DETAILED AIR QUALITY ASSESSMENT FOR A BIOMASS BOILER OPERATING AT THE HALE CONSTRUCTION LIMITED SITE, NEATH

HALE CONSTRUCTION LTD

2, MILLANDS ROAD INDUSTRIAL ESTATE, MILLAND RD, NEATH, SA11 1NJ

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Executive Summary

Environmental Visage Ltd was commissioned to undertake a detailed air quality assessment of pollutant emissions from a 2.0 MW_{th} biomass boiler, burning virgin timber offcuts from on-site manufacturing processes, to be installed at the new site to be occupied by Hale Construction Ltd (SA11 2DL). The air quality assessment is required to support a planning application for the installation of the boiler.

Detailed atmospheric dispersion modelling of emissions from the biomass boiler was undertaken based on process information provided by Novalux Energy Solutions Ltd, technology advisers to the development, and LLC Boiler Factory "Kriger", Zhytomyr of the Ukraine, manufacturers of the boiler.

The results from detailed atmospheric modelling confirmed that the impact on local air quality of emissions of NO_X (as NO_2), PM_{10} and CO from the biomass boiler, will be low and can be screened out as insignificant at local sensitive receptors in relation to guidance provided by the Environment Agency, and applied by Natural Resources Wales. In relation to the EPUK/IAQM assessment criteria, air quality impacts for NO_2 and PM_{10} were predicted to be **negligible** at nearby residential properties. Accordingly, the associated risk to the health of members of the general public living and working nearby will be similarly low.

The results from detailed modelling confirmed that the impact of emissions from the biomass boiler would have an insignificant impact at locations within the Borough where there are concerns about elevated levels of Nitrogen Dioxide due to vehicular emissions, and at locations where the Council currently undertakes NO_2 monitoring.

The results from detailed modelling also confirmed that NO_X emissions from the biomass boiler would have an insignificant impact on nearby ecological habitats.

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Issue and Revision Record

Issue	Date	Author	Review / Authorise	Description
1	02/05/2019	Geoff Fynes	Amanda Owen	Initial draft
2	03/05/2019	Geoff Fynes	Amanda Owen	Version 1

1. Introduction

Environmental Visage Ltd was commissioned to undertake a detailed air quality assessment of pollutant emissions from a biomass boiler to be installed at the new premises of Hale Construction Ltd on the Millands Road Industrial Estate, Neath (SA11 2DL). The air quality assessment is required to support a planning application for a new Kriger 2.0 MW_{th} biomass heating installation to be installed at the site, which will be supplied by Novalux Energy Solutions Ltd (Novalux).

Virgin timber wood chip fuel, generated by on-site processing activities, will be burned in the boiler to provide process heating and space heating for the factory building.

Technical information relating to the operation of the biomass boiler was provided by Novalux and the boiler manufacturer, LLC Boiler Factory "Kriger", Zhytomyr of the Ukraine.

The UK Government, via the Environment Agency, provides guidance for screening the significance of air quality impacts associated with the operation of industrial processes and the procedures recommended by the Environment Agency are similarly applied by Natural Resources Wales (NRW).

2. Modelling Input Data

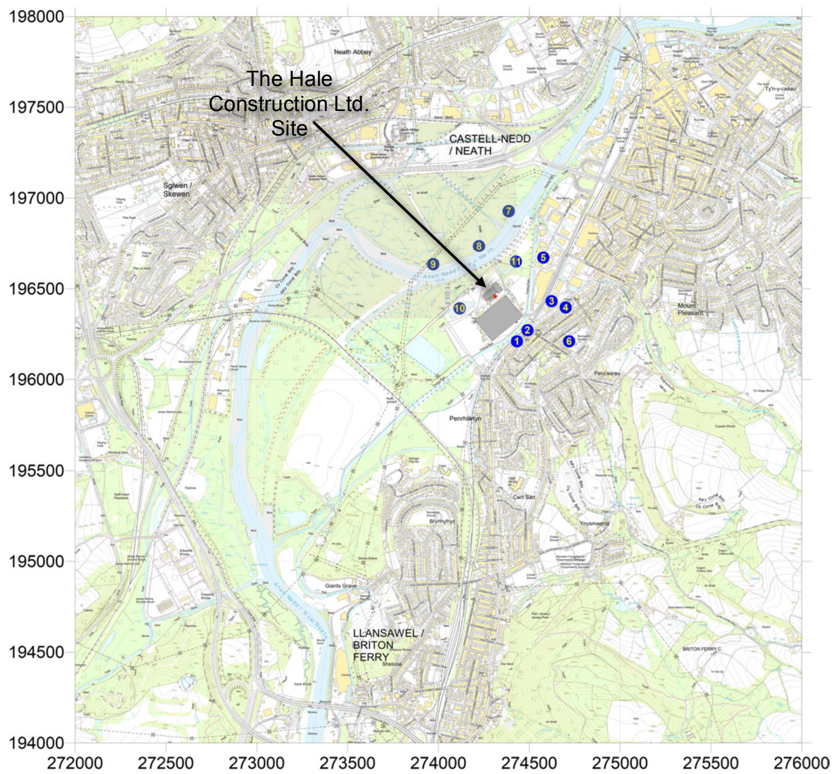
2.1 Introduction

This section provides a summary of the input data used in the model.

2.2 Site Location and Local Setting

The biomass boiler is to be located within the new Hale Construction Ltd site – Ordnance Survey Coordinates SS743964. The site is located at the southern end of the Millands Road Industrial Estate, with the River Neath and its associated floodplain and wetlands to the west, and the nearest residential properties approximately 200 metres to the east. Figure 1 shows the local setting of the Hale Construction Ltd site. Specific receptors included in the model are shown by the blue circles on the map, and represent locations where members of the general public may be present for significant periods of time, as well as nearby ecological habitats.

Figure 1 The Local Setting Showing the Location of the Hale Construction Ltd Site



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2.3 Plant Details

The detailed air quality assessment was based on data generated by the ADMS Version 5.2 atmospheric dispersion model[1], which requires emission sources to be defined in terms of dimensions, location and physical characteristics of temperature, velocity and pollutant discharge rate. This modelling study has been carried out to assess the potential impact on local air quality due to releases of atmospheric pollutants from the biomass boiler to be installed at the Hale Construction Ltd site.

The location and dimensions of the chimney associated with the biomass boiler, along with those of adjacent buildings and structures were obtained from drawings provided by Novalux[2]. Process information for the Kriger 2.0 MW_{th} biomass boiler was provided by LLC Boiler Factory "Kriger", Zhytomyr[3], technology providers to the project.

The following parameters were used in the detailed modelling:

Table 1 Stack Dimensions and Discharge Conditions

Reference	Kriger 2.0 MW_{th} Biomass Boiler
Chimney Diameter	0.5 metres and 0.4 metres
Chimney Height	16 metres
Efflux Temperature	130 ºC
Flue Gas Volumetric Flowrate (As Measured)	4,536 $Am^3 hr^{-1}$
Flue Gas Volumetric Flowrate (As Measured)	1.26 $Am^3 s^{-1}$
Efflux Velocity	10.03 $m s^{-1}$

Initial modelling was undertaken on the basis of a chimney diameter of 0.5 metres. This was subsequently reduced to 0.4 metres for detailed modelling, to increase the efflux velocity and improve the dispersion characteristics of the chimney.

For the purpose of the detailed air quality assessment it has been assumed that the biomass boiler operates at full output whenever operational. As there will be periods of time when the heat requirements will be lower due to seasonal demand for thermal energy within the factory, it is expected that normal operation may account for about 7,000 hours per annum. The models were run to calculate annual average Process Contributions for all 8760 hours of the year, with the results for annual average model predictions pro-rated for the assumed 7,000 operational hours.

2.4 Pollutant Emissions

As the biomass boiler will burn virgin timber wood chip fuel, the detailed air quality assessment was based upon emissions data for Oxides of Nitrogen (NO_X), Particulates and Carbon Monoxide, the principal pollutants associated with the combustion of virgin timber. Pollutant discharge rates were calculated from emissions concentration data provided by Kriger[4].

Emissions data and discharge conditions used in the detailed air quality assessment represent the conditions for maximum output while burning virgin timber wood chip fuel.

Table 2 Pollutant Release Rates

Pollutant	Kriger 2.0 MW_{th} Biomass Boiler Discharge rate ($g s^{-1}$)
Oxides of Nitrogen (NO_x)	0.281
Nitrogen Dioxide (NO_2)*	0.14
Particulates (PM_{10})**	0.006
Carbon Monoxide (CO)	0.126

Note: * Assumes 50% conversion of NO_X to NO_2 in the short-term in line with NRW guidance[5].
** Assumes that all of the particulate emissions are as PM_{10}, which will overestimate the significance of the particulate emissions as they will comprise a wider range of sizes due to the fact that the boiler is not equipped with bag filters, or similar high efficiency filtration systems.

2.5 Local Environmental Conditions

Local environmental conditions describe the factors that might influence the dispersion process (such as nearby structures, sharply rising terrain, etc.) and also describe the locations at which pollutant concentrations are to be predicted. These include:

Surface Roughness

Surface roughness defines the amount of near-ground turbulence that occurs as a consequence of surface features, such as land use (i.e. agriculture, water bodies, urbanisation, open parkland, woodland, etc.). Agricultural areas may have a surface roughness of approximately 0.2m to 0.3m whereas large cities and woodlands may have a roughness of 1 to 1.5m.

The Hale Construction Ltd site is located in an area which is predominantly industrial/commercial in the immediate environs, with the River Neath and its associated wetlands to the west, and residential areas of Neath to the east, north-west and north-east, as can be seen in Figure 1. The biomass boiler is to be located within an existing building that is surrounded on three sides by taller buildings, and to reflect the potentially higher levels of turbulence associated with the passage of wind over these buildings, a surface roughness factor of 1.0 metres, cities and woodlands, was considered appropriate.

Nearby Buildings and Structures

The proximity of solid structures, such as buildings, to an emission source can affect the dispersion of a plume emitted from an adjacent chimney, particularly in the vicinity of that structure. The potential impact of this occurring was assessed based on the buildings data presented in Table 3, and graphically in Figure 2. In the absence of measured data, the heights of the buildings were estimated using the Google Earth Pro website.

Table 3 Associated Building Dimensions

Building / Structure	Height (m)	Length (m)	Width (m)
Building 1 (Hale Construction Ltd)	15.0	55.4	33.1
Building 2 (Hale Construction Ltd)	12.0	73.3	36.3
Building 3 (Boiler House Building)	6.0	43.8	15.9
Building 4 (Adjacent Commercial Premises)	11.0	217.0	150.0
Building 5 (Interconnecting Building)	6.0	80.0	5.6

Figure 2 Site Layout as Modelled

Local Terrain

Local terrain can affect wind flow patterns and, consequently, can affect the dispersion of atmospheric pollutants. The effects of terrain are not normally noticeable where the gradient is less than 10%. Ordnance Survey mapping for the area shows the absence of significant terrain in the vicinity of the Hale Construction Ltd site. Accordingly, terrain effects were excluded from detailed modelling.

Output Grid

When setting up a receptor grid it is important to ensure that there are sufficient receptor points to be able to accurately predict the magnitude and location of the maximum Process Contribution. If the grid of receptor points is too widely spaced, the maximum concentration may be missed. Modelling was undertaken using a 4km x 4km grid with 20 metre grid spacing.

Specific receptors, representing locations where members of the general public may be present for significant periods of time, as well as nearby ecological habitat receptors, were entered into the model, as shown in the following table and figure.

Table 4 Specific Receptors Included in Detailed Modelling

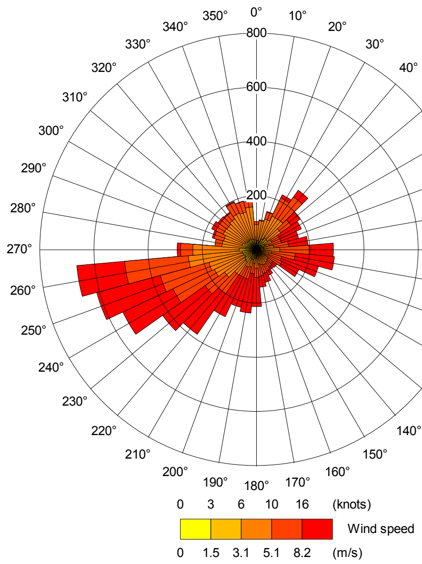
Receptor No.	X	Y	Distance from Site (m)	Receptor Name
1	274432	196211	277	Kumar Stores, Mile End Road, Neath, Briton Ferry
2	274490	196272	260	Kumar Stores, Mile End Road, Neath, Briton Ferry
3	274623	196432	314	Lidl, Mile End Road, Neath
4	274700	196397	395	Melin Junior School, Mile End Road, Neath
5	274577	196672	341	Millands Road, Neath
6	274719	196211	479	Melyn Park patch, Neath
7	274385	196928	474	River Neath Floodplain Wetland Habitat (1)
8	274222	196736	290	River Neath Floodplain Wetland Habitat (2)
9	273970	196635	382	River Neath Floodplain Wetland Habitat (3)
10	274115	196394	206	Pond and Island to South-West
11	274426	196650	223	Woodland Habitat to the North-East
12	270539	196161	3,783	Crymlyn Bay SSSI
13	271799	194333	3,291	Pant-y-Sais SSSI
14	272233	193340	3,748	Crymlyn Burrows SSSI
15	272992	194575	2,300	Eastwood Road Cutting and Ferryboat Inn Quarries SSSI

Figure 3 Location of Specific Receptors in Relation to the Chimney of the Biomass Boiler

2.6 Meteorological Data

The detailed air quality assessment was undertaken using the ADMS Version 5.2 atmospheric dispersion model, applying the 2018 hourly average meteorological data set for the Mumbles measurement station, which is approximately 15 kilometres to the south-west of the Hale Construction Ltd site. As can be seen from the windrose overleaf, the prevailing winds that are experienced in the local area are generally from a westerly to south-westerly vector.

Figure 4 2018 Windrose for the Mumbles Measurement Station



2.7 Background Air Quality

Background air quality data for 2019 in the locality of the Hale Construction Ltd site were taken from the 2015 DEFRA Background Maps website[6], covering an area under the jurisdiction of Neath Port Talbot County Borough Council.

Table 5 Background Levels of Pollution

Pollutant	Annual Average Concentration ($\mu g/m^3$)*
NO_2	11.1
NO_x	15.0
PM_{10}	12.5
* Average of concentrations at grid point 274500,196500	

The Council also undertakes monitoring for NO_2 in the vicinity of the Hale Construction Ltd site, as shown in the following table.

Table 6 NO_2 Monitoring Locations Included in Detailed Modelling

Identifier	Category	X	Y	Distance from Site (m)	2017 Annual Average NO_2 Concentration ($\mu g\ m^{-3}$)
VG2	Roadside	275471	197183	1,368	39.0
4	Roadside	275494	197272	1,436	27.1
13	Roadside	275415	197110	1,282	24.7
22	Roadside	275146	197248	1,149	25.7
23	Roadside	275482	197227	1,401	34.4
24	Roadside	275200	196905	995	29.9
34	Roadside	275472	197185	1,370	39.0

As can be seen, measured values exceed the DEFRA estimates by a significant margin, reflecting the impact of vehicular emissions on background NO_2 concentrations at the roadside locations.

2.8 Chimney Height Assessment

Two approaches were adopted with regard to determining the most appropriate chimney height for the biomass boiler, as follows:

1. Calculating stack height using the D1 calculation procedure; and,
2. Iterative modelling of stack height using the ADMS model.

The results are discussed in the following sections, and relate to a chimney diameter of 0.5 metres.

D1 Chimney Height Calculation

The methodology defined in Her Majesty's Inspectorate of Pollution (HMIP, now the Environment Agency) guidance note D1[7] was used to calculate the appropriate height of the chimney of the biomass boiler. As a minimum, the guidance recommends that a stack is at least 3 metres taller than the height of the building on which the emission stack is located, or near to. In this instance the minimum height for the chimney would be approximately 13 metres as the height of the building that will house the biomass boiler is 10.0 metres at its highest point.

The D1 chimney height methodology was followed based on discharge conditions and emission rates defined in Table 1 and Table 2, and incorporating all of the sections of the buildings associated with the locality as a whole, of which the adjacent building is the highest at 15.0 metres.

The D1 calculation estimated that the stack height for the single chimney associated with the biomass boiler should be approximately 16 metres, based upon the assumption that 50% of the NO_X emitted from the chimney of the biomass boiler is converted to NO_2 in the short-term, as per the recommended basis for assessment of NO_X emissions in Environment Agency/NRW Guidance.

The printout from the D1 calculation is appended to this document.

Iterative Modelling of Chimney Height

An iterative assessment of stack height was then undertaken using the ADMS model to determine what the appropriate chimney height should be to facilitate effective dispersion of atmospheric pollutants from the biomass boiler. The results of the modelling are presented in Table 7 and Figures 5 and 6, and are based upon the maximum NO_2 Process Contribution across the 4km x 4km receptor grid.

Table 7 Results from Iterative Chimney Height Assessment – Annual and Hourly Average NO_2 Process Contributions

Stack Height (m)*	Maximum Annual Average PC ($\mu g\ m^{-3}$)	Percentage of AQS Objective Value	Maximum Hourly Average PC ($\mu g\ m^{-3}$)	Percentage of AQS Objective Value
11	23.3	58%	65.5	33%
12	21.5	54%	57.7	29%
13	19.5	49%	56.6	28%
14	17.4	44%	55.4	28%
15	15.4	39%	53.1	27%
16	13.7	34%	50.8	25%
17	12.1	30%	48.4	24%
18	10.8	27%	46.0	23%
19	7.1	18%	43.7	22%
20	6.5	16%	41.3	21%

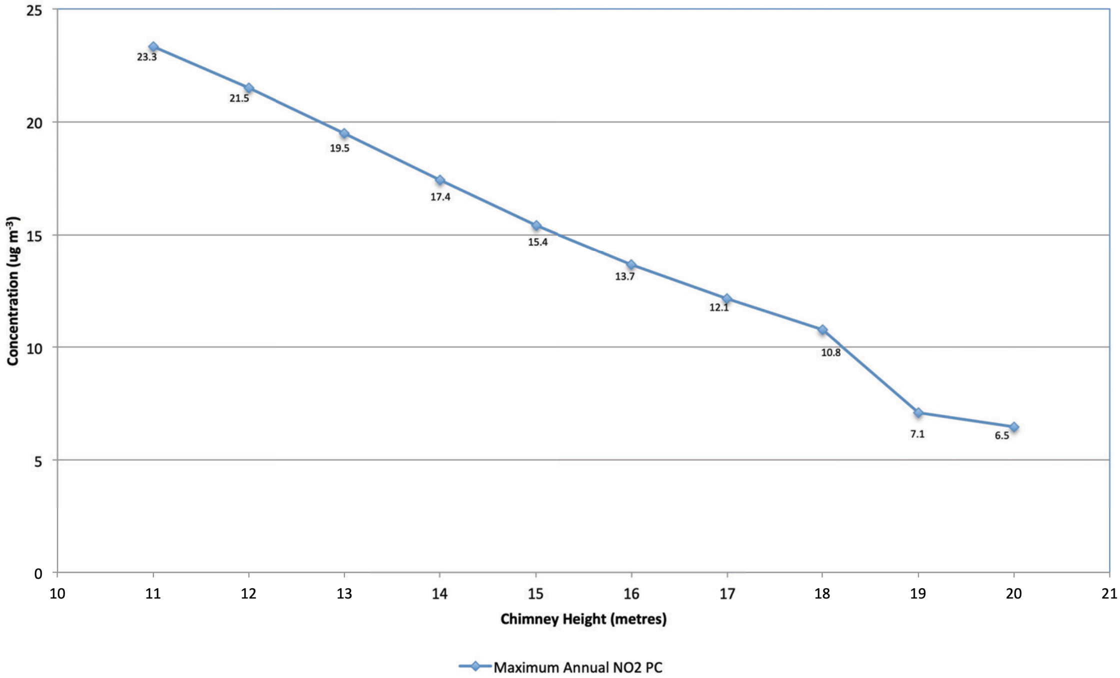
* Note modelling was based on: Surface Roughness – 1.0 metres; Building Effects Module – Active; Terrain Module – Inactive; Release Height – Variable; Meteorological Data – Mumbles 2018

It should be noted that the location of the maximum Process Contribution is within the confines of the site boundary, close to the chimney of the biomass boiler. Process Contributions at nearby residential properties are considerably lower, in relation to their distance from the site.

The above results indicate that the maximum annual average NO_2 Process Contributions are significantly above the 1% insignificance threshold specified by Environment Agency/NRW guidance. However, when considered in relation to the estimated background concentration of 11.1 $\mu g\ m^{-3}$, the resulting Predicted Environmental Concentrations (PECs) are less than the Welsh Air Quality Standards (AQS) objective value. The PEC for a 16 metre chimney represents a value that is 62% of the AQS objective value, and can therefore be screened out at the second stage recommended by Environment Agency/NRW.

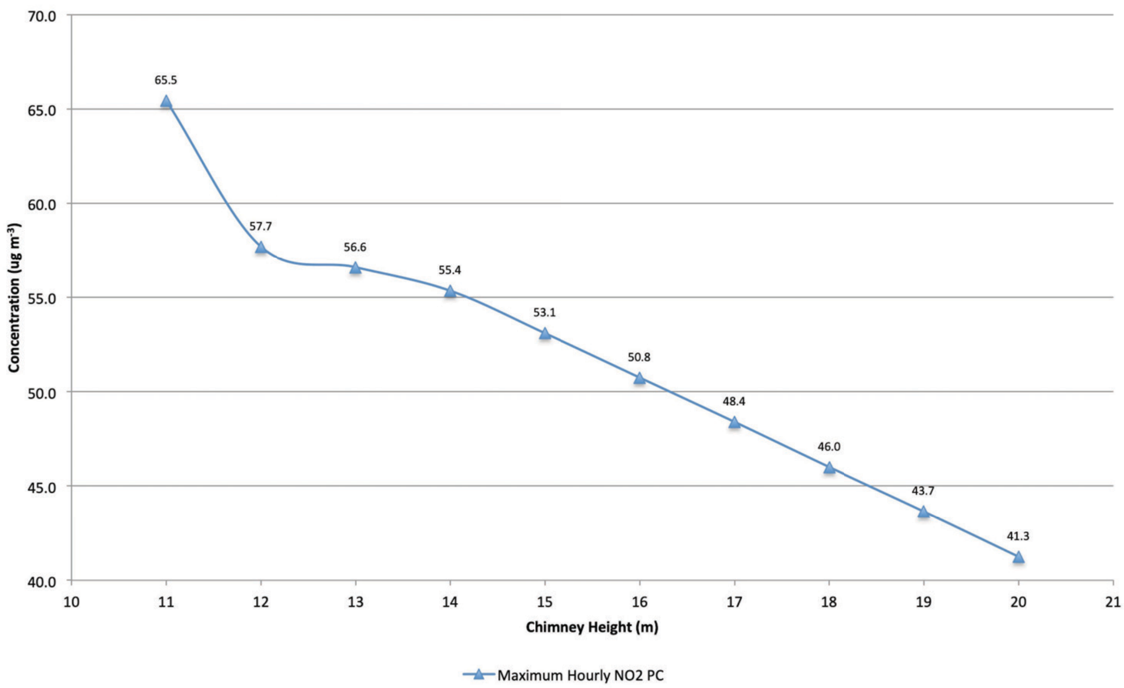
When the results are plotted on a graph, the pattern for the maximum annual average NO_2 Process Contribution is as shown in the following figure.

Figure 5 Variation in Maximum Annual Average Process Contribution of NO_2 ($\mu g\ m^{-3}$) with Different Chimney Heights



The corresponding graph for the maximum hourly average NO_2 Process Contribution is shown in the following figure.

Figure 6 Variation in Maximum Hourly Average Process Contribution of NO_2 ($\mu g\ m^{-3}$) with Different Chimney Heights



The results from the iterative chimney height assessment for the biomass boiler indicate that the maximum annual average and hourly average NO_2 Process Contributions would be approximately 13.7 µg m^{-3} and 51 µg m^{-3} respectively, for the D1-calculated stack height of 16 metres. There is a significant change in the gradient of the line for the hourly average Process Contribution for a chimney height of 13 metres. The change in gradient is generally considered to be indicative of the height when emissions from a chimney escape from the effects of downwash, associated with the passage of the winds over adjacent buildings and structures. However, this effect is not shown by the annual average Process Contributions which instead show a steady decline to 18 m. The break in this graph is instead due to a change in the location of the maximum value.

As the D1 calculation indicates that a 16 metre high chimney will provide effective dispersion of emissions from the biomass boiler, and the fact that the associated PEC value can be screened out as insignificant in relation to Environment Agency/NRW guidance, Hale Construction Ltd propose to install a 16 metre high chimney.

Subsequent detailed modelling was undertaken on the basis of a 16 metre high chimney.

2.9 Assumptions

Environment Agency/NRW guidance for air quality assessments[8] suggests that short-term modelling of NO_2, where atmospheric chemistry is not incorporated, should assume that as a worst-case basis for assessment, 50% of the NO_X is converted to NO_2.

Particulate emissions were also assumed to be totally as PM_{10}, which may overestimate the significance of the particulate release and provides a worst-case basis for assessment.

The heights of on-site buildings were estimated from data available on the Google Earth Pro website.

Annual average Process Contributions were pro-rated in line with the expected 7,000 operational hours per annum.

2.10 Determining Significance

Within this report, the descriptive terms for the impact significance of NO_2 and PM_{10} are based on those published in Land Use Planning and Development Control: Planning for Air Quality (2017 Update) prepared by the Institute of Air Quality Management (IAQM) and Environmental Protection UK (EPUK)[9]. Impact description involves expressing the "*magnitude of incremental change as a proportion of a relevant assessment level and then examining this change in the context of the new total concentration and its relationship with the assessment criterion*". The EPUK/IAQM descriptor matrix is shown in the Table below:

Table 8 Definition of Impact Magnitude for Changes in Annual Mean Nitrogen Dioxide and Particulates (PM_{10}) Concentration

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	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% or more of AQAL	Moderate	Substantial	Substantial	Substantial

The EPUK/IAQM guidance states that impacts on air quality, whether adverse or beneficial, will have an effect on human health that can be judged as "significant" or "not significant". The above assessment criteria were applied to increases in annual average NO_2 and PM_{10} concentrations due to the operation of the biomass boiler at the Hale Construction Ltd Site.

2.11 Other Assessment Criteria

The UK Government, via the Environment Agency, provides guidance for screening the significance of air quality impacts associated with the operation of industrial processes, and the procedures recommended by the Environment Agency are similarly applied by NRW.

For long-term impacts, the guidance recommends a 1% insignificance threshold relative to a long-term AQS or environmental assessment level, with a corresponding 10% insignificance threshold for the assessment of short-term impacts.

Screen out insignificant PCs

To screen out a PC for any substance so that you don't need to do any further assessment of it, the PC must meet both of the following criteria:

- the short-term PC is less than 10% of the short-term environmental standard
- the long-term PC is less than 1% of the long-term environmental standard

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. Record the PCs for your insignificant emissions in your risk assessment.

Screen out PECs from detailed modelling

In the second stage of screening if you meet both of the following requirements you don't need to do any further assessment of that substance. You'll need to do detailed modelling of emissions that don't meet both of the following requirements:

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

Accordingly, the above criteria were also applied in the detailed assessment of air quality impacts associated with emissions from the biomass boiler. The assessment was undertaken using the ADMS Version 5.2 atmospheric dispersion model.

3. Detailed Assessment for the Proposed Biomass Boiler Installation at Hale Construction Ltd

3.1 Introduction

Detailed atmospheric dispersion modelling was undertaken to assess the impact of emissions from the biomass boiler to be installed at the Hale Construction Ltd site. The assessment focussed on emissions of Oxides of Nitrogen (as NO_2), Particulates (PM_{10}) and Carbon Monoxide (CO), which are the most significant pollutants associated with the operation of biomass boilers burning virgin timber wood chip fuels.

The following section relates specifically to the potential impact of emissions from the biomass boiler, operating at full output, and with the chimney diameter reduced to 0.4 metres to aid dispersion.

3.2 Nitrogen Dioxide

The results from detailed modelling are presented in the following table, and are based upon the maximum annual and hourly average NO_2 Process Contributions (PC), due to emissions from the biomass boiler operating at full output, and compared against Welsh Air Quality Standards for NO_2 in ambient air. The biomass boiler is expected to operate for about 7,000 hours per year, and annual average Process Contributions were pro-rated accordingly.

The data presented are for both the maximum Process Contribution (PC) and the Predicted Environmental Concentration (PEC) for NO_2 when modelling the 2018 Mumbles meteorological data.

The PEC values take into account the DEFRA-estimated annual average background NO_2 concentration of 19.3 µg m^{-3}, and conversion of the NO_X released from the biomass boiler, based upon empirical formulae recommended by the Environment Agency; 50% conversion for short-term assessment and 100% conversion for long-term assessment. The results are presented in the following table.

Table 9 Results from Detailed Assessment for Nitrogen Dioxide – At the Location of the Maximum Process Contribution

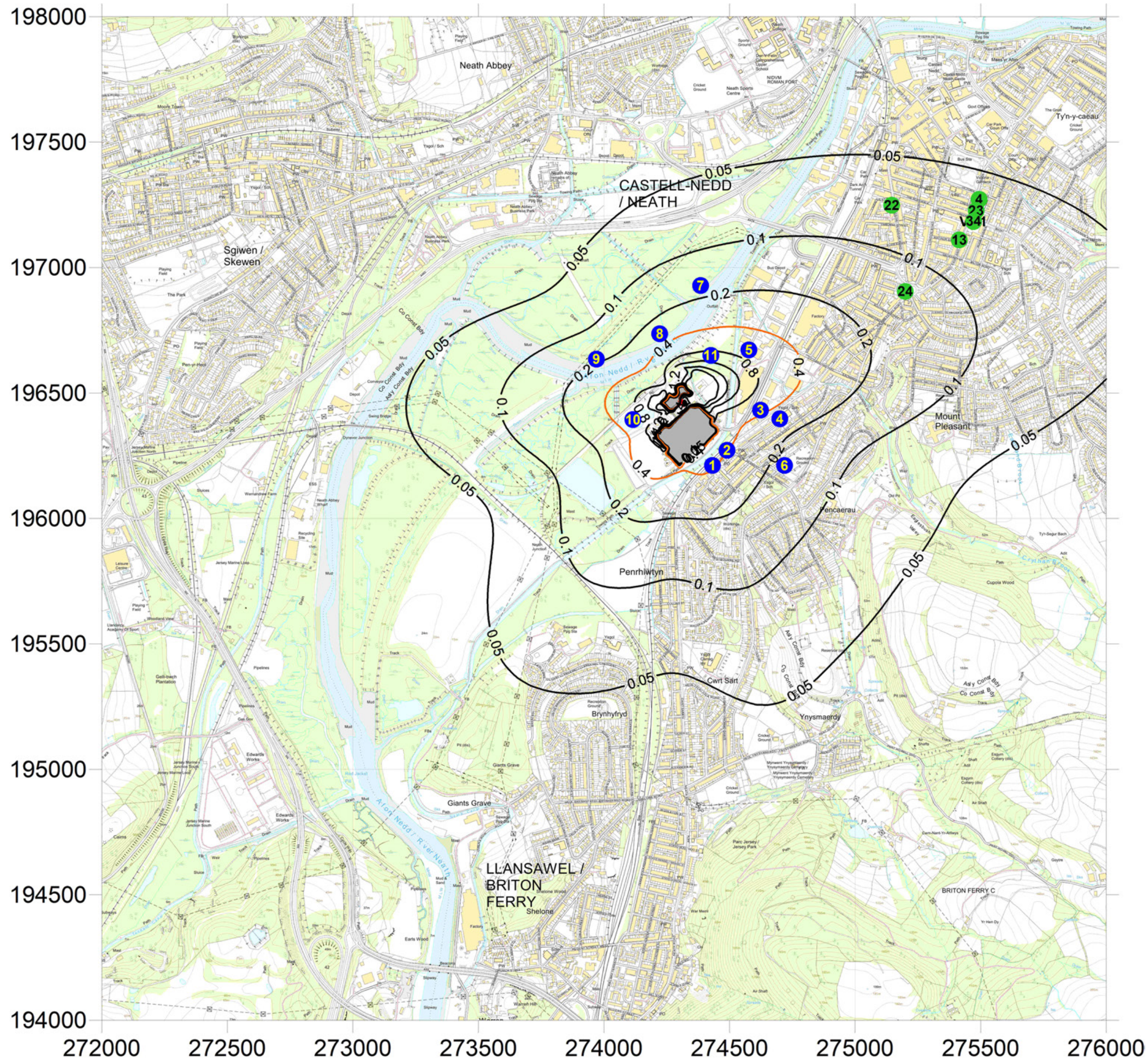
Pollutant	**Statistic**	**Exceedence Threshold**	**Averaging Period**	**Biomass Boiler**	
				Concentration (µg m^{-3})	**Percentage of the AQS**
Nitrogen Dioxide (NO_2)	Annual (PC)	40	Annual	11.3	28.3%
	Annual (PEC)			22.4	56.0%
	Short-Term 99.79% (PC)	200	1hr	57.1	28.6%
	Short-Term 99.79% (PEC)			79.3	39.7%

The results from detailed modelling predict that when the biomass boiler is operating at full output, the maximum annual average NO_2 PEC, taking account of the Process Contribution (PC) and the background NO_2 concentration for the locality (11.1 µg m^{-3}), would be approximately 22 µg m^{-3}, approximately 56% of the 40 µg m^{-3} annual objective value. The maximum annual average NO_2 PC was predicted to be 11.3 µg m^{-3}, or about 28% of the annual objective value for the protection of human health, and is located within the site boundary. Although the annual average Process Contribution cannot be screened as insignificant in relation to Environment Agency guidance, the Predicted Environmental Concentration remains well within 70% of the Air Quality Standard and hence can be screened at the second assessment stage.

In terms of the EPUK/IAQM impact descriptors this represents a **moderate** impact on local air quality at the location of the maximum Process Contribution, which is located within the site boundary. Process Contributions at nearby residential and other sensitive receptors are significantly lower in relation to their distance from the site, where impacts would be considered to be **slight** to **negligible** in relation to the EPUK/IAQM impact descriptors.

When the results from modelling the impact of emissions from the biomass boiler are considered across a 4km x 4km receptor grid surrounding the Hale Construction Ltd site (20 metre grid spacing), the following pattern is shown in relation to the maximum annual average NO_2 Process Contribution. The location of the maximum annual average Process Contribution is within the site boundary, where there are no relevant receptors. Increases in annual average NO_2 at residential and other sensitive receptors farther afield are predicted to be significantly lower in relation to their distance from the site, as can be seen in the figure overleaf.

Figure 7 Maximum Annual Average NO_2 Process Contribution ($\mu g\ m^{-3}$)



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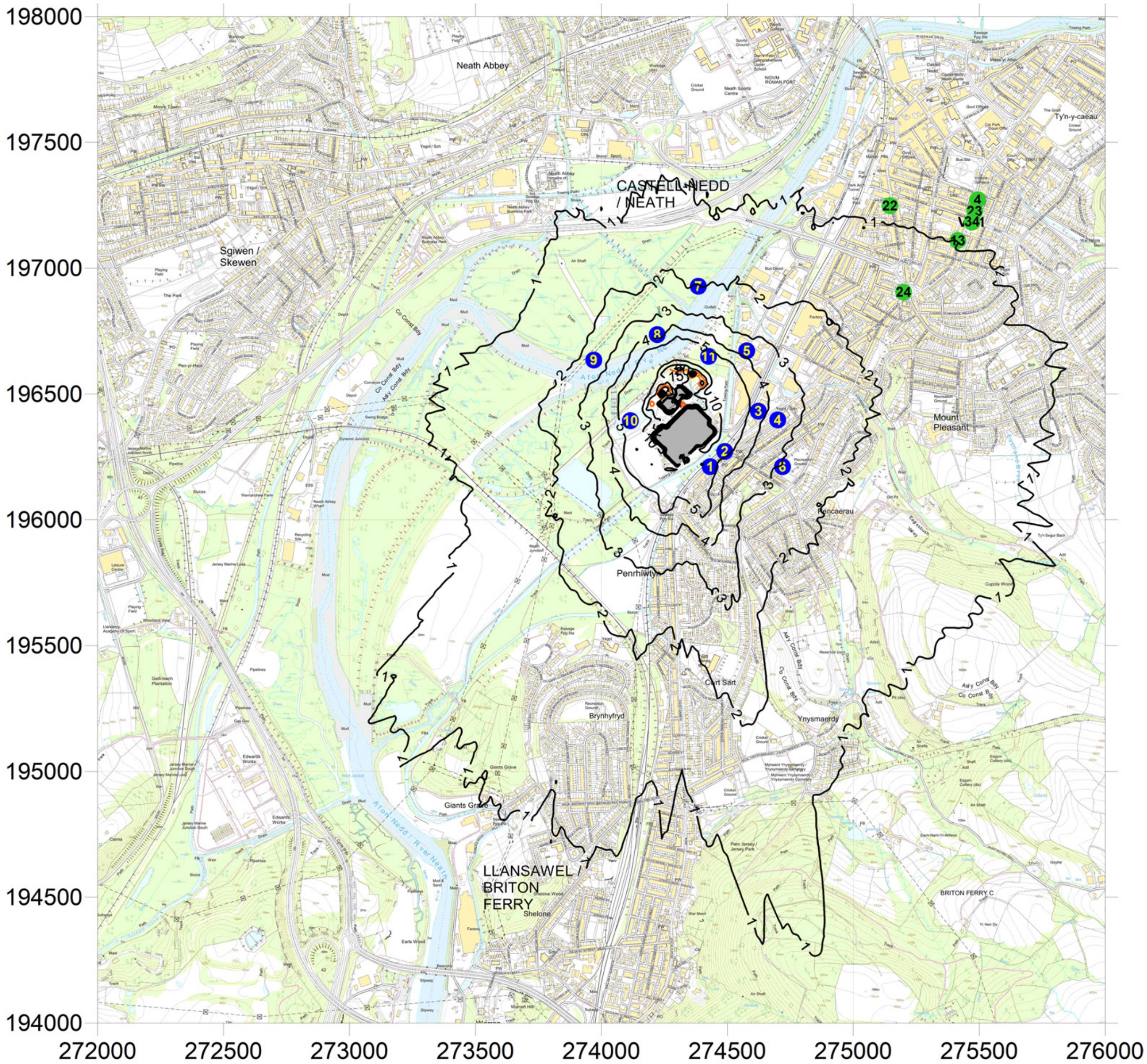
The 0.4 µg m^{-3} contour line, highlighted in orange, represents an increase in pollutant concentrations equivalent to 1% of the annual AQS objective value (0.4 µg m^{-3}) above background, due to emissions from the biomass boiler. Therefore, in all areas outside this contour, the annual average NO_2 Process Contribution may be regarded as insignificant in relation to Environment Agency/NRW guidance. For those receptors within the 0.4 µg m^{-3} contour, when considered in relation to the locally estimated background NO_2 background concentration for 2019 of 11.1 µg m^{-3}, the resulting PEC value of about 12 µg m^{-3} is well within the 70% insignificance threshold, and impacts at those receptors can also be screened out.

In relation to Environment Agency/NRW guidance for the assessment of short-term air quality impacts, the maximum hourly average Process Contribution of 57.1 µg m^{-3} is more than 10% of the AQS Objective Value of 200 µg m^{-3}, and cannot therefore be screened as insignificant. When considered in relation to the estimated annual average background concentration of 11.1 µg m^{-3}, the Process Contribution represents a value equivalent to about 32% of the 200 µg m^{-3} AQS objective value, minus twice the long term background, and cannot therefore be screened out at the second assessment stage. However, the location of the maximum hourly average NO_2 Process Contribution is approximately 80 metres from the chimney of the biomass boiler, and within the confines of the site where there are no relevant receptors. At the nearest residential receptor (Receptor No.2) the hourly average NO_2 Process Contribution is predicted to be about 5 µg m^{-3}, which can be screened as insignificant in relation to Environment Agency/NRW guidance.

The corresponding contour plot for the hourly average NO_2 Process Contribution, expressed as the 99.79^{th} percentile value, is shown in the figure below, assuming that 50% of the NO_X emission from the biomass boiler is released as NO_2.

Figure 8 99.79^{th} Percentile Hourly Average NO_2 Process Contribution (µg m^{-3})



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The results show that hourly average NO_2 Process Contributions can be screened out as insignificant in line with Environment Agency/NRW guidance, at all off-site receptor locations.

Accordingly, emissions of NO_X from the Kriger 2.0 MW_{th} biomass boiler, and their subsequent conversion to NO_2, should not have a significant impact on the health of people living and working nearby.

3.3 Particulates (PM_{10})

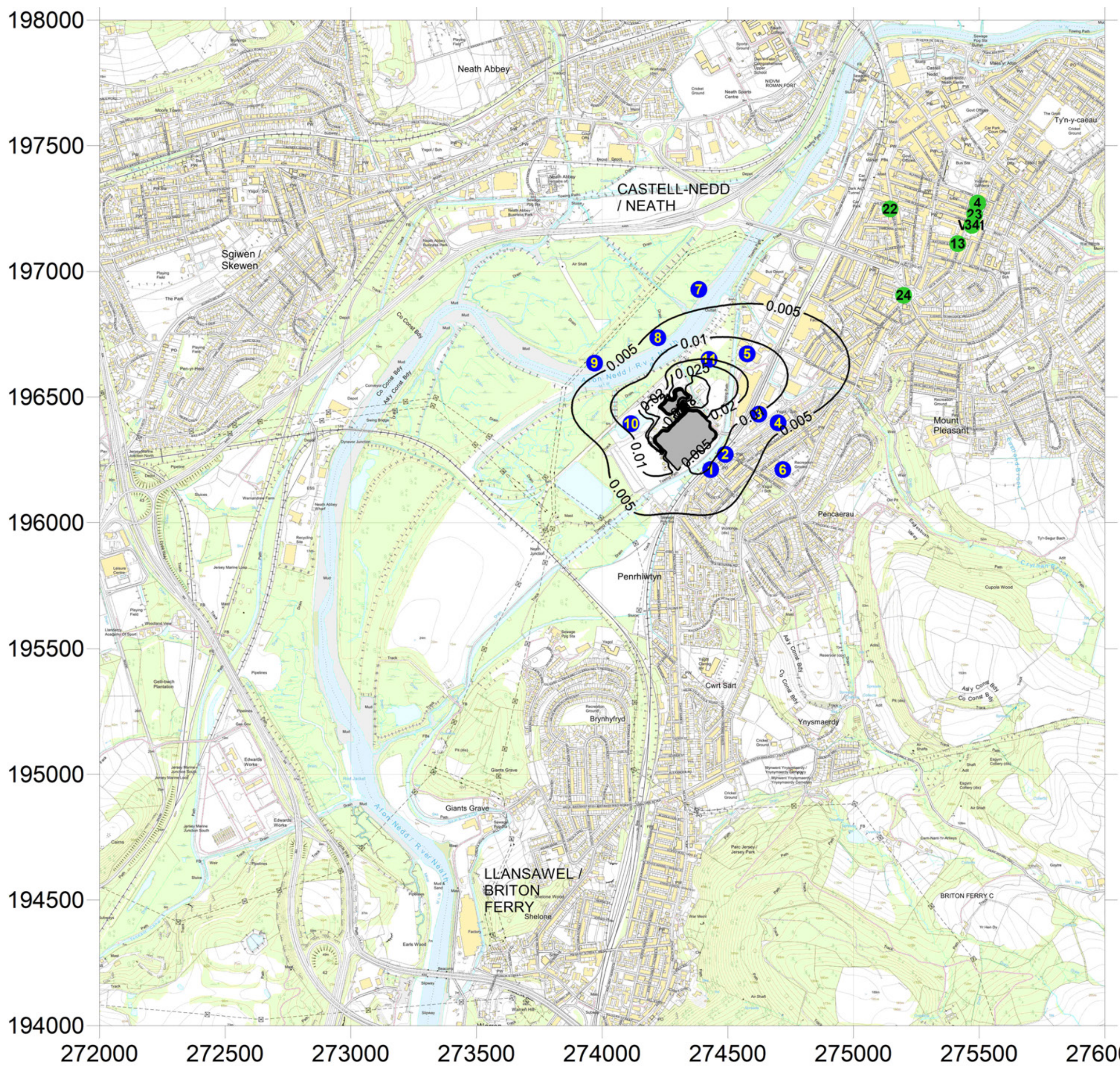
The following results relate to emissions of particulates from the biomass boiler operating at full output, assuming that all of the particles released are sized less than or equal to10 µm in diameter; PM_{10}. The results for the annual average Process Contribution have been pro-rated in relation to the expected 7,000 operational hours per annum.

Table 10 Maximum Process Contribution for Particulates – Location of the Maximum

Statistic	Exceedence Threshold ($\mu g\ m^{-3}$)	Averaging Period	Approximate Concentration ($\mu g\ m^{-3}$)	PC as an Approximate % of AQS Objective Value
Annual Average PC	40	Annual	0.2	0.6%
Annual Average PEC			12.7	32%
Daily average PC (90.41%)	50	24hr	0.4	0.8%
Daily average PEC (90.41%)			25.4	51%

The results from detailed modelling of particulate emissions from the biomass boiler indicate that, based upon the expected 7,000 operational hours, the maximum annual average PM_{10} Process Contribution would be approximately 0.2 $\mu g\ m^{-3}$, or about 0.6% of the 40 $\mu g\ m^{-3}$ annual average AQS objective value, and is located within the site boundary. In terms of the EPUK/IAQM impact descriptors this represents a **negligible** impact on local air quality. Accordingly, the long-term impact of particulate emissions on local air quality at nearby residential and other sensitive receptors can be screened out as insignificant, as can be seen in the figure below.

Figure 9 Maximum Annual Average PM_{10} Process Contribution ($\mu g\ m^{-3}$)



The maximum annual average PM_{10} Process Contribution at nearby residential receptors is less than 0.02 $\mu g\ m^{-3}$, which represents an increase equivalent to less than 1% of the annual AQS objective value (40 $\mu g\ m^{-3}$) above background. Therefore, in all areas outside the site boundary, the annual average PM_{10} Process Contribution may be regarded as insignificant in relation to Environment Agency/NRW guidance.

In relation to Environment Agency/NRW guidance for the assessment of short-term air quality impacts, the maximum daily average Process Contribution of 0.4 µg m^{-3} is less than 10 % of the Welsh Air Quality Standard, and less than 20% of the short-term assessment level (AQS Objective Value of 50 µg m^{-3} minus twice the annual average background PM_{10} concentration of 12.5 µg m^{-3}) and will remain well below the recommended insignificance threshold. As such, Process Contributions can automatically be screened as insignificant.

Similar conclusions could be drawn for emissions of fine particles ($PM_{2.5}$), as their dispersion characteristics are virtually identical to those of the overall PM_{10} fraction. On the basis of the above results, the impact on local air quality of emissions of particulates from the biomass boiler can be screened out as insignificant, and requires no further assessment.

3.4 Carbon Monoxide (CO)

The following results relate to emissions of Carbon Monoxide from the biomass boiler operating at full output. The results for the annual average Process Contribution have been pro-rated in relation to the expected 7,000 operational hours per annum.

Table 11 Maximum Process Contribution for Carbon Monoxide

Statistic	Exceedence Threshold (µg m^{-3})	Averaging Period	Approximate Concentration (µg m^{-3})	PC as an Approximate % of AQS Objective Value
Annual Average PC	-	Annual	5.0	-
8hr Rolling Average PC (100%)	10,000	8hr(R)	45	0.45%

The results from detailed modelling of CO emissions from the biomass boiler indicate that the maximum 8 hour rolling average Process Contribution would be approximately 45 µg m^{-3}, or less than 1% of the 10,000 µg m^{-3} AQS objective value. Accordingly, the short-term impact of CO emissions on local air quality at nearby residential receptors can be screened out as insignificant in relation to Environment Agency/NRW guidance.

The corresponding annual average CO Process Contribution was predicted to be approximately 5.0 µg m^{-3}. There is no equivalent AQS objective for annual average CO Process Contributions.

4. Air Quality Impact at Specific Receptors

The model was set up to calculate the impact of emissions at six specific receptors in the vicinity of the site. The locations of these receptors are shown in the previous figures, and represent locations where members of the general public may be present for extended periods of time, either through residence in a particular area, or as a result of their employment. The results are summarised in the following table, based on the impact of emissions from the biomass boiler, pro-rated for the expected 7,000 operational hours per annum, and are the maximum values reported for the 2018 meteorological data used in the assessment.

Table 12 Results from Detailed Assessment for Nitrogen Dioxide and Particulates (PM_{10}) at Specific Receptors – Impact Due to the Operation of the Biomass Boiler

Receptor	Approximate Distance from the Site (m)	Annual Average NO_2 PC (µg m^{-3})	% AQS	Hourly Average NO_2 PC (µg m^{-3})	% AQS	Annual Average PM_{10} PC (µg m^{-3})	% AQS	Daily Average PM_{10} PC (µg m^{-3})	% AQS
1	277	0.43	1.1%	6.4	3.2%	0.010	0.02%	0.05	0.09%
2	260	0.41	1.0%	5.4	2.7%	0.009	0.02%	0.04	0.08%
3	314	0.46	1.2%	4.4	2.2%	0.010	0.02%	0.04	0.07%
4	395	0.29	0.7%	3.6	1.8%	0.006	0.02%	0.03	0.05%
5	341	0.63	1.6%	3.8	1.9%	0.013	0.03%	0.04	0.08%
6	479	0.18	0.4%	3.0	1.5%	0.004	0.01%	0.02	0.03%

Annual average NO_2 Process Contributions, due to emissions from the biomass boiler, are low or very low at the majority of the nearby receptor locations, and the impacts at Receptor Nos. 2, 4 and 6 can be considered insignificant in relation to Environment Agency/NRW guidance. Those that cannot be screened out as insignificant in this first stage screening process, i.e. those which are greater than 1% of the annual average AQS objective value for NO_2, are Receptor Nos. 1, 3 and 5.

However, when considered in relation to the estimated background concentrations, the resulting Predicted Environmental Concentrations are well below the 70% insignificance threshold and can be screened out as insignificant at the second stage. In relation to the EPUK/IAQM assessment criteria, annual average NO_2 Process Contributions represent a **negligible** impact on local air quality at all of the above specific receptors.

It should be noted also that the assessment is based upon the assumption that all of the NO_X is released as NO_2, which for receptors only a few hundred metres from the point of release is an overly conservative assumption, as the atmospheric chemistry in the locality will vary on a continual basis, and there will be times when the availability of atmospheric oxidants, such as Ozone, will be restricted and will therefore limit the conversion of NO_X to NO_2.

Model predictions for both the annual average and daily average PM_{10} Process Contributions at all of the residential receptors were considerably lower than the 1% and 10% insignificance thresholds recommended by Environment Agency/NRW guidance and contributions can therefore be screened as insignificant. It should also be noted that the assessment for Particulates assumes that all of the emission is as PM_{10}, which may overestimate the significance of the particulate emission.

5. Air Quality Impact at Locations Where NO_2 Monitoring is Undertaken

The model was also set up to calculate the impact of emissions at seven locations in the vicinity of the site, where the Council undertakes NO_2 monitoring. The results are summarised in the following table, and are based upon the impact of emissions from the biomass boiler operating at full output for the expected 7,000 operational hours per annum.

Table 13 Results from Detailed Assessment for Nitrogen Dioxide at Nearby Air Quality Monitoring Locations

Identifier	Distance (m)	Annual Average PC ($\mu g\ m^{-3}$)	Percentage of the AQS	Existing Background ($\mu g\ m^{-3}$)	Annual Average PEC ($\mu g\ m^{-3}$)	Percentage of the AQS
VG2	1,368	0.07	0.17%	39.0	39.1	97.7%
4	1,436	0.06	0.15%	27.1	27.2	67.9%
13	1,282	0.08	0.19%	24.7	24.8	61.9%
22	1,149	0.07	0.18%	25.7	25.8	64.4%
23	1,401	0.06	0.16%	34.4	34.5	86.2%
24	995	0.13	0.32%	29.9	30.0	75.1%
34	1,370	0.07	0.17%	39.0	39.1	97.7%

The results show that the increase in annual average NO_2 concentrations at nearby locations where background NO_2 monitoring is undertaken are all significantly below 1% of the AQS objective value, and can be screened out as insignificant in relation to Environment Agency/NRW guidance. When considered in relation to EPUK/IAQM impact descriptors, the increases at the above receptors can be considered to be **negligible**.

Existing annual average NO_2 concentrations at the above receptor locations represent a significant proportion of the 40 $\mu g\ m^{-3}$ objective value. However, the predicted increases of about 0.1 $\mu g\ m^{-3}$ or less, due to the operation of the biomass boiler, are unlikely to have a measurable impact on background NO_2 concentrations at these locations, and should not affect the Council's Air Quality Action Plan. Furthermore, the Process Contributions do not give rise to an exceedance where currently no exceedance exists.

6. Impacts at Ecological Habitats in the Vicinity of the Site

An assessment has been undertaken to determine the significance or insignificance of the impact of emissions of Oxides of Nitrogen (NO_X) from the biomass boiler on the following ecological habitats. The MAGIC website[10] was used to determine Ordnance Survey coordinates for locations within the various ecological habitat sites, that are within 5 km of the Hale Construction Ltd site, and therefore represent a worst-case basis for assessment. The details are summarised in the following tables.

Table 14 Ordnance Survey Coordinates for the Ecological Habitats Included in the Ecological Assessment

Habitat	Receptor No.	X Coordinate	Y Coordinate	Distance (m)
River Neath Floodplain Wetland Habitat (1)	7	274385	196928	474
River Neath Floodplain Wetland Habitat (2)	8	274222	196736	290
River Neath Floodplain Wetland Habitat (3)	9	273970	196635	382
Pond and Island to South-West	10	274115	196394	206
Woodland Habitat to the North-East	11	274426	196650	223
Crymlyn Bay SSSI	12	270539	196161	3,783
Pant-y-Sais SSSI	13	271799	194333	3,291
Crymlyn Burrows SSSI	14	272233	193340	3,748
Eastwood Road Cutting and Ferryboat Inn Quarries SSSI	15	272992	194575	2,300

The ADMS model was configured to estimate annual average and daily average NO_X Process Contributions at each of the above ecological habitats, and compared against relevant Critical Levels and site-specific Critical Loads. The results are presented in the following section.

Table 15 Ecological Assessment Results for NO_X in Relation to Critical Levels

Habitat	Annual Average NO_X PC	% Critical Level	Daily Average NO_X PC	% Critical Level
River Neath Floodplain Wetland Habitat (1)	0.16	0.5%	1.5	2.1%
River Neath Floodplain Wetland Habitat (2)	0.28	0.9%	4.3	5.8%
River Neath Floodplain Wetland Habitat (3)	0.18	0.6%	1.9	2.5%
Pond and Island to South-West	0.59	2.0%	7.2	9.6%
Woodland Habitat to the North-East	0.94	3.1%	5.4	7.2%
Crymlyn Bay SSSI	0.01	0.02%	0.1	0.1%
Pant-y-Sais SSSI	0.01	0.03%	0.1	0.2%
Crymlyn Burrows SSSI	0.01	0.04%	0.1	0.2%
Eastwood Road Cutting and Ferryboat Inn Quarries SSSI	0.02	0.07%	0.2	0.3%

As can be seen, the increase in annual average NO_X concentrations at most of the above ecological receptors represents a value equivalent to less than or equal to 1% of the Critical Level of 30 µg m^{-3} for the protection of ecosystems. The two exceptions are an area of woodland about 200 metres to the north east, and a pond, also about 200 metres from the site. However, when considered with existing annual average background NO_X concentrations, the resulting PEC values are well below the 70% insignificance threshold specified by Environment Agency/NRW guidance. Daily contributions remain within 10% of the 75 µg m^{-3} Environmental Assessment Level for the protection of ecosystems and are therefore screened as insignificant.

The following discussion relates solely to the impact of NO_X emissions from the biomass boiler at the above SSSIs, in relation to site-specific Critical Loads. The other ecological receptors represent non-statutory habitats and so were excluded from further detailed assessment.

Table 16 Ecological Assessment Results for NO_X in Relation to Critical Loads at Designated Habitats

Habitat	Nutrient Nitrogen Critical Load (kgN/ha/yr)	Nitrogen Deposition (kgN/ha/yr)	Percentage of Critical Load (%)	Acid Deposition Critical Load (keq/ha/yr)	Acid Deposition from Nitrogen (keq/ha/yr)	Percentage of Critical Load (%)
Crymlyn Bay SSSI	10	0.001	0.01%	0.438	0.00007	0.02%
Pant-y-Sais SSSI	10	0.001	0.01%	0.366	0.00007	0.02%
Crymlyn Burrows SSSI	Not Sensitive	-	-	Not Sensitive	-	-
Eastwood Road Cutting and Ferryboat Inn Quarries SSSI	Not Sensitive	-	-	Not Sensitive	-	-

As can be seen for those habitats for which a Critical Load is specified, the increase in annual average nutrient Nitrogen and acid deposition rates (due to Nitrogen only) at the above SSSIs represents a value equivalent to less than 1% of the site-specific Critical Load.

The magnitude of the Process Contributions are so small that they are probably not measurable with any reasonable degree of accuracy, and can be screened out as insignificant. It should also be noted that exceedence of a Critical Load is not a quantitative estimate of damage to a particular habitat, but represents the potential for damage to occur. There is no evidence in the available literature to indicate that the above habitats are suffering as a consequence of Nitrogen or acidity deposition from nearby sources. Despite the fact that Nitrogen and acid deposition rates currently exceed the site-specific Critical Loads at the above ecological receptors, the incremental increase in Nitrogen and acid deposition attributable to emissions of NO_X from the biomass boiler is very small and is unlikely to have a measurable effect on the integrity of the above ecological habitat sites.

7. Conclusions

Environmental Visage Ltd was commissioned to undertake a detailed air quality assessment of pollutant emissions from a 2.0 MW_{th} biomass boiler, burning virgin timber offcuts from on-site manufacturing processes, to be installed at the Hale Construction Ltd's new site on Millands Road Industrial Estate in Neath (SA11 2DL). The air quality assessment is required to support a planning application for the installation of the boiler.

Detailed atmospheric dispersion modelling of emissions from the biomass boiler was undertaken based on process information provided by Novalux Energy Solutions Ltd, technology advisers to the development, and LLC Boiler Factory "Kriger", Zhytomyr of the Ukraine, manufacturers of the boiler.

The results from detailed atmospheric modelling confirmed that the impact on local air quality of emissions of NO_X (as NO_2), PM_{10} and CO from the biomass boiler, will be low and can be screened out as insignificant at local sensitive receptors in relation to guidance provided by the Environment Agency/NRW. In relation to the EPUK/IAQM assessment criteria, air quality impacts for NO_2 and PM_{10} were predicted to be **negligible** at nearby residential properties. Accordingly, the associated risk to the health of members of the general public living and working nearby will be similarly low.

The results from detailed modelling confirmed that the impact of emissions from the biomass boiler would have an insignificant impact at locations within the Borough where there are concerns about elevated levels of Nitrogen Dioxide due to vehicular emissions, and at locations where the Council currently undertakes NO_2 monitoring.

The results from detailed modelling also confirmed that NO_X emissions from the biomass boiler would have an insignificant impact on nearby ecological habitats.

8. References

[1] ADMS 5 Atmospheric Dispersion Modelling System. User Guide Version 5.2 November 2016

[2] Email from Novalux Energy Solutions, 27th March 2019

[3] Email from Kriger, 10th April 2019

[4] Email from Kriger, 27th April 2019

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

[6] https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2015

[7] Her Majesty's Inspectorate of Pollution (HMIP), Technical Guidance Note (Dispersion) D1, Guidelines on Discharge Stack Heights for Polluting Emissions. June 1993

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

[9] EPUK and IAQM, Land-Use Planning and Development Control: Planning for Air Quality. January 2017

[10] https://magic.defra.gov.uk/MagicMap.aspx

Calculation of Chimney Height Using Method in Technical Guidance Note D1

Kriger 2 MWth Biomass Boiler, Hale Construction Ltd, Neath
Calculations Based on Data Supplied by Kriger and Woodtek Energy Ltd (Darren Jones)
April 17, 2019

PG 5/1(18) ELVs converted to 11% O2 equivalents

Gas Temp C	130
Gas Temp K	403
Stack Diameter	0.50
Gas Rate Am3/s	1.26
Gas Velocity m/s	6.4
FG O2 (%)	NA
Building Height m	6.0
FG H2O (%)	NA
Std O2 (%)	NA

XS Area
0.20 m^2
0.85 Nm3/s @ 11% O2
0.85 Nm3/s @ 11% O2
3,043 Nm3/hr @ 11% O2
4,536 Am3/hr
1.26 Am3/s
1.26 Am3/s

Heat Release MWth (1 Boiler)	Heat Release MWth (>1 Boiler)
0.129	

No. of Boilers 1
Diameter of 1 Flue (m)0.5
I Boiler
I Boiler
Multiple Boilers

Q<1	a	-0.94
	b	0.49
Q>1	a	-1.01
	b	0.48
	x	-2.92
	y	5.43
	z	-2.27

	Discharge Conc. (mg/m3)		Discharge Conc. (mg/Nm3)	Discharge Rate (g/s)	Guideline Concentration (mg/m3)	Background Concentration (mg/m3)	Pollution Index (m3/s)	
NOx			332	0.281	4.40	0.020	64	NOx
NO2			166	0.140	0.2	0.015	759	NO2
NO			166	0.140	1	0.005	141	NO
CO			149	0.126	57	0.110	2	CO
PM_{10}	10		7	0.006	0.05	0.014	157	PM10
Total							759	Total

Case for Single Building

Ub (m)	M (m4/s2)		Min Um (m)	Um (m)	U Corrected Chimney Height (Metres)	Height Above Building (Metres)
2.9	5.7		1.4	5.4	9.7	3.7

Case for Multiple Buildings within 5Um

5Um =	27.0	metres	CHECK THAT D<5Um

Building No.	Distance (metres)		Ridge Height (metres)	Height (H)	Projected Width (B)	Length (metres)	K (Min H & B)	T (H+1.5K)
Boiler House	0	1	6.0	6.0	46.6	43.8	6.0	15.0
1	24	1	12.0	12.0	81.8	73.3	12.0	30.0
2	44	0	15.0	0.0	64.5	55.4	0.0	0.0

Length	Width
43.8	15.9
73.3	36.3
55.4	33.1

Hm (Hmax)	Tm (Tmax)		U Min Um&Ub	Is U>Tm? (1=Y, 0=N)	Corr. Disch. Ht. (Metres)
12.0	30.0		2.9	0	16

Effective Chimney Height (U_{eff})

$U_{eff} = 1.66 \times (U_{act} - H)$

U_{eff}	U_{act}
-3.3	10.0
-1.7	11.0
0.0	12.0
1.7	13.0
3.3	14.0
5.0	15.0
6.6	16.0
8.3	17.0
10.0	18.0
11.6	19.0
13.3	20.0