TATA STEEL

Assessment of the impact of emissions from a proposed Burning Booth at Port Talbot BOS plant

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Summary

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Components such as mould heads from the BOS Plant at Tata Steel's Port Talbot site become contaminated with solidified molten metal that must be removed to prolong the life of the equipment. It is proposed that a burning booth will be constructed with a number of articulated fume extraction arms ending with capture hoods that could be brought close to the components to enable the fumes to be captured at source without passing through the operator's breathing zone or being able to escape into the wider workshop environment.

The extracted fumes will be cleaned by a cartridge filter before exhausting to atmosphere and a dispersion modelling exercise has been undertaken to assess the impact on local air quality of residual emissions from the burning booth extraction system.

Dust emissions from the proposed burning booth extraction system at the BOS Plant would have a negligible impact on local air quality. The maximum modelled daily average Process Contribution at any of the PM_{10} monitoring stations in Port Talbot is 0.02 μg/m³, compared to the PM_{10} Air Quality Standard of 50 μg/m³ (0.04%). The annual average Process Contribution is less than 0.005% of the AQS for both PM_{10} and $PM_{2.5}$.

Assessment of the impact of emissions from a proposed Burning Booth at Port Talbot BOS plant

1. Introduction

Components such as mould heads from the BOS Plant at Tata Steel's Port Talbot site become contaminated with solidified molten metal that must be removed to prolong the life of the equipment. It is proposed that a burning booth will be constructed with a number of articulated fume extraction arms ending with capture hoods that could be brought close to the components to enable the fumes to be captured at source without passing through the operator's breathing zone or being able to escape into the wider workshop environment.

The extracted fumes will be cleaned by a cartridge filter before exhausting to atmosphere. This report describes a dispersion modelling exercise to assess the impact on local air quality of emissions from the burning booth extraction system.

The structure of this document is based on guidelines[1] for air dispersion modelling reports published by the Environment Agency and Defra – this guidance is stated to apply to England, but in the absence of alternative guidance specific to Wales it has also been used in this instance.

2. Location

The steelworks is located along a flat strip of land between the town of Port Talbot and the coast of Swansea Bay. In the immediate vicinity of the BOS plant are other process areas on the Tata Steel site and there are residential areas within 800 metres to the east, as shown in Figure 1. Within 3 km the terrain rises to over 250 metres above sea level.

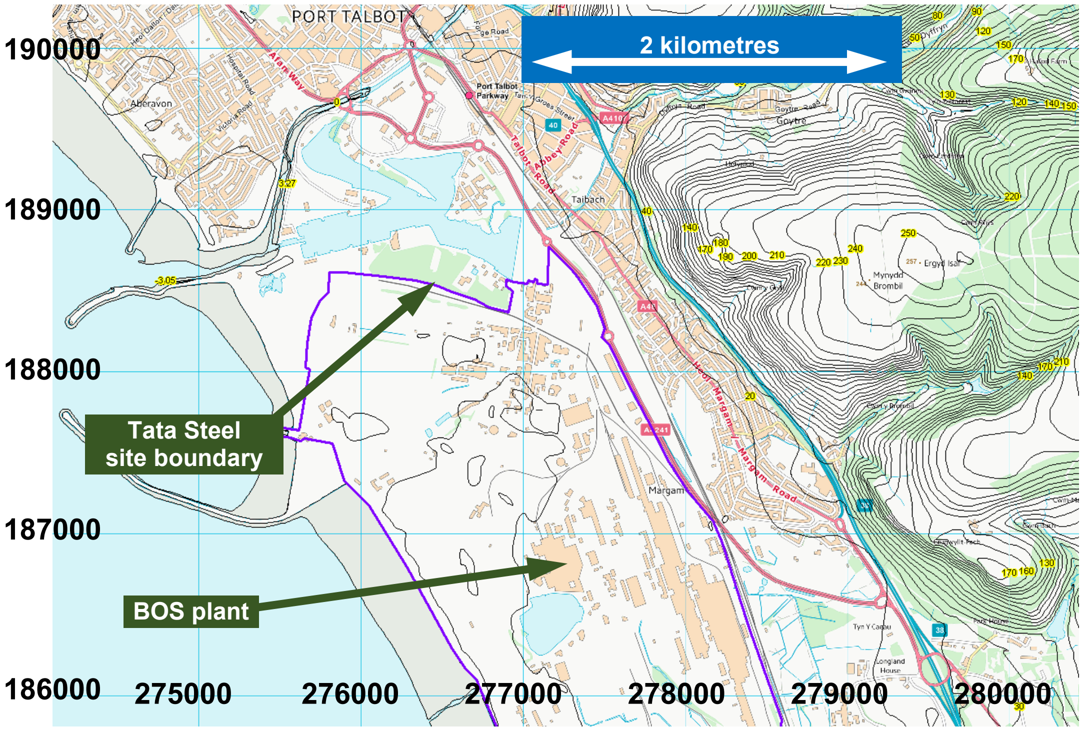

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Figure 1: Location map with National Grid references and 10 m contour intervals

2.1. Protected conservation sites

Guidelines[2] for undertaking air quality risk assessments for environmental permits published by the Environment Agency and Defra include a requirement to assess the impacts on:

- Special Areas of Conservation, Special Protection Areas and Ramsar sites within 10 km of the site
- Sites of Special Scientific Interest and local nature sites (ancient woods, local wildlife sites and national and local nature reserves) within 2 km

This guidance is stated to apply to England, but in the absence of alternative guidance specific to Wales it has also been used in this instance. The only protected sites within the relevant distances from the BOS plant are three Special Areas of Conservation and their locations are shown on Figure 2.

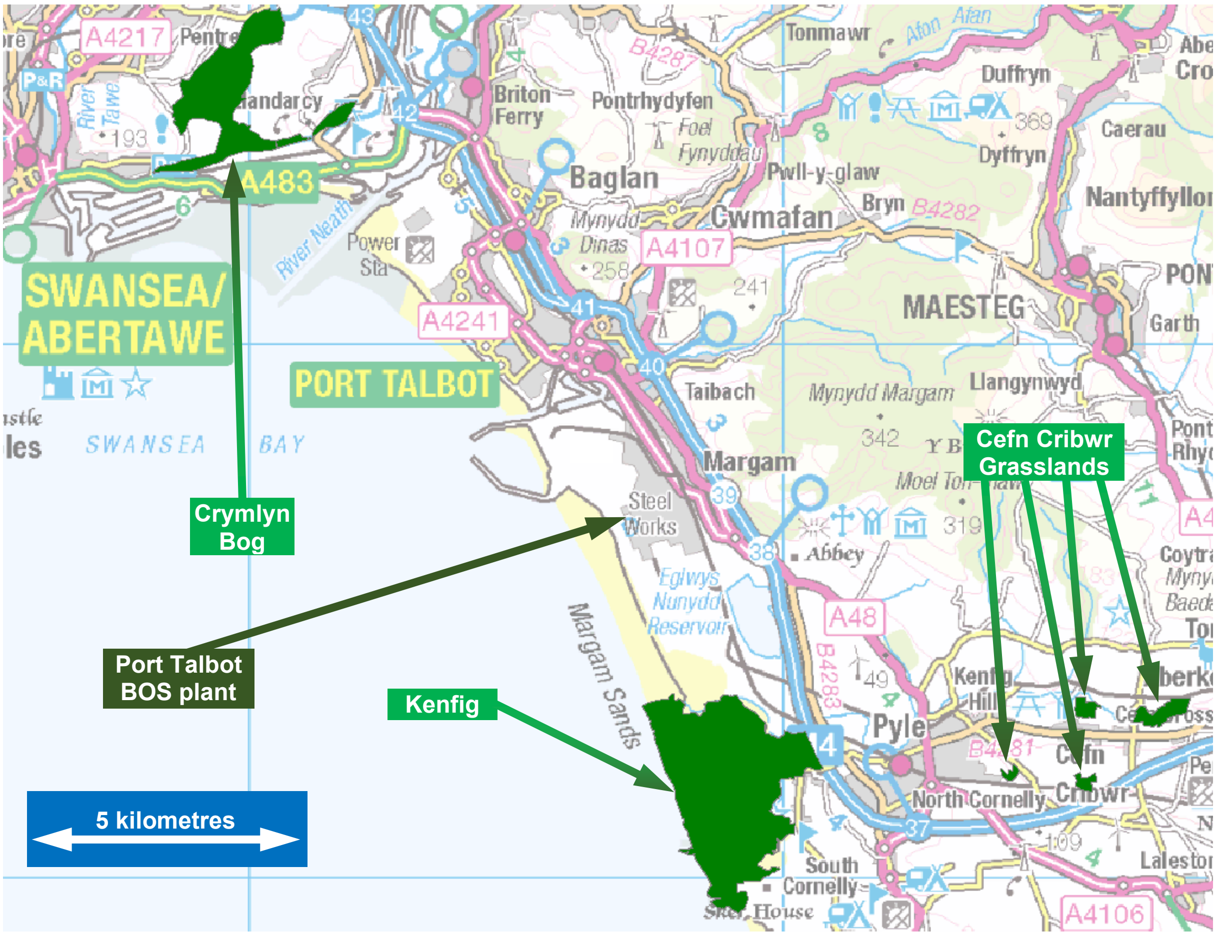

Figure 2: Special Areas of Conservation within 10 km of Tata Steel's Port Talbot site

3. Emissions and standards for assessment

This assessment focusses on emissions of particulate matter from the proposed burning booth extraction system. There are no air quality standards for total particulate matter but standards for specific size fractions (PM_{10} and $PM_{2.5}$) are defined in the Air Quality Standards (Wales) Regulations[3] and are shown in Table 1 below.

Species	Averaging period	Limit Value
PM_{10}	One day	50 µg/m³, not to be exceeded more than 35 times a calendar year
	Calendar year	40 µg/m³
$PM_{2.5}$	Calendar year	25 µg/m³

Table 1: Relevant air quality standards

4. Background levels

Concentrations of PM_{10} in ambient air are measured by the local authority at a number of locations close to the Tata Steel site. $PM_{2.5}$ is also measured at one of those sites and since this monitoring station, at the Fire Station, about 2 km from the BOS plant, is part of the UK Automatic Urban and Rural Network (AURN), with the highest QA/QC standards, results from this site have been used as representative levels for this assessment. Table 2 shows the measured concentrations[4] for the last six years.

Species	Parameter	2015	2016	2017	2018	2019	2020	Air quality standard
PM_{10}	Number of daily means > 50 µg/m³	28	8	17	11	12	10	≤ 35 times
	Annual mean	27	22	23	23	21	21	≤ 40 µg/m³
$PM_{2.5}$	Annual mean	10	9	10	11	11	9	≤ 25 µg/m³

Table 2: PM concentrations in ambient air, Port Talbot Fire Station AURN site

5. Dispersion model

Dispersion modelling was undertaken using the commercially available ADMS software[5] (version 5.2.1.0, February 2017), supplied by Cambridge Environmental Research Consultants. ADMS is a short-range, new generation, Gaussian plume air dispersion model, in which the atmospheric boundary layer properties are characterised by the boundary layer depth and the Monin-Obukhov length. Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution (shown by validation studies to be a better representation than a symmetrical Gaussian distribution).

ADMS has been used in previous studies to model the air quality impact of existing and proposed industrial installations in the UK and abroad and is fit for the purposes of this assessment. The model has been extensively validated and a list of references[6] is available on the supplier’s web site.

6. Emission parameters

Table 3 shows the relevant design parameters for the burning booth extraction system. The booth will operate only as required – some days it may be in continuous use and other days it will not be used at all.

Stack characteristics	Location (National Grid reference)	277421,186899
	Height (metres)	8
	Exit diameter (metres)	0.315
Waste gas characteristics	Flowrate (m^3/hr, actual conditions)	5,000
	Efflux velocity (m/s, actual conditions)	17.8
	Temperature (°C)	50
	Mean molecular weight (kg/kmol)	28.966
	Specific heat capacity (J/°C/kg)	1,012
Pollutant emissions	Assumed dust concentration (mg/m^3)	5
	Dust emission rate (g/s)	0.0069

Table 3: Emission characteristics

For the purposes of this assessment, the following worst-case assumptions have been made:

- The extraction system is in continuous use throughout the year
- The residual dust concentration after the cartridge filter is 5 mg/m^3 (actual conditions)
- Residual dust will be < 2.5 µm aerodynamic diameter so that $PM_{2.5} = PM_{10}$ = total PM

7. Modelled domain and grid resolution

An initial modelling run was undertaken over a 3.5 by 3 km modelling domain as shown in Figure 3, with a grid spacing of 20 metres. The results (see Figures A3.1 and A3.2 in Annex 3) demonstrated that this grid extent was sufficient to identify the areas where the peak ground level concentrations occurred.

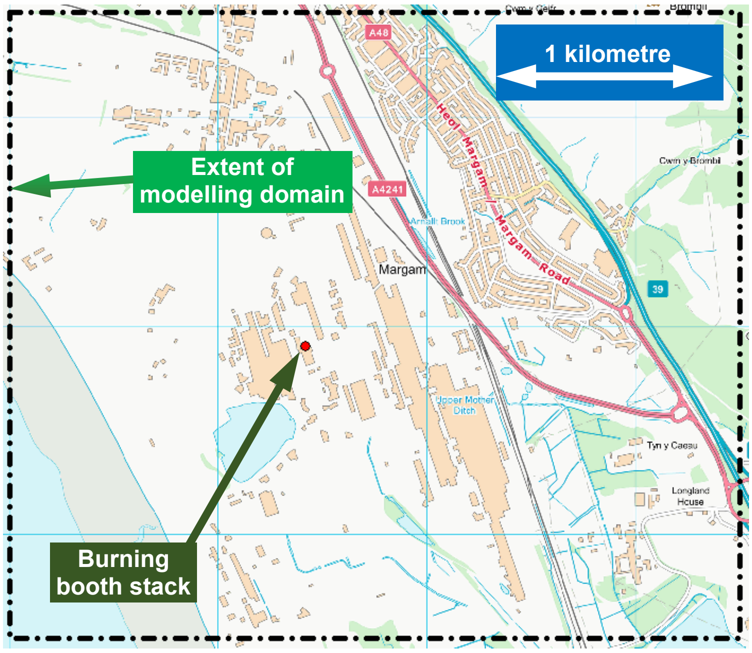

Figure 3: Modelling domain for impact assessment

In addition, Figure 4 shows the locations of eight PM_{10} monitoring stations in Port Talbot, which have been entered into the model as discrete receptors. Three further receptors were added at the closest points of the nearby Special Areas of Conservation (see Section 2.1). The grid references for all these locations are listed in Table 5.

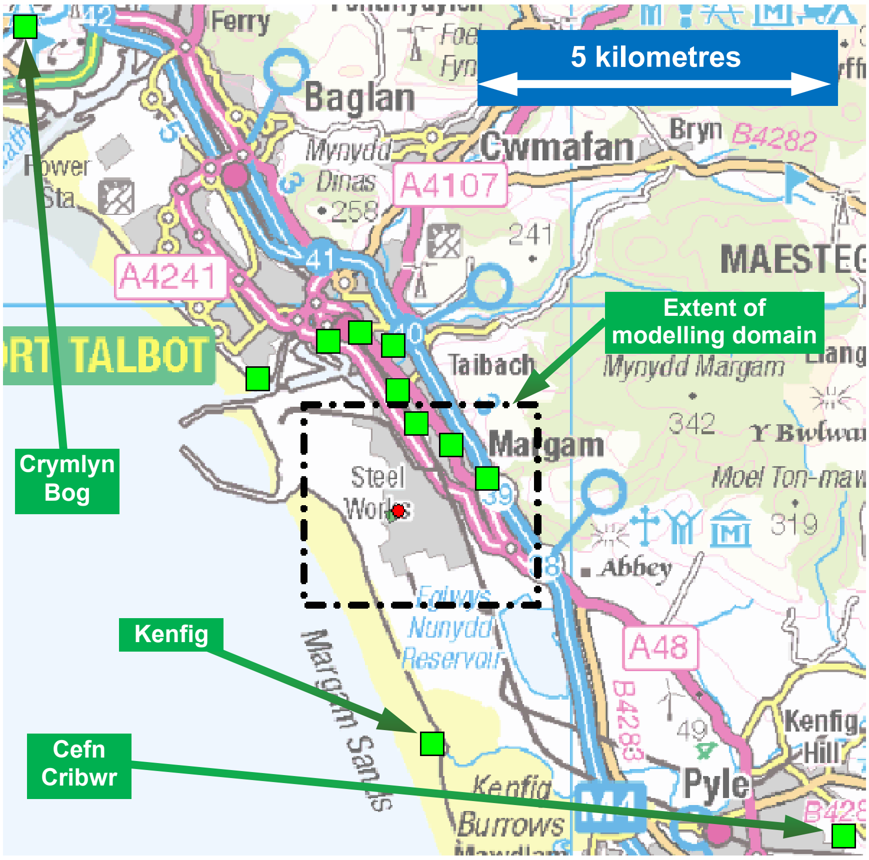

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Figure 4: Discrete receptors entered into dispersion model

	National Grid Reference
PM_{10} monitoring stations	
Little Warren	275313,188879
Port Talbot Docks	276368,189443
Talbot Road	276846,189570
Theodore Road	277340,189387
Margam Fire Station	277406,188719
Prince Street	277690,188227
Twll-yn-y-Wal Park	278205,187890
Dyffryn School	278742,187405
Special Areas of Conservation	
Crymlyn Bog	271821,194171
Cefn Cribwr Grasslands	284085,182027
Kenfig	277913,183424

Table 5: Locations of discrete receptors entered into dispersion model

8. Weather data and surface characteristics

8.1. Weather data

For the purposes of this assessment, wind speed, wind direction and temperature from a weather station at Little Warren, 3 km NW of the BOS plant, have been combined with rainfall, cloud cover and relative humidity data from St Athan, 30 km SE. The composite data set contains hourly sequential data from 10/04/12 to 31/12/16 (four years and nine months). Within this period, valid meteorological data were available for 40,068 hours (96.7% of the time). For sensitivity analysis, a second set of data derived from the Meteorological Office's weather forecasting models (NWP data) has also been used. Figure 5 shows wind roses for the two data sets. Annex 2 gives more details relating to the choice of weather data.

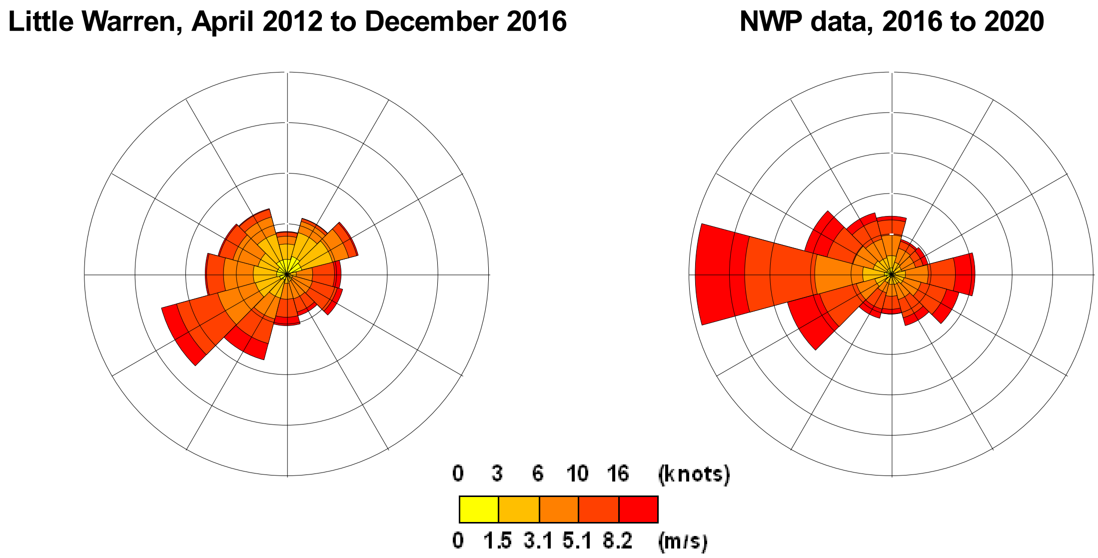

Figure 5: Wind roses – data from Little Warren and NWP data

8.2. Other meteorological characteristics

As well as the hourly sequential data discussed in section 8.1, the ADMS model also uses some other parameters to further define the meteorological conditions. Some of these are entered for both the dispersion site (i.e. the area shown in Figure 3) and the meteorological measurement site. Since the main meteorological data are a mixture of measurements from two sites, the site for which these parameters are defined will vary. The main impact of surface roughness is on the wind profile (the variation of wind speed with height) and since the wind speed data are taken from Little Warren, this is the most appropriate meteorological site for which to enter the roughness. The minimum Monin-Obukhov length relates to the atmospheric stability and since the relevant parameters for this are taken from St Athan airfield, this is the most appropriate meteorological site for which to enter this parameter. For sensitivity analysis, NWP data for a grid square centred within the steelworks boundary have been used and in this case the surface roughness and minimum Monin-Obukhov length for that location have been used instead.

The other parameters entered into the dispersion model are:

- Latitude of Port Talbot steelworks = 51.6°N
- Surface roughness:
    - At meteorological site (Little Warren and NWP) = 0.5 metres
    - At dispersion site – variable (see Section 9.1)
- Minimum Monin-Obukhov length:
    - At meteorological site (St Athan) = 1 metre (representative of rural areas)
    - At meteorological site (NWP) and at dispersion site = 30 metres (representative of mixed urban/industrial areas)
- The following parameters were left at the ADMS default values for both the dispersion site and the meteorological site:
    - Surface albedo = 0.23
    - Priestley-Taylor parameter = 1

9. Specialised modelling treatments

The ADMS dispersion model includes a number of specialised modules to take into account the impacts of, for instance, hills within the modelling domain or buildings close to the source. The following sections describe the modelling treatments used in this study.

9.1. Complex terrain

The hills to the east of the BOS plant have slopes greater than 10% (see Figure 1) and so the complex terrain module in ADMS has been used for this modelling exercise. A digital terrain file covering all the receptors (64 grid points in each direction, with a spacing of 300 metres) was created from Ordnance Survey Landform Panorama data using the “Create terrain file” utility within the ADMS model. The data are illustrated in Figure 6.

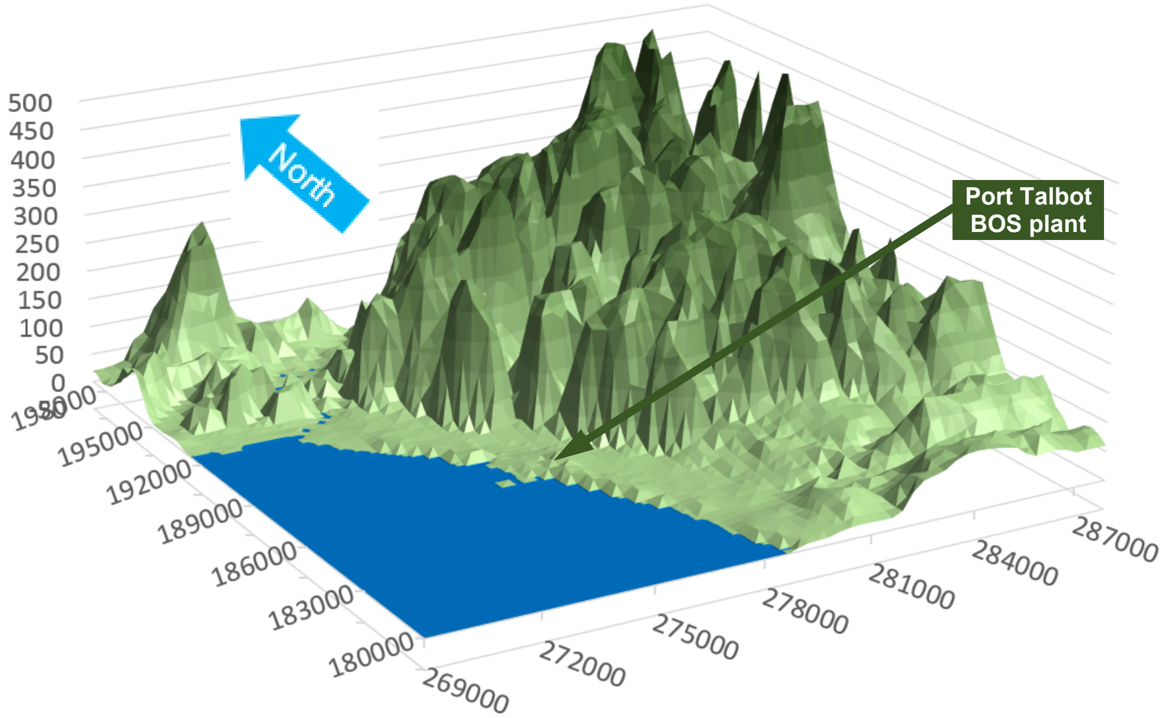

Figure 6: Complex terrain in the vicinity of the Tata Steel site

Furthermore, there are significant spatial variations in the surface roughness over the modelled domain – from less than 0.001 metres over the sea to greater than 1 metre over parts of the Tata Steel site. ADMS allows the use of variable roughness files, but the User Guide[7] states that “an order of magnitude variation in the surface roughness length is allowable”, hence some compromise is necessary to comply with this limitation. For the purposes of this assessment, a surface roughness of 0.05 metres has been used for the sea and 0.5 metres for all areas of land, including the Tata Steel site, urban and suburban areas, woods and grassland.

9.2. Buildings

As shown in Figure 7, the proposed stack extends above the windows of the building containing the burning booth, but is lower than the roofline. Although it would normally be good practice for the stack to be taller than the building, in view of the very low emissions from the extraction system, this has not been deemed necessary in this case. Dispersion from a low stack located next to a building will be affected by entrainment of pollutants into the cavity region in the immediate leeward side of the building, bringing the plume down to ground level more rapidly than would be the case in the absence of a building.

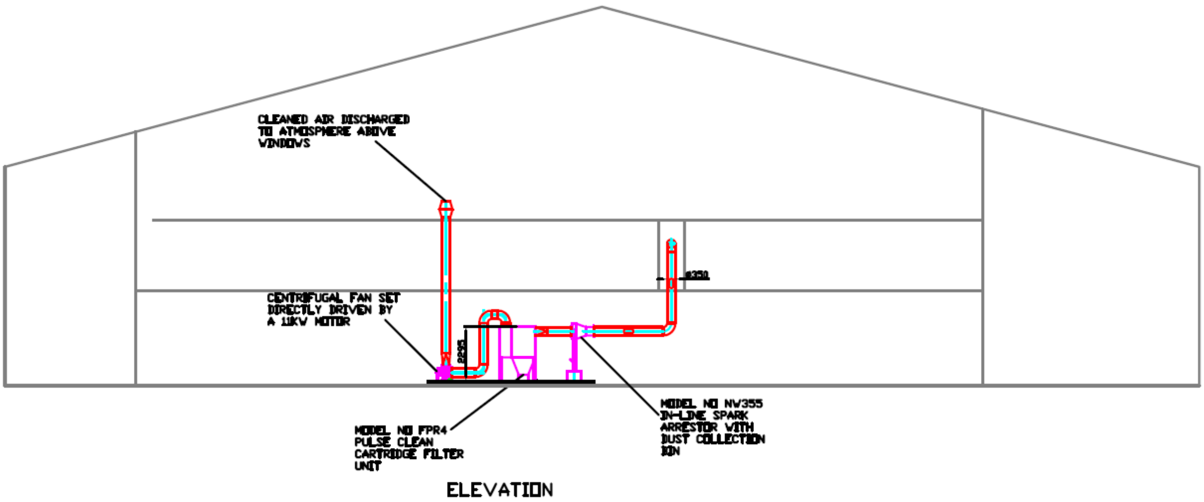

Figure 7: Front elevation showing proposed arrangement of extraction system stack

Other parts of the BOS and Concast buildings may also affect dispersion and Table 6 details all the buildings entered into the model.

Building	National Grid Reference of centre of building	Height metres	Length metres	Width metres	Angle between longest side and North
A Building containing burning booth	277427,186852	29	86	48	161
B Concast	277297,186828	31	177	114	161

Table 6: Details of buildings entered into dispersion model

9.3. Coastline

ADMS includes a coastline module to model the development of a convective boundary layer in the situation where there is a stable boundary layer over the sea and the land is warmer than the sea. However, the coastline module cannot be combined with either the complex terrain module or the buildings module. Furthermore, the coastline module requires hourly sequential data on sea temperature in the area, which are not available, and for these reasons the coastline module has not been used in this modelling exercise.

9.4. Other specialised modelling treatments

Other than the use of the complex terrain and building effects modules discussed above, no other specialised model treatments have been included in this study.

10. Model uncertainty

Two validation studies have been published[8,9] in which both the complex terrain and buildings modules have been used. In these papers, ADMS 5.2 has been tested against short-term measured ground level concentrations from field data sets – long-term model performance was not assessed due to issues with the detection limits of the SO_2 monitors used and the lack of reliable background data.

There is no single statistic that gives a complete measure of the performance of a dispersion model and the studies compare observed and modelled concentrations in a number of different ways. One statistic that gives an indication of the short-term model uncertainty is the ratio between the modelled "robust highest concentration" and the corresponding observed level over a period of twelve months. For hourly average concentrations, this ratio was 0.79 in the first paper and 0.65 in the second and for 24-hour averages the ratios were 0.65 and 0.62 respectively. Hence in these studies ADMS 5.2 underestimated the short-term peak concentration by up to 38%, though some of this may be attributable to the fact that the measured concentrations included background levels from sources not included in the model.

A comparison of the performance of other dispersion models[10] against the same two field data sets (see Table 7) shows that none of the alternative models have better overall performance than ADMS 5.2. It should be noted that for the Baldwin power plant experiments[8], the surrounding hills were lower than the stack height whereas at Martins Creek Steam Electric Station[9] the terrain rose above the stacks, hence the second situation is more similar to that of Port Talbot.

	Ratio modelled:observed robust highest concentration for different models					
Data set	ADMS 5.2	AERMOD	ISCST3	CTDMPLUS	HPDM	RTDM
Baldwin	0.65	1.04	1.13		1.02	
Martins Creek	0.62	1.65	8.88	5.56		3.56

Table 7: Dispersion model performance against field data sets – 24-hour average concentrations

The model uncertainty is not explicitly stated in these validation studies.

11. Sensitivity analysis

The impact of using two different meteorological datasets is examined in section 12. Since the overall impacts of emissions from the proposed burning booth extraction system are negligible compared to measured dust levels and to relevant Air Quality Standards, no other sensitivity analysis has been included in this assessment.

12. Impact assessment

Table 8 shows the modelled long-term and short-term impacts of emissions from the proposed burning booth extraction system for two different sets of meteorological data, either a combination of measured data from Little Warren and St Athan, or modelled data derived from the Meteorological Office's weather forecasting. The figures below are likely to overestimate the actual impacts from the proposed burning booth as a number of worst-case assumptions have been made, particularly the assumption that the process will run continuously throughout the year.

	Concentration of PM_{10} or $PM_{2.5}$ (µg/m³)			
Meteorological data	**Little Warren/St Athan**		**NWP**	
Receptor	**Annual average**	**Maximum daily average**	**Annual average**	**Maximum daily**
Little Warren	3.1E-04	4.3E-03	3.2E-04	7.5E-03
Port Talbot Docks	3.9E-04	5.3E-03	3.0E-04	4.0E-03
Talbot Road	4.8E-04	6.9E-03	2.9E-04	4.7E-03
Theodore Road	5.2E-04	6.0E-03	3.0E-04	6.5E-03
Margam Fire Station	8.4E-04	8.9E-03	4.8E-04	1.1E-02
Prince Street	9.7E-04	1.4E-02	5.6E-04	1.8E-02
Twll-yn-y-Wal Park	9.3E-04	2.1E-02	4.0E-04	1.9E-02
Dyffryn School	1.2E-03	1.2E-02	5.8E-04	1.0E-02
Crymlyn Bog	4.6E-05	9.0E-04	4.6E-05	1.4E-03
Cefn Cribwr Grasslands	1.4E-04	1.8E-03	9.2E-05	1.3E-03
Kenfig	3.3E-04	6.6E-03	2.7E-04	5.5E-03
Maximium impact	0.0012	0.021	0.0006	0.019

Table 8: Ambient dust concentrations attributable to burning booth emissions

Figures A3.1 and A3.2 in Annex 3 illustrate the patterns of dispersion for the long-term average dust concentrations and the highest daily means across the modelling domain.

12.1. Comparison to standards

The modelled impacts of dust emissions from the proposed burning booth extraction system are much lower than the relevant Air Quality Standards for PM_{10} and $PM_{2.5}$ (see Table 2). The maximum daily average Process Contribution at any of the PM_{10} monitoring stations in Port Talbot is 0.02 µg/m³, compared to the PM_{10} AQS of 50 µg/m³ (0.04%). The annual average Process Contribution is less than 0.005% of the AQS for both PM_{10} and $PM_{2.5}$.

12.2. Overall assessment

Dust emissions from the proposed burning booth extraction system at the BOS Plant would have a negligible impact on local air quality.

13. References

1. "Environmental permitting: air dispersion modelling reports", November 2014, *www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports*
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10. Perry, S.G. *et al.*, "AERMOD: A Dispersion Model for Industrial Source Applications. Part II: Model Performance against 17 Field Study Databases", *Journal of Applied Meteorology*, Volume 44(5), May 2005, pages 694-708

Annex 1 – Input parameters

This document is based on guidelines for air dispersion modelling reports published by the Environment Agency and Defra. Since January 2021 a requirement has been added that a separate annex with a table of all the input parameters used should be provided. Much of this is included in the main body of the report, but is reproduced here for clarity. In some cases where the volume of data is large, such as terrain data files or lists of additional specified receptors, these have instead been provided electronically.

Building parameters:

Building	National Grid Reference of centre of building	Height metres	Length metres	Width metres	Angle between longest side and North
A Building containing burning booth	277427,186852	29	86	48	161
B Concast	277297,186828	31	177	114	161

Terrain parameters:
See files *Port Talbot.ter* and *Port Talbot.ruf* provided separately.

Source parameters:

Stack characteristics	Location (National Grid reference)	277421,186899
	Height (metres)	8
	Exit diameter (metres)	0.315
Waste gas characteristics	Flowrate (m³/hr, actual conditions)	5,000
	Efflux velocity (m/s, actual conditions)	17.8
	Temperature (°C)	50
	Mean molecular weight (kg/kmol)	28.966
	Specific heat capacity (J/°C/kg)	1,012
Pollutant emissions	Assumed dust concentration (mg/m³)	5
	Dust emission rate (g/s)	0.0069

Meteorological parameters:

Dispersion site parameters	Latitude (°N)	51.6	
	Surface roughness (m)	Variable - see *Port Talbot.ruf*	
	Surface albedo	0.23	
	Priestley-Taylor parameter	1	
	Minimum Monin-Obukhov length (m)	30	
Meteorological site parameters	Data source	Little Warren/St Athan	NWP
	Surface roughness (m)	0.5	0.5
	Surface albedo	0.23	0.23
	Priestley-Taylor parameter	1	1
	Minimum Monin-Obukhov length (m)	1	30
	Wind directions grouped into sectors ?	N	N
	Data hourly sequential?	Y	Y

Receptor parameters:

A regular receptor grid was used with all receptors at ground level:

Direction	Start	Finish	Distance (km)	Grid spacing (m)	Number of grids
W to E (x)	276000	279500	3.5	20	176
S to N (y)	185500	188500	3	20	151

Specified receptors were also added at current and former PM_{10} monitoring stations in Port Talbot and at the closest points of the nearby Special Areas of Conservation:

	National Grid Reference
PM_{10} monitoring stations	
Little Warren	275313,188879
Port Talbot Docks	276368,189443
Talbot Road	276846,189570
Theodore Road	277340,189387
Margam Fire Station	277406,188719
Prince Street	277690,188227
Twll-yn-y-Wal Park	278205,187890
Dyffryn School	278742,187405
Special Areas of Conservation	
Crymlyn Bog	271821,194171
Cefn Cribwr Grasslands	284085,182027
Kenfig	277913,183424

Output parameters:

Long-term average and maximum daily average PM_{10} concentrations were output; $PM_{2.5}$ concentrations were assumed to be the same as the PM_{10} levels.

Annex 2 – Choice of weather data

Dispersion models predict pollutant concentrations in ambient air attributable to emissions from a source or group of sources under particular weather conditions. The most basic meteorological data required for these calculations are wind direction, wind speed and some measure of turbulence, which governs mixing in the lower layers of the atmosphere. Turbulence may result from friction as the wind passes over the earth's surface or from surface heat flux (warming from the sun, or cooling at night). Friction is a function of wind speed and surface roughness and heat flux is a function of the time of year, time of day, latitude and cloud cover. The ADMS 5 model specifies a number of different sets of minimum meteorological data requirements, the most commonly available of which[A2.1] is wind speed, wind direction, time of year, time of day and cloud cover, with latitude also defined elsewhere in the modelling input files.

A range of weather data has been measured at Port Talbot Fire Station, NE of the steelworks, since August 2007. However, a study by the UK Air Quality Expert Group[A2.2] (AQEG) in 2011 found that it was unclear whether meteorological data from this weather station adequately characterised the air flows over the steelworks and the surrounding area and data from this site have not been considered in this modelling exercise. Following the AQEG recommendations, a more representative meteorological site was identified and in 2012 a weather station was installed by the local authority at Little Warren Playing Fields, NW of the steelworks. Wind speed, wind direction and temperature were routinely measured at Little Warren from April 2012 to December 2017, but no cloud cover data or any other data suitable for the assessment of atmospheric stability/turbulence were measured there.

The nearest Meteorological Office station to Port Talbot is at Mumbles Head, 13 km W of the steelworks, but again no cloud cover data are collected there. The nearest site where cloud cover data are recorded is the Meteorological Office station at St Athan airfield, 30 km SE of the site. The Meteorological Office can also generate data derived from weather forecasting models[A2.3] as a proxy data set where no suitable measured data are available (Numerical Weather Prediction, or NWP). NWP data have been obtained for the grid square centred at 51.555 °N, 3.761°W, which is within the steelworks boundary.

Figure A2.1 shows the locations of the various meteorological data sources discussed above relative to the steelworks.

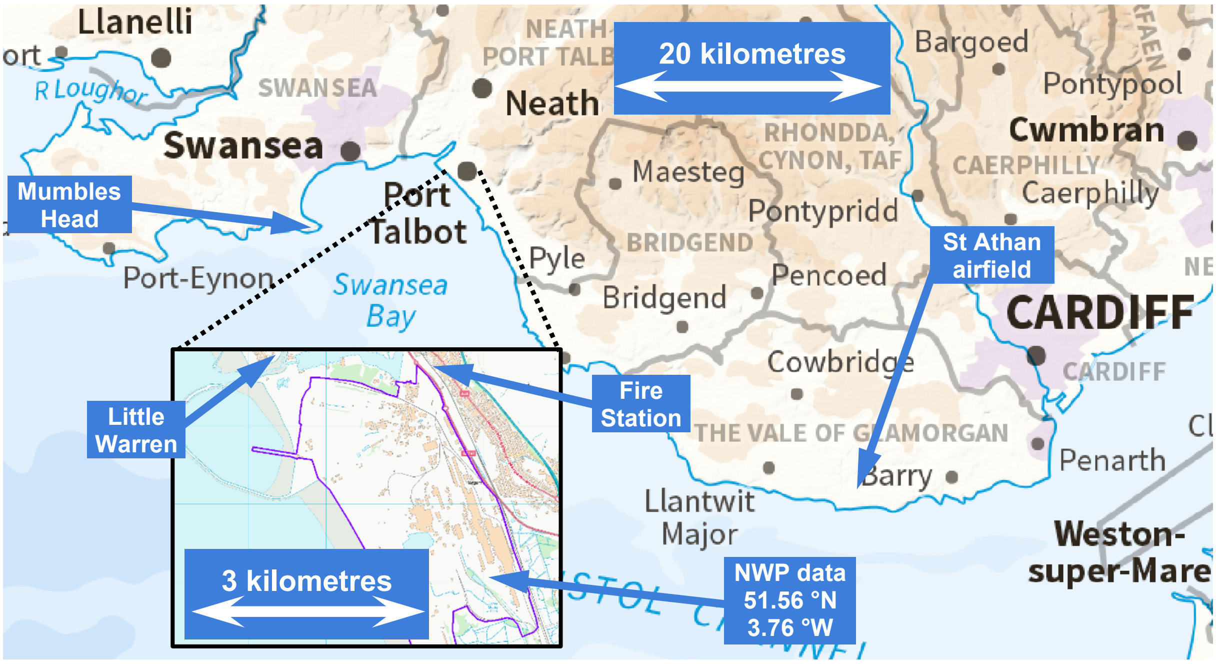

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Figure A2.1: Location of meteorological stations

Figure A2.2 shows five-year wind roses for Little Warren, Mumbles Head, St Athan and the NWP data. The pattern of different wind directions is similar for Little Warren and Mumbles Head, but wind speeds are higher at the latter. The NWP data is also similar to Mumbles Head, but the most frequent wind direction is from 270° for the NWP data and 240° for Little Warren and Mumbles Head. The St Athan wind rose is similar to that for the NWP data, but with more frequent winds blowing from 60°.

Although the NWP and St Athan data are the most complete, they may not be the most representative of the local conditions across the steelworks due to the difference in the most frequent wind direction between these and the measured data at Little Warren and Mumbles Head. For the purposes of this assessment, a composite data set has been created using data measured at Little Warren where available (wind speed, wind direction and temperature), and for parameters not measured at Little Warren (rainfall, cloud cover and relative humidity), contemporaneous data from St Athan have been used instead. The combined data set comprises hourly sequential data from 10/04/12 to 31/12/16 and within this period, valid meteorological data were available for 40,068 hours (96.7% of the time).

For sensitivity analysis, the modelling was also run using the NWP data to determine whether this had a significant impact on the final results.

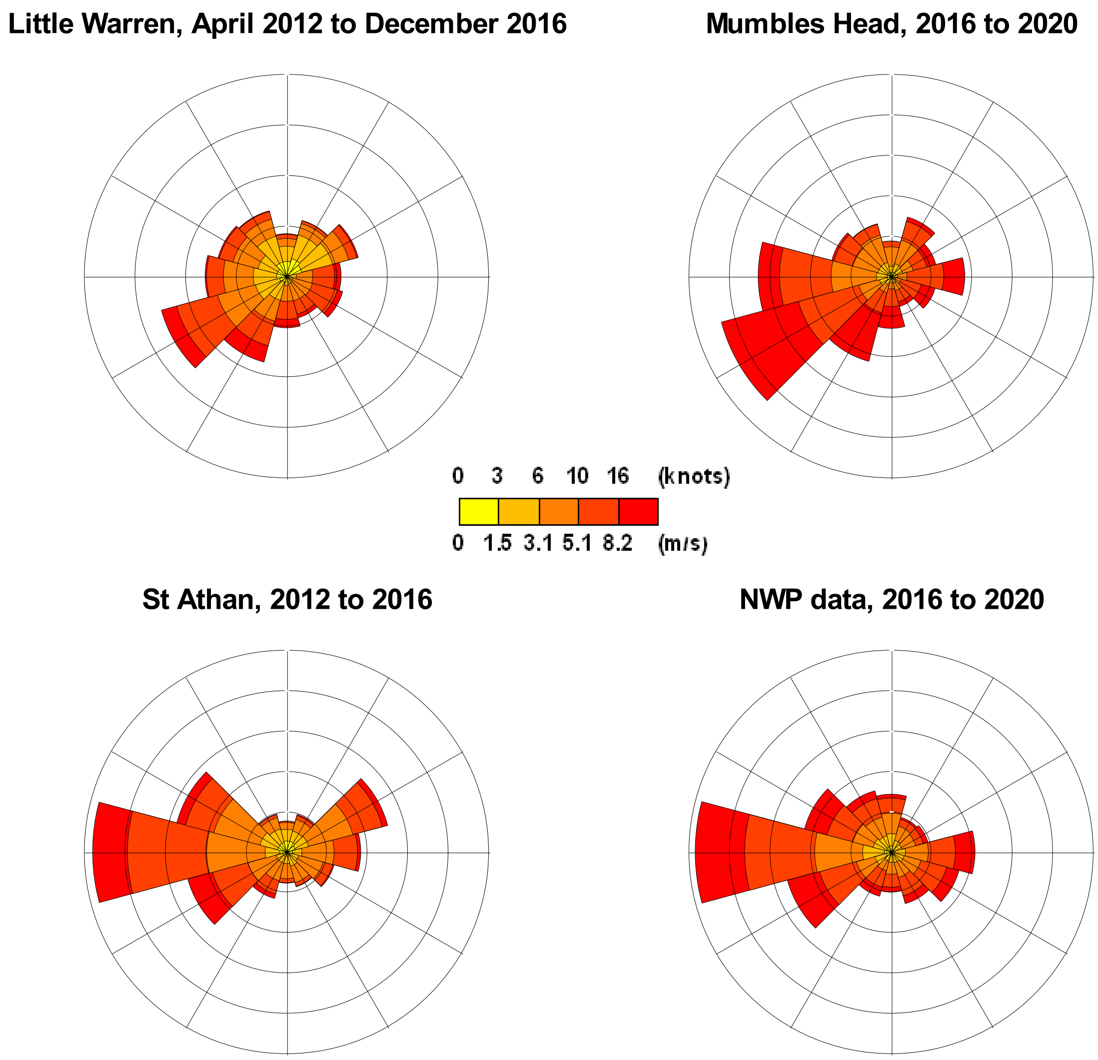


Figure A2.2: Wind roses – outer ring corresponds to 10,000 occurrences

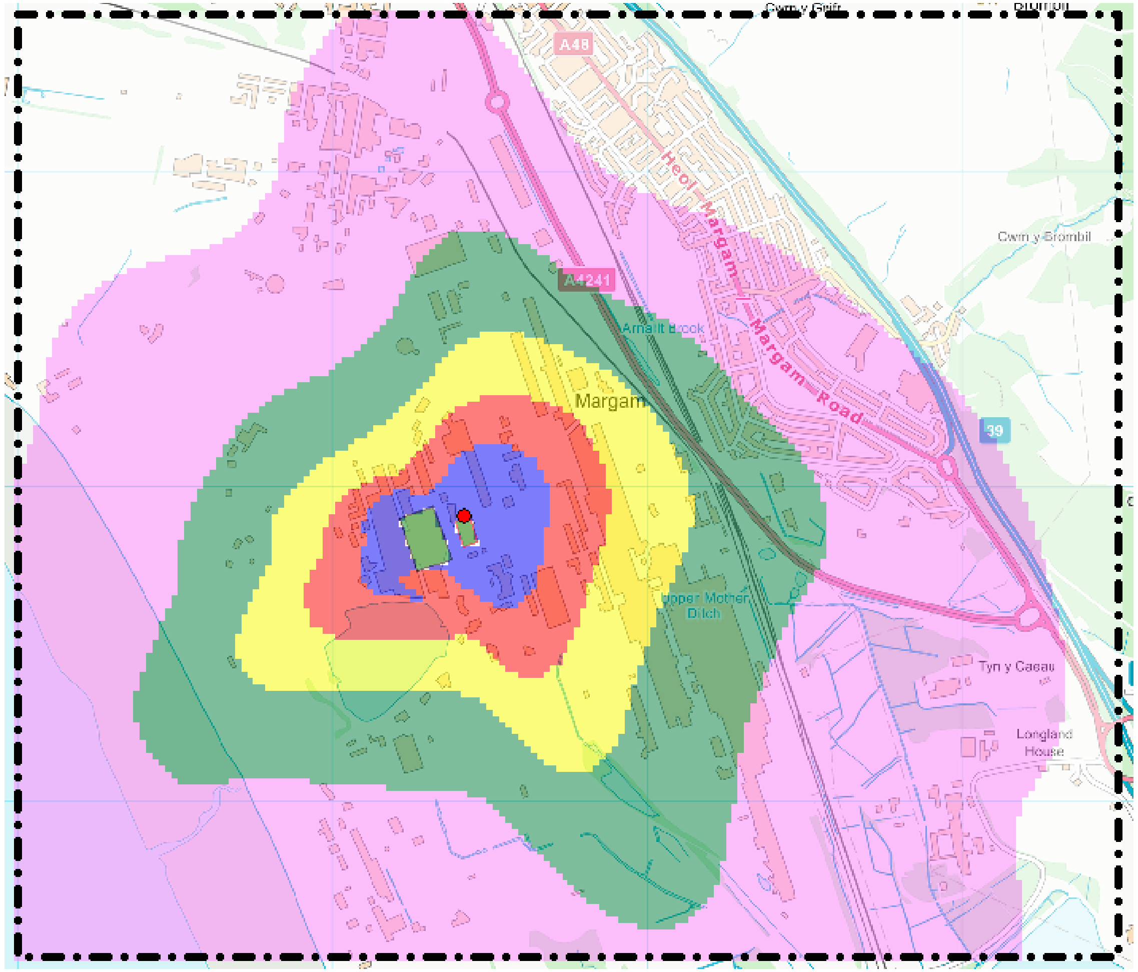
References

A2.1 "ADMS 5 User Guide", version 5.2, November 2016, page 43

A2.2 Air Quality Expert Group, "Understanding PM_{10} in Port Talbot", April 2011, *www.gov.uk/government/publications/understanding-pm10-in-port-talbot*

A2.3 Numerical Weather Prediction Meteorological Data, *https://www.airpollutionservices.co.uk/meteorological-nwp-data/*

Annex 3 – Patterns of dispersion

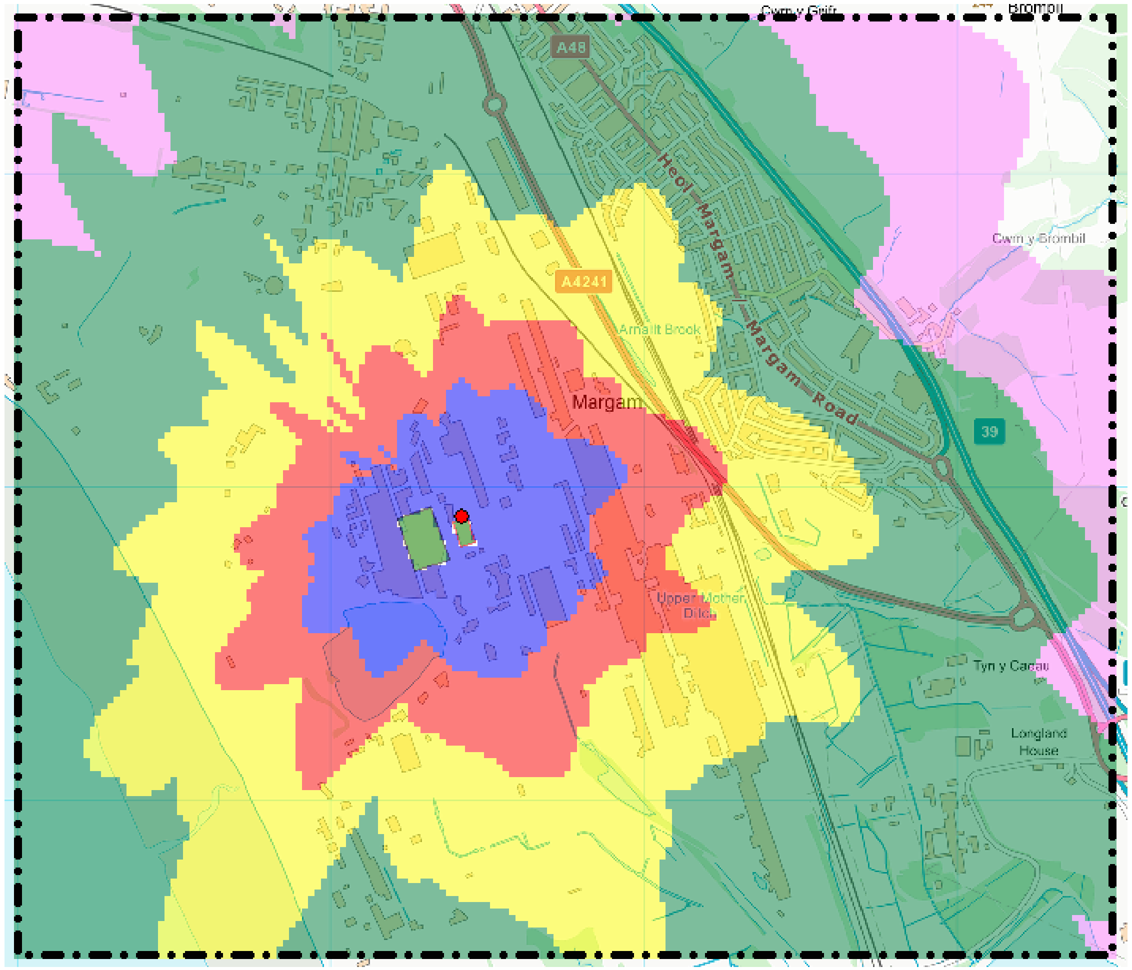


KEY

Long-term average $PM_{10}/PM_{2.5}$ concentrations ($\mu g/m^3$)

- **0.001 – 0.0025**
- **0.0025 – 0.005**
- **0.005 – 0.01**
- **0.01 – 0.025**
- **> 0.025**

Figure A2.1: Process Contribution to long-term average concentrations (Little Warren/St Athan 2012 – 2016 meteorological data)



KEY

Maximum daily average PM_{10}/$PM_{2.5}$ concentrations (µg/m³)

- **0.005 – 0.01**
- **0.01 – 0.025**
- **0.025 – 0.05**
- **0.05 – 0.1**
- **> 0.1**

Figure A2.2: Maximum daily average concentrations (Little Warren/St Athan 2012 – 2016 meteorological data)