

5.2.3.2. The results in Table 12 clearly demonstrate that the effect of the construction phase traffic can be considered not significant at all receptor locations as the difference in concentrations of $PM_{2.5}$ is less than 1% of the AQS (see Section 2.12). Consequently, no further assessment is required.

5.3. Ecological Receptor Locations – Roads Only

5.3.1. Nitrogen Dioxide (NO_X)

Tables 13 and 14 present a summary of the predicted change in long-term and short-term NO_X concentrations, respectively, at the designated Habitat sites considered for the assessment (refer to Table 2 and Figures 4 and 5 in Section 2.4., for details) due to changes in traffic flow associated with the construction phase. Baseline data (2019) is provided for information. The impact of the "2022 no development" and "2022 with development" is then considered at all locations.

Table 13: Predicted Annual Average Concentrations of NO_X at Receptor Locations

ADMS Ref. [a]	Name	Annual NO_X ($\mu g/m^3$)			
		Baseline 2019	2022 No Development	2022 With Development	Development Contribution (% of Annual Critical Level AQS) [b]
RAM1	Midland Meres and Mosses – Phase 1 – Marton Pool	0.00725	0.00542	0.00628	0.003%
RAM2	Midland Meres and Mosses – Phase 2	0.0245	0.0164	0.0176	0.004%
SSSI1	Buttington Brickworks	0.274	0.198	0.265	0.22%
SSSI2	Montgomery Canal	1.96	1.37	1.40	0.11%
SSSI3	Moel y Golfa	0.499	0.346	0.439	0.31%
SAC1	Montgomery Canal	1.96	1.37	1.40	0.11%
SAC2	Granllyn	0.0441	0.0302	0.0331	0.01%
MC36	Montgomery Canal	2.07	1.41	1.48	0.21%
MC37		1.27	0.870	0.925	0.18%
MC38		1.29	0.899	0.926	0.09%
MC39		2.33	1.67	1.76	0.28%
MC40		0.471	0.330	0.342	0.04%
AW01	Ancient Woodland - 33254	0.408	0.282	0.361	0.26%
AW02	Ancient Woodland - 33255	0.346	0.238	0.300	0.21%
AW03	Ancient Woodland - 47343	0.115	0.0835	0.103	0.06%
AW04	Ancient Woodland - 26045	0.110	0.0798	0.0985	0.06%
AW05	Ancient Woodland - 27762	0.0503	0.0352	0.0417	0.02%
AW06	Ancient Woodland - 33238	0.0719	0.0503	0.0595	0.03%
AW07	Ancient Woodland - 27222	0.0523	0.0372	0.0442	0.02%
AW08	Ancient Woodland - 28973	0.0403	0.0282	0.0332	0.02%
AW09	Ancient Woodland - 35167	0.0634	0.0456	0.0549	0.03%

Table 13: Predicted Annual Average Concentrations of NO_X at Receptor Locations (cont.)

ADMS Ref. [(a)]	Name	Annual NO_X (µg/m^3) Baseline 2019	2022 No Development	2022 With Development	Development Contribution (% of Annual Critical Level AQS) [(b)]
AW10	Ancient Woodland - 27086	0.0879	0.0623	0.0733	0.04%
AW11	Ancient Woodland - 27223	0.0490	0.0349	0.0416	0.02%

Notes to Table 13

(a) Refer to Table 2 and Figures 4 and 5, in Section 2.4., for further details on these Habitat sites and their designations and locations.

(b) Refer to Table 4 in Section 2.6., for the relevant assessment criteria.

5.3.1.1. It can be seen from the results in Table 13 that, for the SAC, SSSI and Ramsar sites (i.e. all sites bar AW01 – AW11, inclusive) the development NO_X contributions are all less than 1% of the long-term critical level.

5.3.1.2. For the remaining sites (i.e. the local nature sites – AW01 – AW11, inclusive) the results in Table 13 show that the development NO_X contributions are all less than 100% of the long-term critical level.

5.3.1.3. Consequently, in accordance with the assessment of significance criteria laid out in Sections 2.13. and 2.14., no further assessments are required.

Table 14: Predicted Daily Concentrations of NO_X at Receptor Locations

ADMS Ref. [(a)]	Name	Daily NO_X (µg/m^3) Baseline 2019	2022 No Development	2022 With Development	Development Contribution (% of Daily Critical Level AQS) [(b)]
RAM1	Midland Meres and Mosses – Phase 1 – Marton Pool	0.0649	0.0561	0.0625	0.01%
RAM2	Midland Meres and Mosses – Phase 2	0.218	0.159	0.171	0.02%
SSSI1	Buttington Brickworks	1.83	1.49	2.11	0.83%
SSSI2	Montgomery Canal	11.1	7.73	7.92	0.25%
SSSI3	Moel y Golfa	3.12	2.30	2.89	0.79%
SAC1	Montgomery Canal	11.1	7.73	7.92	0.25%
SAC2	Granllyn	0.373	0.256	0.281	0.03%
MC36	Montgomery Canal	12.2	8.94	9.36	0.56%
MC37	Montgomery Canal	8.06	5.39	6.23	1.12%
MC38	Montgomery Canal	7.54	5.21	5.37	0.22%

Table 14: Predicted Daily Concentrations of NO_X at Receptor Locations (cont.)

ADMS Ref. [(a)]	Name	Daily NO_X ($\mu g/m^3$) Baseline 2019	2022 No Development	2022 With Development	Development Contribution (% of Daily Critical Level AQS) [(b)]
MC39	Montgomery Canal	10.1	7.78	8.21	0.58%
MC40	Montgomery Canal	3.04	2.15	2.23	0.10%
AW01	Ancient Woodland - 33254	2.49	1.74	2.24	0.66%
AW02	Ancient Woodland - 33255	2.16	1.51	1.89	0.50%
AW03	Ancient Woodland - 47343	0.914	0.687	0.873	0.25%
AW04	Ancient Woodland - 26045	0.897	0.564	0.701	0.18%
AW05	Ancient Woodland - 27762	0.488	0.291	0.331	0.05%
AW06	Ancient Woodland - 33238	0.665	0.364	0.426	0.08%
AW07	Ancient Woodland - 27222	0.433	0.276	0.316	0.05%
AW08	Ancient Woodland - 28973	0.387	0.242	0.275	0.04%
AW09	Ancient Woodland - 35167	0.543	0.394	0.459	0.09%
AW10	Ancient Woodland - 27086	0.890	0.444	0.529	0.11%
AW11	Ancient Woodland - 27223	0.414	0.285	0.330	0.06%

Notes to Table 14

(a) Refer to Table 2 and Figures 4 and 5, in Section 2.4., for further details on these Habitat sites and their designations and locations.

(b) Refer to Table 4 in Section 2.6., for the relevant assessment criteria.

5.3.1.4. It can be seen from the results in Table 14 that, for the SAC, SSSI and Ramsar sites (i.e. all sites bar AW01 – AW11, inclusive), the development NO_X contributions are all less than 10% of the short-term critical level.

5.3.1.5. For the remaining sites (i.e. the local nature sites – AW01 – AW11, inclusive) the results in Table 14 show that the development NO_X contributions are all less than 100% of the short-term critical level.

5.3.1.6. Consequently, in accordance with the assessment of significance criteria laid out in Sections 2.13. and 2.14., no further assessments are required.

6. PREDICTED 2022 CONCENTRATIONS – Cumulative

6.1. Maximum Ground Level Concentrations - Cumulative

6.1.1. This part of the assessment has been conducted in the same manner as outlined in Section 5.1., but with the addition of the emissions associated with the proposed ERF also taken into consideration. This was undertaken in the interest of assessing the hypothetical worst-case predicted cumulative impact of the emissions associated with traffic using the A483 and A458 and the operation of the ERF main stack (designated 'A1') for the 2022 construction phase scenario. Refer to ECL air dispersion modelling report ECL.001.01.02/ADM (EIA Chapter TA-6.1) for further details regarding the stack emission parameters for the ERF.

6.1.2. Ground level concentrations of NO_2, PM_{10} and $PM_{2.5}$ were calculated on an area covering the development and nearby potentially affected roads. Estimates of the combined pollutant concentrations of emissions arising from traffic on the nearby roads at roadside potentially sensitive human receptors and at designated Habitat sites were predicted and assessed for the baseline year of 2019 prior to construction. Vehicle pollutant concentrations were then reassessed at roadside sensitive receptors for the construction year of 2022, without construction having taken place and then with construction traffic and the operation of the emission point associated with the ERF (i.e. A1).

6.1.3. Maximum ground level concentrations were determined using NWP data for Met year 2019. This data is presented in Tables 15a and 15b, with a visual representation of the Max PC location provided in Figure 8. Table 15c summarises the impact of the construction phase traffic; with any development contribution that is potentially significant (i.e., greater than 1% of the respective AQS) highlighted in bold type.

Table 15a: Maximum Ground Level Concentrations – Baseline 2022

Pollutant	Met Year	Max PC (µg/m³)	AQS (µg/m³)	PC as % of AQS	Location of Max PC	
					X Coord	Y Coord
NO_2 (annual)	2019 – NWP data	20.54	40	51.35%	323652	308069
PM_{10} (annual)		2.78	40	6.94%	324202	308746
$PM_{2.5}$ (annual)		1.68	25	6.71%	324202	308746

Table 15b: Maximum Ground Level Concentrations – Baseline & Construction Traffic 2022, with A1 active

Pollutant	Met Year	Max PC (µg/m³)	AQS (µg/m³)	PC as % of AQS	Location of Max PC	
					X Coord	Y Coord
NO_2 (annual)	2019 – NWP data	21.34[a]	40	53.35%	323652[b]	308069[b]
					327246[c]	310770[c]
PM_{10} (annual)		2.81	40	7.02%	324202	308746
$PM_{2.5}$ (annual)		1.69	25	6.78%	324202	308746

Notes to Table 15b

(a) The NO_2 PC is the sum of the converted modelled NO_X output for the A483 and A548 combined (with the NO_X converted to NO_2 using the DEFRA v8.1 NO_X to NO_2 calculator) plus the converted modelled NO_X output for the ERF's A1 stack (with the NO_X converted to NO_2 using the AQTAG06 method of assuming a 70% NO to NO_2 conversion).

(b) Location of maximum PC for road sources only (i.e., A483 and A548).

(c) Location of maximum PC for industrial sources only (i.e., the ERF's A1 stack).

Table 15c: Construction Phase Emissions Modelling Results

Pollutant	Baseline (2022) No Construction Traffic		Baseline (2022) + Construction Traffic + A1		Impact	
	µg/m³	%of AQS	µg/m³	%of AQS	µg/m³	%of AQS
NO_2	20.54	51.35%	21.34	53.35%	**0.799**	**2.00%**
PM_{10}	2.78	6.94%	2.81	7.02%	0.0309	0.08%
$PM_{2.5}$	1.68	6.71%	1.69	6.78%	0.0165	0.07%

Figure 8: Approximate Location of Maximum Pollutant GLCs – Cumulative

Notes to Figure 8

The red icon labelled 'S' is the approximate location of the proposed ERF emission point; and

The green, blue and pink markers in Figure 8 represent the approximate locations of the maximum GLCs specified in Tables 15a and 15b (Please note that the colour coded icons in Figure 8 correspond to the colour coded coordinates shown in Tables 15a and 15b).

6.1.4. As shown in Figure 8 (and as also demonstrated in Section 5.1.), maximum concentrations for all modelled pollutants associated with the road sources occur to the south-west of the site at junctions of the A483 and A485 roads. This is as would be expected as the junctions are on the north-east perimeter of the town of Welshpool which is the most populated region of the area modelled and the prevailing winds for the NWP Met year of 2019 were predominantly from the south-west. The prevailing wind direction, for the Met year modelled, also helps to explain the location of the maximum NO_2 concentration for the emissions arising from the A1 stack – with this location being situated north-northeast of the proposed ERF.

6.1.5. The results in Table 15c clearly demonstrate that the effect of the construction phase traffic and the operation of A1 can be considered not significant at the maximum point of impact, for $PM_{2.5}$ and PM_{10}, as the difference in concentrations of pollutants are less than 1% of the relevant AQS (see Section 2.13). Consequently, no further assessment is required for these pollutants.

6.1.5.1. For the predicted NO_2 concentration, the results in Table 15c show that the effect of the construction phase traffic and the operation of A1 can be considered potentially significant (i.e., the difference in the NO_2 concentration is greater than 1% of the respective AQS). Consequently, the PEC must be calculated.

6.1.6. It is worth nothing that, although not considered representative, even if the elevated NO_2 concentration from DT AQ3 (refer to Table 7 in Section 2.4., for details) is used as the background source (i.e., in the interest of assessing the worst-case scenario) - the NO_2 PEC would be 13.31 μg/m^3 (or 33% of the respective AQS). The significance of the impact of the NO_2 development contribution (as outlined in Table 15c), in accordance with the IAQM guidance outlined in Table 5 of Section 2.13., can therefore be described as 'negligible', even when opting for an elevated background concentration of NO_2. Consequently, no further assessment is required.

6.2. Human Receptor Locations - Cumulative

6.2.1. Nitrogen Dioxide (NO_2)

6.2.1.1. Table 16 presents a summary of the predicted change in long-term NO_2 concentrations at sensitive human receptor sites due to changes in traffic flow associated with the construction phase, with A1 as an active emission point. Baseline data (2019) is provided for information. The impact of the "2022 no development" and "2022 with development" is then considered at all locations. Any potentially significant development contributions are highlighted in bold type.

Table 16: Predicted Annual Average Concentrations of NO_2 at Receptor Locations - Cumulative

ADMS Ref. [a]	NO_2 (μg/m^3)				
	Name	**Baseline 2019**	**2022 No Development Traffic**	**2022 With Development Traffic + A1**	**Development Contribution (% of AQS) [b]**
H01	Cefn Cottage	4.17	2.93	4.58	**4.13%**
H07	Methodist Church, Buttington	5.17	3.59	5.36	**4.41%**
H10	Brookside	1.68	1.20	1.60	**1.00%**
H11	Border Hardcore Offices	4.12	2.95	3.78	**2.07%**
H12	York House	2.63	1.88	2.45	**1.41%**
H14	Buttington Trewern Primary School	0.970	0.700	1.21	**1.27%**

Table 16: Predicted Annual Average Concentrations of NO_2 at Receptor Locations – Cumulative (cont.)

ADMS Ref. [(a)]	Name	NO_2 (µg/m^3)			
		Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of AQS) [(b)]
H16	Heldre Lane, Trewern	4.16	2.97	4.00	**2.58%**
H17	Farm Buildings off A458	1.78	1.27	1.66	0.98%
H20	Criggion Lane, Trewern	1.88	1.33	1.91	**1.44%**
H23	A483, Strat Marcella Abbey	1.56	1.08	1.13	0.13%
H25	Offas Dyke path, Pool Quay	3.82	2.67	2.73	0.15%
H27	A458, Buttington and west of The Quarry	1.53	1.08	1.40	0.80%
H28	Trewern, near monument	2.14	1.52	2.08	**1.39%**
H29	Buttington	1.44	1.02	1.32	0.74%
H30	Buttington Church	1.07	0.760	0.983	0.56%
H31	A483 Pool Quay Straight	1.79	1.25	1.32	0.18%
H33	The Old Shop Cottage	1.62	1.16	1.57	**1.03%**
H34	A458, Buttington Bridge	7.96	5.50	8.54	**7.61%**
H36	A483, Buttington Cross	8.31	5.68	5.91	0.58%
H37	A458 between Middleton and Trewern	3.48	2.49	3.20	**1.78%**
H49	Bridge of A483, Welshpool and National Cycle Route 81	4.33	3.04	3.14	0.26%
H50	A483, New Cut	2.06	1.45	1.48	0.08%
H54	A483 at Trederwyn Lane	1.03	0.720	0.740	0.05%
H55	A458 between Plas-y-Court and Wollaston	0.660	0.470	0.628	0.40%
H59	A483 at Trederwein Fweibion Gwnwas	3.64	2.54	2.58	0.10%
H62	A483 by Moat Farm	3.12	2.16	2.65	**1.22%**
H65	A483 by Wernllwyd	3.96	2.74	3.35	**1.52%**
H66	A483 Junction with B4390 to Berriew	3.32	2.28	2.80	**1.29%**
H67	A483, Pant	2.26	1.57	1.59	0.06%
H69	A483 north of the bridge at Berriew	1.57	1.09	1.35	0.64%

Notes to Table 16

(a) Refer to Table 1 and Figures 2 and 3, in Section 2.3., for further details on these potentially sensitive human receptor sites.

(b) Refer to Table 3 in Section 2.5., for the relevant air quality standard.

6.2.1.2. The results in Table 16 clearly demonstrate that, with the exception of the development contributions highlighted in bold type, the effect of the construction phase traffic, with A1 operational, can be considered not significant at the remaining receptor locations as the difference in concentrations of NO_2 is less than 1% of the AQS (see Section 2.13). For the specified human receptor locations with potentially significant impacts (i.e., those with development contributions highlighted in bold type), PECs will need to be calculated.

6.2.1.3. It is worth nothing that, irrespective of the background NO_2 concentration chosen (refer to Section 5.2.1.3., for details), the significance of the impact of the calculated PECs, in accordance with the IAQM guidance outlined in Table 5 of Section 2.13., can be described as 'slight' for H34, A458, Buttington Bridge, and 'negligible' for the remaining human receptor locations with potentially significant development contributions. Consequently, no further assessment is required.

6.2.2. PM_{10}

6.2.2.1. Table 17 presents a summary of the predicted change in long-term PM_{10} concentrations at sensitive human receptor sites due to changes in traffic flow associated the construction phase, with A1 as an active emission point. Baseline data (2019) is provided for information. The impact of the "2022 no development" and "2022 with development" is then considered at all locations. Any potentially significant development contributions are highlighted in bold type.

Table 17: Predicted Annual Average Concentrations of PM_{10} at Receptor Locations - Cumulative

ADMS Ref. [a]	Name	Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of AQS) [b]
	PM_{10} ($\mu g/m^3$)				
H01	Cefn Cottage	0.369	0.354	0.573	0.55%
H07	Methodist Church, Buttington	0.591	0.562	0.916	0.88%
H10	Brookside	0.263	0.257	0.418	0.40%
H11	Border Hardcore Offices	0.654	0.637	1.02	0.95%
H12	York House	0.414	0.404	0.651	0.62%
H14	Buttington Trewern Primary School	0.147	0.145	0.268	0.31%
H16	Heldre Lane, Trewern	0.661	0.642	1.05	**1.02%**
H17	Farm Buildings off A458	0.280	0.273	0.441	0.42%
H20	Criggion Lane, Trewern	0.296	0.285	0.481	0.49%
H23	A483, Strat Marcella Abbey	0.250	0.239	0.251	0.03%
H25	Offas Dyke path, Pool Quay	0.620	0.597	0.617	0.05%

Table 17: Predicted Annual Average Concentrations of PM_{10} at Receptor Locations – Cumulative (cont.)

ADMS Ref. [(a)]	Name	Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of AQS) [(b)]
	PM_{10} (µg/m³)				
H27	A458, Buttington and west of The Quarry	0.240	0.232	0.369	0.34%
H28	Trewern, near monument	0.338	0.328	0.540	0.53%
H29	Buttington	0.225	0.218	0.344	0.32%
H30	Buttington Church	0.165	0.160	0.252	0.23%
H31	A483 Pool Quay Straight	0.283	0.273	0.289	0.04%
H33	The Old Shop Cottage	0.255	0.250	0.411	0.40%
H34	A458, Buttington Bridge	0.701	0.661	1.06	0.99%
H36	A483, Buttington Cross	0.737	0.692	0.723	0.08%
H37	A458 between Middleton and Trewern	0.552	0.537	0.861	0.81%
H49	Bridge of A483, Welshpool and National Cycle Route 81	0.712	0.692	0.736	0.11%
H50	A483, New Cut	0.332	0.323	0.334	0.03%
H54	A483 at Trederwyn Lane	0.165	0.159	0.165	0.02%
H55	A458 between Plas-y-Court and Wollaston	0.103	0.101	0.165	0.16%
H59	A483 at Trederwein Fweibion Gwnwas	0.590	0.568	0.585	0.04%
H62	A483 by Moat Farm	0.511	0.492	0.729	0.59%
H65	A483 by Wernllwyd	0.651	0.626	0.927	0.75%
H66	A483 Junction with B4390 to Berriew	0.545	0.520	0.773	0.63%
H67	A483, Pant	0.365	0.351	0.361	0.03%
H69	A483 north of the bridge at Berriew	0.256	0.248	0.371	0.31%

Notes to Table 17

(a) Refer to Table 1 and Figures 2 and 3, in Section 2.3., for further details on these potentially sensitive human receptor sites.

(b) Refer to Table 3 in Section 2.5., for the relevant air quality standard.

6.2.2.2. The results in Table 17 clearly demonstrate that the development contribution (associated with the emissions arising from construction traffic and the operation of A1) can be considered not significant at all receptor locations, bar one, as the difference in concentrations of PM_{10} is less than 1% of the AQS (see Section 2.12).

6.2.2.3. The development contribution is potentially significant at HS16, Heldre Lane, Trewern, and as a result the PEC will need to be calculated. PCC do not currently monitor for PM_{10}; therefore, DEFRA modelled background pollution maps have been used as the source of background air quality. The background pollution maps make use of a 1x1 km resolution.

6.2.2.4. The nearest DEFRA modelled background location to HS16 is at the following grid coordinates: 327500 (X), 310500 (Y)). The 2022 annual PM_{10} concentration at this location is 10.69 µg/m^3 (the background concentration was taken from the future projection local authority maps for PM_{10} [18], developed by DEFRA, for the year 2022 (using 2018 as the reference year for monitoring meteorological data). Making use of a background concentration of 10.69 µg/m^3 the annual PM_{10} PEC would be 11.10 µg/m^3 (or 28% of the AQS).

6.2.2.5. It should be noted that, when using the latest available DEFRA modelled background maps[19] for PM_{10} (2019 data) the background concentration from the same location (i.e. 327500 (X), 310500 (Y)) is 12.89 µg/m^3 – this would make the PM_{10} PEC 13.29 µg/m^3 (or 33% of the AQS).

6.2.2.6. In accordance with the IAQM impact descriptors laid out in Table 5 of Section 2.12., the significance of both PM_{10} PECs calculated can therefore be regarded as 'negligible' for the potentially significant development contribution at HS16. Consequently, no further assessments are required for PM_{10}.

6.2.3. $PM_{2.5}$

6.2.3.1. Table 18 presents a summary of the predicted change in long-term $PM_{2.5}$ concentrations at sensitive human receptor sites due to changes in traffic flow associated the construction phase, with A1 as an active emission point. Baseline data (2019) is provided for information. The impact of the "2022 no development" and "2022 with development" is then considered at all locations. Any potentially significant development contributions are highlighted in bold type.

Table 18: Predicted Annual Average Concentrations of $PM_{2.5}$ at Receptor Locations

ADMS Ref. (a)	$PM_{2.5}$ (µg/m^3)				
	Name	Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of AQS) (b)
H01	Cefn Cottage	0.238	0.217	0.347	0.52%
H07	Methodist Church, Buttington	0.371	0.336	0.528	0.77%
H10	Brookside	0.161	0.151	0.237	0.35%
H11	Border Hardcore Offices	0.399	0.373	0.586	0.85%
H12	York House	0.253	0.237	0.373	0.54%

[18] Available online via: https://uk-air.defra.gov.uk/data/laqm-background-home
[19] Available online via: https://uk-air.defra.gov.uk/data/pcm-data

Table 18: Predicted Annual Average Concentrations of $PM_{2.5}$ at Receptor Locations (cont.)

ADMS Ref. [(a)]	Name	$PM_{2.5}$ ($\mu g/m^3$) Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of AQS) [(b)]
H14	Buttington Trewern Primary School	0.0899	0.0850	0.135	0.20%
H16	Heldre Lane, Trewern	0.403	0.376	0.590	0.86%
H17	Farm Buildings off A458	0.171	0.160	0.252	0.37%
H20	Criggion Lane, Trewern	0.181	0.167	0.264	0.39%
H23	A483, Strat Marcella Abbey	0.152	0.140	0.144	0.02%
H25	Offas Dyke path, Pool Quay	0.377	0.349	0.359	0.04%
H27	A458, Buttington and west of The Quarry	0.146	0.136	0.211	0.30%
H28	Trewern, near monument	0.206	0.192	0.304	0.45%
H29	Buttington	0.137	0.128	0.198	0.28%
H30	Buttington Church	0.101	0.0938	0.144	0.20%
H31	A483 Pool Quay Straight	0.173	0.160	0.166	0.02%
H33	The Old Shop Cottage	0.156	0.146	0.232	0.34%
H34	A458, Buttington Bridge	0.454	0.405	0.643	0.95%
H36	A483, Buttington Cross	0.477	0.424	0.440	0.07%
H37	A458 between Middleton and Trewern	0.337	0.314	0.494	0.72%
H49	Bridge of A483, Welshpool and National Cycle Route 81	0.434	0.404	0.429	0.10%
H50	A483, New Cut	0.202	0.189	0.194	0.02%
H54	A483 at Trederwyn Lane	0.100	0.0931	0.0959	0.01%
H55	A458 between Plas-y-Court and Wollaston	0.0630	0.0591	0.0941	0.14%
H59	A483 at Trederwein Fweibion Gwnwas	0.360	0.332	0.341	0.04%
H62	A483 by Moat Farm	0.311	0.288	0.422	0.54%
H65	A483 by Wernllwyd	0.396	0.366	0.537	0.69%
H66	A483 Junction with B4390 to Berriew	0.332	0.304	0.448	0.58%
H67	A483, Pant	0.222	0.205	0.211	0.02%
H69	A483 north of the bridge at Berriew	0.156	0.145	0.215	0.28%

Notes to Table 18

(a) Refer to Table 1 and Figures 2 and 3, in Section 2.3., for further details on these potentially sensitive human receptor sites.

(b) Refer to Table 3 in Section 2.5., for the relevant air quality standard.

6.2.3.2. The results in Table 18 clearly demonstrate that the effect of the predicted development contributions associated with the emissions of construction phase traffic and A1 being operational can be considered not significant at all receptor locations as the difference in concentrations of $PM_{2.5}$ is less than 1% of the AQS (see Section 2.12). Consequently, no further assessment is required.

6.3. Ecological Receptor Locations - Cumulative

6.3.1. Nitrogen Dioxide (NO_X)

6.3.1.1. Tables 19 and 20 present a summary of the predicted change in long-term and short-term NO_X concentrations, respectively, at the designated Habitat sites considered for the assessment (refer to Table 2 and Figures 4 and 5 in Section 2.4., for details) due to changes in traffic flow associated with the construction phase, with A1 as an active emission point. Baseline data (2019) is provided for information. The impact of the "2022 no development" and "2022 with development" is then considered at all locations.

6.3.1.2.

Table 19: Predicted Annual Average Concentrations of NO_X at Receptor Locations

ADMS Ref. [a]	Name	Annual NO_X (µg/m³) Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of Annual Critical Level AQS) [b]
RAM1	Midland Meres and Mosses – Phase 1 – Marton Pool	0.00725	0.00542	0.0172	0.04%
RAM2	Midland Meres and Mosses – Phase 2	0.0245	0.0164	0.0241	0.03%
SSSI1	Buttington Brickworks	0.274	0.198	0.297	0.33%
SSSI2	Montgomery Canal	1.96	1.37	1.45	0.28%
SSSI3	Moel y Golfa	0.499	0.346	0.615	0.90%
SAC1	Montgomery Canal	1.96	1.37	1.45	0.28%
SAC2	Granllyn	0.0441	0.0302	0.0464	0.05%
MC36	Montgomery Canal	2.07	1.41	1.51	0.30%
MC37	Montgomery Canal	1.27	0.870	0.969	0.33%
MC38	Montgomery Canal	1.29	0.899	0.979	0.27%
MC39	Montgomery Canal	2.33	1.67	1.77	0.34%
MC40	Montgomery Canal	0.471	0.330	0.368	0.13%
AW01	Ancient Woodland - 33254	0.408	0.282	0.465	0.61%
AW02	Ancient Woodland - 33255	0.346	0.238	0.414	0.59%
AW03	Ancient Woodland - 47343	0.115	0.0835	0.365	0.94%
AW04	Ancient Woodland - 26045	0.110	0.0798	0.407	1.09%

Table 19: Predicted Annual Average Concentrations of NO_X at Receptor Locations (cont.)

ADMS Ref. [a]	Name	Annual NO_X (µg/m^3)			
		Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of Annual Critical Level AQS) [b]
AW05	Ancient Woodland - 27762	0.0503	0.0352	0.108	0.24%
AW06	Ancient Woodland - 33238	0.0719	0.0503	0.159	0.36%
AW07	Ancient Woodland - 27222	0.0523	0.0372	0.128	0.30%
AW08	Ancient Woodland - 28973	0.0403	0.0282	0.0892	0.20%
AW09	Ancient Woodland - 35167	0.0634	0.0456	0.225	0.60%
AW10	Ancient Woodland - 27086	0.0879	0.0623	0.178	0.39%
AW11	Ancient Woodland - 27223	0.0490	0.0349	0.149	0.38%

Notes to Table 19

(a) Refer to Table 2 and Figures 4 and 5, in Section 2.4., for further details on these Habitat sites and their designations and locations.

(b) Refer to Table 4 in Section 2.6., for the relevant assessment criteria.

6.3.1.3. It can be seen from the results in Table 19 that, for the SAC, SSSI and Ramsar sites (i.e. all sites bar AW01 – AW11, inclusive), the development NO_X contributions are all less than 1% of the long-term critical level.

6.3.1.4. For the remaining sites (i.e. the local nature sites – AW01 – AW11, inclusive) the results in Table 19 show that the development NO_X contributions are all less than 100% of the long-term critical level.

6.3.1.5. Consequently, in accordance with the assessment of significance criteria laid out in Sections 2.13. and 2.14., no further assessment is required.

Table 20: Predicted Daily Concentrations of NO_X at Receptor Locations

ADMS Ref. [a]	Name	Daily NO_X (µg/m^3)			
		Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of Daily Critical Level AQS) [b]
RAM1	Midland Meres and Mosses – Phase 1 – Marton Pool	0.0649	0.0561	0.279	0.30%
RAM2	Midland Meres and Mosses – Phase 2	0.218	0.159	0.180	0.03%
SSSI1	Buttington Brickworks	1.83	1.49	2.72	1.64%
SSSI2	Montgomery Canal	11.1	7.73	7.92	0.25%
SSSI3	Moel y Golfa	3.12	2.30	3.13	1.11%

Table 20: Predicted Daily Concentrations of NO_X at Receptor Locations (cont.)

ADMS Ref. [(a)]	Daily NO_X ($\mu g/m^3$)				
	Name	Baseline 2019	2022 No Development Traffic	2022 With Development Traffic + A1	Development Contribution (% of Daily Critical Level AQS) [(b)]
SAC1	Montgomery Canal	11.1	7.73	7.92	0.25%
SAC2	Granllyn	0.373	0.256	0.321	0.09%
MC36	Montgomery Canal	12.2	8.94	9.37	0.58%
MC37		8.06	5.39	6.24	1.13%
MC38		7.54	5.21	5.37	0.22%
MC39		10.1	7.78	8.21	0.58%
MC40		3.04	2.15	2.23	0.10%
AW01	Ancient Woodland - 33254	2.49	1.74	2.56	1.09%
AW02	Ancient Woodland - 33255	2.16	1.51	2.65	1.51%
AW03	Ancient Woodland - 47343	0.914	0.687	3.68	3.99%
AW04	Ancient Woodland - 26045	0.897	0.564	2.73	2.88%
AW05	Ancient Woodland - 27762	0.488	0.291	1.25	1.28%
AW06	Ancient Woodland - 33238	0.665	0.364	1.36	1.32%
AW07	Ancient Woodland - 27222	0.433	0.276	1.23	1.28%
AW08	Ancient Woodland - 28973	0.387	0.242	0.904	0.88%
AW09	Ancient Woodland - 35167	0.543	0.394	1.54	1.53%
AW10	Ancient Woodland - 27086	0.890	0.444	1.95	2.00%
AW11	Ancient Woodland - 27223	0.414	0.285	1.21	1.23%

Notes to Table 20

(a) Refer to Table 2 and Figures 4 and 5, in Section 2.4., for further details on these Habitat sites and their designations and locations.

(b) Refer to Table 4 in Section 2.6., for the relevant assessment criteria.

6.3.1.6. It can be seen from the results in Table 20 that, for the SAC, SSSI and Ramsar sites (i.e. all sites bar AW01 – AW11, inclusive), the development NO_X contributions are all less than 10% of the short-term critical level.

6.3.1.7. For the remaining sites (i.e. the local nature sites – AW01 – AW11, inclusive) the results in Table 20 show that the development NO_X contributions are all less than 100% of the short-term critical level.

6.3.1.8. Consequently, in accordance with the assessment of significance criteria laid out in Sections 2.13. and 2.14., no further assessments are required.

7. CONCLUSIONS

7.1.1. Detailed air quality modelling, using the ADMS-Roads dispersion model, has been undertaken for two main scenarios. Firstly, to assess the impacts of road traffic emissions in the vicinity of the proposed ERF at Buttington Quarry, Powys for the construction phase of the Development. Secondly, to assess the impacts of road traffic emissions in the vicinity of the proposed ERF at Buttington Quarry, Powys for the construction phase of the Development and the hypothetical simultaneous operation of the main stack (designated A1) at the proposed ERF.

7.1.2. This has been carried out to determine what effect the predicted emissions to air, associated with the increased vehicular movements and the operation of A1 as a result of the proposed development, will have on air quality. This has been addressed for the pollutants assessed in terms of both the maximum ground level concentrations and at specified human and ecological receptors in close proximity to site and / or the affected road network.

7.1.3. The study has been carried out adopting a worst-case scenario basis in the interest of being conservative. Consequently, it has been assumed that the site will be operating for 24 hours per day, 365 days of the year.

7.1.4. The effects of the construction phase of the Development take into account emissions from additional road traffic due to the proposed development and predicted traffic growth.

7.1.5. The assessment of impact of the development contribution associated with increased vehicular movements and traffic activity only (also referred to as 'Roads Only'), with respect to exposure to PM_{10} (long-term), $PM_{2.5}$ and NO_X (long-term and short-term) emissions, is determined as insignificant for the maximum point of impact and all of the potentially sensitive human receptor and ecological sites assessed. Where further screening was required for NO_2 (long-term), the impact of the development contribution could be described as 'negligible' at the maximum point of impact, 'slight' for potentially sensitive human receptor H34, A458, Buttington Bridge, and 'negligible' for the remaining human receptor locations with potentially significant development contributions.

7.1.6. The assessment of impact of the development contribution associated with increased vehicular movements and traffic activity and the hypothetical operation of A1 (also referred to as 'Cumulative'), with respect to exposure to PM_{10} (long-term), $PM_{2.5}$ and NO_X (long-term and short-term) emissions, is determined as insignificant for the maximum point of impact, at all of the potentially sensitive human receptors (with the exception of PM_{10} at H16, Heldre Lane, Trewern) and at all ecological sites assessed. Further screening for PM_{10} at H16 demonstrated the impact could be regarded as 'negligible' when using the IAQM impact descriptors for categorising the significance.

7.1.7. For the Cumulative scenario, where further screening was required for NO_2 (long-term), the impact of the development contribution could be described as 'negligible' at the maximum point of impact, 'slight' for potentially sensitive human receptor H34, A458, Buttington Bridge, and 'negligible' for the remaining human receptor locations with potentially significant development contributions.

7.1.8. Maximum concentrations for all modelled pollutants arising from road sources occur to the south-west of the site at junctions of the A483 and A548. This is as would be expected as the junctions are on the north-east perimeter of the town of Welshpool which is the most populated region of the area modelled and the prevailing winds for the NWP Met year of 2019 were predominantly from the south-west. The prevailing wind direction, for the Met year modelled, also helps to explain the location of the maximum NO_2 concentration for the emissions arising from the A1 stack – with this location being situated north-northeast of the proposed ERF.

7.1.9. Vehicle emission concentrations are forecasted to decrease over time, even though it is anticipated that there will be an increase in the level of traffic using the A483 and A458 roads. This is because as vehicle technology improves and emission standards become more stringent, newer vehicles (which are generally considered to be 'cleaner' and emit less harmful pollutants overall) will become an increasing proportion of the traffic using the local road network.

7.1.10. It is worth stressing that the cumulative impact scenario (i.e. the in-combination assessment of both the proposed development traffic emissions alongside the simultaneous continuous operation of the proposed ERF's A1 emission point) addresses a hypothetical worst-case scenario in terms of emissions to air. In reality, A1 would not be able to be operational during the construction phase of the proposed ERF.

7.1.11. The cumulative impact scenario in particular, therefore, represents a highly conservative assessment of the development contribution. It is therefore considered that the actual emission concentrations would be considerably lower when factoring in normal operational scenarios.

7.1.12. In summary, based on the modelled results, it can be concluded that the emissions associated with increased traffic as a result of the construction, as well as the hypothetical worst-case scenario associated with the additional operation of the proposed ERF's A1 emission point, will not have a significant impact on local air quality, human receptor locations or on the ecological sites assessed.

Technical Appendix 6-3
Dust Assessment

ECL Ref: ECL.001.01.02/ES
DATE: February 2021
ISSUE: 1

ENERGY RECOVERY FACILITY AT BUTTINGTON QUARRY

DUST ASSESSMENT

BUTTINGTON QUARRY, BUTTINGTON, WELSHPOOL, POWYS, SY21 8SZ

ECL Ref: ECL.001.01.02/DA
Version: Final
February 2021

DUST ASSESSMENT

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ACRONYMNS/ABBREVIATIONS USED IN THIS REPORT

AQA	Air Quality Assessment
AQMA	Air Quality Management Area
AQS	Air Quality Standard
Broad Energy	Broad Energy (Wales) Limited
Development	All activities within the red line planning boundary (see Drawing ECL-BQ-000 in Technical Appendix TA1-1 of the ES)
Development Site	The physical site on which the Development is to be located as defined by the red line planning boundary (see Drawing ECL-BQ-000 in Technical Appendix TA1-1 of the ES)
DMP	Dust Management Plan
DNS	Development of National Significance
DT	Diffusion Tube
Earthworks Area	The area where construction activities will be undertaken as shown on Drawing BT1180-D14 in Appendix 1
ECL	Environmental Compliance Ltd
EIA	Environmental Impact Assessment
ERF	Energy Recovery Facility
EQS	Environmental Quality Standard
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IAQM	Institute of Air Quality Management
LDV	Light Duty Vehicle
NGR	National Grid Reference
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NRW	Natural Resources Wales
NWP	Numerical Weather Prediction
PM_{10}	Particulate Matter (with a diameter of 10 µm or less)
$PM_{2.5}$	Particulate Matter (with a diameter of2.5 µm or less)
SAC	Special Areas of Conservation
SPA	Special Protection Areas
SSSI	Site of Special Scientific Interest
The Installation	Buttington Energy Recovery Facility

1. INTRODUCTION

1.1. CONTEXT AND STRUCTURE

1.1.1. Broad Energy (Wales) Limited ("Broad") proposes construct and Energy Recovery Facility ("ERF" at Buttington Quarry, Buttington, Welshpool, SY21 8SZ. The development is classed as a Development of National Significance ("DNS") and as such a pre-application consultation has been undertaken. During this pre-application phase, Powys County Council's ("PCCs") Environmental Health Officer ("EHO") commented that:

"*During the construction phase, many thousands of tonnes of earth will need to be quarried away from within the site. This has the potential to create dust which could be released off site and affect the health of nearby sensitive receptors. Therefore I would recommend that a dust assessment and abatement report should be submitted as part of the planning process, and adherence to the report made a condition of the permission".*

1.1.2. The overall cut and fill requirements for the development are shown on Bright and Associates drawing BT1180-D14 which may be found in Appendix 1. The total cut is 334,635m^3 with a total fill requirement of 172,400m^3, which leaves a balance of 162,235m^3. Using a worst case figure of 1.8 tonnes per m^3, the weight of material to be moved off site is likely to be in the region of 292,023 tonnes.

1.1.3. It should be noted that the application and wider Buttington Quarry is an operational quarry. The quarry owners have confirmed that there has no history of dust complaints from quarry operations.

1.1.4. In response to the comments from PCC, Environmental Compliance Ltd ("ECL") has therefore undertaken a Dust Assessment of construction phase impacts of the proposed development, to support the DNS Application.

1.1.5. The assessment comprises a screening assessment of general air quality impacts, and a dust impact assessment of the construction phase.

1.1.6. The air quality screening assessment is based on Institute of Air Quality Management (IAQM) / Environmental Protection UK (EPUK) guidance, *Land-Use Planning & Development Control: Planning for Air Quality*[1].

1.1.7. The dust impact assessment is based on the IAQM *Guidance on the Assessment of Mineral Dust Impacts for Planning.*[2] This considers two types of emissions:

- larger particles, commonly referred to as 'dust', which have the potential to cause annoyance, disamenity, or ecological harm due to the deposition of dust onto surfaces; and
- small particulate matter, with a cross-sectional diameter of less than 10 micrometres (PM_{10}), which are inhalable, and therefore pose a risk to human health.

1.1.8. This report is structured as follows:

[1] IAQM (2017) *Land-use Planning & Development Control: Planning for Air Quality.* v1.2

[2] IAQM (2016) *Guidance on the Assessment of Mineral Dust Impacts for Planning.* Institute of Air Quality Management, London.

- Section 2 - site location and extent;
- Section 3 - sensitive receptors;
- Section 4 - screening assessments for general air quality;
- Section 5 - dust impacts;
- Section 6 - assessment of dust impacts and effects;
- Section 7 – mitigation;
- Section 8 – cumulative;
- Section 9 – summary and conclusions.

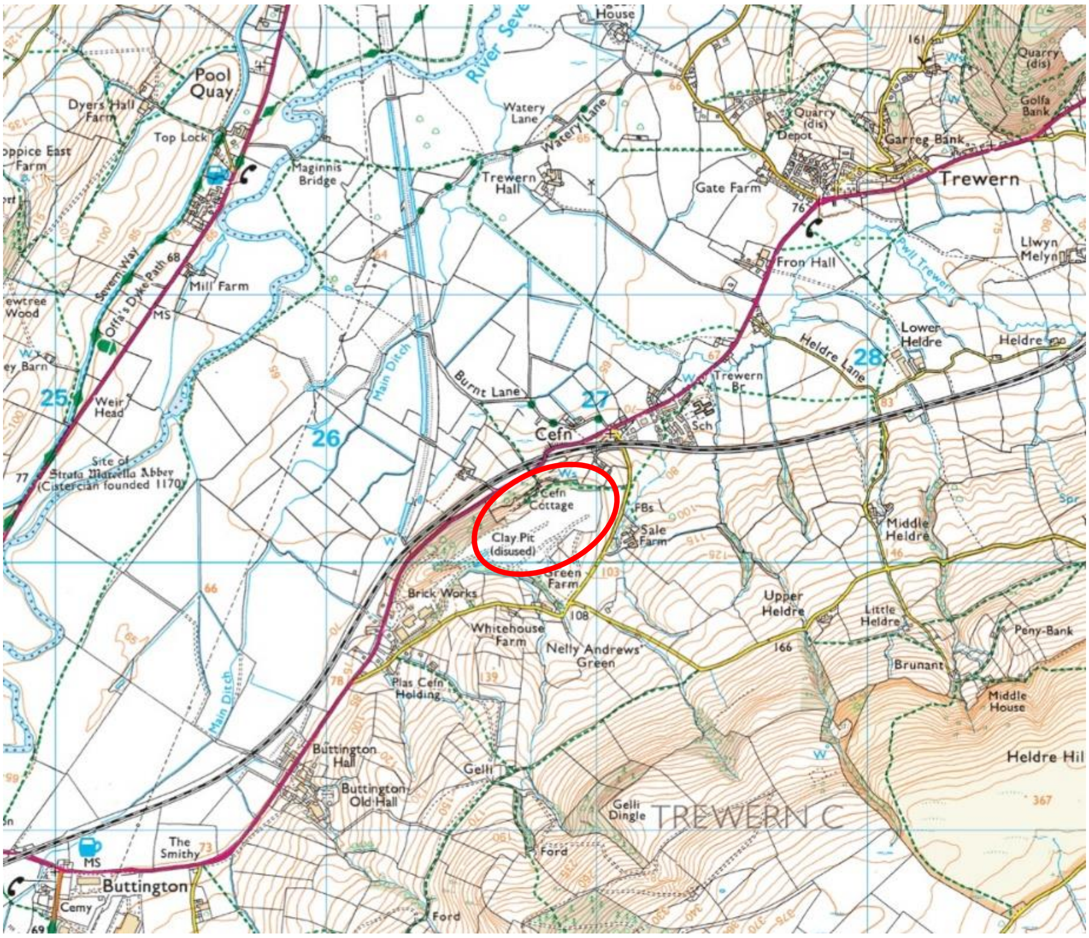
2. SITE LOCATON

2.1. SITE SETTING

2.1.1. The Installation is located within Buttington Quarry located adjacent to the A458 Shrewsbury to Welshpool road to the south of the village of Trewern. The Installation is centred on National Grid Reference ("NGR") 326799 310128 and will occupy an area of approximately 1.9 hectares.

2.1.2. Figure 1 provides the indicative location of the Installation (red outline) within the context of the surrounding environment. The DNS application boundary is shown on ECL Drawing ECL-BQ-000 Planning Boundary in Appendix 1.

Figure 1: Indicative Site Location



2.1.3. The Development Site currently comprises an operational quarry located within an area primarily consisting of open countryside.

2.1.5. The village of Buttington is located approximately 1.9km to the south west of the Development Site and Trewern village is 1.36km to the north east. The small settlement of Cefn lies approximately 214m to the north of the DNS application site boundary.

2.1.6. Within the wider Buttington Quarry area, adjacent to the site entrance is a working claypit which previously supplied clay to the adjoining Buttington Brickworks but, since the closure of the brickworks in 1990, has continued to produce up to 195,000 tonnes per annum of clay for low grade construction purposes. The former brickworks are now occupied and used for third party commercial uses including storage and distribution.

2.1.7. Access and highway improvements will be made to the A458 as part of the construction phase to facilitate access to Development Site approximately 170m to the north of the existing access currently serving Buttington Quarry. The existing access is to be closed off, allowing access to the property known as Brookside only. The proposed new road will be utilised by the third parties mentioned above, and will serve any future developments, consequently, it is not contained within the Environmental Permit boundary.

3. SENSITIVE RECEPTORS

3.1. HUMAN RECEPTORS

3.1.1. The nearest specific sensitive receptors in the area within a 1km radius were identified, this is an area wider than the criteria described in the IAQM Mineral Dust guidance, however, is consistent with the sensitive receptors identified for the Environmental Permit Application.

3.1.2. Fourteen potentially sensitive human receptors have been identified within 1km of the main area where construction activities will occur ("the Earthworks"). Figure 5 shows these receptors, together with the 1km radius search and the main dust creating activities shown as a red rectangle. Further details are provided in Table 3.

Figure 2: Sensitive Human Receptors Identified within 1km of the Earthworks

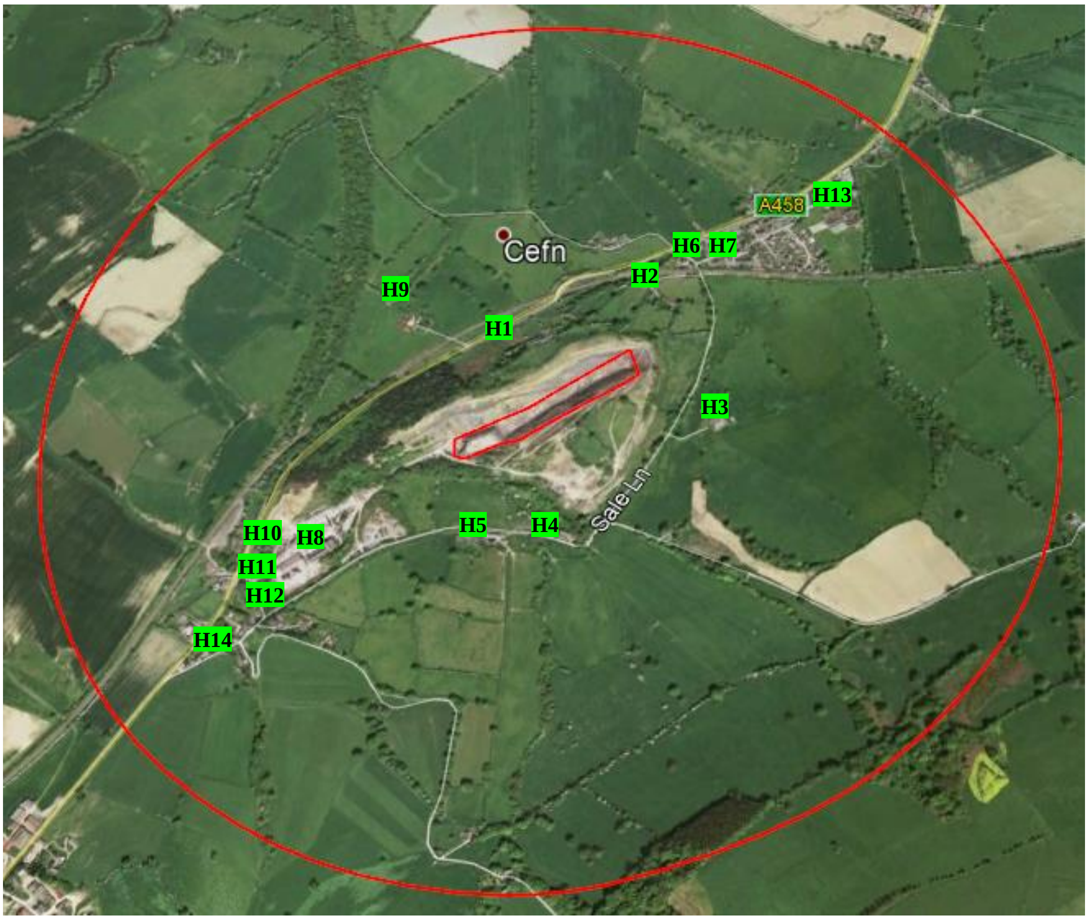


Table 1: Human Receptors within 1km of the Earthworks

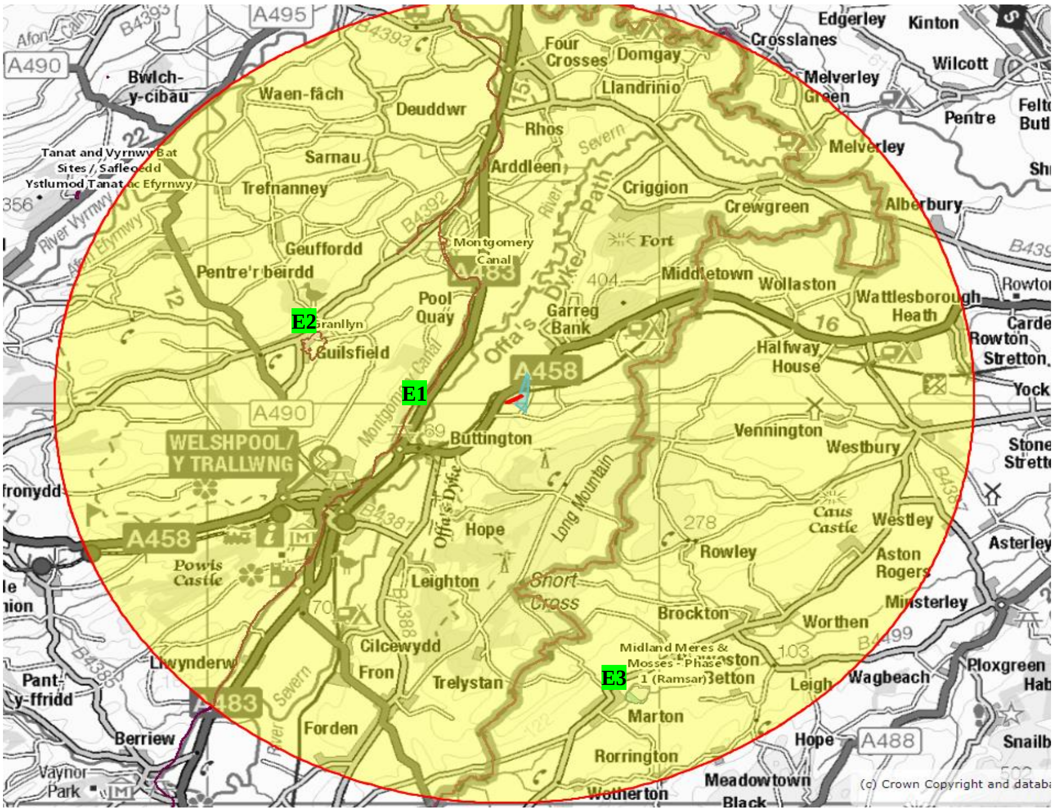
Ref	Name	Receptor Type	Distance	Direction
H1	Cefn Cottage	Residential	0.11	N
H2	Cefn Farm – House Off Sale Lane	Residential/ Commercial	0.12	NE
H3	Sale Farm – House Off Sale Lane	Residential/ Commercial	0.14	E
H4	Green Farm Heldre Lane	Residential/ Commercial	0.18	S
H5	Whitehouse Farm	Residential/ Commercial	0.18	SW
H6	Methodist Church, Buttington	Place of Worship	0.25	NE
H7	Cefn Village	Residential	0.25	NE
H8	Speed Welshpool	Commercial	0.25	SW
H9	Lower Cefn	Residential/ Commercial	0.29	N
H10	Brookside	Residential	0.41	W
H11	Border Hardcore Offices	Commercial	0.46	W
H12	York House	Residential	0.46	W
H13	Buttington Trewern Primary School	Educational	0.48	NE
H14	A458/Heldre Lane	Residential	0.55	W

3.2. ECOLOGICAL RECEPTORS

3.2.1. A review of the area using the Multi-Agency Geographic Information for the Countryside[3] ("MAGIC") online tool identified that the Development Site is located within 10km of Montgomery Canal and Granllyn, both of which are designated as Special Area of Conservation ("SAC"). Additionally, the Development Site is located within 10km of Midland Meres and Mosses – Phase 1, which is designated as a Ramsar Wetlands of International Importance ("Ramsar") site. There are no Special Protection Areas ("SPA") located within 10km of the EP boundary. The indicative locations of the identified ecological receptors are shown on Figure 3.

[3] Department for Environment, Food and Rural Affairs ("DEFRA") MAGIC Online Mapping Tool, available at: https://magic.defra.gov.uk/magicmap.aspx, accessed July 2020.

Figure 3: SPA, Ramsar and SAC identified within 10km of the Earthworks



3.2.2. The national grid references ("NGRs") of the identified ecological receptors are listed in Table 2, together with their distance and direction from the main dust creating activities.

Table 2: SACs and Ramsar within 10km of the Earthworks

Ref	Description	Designation	Easting	Northing	Distance From Earthworks (km)	Direction
E1	Montgomery Canal	SAC	324911	310297	1.77	W
E2	Granllyn	SAC	322501	311267	4.35	W
E3	Midland Meres and Mosses – Phase 1	Ramsar	329510	302730	7.70	SE

3.2.3. The Montgomery Canal SAC is designated due to the occurrence of floating water-plantain *Luronium natans*; and Granllyn SAC supports the largest population of great crested newts, in Powys. Midland Meres and Mosses - Phase 1 Ramsar site is designated for its range of lowland wetland habitats and successional stages, including quaking bogs.

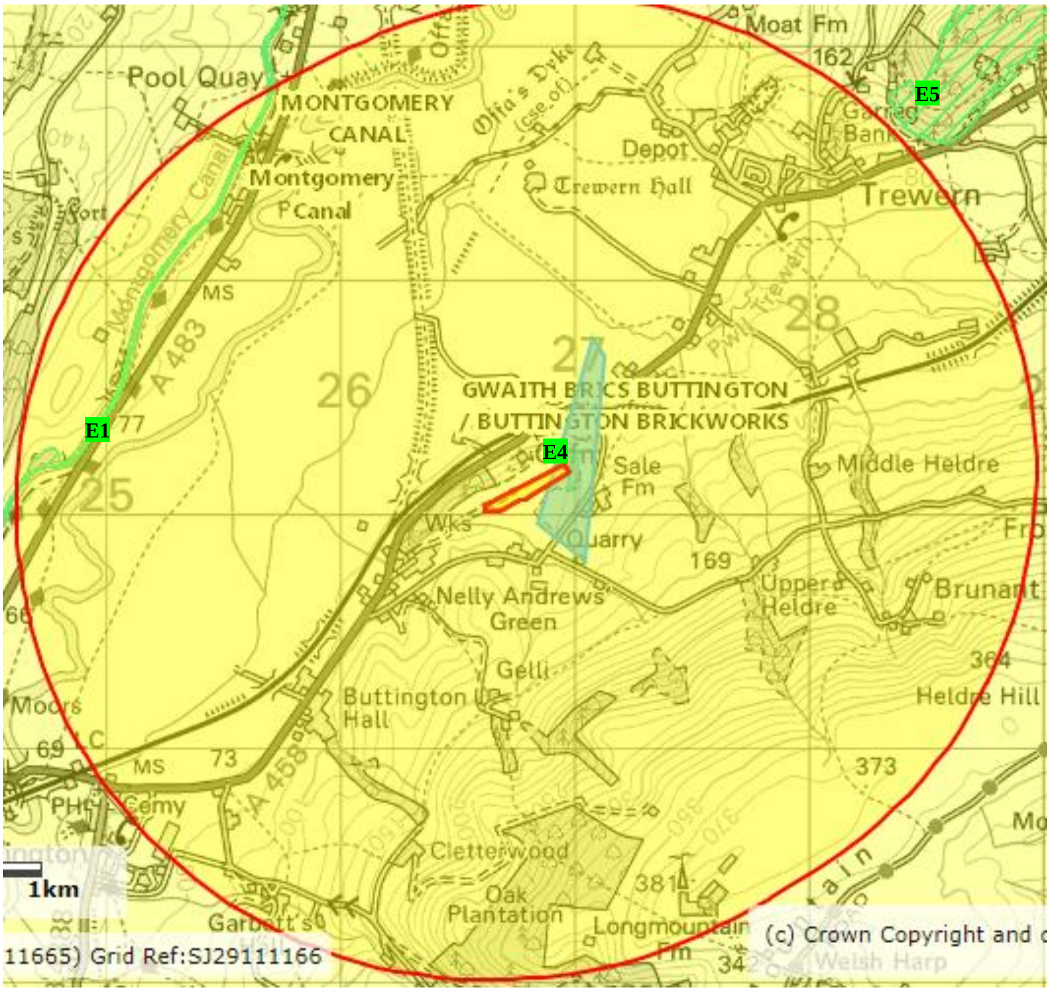
3.2.4. A search of the MAGIC tool was also undertaken to identify Sites of Special Scientific Interest ("SSSI"), National Nature Reserves ("NNR") and Local Nature Reserves ("LNR") within 2km of the Development Site.

3.2.5. Two SSSI are located within 2km of the Development Site. These are Buttington Brickworks SSSI, which was notified for its geological interest and is directly adjacent to the north-eastern face of the existing quarry void. The SSSI will be fully retained, protected and has been excluded from the site boundary.

3.2.6. The Montgomery Canal SSSI shares a common boundary with the SAC of the same name. In addition to the internationally important floating water-plantain population (which is a feature of the SAC), the Montgomery Canal is of special scientific interest for its aquatic, emergent and marginal plant communities, individual rare plants and its invertebrate assemblage. The indicative locations of the identified SSSIs are shown in Figure 4.

3.2.7. A further SSSI, Moel y Golfa, is located approximately 2.1km from the earthworks.

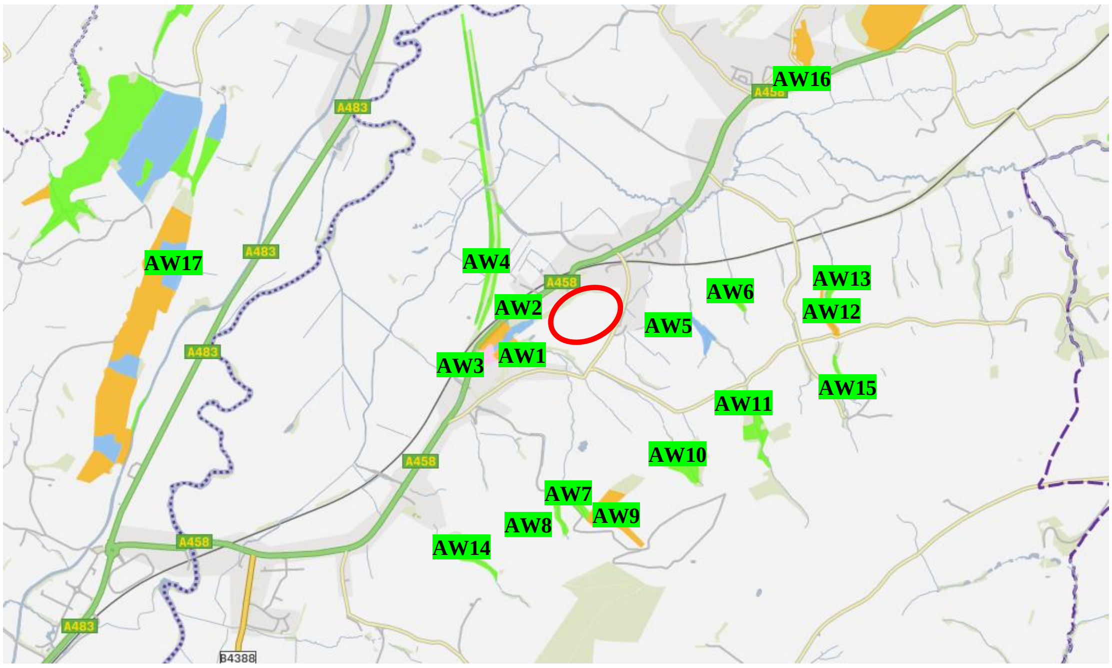
Figure 3: SSSIs Identified within 2km of the Earthworks



3.2.8. According to the Lle Geo-Portal for Wales[4], there are no NNRs or LNR sites 2km of the earthworks.

10.1.1. The ancient woodland ("AW") inventory for Wales on the Lle Geo-Portal indicates that there are areas of ancient woodland within 2km of the earthworks. The closest being adjacent to the west of the quarry void and includes conifer plantation on an ancient woodland site ("PAWS") and restored ancient woodland. The indicative locations of the identified AW sites are shown in Figure 4.

Figure 4: AW Sites Identified within 2km of the Earthworks



3.2.9. The NGR of the identified ecological receptors within 2km are listed in Table 3, together with their distance and direction from the earthworks.

Table 3: Ecological Receptors within 2km

Ref	Description	Designation	Easting	Northing	Distance from Earthworks (km)	Direction
E4	Buttington Brickworks	SSSI	326980	310222	0.13	E
E1	Montgomery Canal	SAC & SSSI	324911	310297	1.77	W
E5	Moel y Golfa	SSSI	328426	311640	2.10	NE
AW1	Restored Ancient Woodland	AW	326439	309970	0.06	W
AW2	Plantation on Ancient Woodland Site	AW	326489	310073	0.08	W

[4] Lle Geo-Portal for Wales Mapping Tool, available at: https://lle.gov.wales/catalogue?t=1&lang=en, accessed November 2020.

Table 3: Ecological Receptors within 2km (Cont.)

Ref	Description	Designa tion	Easting	Northing	Distance from EP Boundary (km)	Direction
AW3	Ancient Woodland Site of Unknown Category	AW	326324	309943	0.28	W
AW4	Ancient Semi Natural Woodland	AW	326336	310916	0.34	NW
AW5	Plantation on Ancient Woodland Site	AW	327545	310044	0.48	E
AW6	Ancient Semi Natural Woodland	AW	327723	310235	0.71	E
AW7	Ancient Semi Natural Woodland	AW	326844	309074	0.89	S
AW8	Ancient Semi Natural Woodland	AW	326718	309018	0.91	S
AW9	Restored Ancient Woodland Site	AW	326972	309046	0.91	S
AW10	Ancient Semi Natural Woodland	AW	327437	309301	0.92	SE
AW11	Ancient Semi Natural Woodland	AW	327809	309504	0.93	SE
AW12	Restored Ancient Woodland Site	AW	328221	310129	1.22	E
AW13	Ancient Semi Natural Woodland	AW	328246	310253	1.25	E
AW14	Ancient Semi Natural Woodland	AW	326229	308800	1.27	SW
AW15	Ancient Semi Natural Woodland	AW	328299	309795	1.31	SE
AW16	Restored Ancient Woodland Site	AW	328119	311626	1.74	NE
AW17	Plantation on Ancient Woodland Site	AW	324570	310487	2.00	W

3.2.10. In addition to the SACs, SPAs, Ramsar, SSSIs, NNRs, LNRs, ancient woodland, other potentially sensitive land uses within 1km of the Installation were also considered. A review of the area using the MAGIC tool and Lle Geo-Portal for Wales indicated that none of the following sensitive land uses are located within a 1km radius of the Development Site:

- Areas of Outstanding Natural Beauty;
- Groundwater Source Protection Zones;
- Marine Conservation Zones;
- Scheduled Monuments;
- National Parks; and/or
- Nitrate Vulnerability Zone.

4. SCREENING ASSESSMENT

4.1. GENERAL AIR QUALITY SCREENING ASSESSMENT

4.1.1. A screening assessment was carried out for the impacts of the site on air quality in the local area, based on criteria and information given in the IAQM/EPUK *Land-Use Planning & Development Control: Planning for Air Quality.*[1]

4.1.2. The IAQM/EPUK planning guidance defines the following general criteria to screen the impact of developments:

A If any of the following apply:

- *10 or more residential units or a site area of more than 0.5ha*
- *more than 1,000 m^2 of floor space for all other uses or a site area greater than 1ha*

B Coupled with any of the following:

- *the development has more than 10 parking spaces*
- *the development will have a centralised energy facility or other centralised combustion process*

4.1.3. The Buttington ERF will provide a total of 38 car parking spaces, and the area of the site is much larger than 1 ha, so the air quality impact of the development on the local area cannot be screened out according to these criteria.

4.1.4. A further level of screening was therefore carried out, considering the more specific criteria outlined in Table 6.2 of the IAQM Planning for Air Quality guidance. These criteria are reproduced below in Table 4, along with a summary of the conclusions of the screening assessment for the development.

Table 4: Specific Screening Criteria for Air Quality Screening Assessment

The development will:	Indicative Criteria to Proceed to an Air Quality Assessment	Significant?
1. Cause a significant change in Light Duty Vehicle (LDV) traffic flows on local roads with relevant receptors.	A change of LDV flows of: - more than 100 AADT within or adjacent to an AQMA - more than 500 AADT elsewhere.	The site is not located within or adjacent to an AQMA. The AADT for LDVs for the 36 month construction phase is 461. **Not significant**
2. Cause a significant change in Heavy Duty Vehicle (HDV) flows on local roads with relevant receptors.	A change of HDV flows of: - more than 25 AADT within or adjacent to an AQMA - more than 100 AADT elsewhere.	The site is not located within or adjacent to an AQMA. The AADT for HGVs for the 36 month construction phase is 69. **Not significant**
3. Realign roads, i.e. changing the proximity of receptors to traffic lanes	Where the change is 5m or more and the road is within an AQMA.	There is a change of 5m or more, however it does not change the proximity of any receptors to traffic lanes and the site is not located within or adjacent to an AQMA. **Not significant**
4. Introduce a new junction or remove an existing junction near to relevant receptors	Applies to junctions that cause traffic to significantly accelerate /decelerate, e.g. traffic lights, or roundabouts	A new junction is being proposed. Vehicular access to the ERF would be achieved via a new priority 'T' junction with a dedicated ghosted right turn lane. The new junction would be located approximately 170m to the north of the existing access junction and would be provided to contemporary design standards. The design is that that is currently permitted under permission P/2015/0439, and 20/0575/REM. An air quality assessment was not required for these applications. In addition, the change to the junction will not cause traffic to significantly accelerate or decelerate, nor will it change the distance of the carriage way to any human receptors. **Not significant**
5. Introduce or change a bus station.	n/a	**Not relevant**
6. Have an underground car park with extraction system	n/a	**Not relevant**
7. Have one or more substantial combustion processes, where there is a risk of impacts at relevant receptors.	n/a	ECL Report ECL.001.01.01/ADM and ECL Report ECL.001.01.01/ADMS Roads address the impact of emissions from the combustion process. **Not relevant**

Note to Table:
LDV = cars and small vans less than 3.5 tonnes gross vehicle weight

4.1.5. Table 4 shows that most of the air quality impacts according to these detailed screening criteria are not significant or not relevant. Detailed air quality assessments have been undertaken for the combustion process and for the road traffic emissions (to ensure a robust assessment), however, no further assessment is required.

4.2. DUST IMPACTS SCREENING ASSESSMENT

4.2.1. The IAQM minerals dust guidance states that *"where there are no receptors near to a mineral site there will be no significant effect. Therefore it is possible to screen out the need for a detailed assessment based on the distance from a mineral site to potentially sensitive receptors*". The screening criteria in Section 3 of the guidance was used to assess whether a detailed dust impact assessment is required.

4.2.2. For the screening process, the guidance suggests different criteria for PM_{10} and disamenity dust, both concerning the presence of sensitive receptors in the vicinity of the site.

4.2.3. For PM_{10} impacts, the guidance states that a detailed assessment should be carried out if there are relevant sensitive receptors within 1 km. For PM_{10}, the only relevant receptors are those relating to human health impacts. The annual average PM_{10} objective for human health applies to areas where members of the public might be regularly exposed, such as residential properties, schools and hospitals. The daily average objective for PM_{10} applies at those locations where the annual mean objective would apply, plus areas such as hotels and residential gardens.

4.2.4. For deposited dust, a relevant receptor location is generally taken to mean anywhere where nuisance or disamenity could occur. Ecological receptors that may be sensitive to deposited dust must also be considered.

4.2.5. For disamenity and ecological dust impacts, the guidance states that the detailed assessment is required if there is a relevant sensitive receptor within 400 m of a hard rock quarry and within 250 m of a soft rock quarry. The proposed development relates to the construction and extraction within mudstone (i.e. brakes easily down fracture/bedding planes), so a 250m search radius is relevant here.

4.2.6. Based on the screening criteria of the IAQM minerals dust guidance, the impact of fugitive PM_{10} and deposited dust cannot be screened out as there are several sensitive receptors within 250 m of the site boundary (see Section 3).

4.2.7. Therefore, a detailed dust impact assessment is required to be carried out for the construction phase, and is described in the remainder of this report.

5. ASSESSMENT OF DUST IMPACTS AND EFFECTS

5.1. ASSESSMENT OF DEPOSITED DUST

5.1.1. The assessment of dust impacts is based on the qualitative risk based approach using the source-pathway-receptor model as recommended by the IAQM.

5.1.2. The detailed assessment methodology outlined in the minerals dust guidance comprises three main steps for the assessment of deposited dust:

- Step 1: Describe Site Characteristics and Baseline Conditions
- Step 2: Estimate Dust Impact Risk
- Step 3: Estimate Likely Magnitude of Effect

Step 1: Describe Site Characteristics and Baseline Conditions

5.1.3. The guidance specifies that Step 1 of the assessment should include the consideration of a number of factors. These are discussed in Table 5.

Table 5: Site Characteristics and Baseline Conditions

Factors	Consideration
Extent of site including site boundary	The overall cut and fill requirements for the development are shown on Bright and Associates drawing BT1180-D14 which may be found in Appendix 1
Existing site operations, including currently-consented working	The quarry operated from the late 19th Century and included a brickworks with permissions approved in 1961 and 1997 for extensions to the original quarry workings (Planning Consent 379 dated 2nd August 1948). The quarry now operates in accordance with the requirements of planning permission granted in 2010 in accordance with a Review of Mineral Permissions ("ROMP") under the Environment Act 1995 (Planning Permission ref: P/2010/0165). In addition, planning permissions have been granted for an improved access approximately 155m north east of the existing quarry access - Planning Permission Ref. P/2015/0439). A Section 73 application (Planning Permission Reference 20/0575/REM) was submitted in April 2020 to request an extension of time for implementation of this permission which granted in September 2020.
Scale and duration of operations, including phasing	The overall cut and fill requirements for the development are shown on Bright and Associates drawing BT1180-D14 (see Appendix 1). The total cut is 334,635m^3 with a total fill requirement of 172,400m^3, which leaves a balance of 162,235m^3. Using a worst case figure of 1.8 tonnes per m^3, the weight of material to be moved off site is likely to be in the region of 292,023 tonnes The construction period is expected to last 36 months, however the earthworks will be undertaken during the first 6 months. The timetable for the construction period will be dependent on the grant of planning permission for the proposed development and subsequent contract negotiations. The current programme of works is based on the assumption of a construction start date towards the early part of 2022. The construction operations will generally be limited to 07:00 – 19:00hrs Monday to Friday and 07:00 – 12:00hrs Saturday.

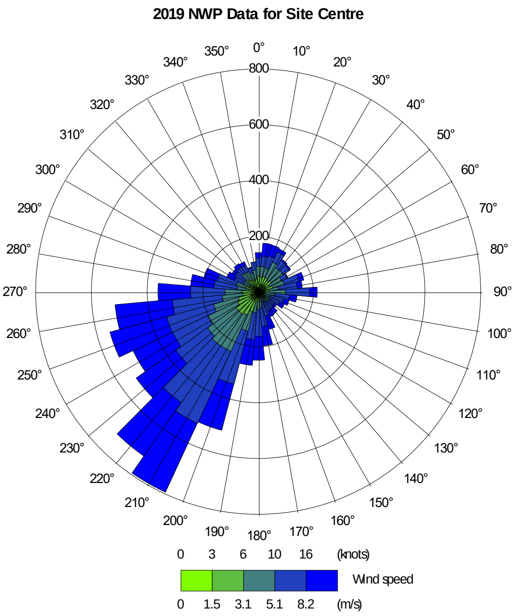
Table 5: Site Characteristics and Baseline Conditions (cont)

Factors	Consideration
Type and location of processing activities, including secondary processing (e.g. concrete batching) Method/s of working Method/s of materials handling	To widen the existing quarry floor and create the proposed south-eastern slope profile, material needs to be excavated from the existing in-situ mudstone. Proposed designs also indicate the north-western quarry face will require minor reprofiling, requiring some excavation and filling. Excavated material will be re-used as part of the construction phase. The material shall be used as fill for a number of areas across the development area, including raising the current quarry bottom from approximately 89m AOD to 90m AOD. Further material will be used in re-profiling the north-western end of the quarry void. Excavation of slopes will be completed using the current quarrying process using a top-down method of excavation. An excavator and dozer will take advantage of fractures within the in-situ mudstone using a combination of ripping and breaking techniques to loosen the material. These are methods which are consistent with those used over the last 25 years of quarrying, consequently, are proven to be effective at material extraction and have not lead to any dust complaints. This material will then be loaded into dump trucks for transport to temporary stockpiles, and ultimately recompacted into areas requiring placement of fill within the void. Potentially dust creating activities will include: • site preparation; • extraction of the mineral; • dry screening of the mineral; • emission from stockpiles or other exposed areas; • emission during handling and transportation by vehicles; • movement of vehicles on haul roads, and trackout onto the external road network; • site fill.
Mineral type and characteristics (size, moisture content, friability, colour, and opacity)	The site is underlain by three main geological units, the Cefn Formation (completely weathered to soil to around 1m depth, weak dark grey mudstone with bands of non-intact laminated mudstone and siltstone), Taranon Mudstone Formation (weak dark reddish brown locally light greenish grey mudstone) and the Trewern Brook Mudstone Formation (very gravelly clay soil, and weak grey to dark grey mudston beds). All three lithologies are exposed within the existing quarry and areas investigated adjacent to the quarry found very shallow soils grading into weathered rock to be present. Localised areas of made ground exist where hardcore materials have been imported to form tracks. The moisture content of samples taken as part of the geotechnical investigation indicated a rage of 6-12% moisture.
Production rate	The total cut is 334,635m^3 therefore over the period of 6 months will be circa 12,871m^3 per week or 2,340m^3 per day based on a 5.5 day week. The total fill is requirement of 172,400m$^{3.}$
Location/s of storage areas and stockpiles	All storage areas and stockpiles will be undertaken with the boundary of the proposed earthworks and extent of cut and fill shown on Drawing BT1180-D14 in Appendix 1.
Location/s and number of access routes and haul roads	Access and highway improvements will be made to the A458 to facilitate access to the Development approximately 170m to the north of the existing access currently serving Buttington Quarry. During the construction phase, the existing quarry access would be used until the new site access is constructed. It is anticipated that the earthworks would undertaken using the existing quarry access. Access roads are shown on Drawing BT1180-D1 in Appendix 1.

Table 5: Site Characteristics and Baseline Conditions (cont)

Factors	Consideration
The main existing sources of dust in the area. This should include any available monitoring data	The main existing sources of disamenity dust in the immediate area are likely to be the existing active mineral sites both to the south of the boundary of the earthworks and also those that are currently undertaken within the Development Site. In addition, there may be dust emissions from agricultural operations in nearby farmland. No dust monitoring data has been used in this assessment as no dust monitoring has been undertaken in relation to the existing quarrying operations nor have there been any dust complaints associated with the quarry.
Background PM_{10} concentrations provided by Defra, and, if available, any existing relevant local monitoring data	There is no suitable measured data for PM_{10} therefore the 2020 DEFRA mapped data will be used. Please note that, whilst it was suspected that there may have been lower background concentrations of PM_{10} in 2020 due to reduced activity as a result of the Covid-19 pandemic, the 2019 DEFRA mapped PM_{10} concentration for the area surrounding the Installation for the year 2019 at NGR 326500, 310500 was 12.42µg/m^3 compared to 12.21 for 2020. This location is 437m north of the Installation, therefore is considered to be reflective of the background concentrations in the area.
The location and nature of dust sensitive receptors, shown on a map and/or in a table detailing the direction, and distance from the site boundary or relevant site activity	The potentially sensitive receptors considered in the assessment are: • AW1 and AW2 (ancient woodland sites); • E4 (Buttington Brickworks) – note as this is a geological SSSI impacts at this location are not considered relevant and will not be assessed; • H1 - Cefn Cottage (residential); • H2 - Cefn Farm (residential); • H3 – Sale Farm (residential); • H4 – Green Farm (residential); • H5 – Whitehouse Farm (residential); • H6 - Methodist Church, Buttington (place of worship); • H7 – Cefn Village (residential); and • H8 - Speed Welshpool (commercial premises). These are also shown on figures 2 and 3 and described in Tables 1 and 3.
The location of likely sources of dust emission from within the site	The location of the likely sources of dust emission would be within the boundary of the proposed earthworks shown on Drawing BT1180-D14 in Appendix 1.
Any natural or existing mitigating features such as topography and areas of vegetative screening.	The existing quarry void itself will provide mitigation for the majority of the excavation activities. In addition there is a partially completed landscape bund to the eastern boundary of the earthworks area which will also provide additional mitigation. The topography of the surrounding area is as follows: 

Table 5: Site Characteristics and Baseline Conditions (cont)

Factors	Consideration
Local wind roses showing the frequency of directions and speed, and possibly rainfall and ground moisture conditions	 The wind rose is provided from numerical weather prediction data for 2019 for the grid coordinates of the approximate centre of the earthworks. The total rainfall from the year, again provided by the NWP data set is 1,1321mm/year.

Step 2: Estimate Dust Impact Risk

5.1.5. This stage of the assessment involves an estimate of the Dust Impact Risk for each of the receptors. The two main factors to consider are the level of residual dust emissions from the site (the 'Source' term) and the pathway effectiveness for each of the receptors (the 'Pathway' term).

5.1.6. Appendix 4 of the IAQM Mineral Dust guidance gives indicative criteria for assessing the magnitude of the residual source emissions from each type of activity. The guidance also states that the assessment should be undertaken with the mitigation measures taken into account.

5.1.7. The mitigation measures specific to air quality (including control of dust) during the construction phase will form part of the construction environmental management plan ("CEMP") to be secured by planning condition in accordance with standard practice. A detailed CEMP will be produced by the Engineering, Procurement and Construction ("EPC") Contractor for approval by the Council pursuant to planning condition. An Outline CEMP has been produced (see Technical Appendix 4-2 (ECL Report ECL.001.01.02/CEMP)), and will be used as a basis for the CEMP to be produced by the EPC Contractor.

5.1.8. Mitigation measures in terms of dust control include:

- the Buttington Brickworks SSSI will be fenced off and construction activities will be set back from the area;
- site access roads will be watered as necessary using a water bowser and surfaces kept in good order and cleaned as required;
- all vehicles carrying loose aggregate and workings will be sheeted at all times;
- dampening of exposed soil and loose material stock piles will be carried out as necessary;
- observation of wind speed and direction will be carried out to determine the potential for dust nuisance to occur at sensitive receptors to the east of the proposed facility prior to conducting potential dust-generating activities; potential dust-generating activities will be avoided during periods of high winds;
- stockpiles of soils and materials will be located in sheltered areas of the site, where practicable;
- windbreak netting will be placed around stockpiles of material sensitive to wind disturbance;
- the use of construction equipment designed to minimise dust generation;
- establishment and enforcement of an appropriate speed limits on roads carrying construction vehicles to minimise dust emissions;
- frequent washdown of roads and made surfaces;
- regular inspection of local highways will take place to monitor the deposition of dust leaving the site;
- wheel washing facilities for vehicles leaving the site if required;
- drop-heights for friable materials will be minimised;
- completed earthworks will be vegetated as soon as practicable.

5.1.9. Details of the proposed methodologies for the above measures will be set out in the CEMP and held on site. These provisions will ensure that risks to human health are managed and minimised for construction related activities.

5.1.10. The assessment of the estimated residual emissions is presented in Table 6.

Table 6: Residual Source Classification

Source type	Factors affecting residual dust emissions	Likely dust magnitude
Site preparation and Fill	The site preparation and fill will be undertaken simultaneously therefore the working area at any one time could be up to the 10.67Ha that comprises the boundary of the earthworks. The volume of material is large and will be undertaken by various heavy mobile plant. However all extraction will be undertaken within the existing quarry void which is circa 20m deep which provides a substantial bund.	Small
Mineral Extraction	The total working area is 10.67Ha. The extraction methods are likely to be low-energy (without frequent use of drilling or blasting) The extracted material is of low dust potential (moisture content of 6-12%). It is anticipated that the extraction rate will be high as it is anticipated that the works can be done within a period of 6 months. However the site has operated at a similar rate previously with no history of dust complaints.	Small
Materials handling	Number of heavy loading plant in use likely to be high, however the majority of the extraction will be undertaken within the quarry void with fill being undertaken approximately 100m from the nearest potentially sensitive receptor. The material is of low dust potential.	Small
On-site transportation	It is likely that the material will be transported onsite using the existing quarry haul roads. The road surface of the unpaved roads will be likely to be of low dust potential under normal conditions. There will be around 104 HDV vehicles onsite per day (circa 208 movements per day).	Small
Mineral processing	The raw material and end product is of low dust potential under normal conditions. Relatively simple processing will be undertaken with no crushing and screening of materials onsite. 334,635m^3 of material will be processed with a 6 month period, however the site has operated at a similar rate previously with no history of dust complaints.	Small
Stockpiles/ Exposed Surfaces	Material stored is of low dust potential and stockpiles will remain within the quarry void, the stockpiles will occupy an area much less than 2.5 Ha. Whilst there is a large volume of material to be extracted this will not be stored on site for prolonged periods – it will either be re-used as fill or transferred off site.	Small
Off-Site Transportation	There will be a large number of HDV movements per day, but the access road will be hardstanding, will be much greater than 50m in length, and wheel washing will be carried out.	Small
Conclusion	**The Residual Source Emissions are estimated to be:**	**Small**

Estimation of the effectiveness of transport through the air (the Pathway)

5.1.11. The estimation of the Pathway Effectiveness can be assessed by considering the distance of each receptor from the site, and the frequency of winds that can potentially cause high dust emissions.

5.1.12. The prevailing wind direction is from the south / south west, with the majority of wind measurements falling between southerly and westerly directions. A very small percentage of wind comes from the remaining wind directions. Therefore the receptors with the greatest potential impact risk, will be those located directly downwind of the site, i.e. those located to the north and east of the site, i.e. those located in a direction from around 0°N to 90°N of the site.

5.1.13. Table A3-2 of the IAQM Mineral Dust guidance gives example criteria for categorising the frequency of potentially dusty winds. This is reproduced in Table 7.

Table 7: Categorisation of Frequency of Potentially Dusty Winds

Frequency Category	Criteria
Infrequent	Frequency of winds (>5 m/s) from the direction of the dust source on dry days are less than 5%
Moderately frequent	The frequency of winds (>5 m/s) from the direction of the dust source on dry days are between 5% and 12%
Frequent	The frequency of winds (>5 m/s) from the direction of the dust source on dry days are between 12% and 20%
Very frequent	The frequency of winds (>5 m/s) from the direction of the dust source on dry days are greater than 20%

5.1.14. Table A3-3 (reproduced as Table 8) of the guidance gives the example criteria for judging the significance of source-receptor distance.

Table 8: Categorisation of Frequency of Potentially Dusty Winds

Frequency Category	Criteria
Distant	*Receptor is between 200 m and 400 m from the dust source*
Intermediate	*Receptor is between 100 m and 200 m from the dust source*
Close	*Receptor is less than 100 m from the dust source*

5.1.15. Table A3-4 (reproduced as Table 9) of the guidance shows the matrix for the assessment of Pathway Effectiveness.

Table 9: Estimation of Pathway Effectiveness

		Frequency of potentially dusty winds			
		Infrequent	**Moderately frequent**	**Frequent**	**Very frequent**
Receptor distance category	**Close**	Ineffective	Moderately Effective	Highly Effective	Highly Effective
	Intermediate	Ineffective	Moderately Effective	Moderately Effective	Highly Effective
	Distant	Ineffective	Ineffective	Moderately Effective	Moderately Effective

5.1.16. The meteorological data shown in Table 5 (and the corresponding met file) was analysed to calculate the annual frequency of hours with potentially dusty winds. 'Dry days' were assumed to be those with rainfall of less than 0.2 mm/day, as suggested in the IAQM guidance. The resulting frequency of wind speeds with the potential of carrying airborne dust towards receptors were then assigned to the categories in Table 5 based on the twelve 30° wind direction sectors (where the receptor lies within 2 sectors the sector with the highest frequency of wind was selected).

5.1.17. Table 8 shows the results of the meteorological data analysis.

Table 10: Calculation of frequency of potentially dusty winds

Receptor Ref	Receptor name	Wind direction range (°)	No of hours > 5 m/s on dry days	% of potentially dusty winds	Frequency Category
H1	Cefn Cottage	180-210	289	3.3	Infrequent
H2	Cefn Farm	210-240	504	5.8	Moderately Frequent
H3	Sale Farm	270-300	165	1.9	Infrequent
H4	Green Farm	0-30	289	3.3	Infrequent
H5	Whitehouse Farm	0-30	289	3.3	Infrequent
H6	Methodist Church, Buttington	210-240	504	5.8	Moderately Frequent
H7	Cefn Village	210-240	504	5.8	Moderately Frequent
H8	Speed Welshpool	240-270	316	3.6	Infrequently
AW1	Ancient Woodland 1	240-270	316	3.6	Infrequently
AW2	Ancient Woodland 2	240-270	316	3.6	Infrequently

5.1.18. Table 9 shows the results of the assessment of Pathway Effectiveness for each receptor, based on the distance and direction of the receptor from the source. Information on the receptors is given in Section 3 of this report.

Table 11: Assessment of the Pathway Effectiveness for each receptor

Receptor Ref	Receptor name	Distance From Construction (km)	Distance Category	Frequency of Dusty Winds	Pathway Effectiveness
H1	Cefn Cottage	0.11	Intermediate	Infrequent	Ineffective
H2	Cefn Farm	0.12		Moderately Frequent	Moderately Effective
H3	Sale Farm	0.14		Infrequent	Ineffective
H4	Green Farm	0.18		Infrequent	Ineffective
H5	Whitehouse Farm	0.18		Infrequent	Ineffective
H6	Methodist Church, Buttington	0.25	Distant	Moderately Frequent	Ineffective
H7	Cefn Village	0.25		Moderately Frequent	Ineffective
H8	Speed Welshpool	0.25		Infrequently	Ineffective
AW1	Ancient Woodland 1	0.06	Close	Infrequently	Ineffective
AW2	Ancient Woodland 2	0.08		Infrequently	Ineffective

Estimation of Dust Impact Risk

5.1.19. Table 12, reproduced from Table 2 of the Dust Impact Risk provided in the IAQM mineral dust guidance, shown the estimation of dust impact risk and Table 13 shows the results of the assessment of Dust Impact Risk for each receptor, based on the Residual Source Emissions and the Pathway Effectiveness for each receptor.

Table 12: Estimation of Dust Impact Risk

		Residual Source Emissions		
		Small	**Medium**	**Large**
Pathway Effectiveness	Highly effective pathway	Low Risk	Medium Risk	High Risk
	Moderately effective pathway	Negligible Risk	Low Risk	Medium Risk
	Ineffective pathway	Negligible Risk	Negligible Risk	Low Risk

Table 13: Assessment of the Dust Impact Risk for each receptor

Receptor Ref	Receptor name	Residual Source Emissions	Pathway Effectiveness	Estimated Dust Impact Risk
H1	Cefn Cottage	Small	Ineffective	Negligible Risk
H2	Cefn Farm		Moderately Effective	
H3	Sale Farm		Ineffective	
H4	Green Farm		Ineffective	
H5	Whitehouse Farm		Ineffective	
H6	Methodist Church, Buttington		Ineffective	
H7	Cefn Village		Ineffective	
H8	Speed Welshpool		Ineffective	
AW1	Ancient Woodland 1		Ineffective	
AW2	Ancient Woodland 2		Ineffective	

STEP 3: Estimate Likely Magnitude of Effect

5.1.20. The final step in the assessment is to consider the residual dust impact risk in conjunction with the sensitivity of the receptors, to estimate the likely magnitude of the effects.

Estimation of Receptor Sensitivity

5.1.21. The IAQM mineral dust guidance gives example criteria for the assessment of Receptor sensitivity to deposited dust, as follows:

- High sensitivity receptor
  - users can reasonably expect enjoyment of a high level of amenity; or
  - the appearance, aesthetics or value of their property would be diminished by soiling; and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land.
  - indicative examples include dwellings, medium and long-term car parks and car showrooms.
- Medium sensitivity receptor
  - users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or
  - the appearance, aesthetics or value of their property could be diminished by soiling; or
  - the people or property would not reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land.
  - indicative examples include parks, and places of work.
- Low sensitivity receptor
  - the enjoyment of amenity would not reasonably be expected; or
  - there is property that would not reasonably be expected to be diminished in

- appearance, aesthetics or value by soiling; or
- there is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land.
- indicative examples include playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short-term car parks and roads.

5.1.22. The sensitivity assigned to each receptor is provided in Table 14.

Table 14: Receptor Sensitivity

Receptor Ref	Receptor name	Pathway Effectiveness
H1	Cefn Cottage	High
H2	Cefn Farm	High
H3	Sale Farm	High
H4	Green Farm	High
H5	Whitehouse Farm	High
H6	Methodist Church, Buttington	Medium
H7	Cefn Village	High
H8	Speed Welshpool	Medium
AW1	Ancient Woodland 1	Low
AW2	Ancient Woodland 2	Low

Estimation of the Magnitude of Dust Effects

5.1.23. Table 15, reproduced from Table 3 of the IAQM Guidance, shows the matrix for the assessment of the Magnitude of Dust Effects. Table 16 shows the results of the assessment of Magnitude of Dust Effects for each receptor, based on the Receptor sensitivity and the Dust Impact Risk for each receptor.

Table 15:Descriptors for Magnitude of Dust Effects

	Receptor Sensitivity		
	Low	**Medium**	**High**
High Risk	Slight Adverse Effect	Moderate Adverse Effect	Substantial Adverse Effect
Medium Risk	Negligible Effect	Slight Adverse Effect	Moderate Adverse Effect
Low Risk	Negligible Effect	Negligible Effect	Slight Adverse Effect
Negligible Risk	Negligible Effect	Negligible Effect	Negligible Effect

Table 16: Assessment of the Magnitude of Dusk Effects for Each Receptor

Receptor Ref	Receptor name	Dust Impact Risk	Sensitivity	Magnitude of Dust Effects
H1	Cefn Cottage	Negligible Risk	High	Negligible Effect
H2	Cefn Farm		High	
H3	Sale Farm		High	
H4	Green Farm		High	
H5	Whitehouse Farm		High	
H6	Methodist Church, Buttington		Medium	
H7	Cefn Village		High	
H8	Speed Welshpool		Medium	
AW1	Ancient Woodland 1		Low	
AW2	Ancient Woodland 2		Low	

5.2. ASSESSMENT OF PM_{10} HEALTH IMPACTS

5.2.1. The UK air quality objectives for particulate matter with cross-sectional diameter of less than 10 micrometres (PM_{10}) are as follows:

- 50µg/m^3 - the 24-hour mean is not permitted to exceed the concentration of 50µg/m^3 up to 35 times a year (90.41st percentile); and
- 40µg/m^3 – annual mean.

5.2.2. Section 5.2 of the IAQM Mineral Dust guidance gives the following five steps for assessing the health impact of PM_{10} emissions:

1. Determine the existing background ambient concentration of PM_{10};
2. Estimate the expected PC of PM_{10} at the sensitive receptors that comes from the site activities. In many cases, this can be done semi-quantitatively, using published estimates of the likely PM_{10} addition locally from this type of activity;
3. Estimate the total predicted environmental concentration (PEC) by adding the PC and background PM_{10} concentration;
4. Compare the PEC with the annual mean objective for PM_{10}; and
5. Determine the overall PM_{10} impact on the surrounding area. The significance of this overall PM_{10} impact (i.e. whether it is “significant” or “not significant”) is determined using professional judgement.

5.2.3. The background concentrations of PM_{10} are discussed in Table 5 a value of 12.21µg/m^3 is considered to be reflective of the background concentrations in the area.

5.2.4. The IAQM mineral dust guidance suggests that: *“If the long-term background PM_{10} concentration is less than 17µg/m^3 there is little risk that the Process Contribution (PC) would lead to an exceedance of the annual-mean objective and such a finding can be put forward qualitatively, without the need for further consideration, in most cases”.*

5.2.5. The IAQM Mineral Dust guidance states that: *"Mineral type can dictate the potential influence on PM_{10}. Extraction of material with a high moisture content, such as sand and gravel, can potentially generate a smaller impact than the percussive processes associated with hard rock. "*

5.2.6. Table A2-6 of the guidance shows a graph of indicative site contribution of PM_{10} from quarry operations, by mineral type. Whilst this graph does not specifically mention mudstone it does consider opencast coal. Typical coal bearing formations such as the South Wales Coal Measures contain interbedded mudstones and siltstones as well as coal bearing strata. Considering all lithologies are excavated during the opencast process, it is considered that the data for opencast coal could be used as the most representative of on-site geology. The concentrations of PM_{10} from opencast coal in Table A2-6 are negligible, less than 1 $\mu g/m^3$.

5.2.7. The total PEC at the sensitive receptor locations is therefore predicted to be less than 13.21$\mu g/m^3$ for all receptors. This is well below the annual average air quality objective for PM_{10}.

5.2.8. For PM_{10} receptor sensitivity, there is a similar general set of criteria as for disamenity dust. Residential receptors, schools, etc. should be classed as having high sensitivity, most places of work would be considered to have medium sensitivity, and areas of transient exposure, such as footpaths, parks, etc. should be assigned low sensitivity. Therefore, all of the residential receptors would be classed as having 'High' sensitivity, with Buttington Methodist Church, Speed Welshpool be classed as having 'Medium' sensitivity.

5.2.9. It is considered to be highly unlikely that emissions from onsite activities would lead to any exceedances of the annual mean objective, and the PM_{10} health impacts at all receptors are considered to be insignificant.

5.2.10. There is no ecological standard for PM_{10} therefore impacts on the two ancient woodland sites have not been considered.

6. ASSESSMENT OF CUMULATIVE IMPACTS

6.1.1. IAQM Mineral Dust guidance states that "Where the mineral development is an extension of an existing site, is close to another mineral site, or other dust generating sources, the cumulative impacts may need to be considered."

6.1.2. The site is part of an existing quarrying operation, once the earthworks have been completed, and the site access constructed, there will cease to be any quarrying activity within the Development Site.

6.1.3. During the initial 6 months of extraction there is the potential that around 10,000-20,000m^3 could be removed from the existing quarrying operations located near the proposed new site access. This is a very low extraction rate and given that these operations are currently on-going with no history of dust complaints then it is considered that cumulative effects are unlikely to lead to a significant impact on the identified receptors.

8. Conclusion

8.1.1. An air quality assessment has been carried out to support the planning application for the earthworks at Buttington Quarry, Welshpool.

8.1.2. A screening assessment was carried out to assess the need for a more detailed assessment, for general air quality impacts. These impacts were screened out at this stage for the earthworks element of the Development.

8.1.3. A second screening assessment was carried out to assess the need for a detailed assessment of deposited dust and fugitive PM_{10} impacts of emissions from the site. These impacts were not screened out, so a detailed assessment of dust impacts was carried out.

8.1.4. The dust impact assessment considered two types of emissions:

- Large deposited particles, commonly referred to as 'dust', which have the potential to cause annoyance, disamenity, or ecological harm due to the deposition of dust onto surfaces; and
- Small particulate matter, with a cross-sectional diameter of less than 10 micrometres (PM_{10}), which are inhalable, and therefore pose a risk to human health.

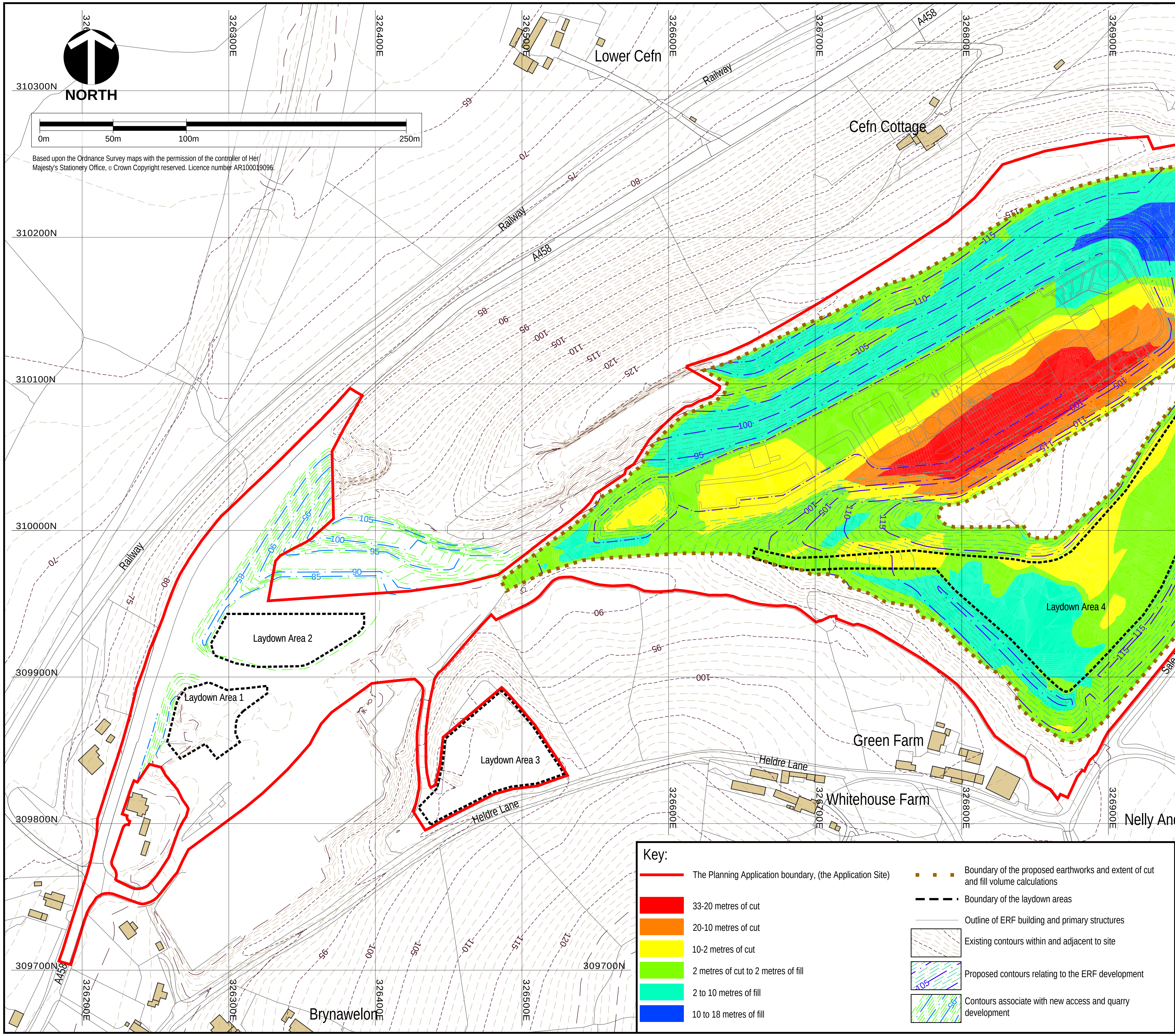
8.1.5. The assessment methodology was based on the IAQM Mineral Dust guidance, with reference to other guidance where relevant.

8.1.6. Regarding deposited dust, the detailed assessment results in an assessment of the magnitude of the likely residual dust effects for each individual receptor; a Negligible effect was predicted for all sensitive receptors.

8.1.7. Regarding PM_{10} health effects, the site is not close to an Air Quality Management Area (AQMA), and the annual average background levels of PM_{10} are relatively low. The fact that the quarry will be extracting mudstone with no processing means that high Process Contributions are unlikely. It is therefore concluded that the PM_{10} air quality effect is insignificant.

8.1.8. Taking into account the outcomes of the dust assessment, and all of the factors considered during the assessment process, including mitigation measures and cumulative impacts, it is concluded that the overall dust impacts are 'not significant'. A Dust Management Plan is therefore not considered to be required provided that the measures described in the CEMP are implemented.

APPENDIX 1: DRAWINGS
BT1180-D14



Client: BROAD ENERGY

Project: **BUTTINGTON QUARRY**
Proposed Energy Recovery Facility (ERF)

Title: **Cut and Fill Isopachytes**

CAD Ref:	Version:	Drawn by:	Plot size: A3 / Scale:	Plan Origin Date:
BT1180-D14v2	2	RB	Plan 1:2500	November 2020

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Drawing: **BT1180-D14**