V1.3

Powys County Council
North Powys Bulking Facility

Environmental Permit Application

Odour Impact Assessment

Project code: 416.00798.00038
Date: February 2023

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1.0 Introduction

SLR Consulting Limited (SLR) has been commissioned by The Waste and Resource Action Programme (WRAP), on behalf of Powys County Council (PCC), to undertake a detailed Odour Impact Assessment (OIA) for the proposed North Powys Bulking Facility located near Newtown, Powys ('the Site'). The purpose of the assessment is to support an Environmental Permit application for the Site to Natural Resources Wales (NRW).

1.1 Background

An indicative site layout plan[1] has been provided which illustrates the proposed layout of the Site. SLR has also produced an Odour Management Plan (OMP) for the Site[2] which accompanies this OIA and the wider application documentation, outlining the likely odour sources and associated mitigation measures which would be adopted at the Site.

1.2 Scope

The Site will introduce a new source of odours within the local area with a potential to impact upon the amenity of existing sensitive receptors in the surrounding area.

The principal objective is to assess whether odour emissions are effectively dispersed so that no significant detriment to amenity will occur when the Site is operational.

This report presents the approach, detailed methodology and findings of this OIA.

1.3 Report Structure

The remainder of this report is structured as follows:

- Section 2.0 presents an overview of the relevant legislation and guidance;
- Section 3.0 details the site operations;
- Section 4.0 details the assessment methodology;
- Section 5.0 identifies sensitive receptors;
- Section 6.0 presents the dispersion model input parameters and assumptions;
- Section 7.0 presents the results of the dispersion model; and
- Section 8.0 concludes the study.

[1] SLR file reference: 416.00798.00038/Drawing 002.

[2] SLR file reference: "416.00798.00038/North Powys Bulking Facility Odour Management Plan", May 2022.

2.0 Relevant Legislation and Guidance

2.1 Acceptability of Predicted Odour Impact

The potential for odorous compounds to cause nuisance is dependent upon a wide range of factors, including:

- The rate of emission of the compound(s);
- The duration and frequency of exposure;
- The time of the day that this emission occurs;
- The prevailing meteorology;
- The sensitivity of the 'receptors' to the emission, i.e. whether the odorous compound is more likely to cause nuisance, such as the sick or elderly, who may be more sensitive;
- The odour detection capacity of individuals to the various compound(s); and
- The individual perception of the odour, (i.e. whether the odour is regarded as unpleasant). This is greatly subjective and may vary significantly from individual to individual.

There are neither European nor United Kingdom (UK) specific regulatory standards for the assessment of the impact of odours. However, it may be reasonably argued that complaints are likely to occur when odours become detectable and recognisable. The longer the odour detection persists for an individual, the greater the level of complaints may be expected, particularly if the odours are unpleasant.

On this basis, odour impact criteria are typically based upon guideline documents (predominately based on research from outside of the UK), case law and research. These documents typically indicate a numerical concentration limit of between 1.5 and 6 ou_E/m^3, (based on the 98^{th} percentile of hourly averages), depending on the offensiveness of the odour and sensitivity of the location. The lower criterion are typically applied to odours categorised as most offensive in more urban areas, and higher criterion to less offensive / more pleasant odours in rural or industrial areas where odours are more likely to be tolerated.

2.1.1 NRW's H4 Odour Management Guidance

NRW's H4 Guidance[3] proposes installation-specific exposure criteria (benchmarks) on the basis that not all odours are equally offensive, and not all receptors are equally sensitive.

The H4 Guidance proposes the following benchmarks levels for the assessment and indication of unacceptable odour pollution:

- $1.5ou_E/m^3$ (as a 98^{th} percentile of 1-hour average concentrations) for the most offensive odours;
- $3ou_E/m^3$ (as a 98^{th} percentile of 1-hour average concentrations) for moderately offensive odours; and

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[3] Horizontal Guidance H4: Odour Management – How to comply with your Environmental Permit, NRW, 2014.

- $6ou_E/m^3$ (as a 98th percentile of 1-hour average concentrations) for less offensive odours.

The H4 Guidance refers to the application of the $1.5ou_E/m^3$ criterion against the most offensive odorous sources, such as those processes involving handling of municipal waste.

2.1.2 IAQM – Odour Assessment for Planning Guidance

The Institute of Air Quality Management (IAQM) '*guidance on the assessment of odour for planning*'[4] summarises the typical requirements and approaches for undertaking an odour assessment to determine the potential amenity impacts, in support of planning applications. Whilst this guidance does not form Environmental Permitting guidance, it is considered that if odour exposure does not cause significant detriment to amenity, then it cannot be causing 'significant pollution'.

To facilitate the assessment of the significance of predicted odour exposure on amenity, the guidance defines receptor sensitivity and proposes 'odour effect descriptors' which combine the relative sensitivity of the receptors, the nature (or offensiveness) of the odour with quantitative predicted odour exposure levels.

The IAQM receptor sensitivity types are summarised in **Table 2-1**.

Table 2-1: IAQM Odour Receptor Sensitivity

Receptor Sensitivity	Example Land-uses
High sensitivity receptors	Surrounding land where: ■ Users can reasonably expect enjoyment of a high level of amenity; and ■ People would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Examples may include residential dwellings, hospitals, schools/education and tourist/cultural
Medium sensitivity receptors	Surrounding land where: ■ Users would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or ■ People wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Examples may include places of work, commercial/retail premises and playing/recreation fields.
Low sensitivity receptors	Surrounding land where: ■ The enjoyment of amenity would not reasonably be expected; or ■ There is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land.

[4] IAQM Guidance on the assessment of odour for planning. IAQM July 2018.

Receptor Sensitivity	Example Land-uses
	Examples may include industrial use, farms, footpaths and roads

The IAQM guidance then presents a matrix for 'most offensive' and 'moderately offensive' odour types. However, given the 'most offensive' type of odour associated with municipal waste specifically referenced by NRW's H4 Odour Management guidance, this assessment has only considered the matrix for 'most offensive' odour types and the associated IAQM effect descriptor as summarised in **Table 2-2**. It is noted that impact descriptors apply equally to cases where there are increases and decreases in odour exposure as a result of a development. Therefore, the terms 'adverse' and 'beneficial' should be applied to the descriptors as appropriate.

Table 2-2: Odour Effect Descriptors (Most Offensive Odours)

Most Offensive Odours	Receptor Sensitivity		
Predicted Odour Exposure $C_{98,1\text{-hour}}$ ou_E/m^3	Low	Medium	High
≥10	Moderate	Substantial	Substantial
≥5 – <10	Moderate	Moderate	Substantial
≥3 – <5	Slight	Moderate	Moderate
≥1.5 – <3	Negligible	Slight	Moderate
≥0.5 – <1.5	Negligible	Negligible	Slight
<0.5	Negligible	Negligible	Negligible

As presented in **Table 2-2**, in relation to impacts upon a 'medium sensitivity' receptor (i.e. commercial/retail premises) from a 'most offensive' odour; the IAQM matrix indicates that exposure greater than $C_{98\text{-\%ile},\ 1\text{ hour}}$ 3.0ou_E/m^3 would be classified as a 'moderate adverse' effect. For a receptor of 'high sensitivity' (i.e. residential dwellings), the IAQM matrix indicates that exposure greater than $C_{98\text{-\%ile},\ 1\text{ hour}}$ 1.5ou_E/m^3 would be classified as a 'moderate adverse' effect. This 'moderate adverse' effect would be considered to represent a 'significant adverse' effect, which correlates with NRW's H4 criterion for 'significant pollution'.

3.0 Site Operations

3.1 Site Location

The Site is located along the A483 to the south-west of Abermule, Powys at approximate National Grid Reference (NGR) x315680, y294150. The Site extends from south-west to north-east along the A483.

3.2 Process Description

The hours available to the Site to operate are between 7am and 6pm Monday to Sunday (including bank holidays). However, it is anticipated that the Site will only be operational between 7am and 4pm Monday to Friday. The site would be operational over the weekend, but only to accept a small number of waste deliveries resulting from street waste collections (waste from public bins and litter picking), tipped by smaller PCC vehicles. .

The Site would receive approximately 22,500 tonnes per annum (tpa) of waste, comprising primarily:

- Residual waste (including street cleaning litter and bulky waste);
- Food waste;
- Dry mixed recyclables (comprising paper cardboard, cans and plastic);
- Absorbent Hygiene Products (AHP);
- Glass; and
- Green waste.

The Site would also receive smaller quantities of rags / textiles, Waste Electrical and Electronic Equipment (WEEE) and non-hazardous batteries.

Material is received at the Site via road by a fleet of Recycling and Refuse Collection Vehicles (RRVs and RCVs). All waste types listed above, with the exception of green waste and glass, would be stored within the Bulking Shed, inside which all handling activities for these waste types take place. Vehicles would gain access to the Bulking Shed via five roller shutter doors on the south-western façade of the building. A ventilation system is in place to maintain negative pressure within the building, to minimise the potential for fugitive odours to be released.

The Bulking Shed will be accessed via five roller shutter doors located on the south-western side of the building, and process air from within the building will be extracted by five ventilation fans, fitted on the north-eastern wall. Two louvres are fitted on the south-western wall to facilitate airflow into the building when the doors are not in use. The Bulking Shed is maintained under negative pressure by the ventilation system at all times. The ventilation system has been designed to achieve a ventilation rate of approximately 1.5 air changes per hour (equating to an approximate extraction airflow of 22,750m^3/hr) during operational hours (7am and 6pm, 7-days per week). Outside of operational hours (between 6pm and 7am), the ventilation system would be operated at a reduced rate. Therefore, there would be no 'accumulation of odours' within the building overnight. The higher ventilation rate applied during operational hours would minimise the potential for fugitive odours to be released from opening of the roller shutter doors during use. Furthermore, as outlined within the OMP for the Site:

- Only one door would be open at any one time, where possible;
- Doors are only opened to allow vehicles and mobile plant to enter the reception building once the vehicle is aligned to reverse, where possible;
- Vehicles are to reverse slowly into the building (i.e. <5mph) to minimise air displacement;
- The opening of doors to permit vehicles to leave the site only occurs once the driver has signalled confirmation that they are ready to exit. Once the vehicle has safely exited the building the doors are immediately lowered (if another vehicle is not waiting to tip) to close behind it; and
- In the event that two vehicles arrive at the Site at the same time the site operative will instruct the vehicles which doors to enter by.

Outside of operational hours (6pm to 7am) the access doors would not be in use, therefore the reduced ventilation rate would be sufficient to maintain negative pressure within the building, thus minimising the potential for fugitive odours to be released.

Green waste and glass would be received and stored within their designated bays outside of the Bulking shed. Food waste would be deposited from the removable pods/stillages within the RCVs in the dedicated food waste bay. On Friday, food waste stored within the bay would be transferred into two sealed skips (hinged lid with rubber seals) for storage over the weekend. AHP waste would be deposited within the dedicated bay and subsequently transferred into a sealed skip (hinged lid with rubber seals) located within the Bulking Shed at the end of each weekday.

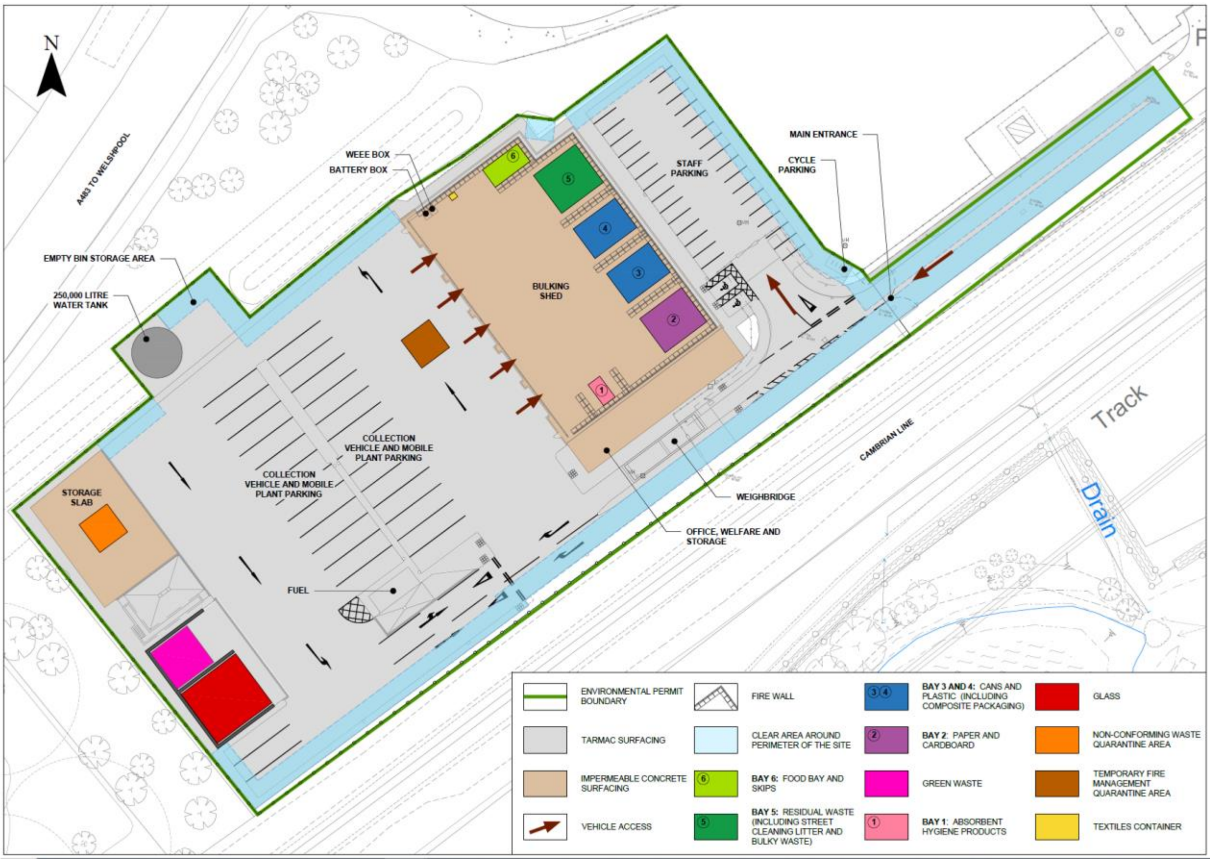
Under normal operational conditions, waste delivered to the Site would be stored for the following periods prior to removal:

- Residual waste would be stored within the residual waste bay for up to 4 days;
- Food waste would be stored within the food waste bay for up to 24 hours during the week, and within the food waste skips over the weekend for up to 72 hours; and
- AHP waste would be stored within the AHP skip for up to 1 week.

The food waste skips would be located in proximity of the food waste bay, and the AHP waste skip would be located in proximity of the AHP waste bay. All sealed skips would be located within the Bulking Shed building.

The layout of the Site is presented in **Figure 3-1** below.

Figure 3-1: North Powys Bulking Facility – Site Layout



3.3 Identification of Odour Sources

Potential sources of odour from the Site have been identified on the basis of a review of the proposed development design, as described in Section 3.2 above.

The following waste types are considered to be significant potential sources of odours:

- Residual waste (including street cleaning litter and bulky waste);
- Food waste;
- Absorbent Hygiene Products (AHP); and
- Rags / textiles.

The following waste types are **not** considered to be significant potential sources of odours:

- Dry mixed recyclables (comprising paper cardboard, cans and plastic);
- Green waste;
- Glass;
- WEEE; and
- Non-hazardous batteries.

Dry mixed recyclables, glass, WEEE and non-hazardous batteries are associated with a negligible odour potential and therefore have not been considered further within this assessment.

In consideration of the similarity of green waste odours to those currently present within the site setting (agricultural)[5], the sensitivity of nearby residential receptors to green-waste type odours is likely to be low. Furthermore, the volume of the green waste storage bay at the Site is relatively small (approximately 184m^3). In consideration of the above, green waste is not considered to represent a significant potential source of odours. Therefore these material types have not been considered further within this assessment. Further information on the associated odour potential of the material types is presented within Appendix D.

A non-conforming waste quarantine area is allocated at the western extent of the permit boundary, for temporary storage of non-conforming waste prior to export off-site. As the purpose of this non-conforming waste quarantine area is for use during abnormal site operations (i.e. during receipt of non-conforming waste prior to removal), this does not fall within the scope of this odour assessment (which is limited to the assessment of 'normal' site operations). Therefore the non-conforming waste quarantine area has not been considered further within this assessment. Operational controls for the non-conforming waste quarantine area are outlined within the OMP.

There are five access doors (roller-doors for vehicular access) located on the south-western side of the Bulking Shed. The Bulking Shed is maintained under negative pressure, as a result of the five ventilation fans located on the north-eastern wall. The negative pressure maintained within the building would ensure containment and minimise the potential for fugitive odours from within the Bulking Shed to be released during periods when the access doors are open.

When not in use, RRVs and RCVs are parked at the Site in the marked bays to the south-west of the Bulking Shed. There is potential for RRVs and RCVs to be a source of odours following use in collection operations as a result of waste residue retained in or on the vehicles. Therefore a cleaning regime is in place to remove waste residuals in or on the RRVs and RCVs following use, as detailed within the accompanying OMP. In consideration of the above, potential odour emissions from the parked RRVs and RCVs are considered insignificant and have not been considered further within this assessment.

The Site would also contain a number of facilities associated with supporting refuse and recycling collections such as an office, welfare facilities, a weighbridge, collection vehicle parking, a refuelling station, a vehicle wash and a staff carpark. None of these facilities are considered to pose a significant source of odour emissions and have not been considered further within this assessment.

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[5] Green waste is typically associated with a 'grassy' or 'musty' odour, similar to that experienced in agricultural areas.

4.0 Assessment Methodology

4.1 Odour Monitoring Study

To derive appropriate emission rates and quantify impacts as part of this OIA, an odour monitoring study was undertaken at PCC's Rhayader bulking facility in April 2022.

The monitoring was undertaken using methods outlined in BS EN13725:2022[6].

For area sources (i.e. the surface of different types of waste), collection of odour samples was undertaken using a ventilated canopy known as a 'Lindvall hood'. The canopy was placed on the odorous material and ventilated at a known rate with clean odourless air. The odour samples was collected from the outlet of the hood using the pneumatic extraction method (as detailed for enclosed sources below). For enclosed sources (i.e. the headspace within enclosed skips), collection of odour samples was undertaken using pneumatic extraction ('ambient' method). The extract air was collected into 40-litre Nalophan sampling bags for transport. The samples were then analysed at a UKAS accredited laboratory as specified in BS EN13725:2022.

Further details on the monitoring methods is provided in Appendix E.

4.2 Derivation of Source Term

The source term and corresponding emission rates for the Site were derived with consideration of the following data sources:

- odour monitoring of food waste and residual waste at the Rhayader bulking facility in April 2022;
- odour monitoring of AHP at the Crymlyn Burrows waste management facility in January 2021; and
- odour emission rates estimates (for soiled textiles) published by UKWIR[7].

The results of the odour monitoring undertaken at the Rhayader bulking facility and the Crymlyn Burrows waste management facility, as well as the published odour emission data for soiled textiles (published by UKWIR), are presented in Appendix E.

Residual Waste

Odour monitoring of residual waste was undertaken at the Rhayader bulking facility in April 2022 during normal operations, as presented in Appendix E.
The residual waste received at the Rhayader bulking facility was collected from a catchment area with the same demographics as the area which would be served by the Abermule WTS.
During the winter months, lower temperatures can result in a lower level of microbial activity within the waste, and therefore lower potential odour emissions from the waste.

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[6] BS EN13725:2022 stationary source emissions – determination of odour concentration by dynamic olfactometry and odour emission rate.
[7] Technical Reference Document 01/WW/13/3 the 'Odour Control in Wastewater Treatment' 2001, UKWIR. Table 5.1 on page 67.

Therefore the monitoring data gathered in April, during a period of mild temperatures[8], represents a mid-point between summer and winter conditions, representing 'average' potential odour emissions from the waste.
The odour monitoring on waste at the Rhayader WTS was undertaken on 'freshly tipped' (within one hour of tipping from the collection vehicles[9]) waste. Odour emissions from waste generally decline following agitation, therefore the odour emission rate measured from 'freshly tipped' residual waste, represents a worst-case scenario.
As outlined in further detail in Section 6.2, the 'freshly tipped' odour emission rate defined from the odour monitoring data gathered at Rhayader WTS have been applied year-round for all residual waste at the Abermule WTS, without any consideration of a reduction factor during the winter months or during periods where waste is not agitated, when potential odour emissions are anticipated to be significantly lower.

As such it is determined that the age, nature and condition of the residual waste monitored at the Rhayader WTS is considered representative of that which would be received at the Abermule WTS, and reflects a reasonable 'worst-case' scenario.

Food Waste ('freshly tipped')

Odour monitoring of food waste was undertaken at the Rhayader bulking facility in April 2022 during normal operations, as presented in Appendix E.
The food waste received at the Rhayader bulking facility was collected from the same catchment area as would be served by the Abermule WTS.
During the winter months, lower temperatures can result in a lower level of microbial activity within the waste, and therefore lower potential odour emissions from the waste.
Therefore the monitoring data gathered in April, during a period of mild temperatures, represents a mid-point between summer and winter conditions, representing 'average' potential odour emissions from the waste.
The odour monitoring on waste at the Rhayader WTS was undertaken on 'freshly tipped' (within one hour of tipping from the collection vehicles[10]) waste. Odour emissions from waste generally decline following agitation, therefore the odour emission rate measured from 'freshly tipped' food waste, represents a worst-case scenario.
As outlined in further detail in Section 6.2, the 'freshly tipped' odour emission rate defined from the odour monitoring data gathered at Rhayader WTS have been applied year-round for all food waste at the Abermule WTS, without any consideration of a reduction factor during the winter months or during periods where waste is not agitated, when potential odour emissions are anticipated to be significantly lower.

As such it is determined that the age, nature and condition of the food waste monitored at the Rhayader WTS is considered representative of that which would be received at the Abermule WTS, and reflects a reasonable 'worst-case' scenario.

Food Waste ('24- and 48-hours aged')

Odour monitoring of food waste was undertaken at the Rhayader bulking facility in April 2022 during normal operations, as presented in Appendix E.

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[8] Ambient temperature measured during the monitoring exercise on 27th April 2022 was 12.6°C. The maximum daily temperatures on the week preceding the monitoring exercise was between 14 and 17°C.
[9] As detailed on the Rhayader odour monitoring report, as detailed in Appendix F.
[10] As detailed on the Rhayader odour monitoring report, as detailed in Appendix F.

The food waste received at the Rhayader bulking facility was collected from the same catchment area as would be served by the Abermule WTS. Odour monitoring was undertaken on 'aged' food waste stored at the Rhayader WTS, stored for a period of 24- and 48-hours, as would be the practice at the Abermule WTS.

As such it is determined that the age, nature and condition of the food waste stored within the skips, as monitored at the Rhayader WTS, is considered representative of that which would be received at the Abermule WTS, and reflects a reasonable 'worst-case' scenario.

AHP Waste

Odour monitoring of AHP was undertaken at the Crymlyn Burrows WTS in January 2022 during normal operations, as presented in Appendix E.
AHP waste typically comprises nappies, sanitary pads, tampons, adult incontinence products and personal care wipes. As such, AHP waste has a comparatively low organic content, and therefore odour emissions from AHP waste are not considered to vary during periods of elevated temperatures.
AHP waste is mostly domestically derived (from the general population), therefore the composition of this waste type across catchments is observed to be relatively uniform.

As such it is determined that the age, nature and condition of the AHP waste monitored at the Crymlyn Burrows WTS is considered representative of that which would be received at the Abermule WTS, and reflects a reasonable 'worst-case' scenario.

Rag / textiles

The rag / textiles received at the Abermule WTS would comprise kerbside collections of textiles for recycling. As such, the textiles collected are anticipated to be in a heavily used/worn but in reasonably clean condition.
However, in consideration that the condition of such textiles could vary significantly, it has been assumed that all textiles collected would be in a poor condition and heavily soiled. As such, odour emissions for rags / textiles have been defined in consideration of estimated odour emission rates for heavily soiled textiles retrieved from raw sewage (referred to as 'screenings') as published by UKWIR[7].

Therefore adoption of the estimated odour emission rate adopted for heavily soiled textiles retrieved from raw sewage for rags / textiles reflects a reasonable 'worst-case' scenario.

4.3 Quantification of Odour Impact

Odour assessments are undertaken using the concept of the European Odour Unit (ou_E), as defined in BS EN13725:2022. This approach allows impact assessment of any odorous gas as it is independent of chemical constituents and centres instead on multiples of the detection threshold (i.e. the physiological response of a human) of the gas in question.

As the odour unit is a Standard Unit in the same way as gram or milligram, the notation used in odour assessment follows the conventions of any mass emission unit as follows:

- Concentration: ou_E/m^3;

- Emission: ou_E/s; and
- Specific emission (emission per unit area): $ou_E/m^2/s$.

Like air quality standards for individual pollutants, exposure to odour is given in terms of a percentile of averages over the course of a year. The exposure criteria most accepted in the UK at present is given in terms of (concentration) European Odour Units as a 98th percentile (C_{98}) of hourly averages. This allows 2% of the year when the impact may be above the limit criterion (175 hours). The notation for impact is therefore: $C_{98,\ 1\ hour}$ X ou_E/m^3.

4.4 Modelling Approach

In order to predict potential odour impacts within the vicinity of the Site a quantitative assessment using the AERMOD dispersion model[11] was undertaken. AERMOD is a regulatory model approved for the United States Environmental Protection Agency (US EPA) and is used extensively for odour impact assessment in the UK.

The detailed dispersion modelling has been used to predict the concentration of odour at a height of 1.5m AOD in accordance with the relevant NRW guidance. In accordance with the H4 Odour Management guidance, an average of the odour concentrations modelled with the application of the 2015 – 2019 meteorological data has been presented. In addition, the modelling results from each individual meteorological year considered are presented (as per the approach outlined within the IAQM odour guidance) in Appendix A, to assess any variation in meteorological conditions year-on-year.

Model sensitivity analysis has been undertaken to verify the 'worst-case' modelling approach. The sensitivity analysis determined that modelling of odour sources as un-enclosed area/volume emission sources (i.e. without consideration of the containment provided by the Bulking Shed structure) represents the 'worst-case' assessment approach in terms of predicted off-site odour concentrations. The findings of the sensitivity analysis are presented in Appendix C.

4.5 Acceptability of Predicted Odour Impacts

The magnitude of the predicted odour effect (i.e. impact significance) has been determined in reference to the NRW H4 Odour Management guidance (Section 2.1.1) and in consideration of the IAQM odour guidance (Section 2.1.2), with specific consideration given to the likely offensiveness of odours from the Site as well as the sensitivity of the nearby receptors.

For the purposes of this Odour Impact Assessment, odours from the Site have been considered 'most offensive'. Commercial/retail premises have been considered to be of 'medium sensitivity', and residential dwellings (including farms) have been considered to be of 'high sensitivity' to odours.

The objective of this assessment is to determine the potential extent to which unacceptable levels of odour impact could reasonably be expected to occur as a result of odour emissions from the site.

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[11] Aermod model executable 21121.

In consideration of the offensiveness of odours and receptor sensitivities outlined above, and in reference to the odour criterions outlined within NRW's H4 Odour Management guidance as well as the IAQM guidance, the following odour criterion have been applied within this assessment to present the point at which the adverse effect of odours could be considered 'significant pollution':

- $C_{98,\ 1\text{-hour}}$ 1.5ou_E/m^3 odour criterion has been applied for all 'high sensitivity' receptors; and
- $C_{98,\ 1\text{-hour}}$ 3.0ou_E/m^3 odour criterion has been applied for all 'medium sensitivity' receptors.

5.0 Identification of Sensitive Receptors

There are a number of sensitive receptors in proximity to the Site, the closest of which are located on Abermule Business Park, a consented commercial development which bounds the Site to the north-east. A number of isolated farmhouses are located off the A483 and B4386, located within 50m of the permit boundary. Beyond, Abermule extends to the north-east of the Site, with the closest residential properties located within 300m (along Court Close), as well as further isolated properties in all directions.

Reference should be made to **Figure 5-1** and **Figure 5-2** for an illustration of the identified sensitive residential (i.e. high sensitivity) and commercial (i.e. medium sensitivity) receptors relative to the Site, respectively. The permit boundary is outlined in red, the Bulking Shed in blue and the Abermule Business Park in green.

Figure 5-1: North Powys Bulking Facility – Receptor Overview

Figure 5-2: North Powys Bulking Facility – Receptors at Abermule Business Park

The sensitive receptors at the Abermule Business Park (DR12-DR17) have been defined to represent a 'worst-case' location, based upon proximity to the Site.

The identified sensitive receptors in proximity of the Site are presented in **Table 5-1**.

Table 5-1: Modelled Discrete Receptors

Receptor	Receptor Type	Receptor Sensitivity	UK NGR (m)		Distance from	
			X	Y	Permit Boundary	Odour Source
DR1	Farm	High	315541	294125	50m	135m
DR2	Farm	High	315928	294395	215m	295m
DR3	Farm	High	315258	293914	400m	480m
DR4	Residential dwelling	High	316069	294369	300m	400m
DR5	Residential dwelling	High	315549	294590	400m	405m

Receptor	Receptor Type	Receptor Sensitivity	UK NGR (m)		Distance from	
			X	Y	Permit Boundary	Odour Source
DR6	Farm	High	315220	293671	600m	680m
DR7	Farm	High	316194	293604	720m	740m
DR8	Residential dwelling	High	315250	294596	580m	585m
DR9	Residential dwelling	High	316591	294353	790m	900m
DR10	Residential dwelling	High	316652	294091	840m	940m
DR11	Residential dwelling	High	316483	293848	760m	830m
DR12	Commercial / retail premises	Medium	315716	294215	5m	28m
DR13	Commercial / retail premises	Medium	315722	294208	5m	28m
DR14	Commercial / retail premises	Medium	315727	294201	5m	28m
DR15	Commercial / retail premises	Medium	315733	294193	5m	28m
DR16	Commercial / retail premises	Medium	315739	294186	5m	28m
DR17	Commercial / retail premises	Medium	315743	294179	4m	28m

The discrete receptors presented within **Table 5-1** are not an exhaustive list, the closest sensitive receptors in each direction surrounding the Site have been identified. There may be more receptors at a greater distance, however when considering that odour concentration decreases with the distance from the source, it can reasonably be inferred that receptors at a greater separation distance would not be adversely effected if receptors in closer proximity are not predicted to experience an adverse effect.

6.0 Model Input Data

6.1 Modelled Scenarios

The modelling of normal Site operations, adopting the worst-case modelling approach, is presented in Section 7.0.

The sensitivity analysis undertaken, to verify the worst-case modelling approach, is presented in Appendix C.

6.2 Modelled Assumptions

This OIA and the associated dispersion modelling assessment has applied the following key assumptions, defined on the basis of operational information provided by PCC:

- Residual waste:
  - On weekdays, residual waste would be received at the Site from 11am. A diurnal profile has been modelled representing the residual waste source on this basis. This represents a conservative estimate as under normal operations, waste deliveries may not be received until as late as 2pm;
  - The volume of residual waste within the bays is assumed to increase to the stored volume over a period of two hours following first delivery at 11am, reflecting a highly conservative representation of the build-up waste as deliveries are received throughout the day;
  - On weekdays, bulk export operations would be undertaken from 10am over a period of one hour; and
  - Residual waste would be present within the Bulking Shed overnight, and over the weekend period. Under normal site operations, the retention time of residual waste would not exceed 4 days.
- Food waste:
  - On weekdays, food waste would be received at the Site from 11am. A diurnal profile has been modelled representing the food waste source on this basis. This represents a conservative estimate as under normal operations, waste deliveries may not be received until as late as 2pm;
  - The volume of food waste within the bays is assumed to increase to the stored volume over a period of two hours following first delivery at 11am, reflecting a highly conservative representation of the build-up waste as deliveries are received throughout the day;
  - On weekdays, under normal Site operations, the retention time of food waste within the food waste bay would not exceed 24-hours;
  - On weekdays, bulk export operations would be undertaken from 10am over a period of one hour;
  - On Friday, food waste deliveries received from 11am would be deposited directly into the food waste skips and subsequently sealed prior to weekend storage;

  - Over the weekend, food waste would be stored within two sealed skips between 11am on Friday (the last food waste deliveries) and 10am on Monday (first bulk export operation). Under normal Site operations, no food waste deliveries to Site would occur during the weekend. Under normal Site operations, the weekend retention time of food waste would not exceed 72-hours; and
  - A variable emission rate has been applied to represent the increase in odour emissions from the food waste within the sealed skips over the weekend storage period.
- AHP waste:
  - On weekdays, AHP waste received at the Site would be deposited within the dedicated bay. Each weekday at 4pm, AHP waste received would be deposited (by loading shovel) into the sealed AHP waste skip for storage;
  - In lieu of anticipated AHP waste throughputs, it is assumed that the entire AHP waste bay would be full of waste between 11am (first waste deliveries) and 4pm (emptying of AHP bay into skip), representing a highly conservative assumption; and
  - AHP waste would be stored within the AHP skip for up to 1 week prior to removal from Site. Therefore, it is assumed that there is always a skip filled with AHP waste within the Bulking Shed at all times.
- Rag / textiles:
  - Rag / textiles would be received on a variable basis, as required. Due to the highly variable (but low) volume of waste to be stored, it has been assumed that the rag / textiles storage container would be full of such waste types at all times, representing a highly conservative assumption.
- Seasonal variation:
  - The odour emission rates defined for food and residual waste (on the basis of monitoring data collected during mild conditions in April) have been applied in the dispersion modelling for 365-days-per-year, without any consideration of a reduction factor (i.e. during the winter months when temperatures and therefore odour potential is anticipated to be lower).
- Derivation of emissions:
  - odour emissions from residual and food waste has been defined from the odour monitoring of 'freshly tipped' waste at Rhayader WTS. This odour emission rate measured from waste which has been recently agitated has then been applied to all residual and food waste at the Abermule WTS, without any consideration of a reduction factor during periods where waste is not agitated, when potential odour emissions are anticipated to be significantly lower. Further detail is provided in Section 4.2;
  - odour emissions from food waste stored within skips has been defined on the basis of monitoring at Rhayader WTS, which is considered representative of that which would be received at Abermule WTS. Further detail is provided in Section 4.2;

- odour emissions from AHP waste has been defined on the basis of monitoring on AHP waste received at the Crymlyn Burrows WTS, which is considered representative of that which would be received at Abermule WTS. Further detail is provided in Section 4.2; and
- odour emissions from rags / textiles has been defined in consideration of estimated summer odour emission data for heavily soiled textiles retrieved from raw sewage (referred to as 'screenings') published by UKWIR.

The usage of the waste bays (for the odorous waste types) within the Bulking Shed at the Site have been calculated on the basis of the proposed site operations and anticipated waste throughputs. The usage of the bays (percentage filled by surface area assuming a fill height of 1m[12]) are presented in **Table 6-5** below.

Where a bay is listed as '0%' full, this corresponds to an odour emission rate of zero.

Table 6-1: Waste Bay Usage

Waste Type	Storage Medium	Bay Capacity (% filled as surface area)			
		Monday	Tuesday to Thursday	Friday	Saturday and Sunday
Residual waste	Storage bay	60% full, with the exception of 10:00 – 11:00 (15% full after export ops) and 11:00 – 12:00 (30% full)			60% full during all operational hours (weekend storage)
Food waste	Storage bay	0% full from 00:00 – 11:00, 30% full from 11:00 – 12:00 (deliveries), 60% full from 12:00	60% full during all operational hours, with the exception of 10:00 – 11:00 (0% full after export ops) and 11:00 – 12:00 (30% full)	60% full from 00:00 – 09:00, 0% full from 10:00 – 00:00 (food waste direct into skips)	0% full during all operational hours (i.e. nothing stored in food waste bay over the weekend)
AHP waste	Storage bay	100% full between 11:00 - 16:00. 0% full from 16:00 – 11:00			0% full (i.e. nothing stored in AHP waste bay over the weekend)
Rag / textiles	Open container	100% full at all times.			

[12] The fill height during normal operations is anticipated to be up to 3m. Consideration of a lower fill height results in a greater surface area, thus representing a more conservative assumption.

6.3 Modelled Sources and Emission Rates

Reference should be made to **Table 6-2** and **Table 6-3** for details of the odour emission rates defined for the area and volume (enclosed) sources modelled, respectively.

Table 6-2: Odour Emission Rates - Area Sources

Odour Source	Area Odour Emission Rate ($ou_E/m^2/s$)	Total Bay Surface Area (m^2)	Calculated Odour Emission Rate (ou_E/s)	Data Source
Residual waste bay	1.9	73.4	139	Measured data from Rhayader (see Table E-1)
Food waste bay	2.2	28.1	62	Measured data from Rhayader (see Table E-1)
AHP waste bay	1.1	11.3	12	Measured data from Crymlyn Burrows (see Table E-3)
Rag / textiles storage	20	1.2	24	UKWIR published odour emission data (see Table E-4)

Table 6-3: Odour Emission Rates - Enclosed Sources

Odour Source	Measured Headspace Odour Concentration (ouE/m^3)	Calculated Air Exchange Rate (m^3/s)	Calculated Odour Emission Rate (ou_E/s)	Data Source
Food waste skip - up to 24-hours	2,680	0.011 (A)	29	Measured data from Rhayader (see Table E-2)
Food waste skip - up to 48-hours	8,037	0.011 (A)	87	Measured data from Rhayader (see Table E-2)
Food waste skip - up to 72-hours	-	0.011 (A)	261 (B)	Calculated through data processing (B)
AHP waste skip	-	0.011 (A)	15 (C)	Calculated through data processing (C)
Notes: (A) Calculated in consideration of a skip volume of $13m^3$ and three air changes per hour (acph). This air exchange rate is considered a highly conservative assumption, as the food waste skips present during the odour monitoring study were observed to provide a high level of containment. Lower exchange rates would result in lower emission rates.				

Odour Source	Measured Headspace Odour Concentration (ouE/m³)	Calculated Air Exchange Rate (m³/s)	Calculated Odour Emission Rate (ou_E/s)	Data Source

(B) Calculated through extrapolation of the 24-hour and 48-hour measurements (3-fold increase between 24- and 48-hours, therefore a further 3-fold increase between 48- and 72-hours).
(C) The area odour emission rate measured for AHP waste is half that measured for food waste. Therefore the odour concentration within the AHP waste skip has been calculated as half that measured within food waste skip (up to 24-hours).

Further to the odour emission data presented above, **Table 6-4** presents a breakdown of the weighted odour emissions from the Site. This allow consideration of the weighted odour emission rates, defined in consideration of the variable emission profiles applied (where applicable), and the odour emission rates defined above.

Table 6-4: Weighted Odour Emissions Breakdown

Odour Source	Emission Source Type	Odour Emission Rate (ou_E/s)	Average Variable Emission Factor	Weighted Odour Emission Rate (A) (ou_E/s)
Residual waste bay	Area	139	0.58	81
Food waste bay	Area	62	0.32	20
AHP waste bay	Area	12	0.15	2
Rag / textiles storage	Area	24	1.0 (constant)	24
Food waste skip #1	Volume (fugitive)	29	1.80 (B)	52
Food waste skip #2	Volume (fugitive)	29	1.80 (B)	52
AHP waste skip #1	Volume (fugitive)	15	1.0 (constant)	15

Notes:
(A) The 'weighted odour emission rate' presented is calculated as an average of the diurnal variable emission profile applied for this source (as defined in Section 6.2).
(B) In addition to the temporal variation of emissions, a multiplying factor (3x) has been applied after each 24-hour period during weekend storage operations to reflect the as monitored increase in the odour potential of the waste stream (see Table 6-3).

6.4 Assessment Area

The modelling has been undertaken using both a radial and cartesian receptor grid across the study area, as well as discrete receptors located at the sensitive receptors identified in proximity to the Site (see Section 5.0). Odour exposure isopleths are generated by interpolation between receptor points and superimposed onto the map. This method allows the predicted odour concentration to be calculated in the local area surrounding the Site.

A radial receptor grid was defined to cover the study area as follows:

- 36 radials of equal size (i.e. 10 degrees between radials);
- 15 rings at: 5, 10, 15, 20, 30, 40, 60, 80, 100, 150, 200, 250, 300, 350 and 400m); and
- centred at NGR coordinates x315692, y294177.

A cartesian receptor grid was defined to cover the study area as follows:

- grid spacing of 10m;
- 10 points on the x-axis and 10 points on the y-axis; and
- centred at NGR coordinates x315708, y294182.

6.5 Meteorological Data

The most important meteorological parameters governing the atmospheric dispersion of pollutants are as follows:

- Wind direction: determines the broad transport of the emission and the sector of the compass into which the emission is released;
- Wind speed: will affect ground level emissions by determining the initial dilution of pollutants emitted; and
- Atmospheric stability: is a measure of the turbulence, particularly of vertical motions.

There are a number of meteorological stations surrounding the Site. A review of meteorological stations in proximity to the Site is presented in **Table 6-5** and **Figure 6-1**.

Table 6-5: Details on Recording Stations in Proximity to the Site

Recording Station Name	Station ID	Station Elevation (m)	Distance from Site (km)	Summary of Location
Lake Vyrnwy (No. 2)	3410	359	28	Rural
Shobdon Airfield	3520	99	40	Semi-rural
Bala	3409	163	46	Rural
Shawbury	3414	76	48	Semi-rural
Trawsgoed	3503	62	52	Rural

Table Notes:
The Site elevation is 94m.
The land use in the immediate vicinity surrounding the Site is rural.

Figure 6-1: Recording Stations in Proximity to the Site

Based upon the distance from the Site, the difference in surrounding land-use class and elevations, the meteorological stations presented in **Table 6-5** and **Figure 6-1** have been discounted from inclusion.

As there are no meteorological stations in proximity to the Site which were considered to be representative of the Site location, therefore Numerical Weather Prediction (NWP) meteorological data has been utilised for the study. Five consecutive years of hourly-sequential NWP data was acquired based on the Site location and applied in the assessment.

The NWP meteorological data (covering the period 2015 to 2019, inclusive) was obtained in '.met' format from the data supplier. The data was converted to the required surface and profile formats for use in AERMOD, in accordance with the latest guidance[13], using AerMet View meteorological pre-processor, details specific to the Site location were used to define surface roughness, albedo and bowen ratio in the conversion (see **Table 6-6**) using the AerSurface tool within AerMet.

Table 6-6: Meteorological Data Preparation – Applied Surface Characteristics

Zone (Start and End Sectors)	Albedo	Bowen	Surface Roughness
0 – 30°	0.18	0.57	0.146
30 – 60°	0.18	0.57	0.157

[13] AERMOD Implementation guide. AERMOD implementation workgroup, USEPA. Last revised July 2021.

Zone (Start and End Sectors)	Albedo	Bowen	Surface Roughness
60 - 90°	0.18	0.57	0.154
90 - 120°	0.18	0.57	0.140
120 - 150°	0.18	0.57	0.090
150 - 180°	0.18	0.57	0.087
180 - 210°	0.18	0.57	0.088
210 - 240°	0.18	0.57	0.088
240 - 270°	0.18	0.57	0.088
270 - 300°	0.18	0.57	0.088
300 - 330°	0.18	0.57	0.158
330 - 0°	0.18	0.57	0.141

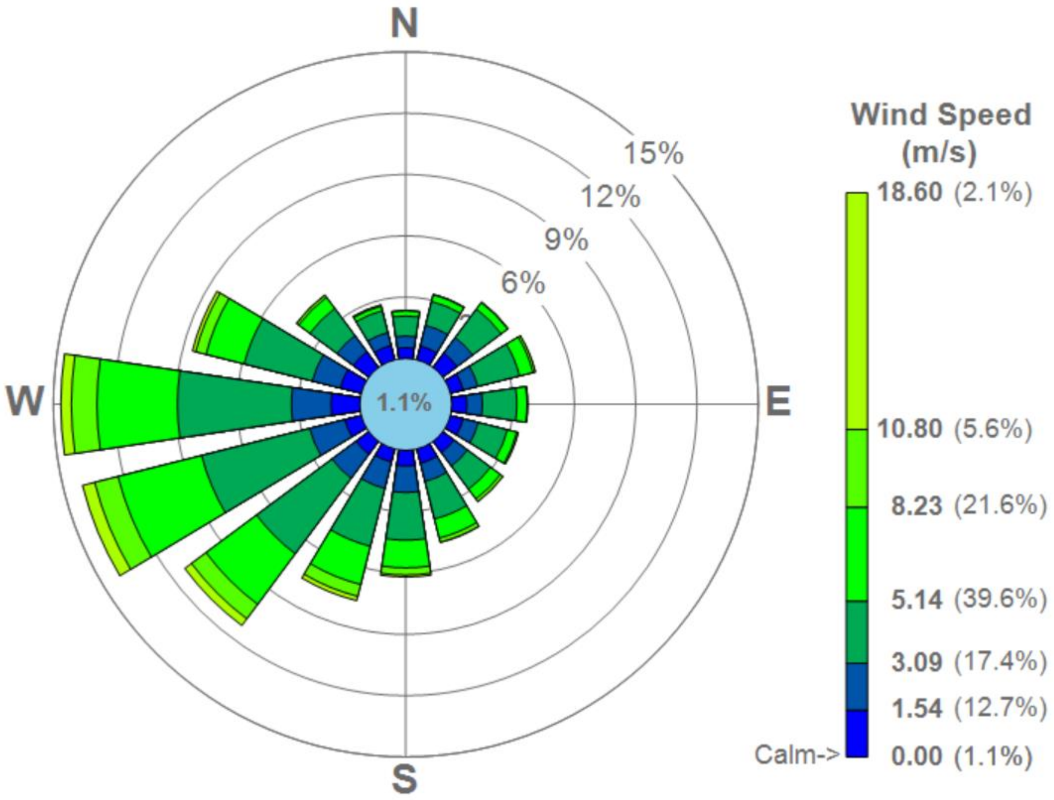
A composite windrose for the 5-year dataset is presented in **Figure 6-2**. Individual wind-roses for each year of meteorological data are presented in Appendix B. The wind-roses indicate that the prevailing wind direction is from the west.

Table 6-7 presents statistics on the meteorological dataset illustrating the number of hours of calms (i.e. no measurable wind-speed) predicted as well as any missing data within the 5-year period. It should be noted that as NWP meteorological data is generated by the supplier based on measured data from the surrounding measurement stations, missing data from one station can be supplemented by data from another station to avoid periods of missing data.

Table 6-7: Numerical Weather Prediction Meteorological Data Statistics

Year	Calm Hours (%)	Missing Hours (%)
2015	0.9	0.0
2016	1.3	0.0
2017	0.8	0.0
2018	1.2	0.0
2019	1.2	0.0

Figure 6-2: NWP Meteorological Data Wind Rose 2015 - 2019

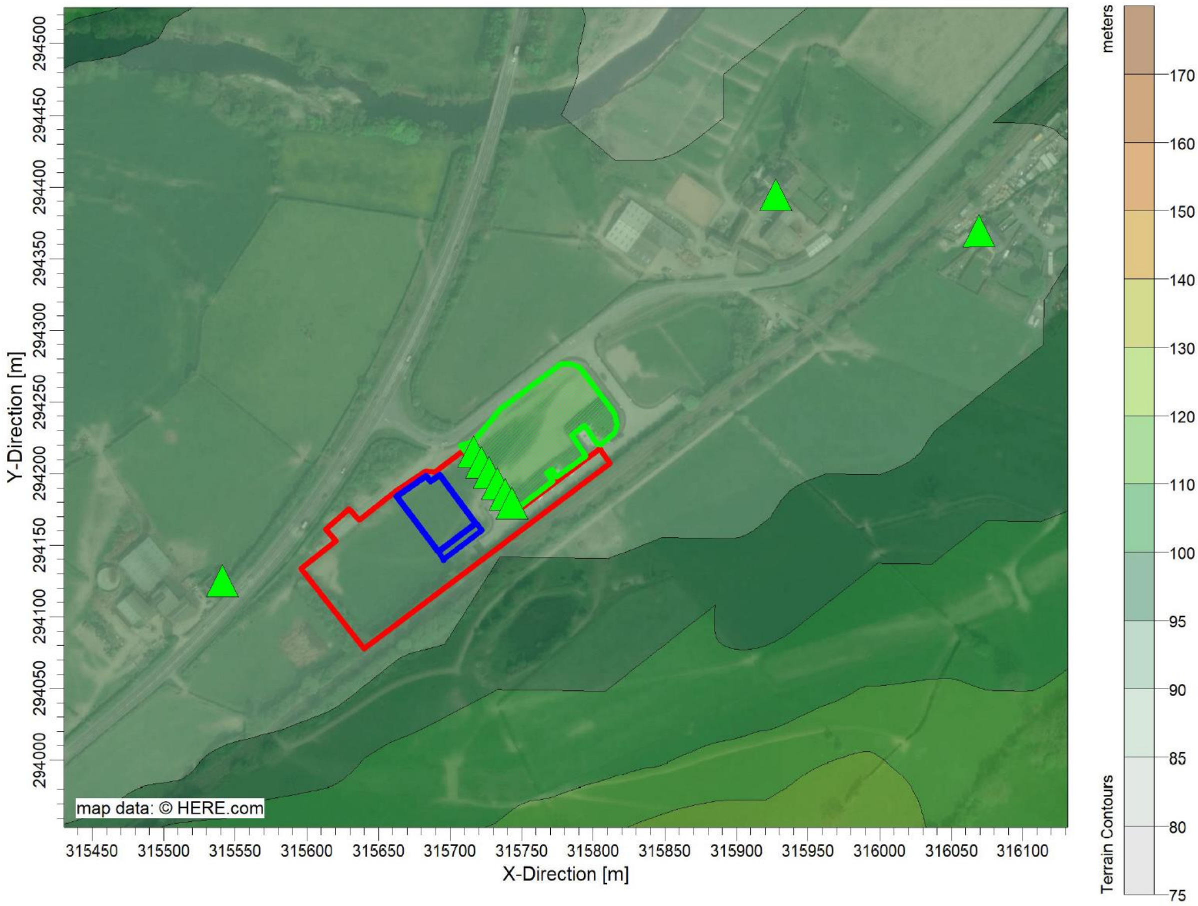


6.6 Terrain Data

The presence of elevated terrain can significantly affect the dispersion of pollutants and the resulting ground level concentration in a number of ways. Elevated terrain reduces the distance between the plume centre line and the ground level, thereby increasing ground level concentrations. Elevated terrain can also increase turbulence and, hence, plume mixing with the effect of increasing concentrations near to a source and reducing concentrations further away. Topography was incorporated within the modelling using 30m resolution Shuttle Radar Topography Mission (SRTM) terrain data. Data was processed by the AERMAP function within AERMOD to calculate terrain heights (see **Figure 6-3**).

The Site is situated in base of a shallow valley which runs from south-west to north-east, at an elevation of approximately 90m AOD. The land rises at the extents of the valley, to the south-east and north-west of the site, to a height of approximately 160m. As such, topography has been incorporated into the model.

Figure 6-3: Terrain Data



7.0 Prediction of Impacts

This section provides a presentation of the predicted odour impact of the Site, as determined through the detailed dispersion modelling study.

The odour exposures predicted as a result of emissions from the Site are presented in **Figure 7-1** and **Table 7-1** below.

7.1 Predicted Odour Concentrations at Sensitive Receptors

The predicted concentrations may be compared against the relevant benchmark criterion of 3.0ou_E/m^3 for 'medium sensitivity' receptors (i.e. DR12 – DR17, corresponding to Abermule Business Park) and 1.5ou_E/m^3 for 'high sensitivity' receptors (i.e. DR1 – DR11, corresponding to residential dwellings and farms).

The odour exposures predicted as a result of emissions from the Site at the identified sensitive receptors are presented in **Table 7-1** below.

Table 7-1: Predicted Odour Concentrations at Sensitive Receptors

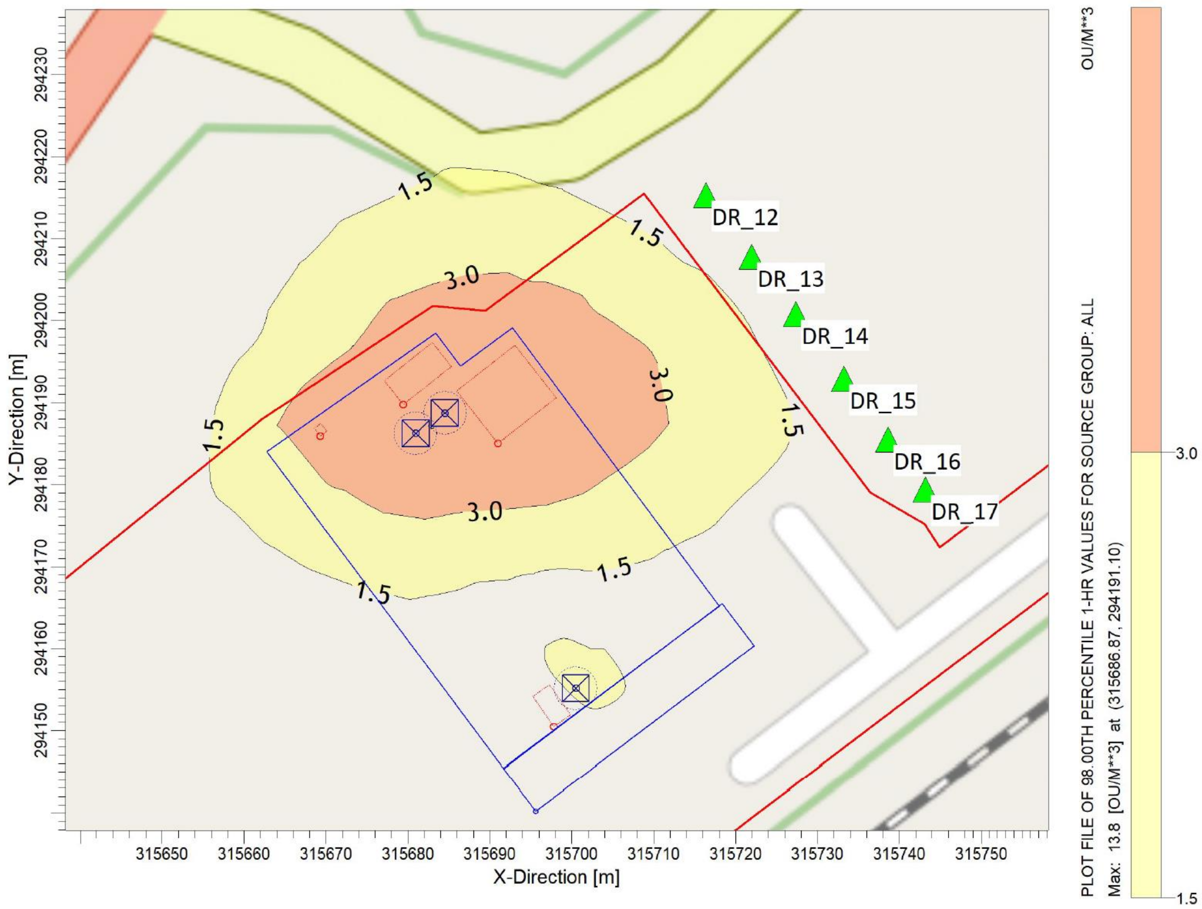
Receptor	Receptor Sensitivity	Relevant Criterion $C_{98, 1\text{-hour}}$ ou_E/m^3	Predicted Odour Concentration ($C_{98, 1\text{-hour}}$ ou_E/m^3)					
			2015	2016	2017	2018	2019	Average 5-years
DR1	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR2	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR3	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR4	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR5	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR6	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR7	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR8	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR9	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR10	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR11	High	1.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DR12	Medium	3.0	0.8	0.9	1.1	1.0	1.2	1.0
DR13	Medium	3.0	0.8	1.0	1.2	1.2	1.3	1.2
DR14	Medium	3.0	0.7	1.1	1.2	1.3	1.4	1.2
DR15	Medium	3.0	0.7	1.2	1.2	1.2	1.5	1.1
DR16	Medium	3.0	0.5	1.0	1.1	1.0	1.3	1.0
DR17	Medium	3.0	0.4	0.7	1.0	0.8	1.0	0.8

7.2 Isopleth Maps

The results of the dispersion modelling have been presented as isopleths of 98th percentile of 1-hour mean concentrations. The predicted concentrations may be compared against the relevant benchmark criterion of $C_{98,\ 1\text{-hour}}$ 3.0ou_E/m^3 for 'medium sensitivity' receptors and $C_{98,\ 1\text{-hour}}$ 1.5ou_E/m^3 for 'high' sensitivity receptors.

Figure 7-1 presents the modelled dispersion of odours from the Site when considering the average of the 5-years'meteorological data investigated to represent *'typical'* dispersion trends.

Figure 7-1: Modelled $C_{98\ 1\text{-hour}}$ Odour Concentrations: 2015-19 Meteorological Data



Whilst it is noted that this is not a requirement of NRW's H4 Odour Management guidance, the modelled dispersion of odours from the Site when considering each of the individual meteorological years investigated are presented for completeness in Appendix A. Comparison of these shows minimal variation and none exceed the relevant criterion at any of the sensitive receptors.

7.3 Interpretation of Results

The results of the dispersion modelling predict that the odour concentrations resulting from the Site operations are below the benchmark criterion of $C_{98,\ 1\text{-hour}}$ 3.0ou_E/m^3 at all medium sensitivity receptors (DR12 to DR17) and less than $C_{98,\ 1\text{-hour}}$ 1.5ou_E/m^3 at all high sensitivity receptors (DR1 to DR11).

Therefore, in accordance with NRW's H4 Odour Management guidance there is no risk of significant pollution at any of the considered sensitive receptors.

8.0 Summary and Conclusion

SLR has undertaken an OIA of identified sources of odour from the North Powys Bulking Facility near Newtown, Powys, to support an environmental permit application to NRW.

The potential odour impact from the Site has been quantified by dispersion modelling in AERMOD, applying a precautionary approach and model inputs as part of a robust assessment. Odour emission rates for use in the dispersion modelling were determined in reference to the odour monitoring study at Rhayader, monitoring undertaken by SLR at the Crymlyn Burrows waste management site and from values provided in published literature.

Dispersion modelling of odour from the standard operation of the Site has been compared against the odour impact criterion of $C_{98,1\text{-hour}}$ 3.0ou_E/m^3 (for 'medium sensitivity' receptors) and $C_{98,1\text{-hour}}$ 1.5ou_E/m^3 (for 'high sensitivity' receptors), in consideration of a 'most offensive' odour as defined by NRW's H4 Odour Management guidance.

The results of the dispersion modelling predict that the odour concentrations resulting from Site operations are below the relevant benchmark criterion at all considered receptors. Therefore, in accordance with NRW's H4 Odour Management guidance there is no risk of significant pollution as a result of odour from the Site operations.

Appendix A: Figures – Modelled Odour Contours and Impact Descriptors

Figure A-1: Modelled $C_{98\ 1\text{-hour}}$ Odour Concentrations: 2015 Meteorological Data

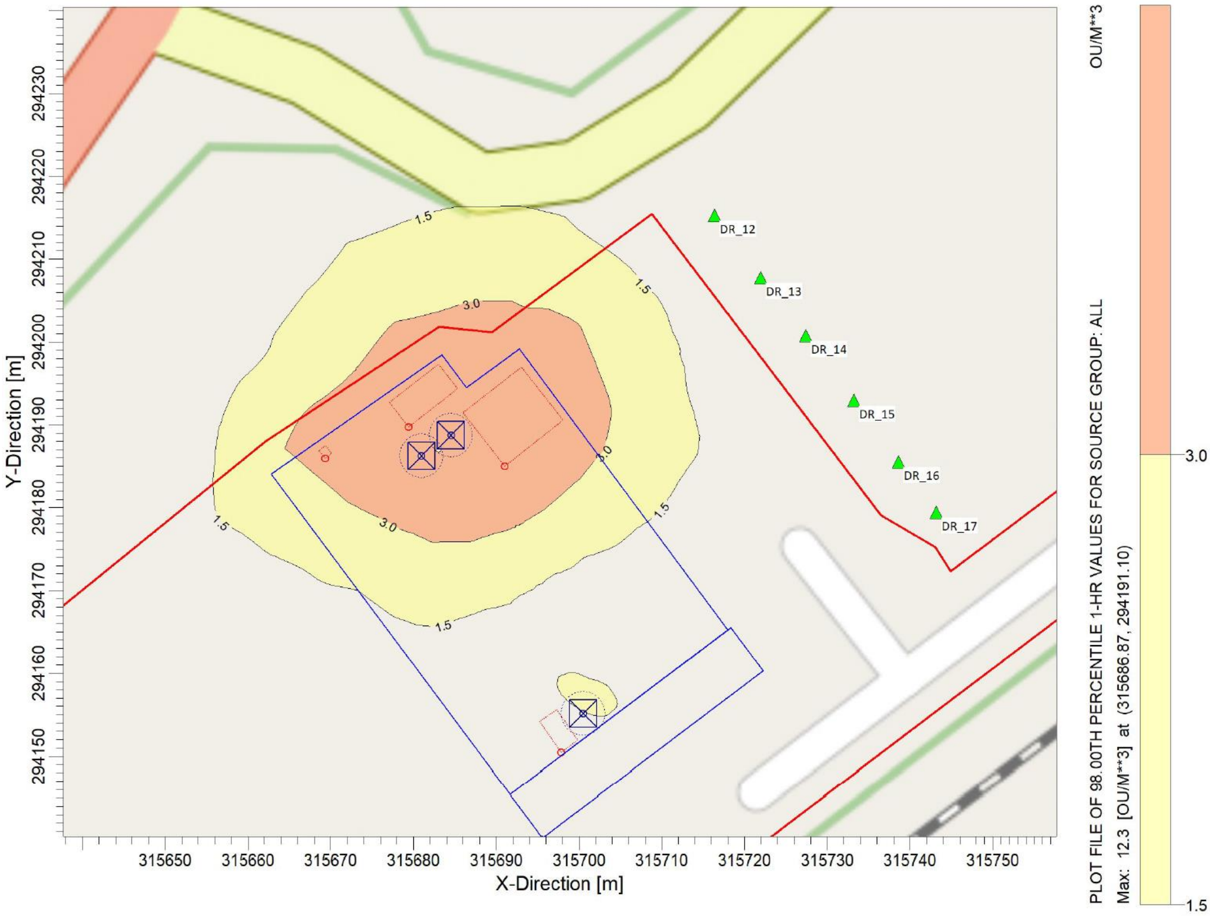


Figure A-2: Modelled $C_{98\ 1\text{-}hour}$ Odour Concentrations: 2016 Meteorological Data

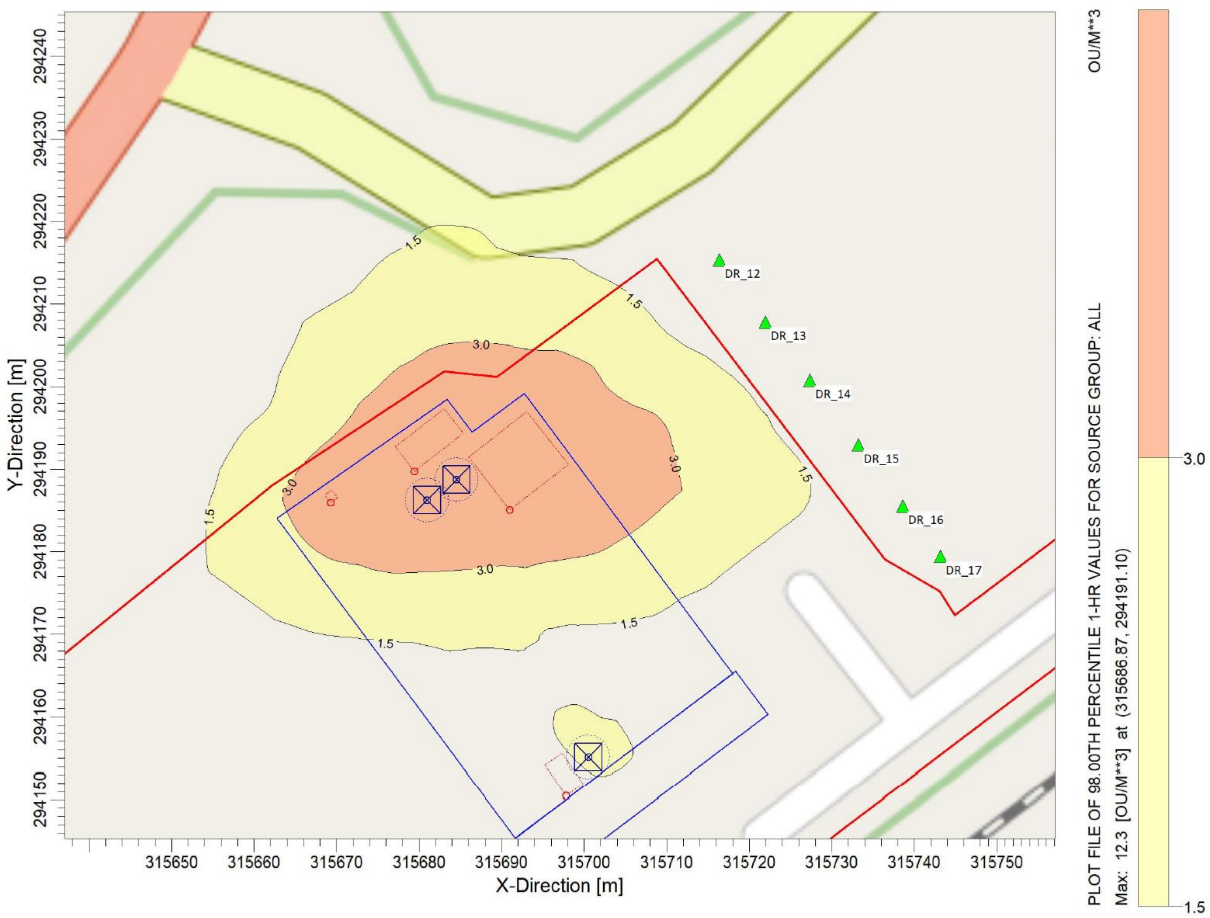


Figure A-3: Modelled $C_{98\ 1\text{-hour}}$ Odour Concentrations: 2017 Meteorological Data

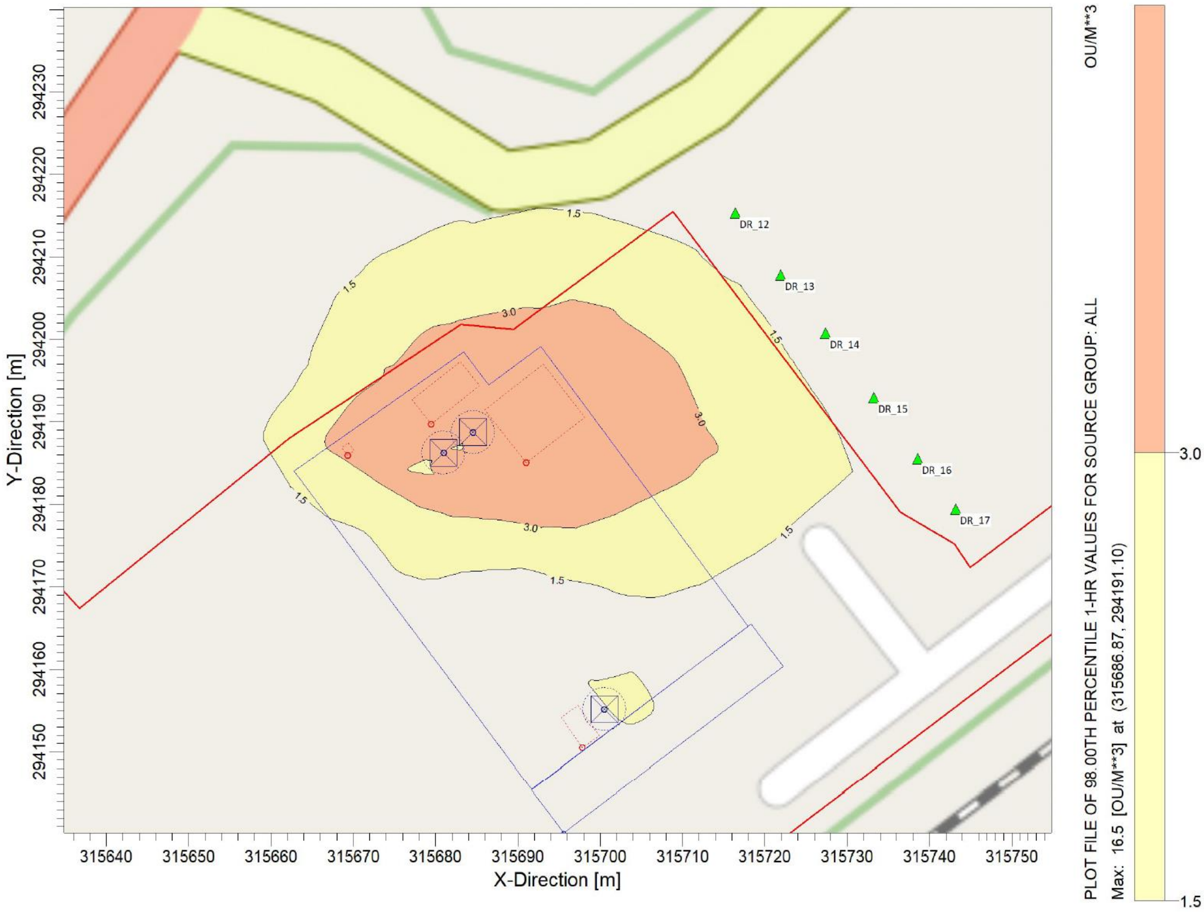


Figure A-4: Modelled $C_{98\ 1\text{-hour}}$ Odour Concentrations: 2018 Meteorological Data

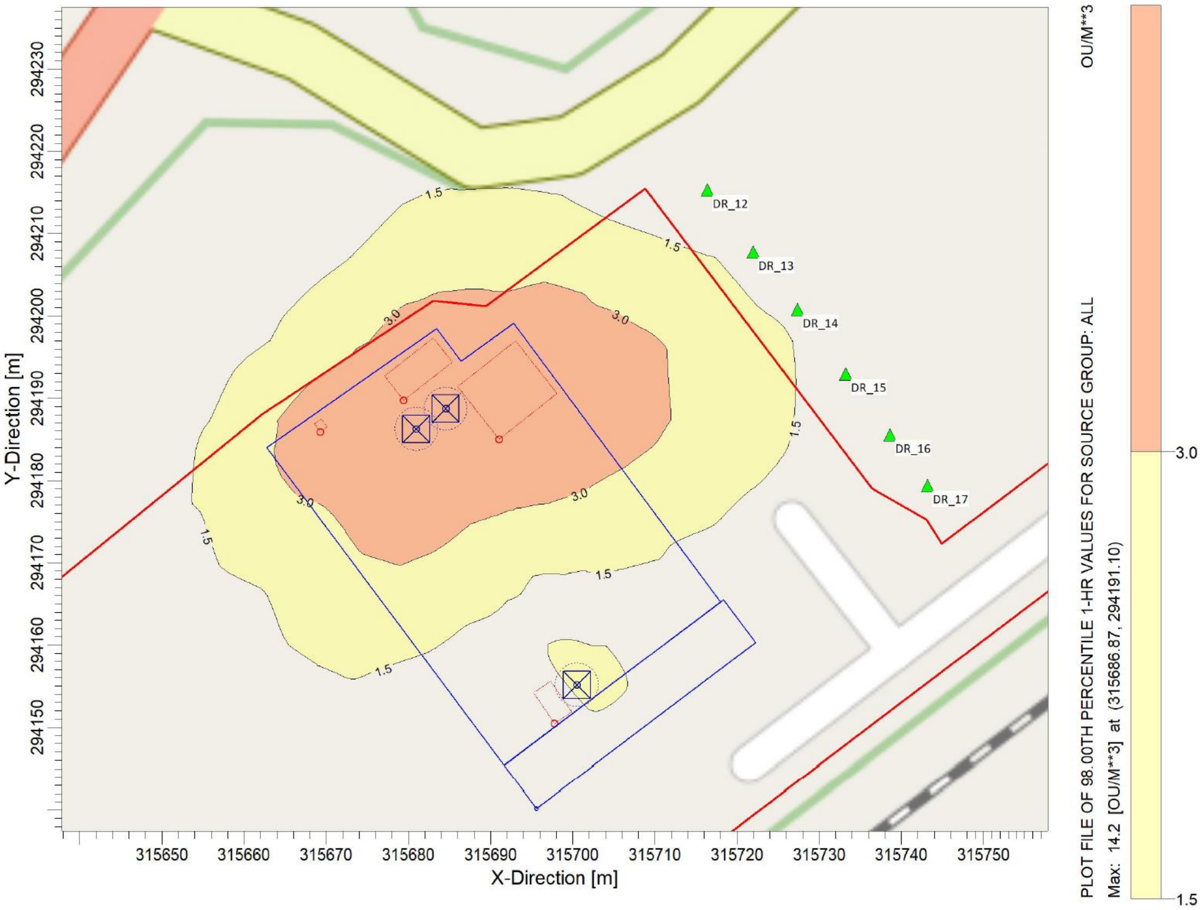


Figure A-5: Modelled $C_{98\ 1\text{-hour}}$ Odour Concentrations: 2019 Meteorological Data

Appendix B: Meteorological Data Wind Roses

Figure B-1: NWP Meteorological Data Wind Rose 2015

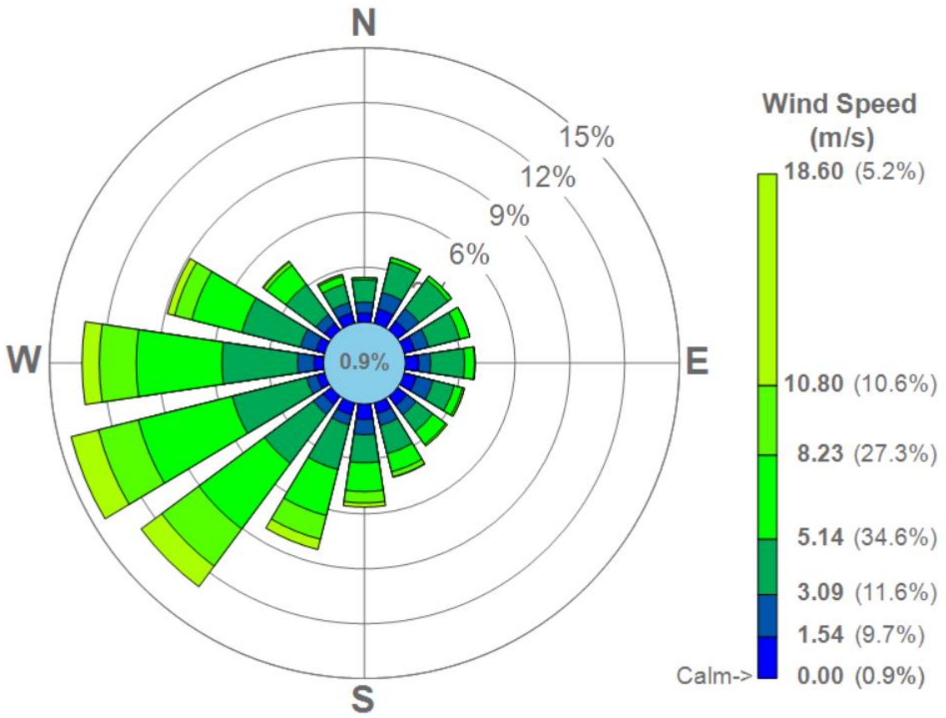


Figure B-2: NWP Meteorological Data Wind Rose 2016

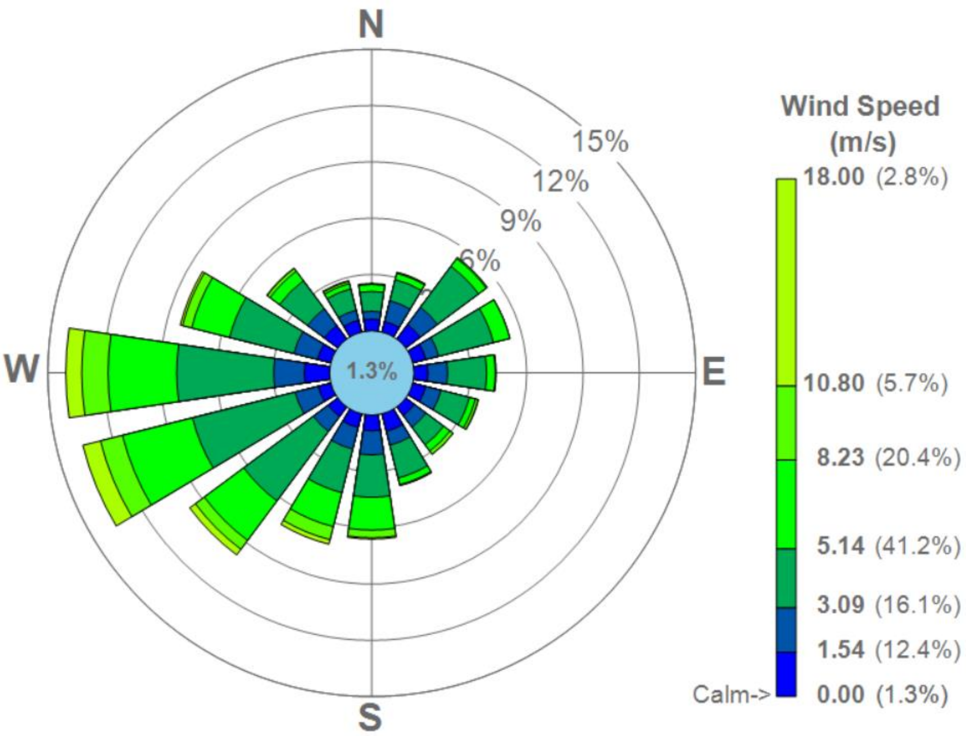


Figure B-3: NWP Meteorological Data Wind Rose 2017

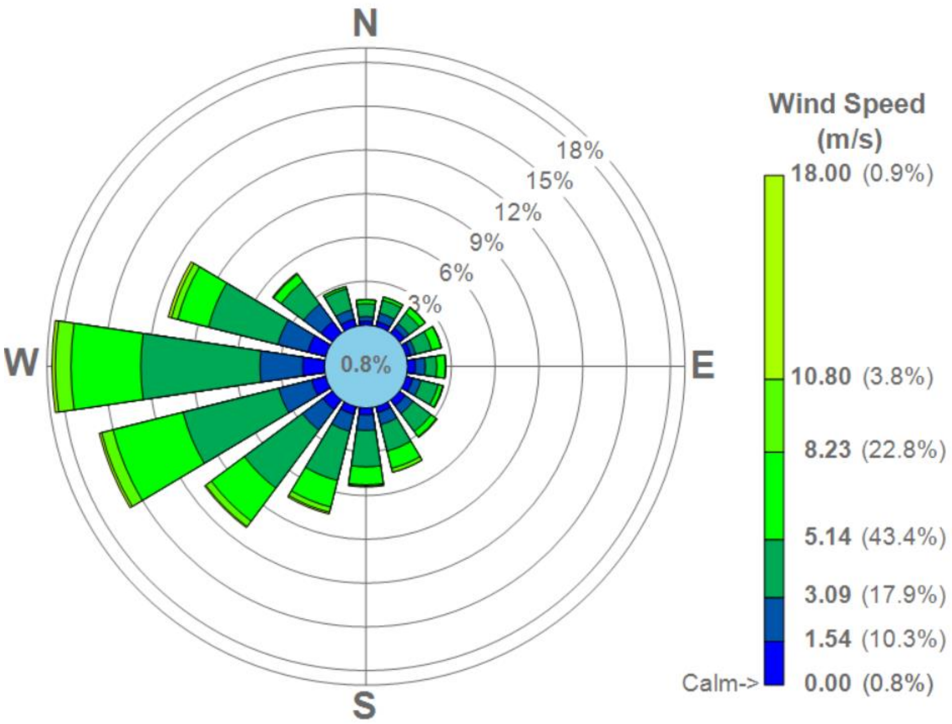


Figure B-4: NWP Meteorological Data Wind Rose 2018

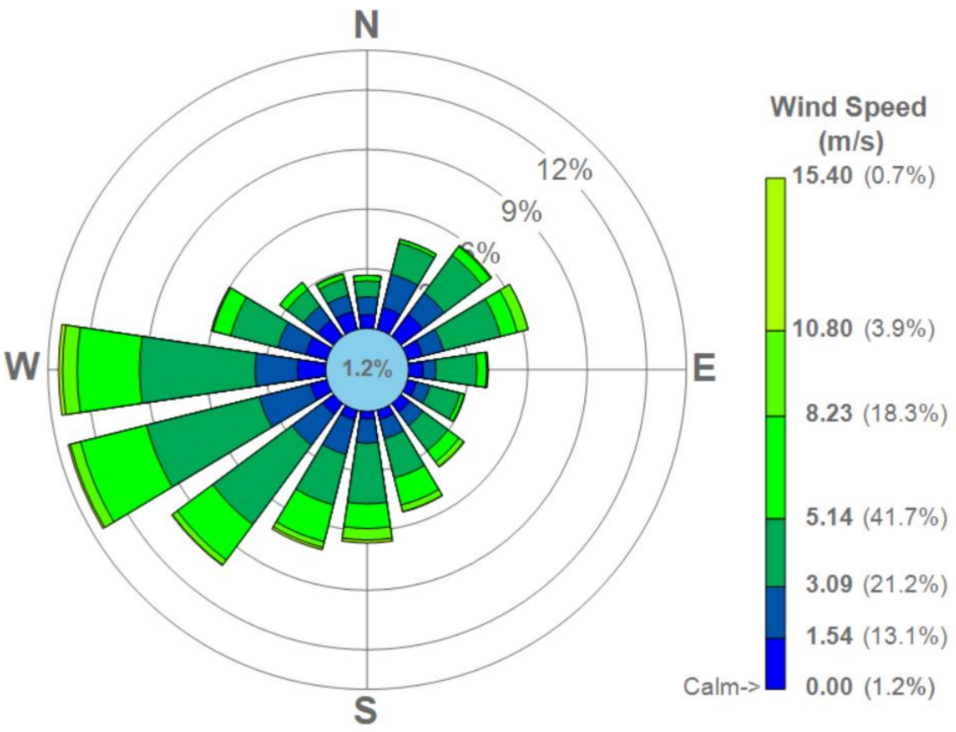
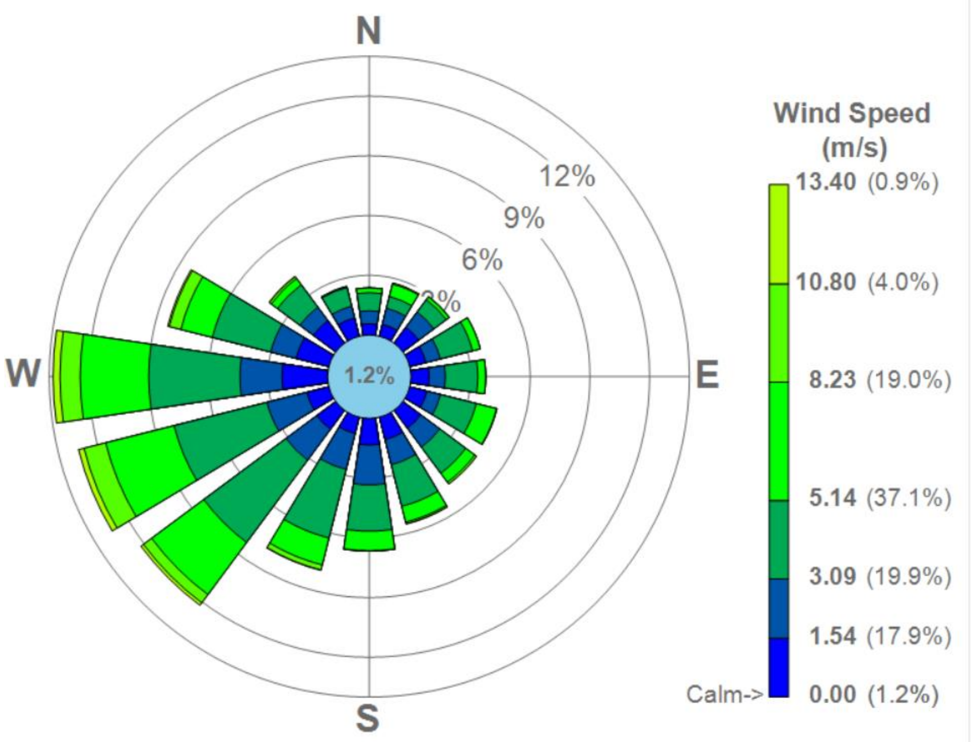


Figure B-5: NWP Meteorological Data Wind Rose 2019



Appendix C: Model Sensitivity Analysis

Sensitivity analysis has been undertaken to investigate the different odour modelling approaches available to predict off-site odour impacts resulting from the Site, to ensure that a conservative assessment approach has been adopted in the OIA.

This sensitivity analysis has explored an alternative modelling approach for the determination of potential odour impacts. The odour sources defined are all located within the Bulking Shed, an enclosed and ventilated building. Therefore, the total odour emissions defined from all odour sources (as defined in Section 6.3) have been represented as five point sources, representing the five horizontally orientated ventilation fans located along the north-eastern wall of the Bulking Shed.

The maximum odour emission rate from each emission source (as defined in Section 6.3) has been calculated in **Table C-1** below. This calculation has considered the maximum diurnal variable emission factor applied to each source, reflecting a highly conservative approach.

Table C-1: Maximum Odour Emission Rate Calculation

Odour Source	Emission Rate (ou_E/s)	Maximum Variable Emission Factor	Maximum Weighted Emission Rate (ou_E/s)
Food waste bay	62	0.6 (representing the bay being 60% filled)	37
Food waste skip #1	29	9.0 (representing odour potential from 48-to 72-hours storage period)	261
Food waste skip #2	29	9.0 (representing odour potential from 48-to 72-hours storage period)	261
Residual waste bay	139	0.6 (representing the bay being 60% filled)	85
AHP waste bay	12	1.0 (representing the bay being 100% filled)	12
AHP waste skip	15	1.0 (representing the skip being 100% filled)	15
Rag / textile storage	24	1.0 (representing the sip being 100% filled)	24
		Total Emission Rate:	**693**

The emission parameters for the five vents are presented in **Table C-2** below, and have applied the maximum odour emission rate as calculated in **Table C-1** (split between the five sources).

Table C-2: Sensitivity Analysis (Point Sources) Emission Parameters

Parameter	Unit	Ventilation Fan 1	Ventilation Fan 2	Ventilation Fan 3	Ventilation Fan 4	Ventilation Fan 5
Emission Source Type	-	Point	Point	Point	Point	Point
Location (NGR)	Easting (x)	315685	315696	315703	315709	315715
	Northing (y)	294197	294195	294186	294179	294171
Discharge Height	Meters (m)	7.0	7.0	7.0	7.0	7.0
Stack orientation	-	Horizontal				
Efflux Velocity	m/s	n/a (A)				
Discharge Temperature	°C	Ambient (B)				
Emission Rate (C)	ou_E/s	139	139	139	139	139

Notes:

(A) In order to reflect the horizontal nature of the emission point, in line with the latest Aermod guidance, the 'Horizontal' release type has been selected within Aermod. By selecting this option, Aermod reduces the efflux velocity to a 0.01m/s value.

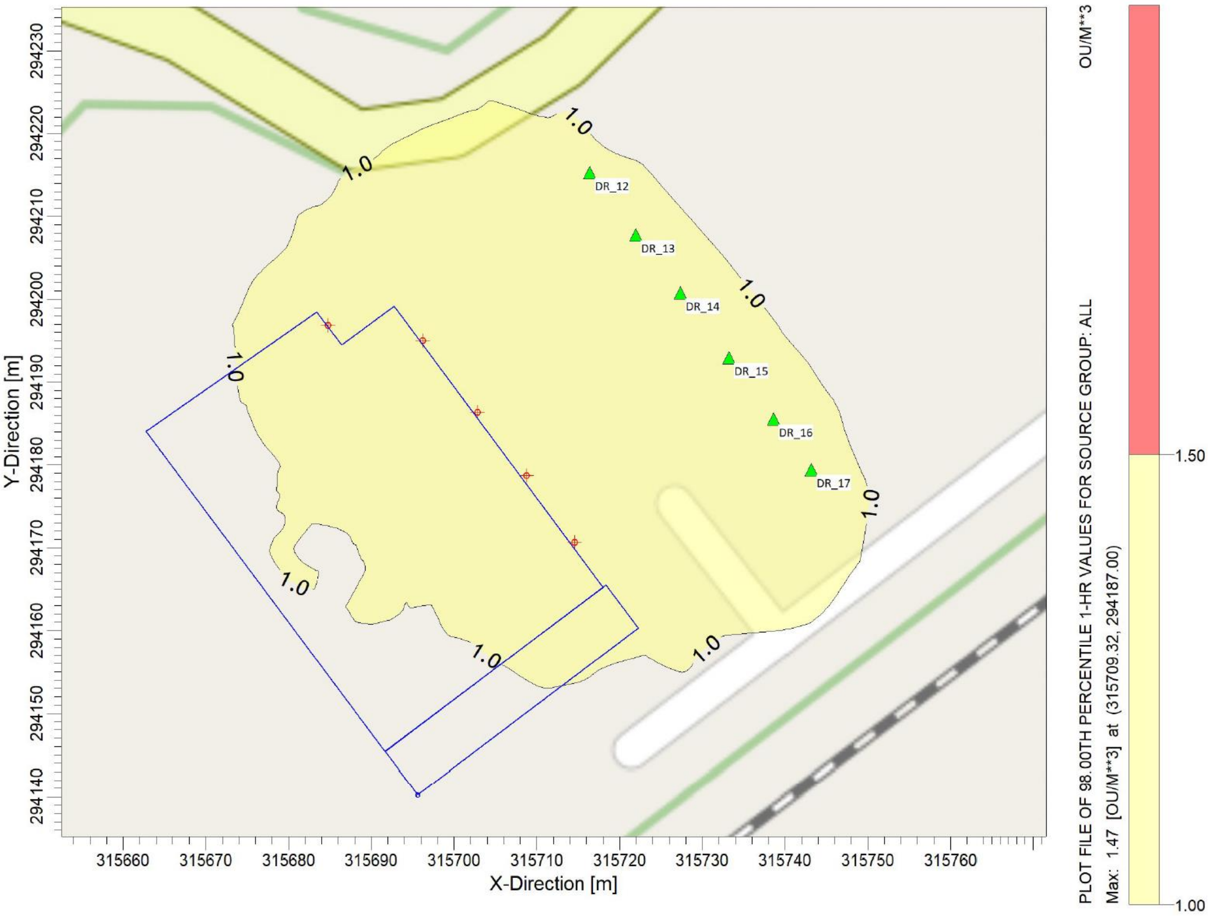
(B) The 'ambient' temperature option has been selected within Aermod. This substitutes the discharge temperature with the ambient temperature value within meteorological file for that hour. Temperatures assigned in this manner are likely to be lower than might be experienced within the Bulking Shed during such conditions, therefore this represents a highly conservative assumption.

(C) Calculated from the total maximum odour emission rate (693ou_E/s) divided between the five emission sources.

This sensitivity analysis has considered the Bulking Shed in calculation of building downwash effects, with a considered height of 13.4m.

Figure C-1 below presents the results of the dispersion modelling undertaken for this sensitivity analysis. This sensitivity analysis has considered the same sensitive receptors as defined in Section 5.0.

Figure C-1: Modelled Odour Concentrations, Sensitivity Analysis, 2015-19 Meteorology



Even when considering the maximum odour emissions from each odour source (as presented in **Table C-1** above), the odour concentrations predicted as a result of the sensitivity analysis as shown in **Figure C-1** above are lower than those presented in Section 7.0. The maximum odour concentration predicted in **Figure C-1** above is 1.47ou_E/m^3 (as a 98th percentile of 1-hour averages).

This therefore demonstrates that the modelling approach adopted within the main assessment (i.e. modelling of sources as un-enclosed, without consideration of the containment provided by the Bulking Shed) is highly precautionary and has adopted the 'worst-case' modelling approach.

Appendix D: Odour Potential of Waste Types

Table D-1: Odour Potential of Waste Types

Description of Waste	Maximum Volume Stored (m³)	Storage Location	Associated Odour Potential
Residual waste (including street cleaning litter and bulky waste)	207	Bunded area located within Bulking Shed	Medium
Food waste (bay)	84.4		Medium-to-High (dependent on retention time)
Food waste (skips)	26 (two sealed skips, weekend storage only)		
AHP (bay)	22.5		Low - Medium
AHP (skip)	13 (one sealed skip)		
Co-mingled cans and plastic (in 2 bays)	331.4 (total amount over 2 bays)		Negligible
Mixed paper and cardboard	191.5		Negligible
Rags / textiles	0.912		Low
Waste Electrical and Electronic Equipment (WEEE)	1.69		Negligible
Non-hazardous batteries	1.69		Negligible
Mixed glass	182.6	Bunded area located Outdoors	Negligible
Green (garden) waste	184		Negligible

The odour potential of the different types of material have been determined in reference to the odour monitoring study, as well as monitoring data from a range of sites around the UK, IAQM Odour Guidance and Waste Sector Guidance[14]. The general trend observed is that the lower the organic content of the waste type, the lower the odour potential (and also the inverse).

Green waste is an exception in that it is comprised almost entirely of organic matter but is typically associated with a low odour potential. However, when considering the similarity of green waste odours to those currently present within the site setting

[14] Best Available Techniques (BAT) Reference Document for Waste Treatment, European Commission, 2018.

(agricultural), the sensitivity of nearby residential receptors to green-waste type odours is likely to be low, therefore the associated odour potential in this setting is considered to be ‘negligible’.

Appendix E: Odour Monitoring Data

An odour monitoring study was undertaken on 27th April 2022. As the Site is not yet operational, odour monitoring was undertaken at the nearby Rhayader bulking facility. The residual waste received at the Rhayader bulking facility was collected from a catchment area with the same demographics as the area which would be served by the Abermule WTS and is therefore considered representative. The food waste received at the Rhayader bulking facility was collected from the same catchment area as would be served by the Abermule WTS.

It should also be considered that food waste is segregated from residual waste within the catchment of the Rhayader bulking facility (as would be the case at the Site). Therefore, the organic content of the residual waste received is reduced in comparison to sites where food waste is co-mingled with municipal waste.

The odour monitoring data gathered allows determination of site-specific odour emission rates for food and residual waste.

The monitoring was undertaken using methods outlined in BS EN13725:2022[15]. For area sources (i.e. the surface of different types of waste), collection of odour samples was undertaken using a ventilated canopy known as a 'Lindvall hood'. The canopy was placed on the odorous material and ventilated at a known rate with clean odourless air. The odour samples was collected from the outlet of the hood using the pneumatic extraction method.
The air flow rate of ventilation air blown into the hood was measured during the monitoring exercise and utilised to calculate a specific odour emission rate per unit area per second (E_{sp}) as follows:

- Odour emission rates for sources where a Lindvall sampling hood was used were calculated in odour units per square metre per second ($ou_E/m^2/s$) using the following equation:
  E_{sp} ($ou_E/m^2/s$) = C_{hood} x L x V
  Where:
  C_{hood} is the concentration result from the laboratory analysis in ou_E/m^3.
  V is the flow presented to the hood in m^3/s.
  L is the Lindvall hood factor: $\frac{flow\ path\ cross\ section\ of\ the\ hood\ in\ m^2}{Covered\ area\ in\ m^2}$

The 'L' factor for the specific Lindvall hood used during the Rhayader monitoring was 0.009 and during the Crymlyn Burrows monitoring was 0.015.

For enclosed sources (i.e. the headspace within enclosed skips), collection of odour samples was undertaken using pneumatic extraction ('ambient' method). The extract air was collected into 40-litre Nalophan sampling bags for transport. The samples were then analysed at a UKAS accredited laboratory as specified in BS EN13725:2022.

[15] BS EN13725:2022 stationary source emissions – determination of odour concentration by dynamic olfactometry and odour emission rate.

Where: C hood is the concentration result from the laboratory analysis. V is the flow presented to the hood. L is the: flow path cross section of the hood (m2)Covered area (m2)

The results of the monitoring are presented in **Table E-1** and **Table E-2** below.

Table E-1: Odour Monitoring Data – Rhayader (Area Sources)

Monitoring Location	Monitoring Period	Hood Ventilation Air Flow Rate (m^3/s)	Odour Concentration (ou_E/m^3)	Area Odour Emission Rate ($ou_E/m^2/s$)	
				Replicates	Geomean
Residual waste Import - Location 1 (A)	12:45 - 12:50	0.83	253	1.9	1.9
	12:50 - 12:56		95	0.7	
	12:56 - 13:01		248	1.9	
Residual waste Import - Location 2 (A)	13:10 - 13:15	0.81	634	4.6	
	13:15 - 13:20		295	2.2	
	13:20 - 13:25		236	1.7	
Food Waste Import #1 (B)	13:37 - 13:42	0.87	305	2.4	2.2
	13:42 - 13:48		349	2.8	
	13:48 - 13:53		282	2.2	
Food Waste Import #2 (C)	14:04 - 14:09	0.83	271	2.0	
	14:09 - 14:16		255	1.9	
	14:16 - 14:21		287	2.2	

Notes:
(A) Residual waste monitored was received (offloaded) at 12:15.
(B) Food waste import #1 monitored was received (offloaded) at 12:50.
(C) Food waste import #1 monitored was received (offloaded) at 13:40.

Table E-2: Odour Monitoring Data – Rhayader (Enclosed Sources)

Monitoring Location	Monitoring Period	Odour Concentration (ou_E/m^3)	
		Replicates	Geomean
Food Waste Skip - 24-hrs after storage (A)	11:51 - 11:56	2,752	2,680
	11:56 - 12:01	2,456	
	12:01 - 12:07	2,848	

Monitoring Location	Monitoring Period	Odour Concentration (ou_E/m^3)	
		Replicates	Geomean
Food Waste Skip - 48-hrs after storage (B)	11:31 - 11:36	8,647	8,037
	11:36 - 11:41	7,807	
	11:41 - 11:47	7,690	

Notes:
(A) Food waste deposited in sealed food waste skip on 26th April 2022.
(B) Food waste deposited in sealed food waste skip on 25th April 2022.

A conservative approach was adopted in regard to the assessment of odour emissions from residual and food waste; monitoring was undertaken on recently agitated waste. Waste was deposited (tipped from collection vehicle) approximately 1-hour prior to sample collection. This reflects the period during which odour emissions from such waste types are highest (i.e. following agitation associated with deposition on the tipping floor of the Bulking Shed).

In general, residual and food waste received has the potential to arrive at the Site in an advanced state of decomposition. However it considered unlikely that waste received at the Site would arrive in such a state, in consideration of the following:

- wastes received at this site are from Local Authority waste collections from household sources and trade co-collections
- residual waste collections are undertaken on a three-weekly basis.
- waste is received directly at the Site following collections (i.e. no prior retention time at another site).
- during the monitoring study undertake at Rhayader, no waste deliveries were observed to be in an advanced state of decomposition.

Food waste has a very high organic content, and as such decomposition and putrefaction of the organic content can lead to an increase in odour emissions over time, as evidenced by the monitoring data collected from the 24- and 48-hour food waste storage skips.

This assessment has also considered additional sources of odour emission data, to supplement the site-specific data presented above. Odour monitoring of AHP at the Crymlyn Burrows waste management facility, undertaken by SLR in 2021, is presented in **Table E-3** below. This monitoring data was collected using the same mythologies and techniques as outlined above. The AHP received at Crymlyn Burrows was sources from local residential collection routes, and did not comprise clinical or trade-waste sources. Therefore, the AHP received at Crymlyn Burrows is considered representative of that which would be received at the Site.

Table E-3: Odour Monitoring Data – Crymlyn Burrows

Waste Type	Monitoring Date	Hood Ventilation Air Flow Rate (m^3/s)	Odour Concentration (ou_E/m^3)	Area Odour Emission Rate ($ou_E/m^2/s$)	
				Replicates	Geomean
AHP waste	21/01/2022	0.60	145	1.1	1.1
			115	1.3	
			102	0.9	

This assessment has further considered published data sources, to supplement the site-specific data presented above. Relevant published odour emission data outlined in the UKWIR guidance which has been applied in this assessment is presented in **Table E-4** below.

Table E-4: Published Emission Data - UKWIR

Waste Type	Area Odour Emission Rate ($ou_E/m^2/s$)
Soiled rags / textiles (A)	20 ('Low')

Notes:

(A) The odour emission rate for Soiled rags / textiles has been determined in consideration of the that determined for 'screenings' (in the context of wastewater treatment). This represents a worst-case assumption, as it can be inferred that the odour potential of highly soiled material removed from raw sewage is higher than that of textiles / rags collected alongside (or removed from) municipal waste.

Appendix F: Odour Monitoring and Analysis Reports

Monitoring at Rhayader on 27th April 2022

The odour monitoring exercised undertaken at the Rhayader waste transfer station on 27th April 2022 was undertaken by SLR using the methodology outlined in BS EN13725:2022, as presented in Appendix E. The monitoring report is provided electronically as file "220427_Odour Monitoring Report_Rhayader.pdf".

The odour samples collected during this monitoring exercise were transported to Olfasense's UKAS accredited laboratory in Bristol for analysis the following day (within 30 hours of collection). The laboratory report is provided electronically as file "220428_SLRC22C_Cert_Bristol.pdf".

Each sample provided to the laboratory was assigned a unique identifier (i.e. "220427HRG"). Each code corresponds to a monitoring location, as outlined within the odour monitoring report provided. For ease, the sampling method utilised and identifiers assigned are summarised in Table F-1 below.

Table F-1: Odour Sample Identfiers and Methods – Rhayader Monitoring

Monitoring Location	Odour Sample Identifier Assigned for Laboratory Analysis	Sampling method applied
Residual waste Import - Location 1	220427GRG	Area source (Lindvall hood)
	220427HRG	
	220427IRG	
Residual waste Import - Location 2	220427JRG	Area source (Lindvall hood)
	220427KRG	
	220427LRG	
Food Waste Import #1	220427MRG	Area source (Lindvall hood)
	220427NRG	
	220427ORG	
Food Waste Import #2	220427PRG	Area source (Lindvall hood)
	220427QRG	
	220427RRG	

Monitoring Location	Odour Sample Identifier Assigned for Laboratory Analysis	Sampling method applied
Food Waste Skip - 24-hrs after storage	220427DRG	Ambient (headspace)
	220427ERG	
	220427FRG	
Food Waste Skip - 48-hrs after storage	220427ARG	Ambient (headspace)
	220427BRG	
	220427CRG	

Monitoring at Crymlyn Burrows on 21st January 2021

The odour monitoring exercised undertaken at the Crymlyn Burrows waste transfer station on 21st January 2021 was undertaken by SLR using the methodology outlined in BS EN13725:2022, as presented in Appendix E. The monitoring report is provided electronically as file "210121_Odour Monitoring Report_Crymlyn Burrows.pdf". It should be noted that the odour monitoring report has been edited to remove information for 'Source 1', 'Source 2' and 'Source 3', as these are not of relevance to this assessment.

The odour samples collected during this monitoring exercise were transported to Olfasense's UKAS accredited laboratory in Bristol for analysis the following day (within 30 hours of collection). The laboratory report is provided electronically as file "210122_SLRC20I_Cert_Bristol.pdf".

Each sample provided to the laboratory was assigned a unique identifier (i.e. "AHP01"). Each code corresponds to a monitoring location, as outlined within the odour monitoring report provided. For ease, the sampling method utilised and identifiers assigned are summarised in Table F-2 below.

Table F-2: Odour Sample Identfiers and Methods – Crymlyn Burrows

Monitoring Location	Odour Sample Identifier Assigned for Laboratory Analysis	Sampling method applied
AHP (hygiene) waste	AHP01	Area source (Lindvall hood)
	AHP02	
	AHP03	

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