Beddington STC Bioaerosol Risk Assessment

Document no: TW_STC_EPR_19_BDN_APPF
Revision no: 4.0

Thames Water Utilities Ltd
EPR/YP3430LL/V006

IED STC Permitting
12 October 2023

Beddington STC Bioaerosol Risk Assessment

Client name:	Thames Water Utilities Ltd		
Project name:	IED STC Permitting		
Client reference:	EPR/YP3430LL/V006	**Project no:**	B22849AM
Document no:	TW_STC_EPR_19_BDN_APPF	**Project manager:**	Harindra HG Gunasinghe
Revision no:	4.0	**Prepared by:**	Mark MA McAree
Date:	12 October 2023	**File name:**	TW_STC_EPR_19_BDN_APPF.docx

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0.1	July 2022	BRA	SK	MM	MM	HG
2.0	July 2023	Updated with sampling details for resubmission	JH	JK	MM	HG
3.0	August 2023	Updated further for resubmission	JK	MM	MM	HG
4.0	October 2023	Minor change to Sections 2.3 and 3.1	JK	MM	MM	HG

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments

Jacobs U.K. Limited

7th Floor, 2 Colmore Square
38 Colmore Circus, Queensway
Birmingham, B4 6BN
United Kingdom

T +44 (0)121 237 4000
www.jacobs.com

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 Beddington Sludge Treatment Centre (STC), EPR/YP3430LL/V006.

1.1 Site description

The Beddington STC is located at Beddington Sewage Treatment Works (STW), approximately 1.1 km North north-west of the suburban settlement of Beddington, in the London Borough of Sutton, between the towns of Carshalton (to the west) and Croydon (to the east).

Immediately to the east of the site is the B272 road and then a large industrial/commercial estate. To the south are former sludge lagoons associated with the STW and residential properties. To the south-west and west are open green spaces of Beddington Park and Beddington Farmlands (a landfill site) and to the north is the Beddington Energy from Waste facility. The nearest residential receptors are approximately 130m to the east of the STC on the boundary of the wider STW.

A surface water body which is a small stream, Oily Brook, can be found approximately 20m to the west of the installation and flows into the River Wandle, which is approximately 420m south of the installation. Most of the STW and STC is within a Flood Zone 1, indicating that there is a low probability of river flooding (less than1:1,000 annual probability of flooding). However, assets within the STC including the sludge dewatering area and parts of the cake barn area are within a Flood Zone 2 indicating an increased risk of flooding, with between a 1:100 and 1:1,000 annual probability of river flooding.

There are five statutory designated habitat sites within the relevant distances of the site. The closest site is Wilderness Island Local Nature Reserve (LNR) which can be found approximately 1,300 m south-west of the site. Three further LNRs, The Spinney, Carshalton, Spencer Road Wetlands and Wandle Valley Wetland are found within 2 km of the site. A SAC, Wimbledon Common, is 7.8 km Northwest of the site. There are no Ramsar sites, SPAs or MPAs within 10 km of the site and no SSSIs or Ancient Woodland within 2 km of the site. There are 17 non-statutory designated local wildlife sites (LWS) within 2 km of the site, the closest of which is Beddington Park/Beddington Farmlands, which include the area of the installation.

Beddington STC is located is within an Air Quality Management Area (AQMA). The London Borough of Sutton has declared the Sutton AQMA for the whole of the Borough for both nitrogen dioxide NO_2 – 1-hour mean and Annual Mean, and for Particulate Matter PM_{10} – Annual and 24-Hour Mean.

The site is not within a Source Protection Zone (SPZ).

The address of the installation is:

Beddington Sludge Treatment Centre;

Beddington Sewage Treatment Works,

Beddington Lane,

Croydon,

Surrey,

CR0 4TH.

1.2 Site Activities

Beddington STC, is located at the Beddington STW, 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. It also includes the importation of specified wastes to the works inlet for treatment through the Urban Waste Water Treatment directive (UWWTD) regulated works.

There are a number of directly associated activities, including the operation of a biogas fuelled CHP engines and boilers (although the existing boilers are inoperable (aged assets)) for the generation of electricity and heat at the site.

The site includes the following Directly Associated Activities (DAA):

- Imports of waste, including sludge from other sewage treatment works;
- Blending of indigenous sludges and imported wastes/waste sludge prior to treatment.
- Storage of digestate prior to dewatering.
- Dewatering of digested sewage sludge.
- Transfer of dewatering liquors back to the head of the sewage treatment works.
- Transfer of surface water runoff via site drainage 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 biogas CHP engines.
- Combustion of biogas or diesel in boilers (not in use).
- Operation of emergency flares.
- Operation of siloxane filter plant.
- Storage of diesel.
- Storage of wastes, including waste oils.
- Storage of raw materials.

There is a waste management activity for the import of municipal liquids or sludges similar in composition to UWWTD derived materials to the works inlet for treatment via the UWWTD aerobic treatment route.

The STC can treat up to 1,780,000m^3 of sludge per year (equating to approximately 1,780,000 tonnes). The STC has a total treatment input of >950m^3 per day (equating to approximately >950 tonnes per day).

Some of this 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 is one Odour Control Unit (OCU) linked to specific tanks or processes which produce potentially odorous air. These units treat the air through a variety of means, including use of biofilters.

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 with excess biogas being subject to flaring. The biogas handling system is equipped with pressure relief valves (PRVs) which activate as a safety precaution when there is excess biogas over what the CHP engines and flares 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).

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

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

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

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 Beddington 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 facility; 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 the Beddington STC, which meets the M17 guidance, only the storage and handling (movement within the semi enclosed Cake Barns 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 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

[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

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

2. Bioaerosol 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 Beddington 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 is received through an enclosed connection via a data logger and into a chamber where it mixes with waste from the sewer before being pumped to the inlet, where it mixes with other sewer derived materials and is subject to aerobic treatment under the Urban Waste Water Treatment Directive (UWWTD) permitted process outside of the permit boundary.

Sludge from the Primary Settlement Tanks (PSTs) is drawn off and pumped to a Primary and SAS Buffer Tank via Sludge Screens. The Primary and SAS Buffer Tank is covered and connected to an OCU. Sludge is pumped in at the top of this tank and is drawn off the bottom to one of four drum thickeners for thickening. Ultrasonic levels and high-level floats in the tank are connected to the site Supervisory Control and Data Acquisition (SCADA) system, which is monitored to prevent over-filling of the tank.

Imported sludge from other works in received through an enclosed connection via a data logger to the Sludge Import Tank, which is covered and connected to an OCU. Imported sludge is pumped to the Sludge Screens to remove inorganic material and then transferred to the Primary and SAS Buffer Tank where it combines with indigenous sludge.

Digested sludge cake can also be imported to the Cake Pad from other STWs via lorries.

If a sludge spillage occurs, spill kits are available on site and staff are trained in their use. Sludge is viscous and not highly mobile, and operators would clean-up in a timely manner. Wheel wash facilities are available.

2.2.2 Waste Treatment

Indigenous and imported sludge is pumped from the Primary and SAS Buffer Tank to drum thickeners for thickening. A polymer is dosed into each belt to aid thickening of the sludge. Thickened sludge is pumped to the enclosed Thickened Sludge Buffer Tank, which is odour abated by an OCU. Duty digester feed pumps then move the sludge to one of the Primary Digester Tanks (PDTs).

There are three PDTs at Beddington STC. Sludge is fed in near the base of each digester (within the digester gallery) continuously, with each digester being fed in turn. Each PDT is fitted with level-controls that are connected to the site SCADA system to prevent overfilling. Sludge is pumped out of each tank and into the Secondary Digester Tanks. Heating is provided to the PDTs via a heat exchange system that uses low temperature hot water from the three site CHP engines for each digester. Biogas from the PDTs is captured in

roof mounted biogas storage holders. Primary Digester Tank number 1 has a dual membrane type biogas holder on the top of the tank while Primary Digester Tanks number 5 has a floating roof biogas holders on top of the tank. Primary Digester Tank number 3 is currently having a dual membrane biogas holder installed.

After treatment over approximately 18 days, digested sludge is transferred in series to Secondary Digester Tank (SDT) number 4 and then SDT number 2. Sludge is fed in near the base of SDT number 4 continuously, from a PDT during the drawdown cycle and then gravitates to SDT number 2. Each digester is fitted with level-controls that are connected to the site SCADA system to prevent overfilling. After approximately 6 days, digested sludge is pumped to the Sludge Buffer Tank for dewatering. There is a sixth digester tank present at Beddington STC which is decommissioned.

In the event of abnormal operations downstream of the PDTs, digested sludge can be transferred to one of the Overflow Tanks for temporary storage, before being removed from the STC.

Under normal conditions, sludge is pumped to the Sludge Buffer Tank and then pumped to the Digested Sludge Dewatering Plant. The Sludge Buffer Tank is not enclosed. Ultrasonic levels monitor the level of sludge within the Sludge Buffer Tank and if a high-level is reached, external pumps automatically transfer sludge into the adjacent Emergency Sludge Storage Tank (ESST), for additional sludge storage capacity. The ESST is not enclosed.

There are four belt presses used to dewater the digested sludge at Beddington STC, located adjacent to the Cake Barn. Digested sludge is pumped from the Sludge Buffer Tank to one of the belt presses via a subsurface sludge line. A polymer, coagulant is dosed to each digested sludge feed line to the belt presses. Under normal operating conditions, three of the four pumps are in operation. Dewatered digested sludge is conveyed by covered belts into the Cake Barn for temporary storage.

Biogas produced in the three PDTs and two SDTs is captured within the roof mounted biogas holders found on top of each tank.. The dual membrane biogas holders each have Pressure Relief Valves (PRVs) that operate in an emergency as a safety precaution in the event of over pressurising the system. Air blowers keep the biogas holder inflated and exhaust air is monitored by methane detectors to identify any leaks of biogas. The floating roof biogas holders also have dual PRVs that operate in an emergency. The biogas holders are protected by different safety features such as laser detectors and ultrasonic level sensors that measure the sludge depth within the tank and the digester bell height. Biogas is withdrawn from the biogas holders and combines in an above ground common biogas line for the CHP engines.

There are condensate pots and chiller units located upstream of biogas boosters that capture entrained moisture from the biogas and a siloxane removal system, which also removes impurities from the biogas prior to combustion within the CHP engines.

In the event there is excess biogas, i.e., more than the CHP engines or boilers can utilise, or in the event that the CHP engines or boilers are unavailable, there are two ground mounted emergency flares. A second (and currently a third temporary) above ground common biogas line transfers biogas to one of the two emergency flares located at the site. These operate automatically when the average level of biogas within the biogas holders reaches a high set point and automatically stops when levels fall back below a second set point. The second emergency flare can be manually activated in the event of a very high level of biogas within the biogas holders. The emergency flares are currently utilised for more than 10% of the year, exceeding 876 hours use and therefore annual monitoring is required.

2.2.3 Digested cake

There are two Cake Barns at Beddington STC. One receives digested sludge cake from the dewatering plant (Cake Barn 1), the other is used for longer term storage (Cake Barn 2). Both Cake Barns are semi-enclosed on three sides by a concrete retaining wall that is approximately 2m high, followed by fly netting to roof level. Both are roofed and made of engineered concrete. Digested sludge cake falls to the floor within Cake Barn 1 and can be moved by plant machinery to Cake Barn 2, as required. There is a one-way system in operation for the Cake Barns.

In the event of non-compliant sludge being produced, it is stored within one of the storage bays for an extended period of time and marked with a 'NC' sign to prevent it being removed from site. Digested sludge cake is subject to removal from both of the cake pads under the Sludge Use in Agriculture Regulations 1989 (SUiAR), and in accordance with the Biosolids Assurance Scheme (BAS). Although the digested sludge cake is

stored within a semi-enclosed cake barn, there are sensitive human receptors within 250 m who may be present for more than six hours.

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 the above-mentioned 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 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. Sludge cake is, therefore, produced daily and at similar levels across the whole year.

However, cake storage on site, both in relation to duration and volume, varies across time. 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, sludge 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 cake within the storage bays during the autumn and winter, under normal conditions, than during the summer period.

2.3 Potential Sources

There are fourteen 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?
A7 – A8	Boilers 2a and 2b (non-operational)	X
A9	Emergency Standby Biogas Flare	X
A10	CHP Engine No.7	X
A11	Emergency Standby Biogas Flare	X
A12	CHP Engine No.8	X
A13	CHP Engine No.9	X
A14 - 16	Primary Digester Tank PRV	X
A17 – A18	Secondary Digester Tank PRV	X
A19	OCU1	✓
A20	Siloxane Filter Stack	X

The Cake Barns (1 and 2) are also illustrated in Appendix B. These are additional potential sources for consideration of bioaerosols release to atmosphere.

2.3.1 Source Assessment

Boilers (A7-A8) are no longer operational and can be discounted as sources of bioaerosol emissions. The CHP engines (points A10, A12-A13) and emergency standby biogas flares (points A9 and A11) 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.

There is one OCU emission point to air (A19) serving the STC. Foul air is treated from the Primary and SAS Buffer Tank, the Thickening Plant, the Thickened Sludge Buffer Tank and Liquor Return Pumping Station 1. The OCU is a two-stage biofilter and scrubber system. The extracted air passes from the tanks through the support media (LavaRock), within the biofilter, while water is irrigated from above. The microbes on the support media, remove potentially odorous contaminants and the partially treated air from the bio-trickling filter is passed to Activated Carbon adsorbers to achieve a stack emission standard of <= 1000 $OuEm^3$ at the outlet. Treated air discharges via the stack. The configuration of the OCU means that any bioaerosols emitted from the biofilter stage should be captured by the activated carbon stage, and therefore, the likelihood of bioaerosols release is anticipated to be minimal, if at all.

The Pressure Relief Valves (PRVs) (points A14 – A18) are normally closed and do not emit to atmosphere. However, in the event of an abnormal situation such as the failure of the flare stacks and/or CHP engines, the PRVs would open to relieve excess biogas pressure, potentially resulting in the release of bioaerosols. While the problem is rectified, biogas generation would be limited 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 sludge cake, which is deposited from the covered conveyors onto the pad in the Cake Barn adjacent to the dewatering plant. There are two Cake Barns. Sludge cake is moved to the second Cake Barn for longer term storage. The site also receives digested sludge cake for storage from other facilities. The type of waste and its location within the Cake Barns is logged.

2.3.2 Risk

As discussed above, there are 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.

There is a risk of exposure from bioaerosols emitted from the semi enclosed Cake Barns and from fugitive releases due to handling operations as sludge cake is moved within and between the Cake Barns. The additional movement of imported sludge cake provides further potential for emissions and the potential for entrainment and resuspension of material from vehicle tyres as the cake is handled.

However, the digested sludge cake at this stage, has low bioaerosol content as a result of the treatment processes and is moist on deposition within the Cake Barn. The digested sludge cake is managed by dozer and deposited within storage areas where it forms a crust within 24 hours and requires no further treatment or disturbance prior to export onto agricultural land.

The semi enclosed walls of the Cake Barns face sensitive receptors with the openings of each Cake Barn facing towards each other. The cake storage areas are monitored for arrangement and row height beneath the walls, therefore minimising the potential for windblown emissions towards receptors.

Egress from the cake pad is via a wheel wash to reduce transfer onto internal roads. The probability of exposure from this source is **medium**.

There are no receptors within 250m of the OCU emission point. Therefore, the risk of bioaerosols emissions from the 2-stage bio-filter OCU is considered to be negligible.

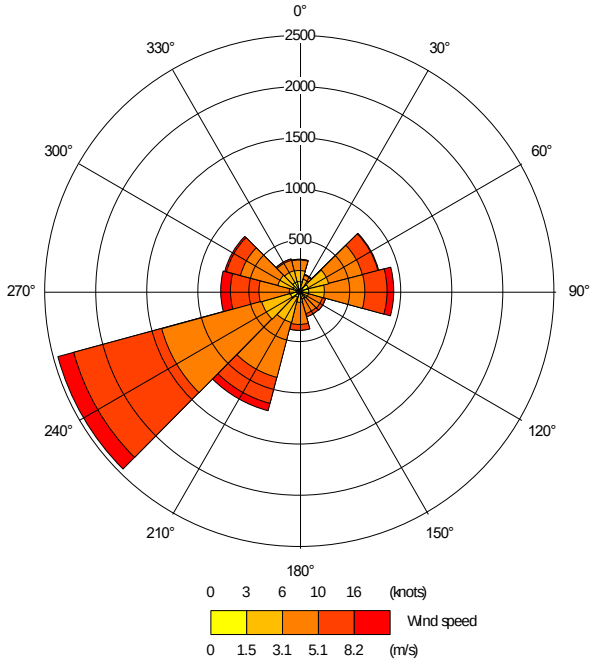
In addition, most storage tanks, treatment tanks and associated pipework are enclosed. The wet wells used to receive incoming sludge are covered. Sludge screening and dewatering takes place in enclosed units. In addition, the PRVs are only open in abnormal situations, which are temporary and unlikely.

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 wind rose for the most representative meteorological site, London City Airport (located approximately 19 km Northeast of the Site centre), is shown in figure 1.

The wind rose data shows that the site experiences strong Southwest prevailing winds, predominantly in excess of 6 knots. The Beddington STC and surrounding area has a relatively flat topography. There is mature woodland surrounding the West and Southwest boundaries of the wider STW, which offers some screening and also West of the housing adjacent to the B272 and closest in distance to the Cake Barns.

Figure 1 – London City Airport 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. Research Report (RR)786 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 quantitative data 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 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

[5] Research Report 786 - Bioaerosol emissions from waste composting and the potential for workers' exposure https://www.hse.gov.uk/research/rrhtm/rr786.htm

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.

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.

Sensitive receptors (identified for the Odour Management Plan (OMP)) and within 250m of potential bioaerosols sources, have been considered and are presented in Table 2 and shown in Appendix C. The distance and direction from each potential bioaerosols emission source to the closest sensitive receptor has been reported.

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

Receptor	Description	Source	Distance from closest source (m)	Direction from the source
R5	Commercial Buildings	Cake Barn 1	207	East
		Cake Barn 2	247	East
R6	ASDA Supermarket	Cake Barn 1	245	East
R15	Residential properties	Cake Barn 1	121	East
		Cake Barn 2	161	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[6] to help determine the magnitude of the risk associated with bioaerosol emissions from a facility.

There is one potential source of bioaerosols release within 250m of static receptors:

- Cake Barns (1 and 2).

The closest sensitive receptors represented by R15 are approximately 121m and 161m from Cake Barn 1 and Cake Barn 2, respectively. Receptors within 250m of potential bioaerosol emission sources are all located East of the source and are therefore downwind of the prevailing Southwest wind direction. The frequency of an effective pathway would be small. The dilution effect as a result of the dispersion distances noted would reduce the concentration of a release. The screening by vegetation in-front of the properties, would further minimise an effect at these properties, should the wind blow from the West. Other receptors are set further back to R15 and would experience a lower concentration in the event of a release.

The daily throughput of sludge is greater than >950m^3/day (equivalent to 950 tonnes per day). The fully digested sludge is dewatered however, the sludge cake remains damp as it passes from the covered conveyors into Cake Barn 1. The moisture content in the cake prevents it drying out and the cake forms a crust after 24 hours in storage, so does not give rise to dust readily. The sludge cake is shovelled to storage areas within the Cake Barn or moved to the adjacent Cake Barn 2 and is not disturbed, until it is removed for

[6] Risk assessments for your environmental permit - GOV.UK (www.gov.uk)

export, further minimising the potential to generate bioaerosols emissions to air. The bioaerosols content within the digested sludge cake is low as a result of the treatment processes prior to storage.

In addition to this, the storage tanks, treatment tanks and associated pipework are enclosed. Where tanks are not gas tight and vent to atmosphere, these are connected to a two-stage biofilter and activated scrubber type of OCU. This source is not within 250m of sensitive receptor and would therefore pose a negligible risk, the likelihood of bioaerosol release from this asset is anticipated to be very low.

The probability of exposure from bioaerosols generated from the permitted processes on site is considered to be **Medium.** 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**.

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 3: Risk Assessment of Potential Bioaerosols 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	What is the harm that can be caused? Consequence	Control Measures Managing the Risk	Overall / Residual risk
Cake Barns	Inhalation via wind-borne transportation	R5, R6, R15	Receptor R15 represents the closest receptors to Cake Barns 1 and 2. At approximately 121m and 161m respectively. Other receptors are set further back and would receive lower concentrations in the event of a release. The closest receptors are upwind of the prevailing wind direction. The proportion of winds blowing from the West is small, relative to the prevailing direction. The Cake Barns are semi enclosed, which could result in fugitive releases during handling or export. Bioaerosol content is considered to be small and colony forming units anticipated to be within acceptable levels. Probability of exposure is considered to be **medium**.	Impact on human health (considered to be a sensitive receptor).	The cake conveyors are covered and contained within the Cake Barn, reducing likelihood of bioaerosol release. The cake conveyor drop heights are minimised to reduce wind borne transportation during deposition. Drop heights from dozers during, handling and movement off site are also kept low. The sludge cake is moist on deposition into the Cake Barns which reduces susceptibility of wind-borne releases. Sludge cake is moved when required to minimise disturbance on the pad. The Cake Barns are semi enclosed and Barn openings are positioned facing towards each other, rather than facing receptors. Cake levels are managed so that under normal operating conditions there is sufficient free-board between the top of the cake and top of the concrete walls, reducing the risk of wind-blown fugitive emissions.	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	What is the harm that can be caused? Consequence	Control Measures Managing the Risk	Overall / Residual risk
					Spillages are cleaned up in a timely manner to reduce generating windblown bioaerosols. Wheel wash facilities are provided at the Cake Barn Egress point and a one-way system on vehicle movements reduces the risk of material entrainment and resuspension during sludge handling and movement around the site.	

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 stacks and/or CHP engines. Such an event would result in releases of biogas from the PRV's located on the roof mounted biogas storage holders of the digesters, which would release bioaerosols. This occurs to prevent over pressurisation 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/ community spaces from bioaerosols arising from operations at the Beddington 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, magnitude, and duration of exposure. This considered control measures in place to reduce the probability or magnitude of release.

One potential source of bioaerosols within the site processes was identified, connected to the storage and movement of treated digestate sludge cake at the site. The risk from the two-stage biofilter OCU was considered to be negligible as it was greater than 250m from sensitive receptors and abnormal releases from pressure relief valves was also scoped out.

Although only qualitative data is available at this stage, the overall bioaerosol risk to the identified, receptors within 250m of potential bioaerosol sources associated with the sludge treatment process is considered to be **Low** 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, (approx. NGR of centre of cake barns) which are diffuse sources and hence will be monitored purely by agar plates and will sample each OCU on a bi-annual basis.

- Cake Barn 1 TQ 29890 65930
- Cake Barn 2 TQ 29931 65919

Downwind samples will tend to be towards the east of the site, as the prevailing wind is from the South West, so receptor R6 is least 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 cake barn to give a background concentration, and three will be located in a fan like arrangement downwind and at the same distance to the nearest sensitive receptor (as per M9):

Source	Upwind Location NGR	Downwind Location 1 NGR	Downwind Location 2 NGR	Downwind Location 3 NGR
Cake Barn 1	TQ 2984 6590	TQ 2994 6602*	TQ 2997 6598**	TQ 3001 6593
Cake Barn 2	TQ 2988 6589	TQ 3000 6605***	TQ 3006 6600	TQ 3009 6592

*Cake Barn 1 d/w 1 NGR only 115m from source as building structure prevents sampling at 121m
** Cake barn 1 d/w 2 NGR only 95m from source as building structure prevents sampling at 121m.
***Cake barn 2 d/w 1 NGR only 155m from source as building structure prevents sampling at 161m

NGR's for sampling locations are only 8 digits at present, to allow the contractor flexibility as to precise location, taking into account the ability to safely locate and access (and security) of the sampling plates.

Appendix A. Site Location Plan

KEY:

Site Location

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

Jacobs

1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 46 7000
www.jacobs.com

Client

Thames Water

Project

STC IED PERMIT
BEDDINGTON STW

Drawing title

APPENDIX A
SITE LOCATION PLAN

Drawing status

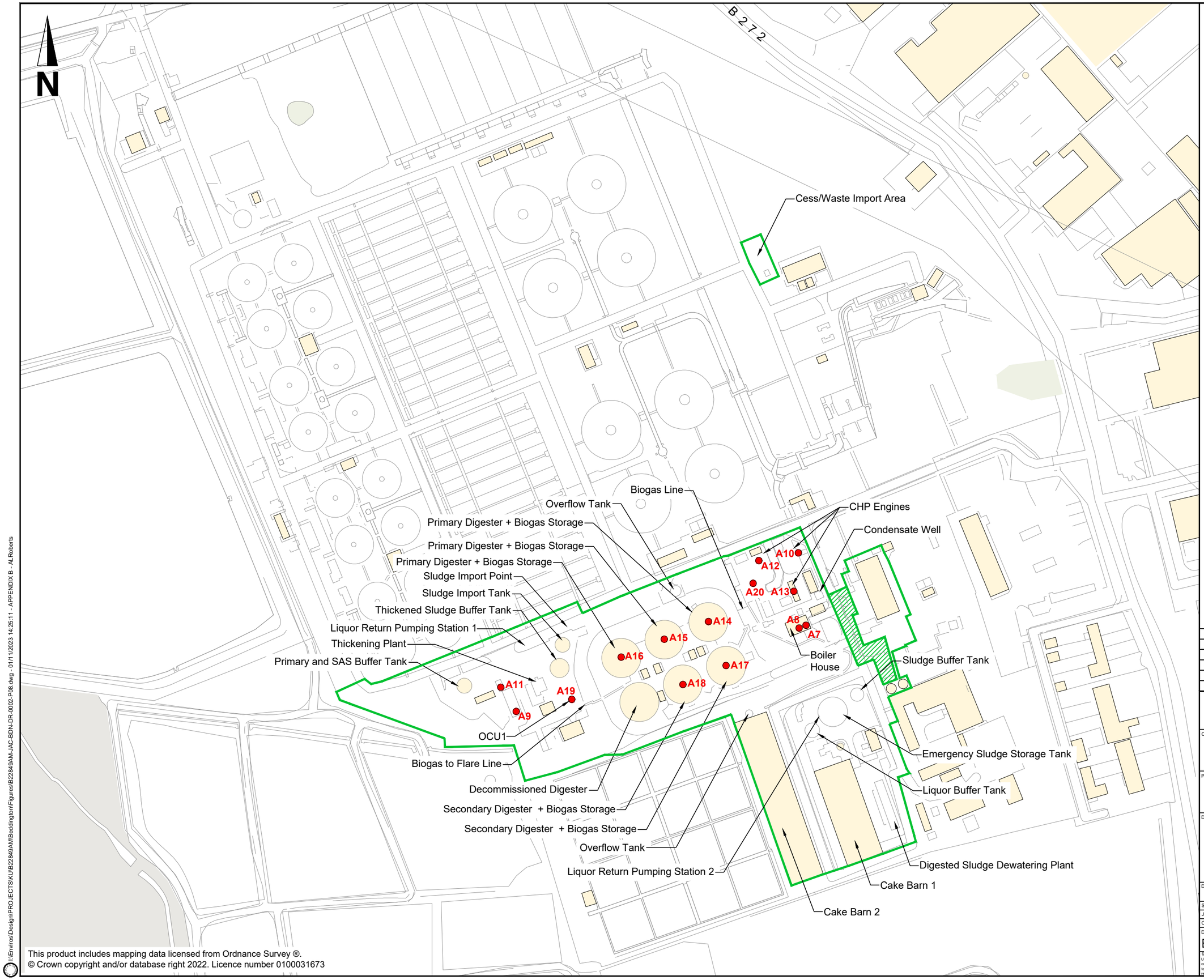
PERMITTING

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

Drawing number

B22849AM-JAC-BDN-DR-0001

Appendix B. Installation Boundary and Air Emission Points



KEY:

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

A1 to A6 - Removed Emission Points Relating to Previous Plant
A7 - Boiler 2a (non-operational)
A8 - Boiler 2b (non-operational)
A9 - Emergency Standby Biogas Flare
A10 - CHP Engine No. 7
A11 - Emergency Standby Biogas Flare
A12 - CHP Engine No. 8
A13 - CHP Engine No. 9
A14 - Primary Digester PRV
A15 - Primary Digester PRV
A16 - Primary Digester PRV
A17 - Secondary Digester PRV
A18 - Secondary Digester PRV
A19 - OCU1
A20 - Siloxane Filter Stack

0 20 40 60 80 100
METRES

P05	NOV 2023	FOR INFORMATION	AR	SK	JK	MM
P04	AUG 2023	FOR INFORMATION	AR	SK	JK	MM
P03	AUG 2023	FOR INFORMATION	AR	SK	JK	MM
P02	JUL 2023	FOR INFORMATION	AR	SK	JK	MM
P01	JUL 2022	FOR INFORMATION	AR	SK	JK	MM
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Jacobs
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel: +44(0)118 46 7000
www.jacobs.com

Client: Thames Water

Project: STC IED PERMIT
BEDDINGTON STW

Drawing title: APPENDIX B
INSTALLATION BOUNDARY
AND AIR EMISSION POINTS

Drawing status: PERMITTING

Scale	1:2000	DO NOT SCALE
Jacobs No.	B22849AM	Rev P05
Client no.		

Drawing number: B22849AM-JAC-BDN-DR-0002

Appendix C. Receptors within 250m of Potential Bioaerosol Emission Sources

N

Cake Barn 1

Cake Barn 2

R15

R5

R6

BATH HOUSE ROAD

KEY:

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

0 20 40 60 80 100

METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P05	NOV 2023	FOR INFORMATION	AR	JK	JK	MM
P04	NOV 2023	FOR INFORMATION	AR	JK	JK	MM
P03	AUG 2023	FOR INFORMATION	AR	SK	JK	MM
P02	MAR 2023	FOR INFORMATION	AR	SK	JK	MM
P01	JUL 2022	FOR INFORMATION	AR	SK	JK	MM

Jacobs
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 46 7000
www.jacobs.com

Client: Thames Water

Project: STC IED PERMIT
BEDDINGTON STW

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

Drawing status: PERMITTING

Scale	1:2000	DO NOT SCALE
Jacobs No.	B22849AM	Rev P05
Client no.		

Drawing number: B22849AM-JAC-BDN-DR-0004