Oxford STC Bioaerosol Risk Assessment

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Thames Water Utilities Ltd
EPR/MP3038LQ/V006

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Oxford STC Bioaerosol Risk Assessment

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Contents

Appendices

Tables

No table of contents entries found.

Figures

No table of contents entries found.

1. Introduction

The purpose of this Bioaerosols Risk Assessment is to provide supplementary information to support the permit variation application for a bespoke installation permit for the Oxford Sludge Treatment Centre (STC), EPR/MP3038LQ/V006.

1.1 Site description

The Oxford STC is located within the Oxford Sewage Treatment Works (STW), south of Littlemore and to the south of Oxford.

The Oxford site is located approximately 5km south-east of the centre if Oxford and less than 1km south of Littlemore. To the north of the site, there is a commercial estate. To the east of the site, there is an area of farmland with a small stream from the Littlemore Brook, followed by commercial and residential areas. The area south of the site is made up of farmland and to the west of the site is a small area of woodland and shrubs, followed by a residential caravan site and commercial estate. The nearest receptors are residential properties approximately 40m to the west of the site.

There are five designated habitat sites within the relevant distances of Oxford STC. There are three Special Areas of Conservation (SAC) approximately 8.5km to the south, 6.5km to the north-west and 7.2km to the west of the STC respectively. These consist of Little Wittenham, Oxford Meadows and Cothill Fen. There are no National Nature Reserves (NNRs) within 2km of the site and there are no Special Protection Areas (SPAs), Marine Protection Areas (MPAs) or Ramsar sites within 10km of the STC. There are two Sites of Special Scientific Interest (SSSIs) located approximately 2km and 1.2km to the north-west of the site, namely Iffley Meadows and Littlemore Railway Cutting. There are no Local Nature Reserves (LNRs) within 2km of the STC. There is one Ancient and Semi-Natural Woodland site located approximately 1.9km to the west of Oxford STC, referred to as Radley Large Wood, together with eight Local Wildlife Sites (LWSs) within 2km of the STC.

There is also a designated species record identified within 500m of the site.

The STC is within Flood Zone 1, indicating that there is a low probability of river flooding (<1:1000 annual probability of flooding).

The site is not within the boundaries of a Source Protection Zone (SPZ). The site is not within an Air Quality Management Area (AQMA). However, it is adjacent to the boundaries of the City of Oxford AQMA, located immediately north of the site.

The address of the installation is:

Oxford Sludge Treatment Centre
Oxford Sewage Treatment Works
Grenoble Road,
Sandford-on-Thames,
Oxford,
OX4 4YU

1.2 Site Activities

Oxford STC is located at the Oxford STW and is operated by Thames Water Utilities Ltd (Thames Water). The STC undertakes the biological treatment of sewage sludge, both indigenous and imported from other wastewater treatment sites, by anaerobic digestion, with a capacity above the relevant thresholds for requiring an environmental permit (which is greater than 100 tonnes of waste per day). It also includes the importation of specified wastes to the works inlet for treatment through the Urban Wastewater Treatment Directive (UUWTD) regulated works.

There are a number of Directly Associated Activities (DAAs), including the operation of three biogas fuelled Combined Heat and Power (CHP) engines for the generation of electricity, steam and heat at the site (which are classified as 'existing' combustion sources under the Medium Combustion Plant Directive (MCPD)), There are also two new boilers which are classified as 'new' combustion sources under the MCPD and two additional emergency generators at the site.

The site includes the following DAAs:

- Imports of waste, including sludge and undigested cake from other sewage treatment works and imports of municipal liquid or sludges similar in composition to UWWTD derived materials;
- Blending of indigenous sludges and imported wastes/waste sludge prior to treatment;
- Pre-treatment of sewage sludge by Thermal Hydrolysis Plant (THP);
- Storage of digestate prior to dewatering;
- Dewatering of digested sewage sludge
- Transfer of treated dewatering liquors back to the head of the sewage treatment works;
- Transfer of surface water runoff back to the head of the sewage treatment works;
- Storage of dewatered digested sludge cake prior to offsite recovery;
- Storage of biogas;
- Transfer of biogas condensate via site drainage back to the head of the sewage treatment works;
- Combustion of biogas in a MCPD and/or Specified Generator (SG) compliant biogas CHP engine and boiler;
- Operation of an emergency flare;
- Operation of a siloxane filter plant;
- Storage of diesel;
- Storage of wastes, including waste oils;
- Storage of raw materials; and,
- Operation of standby emergency generators (for THP and Liquor Treatment Plant (LTP)).

The STC can treat up to 1,000,000m^3 of sludge per year (equating to approximately 1,000,000 wet tonnes per annum). There are four operational Primary Digester Tanks and the STC has a total maximum treatment input of 700m^3 per day (equating to approximately 700 wet tonnes per day).

Some of the treatment throughput is sludge which is subject to dewatering and storage as treated sludge cake at the site prior to removal from site for application to land. Within the area covering the permitted activities, there are four Odour Control Units (OCUs) linked to specific tanks and processes which produce potentially odorous air. The units treat the air through a variety of means, including use of biofilters and carbon filters.

The anaerobic digestion process gives rise to biogas, a mixture of biomethane and carbon dioxide, in a mixture with trace components. This biogas is combusted through CHP engines at the site, by the site boilers and with excess biogas being subject to emergency flaring. The biogas handling system is equipped with a number of pressure relief valves (PRVs) which activate as a safety precaution when there is excess biogas over what the CHP engine, boilers and emergency flare can handle.

1.3 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) and the treatment of liquors prior to disposal above the relevant threshold, Chapter 5, Section 5.4, Part A 1(a)(i).

For permits, if the site is within 250m of sensitive receptors then there is a requirement to monitor bioaerosols in accordance with the EA technical guidance note[1] '*M9: environmental monitoring of bioaerosols at regulated*

[1] Environment Agency. July 2018. M9: Environmental monitoring of bioaerosols at regulated facilities v2, July 2018

facilities'. M9 describes bioaerosols and the risks that they pose, as well as identifying potential sources within biological treatment facilities.

The Oxford Sludge Treatment Centre installation is within 250m of sensitive receptors, as defined by M9. These are detailed in Section 2.5 of this report.

1.4 Bioaerosols

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. They also have the potential to cause eye irritation, gastrointestinal illness and dermatitis.

Bioaerosols are associated with composting, anaerobic digestion and mechanical biological treatment, which are the main processes used to treat organic wastes 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.

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[2] for developments requiring planning permission and environmental permits 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 Oxford STC does not undertake any aerobic composting activities and the anaerobic digestion process on site, undertaken in the primary digesters, is an enclosed process with all produced gases captured within the biogas system.

1.4.1 High Risk Activities

The M17 guidance document, in section 3.3.3, outlines a number of potential sources and release mechanisms of particulate matter, including bioaerosols from waste management facilities. These potential sources are not graded for importance within M17 and include: the movement of waste to and from the STC; storage of waste (under certain conditions) on site; the handling and processing of waste materials e.g. shredding of green waste, turning of windrows, daily cover; and wind scouring of waste surfaces.

In terms of potential sources of bioaerosols release at Oxford STC, which meet the M17 guidance, only the storage and handling (movement within the Cake Pad and during export) of sludge cake would apply. There is no shredding of waste or turning of stockpiles as part of the management process and all sewage waste is contained and received via pipes.

1.4.2 Relevant Thresholds

Based on the accepted Levels at sensitive receptors as set out in the Environment Agency M17 guidance[3] '*M17 Monitoring of particulate matter in ambient air around waste facilities*', and in line with the Governments regulatory position statement (RPS) 209 outlining when a specific bioaerosol risk assessment

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

[3] Environment Agency. 2013. Technical Guidance Note (Monitoring) M17: Monitoring Particulate Matter in Ambient Air around Waste Facilities, v2, July 2013 *https://www.gov.uk/government/publications/m17-monitoring-of-particulate-matter-in-ambient-air-around-waste-facilities*

and/or monitoring is required and use of the Environment Agency Technical Guidance Note M9[4]; key bioaerosols of interest and their respective threshold Levels (including background) at sensitive receptors are outlined below:

- Total bacteria: 1000 cfu/m^3
- Aspergillus Fumigatus: 500 cfu/m^3

[4] Environment Agency. 2018. Technical Guidance Note (Monitoring) M9: Environmental monitoring of Bioaerosols at regulated facilities, v2, July 2018.

2. Bio aerosol risk assessment

2.1 Introduction

A source-pathway-receptor risk assessment has been undertaken to appraise the potential for risk to human health at sensitive receptors within the relevant distance from operations at the Oxford STC. This risk assessment follows a standardised approach, namely:

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

The assessment describes:

- The processing techniques and equipment used within the installation.
- Feedstock, tonnages processed and any seasonal variations.
- Potential 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.

2.2 Processing equipment and techniques

2.2.1 Waste Reception

Waste, via tanker transfer, is pumped to the STW inlet channel through an enclosed connection, before being processed through the STW outside of the permit boundary. Incoming sludge, in a mixture with other sewerage material is subjected to preliminary treatment through screening and de-gritting, before separation of sludge from the main flow in the Primary Settlement Tanks. Settled sludge is transferred to the anaerobic digestion process, following thickening of sludge and SAS.

Sludge may also enter the process, via tanker transfer from other TWUL sewage treatment works or from third parties. These imports are transferred by sealed pipeline from tankers into a Sludge Buffer Tank within the process. Sludge is transferred from the Sludge Buffer Tank, screened and pumped to a second Screened Sludge Holding Tank and then one of two Sludge Blending Tanks where it is mixed with the indigenous thickened primary sludges.

If a sludge spillage occurs, operators will carry out clean up as soon as possible. Lorry and tanker drivers are required to hose down any spillage after each loading. A wheel wash facility is available on the site, and a standpipe is available and can be utilised to wash spillage from vehicles as required. Spill kits are available on site and staff are trained to use them. Significant spillage incidents would be recorded in the site diary.

2.2.2 Waste Treatment

The treatment process of the sludge covered by this permit is for the anaerobic digestion of sludges within four Primary Digester Tanks.

The waste treatment process starts within two, covered Primary Picket Fence Thickeners (PFTs) which thicken separated primary sludge from the main flow within the primary settlement tanks. The Primary PFTs are aboveground steel tanks with a concrete base and fixed roofs and connected to an OCU to manage odour emissions. The thickened sludge is pumped to one of the two Sludge Blending Tanks. Surplus Activated Sludge (SAS) from the Final Settlement Tanks (FSTs), is pumped to the SAS Holding Tank, which is outside of the scope of the permit where pumps transfer the SAS to the Thickening Plant located within the Thickening Building, where a liquid polymer is added to aid coagulation. The SAS thickening stage is the first stage of the sludge treatment process. The thickened SAS is pumped to the covered Sludge Buffer Tank where sludge from other sites can be added, via import through the sludge import loggers. Mixed SAS is pumped via screens to the covered Screened Sludge Holding Tank and further pumped to the Sludge Blending Tank, where the SAS and primary sludge is mixed.

The Sludge Blending Tanks are covered and are connected to an OCU to manager odour emissions. From the Sludge Blending Tanks, sludge is pumped to a Pre-THP Dewatering Feed Tank. This tank is above ground and of steel construction, connected to an OCU. Blended sludge is pumped to the Pre-THP dewatering plant where it is dewatered with the addition of a polymer and then transferred to the THP Feed Silos, prior to treatment within the THP. Liquors from the THP dewatering belts are pumped to the Liquor Treatment Plant Decant Chamber. Undigested, thickened sludge from other STWs can be imported to a cake import building via a cake hopper located to the north of the STC. The imported sludge is pumped to the THP Feed Silos, using final effluent to remain wet.

Sludge is put through the THP process from the two THP Feed Silos. The THP process is a single stream process consisting of three pairs of THP Reactors and two THP Flash Tanks. The THP process takes place within aboveground, enclosed steel tanks on engineered concrete, which is connected to the site drainage system. All drainage and liquids generated from the THP process return to the inlet for further treatment via the site drainage. Sludge is pumped from the THP Feed Silos to the THP Reactors, where the cycle commences. Once filled with sludge, the THP Reactor is filled with steam until the required pressure and temperature is reached in order to hydrolyse the sludge. Once the hydrolysis has been completed, a valve is opened to gradually reduce the pressure with the steam released. A second valve, at the bottom of the THP Reactor is then opened and the sludge is discharged to the THP Flash Tanks. The THP Flash Tanks provide a thermal buffer to release excess energy from the sludge prior to it entering downstream processes. The hydrolysed sludge is then discharged from the THP Flash Tank into a common line and is blended with sludge being recirculated from the Primary Digester Tanks to cool. The common line splits between two individual sludge coolers that use final effluent from site to lower the temperature to be more optimal for anaerobic digestion. Cooled sludge is then pumped to one of the four Primary Digester Tanks at the site.

Primary Digester Tanks 1 and 2 are of concrete construction and are mostly above ground, with biogas holders in the headspace. Primary Digester Tanks 3 and 4 are of steel construction with fixed roofs. The tanks have dual Pressure Relief Valves (PRVs), mixer pumps and re-circulation pumps. Primary Digester Tanks 3 and 4 use anti-foam dosed manually from an Intermediate Bulk Container (IBC), whereas Primary Digester Tanks 1 and 2 use a final effluent shower spray to knock down foaming. Sludge is digested for approximately 15 days then moved to a Digested Sludge Buffer Tank (Half Tank).

Digested sludge is transferred to the Digested Sludge Buffer Tank (Half Tank) via gravity. The Digested Sludge Buffer Tank (Half Tank) is half of one rectangular shaped tank that is of concrete construction, which is mainly above ground. Digested sludge can discharge into an overflow Digested Sludge Buffer Tank (Whole), however this is usually in time of abnormal flow. Digested sludge is then pumped to one of two Digested Sludge Buffer Feed Tanks via a subsurface sludge line. Three pumps transfer sludge from the Digested Sludge Buffer Feed Tanks to the final Pre-Dewatering Feed Tank which is above ground, covered, of steel construction.

Pumps transfer the digested sludge from the Pre-Dewatering Feed Tank for dewatering within one of four digested sludge belt presses inside the digested sludge dewatering building. The belt presses dewater the digested sludge with the aid of a polymer coagulant. The polymer is made up from a bulk bag with the addition of potable water. Filtrate from the dewatering gravitates to the LTP Balancing Tank of the LTP. Dewatered digested sludge cake is conveyed to the cake barn, a semi-enclosed covered building.

The LTP is made up of the LTP Balancing Tank and the LTP itself. The LTP Balancing Tank is connected to its own OCU, of concrete construction and covered. The LTP Balancing Tank is mostly subsurface and receives liquors from the digested sludge dewatering plant. Liquors pumped into the LTP are subject to treatment with caustic soda (sodium hydroxide) and anti-foam. The LTP is a Sequencing Batch Reactor that consists of two treatment lanes that are of concrete construction. The LTPs treats the liquors in order to produce an effluent that is suitable for return to the inlet for treatment. Liquors are agitated via blowers in order to achieve de-ammonification through a biological process that oxidises ammonia to nitrates. From the inlet, treated liquors pass through the UWWTD plant for aerobic treatment.

2.2.3 Digested cake

Dewatered digested sludge cake is conveyed to the cake barn, a semi-enclosed covered building where it is removed from site. The barn has a storage area of approximately 2,620m^2. In the event of non-compliant sludge being produced at Oxford STC, it is stored within one of the storage bays for an extended period of time. Digested sludge cake is transferred onto trucks using an excavator and loading shovel and removed off site for agricultural land spreading. Imported raw undigested sludge can also be stored within an additional, uncovered cake pad located to the south of the cake barn. This cake pad is used for strategic storage and when the THP is unable to accept additional cake imports. This raw undigested sludge is then treated by Oxford STC via the cake import facility.

2.2.4 Odour Control Units

Sewage treatment works have a number of potentially odorous sources within their boundary. Some of these sources may be linked to OCUs to treat potentially odorous compounds given off by the process. These units take air extracted from above tanks or process areas and treat the odour compounds by means of different methodologies dependent upon the nature of the odour compounds. Treatment methodologies include activated carbon systems; biofilters or other biological treatment; and chemical scrubbing. Individual OCUs may use one or more of these methodologies in series.

Under the M9 guidance documents, the Environment Agency has identified that biofilters may give rise to bioaerosols during operation. For completeness all OCUs with biofilters and within the permit installation boundary have been included in this assessment.

2.2.5 Seasonality

Sewage treatment is undertaken at the STC on a continuous basis, 24 hours a day 365 days of the year. Digested sludge cake is, therefore, produced daily and at similar levels across the whole year.

However, digested sludge cake storage on site, both in relation to duration and volume, varies across time. Digested sludge cake is removed from site for spreading to land. Land spreading is controlled under the Biosolids Assurance Scheme and Sludge Use in Agriculture Regulations (1989), as well as the Farming Rules for Water. As such, digested sludge cake will remain on site longer during wet periods and during autumn and winter periods where there would be limited uptake of nutrients from the solids. This means that there will be more digested sludge cake within the storage bays during the autumn and winter, under normal conditions, than during the summer period.

2.3 Potential Sources

There are twenty point-source emissions to air from the processes within the installation boundary, as presented in Table 1 and illustrated in Appendix B. The references and source descriptions match those in the permit:

Table 1: Point source emissions to air

Air emission reference	Source	In scope?
A1	CHP Engine 1	X
A10	CHP Engine 2	X
A11	CHP Engine 3	X
A14	Emergency Flare	X
A15	THP PRV	X
A16	Digester PRV	X
A17	Digester PRV	X
A18	Digester PRV	X
A19	Digester PRV	X
A20	Biogas Holder PRV	X

Air emission reference	Source	In scope?
A21	Siloxane Filter	X
A23	OCU2	✓
A24	OCU3	✓
A25	OCU4	✓
A26	OCU5	✓
A27	New Boiler 1 1	X
A28	New Boiler 2	X
A29	Emergency Generator 3 (DAA to THP)	X
A30	Emergency Generator 4 (DAA to LTP)	X

The open Import Cake Pad is also illustrated in Appendix B and is an additional potential source for consideration of bioaerosols release to atmosphere.

2.3.1 Source Assessment

The CHP engines, boilers and emergency flare (points A1, A10 & A11, A27 & A28, and A14) combust the produced biogas at high temperatures (in excess of 450°C). Due to the combustion of the biogas, these points can be discounted as sources of bioaerosols emissions.

Points A29-A30 relates to diesel fuelled generators at the site, which are not linked to any source of bioaerosols.

- There are four Odour Control Unit (OCU) (point A23-A26) serving the STC, connected to the PFTs, Sludge Blending Tanks, Screened Sludge Holding Tank, Sludge Buffer Tank, Pre-THP Dewatering Feed Tank, Pre-THP Dewatering Plant, THP Feed Silos, Cake Import Facility and the LTP Balancing Tank. The OCUs can be described as follows: OCU 2 is a biofilter with the extracted air from the PFTs and Sludge Blending Tank passed through the support media, which is calcified seaweed, within the biofilter while water is irrigated from above.
- OCU 3 is a biofilter which contains two ETA bio-scrubbers which contain plastic media and a water recirculation system. It takes foul air from the Sludge Buffer Tank and the Screened Sludge Holding Tank and passes it through the bio-scrubber before venting off to the atmosphere.
- OCU 4 takes foul air from the Pre-THP Dewatering Feed Tank, Pre-THP Dewatering Plant, THP Feed Silos and Cake Import Facility. The OCU consists of a bio-scrubber followed by an activated carbon filter.
- OCU 5 takes foul air from the LTP Balancing Tank and consist of a bio-scrubber followed by an activated carbon filter.

The microbes on the support media, remove potentially odorous contaminants and the partially treated air discharges via the stack and biofilters are considered to be a potential emission source for bioaerosols.

The PRVs (points A15 – A20) are normally closed and do not emit to atmosphere. However, in the event of an abnormal situation such as the failure of the flare stack and/or boilers, the PRVs would open to relief excess biogas pressure, potentially resulting in the release of bioaerosols, while the problem is rectified. While the problem is rectified, biogas generation is reduced by reducing or inhibiting the digester feed. These abnormal events are unlikely, temporary, and infrequent due to the extensive monitoring and maintenance programmes undertaken at the site as well as the procedures and warning systems in place.

In addition to the point sources identified above, there is also an unchanneled potential release from treated, dewatered digested sludge cake which is stored on the imported cake pad and the partially enclosed cake barn at the site.

2.3.2 Risk

The overall treatment process is considered to be a low source of bioaerosols. As discussed above, there are a number of control measures in place at the site to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure. The greatest probability of exposure from bioaerosols emitted from the site is from uncovered operations such as the uncovered cake pad.

However, the digested sludge cake is at the end of the sludge treatment process and is moist on deposition from the conveyor to the cake barn. It is managed to control row height and arrangement and is moved by shovel loading vehicle, as required to stockpiles within the designated walled storage bays. There is the potential for entrainment and resuspension of material from via vehicle tyres as the cake is handled. As the digested sludge cake requires no further treatment before being deposited on agricultural land it is therefore likely to have a low concentration of bioaerosols and the probability of exposure from this source is medium.

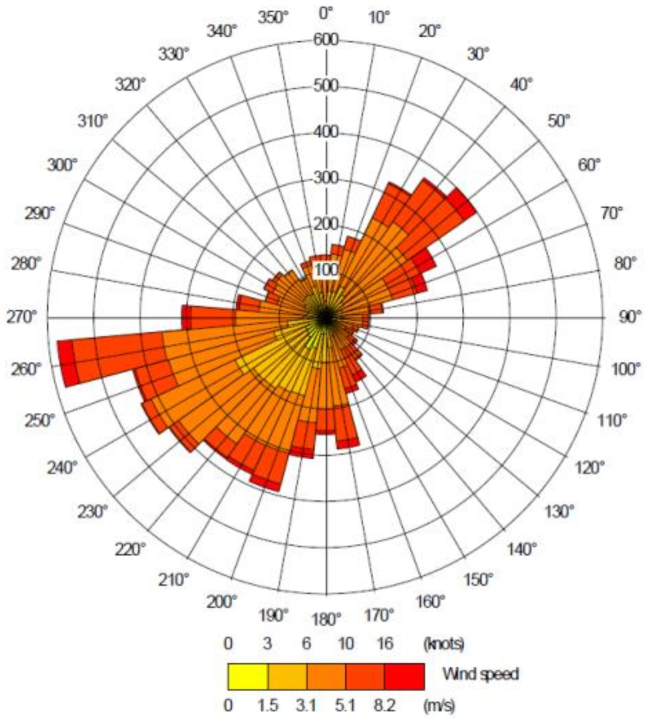
In addition, waste treatment tanks and associated pipework are enclosed. The wet wells used to receive incoming sludge are below ground and covered. Sludge screening and dewatering takes place in enclosed tanks and units that are located within a building. In addition, the PRVs are only open in abnormal situations which are temporary and unlikely.

2.4 Pathways

Bioaerosols are very small and light in weight so can easily be transported by the wind from their source to a receptor. The 2019 wind rose for a representative meteorological site, Lyneham AB /Lyneham RAF Airbase (located approximately 50 km south-west of the Site), is shown in Figure 1.

The wind rose data shows that the site experiences West southwest to Southwest prevailing winds, predominantly in excess of 6 knots. The Oxford STC and surrounding area has a relatively flat topography. The site is bound by mature trees/ hedgerow along its northern, western eastern and southern boundary.

Figure 1 – Lyneham AB Meteorological Site Windrose



Because of the dilution effect in open air, bioaerosol concentrations fall away rapidly with distance from the source. It has been shown by research by the HSE[5] that by 100 to 200m away, the bioaerosol concentration has mostly returned to background levels. Between 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. Note that this research was undertaken on aerobic composting sites, which generate higher levels of bioaerosols than anaerobic digestion sites, although the 250m separation distance has been retained.

At present, Thames Water do not have any empirical evidence for the levels of bioaerosols that might be associated with the potential sources at their Sludge Treatment Centres.

As a responsible operator, Thames Water are currently considering carrying out monitoring for bioaerosols at a number of typical STC's in order to confirm that the understanding of the wider waste water treatment industry, that sewage sludge treatment processes do not give rise to elevated levels of bioaerosols, is correct.

As a responsible operator, Thames Water are arranging for bioaerosol monitoring at a number of typical STC's in order to confirm that the understanding of the wider waste water treatment industry, that sewage sludge treatment processes do not give rise to elevated levels of bioaerosols, is correct. The sampling will be in accordance with the requirements of M9 and M17 and consist of a series of agar gel plates being placed downwind and upwind of the cake pad, including sampling points both directly upwind of the downwind sampling point and additional samples in the direction of the nearest sensitive receptors.

[5] RR786 - Bioaerosol emissions from waste composting and the potential for workers' exposure https://www.hse.gov.uk/research/rrhtm/rr786.htm

2.5 Receptors

Environment Agency guidance note M9 recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations. Sensitive receptors are defined as: 'permitted activities where people are likely to be for prolonged periods'. This term would therefore apply to dwellings (including any associated gardens) and to many types of workplaces. We would not normally regard a place where people are likely to be present for less than 6 hours at one time as being a sensitive receptor. The term does not apply to those controlling the permitted facility, their staff when they are at work or to visitors to the facility, as their health is covered by Health and Safety at Work legislation but would apply to dwellings, commercial or industrial premises nearby where people might be exposed for the requisite period.

There are a number of potentially sensitive receptors found within 250m of potential bioaerosol emission sources at the site. As demonstrated in the site plan found in Appendix C, these receptors are found on all sides of the site.

The areas of sensitive receptors have been identified below in Table 2 based on their location and receptor type. For each of these areas, the distance and direction from each potential bioaerosol emission source to the closest sensitive receptor within the area has been identified. Where multiple assets exist for the same process, such as the cake barn, only the closest location has been presented. The receptor closest to a potential emission source are the commercial buildings south of the STC, which is located approximately 8m east of the open cake pad

Table 2: Static Receptors within 250m of Potential Bioaerosol Sources

Receptor	Description	Source	Distance from closest source (m)	Direction from the Source
R1	Kiln Close Residential Area	Digester PRVs	200m	North-west
		Biogas holder PRV	230m	North-west
		OCU 2	200m	West
R2	The Oxford Science Park - West	Digester PRVs	185m	West
		Biogas holder PRV	150m	West
R3	The Oxford Science Park - East	Cake Barn / Cake Import Pad	225m	North
		Digester PRVs	140m	North
		Biogas holder PRV	90m	North
		OCU 3	230m	North
		OCU 4	80m	North
		OCU 5	205m	North
R4	Kassam Leisure Complex – West	Cake Barn / Cake Import Pad	220m	North
		OCU 5	225m	North-east

2.6 Risk Assessment

The method used for this bioaerosol risk assessment is adapted from the EA's standard guidance on risk assessments for environmental permitting, which recommends using a Source-Pathway-Receptor model to help determine the magnitude of the risk associated with bioaerosol emissions from a facility.

There are three potential sources of bioaerosol releases within 250m of static receptors:

- Odour control units (four OCUs)
- PRVs on digesters and biogas holders
- Cake barn / Import cake pad

The receptors are situated all around the site, but the closest receptors are to the North and West of release points and the prevailing wind is generally south westerly.

Receptor R4 is situated downwind of these sources, so there is potential for wind-borne transportation of bioaerosols with a medium probability of exposure. The other receptors also have a potential for wind-borne transportation of bioaerosols, although with a low probability of exposure.

Receptor R1 is 200m from OCU 2 at the closest point but the residential properties are not directly downwind of the potential sources and separated by mature trees and vegetation. While human receptors are likely to be present for more than 6 hours, these mitigations will reduce the concentration and likelihood of potential releases.

Receptor R2 is a commercial estate made up of multiple large office buildings. Although the human receptors within these buildings are likely to work for more than six hours, it is unlikely that they will be outside for more than an hour at a time. Therefore, the office buildings provide screening from potential exposure to bioaerosols, along with the dense vegetation and mature trees separating the estate and the site. The commercial estate is largely upwind of the site.

Receptor R3 is the eastern side of the same commercial estate as R2. The human receptors are also screened by the buildings and vegetation between the estate and the site, reducing the risk of potential exposure to bioaerosols.

Receptor R4 is another commercial estate adjacent to the Kassam Stadium. The same mitigations apply to R4 as at R2 and R3, in that the human receptors are likely to be inside for the majority of the 6 hour period and mature trees are present to separate the estate from the site for screening. The Kassam Stadium has not been included as, while it is open air, it is beyond the 250m radius.

The daily throughput of sludge is 700m3/day (equivalent to 700 wet tonnes per day). The bioaerosol content within the digested sludge cake is low following the sludge treatment processes. The fully digested sludge remains damp as it passes from the covered Conveyor into the Cake Barn, thus minimising windblown transmissions. The sludge cake forms a crust after 24 hours in storage, so does not give rise to dust readily. The sludge cake is shovelled from under the Conveyor deposits to storage areas within the Cake Barn and then left until it is disturbed for export, further minimising the potential to generate bioaerosols emissions to air. Imported digested sludge cake from inside of the cake import building is transferred to the THP Feed Silo from the Cake Import Facility via enclosed screw conveyors.

The probability of exposure from bioaerosols generated from the permitted processes on site is considered to be Medium and the potential duration of release of bioaerosols varies from infrequent to frequent.

However, when considering the location of receptors, receptor distances from source, the prevailing wind direction and the onsite management and mitigation measures in place, the overall risks of bioaerosols being generated from the permitted processes on site is likely to be Low or Very Low.

Planned monitoring of bioaerosol emissions by Thames Water is expected to validate the expectation that process contributions of bioaerosols from sewage sludge treatment works, would comply with the 'acceptable level' thresholds, set out within EA guidance. Table 3 summarises the risk assessment.

Table 5: Risk Assessment of Potential Bioaerosol Sources

What has the potential to cause harm? Source	How can the source reach the receptor? Pathway	Who can be affected? Receptors	Assessing the risk Probability of Exposure	Consequence (what is the harm that can be caused)	Managing the risk (Control Measures)	Overall / residual risk
Cake Barn, Import Cake Pad and conveyors	Inhalation via wind-borne transportation	R3, R4	Receptor R4 is the closest receptor to the Cake Barn, approximately 220m North of the Cake Barn wall. R3 is the only other receptor within 250m of the cake barn (225m North). Receptor R4 is within downwind range of the Cake Barn, Import Cake Pad and the conveyors. Receptors that are further away from the cake pad and upwind of the cake pad are likely to receive a lower concentration of bioaerosols in the event of a release. The semi enclosed Cake Barn, the concrete walls of the Import Cake Pad and the vegetation between the Cake Barn and Import Cake Pad and the receptors reduces the likelihood of wind-blown transmission during handling and export. The bioaerosol content is considered to be small in digested sludge cake. Due to the proximity the probability of exposure at the closest Receptor is considered to be **medium**. Exposure at other Receptors is **low**.	Impact on human health (considered to be a sensitive receptor).	The cake Conveyor is covered, reducing likelihood of bioaerosol release. The cake Conveyor drop heights and the drop heights from dozers handling the sludge cake are minimised to reduce the risk of wind borne transportation during deposition into the Cake Barn, and via handling and movement around the Cake Barn or off site. The cake barn is semi-enclosed by walls and a roof which protects it from the wind. Water content in the sludge cake reduces susceptibility of wind-borne releases. The Import Cake Pad is enclosed by concrete walls, stockpile levels are managed so that under normal operating conditions they do not exceed the height of the surrounding bund wall. Sludge cake is moved only when required to minimise disturbance and does not occur every day. Spillages are cleaned up in a timely manner to reduce generating windblown bioaerosols or resuspension via vehicle movements.	Low

What has the potential to cause harm? Source	How can the source reach the receptor? Pathway	Who can be affected? Receptors	Assessing the risk Probability of Exposure	Consequence (what is the harm that can be caused)	Managing the risk (Control Measures)	Overall / residual risk
Odour Control Units	Inhalation via wind-borne transportation	R1, R3, R4	Receptor R1 is the closest residential receptor, approximately 200m West of OCU 2 with some screening afforded by vegetation. Receptor R3 is also within 250m of OCUs with OCU 3, 4 and 5 being 230m, 80m and 205m North respectively and screening provided by vegetation. Receptor R4 is 225m North-east of OCU 5. Receptor R4 is within downwind range of OCU 5 and Receptor R3 is within downwind range of OCU 4. All other Receptors are greater than 250m from the potential source of bioaerosols from OCUs. Due to the proximity the probability of exposure is considered to be low at Receptor R1 and R3. Other receptors will have a reduced probability of exposure.	Impact on human health (considered to be a sensitive receptor).	The OCUs are maintained regularly by an agreed Framework contractor to reduce the likelihood of equipment failure. The OCUs and associated tanks are connected by enclosed pipework.	Low
Pressure Relief Valves (digesters / biogas holder)	Inhalation via wind-borne transportation	R1, R2, R3	Receptor R3 is the closest receptor to a PRV, approximately 90m North of the Biogas Holder and 140m North of the Digester PRVs. Receptor R2 is within 185m and 150m west of the Digester PRVs and Biogas Holder PRVs respectively. Receptor R1 is within 200m and 230m North-west of the Digester PRVs and Biogas Holder PRVs respectively. However, release of bioaerosols from the PRVs would be considered an abnormal event and the probability of exposure is considered to be low.	Impact on human health (considered to be a sensitive receptor).	PRV's are closed under normal operating conditions The valves are regularly monitored by visual inspections by the site operators. In the event of an abnormal situation requiring a PRV to open, biogas generation is reduced by reducing or inhibiting the digester feed.	Very Low

2.7 Abnormal Situations

In the event of plant failures or abnormal situations, an alarm would be raised on the Site Supervisory Control and Data Acquisition (SCADA) or telemetry systems, which will be reacted to by on-site or regional control room operators and Duty Managers. Depending upon the nature of the fault or emergency, where required, an operator would contact a mechanical or electrical technician, both of whom are on-call 24-hours, to attend site as soon as practicable.

If the on-call technicians are already engaged upon other response work, there is the facility to access staff from other TW geographic divisions, coordinated by the Duty Manager. All faults, breakdowns and emergencies are logged electronically together with records of the action taken and the solutions reached. One such abnormal event would be failure of the flare stack and/or CHP engines. Such an event would result in releases of biogas from the PRV's located on the roofs of the digesters and in the biogas holder compound, which would release bioaerosols. This occurs to prevent over pressurisation and minimise the likelihood of a catastrophic failure of the digesters and biogas systems. While the problem is rectified, biogas generation is reduced by reducing or inhibiting the digester feed.

3. 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 Oxford STC. 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 of exposure. This considered control measures in place to reduce the probability or magnitude of release.

A small number of potential sources of bioaerosols within the site processes have been identified, connected to the storage and movement of treated digested sludge cake at the site; operation of an odour control unit and abnormal releases from pressure relief valves.

Although only qualitative data is available, the overall bioaerosol risk to the identified, potential, receptors within 250m of potential bioaerosol sources associated with the sludge treatment process is considered to be a 'Low' or 'Very Low' risk based on the receptor distances, probability of exposure and onsite management and maintenance, which would minimise the magnitude of any releases.

3.1 Sampling

Thames Water confirms it will use MCERTS accredited providers for the sampling from the following locations using isokinetic sampling and impingement into a saline solution, suitable for sampling of bioaerosols from stack emissions:

- A23 (OCU2) NGR SP 54296 01953
- A24 (OCU3) NGR SP 54363 01996
- A25 (OCU4) NGR SP 54247 02123
- A26 (OCU5) NGR SP 54456 02059

Sampling will take place via a permanent platform (or a suitable temporary platform will be constructed) making use of existing sampling ports. Samples will be delivered to the testing laboratory within 24 hours of sampling.

In addition, sampling will also take place in relation to SP 54563 02011 (approx. NGR of centre of cake pad) which is a diffuse source and hence will be monitored purely by agar plates. Downwind samples will tend to be towards the east of the site, as the prevailing wind is from the west, so receptors R1-3 are less likely to be impacted from this potential source.

In line with M9, ambient sampling will be conducted to identify background emissions. A sampling round, consisting of four induvial sampling points, each with its own agar plate will be carried out. One point will be located 50m upwind of each OCU stack to give a background concentration, and three points will be located downwind and at the same distance to the nearest sensitive receptor (as per M9):

Source	Downwind Location NGR	Upwind Location 1 NGR	Upwind Location 2 NGR	Upwind Location 3 NGR
OCU2	SP 5424 0194	SP 5444 0208	SP 5449 0199	SP 5448 0188
OCU3	SP 5432 0198	SP 5453 0214	SP 5458 0203	SP 5458 0192
OCU4	SP 5419 0211	SP 5430 0217*	SP 5432 0213	SP 5432 0209
OCU5	SP 5440 0205	SP 5461 0219	SP 5465 0209	SP 5465 0199

Source	Downwind Location NGR	Upwind Location 1 NGR	Upwind Location 2 NGR	Upwind Location 3 NGR

*Location points may require to be changed due to the presence of existing structures making access unsafe or impractical

Location is only 35m from the source because of the proximity of a primary digester

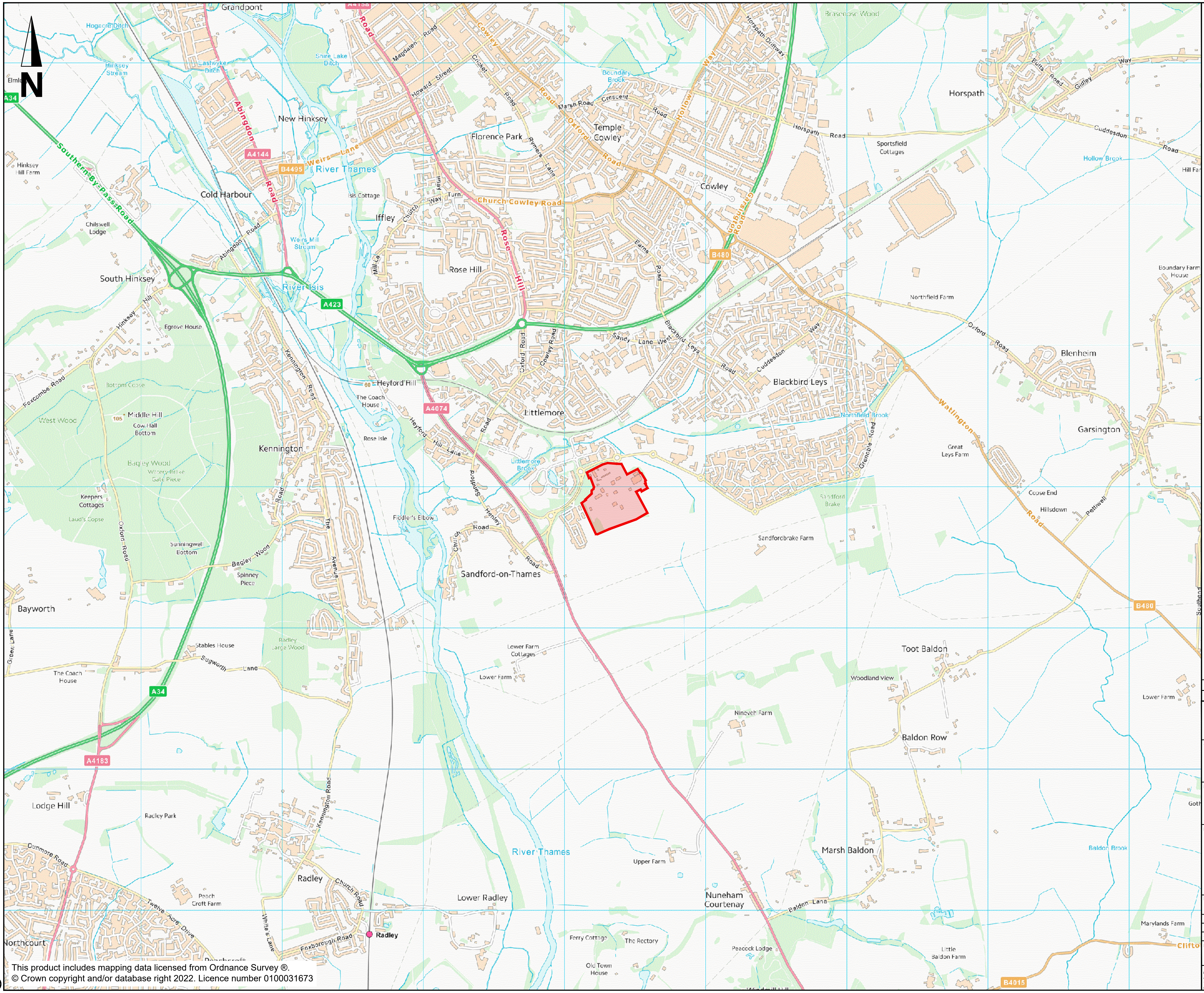
Cake pad

- Upwind sample location which is approx. 50m west of the cake pad: NGR SP 5451 0200
- Downwind sample location 1 which is approx. 220m NW of the cake pad: NGR SP 5473 0215
- Downwind sample location 2 which is approx. 220m W of the cake pad: NGR SP 5478 0205
- Downwind sample location 3 which is approx. 220m SW of the cake pad: NGR SP 5477 0193

All NGRs for sampling locations are only 8 digits at present, to allow the contractor flexibility as to precise location, taking into account access (and security) for the sampling plates.

Appendix A. Site boundary and emission points

Please see drawing 'B22849AM-JAC-OXF-DR-0001' - Figure 1 Site Location Plan



KEY:

Site Location

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Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	SEP. 2022	FOR INFORMATION	AR	TJ	JK	MM

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Drawing title:

FIGURE 1
SITE LOCATION PLAN

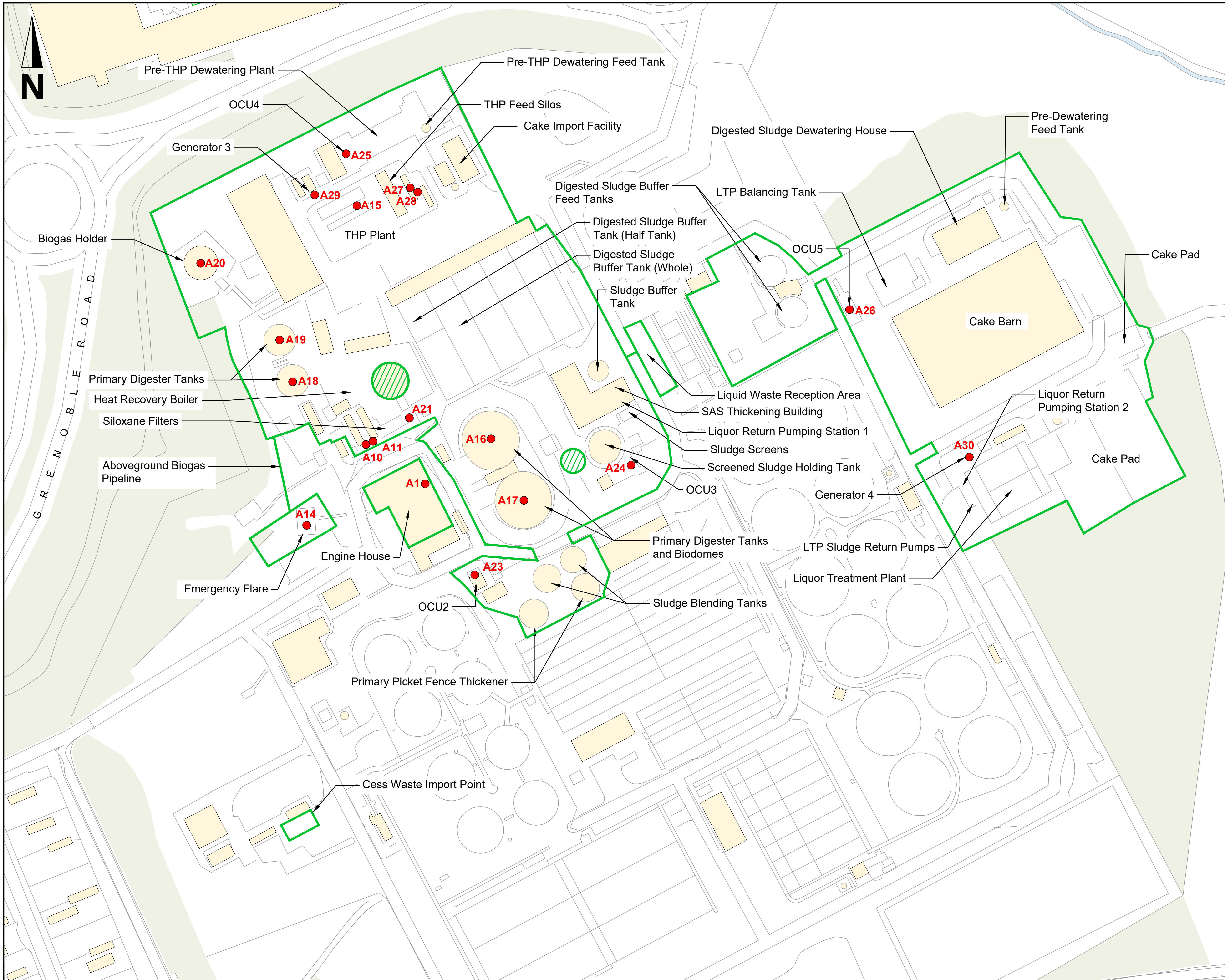
Drawing status: PERMITTING

Scale	1:25,000	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	P01
Client no.			

Drawing number: B22849AM-JAC-OXF-DR-0001

Appendix B. Site plan showing static receptors within 250m of potential bioaerosol sources

Please see drawing 'B22849AZ-JAC-OXF-DR-0002' - Appendix B Installation Boundary and Air Emission Points



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KEY:

- Installation Boundary
- Tanks Excluded from Permit Scope
- Air Emission Point

A1 - CHP Engine 1
A10 - CHP Engine 2
A11 - CHP Engine 3
A14 - Emergency Flare
A15 - THP PRV
A16 - Digester PRV
A17 - Digester PRV
A18 - Digester PRV
A19 - Digester PRV
A20 - Biogas Holder PRV
A21 - Siloxane Filter
A23 - OCU2
A24 - OCU3
A25 - OCU4
A26 - OCU5
A27 - New Boiler 1
A28 - New Boiler 2
A29 - Generator 3
A30 - Generator 4

0 20 40 60 80
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P03	JUL 2023	FOR INFORMATION	AR	TJ	JK	MM
P02	APR 2023	FOR INFORMATION	AR	TJ	JK	MM
P01	SEP 2022	FOR INFORMATION	AR	TJ	JK	MM

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Project
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OXFORD STW

Drawing title
APPENDIX B
INSTALLATION BOUNDARY
AND AIR EMISSION POINTS

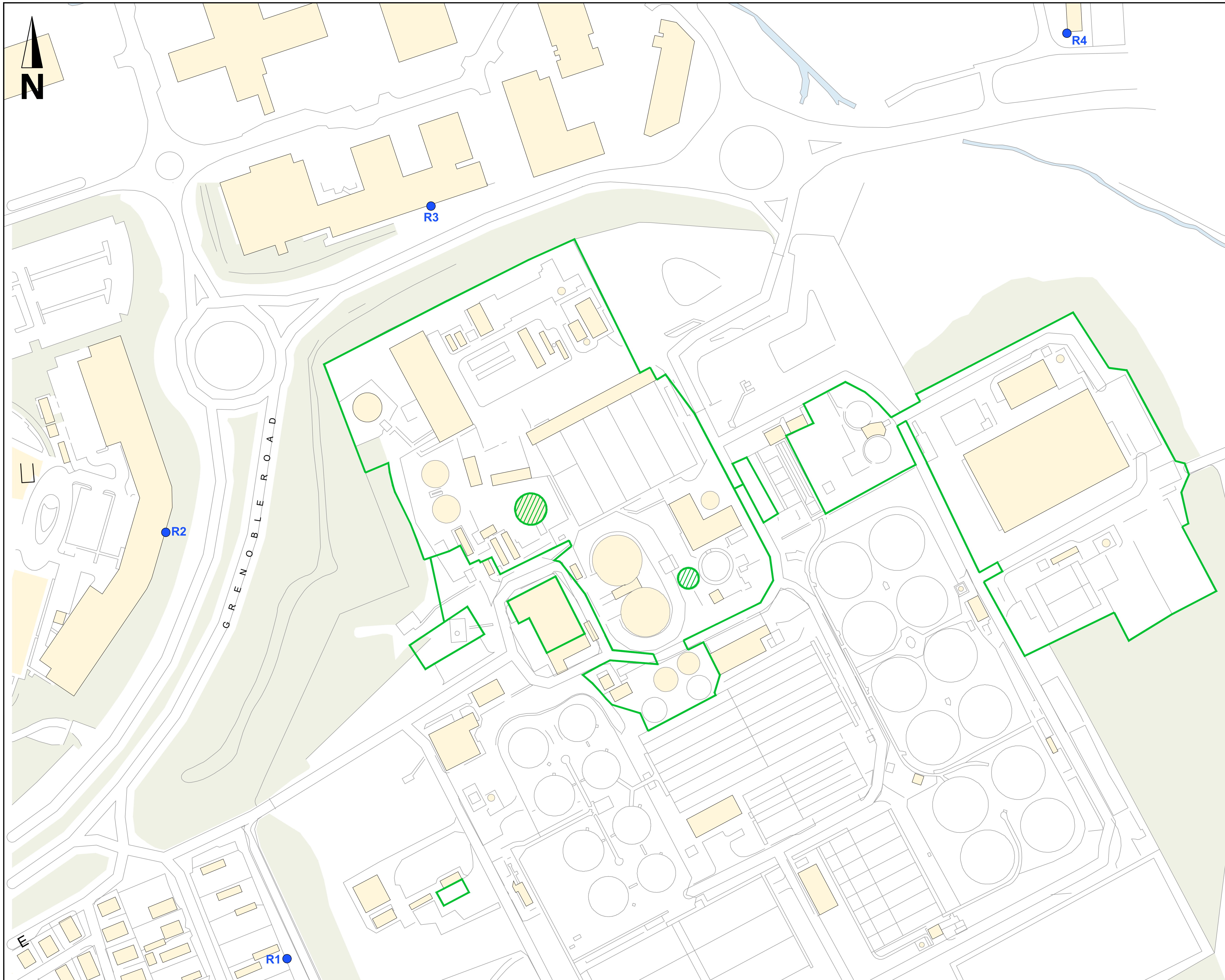
Drawing status
PERMITTING

Scale	1:1500	DO NOT SCALE
Jacobs No.	B22849AZ	Rev P03
Client no.		

Drawing number
B22849AZ-JAC-OXF-DR-0002

Appendix C. Receptors within 250m of potential emission points

Please see drawing ‘B22849AZ-JAC-OXF-DR-0004’ - Appendix C Receptors Within 250m of Bioaerosol Emission Sources



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KEY:

- Installation Boundary
- Tanks Excluded from Permit Scope
- Receptor Point

0 20 40 60 80
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P04	JUL 2023	FOR INFORMATION	AR	TJ	JK	MM
P03	JUN 2023	FOR INFORMATION	AR	TJ	JK	MM
P02	APR 2023	FOR INFORMATION	AR	TJ	JK	MM
P01	MAY 2022	FOR INFORMATION	AR	TJ	JK	MM

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Drawing title
APPENDIX C
RECEPTORS WITHIN 250m OF BIOAEROSOL EMISSION SOURCES

Drawing status
PERMITTING

Scale	AS SHOWN	DO NOT SCALE	
Jacobs No.	B22849AZ	Rev	P04
Client no.			

Drawing number
B22849AZ-JAC-OXF-DR-0004