Air Quality Assessment of Emissions to Atmosphere Project Vesta Paper Machine WEPA UK Ltd: Bridgend Paper Mill, South Wales

P2612

A Report Prepared for
Earth & Marine Environmental Consultants Ltd

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1 INTRODUCTION

Earth & Marine Environmental Consultants Ltd (EAME) has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an air quality risk assessment of emissions to the atmosphere from the proposed Project Vesta paper machine located at WEPA Bridgend paper mill. The Project Vesta is an exact copy of the Neptune machine that was assessed by SLR in 2020 and is now operating [(1)].

The proposed new paper machine will replace the existing Jupiter machine, which was installed in the 1970s.

The proposed paper machine requires a permit variation to operate. This Air Quality Assessment (AQA) is required to support an application for a variation to the existing Environmental Permit (EPR/EP3738NG) under the Environmental Permitting (England and Wales) Regulations 2016 (SI 2016/1154), as amended (the EPR 2016).

The atmospheric pollutants of concern to this assessment are:

- Oxides of nitrogen (NO_x)
- Carbon monoxide (CO)

However, carbon monoxide (CO) has been screened out for the following reasons and is not considered further:

- There is no carbon monoxide (CO) released to the atmosphere from the proposed Vesta paper machine.
- There is no emission limit set for carbon monoxide (CO).
- The impact on air quality of emissions of carbon monoxide (CO) from the existing gas boilers measured in 2025 of less than 2 mg Nm^{-3}, which will have a negligible impact.

The sources of emissions to the atmosphere of concern to this assessment are:

- A11 (Neptune paper machine)
- A14 and A15 (boilers)
- A17 (Proposed Vesta paper machine)

This assessment considers the following three Scenarios:

- Current emissions (A11, A14 and A15).
- Proposed emissions (A17)
- Current + Proposed emissions (A11, A14, A15 and A17)

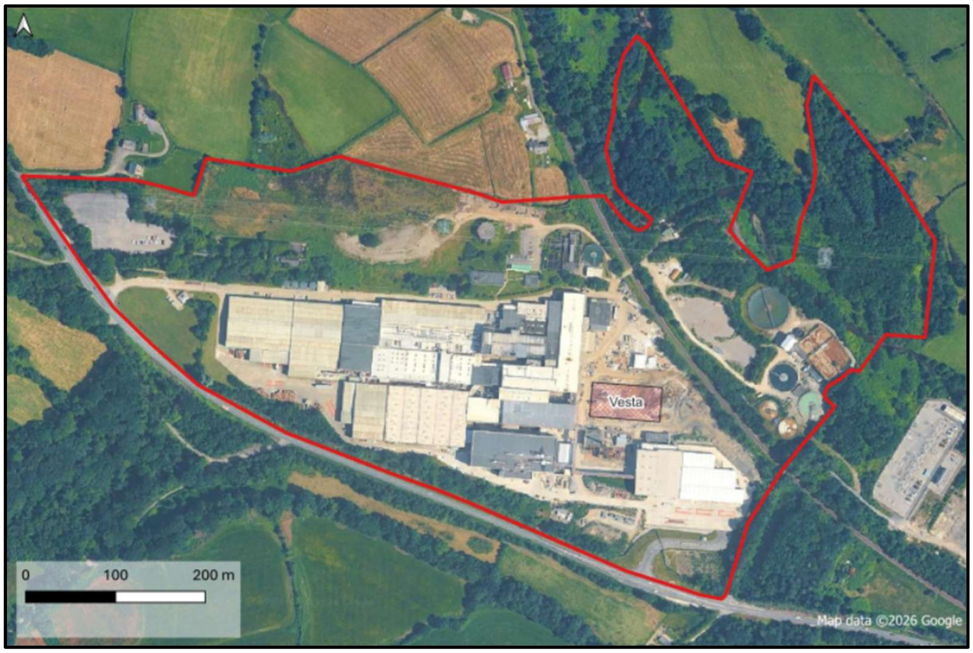
No consideration is taken for the reduction in emissions that will occur because of the decommissioning of the Jupiter paper machine.

(1) SLR (Feb 2020) Air Quality Impact Assessment Bridgend Paper Mill

This assessment assumes continuous full-load operation.

Figure 1.1 shows the location of the Bridgend Paper Mill site boundary (red line) and the proposed Vesta paper machine building.

Figure 1.1 Location of Proposed Vesta Paper Machine and Site Boundary (Red Line)



The ADMS 6.0 dispersion model has been used to make predictions of ground-level concentrations of the oxides of nitrogen (NO_x).

The remainder of this report is structured as follows:

- Section 2: describes the assessment criteria
- Section 3: presents and assesses the existing air quality
- Section 4: describes the modelling methodology
- Section 5: assessment of impacts
- Section 6: Sensitivity analysis
- Section 7: provides a summary and conclusions

About the Author

This air quality assessment and report was prepared by David Harvey, MBA BSc FIAQM, who has 30 years of experience in air quality. Mr Harvey is a Director of ADM Ltd, a company he founded in 1997 and is a Fellow of the Institute of Air Quality Management (FIAQM). Fellowship is for '*professionals who have had a distinguished career in the field of air quality*'.

2 ASSESSMENT AND SIGNIFICANCE CRITERIA

2.1 INTRODUCTION

This section presents the relevant air quality legislation and guidance. Also presented is a description of the pollutants assessed and the assessment and significance levels.

2.2 LEGAL CONTEXT AND GUIDANCE

2.2.1 EUROPEAN LEGISLATION

Local authorities currently have no statutory obligation to assess air quality against European limit values, which have been transposed into UK law, but are encouraged to do so. To assist with longer-term planning and the assessment of development proposals in their local areas, Defra's Technical Guidance LAQM TG22 for Local Authorities provides guidance on assessing against the timeframe of the European limit values (which are transposed into UK legislation) (1).

Air Quality (Wales) Regulations 2000, as amended by the Air Quality (Wales) (Amendment) Regulations 2002, air quality objectives which, in most cases, are numerically synonymous with the European limit values.

These regulations are part of the broader framework for managing air quality across the UK. The key provisions of the regulations are:

Objective Setting: The regulations set specific objectives for the concentration of certain pollutants in ambient air at levels deemed safe for public health and the environment.

Monitoring Requirements: The regulations establish requirements for monitoring air quality in designated air quality management areas (AQMAs) across Wales.

Action Plans: Where air quality objectives are not being met, local authorities must develop and implement action plans to improve air quality within AQMAs.

Review and Reporting: The regulations require regular review and reporting on air quality by local authorities.

2.2.2 NATIONAL LEGISLATION AND GUIDANCE

Section 80 of the Environment Act 1995 requires the UK Government and the devolved governments of Scotland and Wales to prepare a national air quality strategy containing standards, objectives and measures for improving ambient air quality, and to keep that strategy under review. The first Air Quality Strategy was published in 1997 and was subsequently updated, with the last joint Air Quality Strategy for Wales published in 2007.

(1) DEFRA (August 2022) Local Air Quality Management, Technical Guidance (TG22).

In 2023, the Welsh Government completed the first statutory review of the National Air Quality Strategy for Wales, following amendments introduced by the Environment Act 2021. The review concluded that the 2007 Air Quality Strategy no longer reflected Wales' ambitions for improving air quality. Consequently, the Welsh Government formally replaced the 2007 Strategy with the Clean Air Plan for Wales: Healthy Air, Healthy Wales (published in 2020) as the National Air Quality Strategy for Wales, while retaining the existing air quality objectives.

The Clean Air Plan for Wales sets the strategic direction for improving air quality across a range of policy areas and supports action to reduce the impacts of air pollution on public health, biodiversity, the natural environment and the economy. It remains the current national air quality strategy for Wales and is supported by progress updates and by the legislative framework established through the Environment (Air Quality and Soundscapes) (Wales) Act 2024, which introduces new powers and duties to further improve air quality in Wales.

2.2.3 DEVELOPMENT CONTROL: PLANNING FOR AIR QUALITY

In January 2017, the Institute for Air Quality Management (IAQM) and Environmental Protection UK (EPUK) published an update to its guidance document that contains a framework for air quality consideration to be accounted for in local development control [1]. The EPUK/IAQM guidance has been considered when undertaking this assessment. This guidance is currently being updated by IAQM but is not yet available.

This guidance has been included, given that it can be useful, in addition to the guidance for assessment provided by the Environment Agency (EA) and Natural Resources Wales (NRW).

2.2.4 PLANNING POLICY

Given that this assessment is required to support an application for a permit variation from Natural Resources Wales (NRW), National and local planning policies are not directly relevant and are therefore not included.

(1) IAQM (2017) Land-Use Planning & Development Control: Planning for Air Quality.

2.3 DESCRIPTION OF POLLUTANTS

2.3.1 NITROGEN DIOXIDE (NO_2)

Where road traffic is the dominant source of air pollution, which is usually the case in urban environments, Local Authorities have found that the objectives for nitrogen dioxide (NO_2) and particulate matter (PM_{10}) are the most difficult to achieve. It is also generally the case that where annual average concentrations of nitrogen dioxide (NO_2) and particulate matter (PM_{10}) meet their respective objectives and where there are no significant local sources of air pollution, concentrations of all other pollutants in the air quality strategy will also be achieved.

Nitrogen dioxide (NO_2) is a reddish-brown gas (at sufficiently high concentrations). It occurs as a result of the oxidation of nitric oxide (NO), which in turn originates from the combination of atmospheric nitrogen (N_2) and oxygen (O_2) during combustion processes. In terms of ground-level concentrations in many parts of the United Kingdom, nitrogen dioxide (NO_2) concentrations are dominated by emissions from road transport.

The Air Quality Standards (Wales) Regulations 2010 transpose the requirements of the Ambient Air Quality Directive (2008/50/EC) and the Fourth Daughter Directive (2004/107/EC) into Welsh legislation. The Regulations establish limit values, target values, objectives, critical levels and exposure reduction targets for the protection of human health and the environment.

Table 2.1 shows the assessment criteria used to assess the impacts on human health.

Table 2.1 Air Quality Standards Regulations 2010 Limit Values; Air Quality Assessment Level (AQAL)

Substance	Averaging time	Assessment Criteria ($\mu g\ m^{-3}$)
Nitrogen dioxide (NO_2)	Annual mean	40
	99.8th percentile of hourly means	200

The Critical Levels for protecting vegetation and ecosystems are shown in **Table 2.2.**

Table 2.2 Critical Levels for Protection of Vegetation and Ecosystems

Substance	Averaging time	Assessment Criteria ($\mu g\ m^{-3}$)
Oxides of Nitrogen (NO_x)	Annual mean	30
	Daily mean	75

2.4 SIGNIFICANCE CRITERIA

The impact refers to the change predicted to occur to the prevailing environment due to the proposed installation, often referred to as the process contribution (PC).

The significance of an impact is generally determined by the combination of the sensitivity and/or 'value' of the affected environmental receptor and the predicted 'extent' and/or 'magnitude' of the impact or change. The impact descriptors used in this assessment are taken from the IAQM/EPUK guidance for planning and air quality [1]. The assessment of significance ultimately relies on professional judgement, although comparing the extent of the impact with criteria and standards specific to each environmental topic can guide this judgement.

Details of impact descriptors used in this assessment are shown in **Table 2.3.** It should be noted that the IAQM/EPUK impact descriptors refer to permanent changes in air quality brought about by a development and not short-term or temporary changes. They also refer to locations with relevant exposure and not necessarily the location of the maximum impact. The criteria, therefore, are only appropriate for changes to annual average concentrations at locations where there is relevant exposure, ie not generally the point of maximum impact.

Table 2.3 IAQM/EPUK Air Quality Impact Descriptors for Individual Receptors

Long-term Average Concentration at Receptor in Assessment Year	% Change in Concentration Relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL [a]	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
102%-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial
Note: Changes less than 0.5% are Negligible. (a) Air Quality Assessment Level (AQAL).				

The IAQM guidance on significance shown in **Table 2.3** is only applicable to

(1) IAQM (May 2017) Land-Use Planning & Development Control: Planning for Air Quality.

long-term/annual average impacts where there is relevant exposure.

For short-term impacts, the IAQM guidance states:

‘Where such peak short-term concentrations from an elevated source are in the range 11-20% of the relevant AQAL, then their magnitude can be described as small, those in the range 21-50% medium and those above 51% as large. These are the maximum concentrations experienced in any year and the severity of this impact can be described as slight, moderate and substantial respectively.’

National Resources Wales (NRW) states that the H1 risk assessment software tool developed by the Environment Agency (EA) can be used (1).

The H1 risk assessment guidance includes a two-stage test for the insignificance of impacts:

Stage 1:

The H1 guidance states that the process contribution (PC) can be considered as insignificant if both of the following are achieved:

- The long-term PC is <1% of the long-term Environmental Assessment Level (EAL)
- The short-term PC is < 10% of the short-term Environmental Assessment Level (EAL)

The H1 guidance states:

If you meet both of these criteria you don’t need to do any further assessment of the substance. If you don’t meet them you need to carry out a second stage of screening to determine the impact of the PEC.

Stage 2:

The H1 guidance states that detailed modelling of emissions is needed for emissions that do not meet both of the following requirements:

- The long-term PEC is less than 70% of the long-term EAL
- The short-term PC is less than 20% of the short-term EAL minus twice the long-term background concentration

This is not to say that if these thresholds are exceeded, the process contribution (PC) is significant, just that it cannot be ruled out as being insignificant.

For protected conservation areas the guidance states:

If your emissions that affect SPAs, SACs, Ramsar sites or SSSIs meet both of the following criteria, they’re insignificant - you do not need to assess them any further:

(1) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit .

- *the short term PC is less than 10% of the short term environmental standard for protected conservation areas*
- *the long term PC is less than 1% of the long term environmental standard for protected conservation areas*

If you do not meet these requirements you need to calculate the PEC and check the PEC against the standard for protected conservation areas.

You do not need to calculate PEC for short term targets.

If your short term PC exceeds the screening criteria of 10%, you need to do detailed modelling.

If your long term PC is greater than 1% and your PEC is less than 70% of the long term environmental standard, the emissions are insignificant – you do not need to assess them any further.

If your PEC is greater than 70% of the long term environmental standard, you need to do detailed modelling.

When there are local nature sites within the specified distance (2 km)

If your emissions meet both of the following criteria they're insignificant – you do not need to assess them any further:

- *the short term PC is less than 100% of the short term environmental standard for protected conservation areas*
- *the long term PC is less than 100% of the long term environmental standard for protected conservation areas*

3 AMBIENT AIR QUALITY DATA

3.1 INTRODUCTION

This section describes the ambient air quality in the region of the paper mill.

Bridgend County Borough Council has designated one Air Quality Management Area (AQMA) within its administrative area: the Park Street, Bridgend AQMA. Because the Park Street AQMA is located 8 km south of the paper mill, it is not considered relevant to this assessment.

3.2 MEASURED DATA

Bridgend County Borough Council measures ambient nitrogen dioxide (NO_2) concentrations at several locations, including three within 5 km of the paper mill.

Table 3.1 shows the measured annual average concentration of nitrogen dioxide (NO_2) from 2021 to 2024, along with the OS grid reference and distance from the installation. All three of these monitoring locations are classified as 'roadside'.

Table 3.1 Measured Annual Average Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$) for 2021 to 2024

Reference No: Station Name Distance (km) OS Grid Reference	OBC-128: Mill Street, Maesteg 3.3 km 286218,189805	OBC-130: Mason Arms 4.5 km 291386,184168	OBC-125: Commercial St, 4.9 km 285299,191136
2021	16.8	31.1	9.8
2022	8.8	29.0	14.5
2023	-	25.8	20.8
2024	-	24.8	13.1
Air Quality Assessment Level (AQAL)		**40**	

Source: Bridgend CBC: Bridgend (September 2025) 2025 Air Quality Progress Report

Table 3.1 shows that the measured annual average concentration of nitrogen dioxide (NO_2) is in the range of 8.8 to 31.1 $\mu g\ m^{-3}$, less than the Air Quality Assessment Level (AQAL) of 40 $\mu g\ m^{-3}$. It is, however, considered that none of these roadside monitoring sites are in locations representative of the paper mill, given its rural location.

3.3 ESTIMATED BACKGROUND CONCENTRATIONS

The Department for Environment, Food and Rural Affairs (Defra) provides estimates of the background concentrations for several pollutants for many years on a 1 km grid resolution for the whole of the UK. The OS grid reference closest to the paper mill's proposed paper machine is 287500,187500.

Table 3.2 shows the Defra estimated background annual average background pollutant concentrations for grid receptors locations less than 2 km from the Vesta stack location.

Table 3.2 Estimated Annual Average Background Pollutant Concentrations for 2026 ($\mu g\ m^{-3}$)

OS Grid Reference (x, y)		Distance to Vesta Stack (km)	Annual Average	
			Nitrogen Dioxide (NO_2)	Oxides of Nitrogen (NO_x)
288500	187500	0.6	5.7	7.2
287500	**187500**	**0.7**	**10.1**	**13.2**
288500	186500	0.8	5.1	6.4
287500	186500	0.8	5.2	6.5
288500	188500	1.5	5.7	7.2
287500	188500	1.5	5.9	7.4
289500	187500	1.5	4.9	6.2
286500	187500	1.6	5.2	6.5
289500	186500	1.6	4.8	6.0
286500	186500	1.6	5.0	6.2
288500	185500	1.7	4.8	6.0
287500	185500	1.7	4.8	6.0
Maximum			**10.1**	**13.2**
Minimum			**4.8**	**6.0**
Average			**5.6**	**7.1**
Air Quality Assessment Levels (AQALs)			**40**	**30**

Table 3.2 shows that all the estimated background annual average concentrations of the oxides of nitrogen (NO_x) and nitrogen dioxide (NO_2) are considerably less than the Air Quality Assessment Levels (AQALs).

Given that there is some variation in the estimated background concentration, this assessment uses the maximum estimated background concentration within 2 km, which is grid receptor 287500, 187500. This is a conservative approach to the assessment.

4 METHODOLOGY

4.1 INTRODUCTION

This section describes the methodology and assumptions made for the air quality assessment and the emissions data used.

The atmospheric pollutant of concern to this assessment is oxides of nitrogen (NO_x)/nitrogen dioxide (NO_2).

The sources of emissions to the atmosphere of concern to this assessment are

- A11 (Neptune paper machine)
- A14 and A15 (boilers)
- A17 (Proposed Vesta paper machine)

This assessment considers the following three Scenarios:

- Current emissions (A11, A14 and A15).
- Proposed emissions (A17)
- Current + Proposed emissions (A11, A14, A15 and A17)

4.2 EMISSIONS DATA

Table 4.1 shows the parameters that describe the physical properties of emissions from each source, as required for defining the emissions in dispersion modelling terms.

The existing sources are modelling at their measured emissions concentrations. The proposed Vesta paper machine is modelled at its emission limit of 40 mg Nm^{-3} for the oxides of nitrogen (NO_x). The emissions data are from stack emission monitoring undertaken in 2025 (1).

(1) Anchem (14/11/25) Test Report ALL111790/25/PR-1. Anchem (19/11/25) Test Report ALL111787/25/PR-2 and ALL111788/25/PR-2

Table 4.1 Emissions and Physical Properties

	Existing			Proposed
	A11: Neptune	**A14: Gas Boiler 1**	**A15: Gas Boiler 2**	**A17: Vesta**
Number of Flues	1	1	1	1
Fuel	-	Gas	Gas	-
OS Grid Reference (x, m)	287882	287930	287930	288009
OS Grid Reference (y, m)	187036	187021	187021	187086
Release height above ground level (m)	30.4	30	30	27.1
Actual volumetric flow rate per flue ($Am^3\ hr^{-1}$)	40,680	11,600	13,754	40,680
Actual volumetric flow rate per flue ($Am^3\ s^{-1}$)	11.3	3.2	3.8	11.3
Exhaust gas water (H_2O) content (% v/v)	-	12	12	-
Exhaust gas oxygen (O_2) content (% v/v, dry)	-	3.3	3.2	-
Pressure (kPa)	99.0	99.3	99.3	99.0
Flue diameter (m)	0.975	0.645	0.645	0.975
Exit velocity ($m\ s^{-1}$)	15.0	9.7	11.5	15.0
Flue gas emission temperature (deg C)	82	132	139	82
Normalised volumetric flow per flue ($Nm^3\ hr^{-1}$)	30,569 (a)	6,632 (b)	7,773 (b)	30,569 (a)
Normalised volumetric flow per flue ($Nm^3\ s^{-1}$)	8.49 (a)	1.84 (b)	2.16 (b)	8.49 (a)
Oxides of Nitrogen (NO_x) concentration ($mg\ Nm^{-3}$)	30.8 (a)	66.1 (b)	66.5 (b)	40.0 (a)
Oxides of Nitrogen (NO_x) emission rate ($g\ s^{-1}$)	0.26	0.12	0.14	0.34
Oxides of Nitrogen (NO_x) emission rate ($kg\ hr^{-1}$)	0.94	0.44	0.52	1.22
Operation (%)	100	100	100	100

(a) Corrected to: temperature; 273 K; pressure; 101.3kPa (1 atmosphere).
(b) Corrected for: dry air at temperature 273 K; pressure 101.3 kPa (1 atmosphere), 3% O_2 (dry).

The modelling assumes continuous operation.

4.3 RECEPTORS

Predictions of ground-level concentrations are made using a grid of receptors. The receptor grid is 4,000 m by 3,500 m, with a 25 m grid spacing. Predictions using a grid of receptors allow the maximum impact to be determined, and the predicted ground-level concentrations can be presented as contour plots.

For Local Air Quality Management (LAQM), the Air Quality Strategy Objectives (AQS) only apply where there is 'relevant exposure'. This is defined as being where members of the public are regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. For the annual average objective, locations of relevant exposure include residential properties, schools and hospitals.

In addition to predictions made using a grid of receptors, predictions are made at 25 specific receptors selected to represent locations with relevant exposure, such as residential properties. For consistency with previous modelling, the specific receptors used in this assessment are the same as those selected by SLR for their 2020 assessment of emissions from the whole installation (1).

(1) SLR (Feb 2020) Air Quality Impact Assessment Bridgend Paper Mill

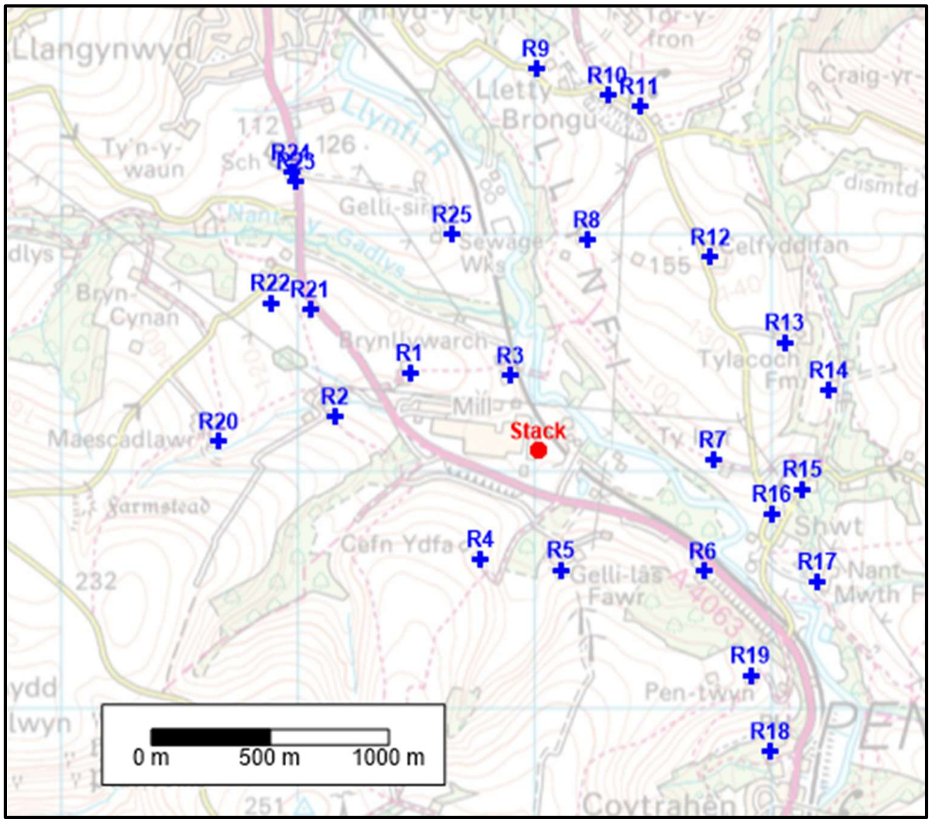
Table 4.2 presents details of the specific receptors included in the modelling selected because of their potential for 'relevant exposure' for human health.

Table 4.2 Human Health Receptor Locations

No.	Description	Distance from Stack (km)	OS Grid Reference (m)
R1	Residential property off A4603	0.6	287469 187416
R2	Residential property off A4603	0.8	287152 187231
R3	Residential property off A4603	0.4	287893 187404
R4	Residential property off A4603	0.4	287767 186631
R5	Residential property off A4603	0.5	288106 186585
R6	Residential property off A4603	0.9	288706 186578
R7	Residential property off Green Field	0.8	288748 187049
R8	Residential property off Green Field	1.0	288216 187979
R9	Residential property at The Brackens	1.7	288001 188702
R10	Residential property at Lletty Brongu	1.6	288303 188589
R11	Residential property at Lletty Brongu	1.6	288437 188542
R12	Residential property off Green Field	1.2	288737 187906
R13	Residential property off Green Field	1.2	289050 187545
R14	Residential property off Green Field	1.3	289237 187344
R15	Residential property off Green Field	1.2	289126 186925
R16	Residential property at Shwt	1.1	288997 186820
R17	Residential property off A4603	1.4	289189 186534
R18	Residential property off Nicholls Rd	1.6	288990 185817
R19	Residential property off A4603	1.3	288905 186139
R20	Residential property off A4603	1.3	286662 187126
R21	Residential property off A4603	1.1	287048 187684
R22	Residential property off A4603	1.2	286881 187713
R23	Residential property off A4603	1.5	286989 188225
R24	School: Ysgol Gyfun Gymraeg	1.6	286968 188263
R25	Residential property off A4603	1.0	287647 188001

Figure 4.1 shows the locations of the human receptors.

Figure 4.1 Location of Human Health Receptors and Vesta Stack Location



In addition to the human health receptors, impacts on ecological sites require consideration.

For impacts on ecological sites, the H1 risk assessment guidance states that assessment is required for the following two groups of ecological sites (1).

Within 2 km of the installation site:

- sites of special scientific interest (SSSIs)
- local nature sites (ancient woods, local wildlife sites and national and local nature reserves)

Within 10 km of the installation site:

- special protection areas (SPAs)
- special areas of conservation (SACs)
- Ramsar sites (protected wetlands)

Figure 4.2 shows the location of the ecological sites within 2 km of the installation and the seven receptors selected to represent the maximum impacts of these sites.

(1) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit .

Figure 4.2 Ecological Sites with 2 km (Red Circle) and Selected Receptors

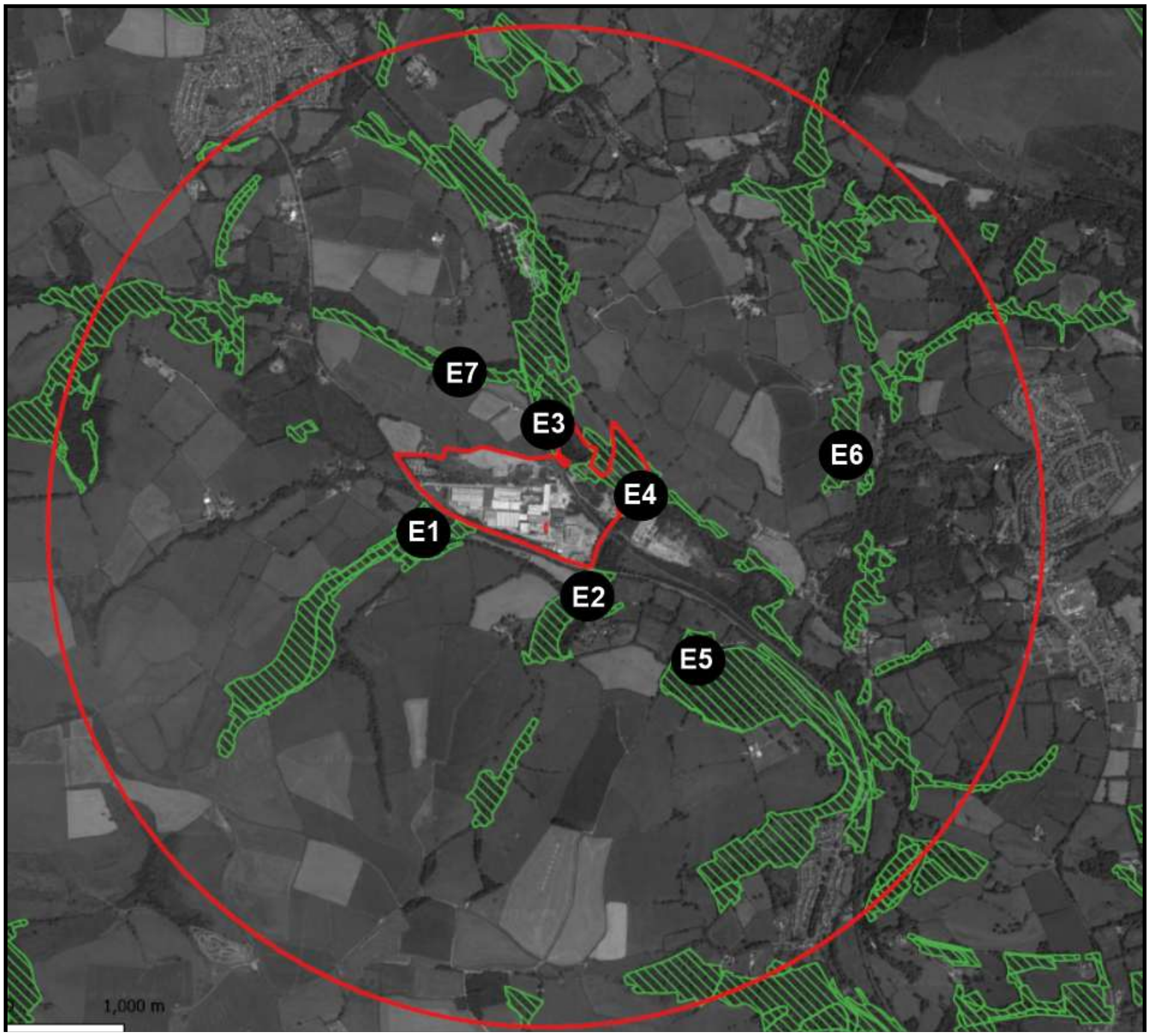
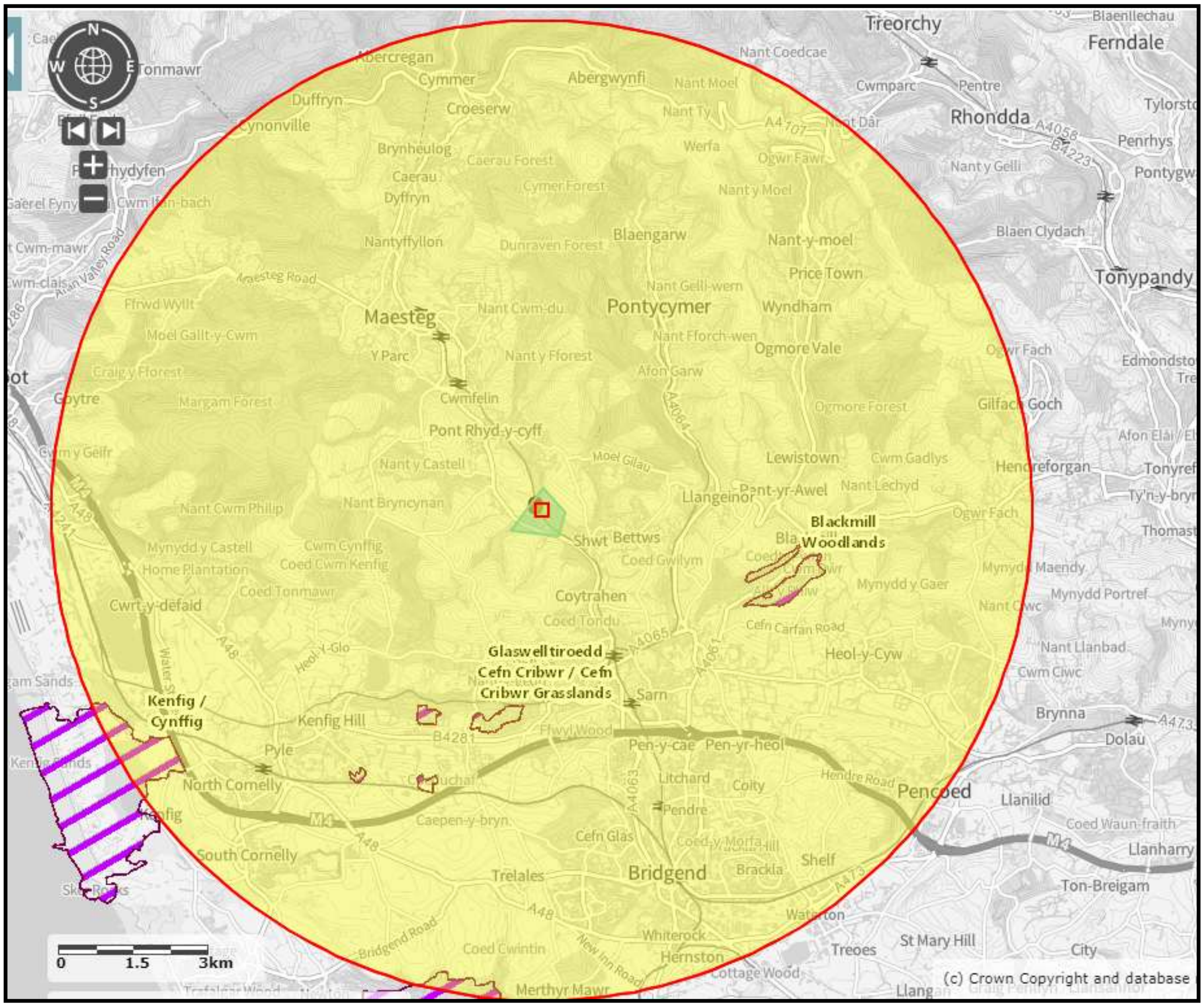


Figure 4.3 shows the relevant ecological sites (SPA, SAC, Ramsar) within 10 km of the installation.

Figure 4.3 SPA, SAC, Ramsar Sites with 10 km (Red Circle)



Source: Magic/defra.gov.uk

Table 4.3 presents details of the specific receptors selected to be representative of the ecological sites within 2 km and 10 km of the installation.

Table 4.3 Ecological Receptor Locations

No.	Description	Distance from Stack (km)	OS Grid Reference (m)	
E1	Ancient woodland	0.4	287528	187071
E2	Ancient woodland	0.3	288132	186820
E3	Ancient woodland	0.3	287973	187376
E4	Ancient woodland	0.3	288258	187085
E5	Ancient woodland	0.7	288490	186594
E6	Ancient woodland	1.2	289088	187268
E7	Ancient woodland	0.7	287643	187686
E8	Kenfig / Cynffig (SAC: coastal grassland – acid)	9.2	280000	182300
E9	Glaswelltiroedd Cefn (SAC: non-med grassland)	3.9	287400	183150
E10	Blackmill Woodlands (SAC: woodland)	4.5	292330	186000

4.4 FACTORS AFFECTING DISPERSION

Several factors will affect how emissions disperse once released into the atmosphere. The four factors having the most significant effect on dispersion are:

- Physical characteristics of the emissions
- Climate
- Terrain
- Building downwash

4.4.1 PHYSICAL CHARACTERISTICS OF THE EMISSIONS

Provided that the exhaust gases have sufficient velocity to overcome the effects of stack tip downwash (which, under most meteorological conditions, is the case for velocities of 10 m s^{-1} or more), the physical characteristics of the flue gases will determine the amount of plume rise and hence the effect on ground level pollutant concentrations. The degree of plume rise depends on the greater of the thermal buoyancy or momentum effects and not necessarily a combination of the two effects.

4.4.2 CLIMATE

The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind speed, wind direction and atmospheric stability.

- **Wind direction** determines the broad transport of the plume and the sector of the compass into which the plume is dispersed.

- **Wind speed** can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise.

- **Atmospheric stability** is a measure of the turbulence of the air, particularly of the vertical motions present. Dispersion models, such as ADMS and AERMOD, do not allocate the degree of atmospheric turbulence into six discrete categories (eg A-F). These models use a parameter known as the Monin-Obukhov length, which, together with the wind speed, describes the atmosphere's stability.

4.4.3 BUILDING DOWNWASH

The presence of buildings can significantly affect the dispersion of atmospheric emissions. Wind blowing around a building distorts the flow and creates greater turbulence zones than if the building were absent. Increased turbulence causes greater plume mixing; the rise and trajectory of the plume may be depressed generally by the flow distortion. For elevated releases such as from stacks, building downwash leads to higher ground-level concentrations closer to the stack than those present if a building was not there. The effects of building downwash are usually only significant where the buildings are more than about 40% of the stack height.

The zone of influence is related to the dimensions of the buildings and is typically a horizontal distance of five times the building height.

Figure 4.4 shows the location and heights of buildings that will affect dispersion from the proposed Vesta paper machine.

Figure 4.4 **Location and Heights of Buildings that Will Affect Dispersion from the Proposed Vesta Stack**

Table 4.4 shows the dimensions of the buildings included in the modelling.

Table 4.4 Dimensions of Buildings Included in the Modelling

Building	Centre (m)		Height (m) [a]	Length (m)	Width (m)	Angle (deg) [b]
Vesta	288000	187101	24.1	80.2	40.0	92
Bale Handling	288041	187023	15.4	51.9	59.3	92
Dept A Pilp Storage	288104	187019	9.6	72.5	54.7	92
Boiler House	287936	187040	8.5	17.4	22.4	92
Neptune Dep C	287880	187040	25.0	92.5	40.0	92
Jupiter MC House	287895	187086	20.0	122	27.5	92
JRS Warehouse D	287932	187170	15.0	24.2	110	92
Main Store	287965	187197	4.6	35.8	35.6	92

(a) Height above ground level.
(b) Angle building length makes to the north.

Section 6 includes a sensitivity analysis of the model-predicted concentration to building downwash effects.

4.4.4 NATURE OF THE SURFACE

Terrain

The effects of elevated terrain can affect dispersion and have been included in the modelling.

Roughness

The nature of the surface can have a significant influence on dispersion by affecting the vertical velocity profile (ie the rate of increase in wind speed for increasing heights above ground level). The amount of atmospheric turbulence also affects dispersion.

Considering the site's surrounding nature, the dispersion modelling has assumed a surface roughness length of 0.5 m.

Section 6 includes a sensitivity analysis of the model-predicted concentration to surface roughness.

4.5 SELECTION OF SUITABLE DISPERSION MODEL

The dispersion models widely used to predict ground-level pollutant concentrations are based on the concept of the time-averaged lateral and vertical concentration of pollutants in a plume being characterised by a Gaussian [(1)] distribution. Older models, such as ISC, characterise the atmosphere into several discrete stability classes. Dispersion models such as ADMS and AERMOD have been developed, which replace the description of the atmospheric boundary layer as being composed of discrete stability classes with an infinitely variable measure of the surface heat flux, which in turn

(1) A Gaussian distribution has the appearance of a bell-shaped curve. The maximum concentration occurs on the centre line.

influences the turbulent structure of the atmosphere and hence the dispersion of a plume.

Two commercially available dispersion models described by the Environment Agency (EA) as being 'new generation' are:

- AERMOD: The US **A**merican Meteorological Society and **E**nvironmental Protection Agency **R**egulatory Model **I**mprovement Committee developed the dispersion **MOD**del called AERMOD, which incorporates the latest understanding of the atmospheric boundary layer.

- Atmospheric Dispersion Modelling System (ADMS): This dispersion model was developed by the UK consultancy CERC. The model allows for the skewed nature of turbulence within the atmospheric boundary layer.

In many respects, the models are quite similar and generate comparable predictions of ground-level concentrations in many situations.

The ADMS 6.0 dispersion model was selected for use in this assessment because it has been extensively validated and widely used for assessment work of this nature.

4.6 METEOROLOGICAL DATA

An essential input to the dispersion model is the meteorological data.

Cardiff Airport (22 km) is the closest observation station where complete data is available, while St Athan is at a similar distance (25 km). Given that both observing stations are located close to the coast and at a lower elevation than the site, there is doubt over how representative either data set would be. This assessment, therefore, uses Numerical Weather Prediction (NWP) data, which is increasingly being used, especially for locations where there are concerns about how representative observed data are. Five years of hourly NWP meteorological data used for this assessment are from 2021 to 2025.

Figure 4.5 shows the windrose for the 2021 to 2025 NWP meteorological data used in this assessment.

Figure 4.5 **Wind Rose from the NWP Data (2021-2025)**

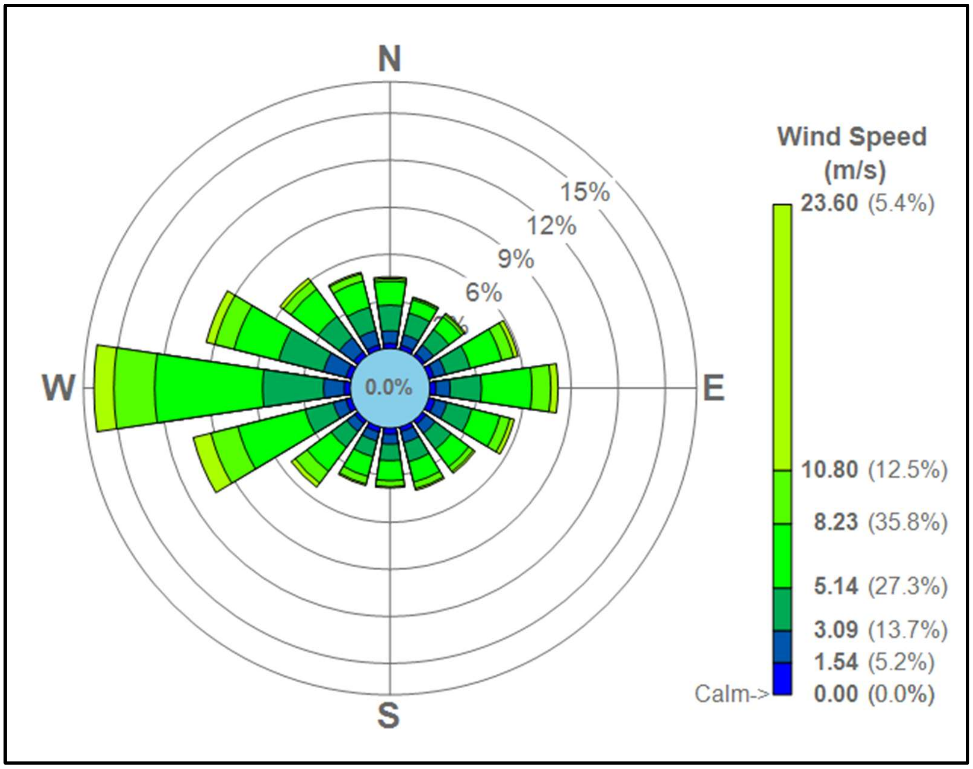


Figure 4.5 shows that the prevailing wind direction is from the west, which will transport emissions to the east.

Section 6 includes a sensitivity analysis of model-predicted concentrations to meteorological data.

4.7 PERCENTAGE OXIDATION OF NITRIC OXIDE (NO) TO NITROGEN DIOXIDE (NO_2)

Oxides of nitrogen (NO_x) emitted to the atmosphere due to gas combustion will consist mainly of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, nitric oxide (NO) is oxidised to nitrogen dioxide (NO_2), which concerns human health and other environmental impacts. The proportion of nitric oxide oxidised to nitrogen dioxide depends on several factors, and the oxidation is limited by the availability of oxidants, such as ozone (O_3).

Oxidation of 50% has been assumed for nitric oxide (NO) oxidation to nitrogen dioxide (NO_2) for short-term concentrations. For predictions of annual averages, it is assumed that 100% of nitrogen (NO_x) oxides are in the form of nitrogen dioxide (NO_2). These assumptions are recommended by the Environment Agency (EA) and are considered to be conservative [1].

(1) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#detailed-modelling.

5 PREDICTIONS AND ASSESSMENT OF IMPACTS

5.1 INTRODUCTION

This section presents the incremental increase in ground-level concentrations predicted to occur due to emissions to the atmosphere from the operation of the Vesta paper machine. The incremental increase is referred to as the Process Contribution (PC). The Process Contribution (PC) + the prevailing background concentration is the Predicted Environment Concentration (PEC). Modelling is also undertaken of the existing sources to provide baseline impact from the installation. Also, modelled is the baseline plus the proposed Vesta paper machine.

This assessment considers the following three Scenarios:

- Scenario 1: Current emissions (A11, A14 and A15).
- Scenario 2: Proposed emissions, Vesta paper machine (A17)
- Scenario 3: Current + Proposed emissions (A11, A14, A15 and A17)

It should be noted that this assessment does not take into account the reduction in emissions due to the decommissioning of the Jupiter paper machine.

5.2 MODELLING AND ASSESSMENT OF EMISSIONS

5.2.1 HUMAN HEALTH

Table 5.1 shows the predicted annual average ground-level Process Concentration (PC) of nitrogen dioxide (NO_2) at the specific receptors and at the point of maximum off-site impact for each of the five years of meteorological data, from the proposed Vesta paper machine. The Predicted Environmental Concentrations (PEC) are also shown.

Table 5.1 Vesta Paper Machine (Scenario 2): ADMS 6.0 Predicted Process Contribution (PC) and Predicted Environmental Concentration (PEC) Annual Average Ground Level Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$) (a)

Location	Process Contribution (PC)						Max PEC (b)	Stage 1 Test Maximum PC as %age of AQAL (%)	Stage 2 Test Maximum PEC as %age of AQAL
	2021	2022	2023	2024	2025	Max.			
R1	0.09	0.10	0.09	0.10	0.13	**0.13**	10.2	0.3%	26%
R2	0.07	0.07	0.06	0.06	0.10	**0.10**	10.2	0.3%	26%
R3	0.17	0.24	0.21	0.23	0.27	**0.27**	10.4	0.7%	26%
R4	0.07	0.09	0.06	0.07	0.05	**0.09**	10.2	0.2%	25%
R5	0.09	0.10	0.08	0.11	0.08	**0.11**	10.2	0.3%	26%
R6	0.11	0.09	0.09	0.10	0.08	**0.11**	10.2	0.3%	26%
R7	0.20	0.20	0.25	0.23	0.20	**0.25**	10.3	0.6%	26%
R8	0.03	0.03	0.03	0.03	0.03	**0.03**	10.1	0.1%	25%
R9	0.01	0.02	0.01	0.01	0.02	**0.02**	10.1	0.0%	25%
R10	0.01	0.02	0.01	0.01	0.01	**0.02**	10.1	0.0%	25%
R11	0.01	0.02	0.01	0.01	0.01	**0.02**	10.1	0.0%	25%
R12	0.03	0.03	0.03	0.03	0.02	**0.03**	10.1	0.1%	25%
R13	0.05	0.05	0.06	0.05	0.05	**0.06**	10.2	0.1%	25%
R14	0.07	0.07	0.08	0.08	0.07	**0.08**	10.2	0.2%	25%
R15	0.11	0.11	0.13	0.13	0.11	**0.13**	10.2	0.3%	26%
R16	0.13	0.12	0.15	0.15	0.13	**0.15**	10.3	0.4%	26%
R17	0.08	0.07	0.08	0.08	0.07	**0.08**	10.2	0.2%	25%
R18	0.04	0.03	0.03	0.03	0.02	**0.04**	10.1	0.1%	25%
R19	0.05	0.04	0.04	0.04	0.03	**0.05**	10.1	0.1%	25%
R20	0.04	0.03	0.03	0.03	0.05	**0.05**	10.1	0.1%	25%
R21	0.04	0.04	0.04	0.04	0.05	**0.05**	10.2	0.1%	25%
R22	0.03	0.04	0.03	0.04	0.05	**0.05**	10.1	0.1%	25%
R23	0.02	0.02	0.03	0.03	0.03	**0.03**	10.1	0.1%	25%
R24	0.02	0.02	0.03	0.03	0.03	**0.03**	10.1	0.1%	25%
R25	0.04	0.04	0.04	0.05	0.05	**0.05**	10.2	0.1%	25%
Receptor Maximum	**0.20**	**0.24**	**0.25**	**0.23**	**0.27**	**0.27**	**10.4**	**0.7%**	**26%**
Off-Site Grid Maximum	**1.38**	**1.42**	**1.72**	**1.62**	**1.43**	**1.72**	**11.8**	**4.3%**	**30%**
NRW Stage 1 and Stage 2 Long-Term Screening Thresholds								1%	70%
Air Quality Assessment Level (AQAL)						**40**			

(a) Assuming 100% oxidation of oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2).
(b) Predicted Environmental Concentration (PEC) = PC + background of 10.1 $\mu g\ m^{-3}$.

Table 5.1 shows that the maximum predicted annual average ground-level Process Contribution (PC) at any of the specific receptors of nitrogen dioxide (NO_2) is 0.27 $\mu g\ m^{-3}$, which is 0.7% of the long-term Air Quality Assessment Level (AQAL) of 40 $\mu g\ m^{-3}$. Given that the maximum PC with relevant exposure is less than 1% of the Air Quality Assessment Level (AQAL), it is screened out as insignificant using the EA/NRW Stage 1 screening test for insignificance.

The EA/NRA long-term test for insignificance is not applicable at locations where there is no ‘relevant exposure’.

The IAQM/EPUK significance criteria apply to locations with relevant exposure and only apply to annual average concentrations. Defra's TG22 guidance gives the following examples of where there is relevant exposure to annual average objectives:

- Building facades of residential properties
- Schools
- Hospitals
- Care homes

Examples of where there is no relevant exposure to annual average objectives include; gardens of residential properties, hotels, and kerbside sites.

The IAQM/EPUK impact description is '*negligible*' at all the receptor locations with relevant exposure to annual average concentration (eg residential properties).

Table 5.2 shows the predicted annual average ground-level Process Concentration (PC) of nitrogen dioxide (NO_2) at the specific receptors and at the point of maximum off-site impact for the maximum of five years of meteorological data, the process contribution (PC) are presented for each of the three scenarios modelled.

Table 5.2 ADMS 6.0 Predicted Process Contribution (PC) and Predicted Environmental Concentration (PEC) Annual Average Ground Level Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$) Maximum for Five years of Meteorological Data [(a)]

Location	Scenario 1: Baseline (A11, A14, A15)	Scenario 2: Process Contribution (A17)	Scenario 3: Cumulative Impact (A11, A14, A15, A17)	Predicted Environmental Concentration (PEC) Scenario 3 + Background [(b)]	Process Environmental Concentration (PEC) as %age of AQAL (%)
R1	0.18	0.13	0.30	10.4	26%
R2	0.16	0.10	0.26	10.4	26%
R3	0.30	0.27	0.56	10.7	27%
R4	0.19	0.09	0.28	10.4	26%
R5	0.21	0.11	0.32	10.4	26%
R6	0.18	0.11	0.29	10.4	26%
R7	0.28	0.25	0.53	10.6	27%
R8	0.04	0.03	0.08	10.2	25%
R9	0.02	0.02	0.04	10.1	25%
R10	0.02	0.02	0.04	10.1	25%
R11	0.02	0.02	0.04	10.1	25%
R12	0.04	0.03	0.08	10.2	25%
R13	0.07	0.06	0.13	10.2	26%
R14	0.10	0.08	0.18	10.3	26%
R15	0.17	0.13	0.31	10.4	26%
R16	0.21	0.15	0.36	10.5	26%
R17	0.12	0.08	0.20	10.3	26%
R18	0.05	0.04	0.09	10.2	25%
R19	0.07	0.05	0.12	10.2	26%
R20	0.08	0.05	0.13	10.2	26%
R21	0.07	0.05	0.13	10.2	26%
R22	0.06	0.05	0.11	10.2	26%
R23	0.04	0.03	0.07	10.2	25%
R24	0.04	0.03	0.06	10.2	25%
R25	0.07	0.05	0.12	10.2	26%
Receptor Maximum	**0.30**	**0.27**	**0.56**	**10.7**	**27%**
Off-Site Grid Maximum	**1.88**	**1.72**	**3.06**	**13.2**	**33%**
Air Quality Assessment Level (AQAL)				**40**	

(a) Assuming 100% oxidation of oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2).
(b) Predicted Environmental Concentration (PEC) = PC + background of 10.1 $\mu g\ m^{-3}$.

Table 5.2 shows that the maximum predicted off-site annual average ground-level Process Contribution (PC) increases from 1.88 $\mu g\ m^{-3}$ to 3.06 $\mu g\ m^{-3}$ (an increase of 1.18 $\mu g\ m^{-3}$) as a consequence of the proposed Vesta paper machine.

Table 5.3 shows the predicted 99.8th percentile of hourly average Process Contribution (PC) at the specific receptors at the point of maximum off-site impact for each of the five years of meteorological data from the proposed Vesta paper machine. The Predicted Environmental Concentrations (PEC) are also shown.

Table 5.3 Vesta Paper Machine (Scenario 2): ADMS 6.0 Predicted Process Contribution (PC) and Predicted Environmental Concentration (PEC) 99.8th Percentile of Hourly Average Ground Level Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$) (a)

Location	Process Contribution (PC)						Stage 1 Test Maximum PC as %age of (AQAL) (%)	Stage 2 Test Maximum PC as %age of (AQAL-2 * background) (%) (b)
	2021	2022	2023	2024	2025	Max.		
R1	1.2	1.4	1.3	1.3	1.4	**1.4**	0.7%	0.8%
R2	0.7	0.8	0.7	0.7	0.7	**0.8**	0.4%	0.4%
R3	3.1	2.9	3.1	2.9	3.2	**3.2**	1.6%	1.8%
R4	1.4	1.4	1.4	1.4	1.4	**1.4**	0.7%	0.8%
R5	1.2	1.2	1.2	1.2	1.2	**1.2**	0.6%	0.7%
R6	0.8	0.7	0.7	0.8	0.8	**0.8**	0.4%	0.5%
R7	0.9	0.9	1.0	0.9	0.9	**1.0**	0.5%	0.5%
R8	0.7	0.6	0.7	0.6	0.5	**0.7**	0.4%	0.4%
R9	0.3	0.3	0.3	0.3	0.3	**0.3**	0.2%	0.2%
R10	0.4	0.3	0.3	0.3	0.3	**0.4**	0.2%	0.2%
R11	0.4	0.3	0.4	0.3	0.3	**0.4**	0.2%	0.2%
R12	0.5	0.5	0.5	0.6	0.4	**0.6**	0.3%	0.3%
R13	0.6	0.6	0.6	0.6	0.5	**0.6**	0.3%	0.4%
R14	0.6	0.5	0.5	0.6	0.5	**0.6**	0.3%	0.3%
R15	0.6	0.6	0.6	0.6	0.6	**0.6**	0.3%	0.3%
R16	0.8	0.8	0.8	0.8	0.7	**0.8**	0.4%	0.5%
R17	0.7	0.7	0.6	0.7	0.6	**0.7**	0.4%	0.4%
R18	0.5	0.4	0.5	0.5	0.4	**0.5**	0.2%	0.3%
R19	0.6	0.5	0.6	0.6	0.5	**0.6**	0.3%	0.3%
R20	0.4	0.4	0.3	0.4	0.4	**0.4**	0.2%	0.2%
R21	0.7	0.8	0.9	0.9	0.8	**0.9**	0.4%	0.5%
R22	0.6	0.7	0.7	0.8	0.7	**0.8**	0.4%	0.4%
R23	0.5	0.6	0.6	0.5	0.5	**0.6**	0.3%	0.3%
R24	0.5	0.6	0.6	0.6	0.5	**0.6**	0.3%	0.3%
R25	0.8	0.7	0.8	0.8	0.8	**0.8**	0.4%	0.5%
Receptor Maximum	**3.1**	**2.9**	**3.1**	**2.9**	**3.2**	**3.2**	**1.6%**	**1.8%**
Off-Site Grid Maximum	**7.2**	**7.1**	**6.4**	**6.6**	**7.3**	**7.3**	**3.6%**	**4.0%**
NRW Stage 1 and Stage 2 Short-Term Screening Thresholds							**10%**	**20%**
Air Quality Assessment Level (AQAL)						**200**		
(a) Assuming 50% oxidation of the oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2).								
(b) AQAL minus twice annual average background (200 – (2 * 10.1)) = 179.8 $\mu g\ m^{-3}$.								

Table 5.3 shows that the maximum predicted 99.8th percentile of hourly average nitrogen dioxide (NO_2, PC) is 7.3 $\mu g\ m^{-3}$, which is 3.6% of the Air Quality

Assessment Level (AQAL) of 200 μg m^{-3}.

The EA/NRA short-term test for insignificance applies to all off-site locations.

Given that the off-site grid maximum PC is less than 10% of the short-term Air Quality Assessment Level (AQAL), it is screened out as insignificant using the EA/NRW screening criteria.

The IAQM/EPUK impact description is '*negligible'* at all the receptor locations with relevant exposure to short-term concentrations.

Table 5.4 shows the predicted 99.8th percentile ground-level Process Concentration (PC) of nitrogen dioxide (NO_2) at the specific receptors, and at the point of maximum off-site impact for the maximum of five years of meteorological data, the process contribution (PC) for each of the three scenarios modelled.

Table 5.4 ADMS 6.0 Predicted Process Contribution (PC) and Predicted Environmental Concentration (PEC) 99.8th Percentile Ground Level Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$) Maximum for Five years of Meteorological Data [(a)]

Location	Scenario 1: Baseline (A11, A14, A15)	Scenario 2: Process Contribution (A17)	Scenario 3: Cumulative Impact (A11, A14, A15, A17)	Increase Due to Proposed Vesta Paper Machine	Increase as Percentage of AQAQL (%)
R1	2.41	1.40	3.30	0.9	0.4%
R2	1.25	0.76	1.97	0.7	0.4%
R3	3.43	3.19	5.35	1.9	1.0%
R4	2.75	1.42	3.99	1.2	0.6%
R5	2.18	1.25	2.89	0.7	0.4%
R6	1.15	0.82	1.90	0.7	0.4%
R7	1.22	0.96	2.13	0.9	0.5%
R8	0.92	0.75	1.57	0.6	0.3%
R9	0.48	0.32	0.81	0.3	0.2%
R10	0.50	0.39	0.94	0.4	0.2%
R11	0.52	0.39	0.92	0.4	0.2%
R12	0.77	0.57	1.32	0.5	0.3%
R13	0.77	0.64	1.39	0.6	0.3%
R14	0.79	0.59	1.37	0.6	0.3%
R15	0.75	0.57	1.33	0.6	0.3%
R16	1.00	0.83	1.79	0.8	0.4%
R17	1.08	0.73	1.72	0.6	0.3%
R18	0.73	0.48	1.17	0.4	0.2%
R19	0.94	0.60	1.45	0.5	0.3%
R20	0.61	0.36	0.94	0.3	0.2%
R21	1.32	0.87	1.96	0.6	0.3%
R22	0.98	0.75	1.56	0.6	0.3%
R23	0.93	0.57	1.55	0.6	0.3%
R24	0.91	0.56	1.50	0.6	0.3%
R25	1.16	0.83	1.99	0.8	0.4%
Receptor Maximum	3.43	3.19	5.35	1.9	1.0%
Off-Site Grid Maximum	9.58	7.26	13.09	3.5	1.8%
Air Quality Assessment Level (AQAL)				**200**	

(a) Assuming 50% oxidation of oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2).

Table 5.4 shows that the proposed Vesta paper machine is predicted to increase the maximum off-site 99.8th percentile hourly average concentration of nitrogen dioxide (NO_2) by 3.5 $\mu g\ m^{-3,}$ which is 1.8% of the Air Quality Assessment Level (AQAL) of 200 $\mu g\ m^{-3}$.

Tables 5.1 to 5.4 show that predicted Process Contribution (PC) concentrations of nitrogen dioxide (NO_2) occurring due to emissions from the proposed paper machine operating at its emissions limit are insignificant and not of concern to human health.

The following figures illustrate the distribution of nitrogen dioxide (NO_2) concentration. The year of meteorological data used gives rise to the highest off-site impact (2023 for the annual average and 2025 for the 99.8th percentile). The predictions are for the Process Contributions (PC).

- **Figure 5.1;** Scenario 2: Vesta Paper Machine annual average
- **Figure 5.2:** Scenario 3: Combined impact, annual average
- **Figure 5.3**; Scenario 2: Vesta Paper Machine 99.8th %ile hourly averages
- **Figure 5.4**; Scenario 3: Combined impact 99.8th %ile hourly averages

The figures show that peak predicted increments to ground-level concentrations occur within about 100 m of the installation.

Figure 5.1 Vesta Paper Machine (Scenario 2): ADMS 6.0 Predicted Annual Average Ground Level Process Contribution (PC) of Nitrogen Dioxide (NO_2); 2023 Meteorological Data ($\mu g\ m^{-3}$); Assuming 100% Oxidation

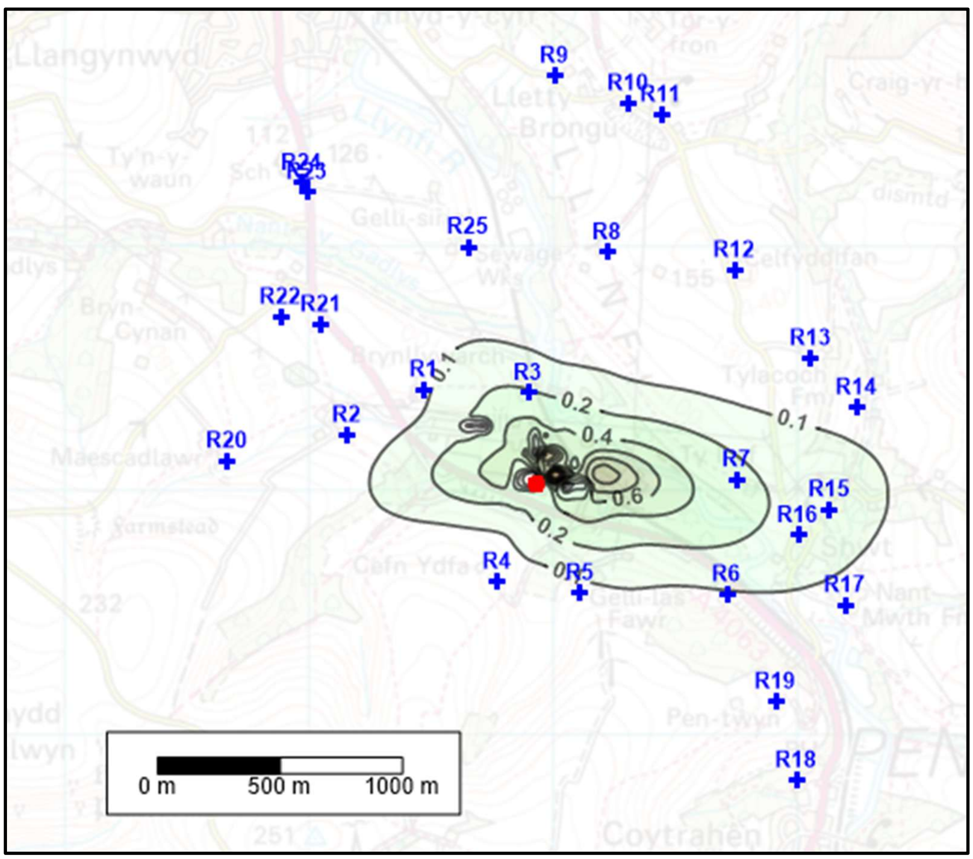


Figure 5.2 Combined Impact (Scenario 3): ADMS 6.0 Predicted Annual Average Ground Level Process Contribution (PC) of Nitrogen Dioxide (NO_2); 2023 Meteorological Data (μg m^{-3}); Assuming 100% Oxidation

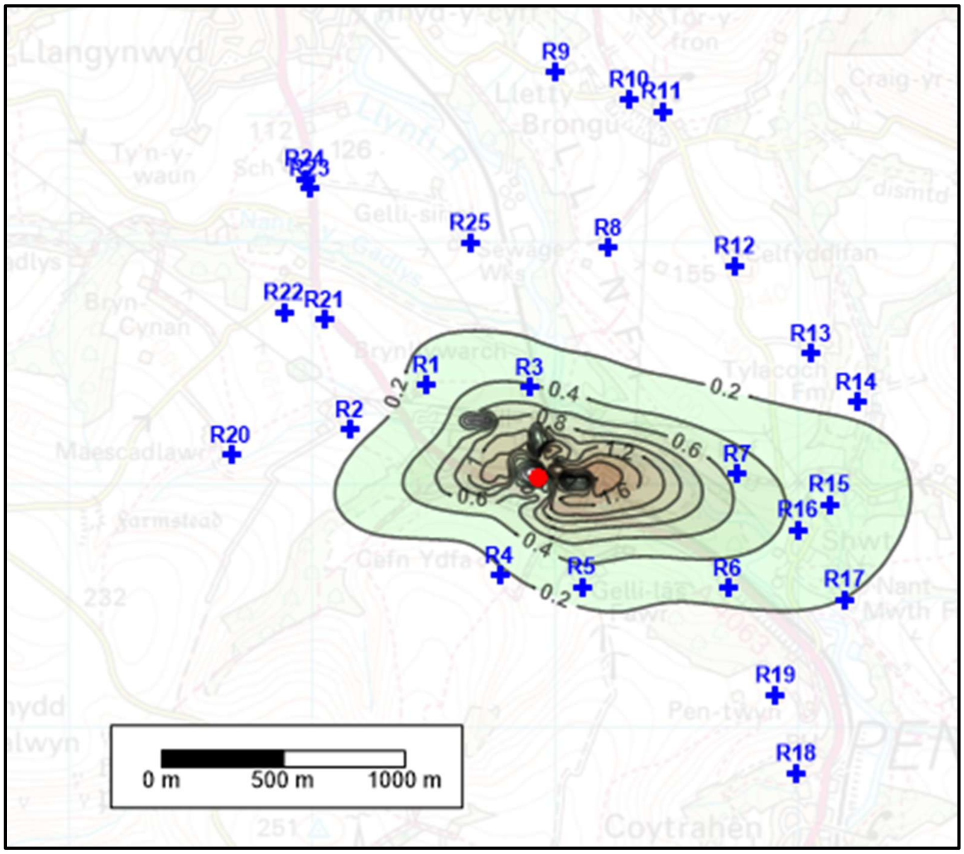


Figure 5.3 Vesta Paper Machine (Scenario 2): ADMS 6.0 Predicted 99.8th Percentile of Hourly Average Ground Level Process Contribution (PC) Concentrations of Nitrogen Dioxide (NO_2); 2025 Meteorological ($\mu g\ m^{-3}$); Assuming 50% Oxidation

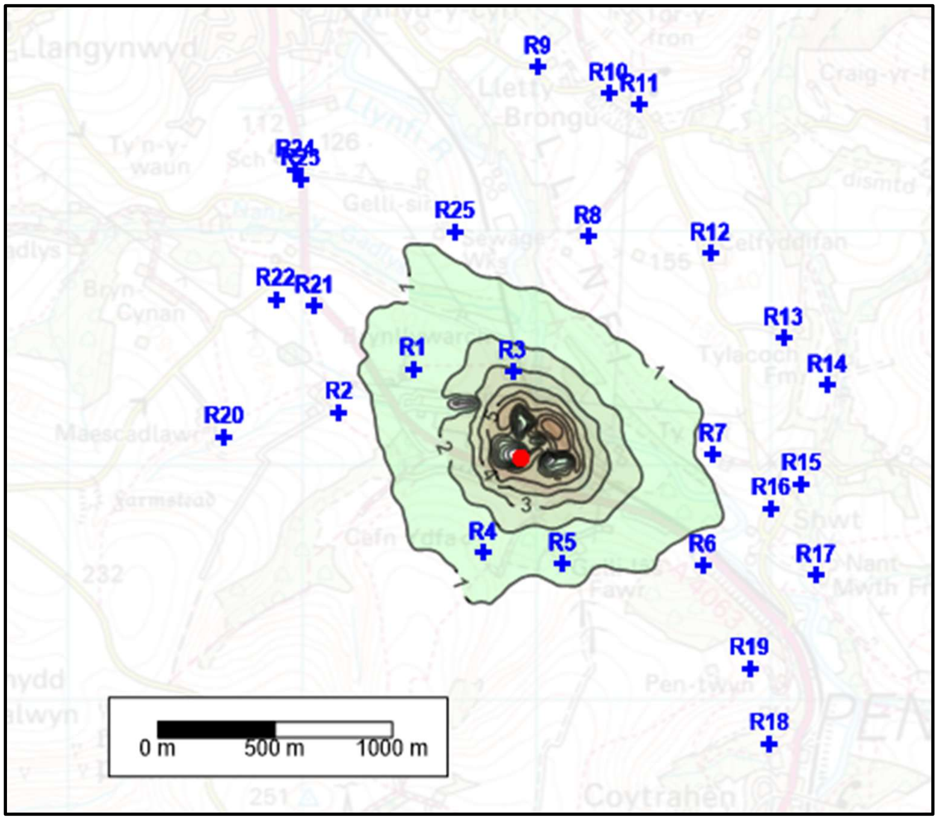
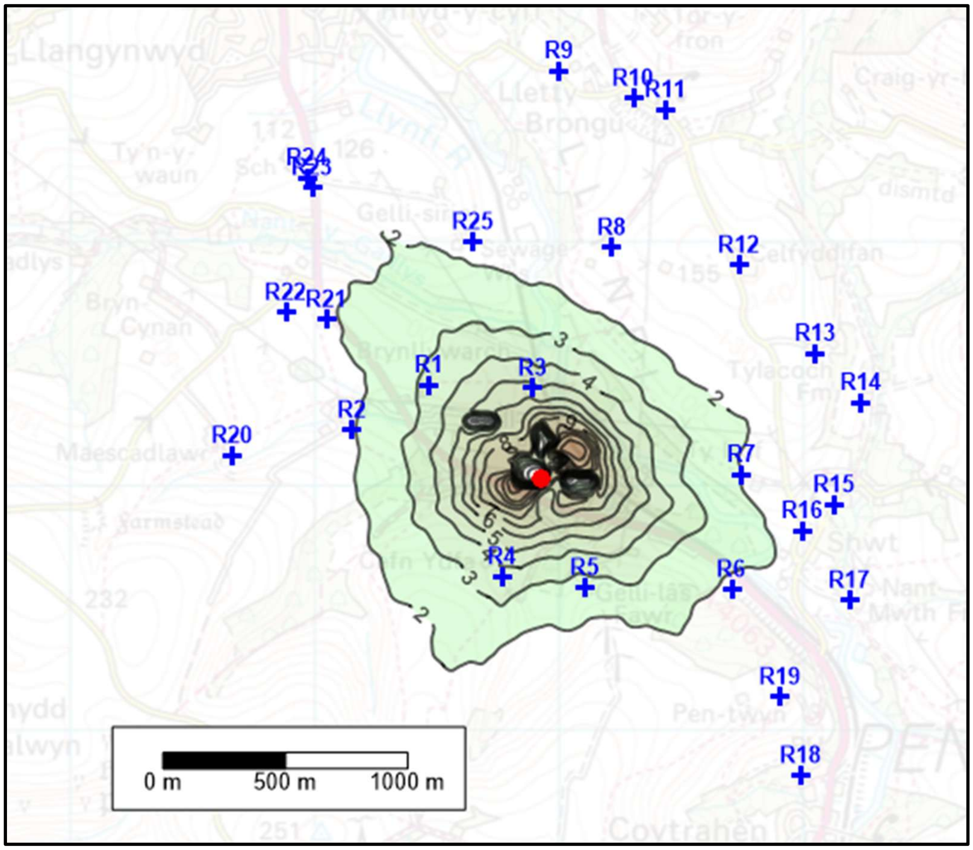


Figure 5.4 Combined Impact (Scenario 3): ADMS 6.0 Predicted 99.8th Percentile of Hourly Average Ground Level Process Contribution (PC) Concentrations of Nitrogen Dioxide (NO_2); 2025 Meteorological (μg m^{-3}); Assuming 50% Oxidation



5.2.2 VEGETATION AND ECOSYSTEMS

Critical Levels

Table 5.5 shows the predicted annual average ground-level Process Concentration (PC) of nitrogen oxides (NO_x) at the ecological sites.

Table 5.5 Vesta Paper Machine (Scenario 2): ADMS 6.0 Predicted Process Contribution (PC) and Predicted Environmental Concentration (PEC) Annual Average Ground Level Concentrations of Oxides of Nitrogen (NO_x, $\mu g\ m^{-3}$)

Location	Process Contribution (PC)						Predicted Environmental Concentration (PEC) [(a)]	Maximum PC as Percentage of AQAL (%)
	2021	2022	2023	2024	2025	Max.		
E1 (Woodland)	0.23	0.21	0.22	0.17	0.30	**0.30**	13.5	1.0%
E2 (Woodland)	0.28	0.27	0.27	0.31	0.22	**0.31**	13.5	1.0%
E3 (Woodland)	0.21	0.30	0.22	0.25	0.30	**0.30**	13.5	1.0%
E4 (Woodland)	0.82	0.86	1.00	0.94	0.85	**1.00**	14.2	3.3%
E5 (Woodland)	0.12	0.09	0.09	0.10	0.08	**0.12**	13.3	0.4%
E6 (Woodland)	0.09	0.09	0.10	0.10	0.08	**0.10**	13.3	0.3%
E7 (Woodland)	0.07	0.08	0.08	0.09	0.09	**0.09**	13.3	0.3%
E8 (SAC)	0.00	0.00	0.00	0.00	0.00	**0.00**	13.2	0.0%
E9 (SAC)	0.00	0.01	0.00	0.00	0.00	**0.01**	13.2	0.0%
E10 (SAC)	0.01	0.01	0.01	0.01	0.01	**0.01**	13.2	0.0%
Air Quality Assessment Level (AQAL)						**30**		
(b) Predicted Environmental Concentration (PEC) = PC + background of 13.2 $\mu g\ m^{-3}$.								

Table 5.6 presents the predicted 24-hour average ground-level Process Concentration (PC) of nitrogen oxides (NO_x) at the ecological sites resulting from emissions from the proposed Vesta Paper machine.

Table 5.6 Vesta Paper Machine: ADMS 6.0 Predicted Process Contribution (PC) and Predicted Environmental Concentration (PEC) 24-Hour Average Ground Level Concentrations of Oxides of Nitrogen (NO_x, $\mu g\ m^{-3}$)

Location	Process Contribution (PC)						Predicted Environmental Concentration (PEC) [(a)]	Maximum PC as Percentage of AQAL (%)
	2021	2022	2023	2024	2025	Max.		
E1 (Woodland)	2.16	2.44	2.00	2.12	2.32	**2.44**	28.8	3.3%
E2 (Woodland)	2.97	3.60	4.16	3.27	2.79	**4.16**	30.6	5.5%
E3 (Woodland)	2.66	3.37	3.02	3.15	3.89	**3.89**	30.3	5.2%
E4 (Woodland)	4.03	3.93	3.82	4.31	4.08	**4.31**	30.7	5.7%
E5 (Woodland)	1.00	0.76	1.29	0.82	0.81	**1.29**	27.7	1.7%
E6 (Woodland)	0.70	0.56	0.54	0.57	0.49	**0.70**	27.1	0.9%
E7 (Woodland)	1.01	0.83	1.44	0.78	1.27	**1.44**	27.8	1.9%
E8 (SAC)	0.08	0.08	0.05	0.03	0.05	**0.08**	26.5	0.1%
E9 (SAC)	0.09	0.07	0.12	0.09	0.10	**0.12**	26.5	0.2%
E10 (SAC)	0.07	0.07	0.06	0.07	0.08	**0.08**	26.5	0.1%
Air Quality Assessment Level (AQAL)						**75**		
(a) Defra guidance TG4(00); NO_x max 24 Hour + 2 x annual average NO_2 background (13.1 $\mu g\ m^{-3}$).								

Consideration of Special Areas of Conservation (SAC)

The NWR/EA guidance states:

If your emissions that affect SPAs, SACs, Ramsar sites or SSSIs meet both of the following criteria, they're insignificant - you do not need to assess them any further:

- *the short term PC is less than 10% of the short term environmental standard for protected conservation areas*
- *the long term PC is less than 1% of the long term environmental standard for protected conservation areas*

Table 5.5 and **Table 5.6** show that the maximum predicted short-term PC at three SACs is 0.2%, and the maximum predicted long-term PC is 0.0% of the environmental standards. Therefore, the predicted impacts on Critical Levels at the SACs are insignificant and do not need further assessment.

Consideration of Ancient Woodlands

The NWR/EA guidance states:

When there are local nature sites within the specified distance (2 km)

If your emissions meet both of the following criteria they're insignificant – you do not need to assess them any further:

- *the short term PC is less than 100% of the short term environmental standard for protected conservation areas*
- *the long term PC is less than 100% of the long term environmental standard for protected conservation areas*

Table 5.5 and **Table 5.6** show that the maximum predicted short-term PC at any local nature site is 5.7%, and the maximum predicted long-term PC is 3.3% of the environmental standards. Therefore, the predicted impacts on Critical Levels at local nature sites are insignificant and do not need further assessment.

Critical Loads

There are critical loads for eutrophication (ecosystem response to the addition of artificial or natural substances) and for acidification.

Table 5.7 shows the Environment Agency (EA) dry deposition velocities used in this assessment [1].

(1) Environment Agency (March 2014); AQTAG06; Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air.

Table 5.7 Dry Deposition Velocities (m s^{-1})

Pollutant	Grassland	Forest
Nitrogen Dioxide (NO_2)	0.0015	0.003

Table 5.8 shows the annual average deposition rates at each ecological site for nitrogen dioxide (NO_2), it is assumed that wet deposition is insignificant.

Table 5.8 Nitrogen Dioxide (NO_2) Estimated Annual Average Deposition Rate ($\mu g\ m^{-2}\ s^{-1}$)

No.	Description	Land Type	Deposition Rate ($\mu g\ m^{-2}\ s^{-1}$)
E1	Ancient woodland	Forest	0.000897
E2	Ancient woodland	Forest	0.000937
E3	Ancient woodland	Forest	0.000899
E4	Ancient woodland	Forest	0.002996
E5	Ancient woodland	Forest	0.000349
E6	Ancient woodland	Forest	0.000291
E7	Ancient woodland	Forest	0.000273
E8	Kenfig/Cynffig (SAC: coastal grassland acid)	Grassland	0.000005
E9	Glaswelltiroedd Cefn (SAC: non-med grassland)	Grassland	0.000008
E10	Blackmill Woodlands (SAC: woodland)	Forest	0.000030

Table 5.9 shows the nutrient nitrogen deposition rates (kg N ha^{-1} $year^{-1}$) at each ecological receptor for nitrogen from nitrogen dioxide (NO_2).

Table 5.9 Estimated Nutrient Nitrogen Deposition Rate (kg N ha^{-1} $year^{-1}$) [(a)]

No.	Description	From NO_2
E1	Ancient woodland	0.086
E2	Ancient woodland	0.090
E3	Ancient woodland	0.086
E4	Ancient woodland	0.29
E5	Ancient woodland	0.033
E6	Ancient woodland	0.028
E7	Ancient woodland	0.026
E8	Kenfig/Cynffig (SAC: coastal grassland acid)	0.00048
E9	Glaswelltiroedd Cefn (SAC: non-med grassland)	0.00081
E10	Blackmill Woodlands (SAC: woodland)	0.0029

(a) Factor used: NO_2 95.9.

Table 5.10 shows the calculated nitrogen deposition rates (Process

Contribution) as a percentage of the critical load range and the total load (ie baseline + additional load).

Table 5.10 Nitrogen Deposition Rate and Critical Loads (Kg N ha^{-1} $year^{-1}$)

	Habitat [(a)]	Critical Load Range Min	Critical Load Range Min	Additional Load (PC)	%age of Critical Load			Baseline Deposition [(b)]	Total (PEC)
E1	Broadleaved, mixed	10	15	0.086	0.57%	-	0.86%	18.6	18.7
E2	Broadleaved, mixed	10	15	0.090	0.60%	-	0.90%	18.6	18.7
E3	Broadleaved, mixed	10	15	0.086	0.57%	-	0.86%	18.6	18.7
E4	Broadleaved, mixed	10	15	0.287	1.92%	-	2.87%	18.6	18.9
E5	Broadleaved, mixed	10	15	0.033	0.22%	-	0.33%	18.7	18.7
E6	Broadleaved, mixed	10	15	0.028	0.19%	-	0.28%	19.0	19.0
E7	Broadleaved, mixed	10	15	0.026	0.17%	-	0.26%	18.8	18.8
E8	Acid Grassland	5	15	0.000	0.00%	-	0.01%	9.4	9.4
E9	Acid Grassland	5	15	0.001	0.01%	-	0.02%	11.5	11.5
E10	Broadleaved, mixed	10	15	0.003	0.02%	-	0.03%	19.4	19.4

(a) The habitat with the lowest critical range has been selected for each location.
(b) Baseline deposition from www.apis.ac.uk

Table 5.10 shows that, as a percentage of the Critical Load, the Process Contribution (PC) is less than 1% at three SACs (Kenfig / Cynffig, Glaswelltiroedd Cefn and Blackmill Woodlands SAC: woodland and therefore insignificant.

For ecological locations other than SPAs, SACs, Ramsar and SSSIs, the Environment Agency (EA) guidance states that no further assessment is required if the PC is less than 100% of the environmental standard for protected conservation areas. In this case, the environmental standard is the Critical Load. As the maximum Process Contribution (PC) as a percentage of the Critical Load is 2.9% (receptor E4), no further assessment is required.

Table 5.11 shows the estimated annual average acid deposition rates (keq ha^{-1} $year^{-1}$) at each ecological receptor for nitrogen (N).

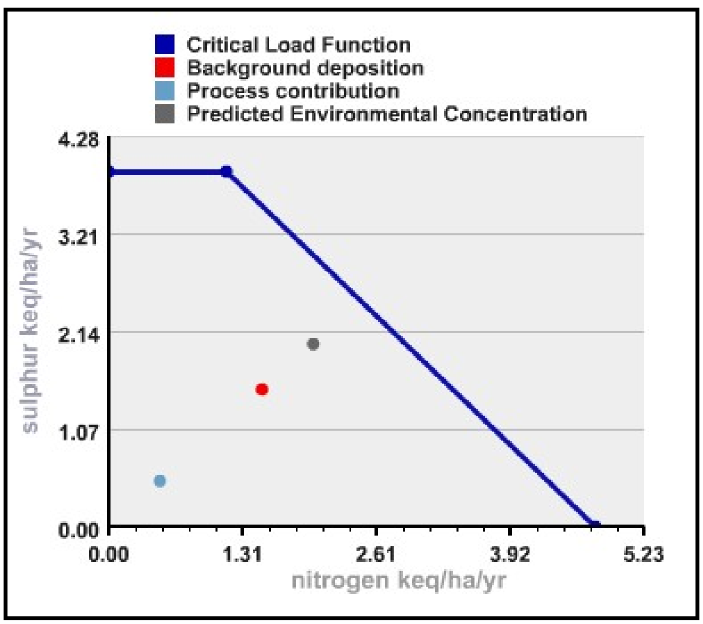
Table 5.11 Estimated Annual Average Acid Deposition Rate (keq ha^{-1} $year^{-1}$) [(a)]

No.	Description	N
E1	Ancient woodland	0.0061
E2	Ancient woodland	0.0064
E3	Ancient woodland	0.0062
E4	Ancient woodland	0.0205
E5	Ancient woodland	0.0024
E6	Ancient woodland	0.0020
E7	Ancient woodland	0.0019
E8	Kenfig/Cynffig (SAC: coastal grassland acid)	0.000034
E9	Glaswelltiroedd Cefn (SAC: non-med grassland)	0.000058
E10	Blackmill Woodlands (SAC: woodland)	0.00021
(a) Factor used; NO_2 6.84		

The critical load function for acidification is defined by three quantities CLmaxS, CLmaxN and CLminN. **Figure 5.5** illustrates how it is possible to compare acid deposition with the critical load function. In this illustration, both the background and the background plus Process Contribution (PC) are below the critical load function line, and therefore, there is no exceedence.

For acidification, the nitrogen (N) and sulphur (S) deposition rates are expressed as 'equivalents', which is a measure of how acidifying a substance can be. The units for N and S deposition are keq ha^{-1} $year^{-1}$.

Figure 5.5 Illustration of Critical Load Function



Source: www.apis.ac.uk

The critical load function for each habitat is available from the APIS website and has been used in this assessment, together with the tool to compare the acidification with the critical load function [1].

This assessment considered critical load functions for the two receptors with the highest impacts for each of the two classes of ecological receptors.

The two receptors given further assessment for critical load function are:

- E4: Ancient woodland
- E10 Blackmill woodland (SAC)

Table 5.12 shows the CLmaxS, CLmaxN and CLminN, which define the critical load function and the baseline deposition rates for E4 and E10.

Table 5.12 Critical Load Function and Baseline Deposition Rates (keq N ha^{-1} year^{-1}) [a]

No.	Description (Features)	Critical Load Function			Baseline Deposition Rate		
		CLmaxS	CLminN	CLmaxN	S	N	Total
E4	Ancient woodland [b]	0.859	0.285	1.144	0.28	1.50	1.67
E10	Blackmill Woodland (SAC) [b]	0.952	0.285	1.237	0.28	1.57	1.73

(a) Source: Air Pollution Information System (APIS) www.apis.ac.uk
(b) Class: Broad-leafed / Coniferous unmanaged woodland.

Table 5.13 shows the additional loading/Process Contribution (PC), the Predicted Environmental Concentration (PEC) and the percentages of these compared to the critical load function for expected emissions. The calculations are made using the APIS critical load function tool.

Table 5.13 Deposition and Deposition as Percentage of Critical Load Function (keg ha^{-1} year^{-1})

No.	Description	Process Contribution (PC)		Total Acid Deposition (S+N)		
		S	N	Process Contribution (PC)	Background	Predicted Environmental Concentration (PEC)
E4	Ancient woodland	0.0000	0.0205	0.02	1.78	1.80
E10	Blackmill Woodland (SAC)	0.0000	0.00021	0.00	1.85	1.85

Table 5.13 shows that, as a percentage of the Critical Load Function, the predicted Process Contribution (PC) to Critical Loads at the Blackmill Woodland SAC (E10) is less than 1% and therefore insignificant. The same applies to receptors E8 and E9, as the impacts are lower than at E10.

(1) Air Pollution Information System (APIS) www.apis.ac.uk.

The maximum predicted process contribution (PCs) to the Critical Load Function at all the local wildlife sites and ancient woodlands (E1 to E7) are less than 100% of the critical levels (maximum is 1.1% for E4) and therefore do not require further assessment

Table 5.13 shows that acid deposition is not of concern to habitats and ecosystems and does not require further assessment.

6 SENSITIVITY ANALYSIS

6.1 INTRODUCTION

This section considers the sensitivity of model-predicted concentrations to the following:

- Meteorological data
- Roughness length
- Grid spacing
- Building downwash
- Terrain
- Stack height

6.2 METEOROLOGICAL DATA

The assessment presented in this report is based on predictions made using five years (2021-2025) of NWP meteorological data.

To illustrate the year-to-year variation in meteorological data, **Table 6.1** shows the maximum predicted off-site ground-level concentration of nitrogen (NO_2) for five years of NWP meteorological data and predictions made with 2023 meteorological data from both St Athan and Cardiff Airport.

Table 6.1 Vesta Paper Machine: ADMS 6.0 Maximum Predicted Off-Site Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$): Effect of Meteorological Data (a)

Year and Source	Annual Average	99.8th Percentile of Hourly Averages
NWP 2021	1.38	7.16
NWP 2022	1.42	7.10
NWP 2023	1.72	6.38
NWP 2024	1.62	6.63
NWP 2025	1.43	7.26
St Athan 2023	1.81	6.61
Cardiff 2023	1.74	6.88
Assessment Criteria	**40**	**200**

(b) Assuming 100% oxidation of the oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2) for the annual average and 50% for 99.8th percentiles

Table 6.1 shows that there is some year-to-year variation in predicted concentrations, although it is not considered to be significant. The maximum predicted annual average concentration using meteorological data from St Athan and Cardiff is higher than that predicted using NWP data; the 99.8th percentiles are similar. The NWP data are considered more representative than either Cardiff or St Athan, given their coastal location.

6.3 ROUGHNESS LENGTH

The roughness length of 0.5 m used in this assessment was selected using professional judgment because roughness length cannot be directly measured. There is no one unique roughness that fits a given wind speed profile in practice. Roughness length will also vary depending on wind direction and other factors, such as the season of the year.

Therefore, it is of interest to see how sensitive the model predictions are to roughness length.

Table 6.2 shows the maximum predicted off-site ground-level concentration of nitrogen dioxide (NO_2) for roughness lengths in the 0.25 m to 0.75 m range using 2023 meteorological data.

Table 6.2 Vesta Paper Machine: ADMS 6.0 Maximum Predicted Off-Site Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, μg m^{-3}): Effect of Roughness Length [(a)]

Roughness Length (m)	Annual Average	99.8th Percentile of Hourly Averages
0.25	1.75	6.01
0.50	**1.72**	**6.38**
0.75	1.67	6.56
Assessment Criteria	**40**	**200**

(a) Assuming 100% oxidation of the oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2) for the annual average and 50% for the 99.8th percentiles.

Table 6.2 shows that increasing roughness length does not significantly affect the maximum predicted off-site concentration.

6.4 BUILDING DOWNWASH AND TERRAIN

The modelling presented in this assessment includes both the effects of building downwash and terrain. **Table 6.3** shows the predicted maximum off-site ground-level concentration of nitrogen dioxide (NO_2) both with and without the effects of building downwash and terrain using 2023 meteorological data.

Table 6.3 Vesta Paper Machine: ADMS 6.0 Maximum Predicted Off-Site Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$) (a)

Building Downwash Effects	Terrain Effects	Annual Average	99.8th Percentile of Hourly Averages
Yes	**Yes**	**1.72**	**6.38**
No	Yes	1.01	2.92
Yes	No	1.81	6.02
No	No	0.66	2.47
Assessment Criteria		**40**	**200**

(a) Assuming 100% oxidation of the oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2) for the annual average and 50% for the 99.8th percentiles.

Table 6.3 indicates that building downwash effects are predicted to have a significant impact on dispersion. The effects of terrain on dispersion are not as significant.

6.5 GRID SPACING

If the grid spacing is too large, the reported maximum concentrations may be less than the actual maximum. This assessment uses a grid spacing of 25 m. One way to demonstrate this is to model with smaller and larger grid spacing. If the maximum concentration is not significantly different, one can be confident that the grid spacing is adequate.

Table 6.4 shows the maximum predicted ground-level concentration of nitrogen dioxide (NO_2) for grid spacing of 12.5 m, 25 m (used in this assessment), and 50 m. Predictions are made using 2023 meteorological data. It should be noted that the presented concentrations are for all locations (i.e., this includes on-site locations).

Table 6.4 Vesta Paper Machine: ADMS 6.0 Maximum Predicted Annual Average and 99.8th Percentile of Hour Average Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$): Effect of Grid Spacing (a)

Grid Spacing (m)	Annual Average	99.8th Percentile of Hourly Averages
12.5	3.02	10.3
25	**3.02**	**9.6**
50	2.08	8.5
Assessment Criteria	**40**	**200**

(a) Assuming 100% oxidation of the oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2) for the annual average and 50% for the 99.8th percentiles

Table 6.4 shows that halving the grid spacing does not affect the maximum predicted concentrations. It can be concluded from this that the selected receptor spacing of 25 m is adequate to capture the maximum impact.

6.6 STACK HEIGHT

Table 6.5 presents the ADMS 6.0 maximum predicted off-site annual average and 99.8th percentile of hourly average nitrogen dioxide (NO_2) concentrations for stack heights ranging from 25.1 m to 29.1 m. Predictions are made for the 2023 meteorological data.

Table 6.5 Vesta Paper Machine: ADMS 6.0 Maximum Predicted Off-Site Annual Average and 99.8th Percentile of Hourly Average Concentrations of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$): Effect of Stack Height [(a)]

Stack Height (m)	Annual Average	99.8th Percentile
25.1	1.88	7.42
26.1	1.80	6.90
27.1	**1.72**	**6.38**
28.1	1.64	5.94
29.1	1.56	5.48
Assessment Criteria	**40**	**200**

(a) Assuming 100% oxidation of the oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2) for the annual average and 50% for the 99.8th percentiles

Table 6.5 shows that the maximum predicted off-site concentration reduces with increasing stack height. This assessment has demonstrated that the selected stack height of 27.1 m gives rise to impacts that are not of concern to human health or ecology.

7 SUMMARY AND CONCLUSIONS

Earth & Marine Environmental Consultants Ltd (EAME) has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an air quality risk assessment of emissions to the atmosphere from the proposed Project Vesta paper machine located at WEPA Bridgend paper mill. The Project Vesta is an exact copy of the Neptune machine that was assessed by SLR in 2020 and is now operating [(1)].

The proposed new paper machine will replace the existing Jupiter machine, which was installed in the 1970s.

The sources of emissions to the atmosphere of concern to this assessment are

- A11 (Neptune paper machine)
- A14 and A15 (boilers)
- A17 (Proposed Vesta paper machine)

This assessment considers the following three Scenarios:

- Current emissions (A11, A14 and A15).
- Proposed emissions, Vesta paper machine (A17)
- Current + Proposed emissions (A11, A14, A15 and A17)

No consideration is taken for the reduction in emissions that will occur as a consequence of the decommission of the Jupiter paper machine.

This assessment assumes continuous full-load operation.

The ADMS 6.0 dispersion model has been used to predict ground-level concentrations of the oxide of nitrogen (NO_x) and nitrogen dioxide (NO_2) released into the atmosphere from the proposed paper machine, together with the existing sources of emissions of the oxides of nitrogen (NO_X).

The principal conclusion of this assessment is that emissions to the atmosphere at their emission limits from the proposed Vesta paper machine give rise to predicted ground-level pollutant concentrations (process contributions, PC) that are not of concern to human health or ecosystems. The impacts are predicted to be insignificant.

(1) SLR (Feb 2020) Air Quality Impact Assessment Bridgend Paper Mill