MONA AD PLANT ODOUR ASSESSMENT

Grays Biogas Ltd

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1 Summary

1.1 An Odour Modelling Assessment has been undertaken in support of a permit variation application being submitted for an Anaerobic Digestion Plant to be located at Mona Industrial Estate. The purpose of the report was to quantify potential odour impacts at sensitive receptor locations surrounding the site. The assessment was undertaken in accordance with Relevant Natural Resources Wales and Environment Agency odour assessment guidance. The odour modelling exercise has demonstrated the resulting odour concentrations will be significantly below even the most stringent odour assessment criteria at sensitive receptors. As such potential for odour nuisance/impact is considered to be negligible.

2 Introduction

2.1 Background and Context of Assessment

2.1.1 An odour modelling assessment has been undertaken in support of an Environment Permit Variation application being submitted for an Anaerobic Digestion (AD) Facility to be located at Mona Industrial Estate, Anglesey. The assessment has been undertaken to predict the potential odour impacts at surrounding human receptor locations as a result of the proposed operations. Detailed dispersion modelling has been undertaken to predict likely resulting ground level odour concentrations surrounding the proposed plant, which have been compared with the relevant assessment criteria. This has enabled a judgement to be made over whether the plant is likely to have potential to cause statutory nuisance in terms of odour.

2.2 Site Location

2.2.1 The site is located off the A5 road, within the Mona Industrial Estate, at approximate National Grid Reference (NGR) 242029, 375477. Reference should be made to the Appendix I for a map illustrating the site location.

2.3 Proposed Activities

2.3.1 The proposed activities include the operation of an AD plant. AD is a biological process, which breaks down organic matter within biodegradable wastes in the absence of oxygen, through the actions of a variety of micro-organisms. The result of these processes is the production of biogas, which consists predominantly of methane (CH4) and carbon dioxide (CO_2) and a useable digestate product which has environmental benefits when used in place of fertilisers. It is proposed to utilise the biogas to power internal combustion engines for the production of electricity and heat. The electricity produced will be exported to the National Grid.

2.3.2 The feedstocks to be used will include the following, which are annual quantities:

- 15,000 tonnes chicken litter;
- 25,000 tonnes DAF effluent;
- 10,000 tonnes energy crops; and,
- 3,000 tonnes glycerol.

2.3.3 During the initial phase of the project, which is considered within this assessment, digestate will be exported from site without further treatment. The second phase will include separation and drying to produce a compost material. The second phase will be covered by a further permit variation application, at which stage this odour assessment will be updated.

2.3.4 The site has already been awarded full planning permission. An Environmental Permit (EP) was previously issued for the operation of an AD facility at the site. However, since the EP was issued, the site layout, proposed feedstocks and quantities have been revised. As such, an application is required to vary the EP for the site. This report contains a detailed assessment of potential odour arising from the operation, in support of the EP variation application.

3 Odour Legislation and Relevant Guidance

3.1 Consulted Documents

3.1.1 The following documentation has been consulted for the purpose of this assessment:

Legislation and Guidance Documents

- How to Comply with your Environmental Permit, Additional Guidance for: H4 Odour Management, Natural Resources Wales, 2014; and,
- H4 Odour Management: How to Comply with your Environmental Permit, Environment Agency, 2011.

3.2 Regulation of Odour Within the United Kingdom

3.2.1 There are no legislative standards or limits for regulating the concentration of odour in ambient air. Odour is difficult to quantify and its impact is subjective since the response of individuals and groups of people to the same odour can vary significantly. The Local Authority (LA) is obliged, where statutory complaint about odour nuisance is made, to take steps to investigate in accordance with Part III of the Environmental Protection Act (1990). Although the modelling of odour can be used as a tool to indicate the potential for a site to cause odour nuisance, the most useful tool for preventing nuisance from odour is through implementation of appropriate management plans and complaints procedures, given the subjective nature of odour. Such plans will be required to be in place under the EP.

3.3 Important Factors in Determining Odour Impact

3.3.1 The FIDOR acronym is used to outline the combinations of factors that determine the degree of odour pollution/magnitude of impact, as follows:

- Frequency of detection – the more frequent the odour detection, the more likely complaints are;

- Intensity as perceived – the more intense the odour, the more likely complaints are;
- Duration of exposure – the more prolonged the exposure, the more likely complaints are;
- Offensiveness – the more offensive the odour, the more likely complaints are;
- Receptor sensitivity – the higher the sensitivity of receptor, the lower the likely odour threshold above which complaints are likely.

3.4 Odour Assessment Criteria

3.4.1 As outlined above, odour is difficult to quantify and it's impacts are highly subjective. To simplify this problem, odour concentrations can be expressed as the number of odour units per metre cubed of air ($OU.m^{-3}$). Odour units are the measure of odour concentration within a compound/mixture of compounds and can be determined by means of olfactometry. For any given compound/mixture of compounds, 1 $OU.m^{-3}$ is the point above which the compound(s) can be detected. However, some odours are more offensive than others. For example an odour concentration of 1 $OU.m^{-3}$ resulting from a chocolate manufacturing process would be considered less offensive than from a biological landfill. Therefore, odour annoyance potential criteria have been developed by the Environment Agency (EA), which are known as benchmark levels for odour, above which there would be considered to be potential for odour annoyance. The benchmarks are based upon the 98th percentile of hourly average concentrations for odour modelled over a year as follows:

- 1.5 odour units for the most offensive odours;
- 3 odour units for moderately offensive odours; and,
- 6 odour units for less offensive odours.

3.4.2 EA H4 guidance provides broad categorisation of odour offensiveness as follows:

- Most offensive – processes involving decaying animals or fish remains, processes involving sceptic effluent or sludge, and biological landfill odours;
- Moderately offensive – intensive livestock rearing, fat frying (food processing), sugar beet processing and well aerated green composting; and,
- Less offensive – brewery, confectionary, coffee roasting and bakery.

3.4.3 In lieu of specific guidance on odour thresholds in the Natural Resources Wales (NRW) guidance, the above EA guidance has been used to establish suitable odour thresholds to use.

3.4.4 It is clear from the EA H4 guidance that the potential odours from the AD plant can be described as 'moderately offensive, given the feedstocks to used, which are most similar to intensive livestock rearing (chicken litter and DAF from dairy farms) and green composting (grass and maize silage). Therefore, a benchmark of 3 OU.m^{-3} is considered most appropriate when considering potential for impact.

3.4.5 Given the highly conservative assumptions used in the model (discussed later), it can be assumed that provided the odour criteria of 3OU.m^{-3} is not exceeded at sensitive receptors, that the proposals will not have significant potential to create odour nuisance.

4 Baseline Position

4.1 Site Context

4.1.1 The proposed site is located in a rural location with other potential sources of odour in the vicinity, including the poultry farm to the North.

4.2 Sensitive Receptors

4.2.1 Discrete sensitive human receptors have been identified for inclusion within the model. Table 1 contains a list of all identified sensitive receptors within the vicinity of the proposed plant, which would be most sensitive to odour. Where these are referred to in the report, they are identified as O1 to O4. These are all residential receptors. Reference should be made to Appendix II for a graphical representation of receptor locations. The identified NGR for each receptor represents the nearest point to the proposed site boundary in order to ensure a 'worst case' assessment.

Table 1 Identified Odour Sensitive Receptor Locations

Odour Receptor Identifier	Odour Sensitive Receptor Description	National Grid Reference (m)	
		X	Y
O1	Fronleu Haulfre	242094	375822
O2	Mathafarn	242212	375540
O3	Cae Eithin	241940	375214
O4	Tyn Rhos	241141	376205

5 Modelling Methodology

5.1 Model Description

5.1.1 The potential air quality impact that may arise through emissions of odour during operation of the AD facility has been quantified using AERMOD, which is a steady state, next generation, dispersion model. AERMOD was developed jointly by the American Meteorological Society (AMS) and the United States (US) Environmental Protection Agency (EPA) Regulatory Model Improvement Committee. The AERMOD model is a development from the ISC(Industrial Source Complex) 3 dispersion model and incorporates improved dispersion algorithms and pre-processors to integrate the impact of meteorology and topography within the modelling output, and is approved for use within the UK by EA and NRW. The version of AERMOD that has been used for this current assessment is Lakes Environmental ISC-AERMOD View Version 9.0.0. The model has been run using the most recent version of the AERMOD executable file, 15181.

5.2 Model Inputs

5.2.1 Odour Emissions and Sources

5.2.1.1 There are no emission limit values for odour. In the absence of site specific odour monitoring information, which is not available given that the site is yet to be developed, an estimation of odour emissions has to be made. There is potential for odour to arise during the storage and handling of feedstocks and from the digestate during loading from the post-digester/digestate storage tank to the tanker lorry.

5.2.1.2 Glycerol is an odourless feedstock. As such, the handling and storage of this feedstock does not present a potential source of odour. The DAF effluent will be delivered to site in sealed tankers, unloaded to an enclosed tank via enclosed delivery line. Chicken litter will be delivered to site via sheeted trailers, deposited to a chicken litter storage shed with fast acting roller/shutter doors. An Odour Control System will be used to control odours arising from the DAF tank vents and chicken litter storage shed, with residual exhaust air vented via a vertical flue located adjacent to the chicken litter shed. Reference should be made to the Odour Management Plan for more details on the Odour Control Unit.

5.2.1.3 Reference should be made to Appendix I for a site layout plan. The potential sources of odour include the following:

- Exposed silage in the silage clamp;
- Exposed silage during transfer to the solids feeder;
- Chicken litter during storage within the building;
- Chicken litter during transfer to the solids feeder; and,
- Digestate during transfer to tankers.

5.2.1.4 Within the following sections, reference to working day(s) includes the following hours of operation:

- Monday to Friday 07:00 to 19:00
- Saturdays 07:00 to 16:00
- Sundays 09:00 to 16:00

Silage

5.2.1.5 It is understood that the silage will predominantly comprise of maize and grass, although other energy crops may be used. Reference has been made to odour monitoring data reported in literature for other sites[1,2]. On this basis, an odour emission rate of 25 $OU.m^2.s^{-1}$ has been assumed for the silage, which is the upper end of the datasets considered. The silage clamp will be covered when material is not being deposited/extracted for use in the process. It is anticipated

1 Courtenhall Anaerobic Digestion Facility, Local Air Quality Assessment, SLR/Agrivert, August 2008
2 Odour Impact Assessment for a Proposed Crop CHP plant at Stoke Bardolph, Odournet, May 2008

that silage would be delivered in covered vehicles and the clamp only uncovered during the short time for delivery. Therefore, potential odour emissions during delivery of silage are anticipated to be minimal. As a highly conservative, worst case assessment, it has been assumed that the end of the silage clamp will be exposed during the whole course of a working day. In reality, the end of the clamp is only anticipated to be exposed for up to 30 minutes each day whilst material is being extracted for use in the process. Therefore, this assessment provides a significant overestimation of potential impacts. The exposed silage clamp has been modelled as an area odour emission source, with a surface area of 256.2m^2 and release height of 3.05m and with an odour emission rate of 25 OU.m^2.s^{-1}.

Chicken Litter Building and DAF Effluent Tanks

5.2.1.6 Chicken litter will be delivered into an enclosed reception building with fast acting roller shutter doors. Odour during delivery will be prevented as trailers will be covered. DAF effluent will be delivered to site within enclosed tankers, unloaded to dedicated storage tanks, thus preventing odour during delivery of the effluent to the site. Odour arising from the chicken litter shed and DAF tank vents will be controlled by a dedicated odour abatement system. The system manufacturer has advised that the unit will be designed to meet a residual odour concentration of <5 OU.m^{-3}. Residual odour arsing from the control unit has been modelled as a vertical point source emission. The system manufacturer has advised that the vent will have an exhaust velocity of 3,500m^3.hour^{-1}. Based on the residual odour concentration, this will result in an odour emission rate of 4.86 OU.s^{-1}, which has been used in the model.

Odour During Transfer of Silage and Chicken Litter to Feed Hoppers

5.2.1.7 There is potential for odour to arise from the chicken litter during transfer from the reception hall to the solids feeder and from silage during transfer from the clamp to the feed hopper.

5.2.1.8 It is anticipated that up to 35 tonnes of chicken litter will be loaded to the process each day. The chicken litter will be loaded to the feed hopper using rubber wheeled shovel and the site operator has estimated that the loading process will total 45 minutes each day as a maximum duration. In order to determine an emission value for the poultry litter, reference has been made to odour monitoring data reported in literature[3], which outlines an odour emission rate of 77 $OU.m^2.s^{-1}$ for poultry manure. The transfer route between the chicken litter shed and feed hopper has been represented by an area emission source within the model with a surface area of $108.5m^2$ and it has been assumed that odour arises continuously from this source throughout the entire course of the working day. The poultry manure will be transferred by bucket loader. It is anticipated that each load will only result inPage approximately $3m^2$ to $9m^2$ of litter being exposed at any one time. The model provides a highly conservative, worst case assessment, since it has been assumed that poultry manure is continuously exposed throughout the entire course of the working day throughout the entire surface area of the assumed transfer route.

5.2.1.9 The transfer route between the silage clamp and feed hopper has been represented by an area emission source within the model with a surface area of $118.9m^2$ with an odour emission rate of 25 $OU.m^2.s^{-1}$ and it has been assumed that silage is continuously exposed during the whole of each working day. This provides a highly conservative, worst case assessment, since it has been assumed that silage is continuously exposed throughout the entire surface area of the assumed transfer route when the load will occupy a small fraction of this area at any given time. Furthermore, the total transfer and loading time per day is estimated as 30 minutes. Therefore, the model provides a highly conservative estimate of potential emissions.

<u>Feed Hoppers</u>

5.2.1.10 The feed hopper will be closed when not being loaded with feedstocks, thus preventing odour emission. During loading operations, odour abatement in the form of an odour neutralising spray will be used to minimise potential odour

[3] Sniffer ER26: Final Report, March 2014 – SCAIL Agriculture, 2014.

emission from the feed hoppers. More details on this system can be found within the Odour Management Plan. Given the above, the feed hoppers themselves are not considered to present a significant source of odour and have not therefore been considered further within this assessment.

Digestate

5.2.1.11 Digestate will be stored within an enclosed tank prior to removal from site. Therefore, there will be no odour arising from the storage of digestate. The digestate is to be removed from site via sealed tanker lorry, the digestate pumped from the tank to the tanker via enclosed pipework. Air will be displaced from the tankers whilst the filling operation takes place, which is a potential source of odour. Based upon monitoring data presented in the literature[4], an odour emission concentration of 100,000 $OU.m^{-3}$ has been assumed within the displaced air. Digestate will be exported from the site within 44 tonne tanker lorries. It has been assumed that each tanker would take up to 30 minutes to fill. The volume of each tanker is approximately $44m^3$, resulting in a volumetric displacement of air of $0.024m^3.s^{-1}$. Based on the potential odour emission concentration, this works out at an emission rate of 2,444.4 $OU.s^{-1}$, which has been modelled as a vertical point source emission. As a highly conservative, worst case assessment, it has been assumed that the digestate filling operation takes place continuously throughout the entire working day.

Summary of Odour Emission Sources and Parameters

5.2.1.12 The following table provides a summary of odour emission sources and parameters assigned within the model. Reference should be made to Appendix I for a plan illustrating emission source locations. Digestate may be loaded to tankers from either the post-digester or storage tanks. The model was run for each scenario to ensure a robust assessment of potential impacts.

4 Odour Impact Assessment of a Proposed Anaerobic Digester Facility in Anglesey, Odournet UK ltd, December 2010.

Table 2 Summary of Odour Emission Sources and Parameters Assigned in Model

Odour Source	Type of Emission Source	Point Source Diameter (m)	Exhaust Flow Rate ($m^3.s^1$)	Odour Emission Rate	Area of Emission Source (Area Source Emission) (m^2)	Release Height (m)	Release Temperature
Vent on Odour Control Unit serving DAF effluent tanks and chicken litter shed	Point Source	0.35	0.972	4.861 $OU.s^{-1}$	-	12	Ambient
Vent on Digestate Tanker	Point Source	0.5	0.024	2444.4 $OU.s^{-1}$	-	2	Ambient
Silage Clamps	Area Source	-	-	25 $OU.m^2.s^{-1}$	256.2	3.05	-
Transfer of silage to feed hoppers	Area Source	-	-	25 $OU.m^2.s^{-1}$	118.9	1	-
Transfer of chicken litter to feed hoppers	Area Source	-	-	77 $OU.m^2.s^{-1}$	108.5	1	-

5.2.2 Building Downwash

5.2.2.1 The on-site structures were digitised within the model from site layout and height information provided by the site operator. As the closest buildings to the odour emission sources, these would be expected to have an influence on pollutant dispersion from point source emissions. Table 3 contains information on building dimensions assigned within the model. Reference should be made to the drawing in Appendix I for details of structure locations.

Table 3 Building and Structure Heights

Structure	Max Height (m)	Length and Width (m)	Diameter (m)
Storage Tank	14.45	-	25.31
Post Digester	14.45	-	24.93
Digester 2	12.63	-	18.98
Digester 1	12.63	-	19.08
Chicken Litter Storage Building	10.02	15.99 x 8.29	-
Drying Hall	8.58	14.65 x 28.13	-
Silage Clamp	6.1	46 x 53	-
Compost Hall	7.38	13.25 x 13.62	-
Glycerol Tank	6.4	-	4.4
DAF SCC1	7.2	-	4.06
DAF SCC2	7.2	-	4
DAF Glambia	6.4	-	3.75
Feedstock Hoppers	3	13.72 x 2.71	-
Hydronisation Tanks	5.4	-	2.5
Buffer Tank	5.4	-	3.17
PW Tank	5.4	-	3.25
CHP	4.420	13.8 x 3.4	-

5.2.2.2 The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. All building structures were input into the BPIP processor.

5.2.3 Meteorological Data

5.2.3.1 Meteorological data used in this assessment was obtained from Valley meteorological station, including missing cloud cover data from Liverpool. Valley meteorological station is located approximately 11km to the West of the proposed site.

5.2.3.2 Five years of meteorological data observed between 2004 and 2008 was used within the assessment. Data was supplied by ADM Ltd, an established distributor of met data within the UK. The AERMET processor within AERMOD was used to process the data to be site specific. US EPA guidance on processing met data for use within AERMOD states that land use up to 1km upwind from a site should be considered when determining surface roughness characteristics, whilst for Bowen ratio and albedo, land use types within a 10km by 10km area centred over the site should be considered[5]. The land use over the 10km by 10km area is dominated by rural and cultivated land, which make up approximately 90% of the land coverage. The remaining 10% consists of buildings and trees. AERMOD guidance states that albedo and bowen ratio should be calculated as the arithmetic and geometric mean respectively of land use types over the 10km by 10km grid, not weighted by direction or distance. In terms of surface roughness, land use surrounding the site consists of scattered trees, hedges and buildings, therefore, a surface roughness factor of 0.3 was considered appropriate.

5.2.3.3 The parameters use to process the meteorological data are contained within Table 4

Table 4 Parameters for Surface Roughness, Albedo and Bowen Ratio

Parameter	Directional Sector	Value
Surface Roughness	All	0.3
Albedo	All	0.239
Bowen Ratio	All	0.8608

5.2.4 Assessment Area

5.2.4.1 A 1,250m x 1,250m uniform Cartesian receptor grid was used to represent the modelling domain with a grid spacing of 25m. In addition, discrete Cartesian receptors were included as model inputs. The receptor heights were set at ground level.

5 AERMOD Implementation Guide, US EPA, 2015.

5.2.5 Modelled Scenarios

5.2.5.1 The scenarios modelled are contained within Table 5. These were modelled for each year of meteorological data. The model was used to model 98th percentile 1-hour mean odour concentrations.

Table 5 Modelled Scenarios

Scenario	Modelled Scenarios
Scenario1	98th percentile 1-hour mean odour concentrations. Based on digestate being loaded from post-digester to tanker
Scenario 2	98th percentile 1-hour mean odour concentrations. Based on digestate being loaded from storage tank to tanker

5.2.6 Model Uncertainty and Error

5.2.6.1 It is widely accepted that there can be a significant degree of uncertainty in predictions made by any atmospheric dispersion model, which needs to be taken into account when assessing modelled results. As the site is not operational, this report has based odour emission rates on data contained within literature, which is based on data from other sites and it is acknowledged that such emission rates can vary from site to site. However, a series of highly conservative assumptions have been used in this assessment which are considered to provide a high level of confidence that that the odour model predictions present a highly conservative, worst case assessment.

6 Model Results

6.1 The tables below present the modelled 98th percentile 1-hour mean odour concentrations at sensitive receptor locations for each scenario. As is shown, modelled 98th percentile 1-hour mean odour concentrations are predicted to be significantly below the relevant assessment criteria of 3 $OU.m^{-3}$ at all sensitive receptors and as such, odour impacts are not predicted to be significant. It should also be noted that modelled 98th percentile 1-hour mean odour concentrations are also significantly below the most stringent odour assessment criteria of 1.5 $OU.m^{-3}$ at all sensitive receptors. Reference should be made to Appendix III for odour contour profiles for all assessment years for each scenario which illustrate modelled odour concentrations at all locations in the vicinity of the plant.

Table 6 Resulting 98th Percentile 1-Hour Mean Odour Concentrations – Scenario 1

Receptor	98th Percentile 1-Hour Mean Odour Concentrations ($OU.m^{-3}$) For Each Assessment Year				
	2004	2005	2006	2007	2008
01	0.289	0.255	0.304	0.311	0.339
02	0.425	0.407	0.413	0.509	0.498
03	0.202	0.271	0.169	0.215	0.184
04	0.003	0.004	0.005	0.004	0.004

Table 7 Resulting 98th Percentile 1-Hour Mean Odour Concentrations – Scenario 2

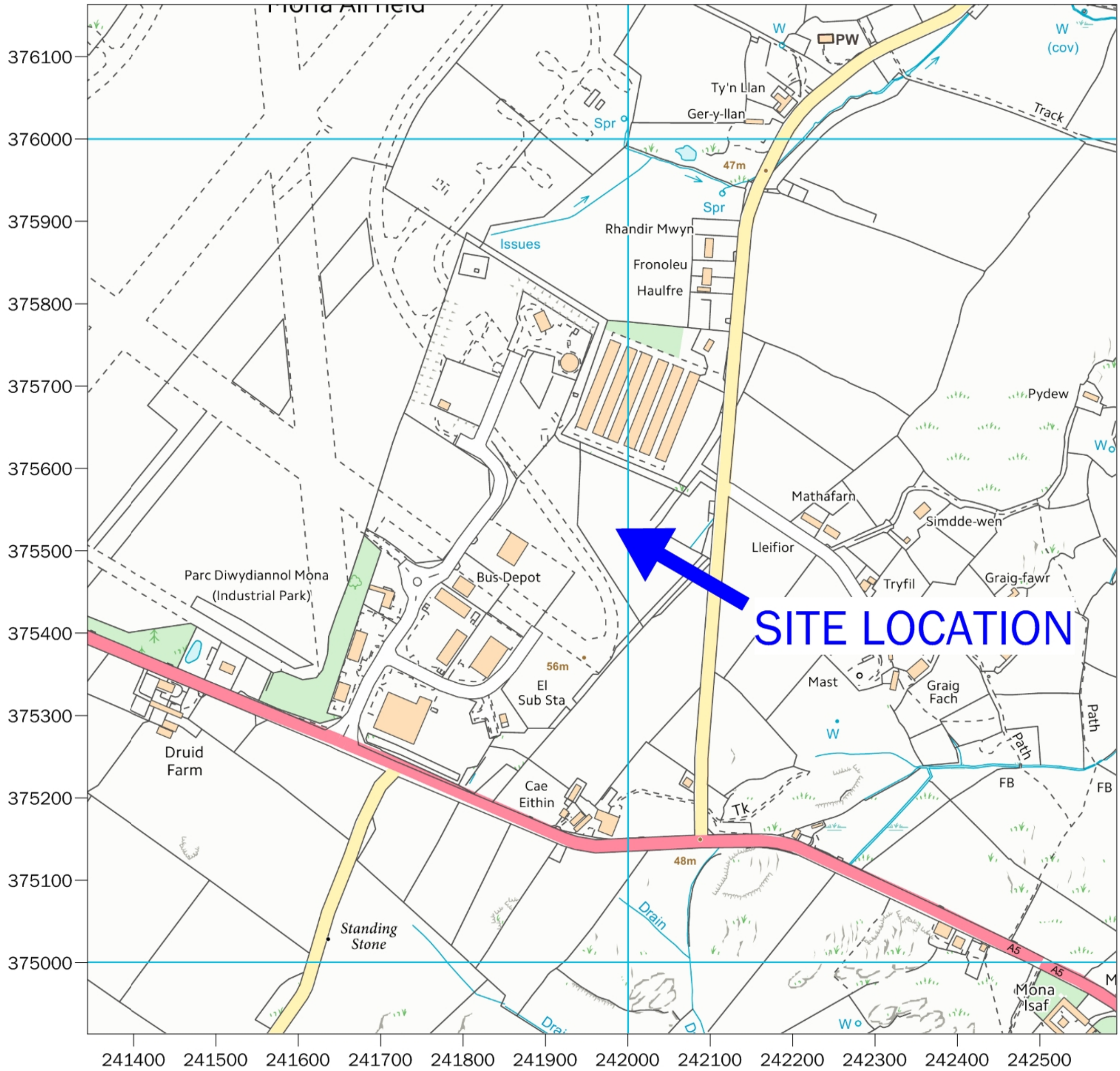
Receptor	98th Percentile 1-Hour Mean Odour Concentrations ($OU.m^{-3}$) For Each Assessment Year				
	2004	2005	2006	2007	2008
01	0.281	0.256	0.336	0.329	0.354
02	0.431	0.405	0.412	0.508	0.508
03	0.199	0.255	0.173	0.207	0.176
04	0.003	0.004	0.005	0.004	0.004

7 Conclusions

7.1 A detailed assessment of potential odour arising from the operation of an AD plant at Mona Industrial Estate has been undertaken using AERMOD. The model has incorporated potential sources of odour as emission sources including the storage, handling and processing of solid and liquid feedstocks and products. The modelled odour levels at sensitive receptors have been predicted to be significantly below even the most stringent odour impact assessment criteria and therefore the risk of significant odour impact at sensitive receptors is considered to be negligible. Given the series of highly conservative worst case assumptions used in the assessment, the confidence in this prediction is considered to be high.

Appendix I

Site Location and Layout Plans



Appendix I - Site Location Map

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POST
Assumed line of buried cable
Chain-Link Fence Ht 1.3
2.4m HIGH PALISADE FENCING
Emergency Flare
Storage Tank
Post Digester
Digester
Crane Base
BELOW GROUND STORAGE TANK
Gas Cooling
Pump Room
optional Biofilter
Attenuation pond
Assumed Line of Drain
Pipe
SIGN
Bushes
STNBASE
sliding gate
former wood storage area
Tarmac
Grass
Weighbridge
3.65m WIDE ACCESS ROAD
optional office
MH CL:56.53 IL:54.04
MH CL:56.74
MH CL:56.94
MH CL:55.23 IL:51.58
MH CL:55.57 IL:52.24
MH CL:55.72
BELOW GROUND LEACHATE TANK
BELOW GROUND PETROL INTERCEPTOR
from clamps
from sec. clm
SICLAMP1
SICLAMP2
SICLAMP3
SICLAMP4
EASEMENT TO FOUL SEWER
C
B
A 02.12.2015 V.Abels J.Weyer EYS, LV Station, pump leachate tank, compost hall, siclamps, CHP, gateway, weighbridge
Rev. Date Drawn Checked Revision
Project: A2529UK_MONA
State Of Planning: draft
Drawing Title: General Layout overview
Client:
Plan Author: agraferm technologies
Agraferm Technologies AG
Färberstraße 7
D-85276 Pfaffenhofen/Ilm
www.agraferm.com
Drawn Checked
Date 08.10.2015
Name V.Abels
Rev: A
Sheet Size: A0
Scale: 1:250
Drawing No.: A2529UK_MONA-00-01-layout
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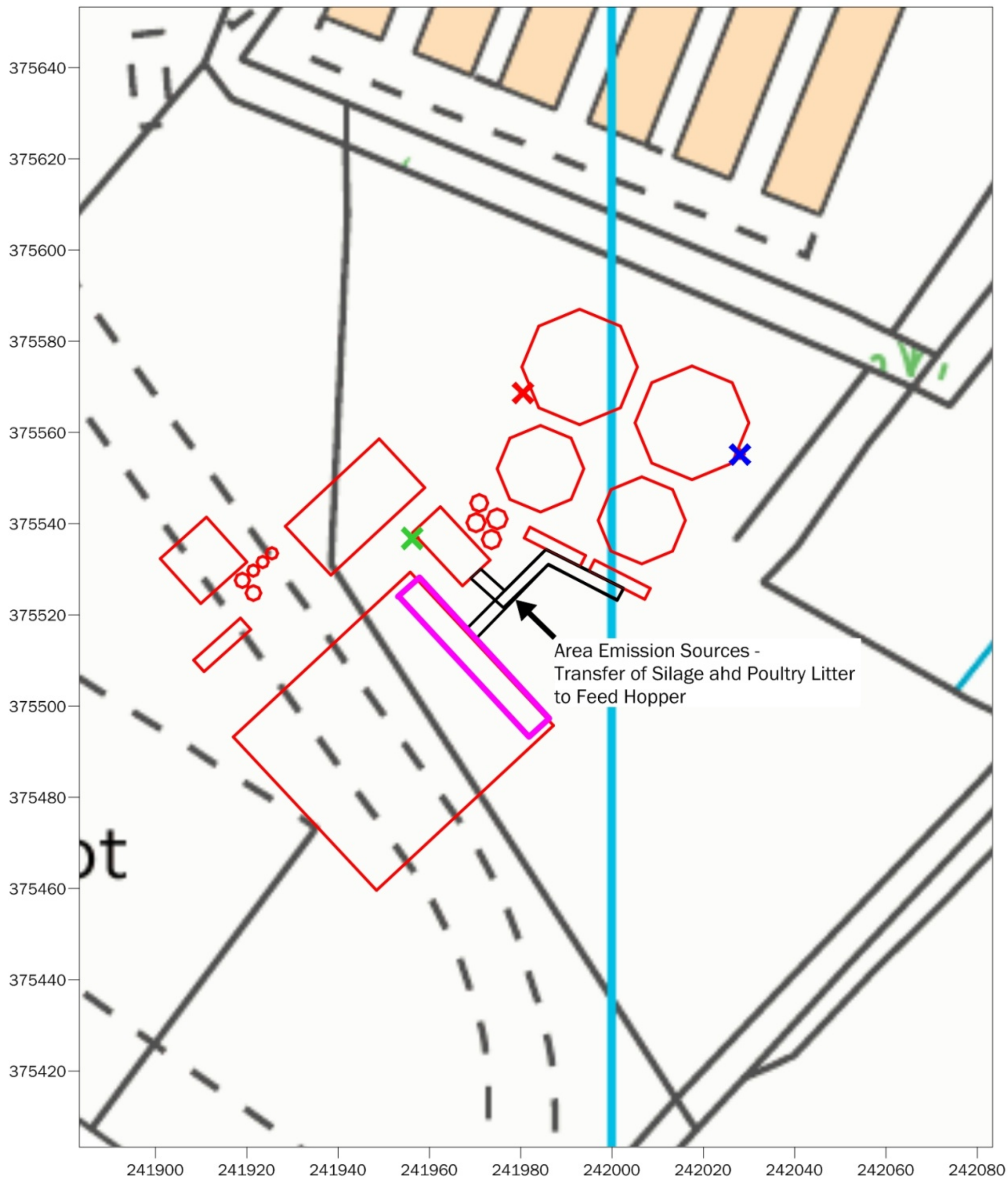

Appendix I - Buildings and Emission Sources Digitised within Model

- Point Source Emission - Chicken Litter Building/DAF Tank Control Unit
- Point Source Emission - Digestate Tanker (Scenario 2)
- Point Source Emission - Digestate Tanker (Scenario 1)
- Area Source Emission - Silage Clamp

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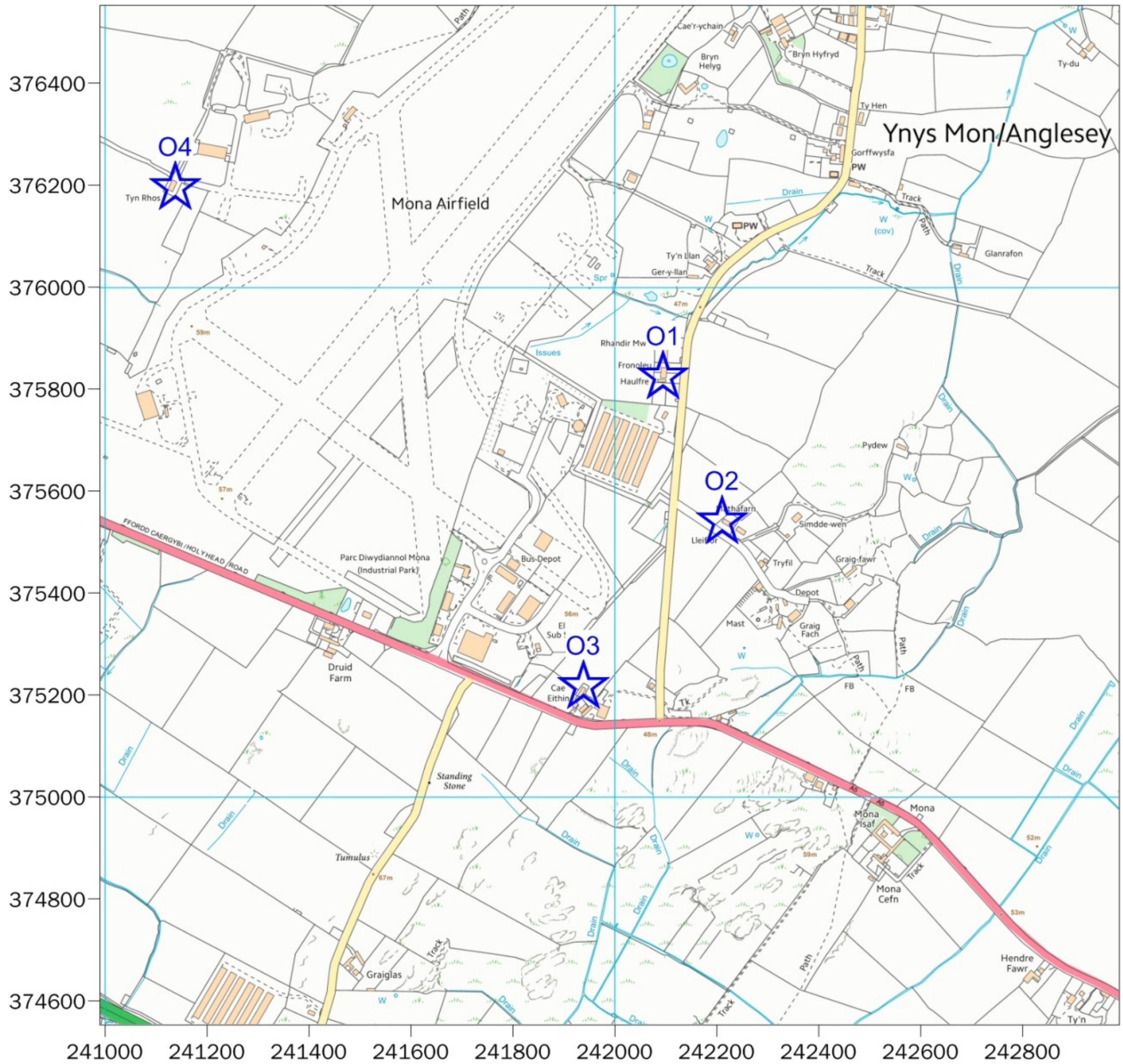
Appendix II

Odour Sensitive Receptor Locations



Appendix II Figure 1 - Odour Sensitive Receptors

☆ Odour Receptor Location

O1 Odour Receptor Identifier

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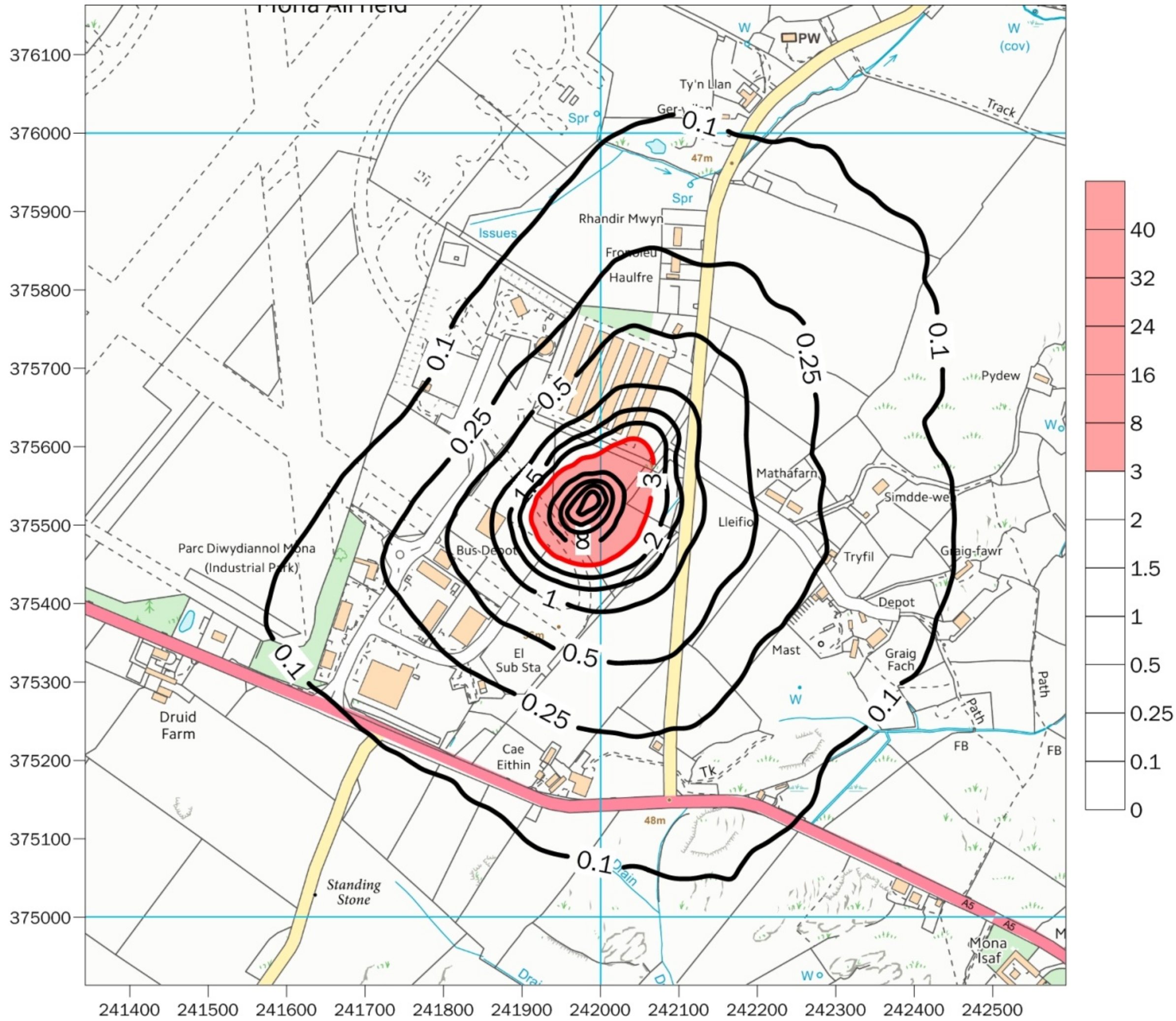
N.B - Map contains Ordnance Survey data

Appendix III

Odour Contour Profiles



Appendix III Figure 1 - Scenario 1 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2004 Meteorological Data (OU.m^{-3})

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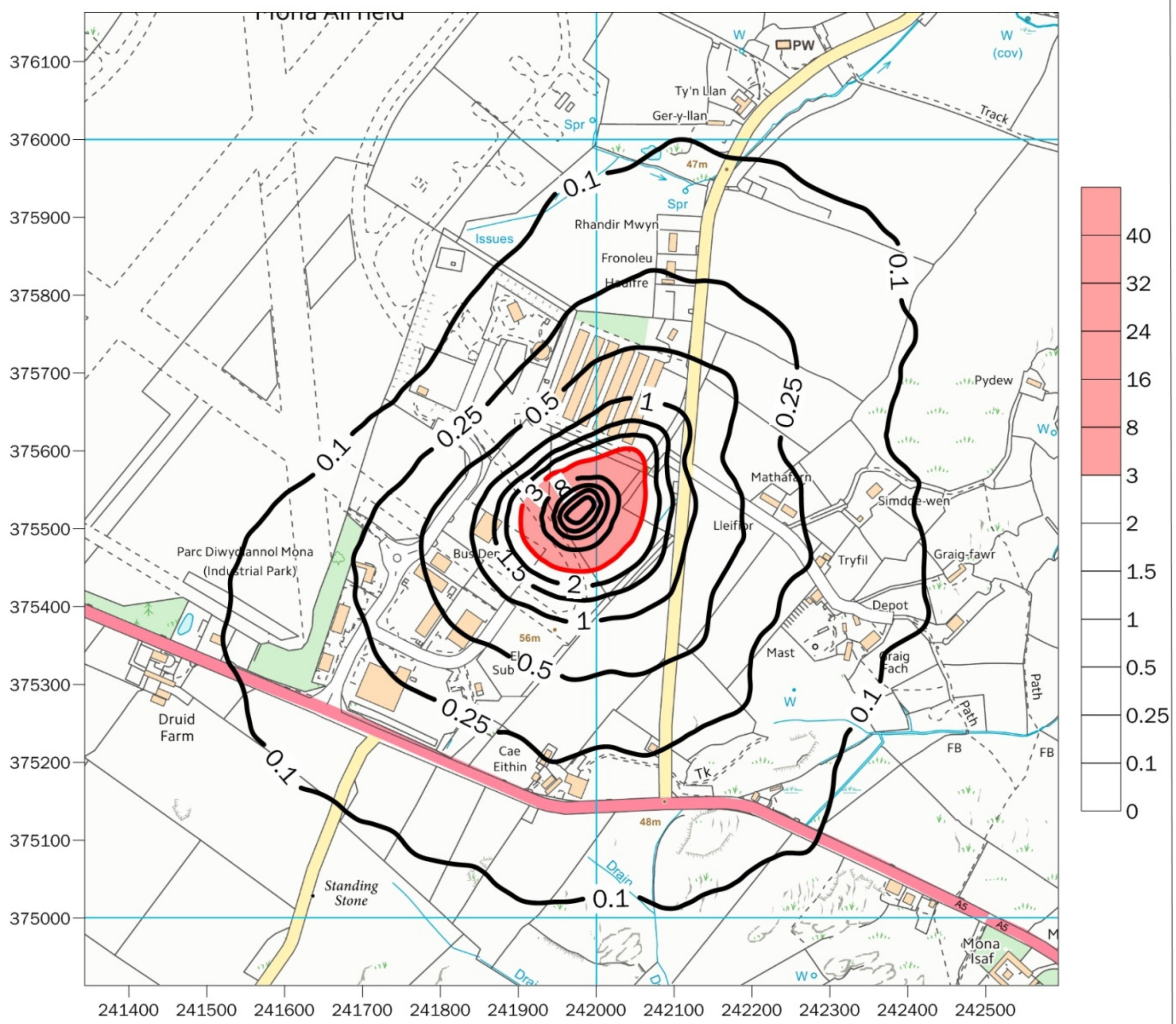

Appendix III Figure 2 - Scenario 1 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2005 Meteorological Data ($OU.m^{-3}$)

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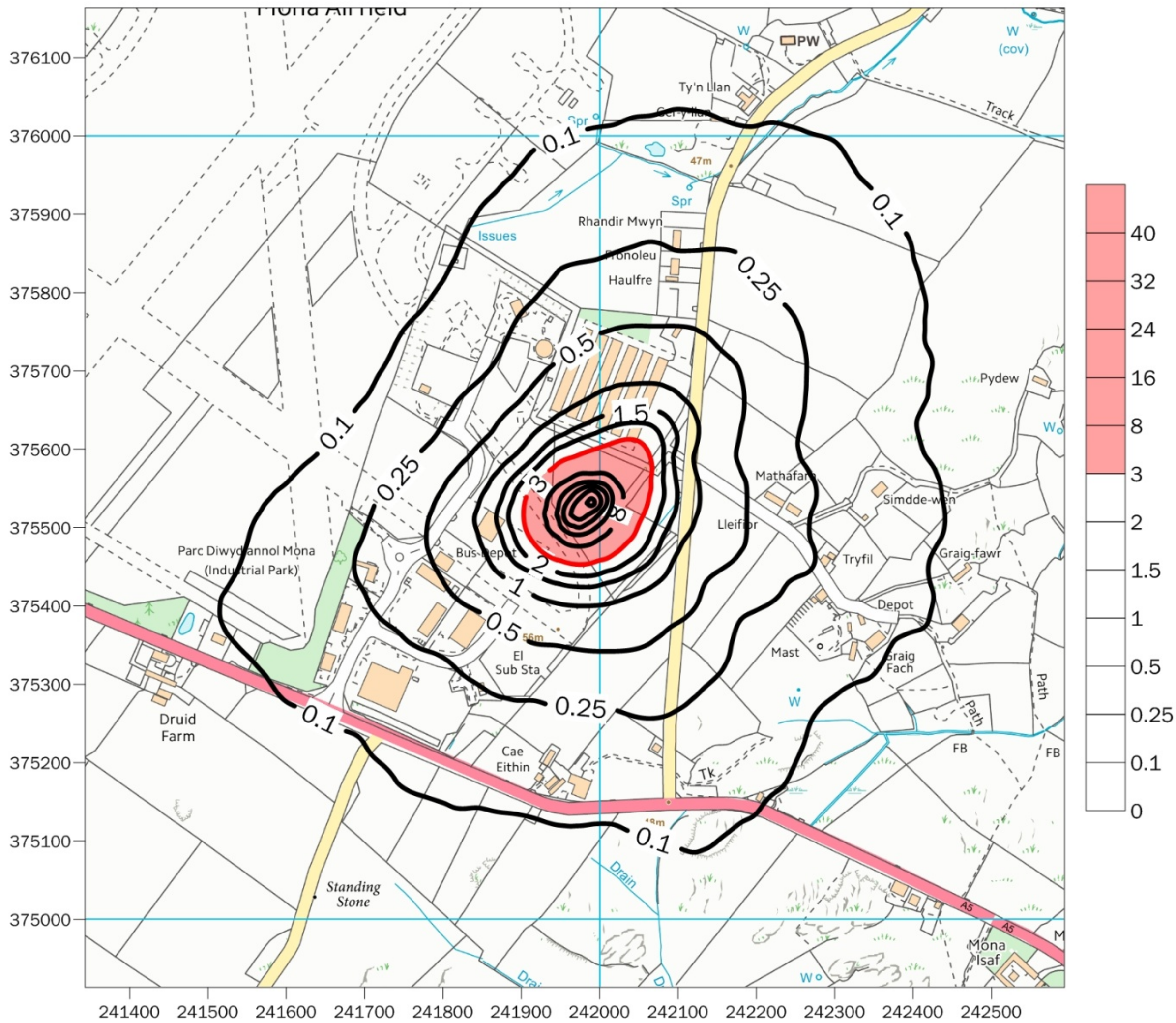
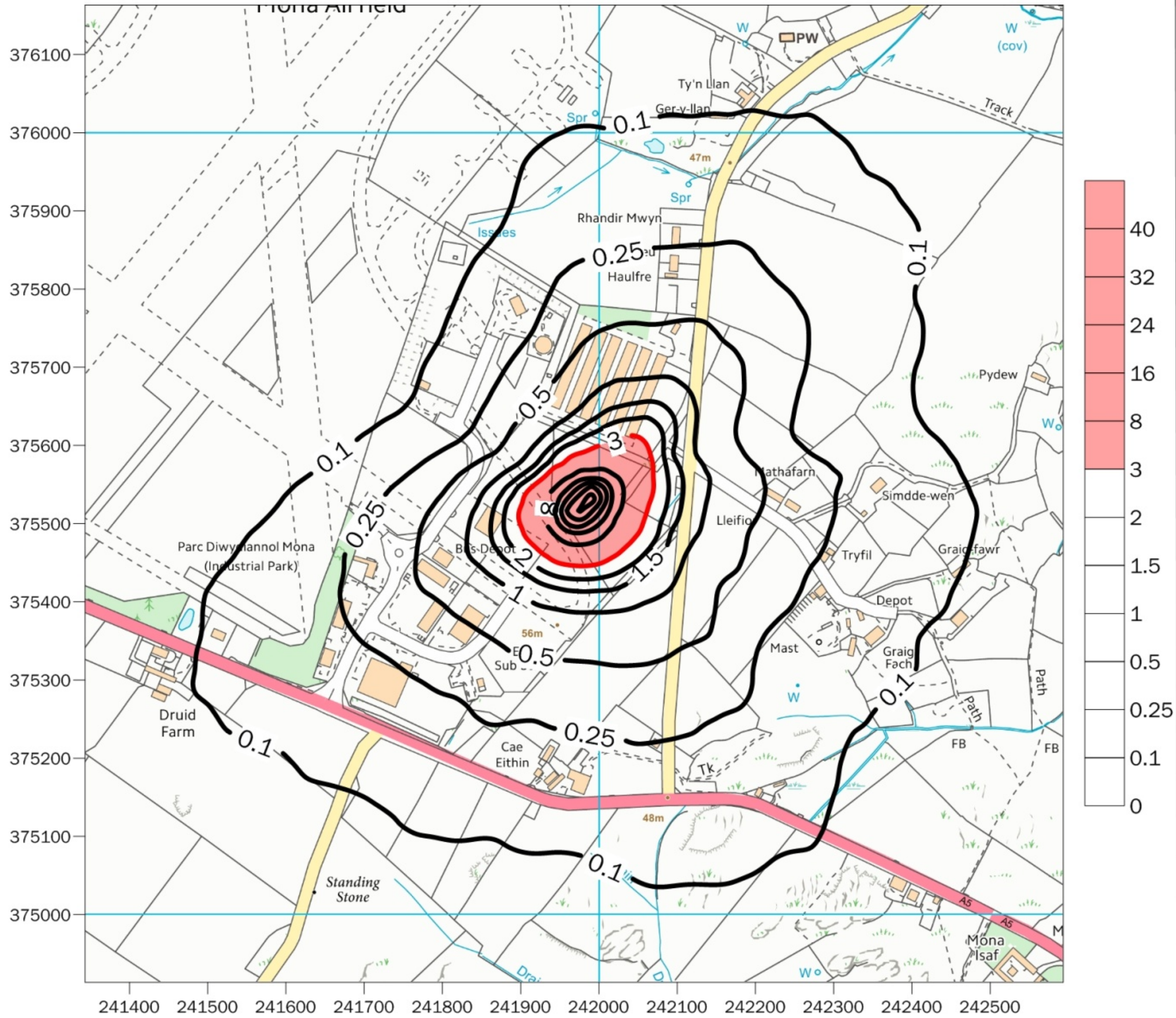
Cheshire
CW7 3RY



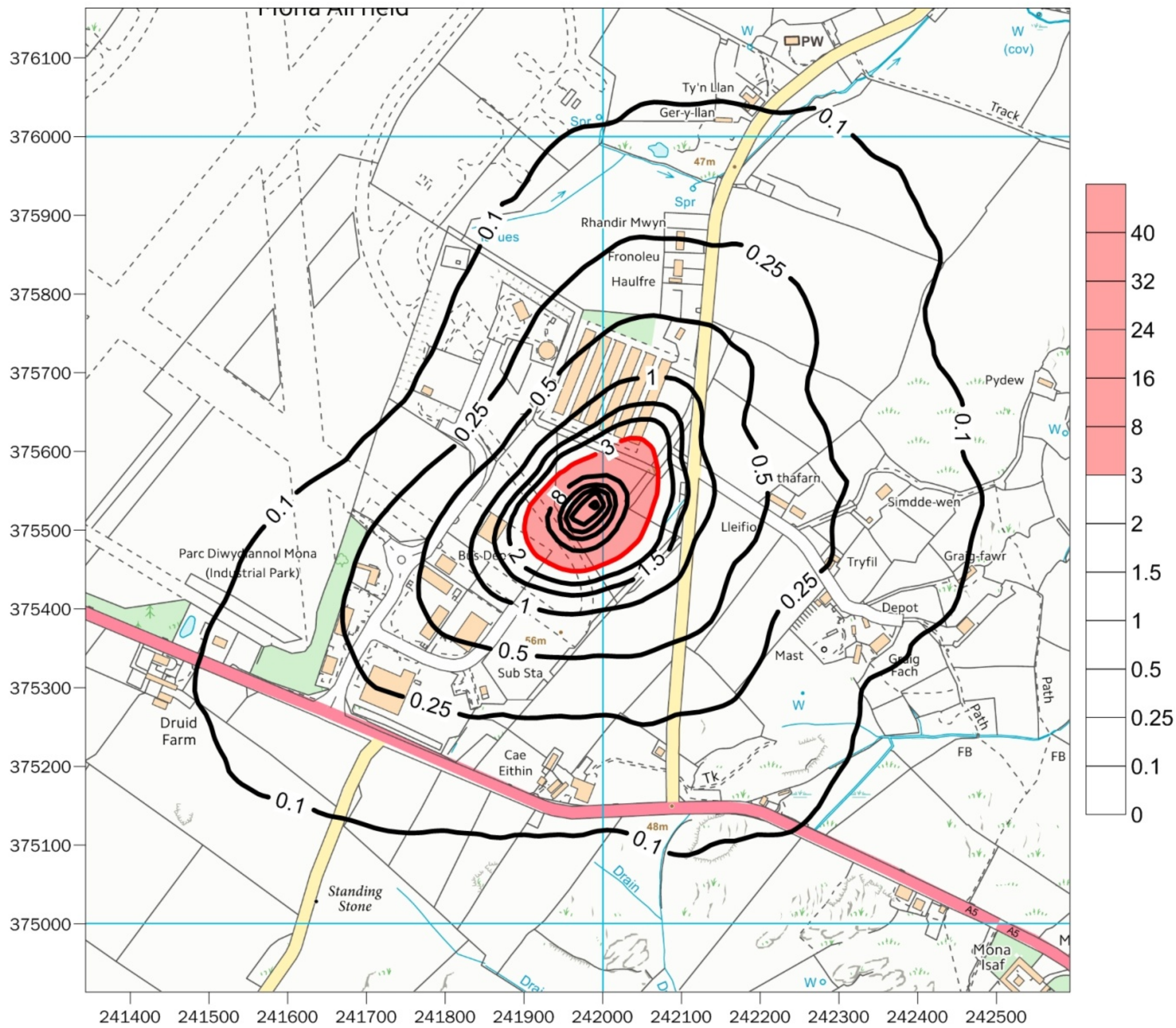
Appendix III Figure 3 - Scenario 1 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2006 Meteorological Data (OU.m^{-3})

Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY



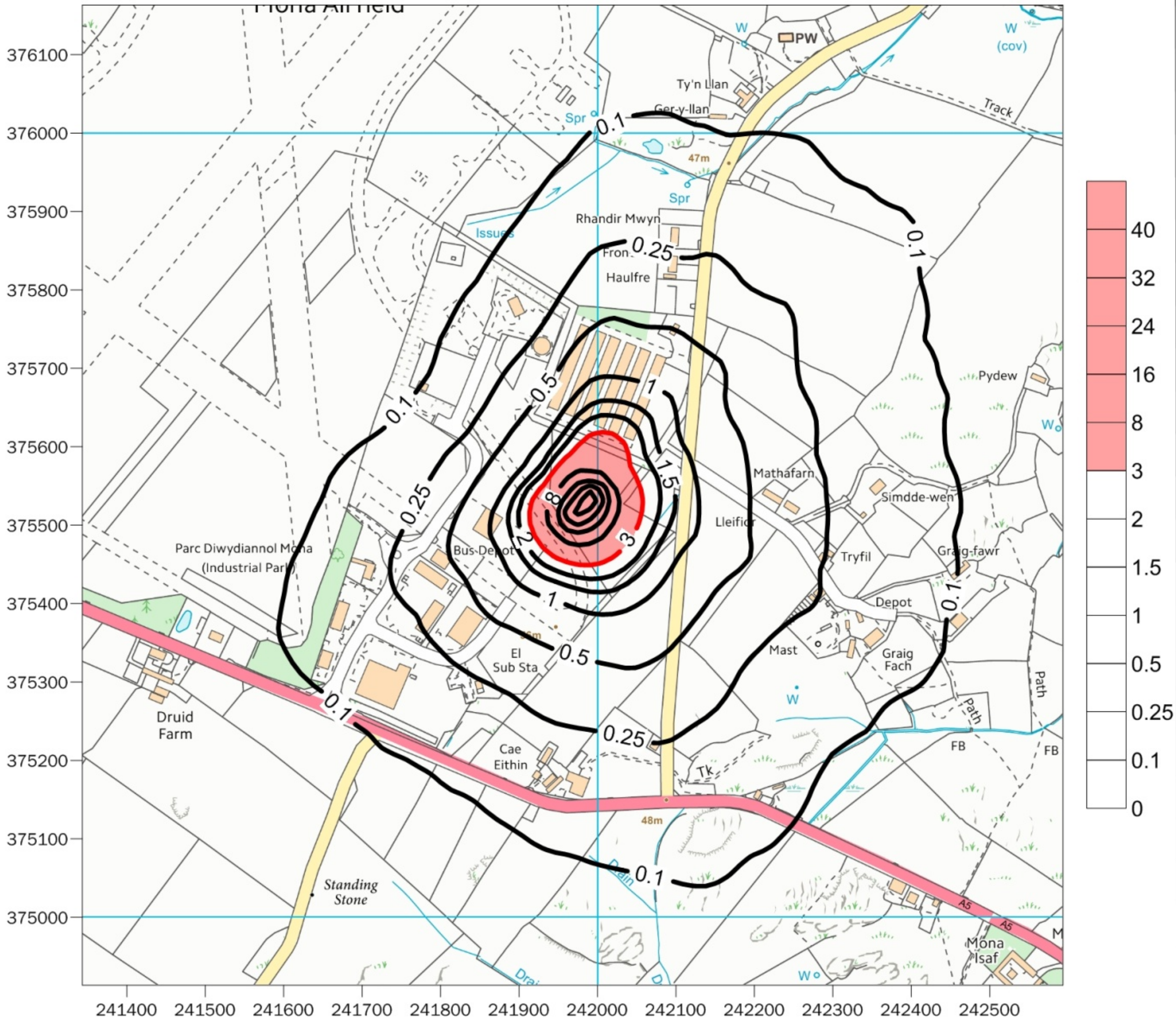
Appendix III Figure 4 - Scenario 1 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2007 Meteorological Data (OU.m^{-3})

Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY



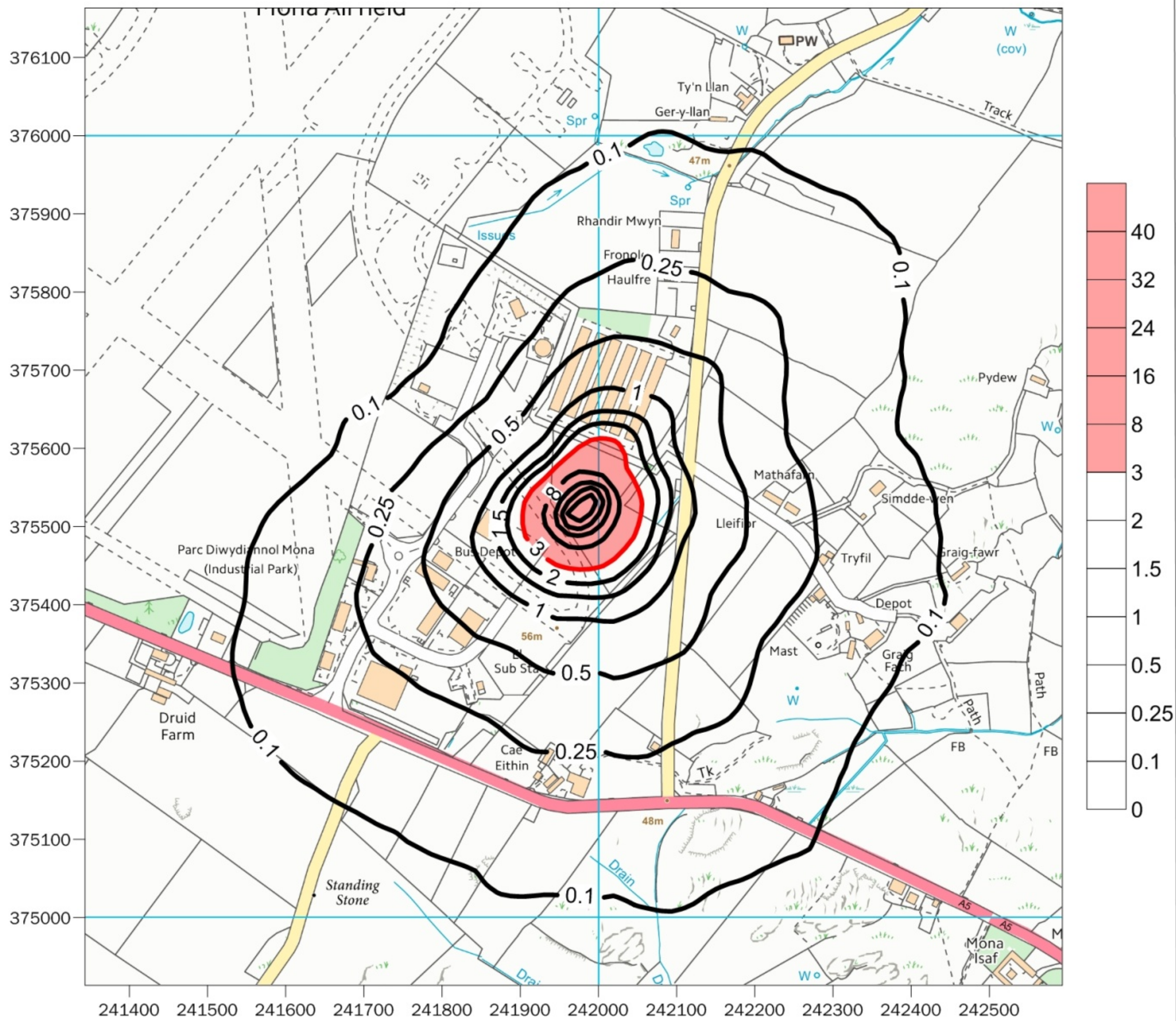
Appendix III Figure 5 - Scenario 1 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2008 Meteorological Data (OU.m^{-3})

Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY



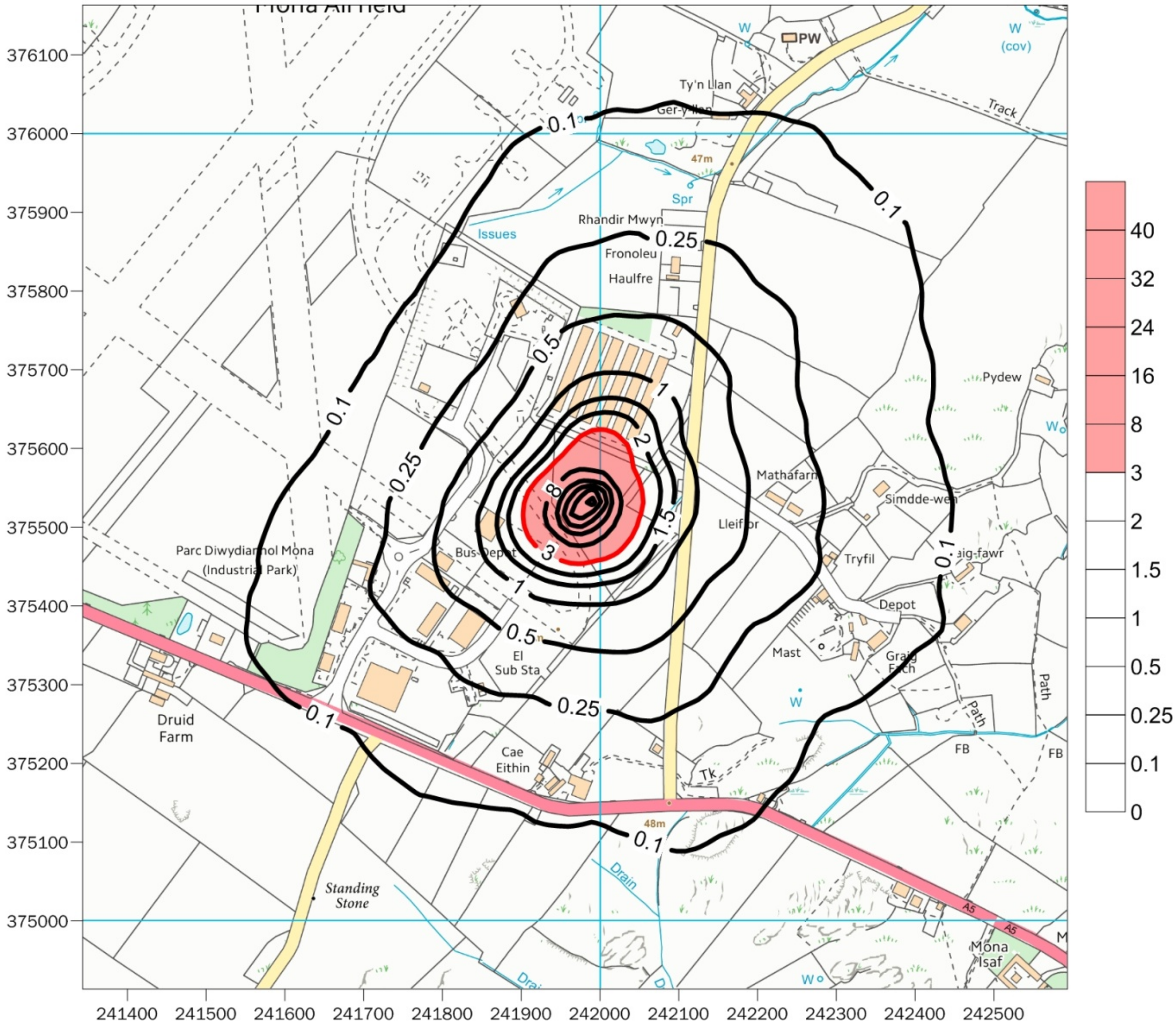
Appendix III Figure 6 - Scenario 2 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2004 Meteorological Data ($OU.m^{-3}$)

Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY



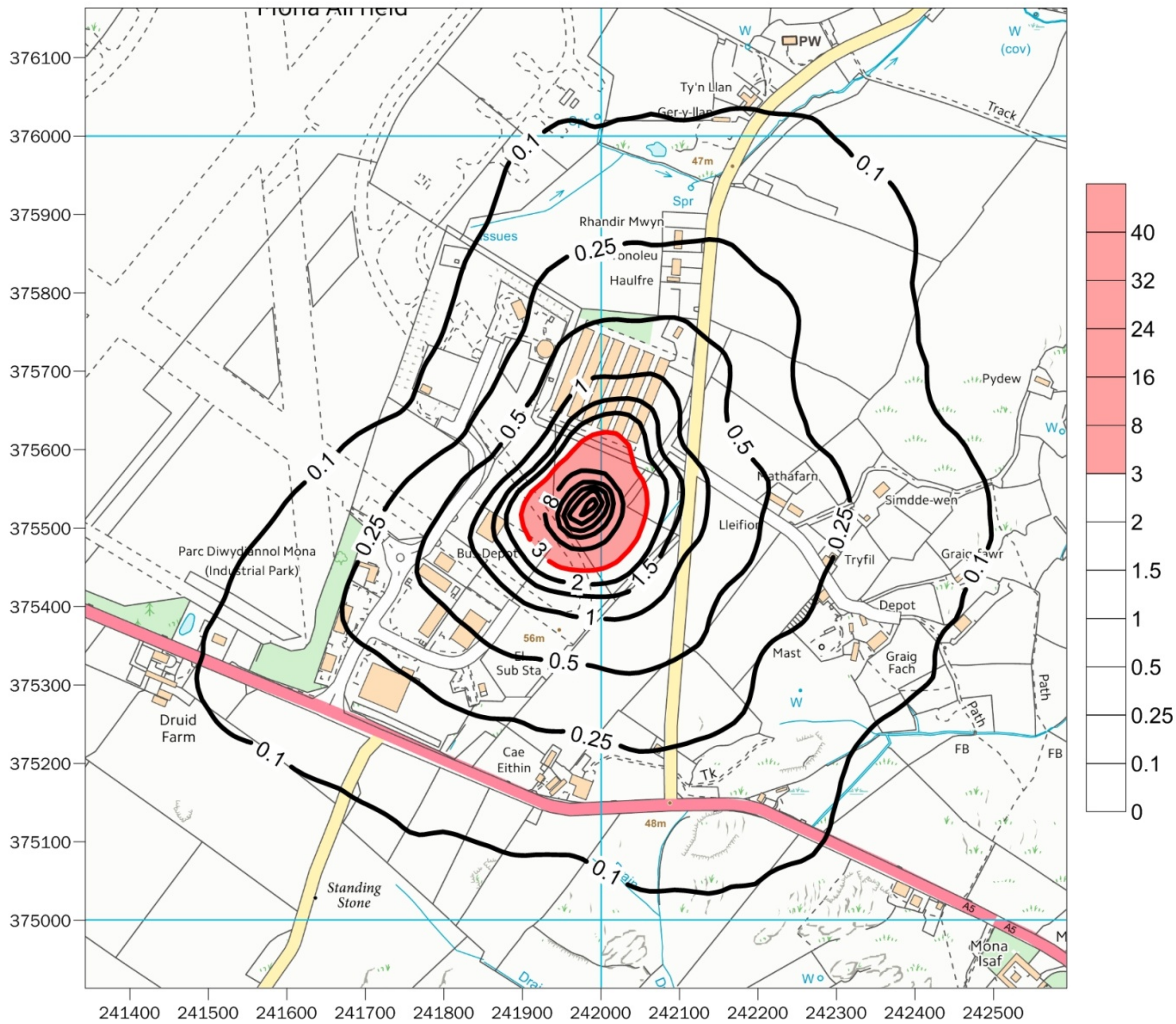
Appendix III Figure 7 - Scenario 2 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2005 Meteorological Data ($OU.m^{-3}$)

Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY



Appendix III Figure 8 - Scenario 2 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2006 Meteorological Data ($OU.m^{-3}$)

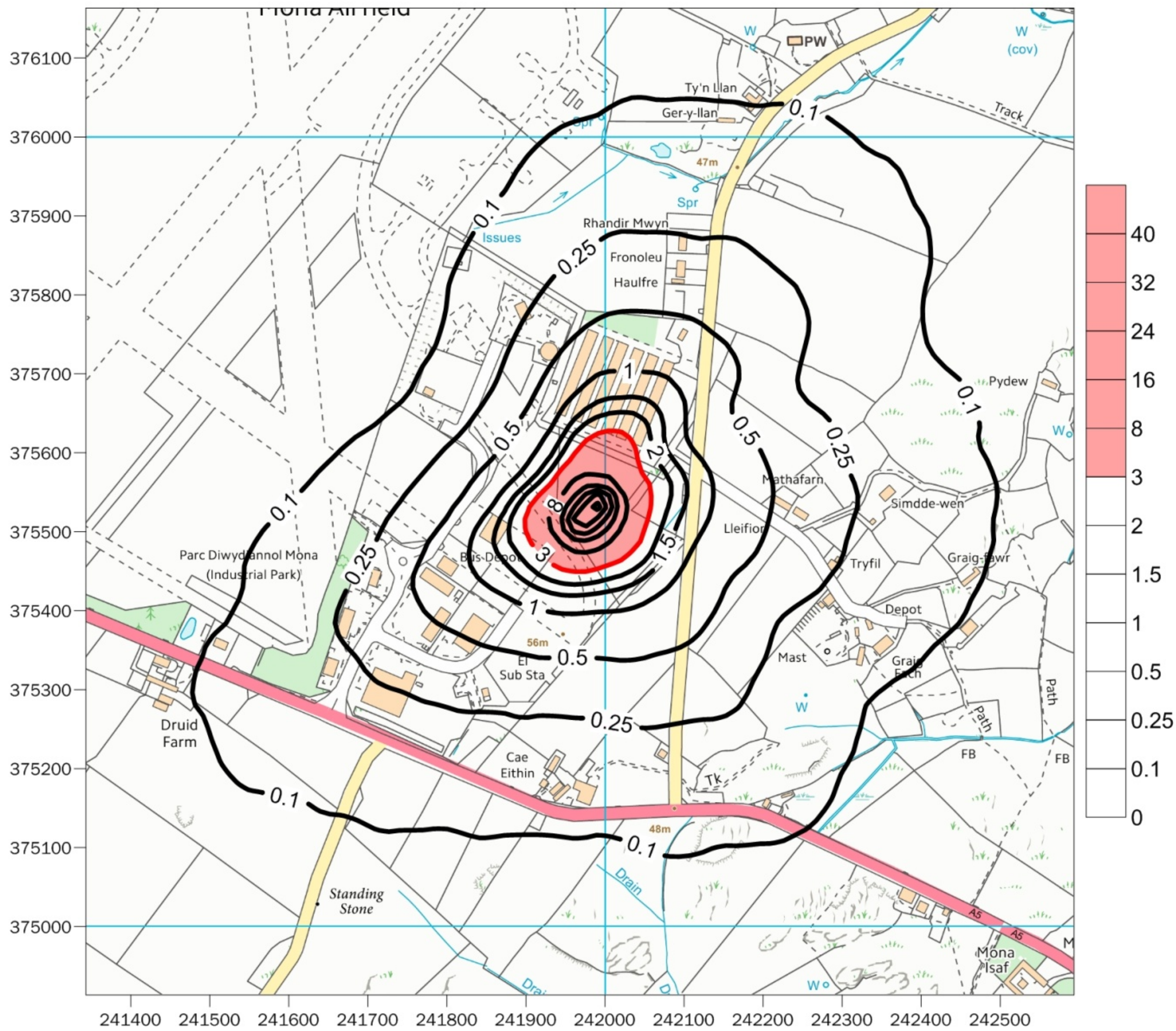
Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY



Appendix III Figure 9 - Scenario 2 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2007 Meteorological Data ($OU.m^{-3}$)

Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY

N.B - Map contains Ordnance Survey data



Appendix III Figure 10 - Scenario 2 - 98th Percentile 1-Hour Mean Odour Concentrations Based on 2008 Meteorological Data ($OU.m^{-3}$)

Oaktree Environmental Ltd
Unit 5 Oasis Park
19 Road One
Winsford
Cheshire
CW7 3RY

N.B - Map contains Ordnance Survey data

Appendix IV

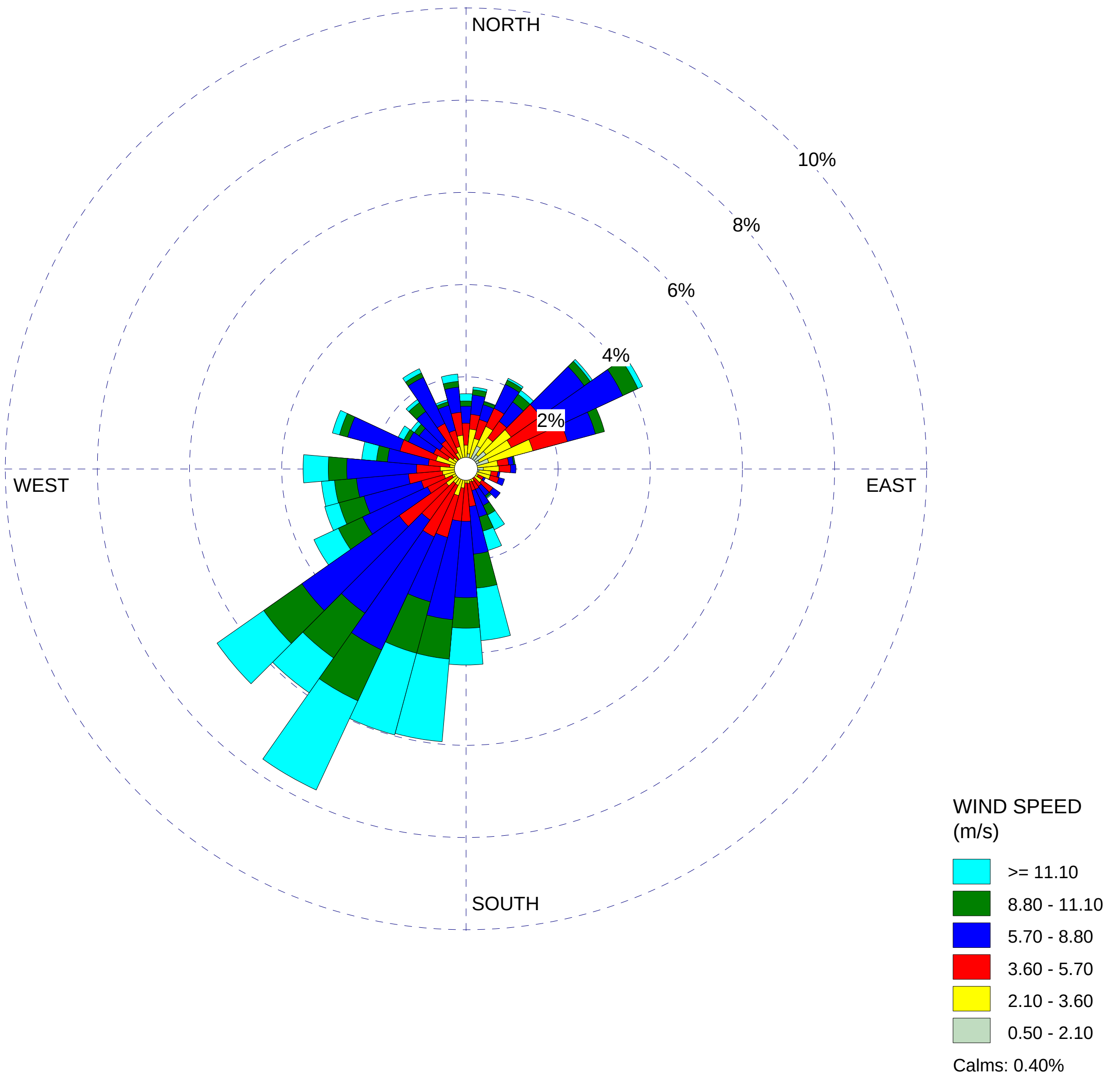
Wind Roses

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 01/01/2008 - 00:00
End Date: 31/12/2008 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

0.40%

TOTAL COUNT:

8707 hrs.

AVG. WIND SPEED:

6.81 m/s

DATE:

09/03/2016

PROJECT NO.:

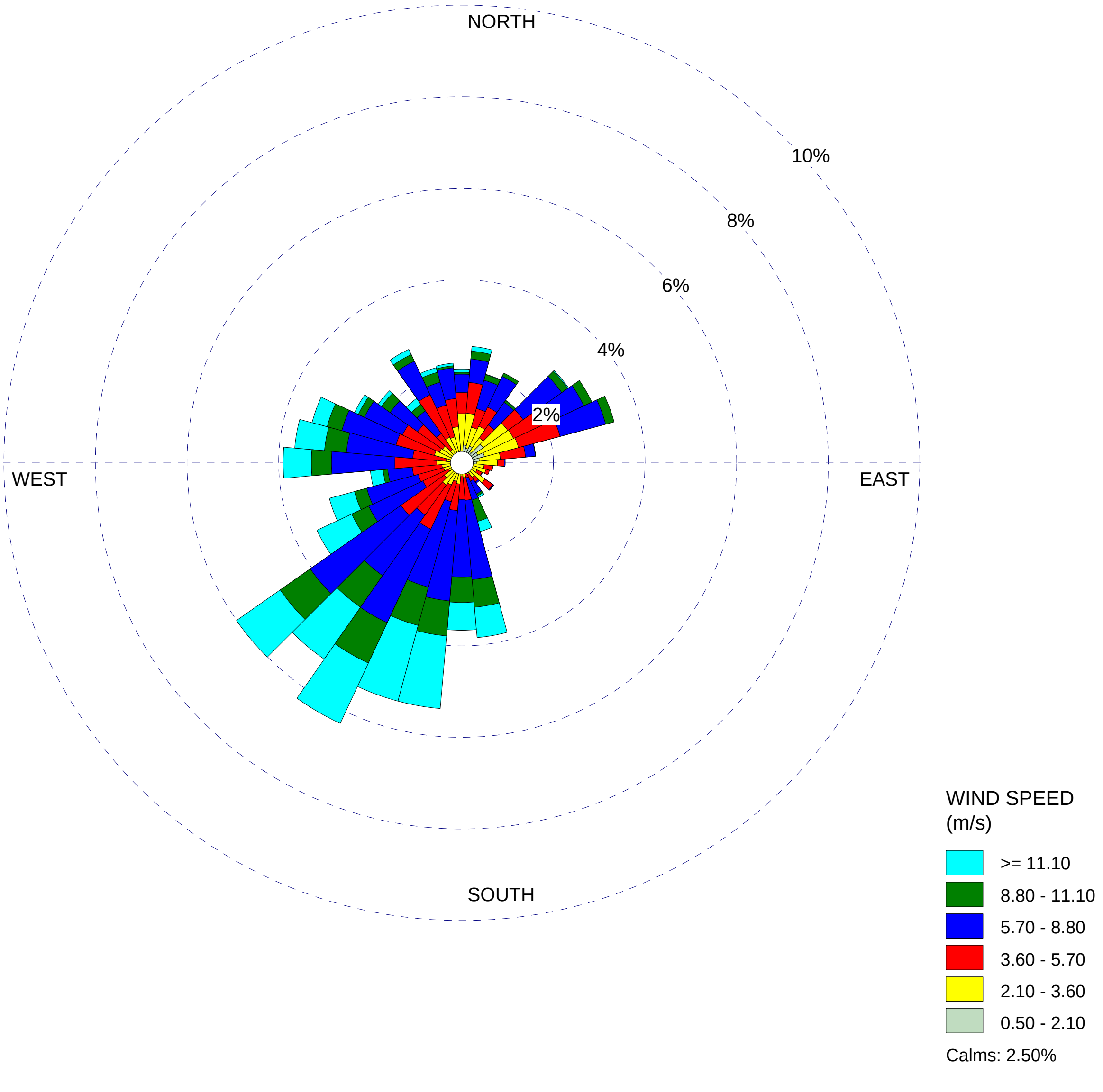
819

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



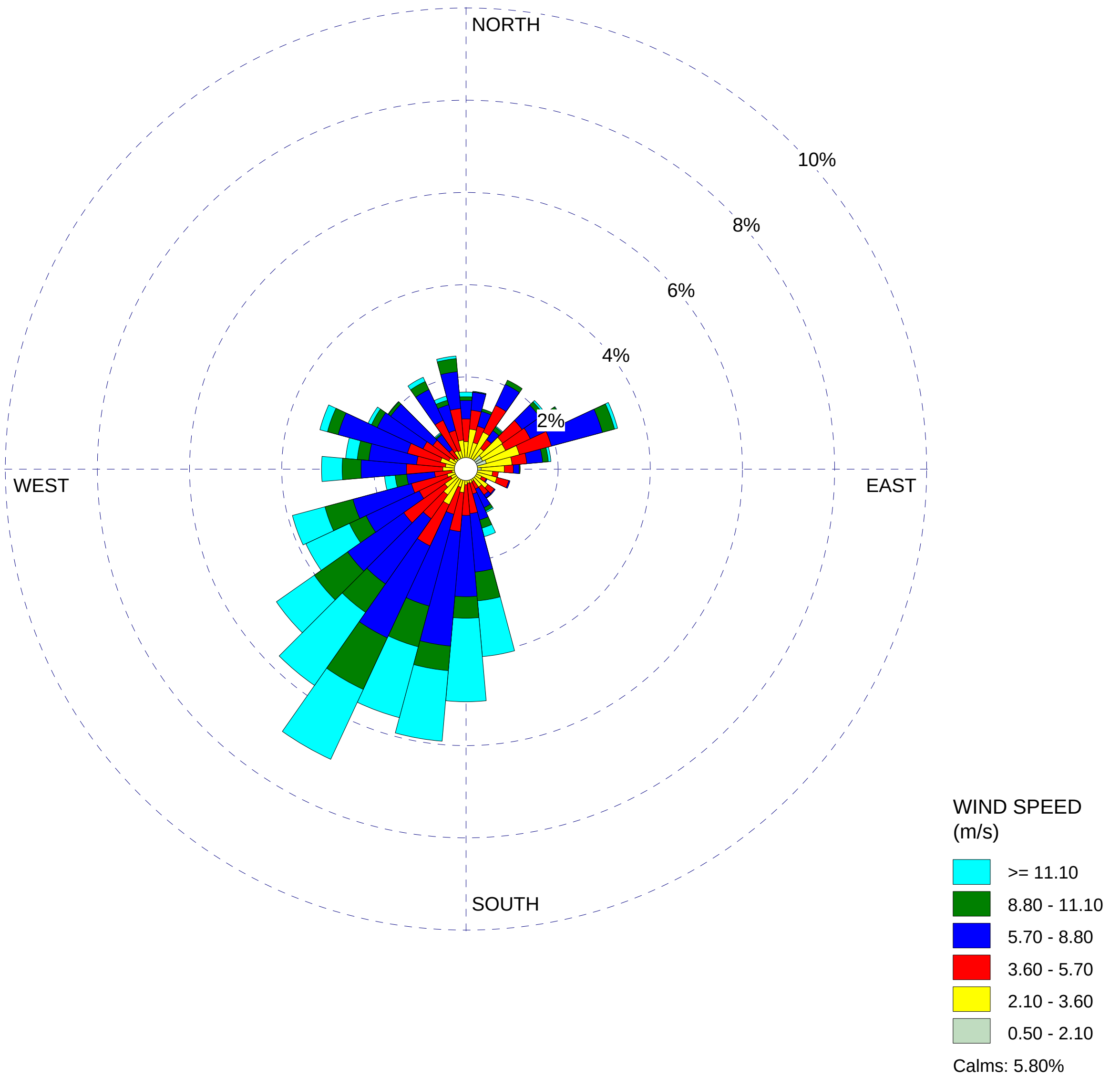
COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 01/01/2007 - 00:00 End Date: 31/12/2007 - 23:00	MODELER:	
	CALM WINDS: **2.50%**	TOTAL COUNT: **8689 hrs.**	
	AVG. WIND SPEED: **6.39 m/s**	DATE: **09/03/2016**	PROJECT NO.: **819**

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 01/01/2006 - 00:00 **End Date: 31/12/2006 - 23:00**	MODELER:	
	CALM WINDS: **5.80%**	TOTAL COUNT: **8704 hrs.**	
	AVG. WIND SPEED: **6.46 m/s**	DATE: **09/03/2016**	PROJECT NO.: **819**

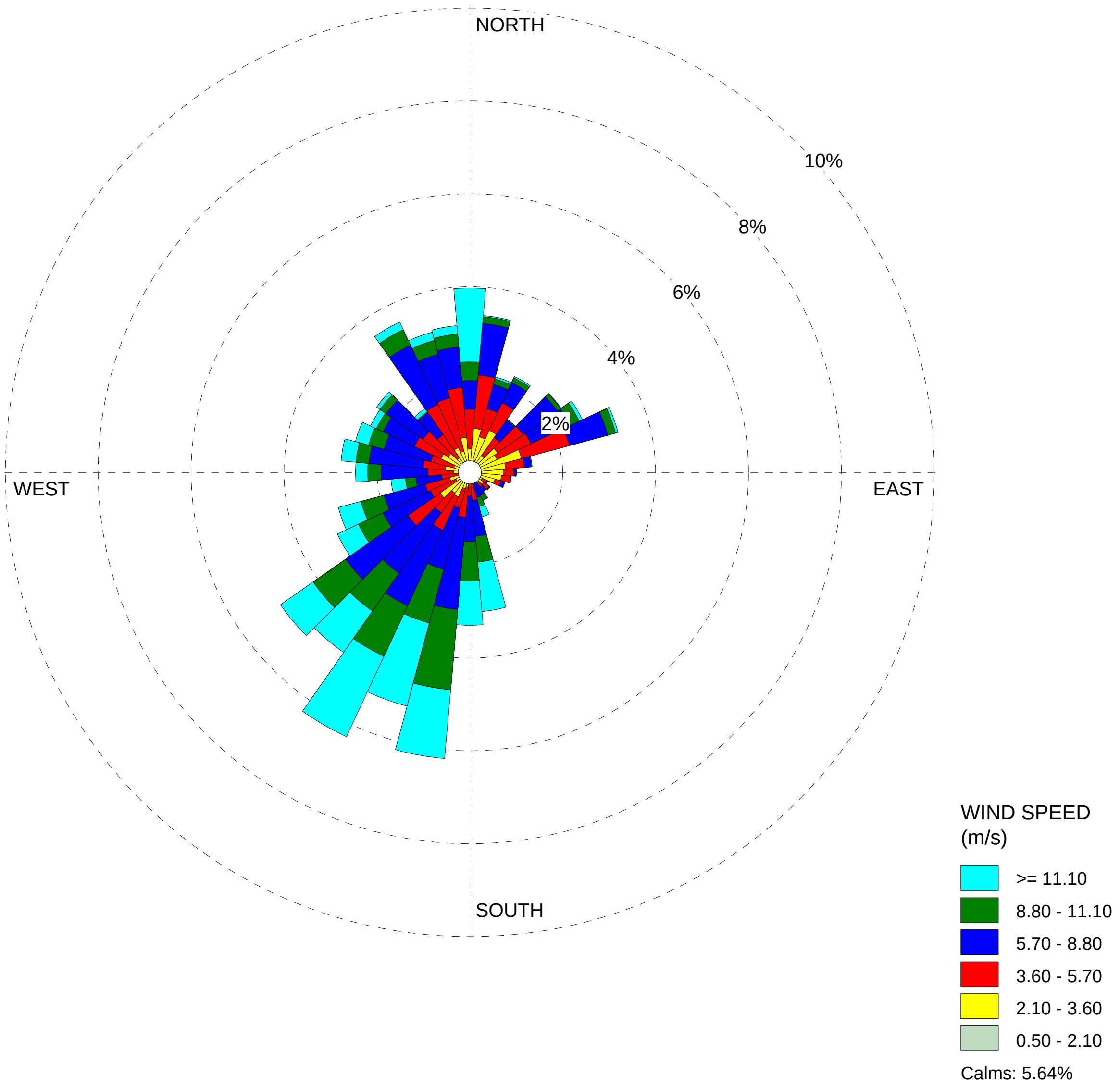
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 01/01/2005 - 00:00
End Date: 31/12/2005 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

5.64%

TOTAL COUNT:

8743 hrs.

AVG. WIND SPEED:

9.04 m/s

DATE:

09/03/2016

PROJECT NO.:

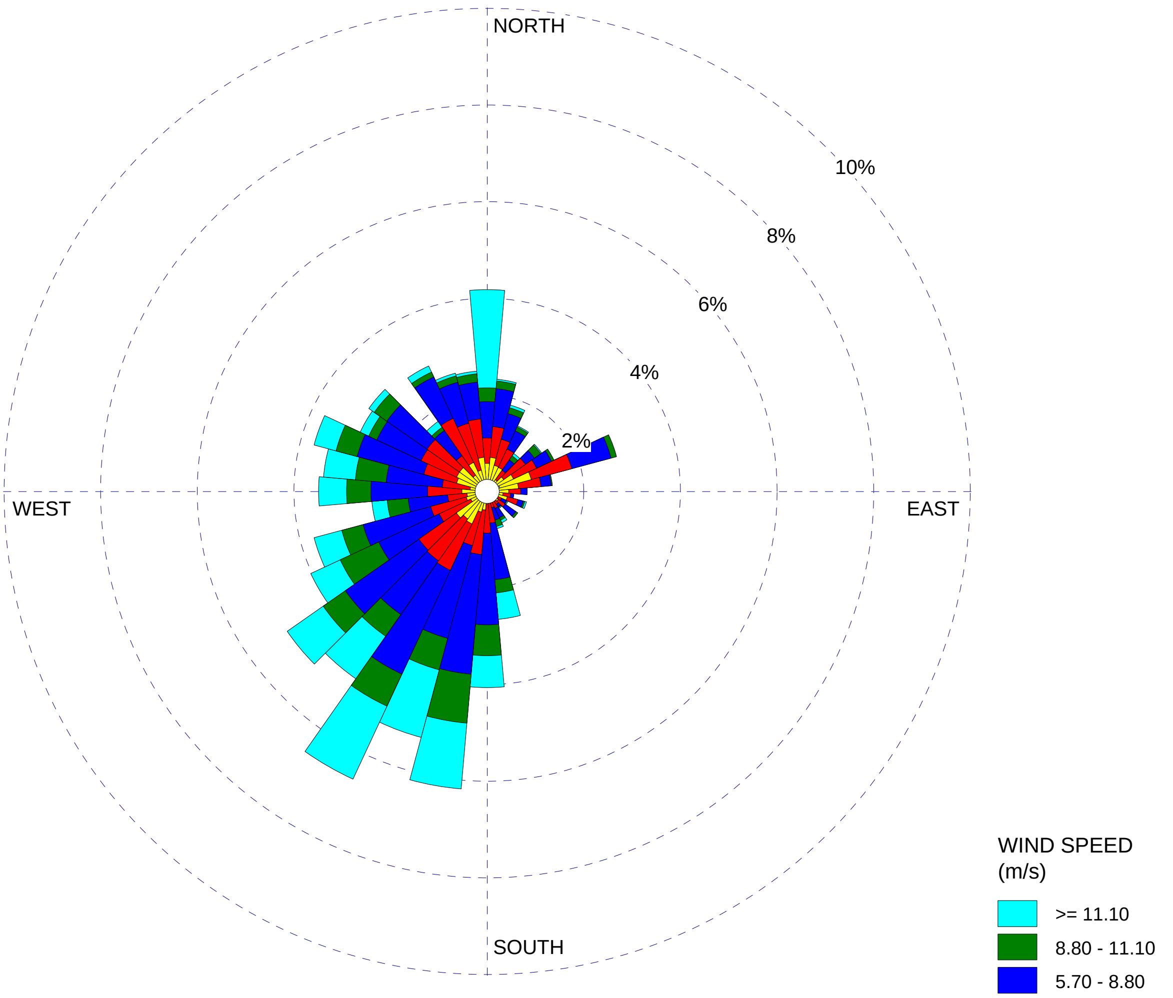
819

WIND ROSE PLOT:

Valley - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 01/01/2004 - 00:00 **End Date: 31/12/2004 - 23:00**	MODELER:	
	CALM WINDS: **5.90%**	TOTAL COUNT: **8766 hrs.**	
	AVG. WIND SPEED: **9.57 m/s**	DATE: **09/03/2016**	PROJECT NO.: **819**