Long Reach STC Bioaerosol Risk Assessment

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Thames Water Utilities Ltd
EPR/MP3838UP

IED STC Permitting
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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 Long Reach Sludge Treatment Centre (STC), EPR/MP3838UP.

This is a multi-operator installation with Finning (UK) Ltd, who operate some of the combustion plant at the facility.

1.1 Site description

The Long Reach site is located immediately South of the River Thames, near the town of Dartford, Kent. The site is in a relatively rural location for the East of London, approximately 2.5 km North of Dartford, with a large housing estate approximately 50 m to the South of the site entrance. To the East is the former Littlebrook Power Station, which is currently being demolished with warehouses beyond. To the West of the site are the Dartford Marshes and the River Darent.

The site location plan is shown in Appendix A and the address of the installation is:

Long Reach STW;

Marsh Street,

Kent,

Dartford,

DA1 5PP.

The whole of the STW and STC is within a Flood Zone 3 in an area that benefits from flood defences. This indicates that the land within this zone would have a high probability of flooding without the local flood defences. These protect the area against a river flood with a 1:100 annual probability of flooding as a result, or a flood from the sea with a 1:200 annual probability.

The site sits outside a Source Protection Zone (SPZ) and sits outside of an Air Quality Management Area (AQMA), although the closest one is 1.3 km away.

There are a number designated habitat sites within the relevant distances of the site. The nearest site is the Purfleet Chalk Pits Site of Special Scientific Interest (SSSI) are approximately 1.5 km to the North-East of the site. The Inner Thames Marshes SSSI are approximately 1.5 km to the North-West of the site and the West Thurrock Lagoon and Marshes SSSI are approximately 1.7 km to the East of the site. There is one MCZ (Swanscombe MCZ) located approximately 3 km to the East of the site. There is one area of Ancient Woodland within 2 km of the site, Watts Wood Ancient and Semi-Natural Woodland habitat, located approximately 1.9 km to the north-east of the site. There are also eight Local Wildlife Sites (LWS) within the relevant distance of the site, the nearest of which is adjacent to the western perimeter of the wider STW.

1.2 Site Activities

Long Reach Sludge Treatment Centre (STC), is located at the Long Reach Sewage Treatment Works (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. It also includes the importation of specified wastes to the works inlet for treatment through the Urban Waste Water Treatment directive (UWWTD) regulated works.

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

- Imports of waste, including sludge 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.
- Storage of digestate prior to de-watering.
- Pre-treatment of sewage sludge by Thermal Hydrolysis Plant (THP).

- Dewatering of digested sewage sludge.
- Transfer of treated dewatering liquors back to works inlet.
- Transfer of surface water runoff back to the works inlet.
- Storage of dewatered digested sludge cake prior to offsite recovery.
- Storage of biogas.
- Transfer of biogas condensate via site drainage back to the works inlet
- Pressurisation of biogas in existing boosters.
- Removal of siloxanes.
- Combustion of biogas
- Operation of emergency flares.
- Storage of raw materials;
- Storage of diesel; and
- Storage of waste

The facility can treat up to 2,500,000m^3 of sludge per year (equating to approximately 2,500,000 wet tonnes). The Sludge Treatment Centre has a total maximum treatment input of 1,781m^3 per day (equating to approximately 1,781wet 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 are a number of odour control units 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. CHP engines at the site are operated by a different operator under a multi-operator installation Environmental Permit. 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 and 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)(ii).

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 Long Reach Sludge Treatment 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.

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

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 Long Reach Sludge Treatment Centre 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 (section 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 bioaerosol release at the Long Reach STC, only the storage of sludge cake and export i.e. the handling and storage of waste (under certain conditions) and wind scouring of waste surfaces would apply. Sewage waste to site is received via pipes and is contained and shredding of waste or turning of stockpiles is not undertaken.

1.4.2 Relevant Thresholds

Based on the Environment Agency M17 guidance[3] '*M17 Monitoring of particulate matter in ambient air around waste facilities*', and RPS 209[4] guideline levels for the two key identified potential bioaerosols have been set for acceptable levels at sensitive receptors, above background concentrations, as the following:

- 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 April 2014 M17 monitoring of particulate matter in ambient air around waste facilities https://www.gov.uk/government/publications/m17-monitoring-of-particulate-matter-in-ambient-air-around-waste-facilities

[4] Environment Agency. Guidance: Bioaerosol monitoring at regulated facilities - use of M9: RPS 209

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 Long Reach 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; and
- Local wind direction data.

Due to the nature of their operations, the Finning (UK) Ltd permit at the facility does include any source within its boundary, and as such is not considered further in this assessment.

2.2 Processing equipment and techniques

2.2.1 Waste Reception

The STC comprises two waste import off-loading points for permitted, imported wastes. One of the import points can be found close to the works inlet of the sewage treatment works for wastes that consists of liquids and associated sludges from domestic and municipal sources, that are similar in composition to those materials derived from the sewer network and managed via the UWWTD route. These wastes are imported by road, including small vehicles up to and including articulated tanker vehicles.

Imported wastes to the inlet are handled via the UWWTD treatment route and is mixed with the main incoming sewer derived material before being subject to the **aerobic** water treatment processes on site.

The second waste import offloading point is for permitted imports of sludges into the **anaerobic** process, to be mixed with indigenous sludges. Sludge is imported to the anaerobic digester plant from other waste-water treatment works, via a data logger into the Sludge Import Tank. The Sludge Import Tank is steel on a concrete base, enclosed and odour abated, with malodourous air extracted to an Odour Control Unit (OCU) that is shared with the Picket Fence Thickeners (PFTs). Sludge is screened, to remove rag and grit, which is discharged into skips for offsite disposal. Imported sludge is pumped from the Sludge Import Tank to the High Energy Blending Tank (HEBT) where it is mixed with indigenous sludge and Surplus Activated Sludge (SAS), prior to the Thermal Hydrolysis Plant (THP) process.

Sludge from the aerobic treatment processes is pumped from the primary settlement tanks via a subsurface pipe into one of the four PFTs on site. These PFTs are all covered steel tanks on concrete bases and are odour abated. Once thickened, the sludge is pumped above ground from the PFT to the HEBT for processing via the THP or directly to the Digester Feed Tanks, via a THP bypass.

SAS from elsewhere in the process is pumped to the SAS Buffer Tank, (out of scope) before it is pumped to and thickened within the SAS thickening building, which contains SAS Thickeners. Operations prior to the SAS Thickeners is outside of the scope of the Environmental Permit. The thickened SAS is pumped above ground to the HEBT to be mixed with primary thickened indigenous sludges and imported sludge. Liquors are returned via the site drainage to the works for additional treatment via the aerobic process.

2.2.2 Waste Treatment

Prior to digestion, a proportion of the sludge is treated within the THP. The THP plant is bunded, with drainage returning via the site drainage for additional treatment. The THP uses heat and pressure to make the sludge more readily available for digestion and increases the efficacy of the digestion process, generating more biogas as a result.

Thickened sludges combine within the HEBT and are blended in order to achieve a homogenous blend of SAS and mixed primary sludges for the centrifuges and other downstream processes. Blended sludge in the HEBT weirs equally into a Pre-THP Storage Tank at the beginning of the THP Process.

The Pre-THP Storage Tank is of steel construction, covered and connected to an OCU. The sludge is transferred to the THP Screened Sludge Holding Tank. Each THP Screened Sludge Holding Tank is of steel construction, covered and pumps sludge to three THP centrifuges, which dewaters the sludge prior to the THP.

The centrate from all centrifuges drains to the Liquor Buffer Tank and is returned to the works inlet for further treatment via the Return Liquor Pumping Station. Dewatered sludges fall into hoppers and is pumped to the top of the THP Feed Silo. The THP Feed silo acts as buffer capacity for the THP and is of steel construction. Screw augers move the sludge into the inlets of the THP feed pumps, which pumps sludge to the THP Pulper Tank.

There is one THP stream which operates a 24-7, batch process in parallel across the three reactor tanks. THP combines medium-pressure boiling of sludge and is followed by a rapid decompression which also sterilises the sludge, destroying pathogens in the sludge so it exceeds the requirements for subsequent use in agriculture.

In the THP Pulper Tank, fresh dewatered sludge is preheated via recovered steam from the Reactors and Flash Tank. Once filled with sludge, the reactor is filled with steam from the THP boiler, until the required pressure and temperature is reached in order to hydrolyse the sludge. The THP Flash Tank provides a thermal buffer to release excess energy from the sludge which is cooled by inline mixing with sludges from the digester feed tanks, prior to it entering downstream processes. Alternatively, sludge can be bypassed directly for digestion from the PFTs to the Digester Feed Tanks.

As the warm, foul air from the THP is malodourous and saturated with water, a foul gas system is used to reduce temperature and moisture content prior to further treatment of this gas through the digestion process.

There are eight Primary Digestion Tanks adjacent to the THP, all with insulated steel tanks on a concrete base, each tank has a fixed concrete roof, with the exception of tank no. 3 which has a metal roof. These tanks are filled on a batch basis and empty by gravity, with digested sludge continuously transferring out into Sequential Primary Digestion Tank. All tanks are fitted with pressure relief valves on the fixed roof and teardrop alarms measuring levels within the tank. Alarms linked to these will inhibit further pumping from the digester feed tanks. After 14 days, sludge gravitates via above ground pipes to the Sequential Primary Digestion Tanks.

Sludge gravitates into the Sequential Primary Digestion Tank on site via an above ground pipe, which then gravitates into the Main Dewatering Press Buffer Tank. The Sequential Primary Digestion Tank is an above ground concrete tank with a fixed roof. The Main Dewatering Press Buffer Tank is of steel construction, sitting on top of an existing concrete tank that extends partially subsurface, and with a fixed roof.

The site has three biogas CHP engines and the HRB which supplies steam to the THP process, that are located within a separate energy compound and operate under a separate multi-operator permit. The CHP engines and HRB receive biogas from the site operations for combustion, which generates electricity and recoverable heat, both of which are used on site.

Anaerobic digestion of sludge takes place within a closed system, so the risk of bioaerosols from this source is low.

Biogas from the Primary Digestion and Sequential Primary Digestion Tanks is collected into biogas storage holders and either used to fuel the Combined Heat and Power plant (CHP), heating boilers or combusted in enclosed emergency flares.

Odorous air from a number of locations is continuously extracted to an Odour Control Unit (OCU). The air is treated within the OCUs to remove odour and bioaerosols using various methods such as biofilters and activated carbon (described in Section 2.3), before it is released to the atmosphere.

Biofilters are considered to be a potential emission source for bioaerosols. Scrubbers are unable to remove 100% of bioaerosols, so in any location where there is a biofilter there is still the potential for bioaerosol emission, however it is expected to be minimal.

Carbon filters are considered to effectively remove bioaerosols and so any OCUs using carbon filters are not considered to be a source of bioaerosols. It should however be noted that where carbon filters are used in combination with biofilters, whilst any emission of bioaerosols are expected to be minimal the possibility of emission cannot be entirely ruled out.

2.2.3 Digested cake

Fully digested sludge is then pumped above ground into the Local Press Buffer Tank, which is adjacent to the sludge dewatering presses located within the cake barn. There are five Sludge Dewatering Presses which are serviced by dedicated pumps.

Digested sludge cake falls onto the floor of the Cake Barn into one of two bays, before shovel loaders move the digested sludge cake into the main barn. Digested sludge cake is subject to removal from site under the Sludge Use in Agriculture Regulations 1989 (SUiAR), and in accordance with the Biosolids Assurance Scheme (BAS). If the digested sludge cake is not suitable for application immediately, remedial actions are undertaken which includes isolation for an increased amount of time. The cake barn is an enclosed building with solid concrete floors and solid concrete internal walls. A large OCU is used to provide odour abatement to the cake barn and SAS thickening building, while the Local Press Buffer Tank is connected to one of the two OCUs which abate the THP. As the cake barn is totally enclosed and equipped with an abated air extraction system (the OCU) there is a low risk from bioaerosols from stored digested sludge cake.

2.2.4 Odour Control Units

Sewage treatment works have a number of potentially odorous sources within their boundary. During site assessment and design, some of these sources may be linked to odour control units (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 odours compounds by means of different methodologies dependent upon the nature of the odours 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. Biofilters are considered to be a potential emission source for bioaerosols, whether used in isolation or with a second methodology.

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 of the cake barn during the autumn and winter, under normal conditions, than during the summer period.

2.3 Potential Sources

There are twenty-three point-source emissions to air from the processes within the installation boundary, at the following locations as described in the main permit. The references and source descriptions match those in the permit:

Table 1: Point Source Emissions to air

Air emission reference	Source	In scope as a source?
A4	Biogas Emergency Flare	x
A5	Biogas Emergency Flare	x
A8	Boiler 1	x
A9	Boiler 2	x
A10	Boiler 3	x
A11	Boiler 4	x
A13	OCU1	✓
A14	OCU2	✓
A15	OCU3	✓
A16	OCU4	✓
A17	THP PRV	x
A18-A25	Primary Digestion Tank PRVs	x
A26	Sequential Primary Digestion Tank PRV	x
A27	Main Dewatering Press Buffer Tank PRV	x
A28	Biogas Storage Holder PRV	x
A29	Biogas Storage Holder PRV	x

The location of these emission points is shown on the site layout plan emission plan in Appendix B.

2.3.1 Source Assessment

The boilers (currently inoperable) and emergency flares (points A4 & A5, A8 – 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 are four no. odour control units (OCUs) (point A13-A16) serving the Sludge Treatment Centre (within the installation boundary;

- OCU 1 (A13): Sludge Import Tank, Picket Fence Thickeners (PFT) and Primary Sludge Distribution Chamber. Air is drawn through a biofilter and then through 2 No. activated carbon filters by 2 No. fixed speed fans. The fans operate on a duty / standby basis and treated air is vented to atmosphere via an exhaust.
- OCU 2 (A14): Local Press Buffer Tank and Local Press Filtrate Tank. Air is drawn through bio filter media made of lava rock and 2 no Carbon filters. Air is discharged via 2 extract fans after Carbon filter
- OCU 3 (A15): Thermal Hydrolysis Plant and Associated storage tanks. Air is drawn through a biofilter and then through activated carbon filters by 2 No. fixed speed fans. The fans operate on a duty / standby basis and treated air is vented to atmosphere via an exhaust stack.

- OCU 4 (A16) Cake Barn, SAS Thickeners ad Sludge Dewatering Presses. Air is drawn by three variable speed exhaustion fans through an Activated-Carbon Annular filter. The Fans operate on a duty/assist/ standby basis and treated air is vented to atmosphere via an exhaust stack.

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 Pressure Relief Values (PRVs) 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 CHP, 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.

2.3.2 Risk

The overall treatment process is considered to a 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 sludge treatment works is generally from uncovered operations such as the cake bay and cake conveyor, however treated sludge cake is managed in an enclosed cake barn with attached OCU.

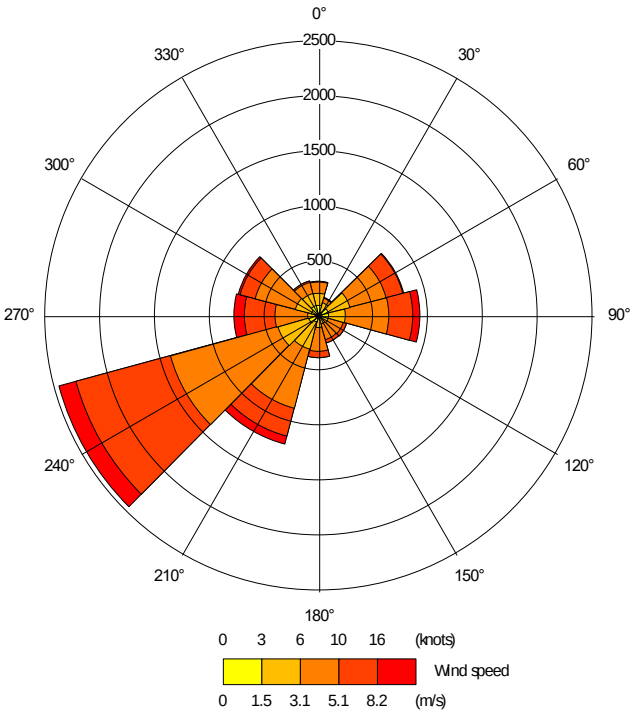
All storage tanks, treatment tanks and associated pipework are enclosed. The wet wells used to receive incoming sludge are below ground and covered with metal plates. Sludge screening and dewatering takes place in enclosed units. In addition, the PRVs are only open in abnormal situations which are temporary 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 2020 wind rose for the most representative meteorological site, London City (located approximately 22 km West of the Site), is shown in figure 1. The choice of location is based on its elevation compared to the site and proximity.

The wind rose data shows that the site may experience strong prevailing south westerly winds, predominantly in excess of 6 knots.

Figure 1 – London City Airport Wind rose (2021)



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 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 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.

There are three sensitive receptors found within 250m of potential bioaerosol emission sources at the site, as shown on the site plan found in Appendix C.

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

For each of these receptors, the distance and direction from each potential bioaerosol emission source to the closest sensitive receptor has been identified. The receptor closest to a potential emission source are the warehouses, approximately 70m South-East of the Odour Control Unit (A15).

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

Receptor	Description	Source	Distance from closest source (m)	Direction from the site
R1	Purfleet Container RM19 1RP	n/a	>250m	
R2	Warehouses / commercial/industrial land	A13 (OCU 1)	195m	South-East
		A14 (OCU 2)	105m	South-East
		A15 (OCU 3)	70m	South-East
		A16 (OCU 4)	140m	South-East
R3	The Bridge residential development Binnie Road & Marsh Street, Dartford	A13 (OCU1)	180m	South-West
		A14 (OCU 2)	n/a >250m	
		A15 (OCU 3)	n/a >250m	
		A16 (OCU 4) a	200m	West
R4	Dartford Clay Shooting Club, Dartford DA1 5PN	n/a	>250m	
R5*	CEVA Logistics, Dartford	A13 (OCU 1)	120m	South
		A14 (OCU 2)	215m	South-West
		A15 (OCU 3)	230m	South-West
		A16 (OCU 4)	100m	South-West

Note: Receptor numbers are consistent with the Odour Management Plan

*In addition to the Odour Management Plan

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

- OCU 1 (A13)
- OCU 2 (A14)
- OCU 3 (A15)

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

- OCU 4 (A16)

The receptors are mostly located South- East and South-West of the emission points and the prevailing wind direction is from the South-West, this significantly reduces the likelihood that bioaerosols can be carried on the wind to receptors.

Most storage tanks, treatment tanks and associated pipework are enclosed. Where tanks are not gas tight and vent to atmosphere, these are connected to an odour control unit. There are a number of types of odour control, given the types of Odour Control unit, the likelihood of bioaerosol release is anticipated to be minimal.

The maximum daily throughput of sludge is 1,781m^3/day.

Following digestion, the waste is pumped to Sludge Dewatering Presses to reduce its water content, although it remains relatively damp and forms a crust after 24 hours in storage, so does not give rise to dust readily. In addition, the waste is not handled whilst stored until it is removed from the site, therefore minimizing potential to generate dust due to disturbance.

Overall, the probability of bioaerosols being generated and released from the sludge treatment process and the identified potential sources is considered to be low.

The potential duration of release of bioaerosols varies from infrequent to frequent. The magnitude of release is considered to be low.

The closest residential receptors are 180m South-West from the closest source. Given that the identified potential sources are considered to represent a low risk, the prevailing wind direction is from the South-West and that screening is provided by the vegetation and trees present, it is considered that the risk of exposure to occupants of these properties from bioaerosols emitted from the site is likely to be low.

The closest receptor is the commercial land 70m South-East from the closest source. Given that the identified potential sources are considered to represent a low risk, the prevailing wind direction is from the South-West and that significant screening is provided by the 60m of vegetation and trees present it is considered that the risk of exposure to workers from bioaerosols emitted from the site is likely to be low.

Planned monitoring of bioaerosol emissions by Thames Water is expected to validate the assumption that process contributions from sewage sludge treatment works would comply with the 'acceptable level' thresholds.

The risk assessment is summarised in Table 3 below.

Table 3: Risk of Exposure to Receptors within 250m 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	Consequence (what is the harm that can be caused)	Managing the risk (Control Measures)	Overall/residual risk
OCU 1 – (A13) Sludge Import Tank and Picket Fence Thickeners	Inhalation via wind-borne transportation	R2, R3, R5	R2 has the limited potential to be exposed to bioaerosols due to location, being 195m South-East, with prevailing wind from the South-West. There is also significant protection by vegetation and trees. R3 and R5 are120m South and 180m South -West respectively, however the prevailing wind is expected to come from this direction and so they are not likely to be affected. Probability of exposure from A13 is considered to be **low**.	Impact on human health (considered to be a sensitive receptor).	Most storage tanks, treatment tanks and associated pipework are enclosed. Where tanks are not gas tight and vent to atmosphere, these are connected to an OCU. There are a number of types of odour control, given the types of OCU, the likelihood of bioaerosol release is anticipated to be minimal. Control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.	Low
OCU 2 – (A14) Local Press Buffer Tank	Inhalation via wind-borne transportation	R2, , R5	R2 has the limited potential to be exposed to bioaerosols, being 140m South-East, with prevailing wind from the South-West. There is also significant protection by vegetation and trees. R5 is 215m South-West, however the prevailing wind is expected to come mainly from this direction and so they are not likely to be affected. Probability of exposure from A14 is considered to be **low**.	Impact on human health (considered to be a sensitive receptor).	Most storage tanks, treatment tanks and associated pipework are enclosed. Where tanks are not gas tight and vent to atmosphere, these are connected to an OCU. There are a number of types of odour control, given the types of OCU, the likelihood of bioaerosol release is anticipated to be minimal. Control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.	Low
OCU 3 – (A15) Thermal Hydrolysis Plant	Inhalation via wind-borne transportation	R2, R5	R2 has the limited potential to be exposed to bioaerosols although in closest proximity, being 70m South-East, with the prevailing wind from the South-	Impact on human health (considered	Most storage tanks, treatment tanks and associated pipework are enclosed. Where tanks are not gas tight and vent to atmosphere, these are connected to an OCU.	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
and Associated storage tanks			West. There is also significant protection by vegetation and trees. R5 is 230m South-West and given this is the direction of the prevailing wind this location is unlikely to be affected. Probability of exposure from A15 is considered to be **low**.	to be a sensitive receptor).	There are a number of types of odour control, given the types of OCU, the likelihood of bioaerosol release is anticipated to be minimal. Control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.	
OCU 4 – (A16) Cake Barn, SAS Thickening, Sludge Dewatering Presses	Inhalation via wind-borne transportation	R2, R3, R5	R2 has the limited potential to be exposed to bioaerosols, being 140m South-East, with prevailing wind from the South-West. There is also significant protection by vegetation and trees. R3 has limited potential being 200m in a westerly direction, due to the distance although the prevailing wind from the South-West. R5 is 100m South-West and given this is the direction of the prevailing wind this location is unlikely to be affected. Probability of exposure from A16 is considered to be **low**.	Impact on human health (considered to be a sensitive receptor).	Most storage tanks, treatment tanks and associated pipework are enclosed. Where tanks are not gas tight and vent to atmosphere, these are connected to an OCU. There are a number of types of odour control, given the types of OCU, the likelihood of bioaerosol release is anticipated to be minimal. Control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.	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. 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 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 Long Reach Sludge Treatment Centre. 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, including four OCUs, which are within 250m of a static receptor. However, given the distance from the emission points, the prevailing wind direction and the control measures in place to contain bioaerosols and prevent their release the overall (residual risk) to receptors is considered to be low.

Planned monitoring of bioaerosol emissions by Thames Water is expected to validate the assumption that process contributions from sewage sludge treatment works would comply with the 'acceptable level' thresholds.

3.1 Sampling

Thames Water confirms it will use MCERTS accredited providers for the sampling from location A13 –OCU1 (NGR: TQ 55262 76379), A14 – OCU2 (NGR: TQ 55371 76440) A15 – OCU3 (NGR: TQ 55399 76434) and location A16 – OCU4 (NGR: TQ 55303 76340) and will sample each OCU on a bi-annual basis.

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 upwind of the OCU stack to give a background concentration, and three will be located in a fan like arrangement downwind:

Upwind sample location (approx.) which is 50m SW of OCU 1: TQ 5521 7635
Downwind sample location which is 70m NNE of OCU 1: TQ 5529 7644
Downwind sample location 2 which is 70m NE of OCU 1: TQ 5532 7641*
Downwind sample location 3 which is 70m E of OCU 1: TQ 5533 7638

Upwind sample location (approx.) which is 50m SW of OCU 2: TQ 5532 7641*
Downwind sample location which is 70m NNE of OCU 2: TQ 5540 7650
Downwind sample location 2 which is 70m NE of OCU 2: TQ 5543 7647
Downwind sample location 3 which is 70m E of OCU 2: TQ 5544 7644

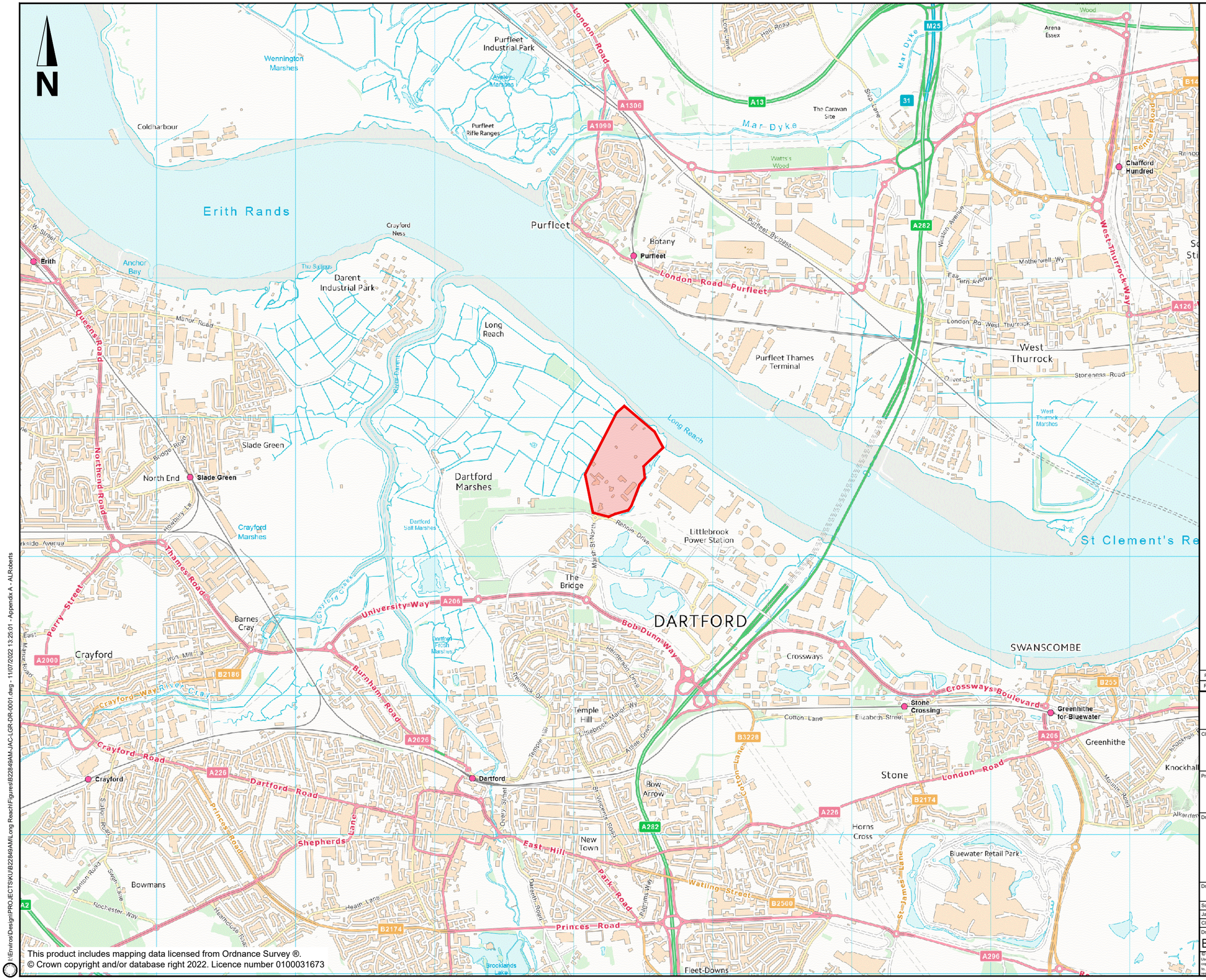
Upwind sample location (approx.) which is 50m SW of OCU 3: TQ 5535 7640
Downwind sample location which is 70m NNE of OCU 3: TQ 5543 7649
Downwind sample location 2 which is 70m NE of OCU 3: TQ 5545 7647
Downwind sample location 3 which is 70m E of OCU 3: TQ 5546 7643

Upwind sample location (approx.) which is 50m SW of OCU 4: TQ 5526 7631
Downwind sample location which is 70m NNE of OCU 4: TQ 5533 7640
Downwind sample location 2 which is 70m NE of OCU 4: TQ 5536 7637
Downwind sample location 3 which is 70m E of OCU 4: TQ 5537 7634

Where 70 m is the distance to the nearest receptor. 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.

*it is possible that two sampling points could be shared.

Appendix A. Site Location Plan



KEY:

Site Location

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

Jacobs
1180 Eskdale Road, Winnersh, Reading, RG41 5TU
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www.jacobs.com

Client: Thames Water

Project: STC IED PERMIT
LONG REACH STW

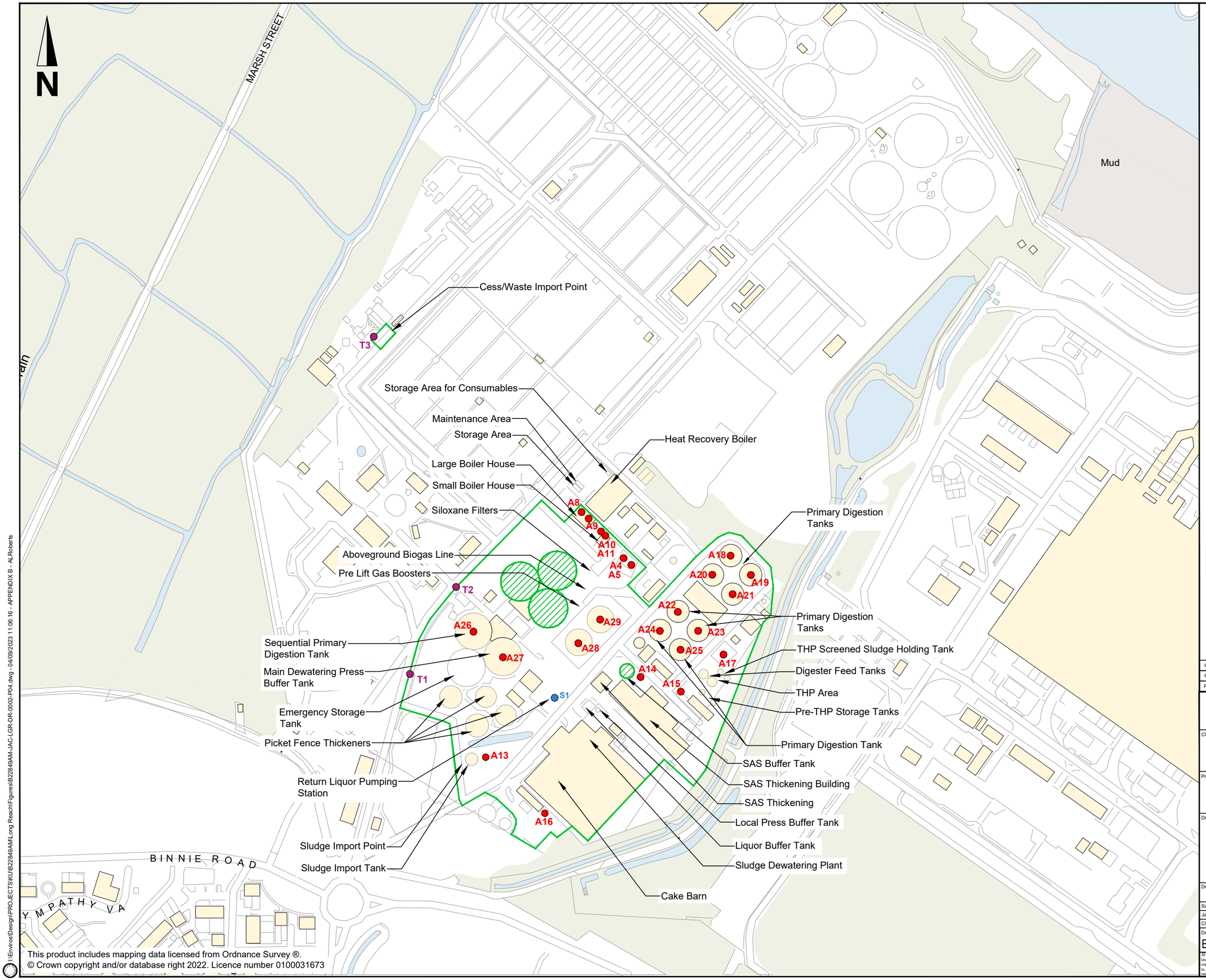
Drawing title: APPENDIX A
SITE LOCATION PLAN

Drawing status: PERMITTING

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

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

Appendix B. Potential Bioaerosol Emission Points



KEY:

Installation Boundary

Air Emission Point

A4 - Biogas Flare
A5 - Biogas Flare
A8 - Boiler 1
A9 - Boiler 2
A10 - Boiler 3
A11 - Boiler 4
A12 - Heat Recovery Boiler - Operated by Finning (UK) Limited
A13 - OCU1
A14 - OCU2
A15 - OCU3
A16 - OCU4
A17 - THP PRV
A18-A23 - Primary Digester PRVs
A24-A26 - Secondary Digester PRVs
A27 - Main Dewatering Press Buffer Tank PRV
A28 - Biogas Holder PRV
A29 - Biogas Holder PRV

0 20 40 60 80 100
METRES

P02	SEP 2023	FOR INFORMATION	AR	HEK	JK	MM
P01	JUN 2022	FOR INFORMATION	AR	HEK	JK	MM
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

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Client: Thames Water

Project: STC IED PERMIT
LONG REACH STW

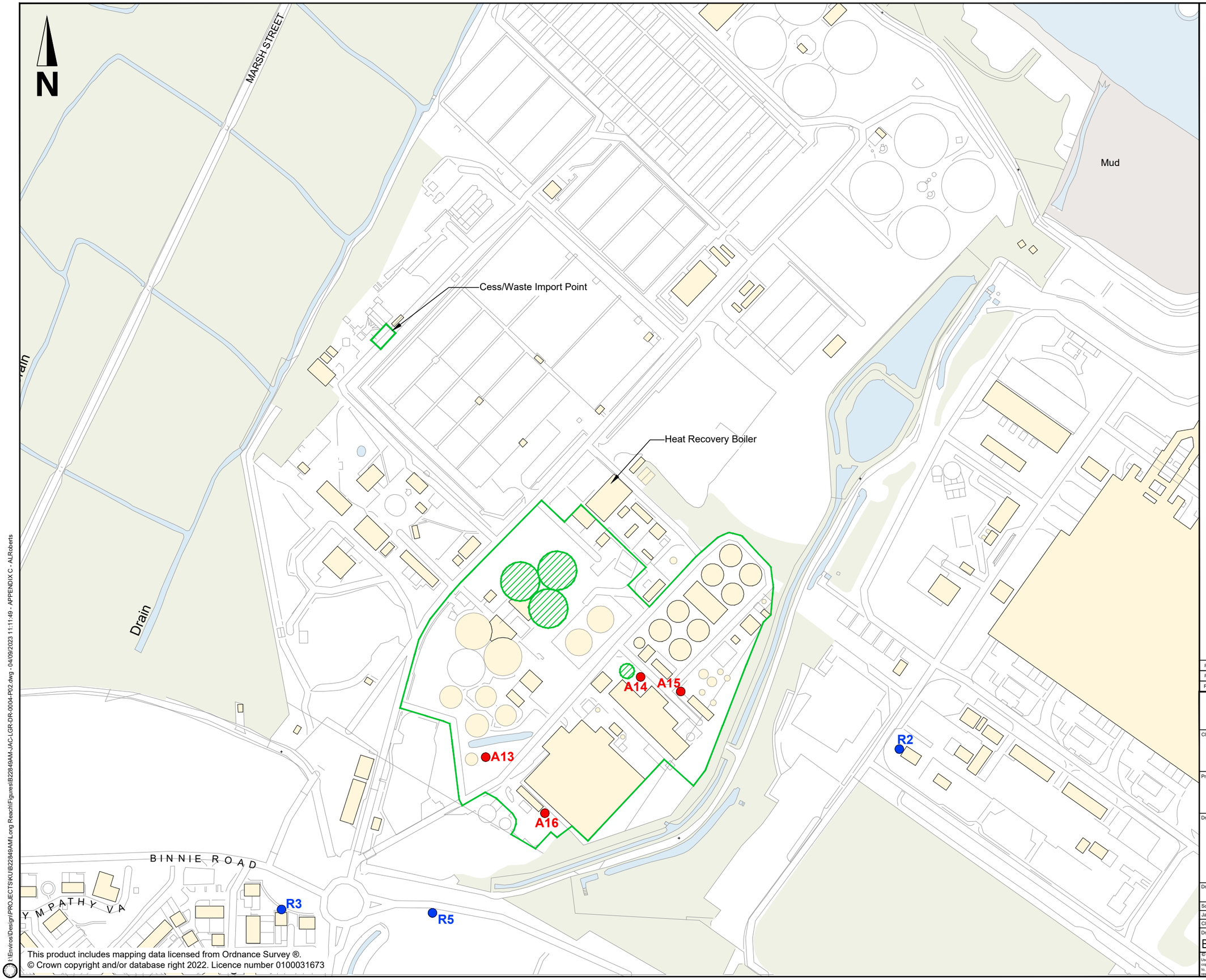
Drawing title: APPENDIX B
POTENTIAL BIOAEROSOL EMISSION SOURCES

Drawing status: PERMITTING

Scale	1:2500	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	P02
Client no.			

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

Appendix C. Receptors within 250m of potential emission points



KEY:

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

A13 - OCU1
A14 - OCU2
A15 - OCU3
A16 - OCU4

0 20 40 60 80 100
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P02	AUG 2023	FOR INFORMATION	AR	HEK	JK	MM
P01	JUN 2022	FOR INFORMATION	AR	HEK	JK	MM

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Client: Thames Water

Project: STC IED PERMIT
LONG REACH STW

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

Drawing status: PERMITTING

Scale	1:2500	DO NOT SCALE
Jacobs No.	B22849AM	Rev P02
Client no.		

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