Title	**Odour Assessment Report**
Site	**WHITLINGHAM WRC**
Purpose of report	**Industrial Emission Directive (IED) permit applications**

Project Personnel and Contacts

ROLE	NAME	LOCATION
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Version Control

VERSION	DATE	BY	AMENDMENT	REASON

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1 Executive summary

Odour models are required as part of the Industrial Emission Directive (IED) permit applications for all of Anglian Water's (AW) Sludge Treatment Centres (STC).

Whitlingham Water Recycling Centre (WRC) already has two waste operation permits which covers the Combined Heat and Power (CHP) plant and the STC. These operate under Environmental Permitting Regulations (EPR) but due to the requirements of the Industrial Emissions Directive (IED), the site requires a permit variation under IED.

Anglian Water Services (AWS) are applying for a Bespoke Installation Permit for the STC waste activity, as a joint Environment Agency (EA) and Department for Environment, Food and Rural Affairs (DEFRA) decision has been made that Anaerobic Digestion (AD) treatment facilities at Water Recycling Centre (WRCs) and STCs should be fall under the Industrial Emissions Directive.

AW needs to demonstrate that the STCs have minimal impact at the permit boundary and comply to H4/the BAT conclusions.

An odour impact assessment using AERMOD (9.9.0) was undertaken to determine the odour exposure levels across the areas surrounding the STC.

The modelling methods used are based on assessment techniques that are presented within guidance published by the EA, DEFRA, and the Institute of Air Quality Management (IAQM).

An odour concentration of 1.5 Odour Units Per Cubic Metre (OU/m^3) has been taken as the benchmark level at which nuisance and potential loss of amenity would be anticipated. This assessment criterion for the protection of public nuisance/amenity is in line the EA H4 Planning Guidance, including septic effluent and sludge in amongst a range of substances categorised as most offensive and for which a low detection threshold should be taken into consideration.

The odour emission rates used for the modelling study were mainly based on the olfactometric samples collected and analysed from similar odour sources at AW different STCs.

Certified processed meteorological data (2018-2020) from Norwich meteorological station, representative of Whitlingham WRC was obtained from Atmospheric Dispersion Modelling Ltd (ADM Ltd) for the modelling study.

The atmospheric dispersion model AERMOD was used to predict the dispersion of odour from the STC, utilising meteorological data and the odour sources details. A model run was completed with each year of meteorological data to determine the odour impacts from Whitlingham STC on the surrounding area.

The modelling showed that the sensitive receptors around the WRC will be subject to odour concentrations greater than 1.5 OU/m^3.

To reduce the odour to acceptable levels, measures such as reduction of cake storage area and servicing the Odour Control Units are required.

2 Introduction

Whitlingham WRC is located to the south east of city of Norwich, South of A47 motorway. The WRC coordinates are given in Figure 1. The site approximate centre point is at X=627752 E, Y=307592 N.

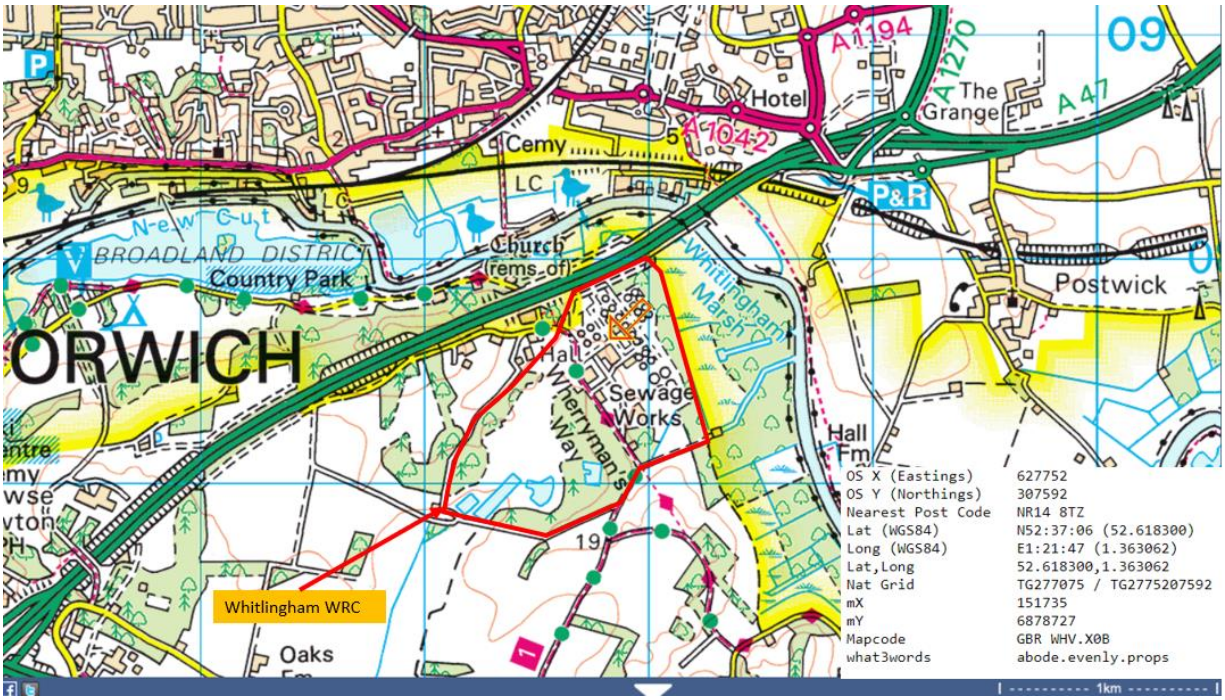

Figure 1: Whitlingham WRC-Coordinates

Whitlingham Water Recycling Centre (WRC) and Sludge Treatment Centre (STC) is located Whitlingham Sludge Treatment Centre. The site address is as follows:
Whitlingham WRC (Site short code = WHITST)
Kirby Bedon Road, Trowse, Norwich, Norfolk, NR14 8TZ Grid reference: TG 27880 07554

The WRC location is given in figure 2.

Figure 2: Whitlingham WRC location map and STC, EA permitting area.

2.1 The Existing Wastewater Treatment Processes

Whitlingham Water Recycling Centre (WRC) and Sludge Treatment Centre (STC) is located Whitlingham Sludge Treatment Centre, Kirby Bedon Road, Trowse, Norwich, Norfolk, NR14 8TZ (NGR: TG 27880 07554). The WRC is operated under the Urban Wastewater Treatment Regulations (UWwTR) and has a standalone Water Discharge Activity Environmental Permit, this will remain an independent permitted activity. The STC operation is a non-hazardous waste activity which is currently carried out under a bespoke waste operation permit (EPR/LP3499SY). The waste activity comprises of imports, physio-chemical and anaerobic digestion (AD) treatment, and the storage of waste, all for recovery purposes. The STC handles waste derived from the wastewater treatment process indigenously produced on-site and imported wastes. The Site undertakes AD of sewage sludge from the on-site WRC and will continue this operation under a new bespoke Industrial Emissions Directive (IED) installation permit.

The Combined Heat and Power plant is also currently permitted under a waste operation permit (EPR/RP3435GB). Electricity and heat for the site are primarily provided by the combustion of biogas generated from the 2 CHP engines (1 x 1.2 MWe, 1 x 1750 kWe spark ignition engines) and on-site treatment processes, and by dual fuel (biogas and gas oil) steam raising boiler providing steam to the thermal hydrolysis process (THP) plant.

AWS are applying for a variation to the existing STC waste operation permit and consolidate with the CHP waste operation permit. This will form a Bespoke Installation Permit for the STC waste

activity, as a joint Environment Agency and Department for Environment, Food and Rural Affairs (DEFRA) decision has been made that AD treatment facilities at WRCs and STCs are covered by the Industrial Emissions Directive and should no longer operate as separate waste activities.

The primary permitted installation activity will be the AD treatment activity. The AD activity will treat indigenously produced sludges, and imported sludges and domestic waste. Permitted Directly Associated Activities (DAAs) will be the physio-chemical treatment of sludges; the storage of sludges and cake from AD activity; the storage of biogas derived from the AD treatment of waste and the combustion of biogas in an on-site Combined Heat and Power plant (CHP). In the event the CHP cannot run in an emergency or due to operational issues, biogas will be combusted via an on-site flare stack and back-up boiler system.

2.2 Odour assessment and modelling

Investigative modelling study was carried out to assess odour impacts from Whitlingham WRC on the surrounding area.

2.3 Odour Survey and emissions data

AWS developed an odour dispersion model for Whitlingham WRC in 2013. Over the years the model has been updated to include the latest developments and operating regime of the treatment plant.

The odour emission rates used for the reactors are based on actual olfactometric samples taken and analysed by specialised odour contractors in an accredited odour laboratory. Some samples were collected by H&M Environmental Ltd, and some were collected by Silsoe Odours. All samples were analysed in Silsoe Odours olfactometry laboratory.

Olfactometry is a sensory measurements that employs the human nose as the odour detector and hence relate to the effect of odours as experienced by humans. The most common sensory measurement is threshold olfactometry which measures the odour concentration in terms of dilution required to reduce an odorous compound until its threshold concentration.

The purpose of this emissions data is to support conclusions to be drawn on prevailing odour risk and to provide source data for the odour dispersion modelling.

3 Atmospheric Dispersion Modelling

Atmospheric dispersion modelling is the mathematical simulation of how air pollutants disperse in ambient atmosphere. It is solved by computer programmes that use mathematical equations and algorithms which simulate the pollutants dispersion. The dispersion models are used to estimate or to predict the downwind concentration of air pollutants emitted from sources such as wastewater treatment plants, industrial plants, and vehicular traffic.

Atmospheric dispersion modelling is a well-documented and recognised technique to predict the dispersion of malodours. Modelling was undertaken using the AERMOD computer programme (release version 9.9.0).

AERMOD is recognised by the Environment Agency, UK Met Office, and the US Environmental Protection Agency. AERMOD uses meteorological data, terrain data and emission data as input to predict the dispersion of odours.

3.1 Modelling Method

Six steps were followed in the modelling of odour dispersed from Whitlingham STC.

1. Certified pre-processed meteorological data was purchased from an independent source (Atmospheric Dispersion Modelling) for the WRC.
2. Terrain data was processed for use in the model.
3. Source emission data used were based on actual WRC olfactometric samples taken and analysed in specialised laboratory over the past years.
4. The processed Met data, process units, sources emission data were all inputted into the AERMOD model.
5. The AERMOD model was compiled and ran.
6. Results from AERMOD are processed by the graphical post-processor. This gives a graphical representation of the odour dispersal on a map of the affected area. These are presented in Section 4 of this report.

Graphical representations of the resultant odour dispersal models over a map of Whitlingham are presented in Section 4.

3.2 Meteorological Data

Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the diluting effect of the atmosphere. It is extremely important that the correct meteorological data is used for the modelling study.

Certified meteorological data (2018-2020) from Norwich meteorological station representative of Whitlingham WRC was purchased from ADM Ltd for the modelling study. ADM Ltd are an independent, accredited source that provide a range of services to industry, developers, consultancies, and government organisations. These services cover the full spectrum of air quality and odour, project management and provision of dispersion modelling software together with terrain and meteorological data.

The certificate of met data from ADM Ltd is provided in Appendix A.

AERMOD requires the input of data that include hourly averaged values for wind speed and direction, cloud cover, ambient temperature, solar radiation, the amount of atmospheric turbulence, the height of mixing layer and other parameters.

Longitude and latitude of both Whitlingham WRC and of the meteorological station are given in Table 1.

Table 1: Longitude and latitude of WRC and Meteorological Station.

Location	Latitude	Longitude
Whitlingham WRC	52.618N	0.806W
Norwich Met Station	52.633N	1.363E

Wind roses from Norwich station for years 2018-2020 are presented in figures 3 to 5.

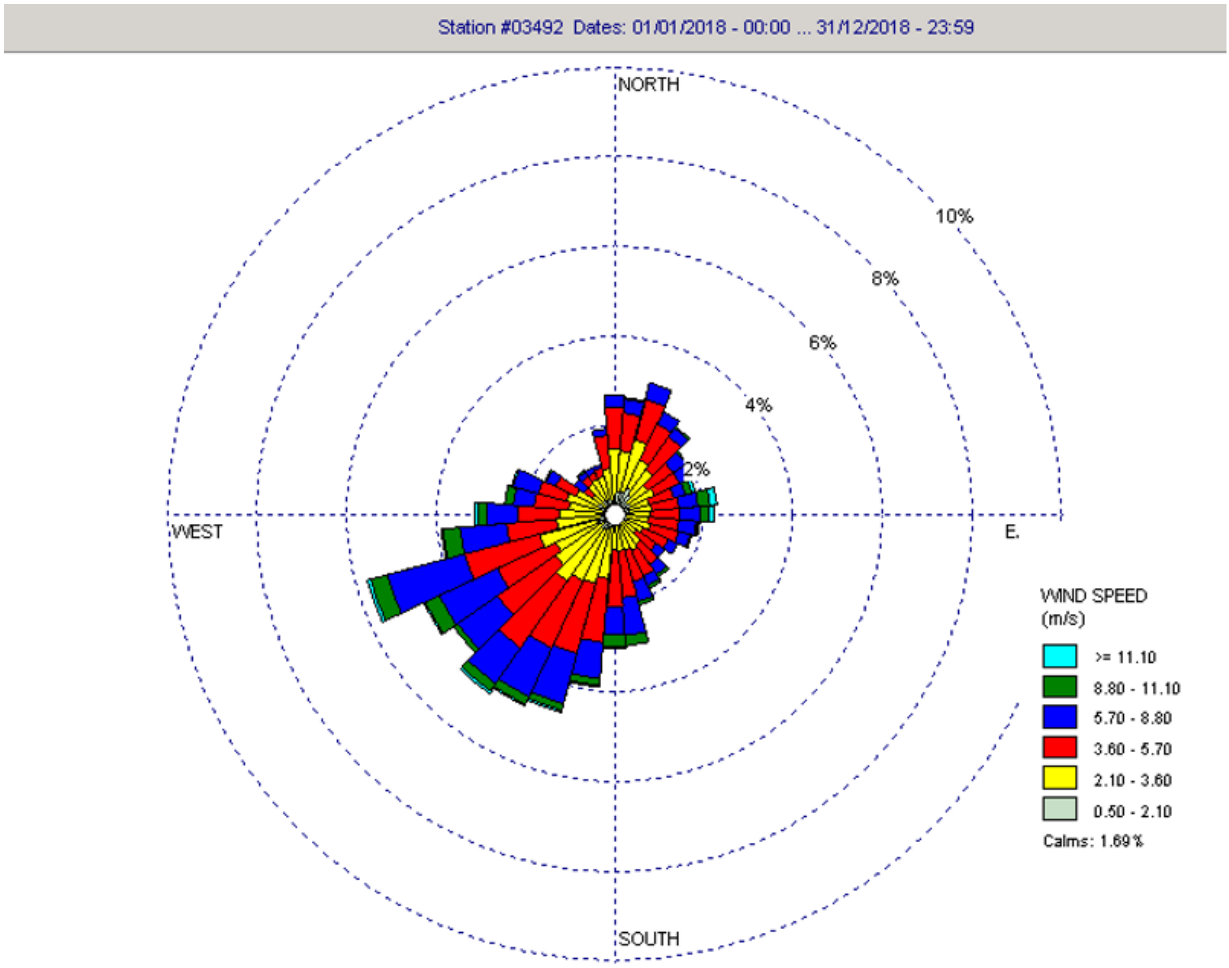

Figure 3: 2018 wind rose for Norwich Meteorological Station

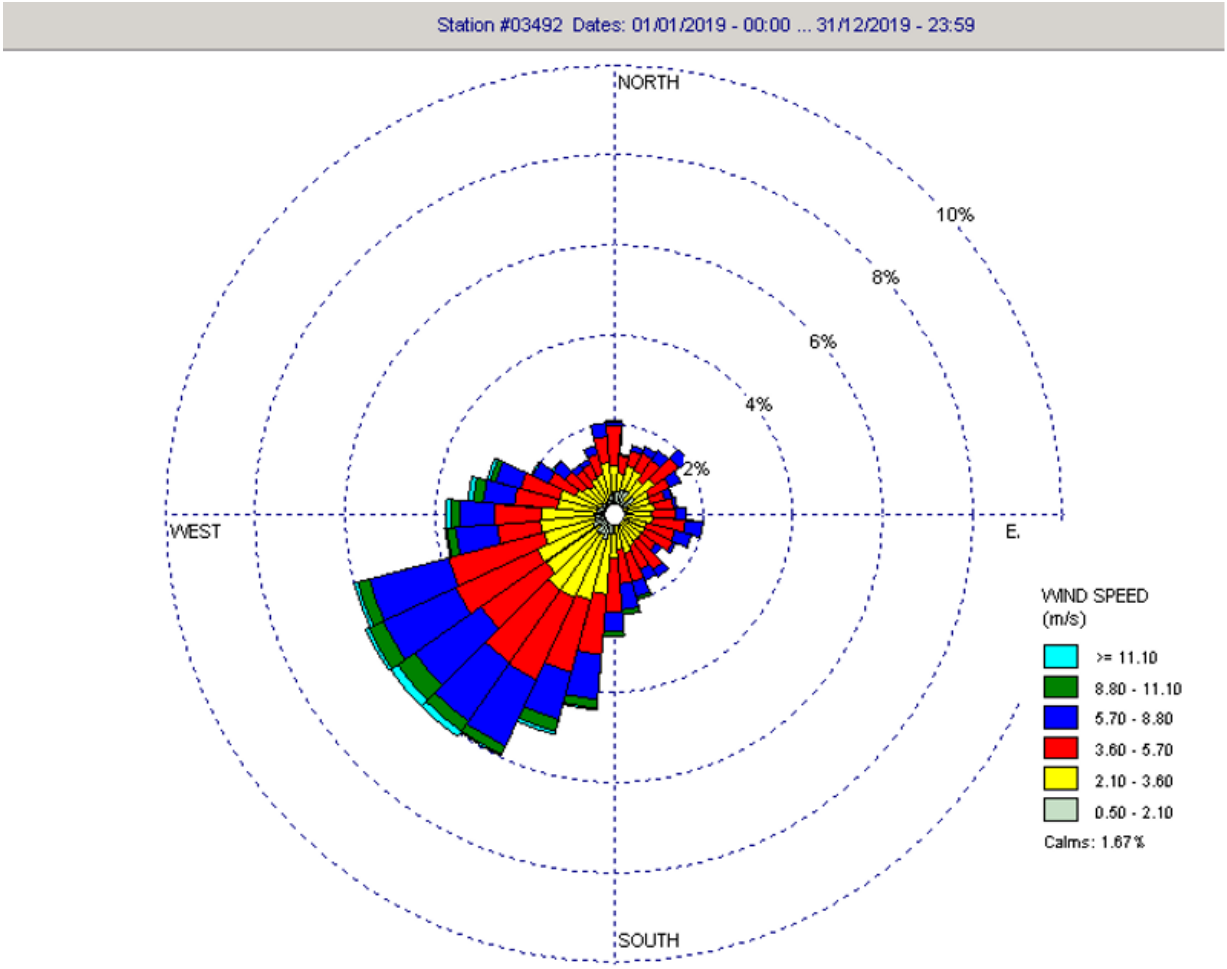

Figure 4: 2019 wind rose for Norwich Meteorological Station

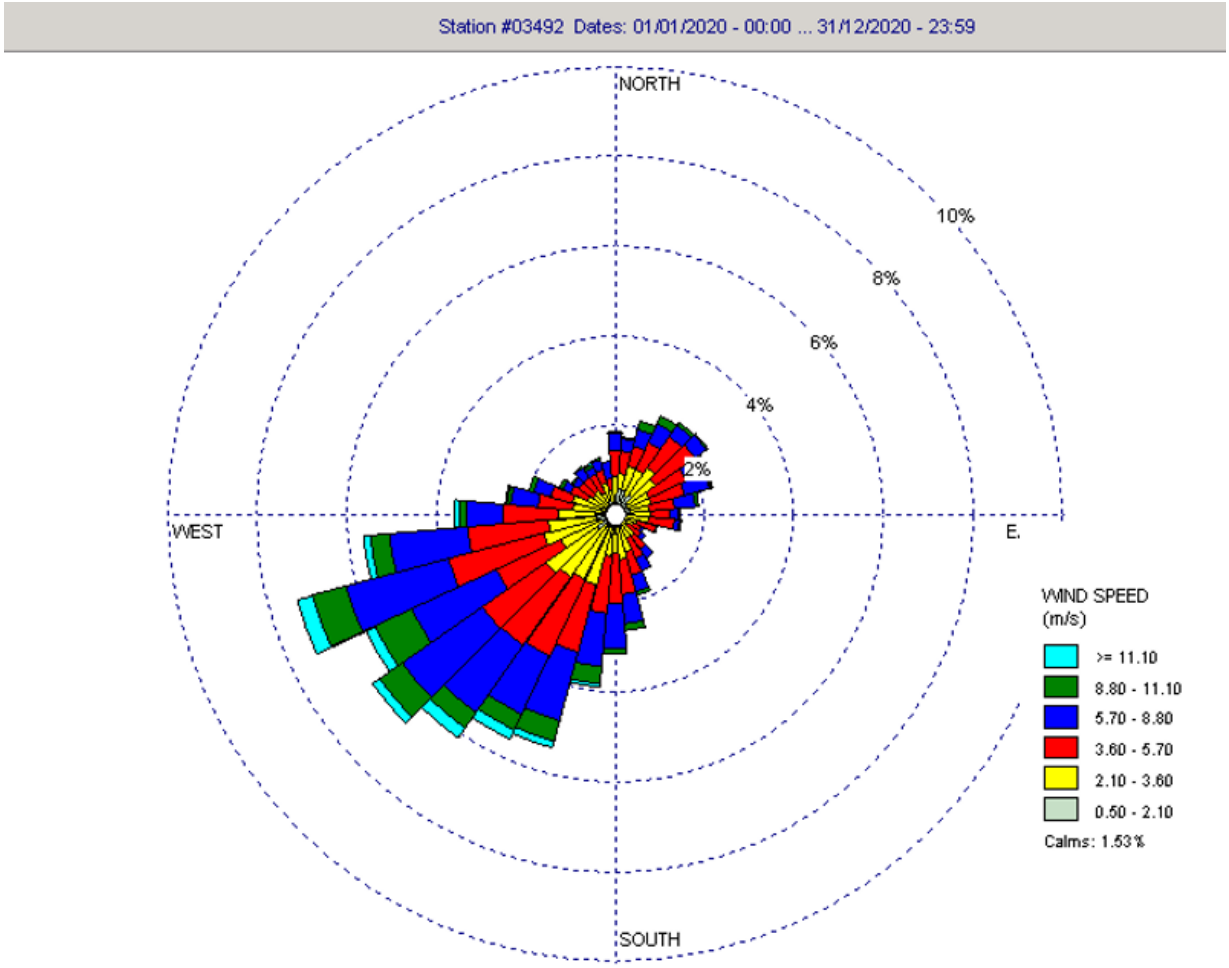

Figure 5: 2020 wind rose for Norwich Meteorological Station

The wind roses indicate the frequency of occurrence of wind from different directions for the number of wind speed ranges.

These wind roses indicate that the prevailing wind direction is blowing from a south westerly direction directing the odours towards a north easterly direction for majority of the time.

During calm days with no wind and low temperatures dispersion is very poor and odours tend to concentrate close to the source.

3.3 AERMOD

This section details the control options; source inputs and receptor networks used in the models.

Gaussian plume air dispersion model: AERMOD version 9.9.0 was used for the modelling work. The AERMOD atmospheric dispersion modelling system is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concept, including treatment of both surface and elevated sources, and both simple and complex terrain.

3.3.1 Control Options

The key parameters for the control options of the model are detailed in Table 2 below. The values for dispersion options and averaging time are standard defaults. The rural coefficient is applicable to this location.

Table 2: Control Option Parameters

SETTING	VALUE
Dispersion Options	Regulatory Default
Dispersion Coefficient	Rural
Pollutant Averaging time	1 hr
Flagpole Receptors	zero

3.3.2 Sources and Emissions Input

The location of Whitlingham STC permit area is given in Figure 6 in green boundary line. The STC is divided into 3 different areas and includes covered tanks, and reactors, buildings, and odour sources.

Figure 7 gives details of the buildings, covered tanks in area 1. There are no odour sources in this area. The sludge cake reception building is the only source of odour which is extracted to the odour control unit on the treatment site area.

Figure 8 shows the location of buildings, covered tanks, and odour sources in the treatment site permit area.

Figure 9 shows the location of buildings, covered tanks, and odour sources in the treatment site sludge cake storage permit area.

Figure 10 shows the location of odour sources in the sludge cake storage area

Figure 6: Whitlingham permit area boundary.

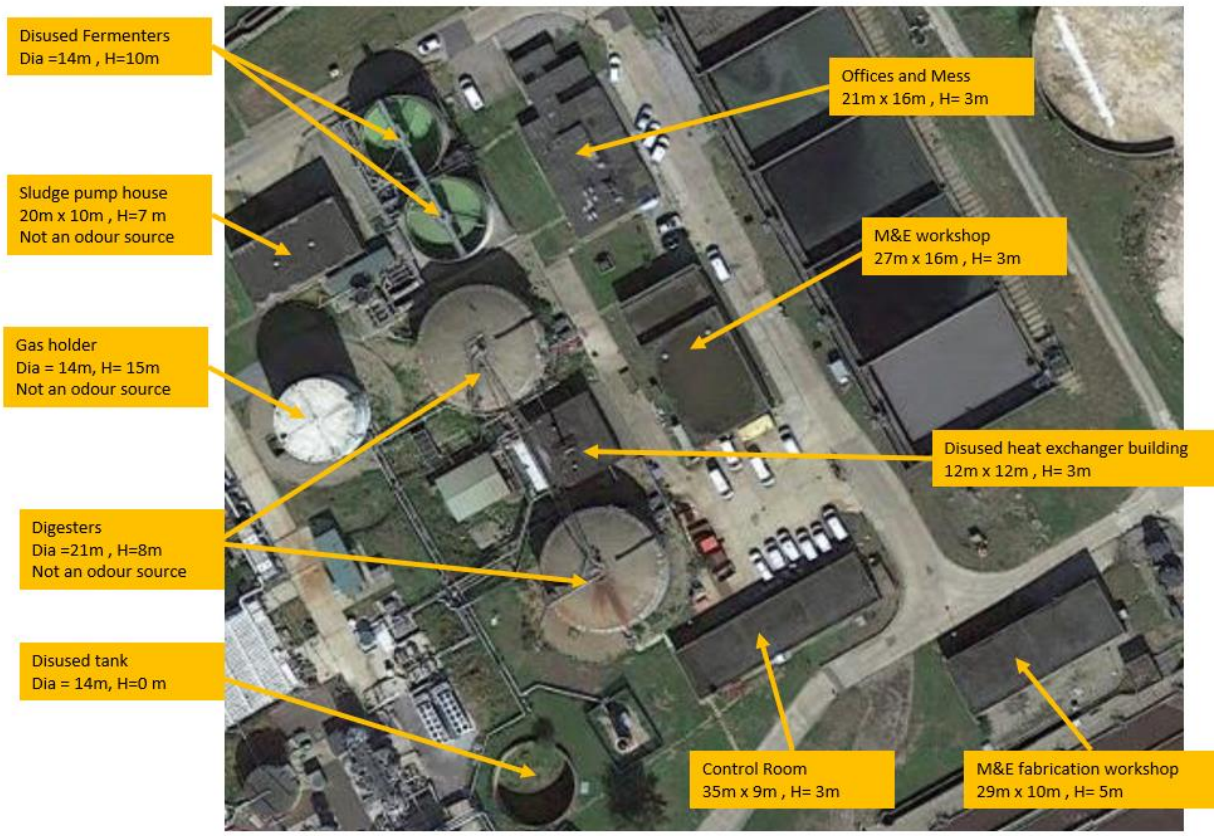

Figure 7: Whitlingham STC – Details of the buildings, covered tanks, and odour sources in area 1.

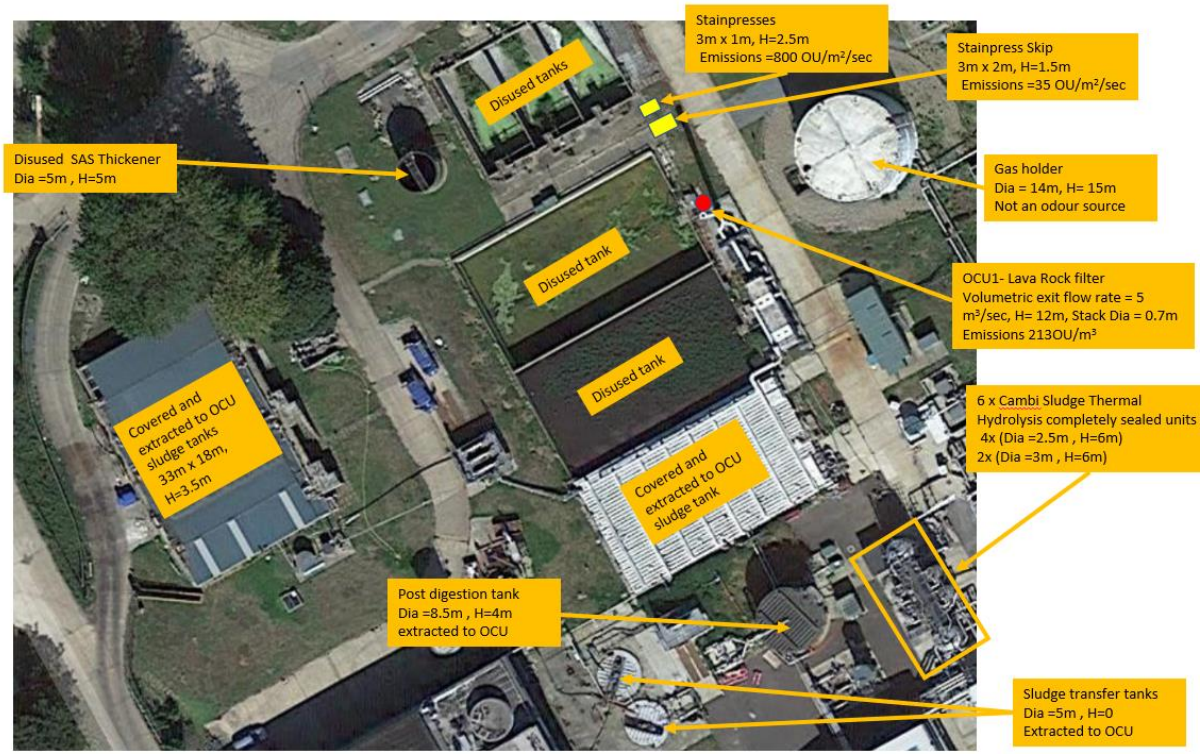

Figure 8: Whitlingham STC – Details of the buildings, covered tanks, and odour sources in area 2

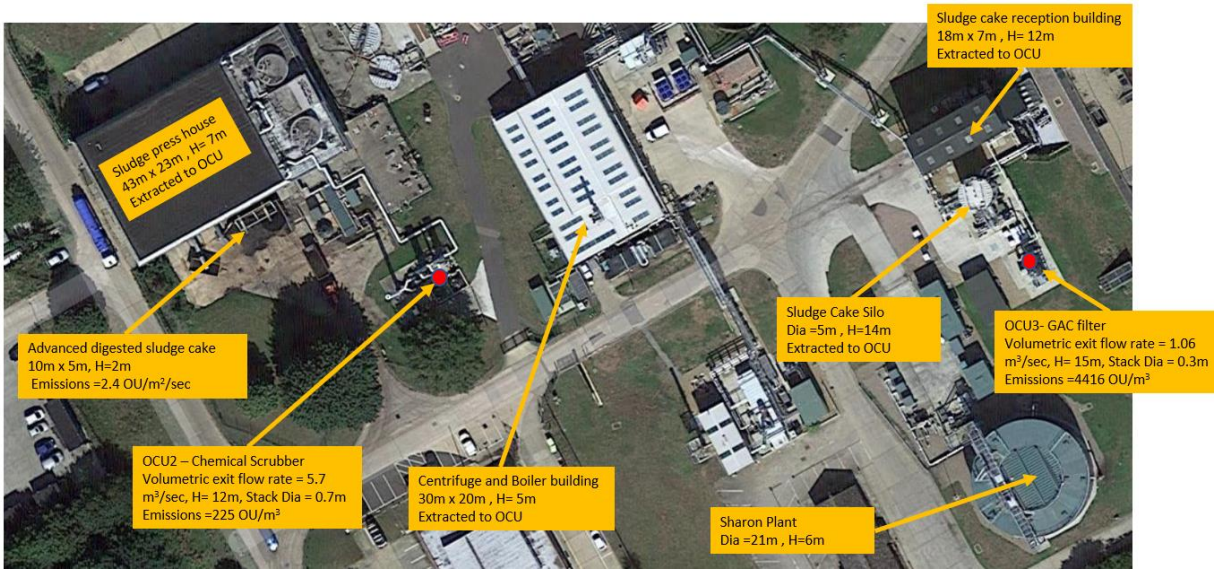

Figure 9: Whitlingham STC – Details of the buildings, covered tanks, and odour sources in area 3

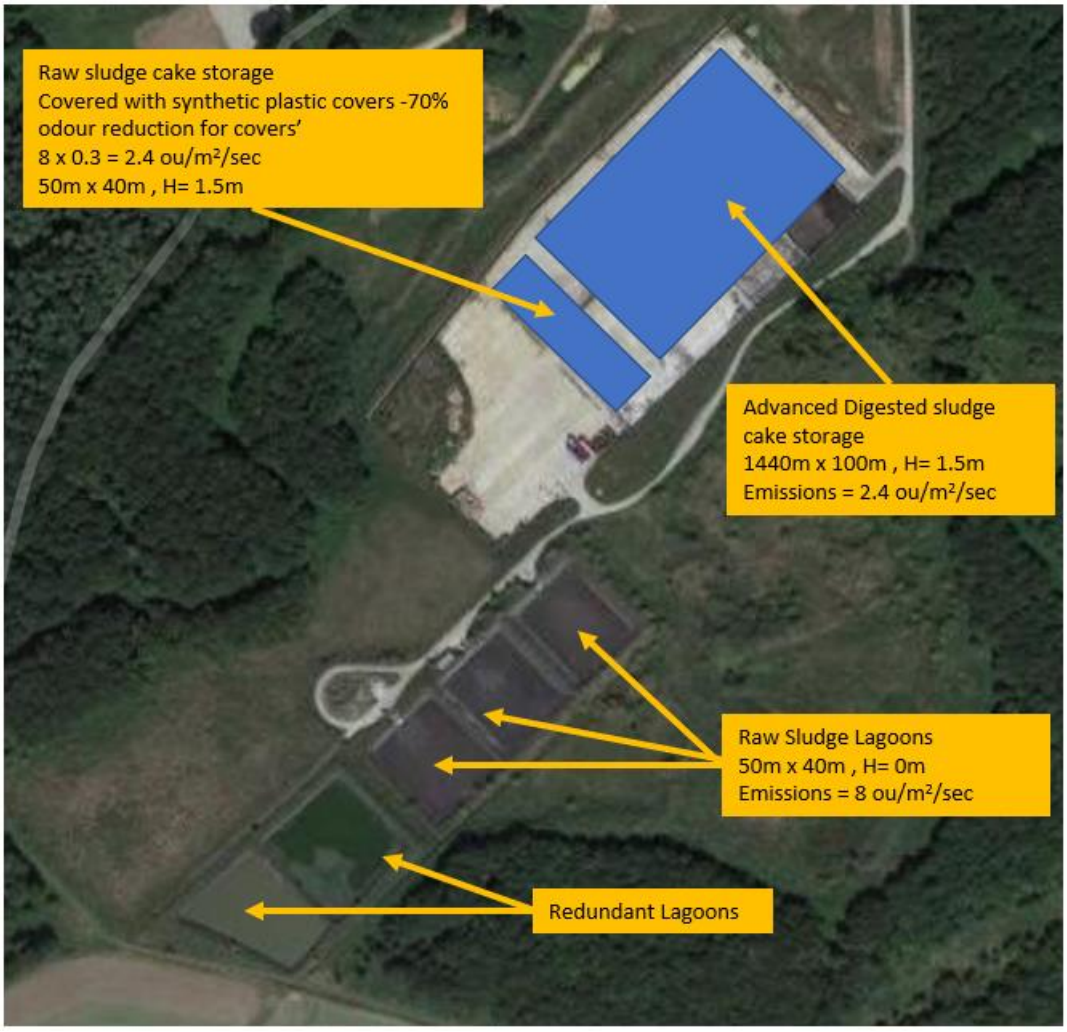

Figure 10: Whitlingham STC – Details of odour sources in area 4

May of the tanks and reactors are completely sealed and therefore, are not an odour sources. They have been included in the odour model to incorporate the effects of building downwash.

Building downwash occurs as the wind flows over and around buildings and impacts the dispersion of pollution from nearby stacks.

The advanced treated sludge cake emission rate is from olfactometric samples collected by H&M Environmental and analysed by Silsoe Odours from Cotton valley WRC and Whitlingham WRC.

3.3.3 Receptor Network

A uniform polar grid with 30 rings at 50m spacing with 45 radials at 8-degree intervals, extending to 1500m from the centre of STC (X= 627637 E, Y= 307544 N), was placed over the map of the area as a receptors network providing 1350 receptors in and around the STC.

The odour contour maps were generated by orienting the map on the STC centre with a zoom radius of 1400m.

4.0 Dispersion Modelling Results

The model was run using the three meteorological years (2018-2020) to test the variability of the odour concentration results among the different years.

The 98th percentile of hourly mean odour concentrations has been calculated. Contour lines for odour concentrations of 1.5, 3, 5, and 10 OU_E/m^3 have been included for all the scenarios. The significance of these odour concentrations is explained below:

- 1 OU_E/m^3 is the level of odour detection under laboratory conditions.
- 3 OU_E/m^3 is the level of odour detection in open environment. Complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution.
- 5 OU_E/m^3 is when odour becomes detectable & recognisable. Complaints may occur and de-pending on the sensitivity of the locality and nature of the odour.
- 10 OU_E/m^3 is when odour becomes distinct and intrusive. Complaints are highly likely and odour exposure at these levels represents an **actionable nuisance.**

The odour contour maps for three model runs are shown in figures 10 to 12.

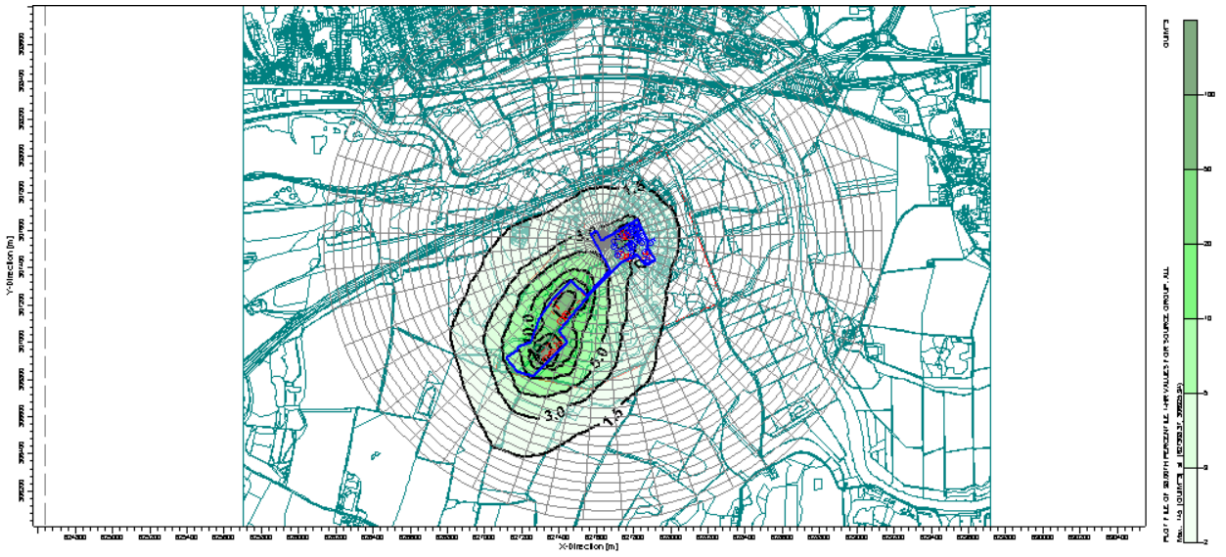

Figure 10: Whitlingham WRC 98%ile hourly means odour contour map (year 2018). Zoom radius 1200m.

The 98th percentile of hourly mean odour concentrations calculated using 2018 meteorological data show that the 1.5 OU_E/m^3 contour isopleth extends 1250m in south westerly direction and encompasses an area of 1270516m^2 approximately.

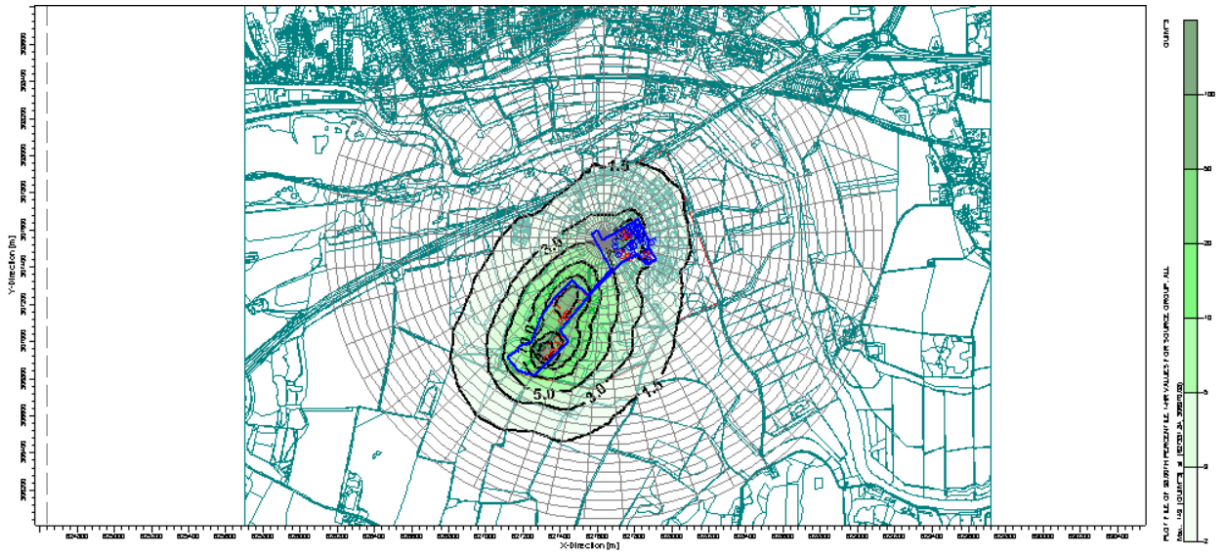

Figure 11: Whitlingham STC 98%ile hourly means odour contour map (year 2019). Zoom radius 1200m.

The 98th percentile of hourly means odour concentrations calculated using 2019 meteorological data show that the 1.5 OU_E/m^3 contour isopleth extends 1173 in a south westerly direction and encompasses an area of 1390094m^2 approximately.

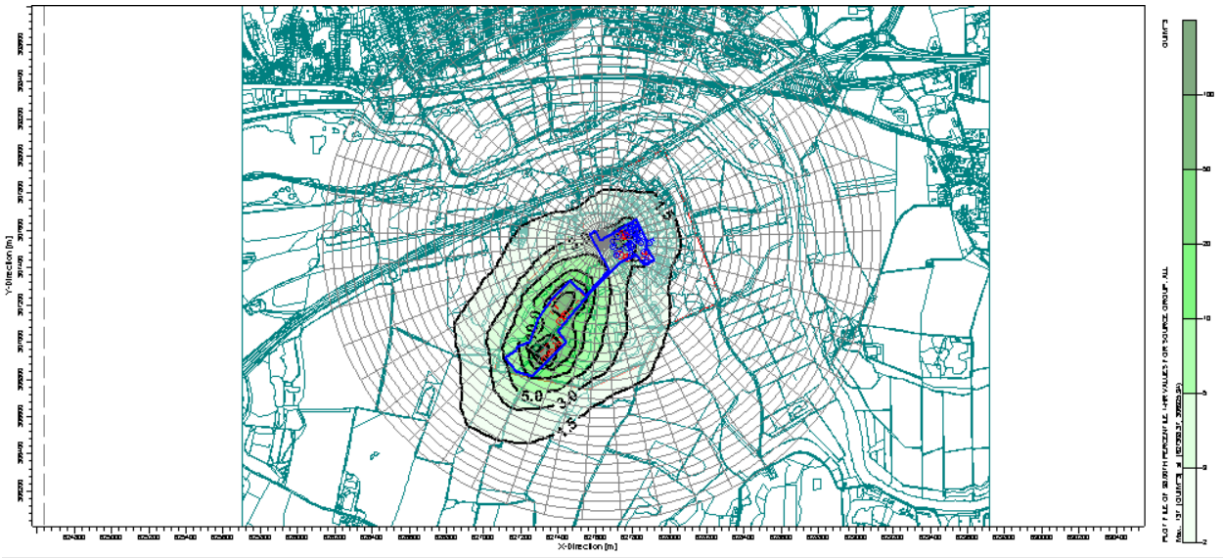

Figure 12: Whitlingham STC 98%ile hourly means odour contour map (year 2020). Zoom radius 1200m.

The 98th percentile of hourly mean odour concentrations calculated using 2020 meteorological data show that the 1.5 OU_E/m^3 contour isopleth extends 1234m in a south westerly direction and encompasses an area of 1170329m^2 approximately.

The model run with 2019 meteorological data gave the worst-case scenario as the area encompassed under the 1.5 OU/m^3 was larger than modelled year with meteorological data for 2018 and 2020 by 9% and 19% respectively.

As it can be seen from these contour maps the odour from the STC extend beyond the WRC boundary, mainly in a south westerly direction and affect nearby sensitive receptors around the site.

6.0 Conclusions

This modelling study evaluates the risk of amenity loss to areas around Whitlingham STC.

An odour concentration of 1.5 OU/m^3 has been taken as the benchmark level at which nuisance and potential loss of amenity would be anticipated. This assessment criterion for the protection of public

nuisance/amenity is in line the Environment Agency (EA) H4 Planning Guidance, including septic effluent and sludge in amongst a range of substances categorised as most offensive and for which a low detection threshold should be taken into consideration.

The actual odour concentrations around at the STC permit area and WRC boundary is given in Figure 11.

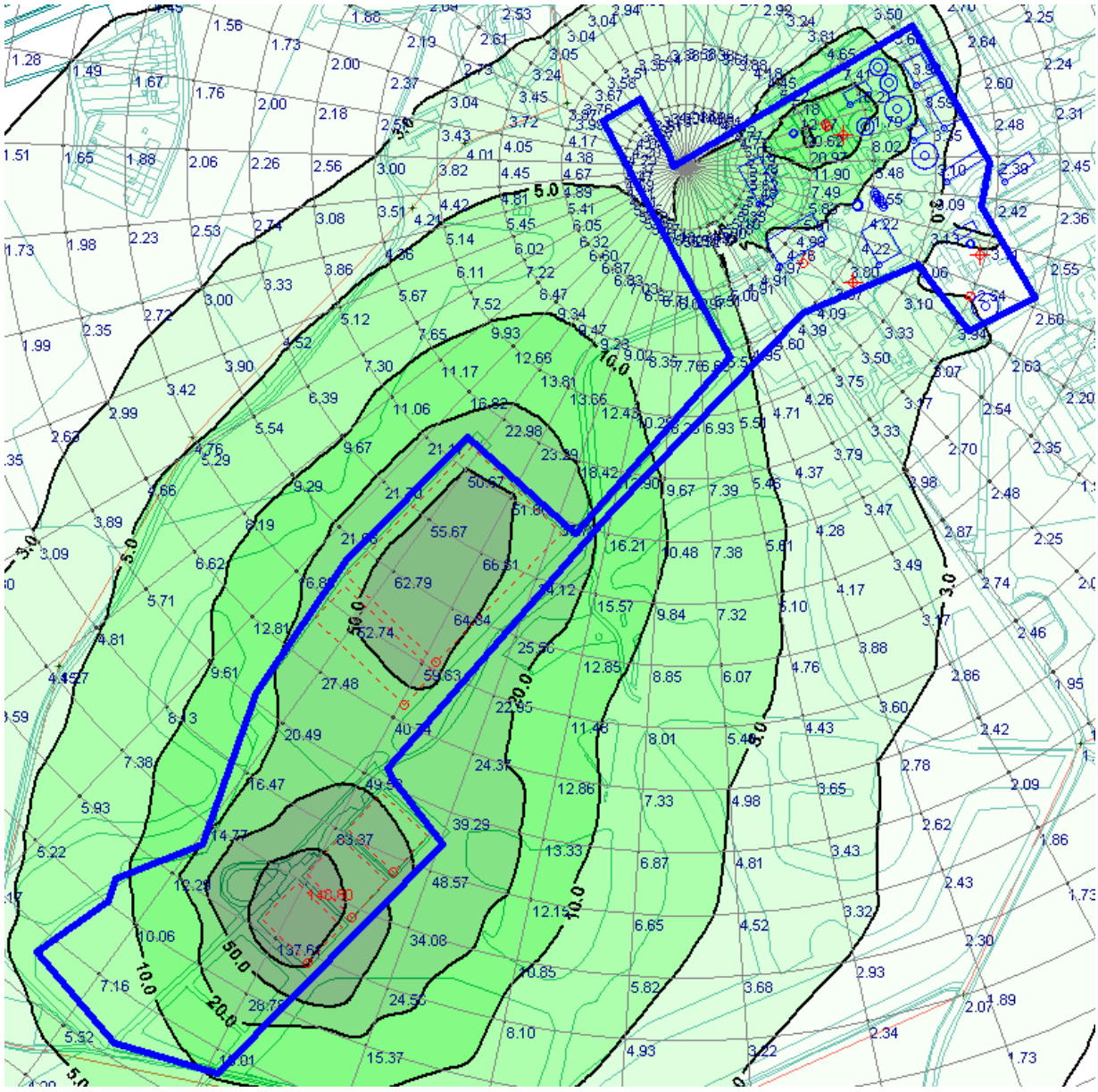

Figure 11: Whitlingham STC 98%ile hourly means odour concentrations (year 2019). Around the permit boundary

For WRC:

The max odour concentration at the permit area is 148.79 OU_E/m^3 and occur over the raw sludge storage lagoons (X=627332, Y=306971).

The odour concentrations over the sludge storage area permit boundary varies between 48.57 to 5.52 OU_E/m^3. The odour concentrations at the WRC south boundary varies between 3.48 to 9.78 OU_E/m^3.

The odour concentrations over north side of the permit boundary varies between 2.6 to 5.3 OU_E/m^3. The odour concentrations at the WRC north boundary varies between 0.98 to 3.45 OU_E/m^3.

The modelling shows that odour from Whitlingham STC effects areas around the site with odour concentrations above 1.5 OU/m^3.

7.0 Recommendations

It is recommended that Whitlingham investigates further into the sources of the most offensive odours and seeks mitigation measures to ensure that the impact on the surrounding area is limited as much as reasonable possible.

- Possible mitigation measures could include;
- Carry out a complete refurbishment of the OCUs.
- Ensure all gas extraction pipe works are completely sealed and free of blockages.
- Strict enforcement that trucks bringing raw cake to site are to be sheeted. Sheets should only be removed as soon as practical prior to tipping; trucks should be re-sheeted even when empty leaving sites. This should be re-enforced throughout the site team and RES operations managers.
- Review resource levels to improve management of sheeting of raw cake.
- Regular liaison meeting with AW and key stakeholders in the local area to discuss issues and proactive solutions.
- AW has identified a need to review and implement a more transparent and robust complaints monitoring and actions process. This is to increase the site's visibility of complaints. AW are proactively starting a review of the current process so action and an improved system can be put in place.
- Assess activities and potential impact under certain extreme/unusual weather conditions. Whitlingham has a weather station and monitor wind direction on site.

- It would be beneficial to continue with frequent boundary monitoring & monitoring of the odour control equipment.

Appendix A – Certificate of Met Data from Atmospheric Dispersion Modelling

ADM Ltd
Old Chambers
93-94 West Street
Farnham
Surrey GU9 7EB

15 January 2021

Anglian Water
Thorpe Wood House
Thorpe Wood
Peterborough
Cambs
PE3 6WT

Statement of Meteorological Data: Whitlingham

AERMOD ready met data provide from observations made at Norwich (2018-2020)
Details of Parameters used to process the met data shown below

	Observing Station	Modelling Site
Long	52.633 N	52.618 N
Lat	1.317 E	1.363 E
Albedo	0.242	
Bowen	1.033	
Roughness (Ro)	0.4-0.5	

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