Leigh WwTW Sludge Treatment Facility

Bioaerosols Risk Assessment

October 2023

Contents

1. Introduction

1.1. Site Activities

The purpose of this Bioaerosols Risk Assessment is to provide supplementary information to support an environmental permit (EP) application for the screening, thickening and anaerobic digestion of indigenous and imported wastewater (sewage) sludge at Leigh Wastewater Treatment Works (WwTW). The application is being made under the Environmental Permitting (England and Wales) Regulations 2016 (the EPR 2016).

The address of the installation is:
Leigh WwTW Sludge Treatment Facility
Hope Carr Lane,
Leigh,
Lancashire,
WN7 3XB

NGR: SJ 66302 99084

United Utilities Water Limited (UUW) operates a non-hazardous wastewater treatment works at the Leigh WwTW. The site is situated approximately 1.3km southeast of Leigh town centre. The area surrounding the site to the west generally comprises housing, whilst to the north and east there is a mix of housing and industrial/commercial properties. To the south the land use is predominantly agricultural. The works are situated next to a commercial estate and Hope Carr nature reserve. There are residential properties and commercial properties within 250m of the works boundary. The nearest local wildlife site of Hope Carr Nature Reserve is approximately 160m from the installation respectively.

The treatment of imported sludge and indigenous sewage sludge arising from the wastewater treatment process at Leigh comprises:

- Sludge screening (solids separation);
- Sludge de-watering and thickening by centrifuge (x 4);
- Thermal hydrolysis;
- Anaerobic digestion;
- Degassing;
- Biogas storage;
- Combustion of biogas in CHP engines (x 2) and a dual fuel boiler;
- Flaring of excess biogas;
- Siloxane removal from the biogas;
- Raw material storage;
- Treatment and disposal of process liquors;
- Odour abatement; and

- Storage of digestate cake.

The maximum design throughput at the facility is limited by the feed rate to the centrifuges, providing a total maximum capacity of 630,720m^3 per year. The current operational treatment capacity of the digester per year is 180,206m^3, based on the feed into the digester. The daily throughput will vary depending on operational needs.

1.2. Regulatory Requirements

The sludge treatment activity has not previously required an environmental permit as the digested sewage sludge from the site is normally sent for recovery to land; however, a permit application has been submitted based on the Environment Agency's recent conclusion that sewage sludge is a waste and therefore the treatment of sewage sludge by anaerobic digestion for recovery is a permittable activity under Schedule 1 of the EPR 2016, specifically Chapter 5, Section 5.4, Part A 1(b)(i).

For new permits, if the site is within 250m of sensitive receptors then there is a requirement to do a site specific bioaerosol risk assessment and, based on the outcome of the risk assessment, monitor bioaerosols in accordance with the EA technical guidance[1]. The Leigh Sludge Treatment Facility is within 250m of sensitive receptors; these are detailed in Section 2.3 of this report.

1.3. Bioaerosols

Bioaerosols are described in EA technical guidance note M9: environmental monitoring of bioaerosols at regulated facilities.

Bioaerosols are found naturally within the environment. They consist of airborne particles that contain living organisms, such as bacteria, fungi and viruses or parts of living organisms, such as plant pollen, spores and endotoxins from bacterial cells or mycotoxins from fungi. The components of a bioaerosol range in size from around 0.02 to 100 micrometres (µm) in diameter. The size, density and shape of a bioaerosol will affect its behaviour, survivability and ultimately its dispersion in the atmosphere. Bioaerosols are easily breathed into the human respiratory system, potentially causing allergic responses and inflammation. Bioaerosols also have the potential to cause eye irritation, gastrointestinal illness and dermatitis.

Bioaerosols are also associated with composting, anaerobic digestion and mechanical biological treatment, which are the main processes used to treat organic waste in the UK. As organic waste material breaks down it goes through different temperature dependent stages that are dominated by certain groups of bacteria and fungi. Bacteria are the most numerous group of microorganisms. *Aspergillus fumigatus* is a mesophilic fungus that is thermotolerant and is present throughout the different stages of the organic breakdown process. This fungus can cause severe respiratory infection if inhaled.

[1] Environment Agency. July 2019. M9: Environmental monitoring of bioaerosols at regulated facilities

The dependence on microorganisms to degrade organic material and the way in which the material is processed make biological treatment facilities a potential source of bioaerosols. However, we note that the 2012 EA guidance note for developments requiring planning permission and environmental permits[2] states that the EA do not consider bioaerosols from anaerobic digestion to be a serious concern. This is due to the fact that anaerobic digestion is generally a wet process undertaken in enclosed tanks and equipment, whereas composting is often undertaken using open systems such as windrows and static piles. The Leigh Sludge Treatment Facility does not undertake any composting activities.

A source-pathway-receptor risk assessment has been undertaken to appraise the potential for risk to human health at sensitive receptors from operations at the Leigh Sludge Treatment Facility.

[2] Environment Agency. October 2012. Guidance for developments requiring planning permission and environmental permits

2. Bioaerosols Risk Assessment

2.1. Introduction

This risk assessment follows a standardised approach, namely:

- Hazard identification: what sources of bioaerosols are present;
- Exposure assessment: what are the mechanisms or pathways allowing bioaerosols to migrate off site and reach a receptor; and
- Risk evaluation: who is potentially exposed to bioaerosols; what is the probability, magnitude and duration of exposure.

The assessment describes:

- The processing techniques and equipment used;
- Feedstock, tonnages processed and any seasonal variations;
- Sources of bioaerosols;
- The site layout, including any screens, bunds, or trees around the site;
- What is beyond the site boundaries and the location of sensitive receptors;
- Local wind direction data; and
- Other sources of bioaerosols in the vicinity.

2.2. Processing techniques and equipment

Waste Reception

The wastewater sludge received for treatment consists of sludges imported from other WwTWs and indigenous sludges produced from Leigh WwTW (on-site). WwTW's sludge streams are well known and have been fully characterised over the years.

Imported and indigenous sludge passes through one of two raw screen sludges before combing in a screened sludge tank. Surplus activated sludge (SAS) also enters the screened sludge tank. All transfer pipework is enclosed.

Waste Treatment

From the screened sludge tanks the sludge is pumped through one of two thickening centrifuges where polyelectrolyte mix is added. The thickened sludge is then pumped into a cake silo (thickened sludge storage tank). From here it passes through the thermal hydrolysis plant (THP) and the hydrolysed sludge is then pumped into the anaerobic digester tank via a sludge cooler. Once anaerobic digestion is complete, the sludge is displaced from the digester into the degassing tank, before being directed onto the digested sludge tank. The digested sludge is pumped to one of two de-watering centrifuges and dosed with polyelectrolyte mix, in order to thicken the sludge into a cake. The dewatered sludge cake from the

centrifuge then falls into a covered cake storage building. The digestate cake is spread to land for agricultural benefit in accordance with the Sludge (Use in Agriculture) Regulations 1988.

Biogas produced during the anaerobic digestion process is stored on site in a gas holder prior to being combusted in two CHP engines, generating renewable electricity. In the event of an emergency, or during planned maintenance of the engine, excess biogas is diverted to a flare to be combusted.

All tanks are constructed of materials suitable for the containment of urban wastewater sludges and the sludge treatment/storage areas are almost completely impermeably surfaced and drained via a private drainage system that returns all drainage to the WwTW flow to full treatment. In addition, process centrate, once treated in the on-site liquor treatment plant, is returned to the WwTW flow to full treatment.

Odorous air streams from the raw sludge screens, screened sludge tank, sludge thickening centrifuges, thickened sludge cake silo, degassing tank, digested sludge storage tank, centrate buffer tanks, centrate balancing tank and dewatering centrifuges are treated within an odour control unit.

2.3. Sources

There are seven point-source emissions to air from the following locations:

- A1 – CHP gas engine 1 (combusting biogas) (NGR SJ 66351 98973);
- A2 – CHP gas engine 2 (combusting biogas) (NGR SJ 66351 98973);
- A3 – Dual fuel boiler (the boiler is a dual fuel design and can run on biogas but currently runs on gas oil) (NGR SJ 66349 98973);
- A4 - the Odour Control Unit (OCU) serving the raw sludge screens, screened sludge tank, sludge thickening centrifuges, thickened sludge cake silo, degassing tank, digested sludge storage tank, centrate buffer tanks, centrate balancing tank and dewatering centrifuges (NGR SJ 66326 99072);
- A5 – Flare stack (NGR SJ 66253 99015);
- A6 – PVRV on digester (NGR SJ 66306 98972); and
- A7 – PVRV on gas holder (NGR SJ 66290 99010).

The CHP engine emissions discharge via a combined stack, circa 35m in height. The location of all discharge points to air are shown on the emissions points plan at Appendix A.

The CHP engines, boiler and flare combust biogas at high temperatures (in excess of 100^{o}C) and as such can be discounted as sources of bioaerosols emissions.

The OCU is a potential source of bioaerosols as it receives air extracted from sludge storage tanks and treatment processes. The odour control system includes two stages of treatment, consisting of two pumice media biotrickling filters and a subsequent activated carbon scrubber. The OCU is an enclosed unit so all process air is treated prior to emission via the OCU stack.

The OCU is designed to continuously remove odours from the malodorous air passed through them. This is achieved by passing the air through the biofilters and activated carbon treatment. This enables adsorption of hydrogen sulphide, mercaptans, ammonia and VOCs and other sewerage derived odours within the foul air stream.

Fugitive emissions of biogas may arise from the activation of pressure vacuum relief valves (PVRVs) on gassing tanks or leaks in gas pipework e.g. around flanges. There are several PVRVs and vents on the process tanks. The PVRVs on the digester operate on a Duty/Stand-by configuration (with all others operating on a duty only basis) to protect against over/under pressurisation of the vessel. The PVRV's are maintained, monitored, inspected and calibrated on a periodic basis to ensure correct operation of the valves.

The risk of fugitive bioaerosol emissions from the treatment process is considered to be low, given that storage tanks, treatment tanks and associated pipework are enclosed. Sludge screening and dewatering also takes place in enclosed units. Screening waste is generated from the sludge strain presses. Screenings are directly discharged into skips for transport off site and ultimate disposal by a licensed waste management contractor. The screenings are wet and the associated risk of bioaerosol emissions is low. Once full, skips are sheeted and removed from site within 48 hours.

Dewatered digestate cake is transferred by enclosed conveyors and deposited in a concrete surfaced and enclosed (on three sides and roofed) cake storage building. The cake is transferred onto covered trailers using a telehandler. Under normal operations, loading a trailer typically takes approximately 30 minutes, before it is automatically covered and removed from site. Storage duration within trailers prior to removal is typically less than 24 hours. The water/wastewater industry understands that there is a low level of risk of bioaerosols from this material.

The potential sources of bioaerosols at the sludge treatment facility should be taken in context of the wider wastewater treatment works where there are large open tanks for the treatment of urban wastewater.

2.4. Pathways

The main pathway for bioaerosols transport is air movement and wind. Wind rose data from 2015-2019 for the site is shown in Appendix B, recorded at Manchester Airport meteorological station. Manchester Airport meteorological station is located approximately 20.5km to the southeast of the site and is considered the closest most representative meteorological monitoring station to the site.

The wind rose data shows that the site experiences prevailing southerly winds, with occasional strong easterly or westerly winds. The Leigh Sludge Treatment Facility and surrounding area has a relatively flat topography with few natural barriers to the transportation of bioaerosols by the wind. However, there is planting that provides screening along the boundaries of the site in the direction of the nearby residential and commercial properties.

Because of the dilution effect in the open air, bioaerosol concentrations fall away rapidly with distance from the source. It has been shown by research (RR786 - Bioaerosol emissions from waste composting and the potential for workers' exposure[3]) that by 100 to 200m away, the bioaerosol concentration has mostly returned to background levels. By 50m and 100m distances downwind of the process, bioaerosol concentrations were substantially reduced by comparison to those level measurements at source. RR786 confirmed previous published studies which showed that at a distance of 250m from composting activity, in most cases, the bioaerosol concentrations will be reduced to background levels.

2.5. Receptors

EA guidance indicates that sensitive receptors are considered to be people likely to be within 250 metres of the operational area (source of release) for prolonged or frequent periods. This term would therefore apply to dwellings (including any associated gardens) and to workplaces where workers would frequently be present. It does not apply to the operators of the facility as their health is covered by Health and Safety legislation.

Table 2.5.1 below provides details of static receptors within 250m of potential bioaerosol sources from the permitted processes. There is only one open source; this being the partially enclosed digestate storage building (see Photo 1 below). The location of these receptors is shown on the plan at Appendix C.

Table 2.5.1: Static Receptors within 250m of Potential Bioaerosol Sources

Receptor	Description	Distance from closest source (m)	Source	Source Grid Reference	Direction from the site
R1	Commercial properties at Greenfold Way	75	OCU	SJ 66326 99072	SE
		80	Digester PVRV	SJ 66306 98972	E
		85	Gas holder PVRV	SJ 66290 99010	E
		90	Digested sludge covered cake storage building	SJ 66291 99138	E
R2	Residential properties at Rossall Crescent	225	Digested sludge covered cake storage building	SJ 66291 99138	NW
R3	Residential properties at Claycroft Bungalows, Hope Carr Road	190	Digested sludge covered cake storage building	SJ 66291 99138	N

[3] HSE. 2010. RR786 Research Report. Bioaerosol emissions from waste composting and the potential for workers' exposure

Photo 1: Cake storage building

2.6. Magnitude of Risk

There are four potential sources of bioaerosols release within 250m of static receptors:

- Emission Point A6 - the digester PVRV;
- A7 – the gas holder PVRV;
- A4 - the OCU; and
- The digestated sludge covered cake storage building.

The receptors are situated to the north and north west of the release points and the prevailing wind direction is from the south. There is therefore potential for wind-borne transportation of bioaerosols.

All process tanks for sludge treatment are contained and connected to the OCU. Given that adsorption of micro-organisms onto the activated carbon would be expected, the likelihood of bioaerosol release is anticipated to be minimal. The closest receptor to the OCU is a commercial property 75m away.

The digester and gas holder PVRVs only activate to release biogas when the pressure or vacuum operating set conditions (or set points) in the tank are exceeded. These valves are safety devices to ensure the tank is not subjected to over or under pressurisation. As such, they only operate infrequently and are not a constant source of bioaerosol release. The valves are only open for a short period of time and thus the potential for bioaerosol release is considered to be very low.

The pressure vacuum relief valves are calibrated on an annual basis to ensure they are operating at the correct set points. The valves are visually checked daily to ensure there is no unplanned biogas releasing to atmosphere. This is in conjunction with a check of SCADA pressure related information and trends available for the previous 24 hours.

The digested sludge covered cake storage building/bay is situated 90m away from a commercial property and 190m from the nearest residential properties. The risk of bioaerosols being generated from digestate cake are considered to be low. Following digestion, the waste is centrifuged to reduce its water content to around 30% dry solids, although it remains relatively damp and does not give rise to dust readily. The storage building is roofed and has retaining walls around three sides that are higher than the maximum height of cake stored within it. The walls will provide some protection from the wind and limit the effect of windblown transport of any bioaerosols. Sludge cake from the storage building is loaded onto trailers via a telehandler. Under normal operations, loading a trailer typically takes approximately 30 minutes, before it is automatically covered and removed from site. Storage duration within trailers prior to removal is typically less than 24 hours.

Overall, the probability of bioaerosols being released from the sludge treatment process and the identified potential sources is considered to be very low to low. The potential duration of release of bioaerosols varies from infrequent to frequent. The magnitude of release is considered to be very low to low.

There are commercial properties located at approximately 75m distance from the OCU and 80m from the digester PVRV. The treatment of air by the OCU would considerably reduce bioaerosol content of the air and therefore present a very low risk for bioaerosol emissions. Given the very infrequent operation of PVRVs only in abnormal situations this is also considered to be low risk.

Residential properties are located at 190-225m of other identified potential bioaerosol sources. Because of the dilution effect in the open air, research has shown that bioaerosol concentrations fall away rapidly with distance from the source. It has been shown (RR786 - Bioaerosol emissions from waste composting and the potential for workers' exposure[4]) that by 100 to 200m away the bioaerosol concentration has mostly returned to background levels. Given that the identified potential sources are considered to represent a low risk, the intervening distance and the screening provided by the vegetation bund, it is considered that the risk of exposure to occupants of these properties from bioaerosols emitted from the site is likely to be negligible.

The overall magnitude of the risk is summarised in Table 2.6.1 below. However, to validate this bioaerosols sampling is proposed (see Section 3.2).

[4] HSE. 2010. RR786 Research Report. Bioaerosol emissions from waste composting and the potential for workers' exposure

Table 2.6.1: Risk of Exposure to Receptors within 250m of Potential Bioaerosols Sources

Source	Magnitude of Release	Pathway	Receptor	Control Measures	Probability of Exposure	Magnitude of Risk
Digester and Gas Holder PVRVs	Very low – infrequent operation	Inhalation via wind-borne transportation	R1 - commercial properties at Greenfold Way	PVRVs are safety devices; they are designed to operate infrequently for short periods of time. The valves are calibrated every 2 years by a specialist contractor to ensure safe and effective operation within design parameters. Operation of the valves is checked visually by the operators and the SCADA pressure related information and trends are checked to ensure the valves are not leaking.	Very Low	Negligible
Odour Control Unit	Low	Inhalation via wind-borne transportation	R1 - commercial properties at Greenfold Way	The air stream is treated via a biofilter and carbon adsorption. Scheduled maintenance is undertaken in accordance with UUW's Mobile Asset Resource Scheduling (MARS).	Low	Negligible
Digested cake covered cake storage building	Low	Inhalation via wind-borne transportation	R2 - residential properties at Rossall Crescent R3 - Residential properties at Claycroft Bungalows, Hope Carr Road	The storage building is roofed and has retaining walls around three sides that are higher than the maximum height of cake stored within it. Loading of digested sludge cake is typically conducted over a 30-minute period before it is covered and removed from site within 24 hours.	Low	Negligible

3. Conclusions and Recommendations

3.1. Conclusions

A source-pathway-receptor risk assessment has been undertaken to appraise the potential for risk to human health in dwellings and other nearby buildings from bioaerosols arising from operations at the Leigh Sludge Treatment Facility. The risk assessment followed a standardised approach, namely:

- Hazard identification: what sources of bioaerosols are present;
- Exposure assessment: what are the mechanisms or pathways allowing bioaerosols to migrate off site and reach a receptor; and
- Risk evaluation: what is the probability, magnitude and duration of exposure. This considered control measures in place to reduce the probability or magnitude of release.

The overall bioaerosol risk to receptors within 250m of potential sources of the sludge treatment process is considered to be negligible.

Potential sources of bioaerosols at the sludge treatment facility should also be taken in context of the wider wastewater treatment works where there are open tanks (primary settlement tanks, aeration tanks and final settlement tanks) for the treatment of urban wastewater.

3.2. Recommendations

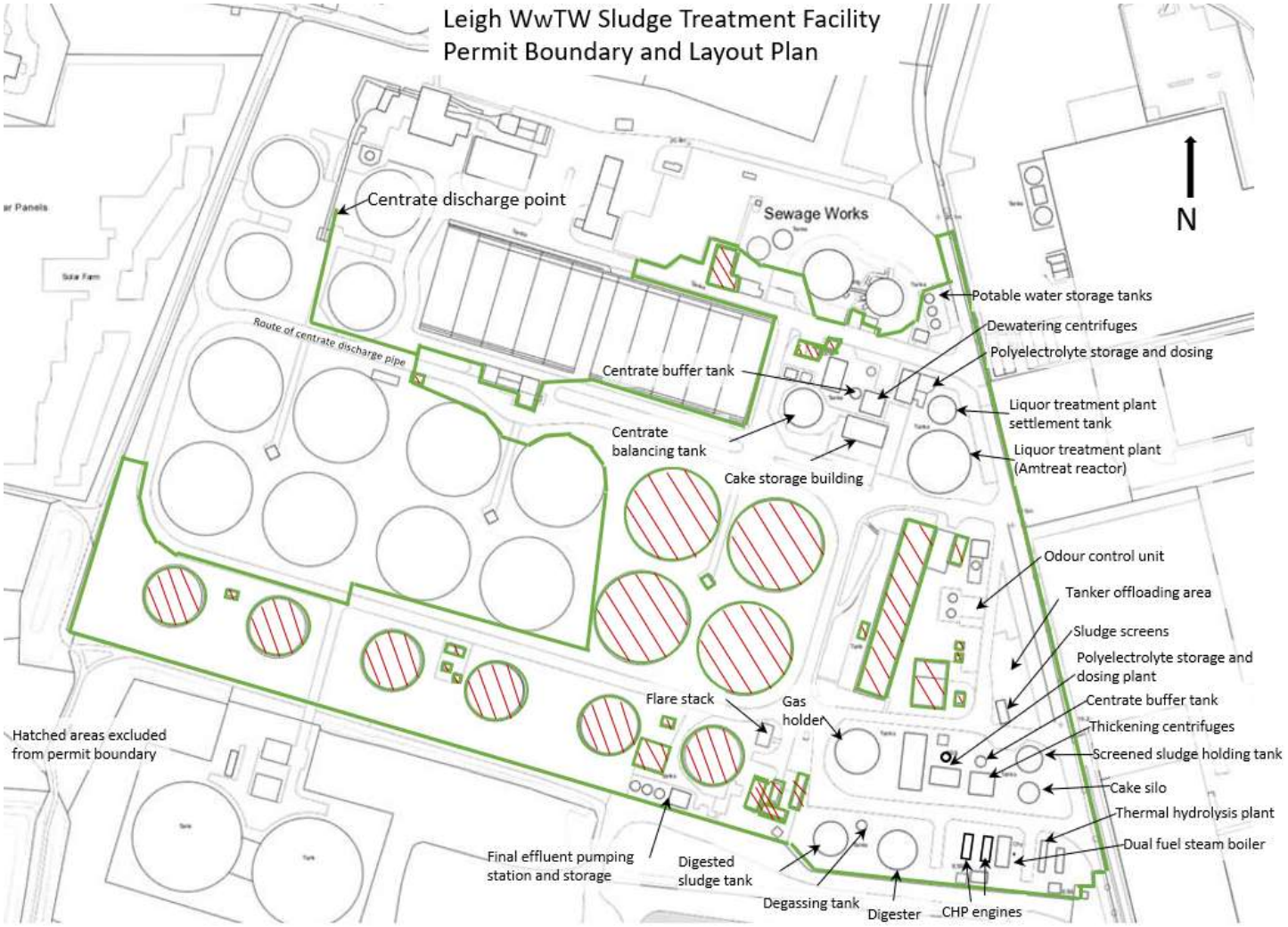
To confirm that the bioaerosol risk to receptors is negligible, UUW will undertake the following ambient monitoring[5] at Leigh:

- B1 – 25m upwind of the operational sludge treatment area;
- B2 – downwind of the sludge treatment area, but in line with upwind monitoring location;
- B3 – downwind. Approximately 45 degrees to the right from the central point (between R2 and the bioaerosol source); and
- B4 – downwind. Approximately 45 degrees to the left from the central point (between R1 and the bioaerosol source).

The proposed monitoring locations are shown on Appendix D. The monitoring will be undertaken in accordance with EA Technical Guidance Note (Monitoring) M9: Regulatory Position Statement (RPS) 209 – Bioaerosol monitoring at regulated facilities.

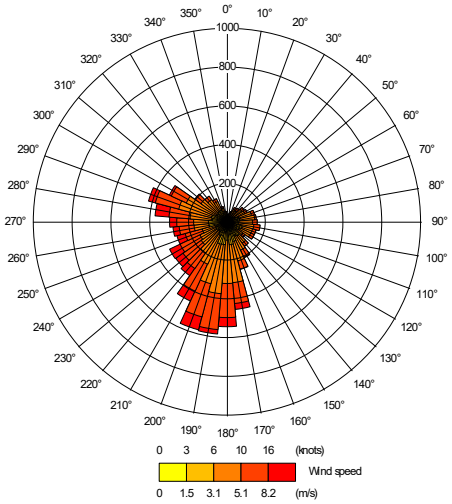
[5] The monitoring locations assume that the prevailing wind direction is in occurrence at the time of the monitoring. Should wind conditions be different on the day of sampling the monitoring locations may vary. In any event they will follow the M9 guidance of one monitoring location upwind and three monitoring locations downwind.

Appendix A: Site Layout and Emission Points Plans

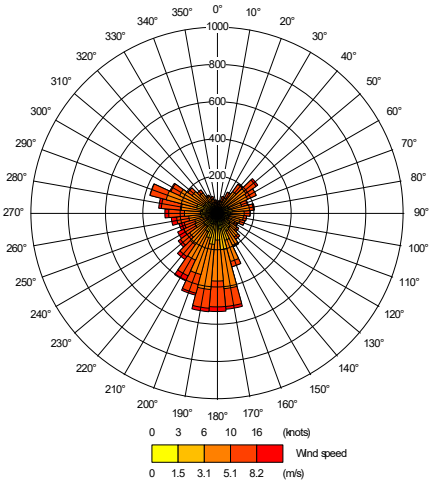


Appendix B: Meteorological Data – Wind Roses

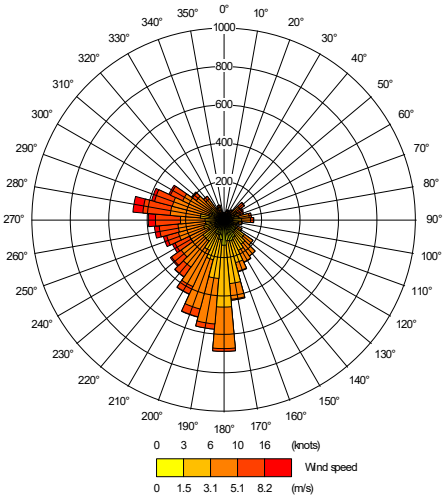
Manchester Airport meteorological station, 2015



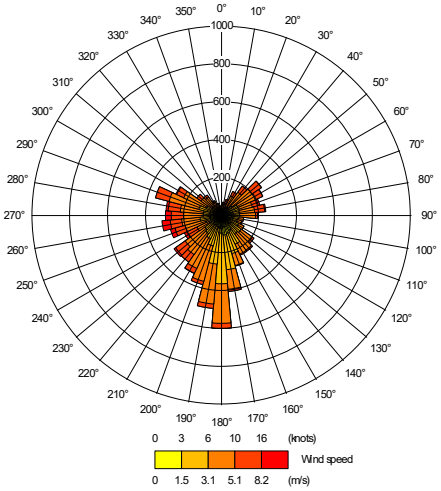
Manchester Airport meteorological station, 2016



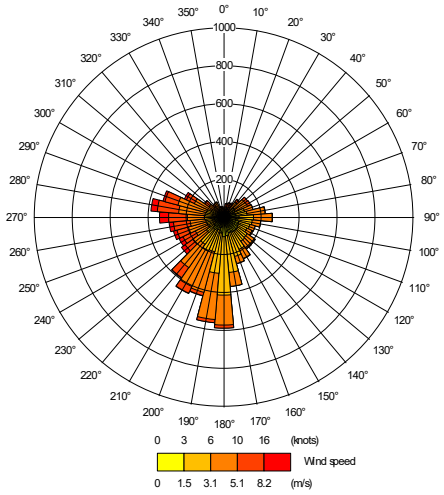
Manchester Airport meteorological station, 2017



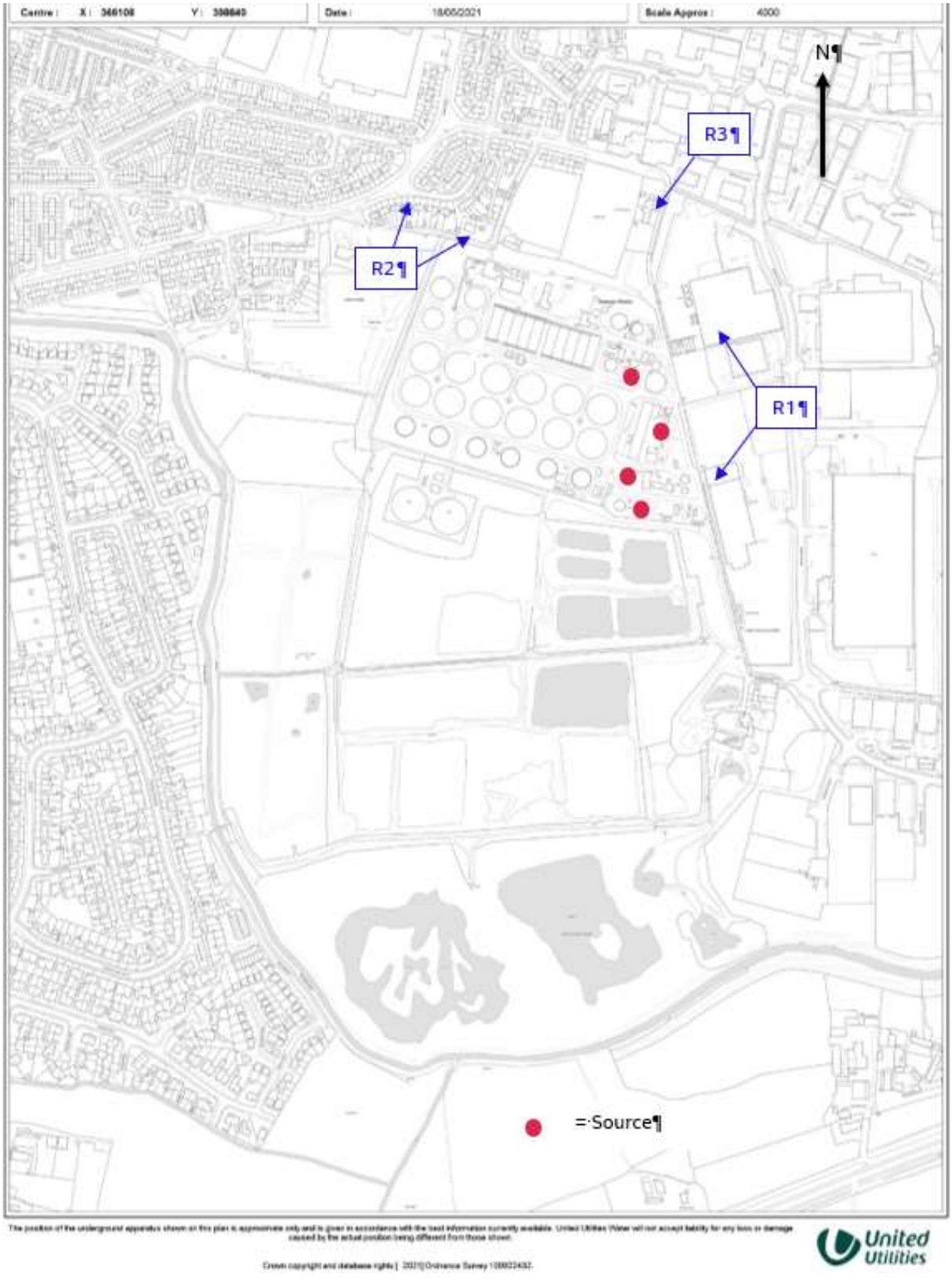
Manchester Airport meteorological station, 2018



Manchester Airport meteorological station, 2019

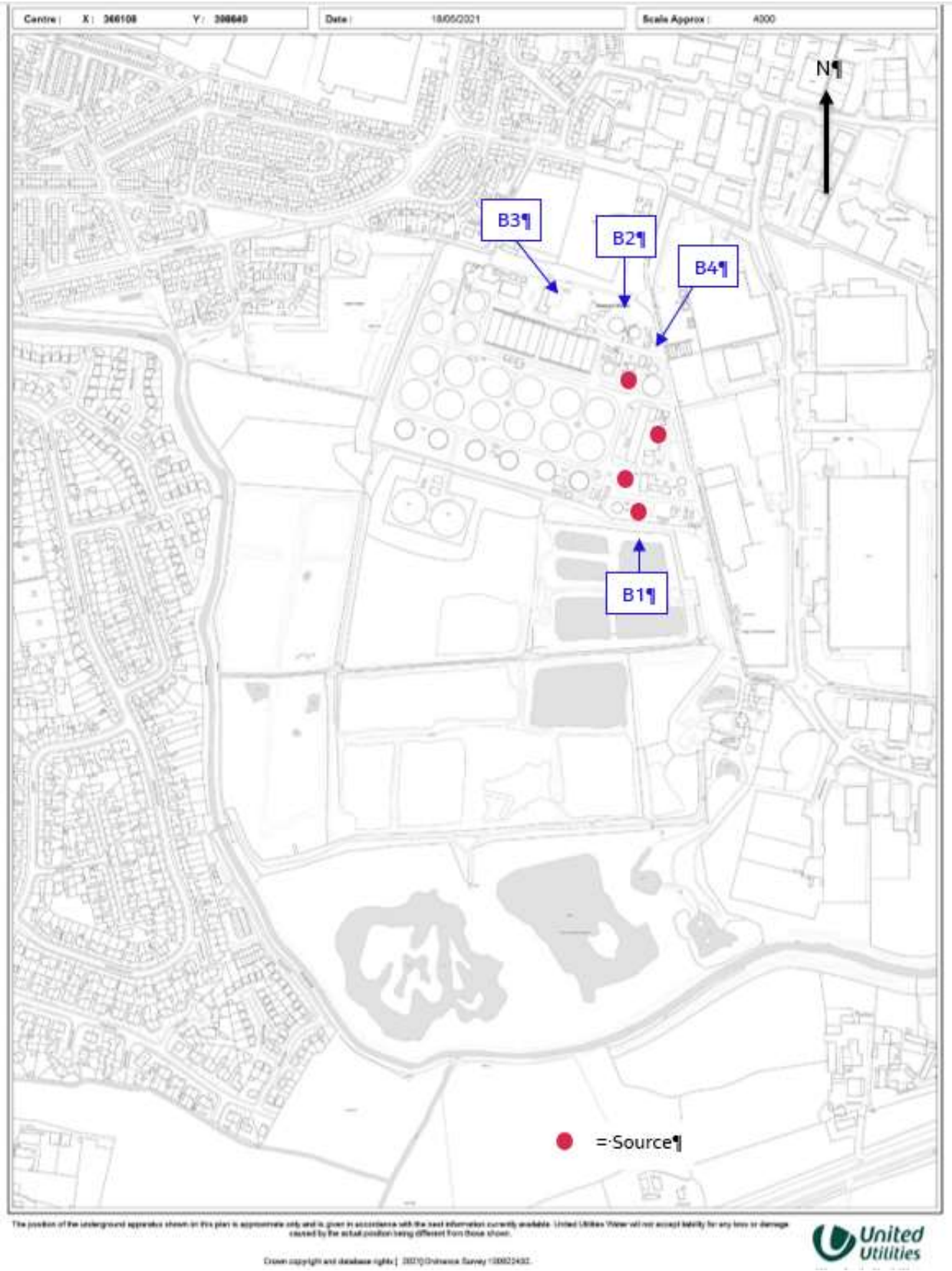


Appendix C: Location of Receptors



Receptor	Description	Distance from closest source (m)	Source	Direction from the site
R1	Commercial properties at Greenfold Way	75	Odour Control Unit	SE
		80	Digester PVRV	E
		85	Gas holder PVRV	E
		90	Digested sludge covered cake storage building	E
R2	Residential properties at Rossall Crescent	225	Digested sludge covered cake storage building	NW
R3	Residential properties at Claycroft Bungalows, Hope Carr Road	190	Digested sludge covered cake storage building	N

Appendix D: Proposed Bioaerosol Monitoring Locations



Emission Points*	National Grid Reference
B1 - 25m upwind of the operational sludge treatment area	SJ 66313 98943
B2 - downwind of the sludge treatment area, but in line with upwind monitoring location	SJ 66275 99227
B3 - downwind. Approximately 45 degrees to the right from the central point (between R2 and the bioaerosol source)	SJ 66206 99235
B4 - downwind. Approximately 45 degrees to the left from the central point (between R1 and the bioaerosol source)	SJ 66332 99173

* The monitoring locations are expected to be as above, however should wind conditions be different on the day of sampling the monitoring locations may vary.