

Report for:



**Grundon Waste Management Ltd
and CEMEX UK Properties Ltd**

Residential Development at Land at
Merton Street, Banbury

Odour Assessment

Status: Final

Date: 18.02.2020

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Date	18.02.2020
Version Number	A3810/O/001
Status	Final

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Contents

1.	Introduction.....	5
2.	Planning Policy.....	7
3.	Odour Background, Policy, Legislation and Guidance.....	9
3.1.	Odour Legislation and Guidance Used in this Assessment.....	9
3.2.	Odour Background.....	9
3.3.	Odour Standards and Benchmarks.....	13
4.	Assessment Methodology.....	16
4.1.	Sniff Testing Methodology.....	16
4.2.	Dispersion Modelling Methodology.....	17
4.3.	Model Uncertainty and Limitations.....	17
4.4.	Odour Benchmarks.....	17
4.5.	IAQM – Significance Criteria.....	18
5.	Quantification of odour emissions.....	19
5.1.	STW Process Overview.....	19
5.2.	Odour Emission Rates.....	20
5.3.	Dispersion Model Input Data.....	20
6.	Dispersion Model Input Data.....	22
6.1.	Modelling Scenarios.....	22
6.2.	Assumptions.....	22
6.3.	Meteorological Data.....	22
6.4.	Building Effects.....	23
6.5.	Receptor Locations.....	23
7.	Results.....	24
7.1.	Qualitative Assessment.....	24
7.2.	Qualitative Assessment.....	24
8.	Conclusions.....	26
	Appendices.....	27
	Appendix 1: Meteorological Data – 2014 to 2018 Wind Roses.....	28
	Appendix 2: 2014 98%ile 1-hour Odour Contours.....	31
	Appendix 3.1: Indicative Development Proposals and Dispersion Modelling Receptor Locations.....	32
	Appendix 3.2: Sniff Testing Locations.....	33
	Appendix 4: Odour Report Forms – ‘Sniff Tests’.....	34

Appendix 5: Correspondence from Thames Water.....	36
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List of Tables

Table 1.1: Proposed Strategic Housing Allocations for Banbury.....	7
Table 3.1: Description of the FIDOL factors.....	11
Table 3.2: Receptor sensitivity to odours.....	12
Table 3.3: IAQM suggested descriptors for magnitudes of odour effects	13
Table 3.1: IAQM odour effect descriptors for impacts predicted by modelling	18
Table 5.1: Dispersion Model Input Data.....	21
Table 6.1: Annual Meteorological Statistics	22
Table 6.2: Maximum Modelled Concentrations (98 th %ile, 1 hour)	23
Table 7.1: Meteorological Conditions on Assessment Days.....	24
Table 7.2: Highest Annual 98 th Percentile Hourly Mean Odour Concentrations (2014)	25

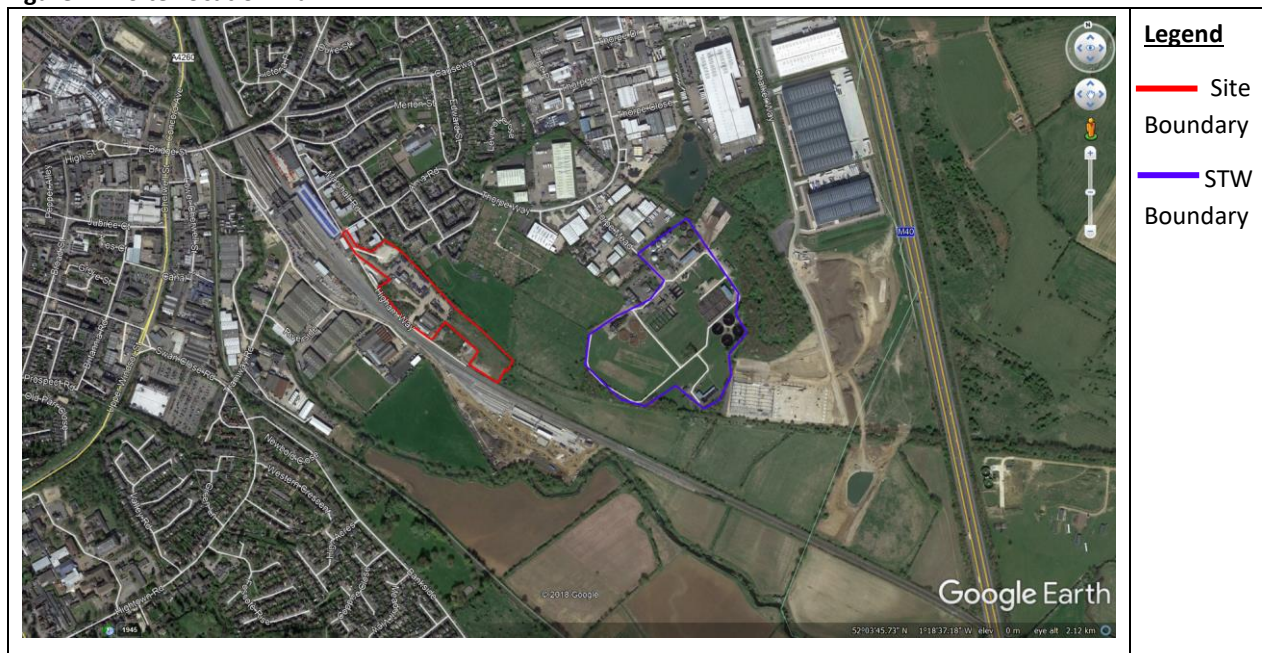
1. INTRODUCTION

ACCON UK Limited (ACCON) have been commissioned by Grundon Waste Management Ltd and CEMEX UK Properties Ltd to carry out an odour assessment to support a planning application for a proposed residential development on land at Merton Street, Banbury. The proposed development will consist of approximately 200 residential dwellings.

The proposed development location will have Higham Road as its main access to the north-west, along with Merton Street, Bridge Street and Middleton Road to the north. The proposed development is located within Cherwell District Council (CDC).

The location of the site is identified in **Figure 1** in relation to the Sewage Treatment Works (STW).

Figure 1.1: Site Location Plan



The site is bounded by Banbury Railway Station and existing residential properties to the north-west, open grassland to the north-east and Banbury railway line and station to the west and south-west.

The Banbury Sewage Treatment Works is located 170m east of the proposed development boundary and consists of various reactors on the south-west boundary and trickle filter units in the centre of the works.

Potential odour as a result of the STW could result in complaints and potentially statutory nuisance at the proposed residential properties due to their proximity to the treatment plant.

ACCON have therefore undertaken the following tasks:

- Carried out one site visit and a qualitative odour assessment was undertaken in the vicinity of the sewage treatment works, which is located approximately 170m to the east of the proposed development site;

- Carried out an odour impact assessment in accordance with published guidance from the Department for Environment, Food & Rural Affairs (DEFRA)¹, the Environment Agency (EA)², the Institute of Air Quality Management (IAQM)³ and statements from bodies such as the Chartered Institution of Water and Environmental Management (CIWEM) and the UK Water Industry Research (UKWIR) to determine the potential odour impact of the sewage treatment works on the proposed development; and
- Carried out detailed dispersion modelling in accordance with guidance and legislation outlined in **Section 3**.

¹ 'Odour Guidance for Local Authorities', DEFRA (2010)

² IPPC H4 'Odour Management', Environment Agency (2011)

³ 'Guidance on the assessment of odour for planning' IAQM (2014)

2. PLANNING POLICY

The Cherwell Local Plan⁴, which incorporates the Core Strategy was adopted in July 2015 and re-adopted in December 2016. The plan sets out how the district “will grow and change in the period up to 2031” and how it will “set out the long-term spatial vision for the District and contains policies to help deliver that vision”.

The plan also discusses air quality as a public health issue, in its policy for Building Sustainable Communities (B.2 Theme Two), where it states, “new housing needs to be provided in such a way that it minimises environmental impact, including through the elimination and control of pollution and the effective and efficient use of natural resources”.

Table 2.1: Proposed Strategic Housing Allocations for Banbury

Site	Total No. Homes 2014 – 2031	Policy No.
Higham Way	150	Banbury 19

Policy Banbury 19: Land at Higham Way

This site is a former waste management facility and concrete batching plant and is located to south east of Banbury town centre. The site is bounded by residential and sports pitches to the north, railway lines to the south and former railway land within site Banbury 6 to the east.

The site is within Flood Zone 2 and 3. A Flood Alleviation Scheme (FAS) for the north of Banbury was completed in 2012 and a large part of the site falls within the defended area. The proximity to the railway would present noise pollution to future residents and require a buffer/design solution which might reduce yield.

In principle the site offers a suitable location for development and would contribute to the creation of sustainable and mixed communities. The site is close to the town centre and railway station and is in need of bringing back into effective use. However, there are current physical constraints that need to be overcome before development can be progressed. These include addressing the potential for land contamination from the previous use, and noise mitigation measures to reduce noise impact from the railway for future residents. A replacement waste management site for Grundon’s has been approved nearby. The Cemex site had been cleared and is surplus to requirements. The access road (Higham Way) is in the process of being adopted. The site was marketed for a mixed-use development in 2013.

Policy Banbury 19: Land at Higham Way

Development Area: 3 hectares

Development Description: Re-development would bring about environmental benefits in terms of using previously developed and vacant land within the town.

Housing:

- Number of homes – Approximately 150

⁴ Cherwell District Council, Cherwell Local Plan, July 2015

- Dwelling mix - approximately 70% houses, 30% flats.
- Affordable Housing – 30%
- The provision of extra-care housing and the opportunity for community self-build affordable housing.

Infrastructure Needs:

- Education – Contributions towards Primary School and secondary education provision
- Access and Movement – Access via Higham Way
- Open space – as outlined in Policy BSC 11.

Key site-specific design and place shaping principles:

- Proposals should comply with Policy ESD15
- A distinctive residential proposition for Banbury that integrates well and helps make connections with the adjoining town centre and Railway Station
- An appropriate location for higher density housing to include a mixture of dwelling styles and types
- Taking advantage of the accessibility of the town centre, an age friendly neighbourhood with extra care housing and housing for wheel chair users and those with specialist supported housing needs
- The potential inclusion of live/work units
- A layout that maximises the potential for walkable neighbourhoods and enables a high degree of integration and connectivity between new and existing communities. New footpaths and cycleways should be provided that link to existing networks
- Provision of Green Infrastructure links beyond the development site to the wider town and open countryside
- Open/urban spaces provided in various locations within the site and new trees planted
- Development should promote biodiversity enhancement
- The implementation of proposals in the Movement Strategy including improved junction arrangements on Bridge Street and Cherwell Street to improve traffic capacity but also to facilitate pedestrian movement between the town centre and the site
- Some car free or reduced levels of parking with innovative solutions to accommodating the private car
- Good accessibility to public transport services should be provided for A transport assessment and Travel Plan to accompany development proposals Appropriate treatment and remediation of contaminated land

3. ODOUR BACKGROUND, POLICY, LEGISLATION AND GUIDANCE

3.1. Odour Legislation and Guidance Used in this Assessment

The following legislation and guidance were utilised as part of this assessment:

- Odour Guidance for Local Authorities', DEFRA (2010);
- IPPC H4 'Odour Management', Environment Agency (2011);
- 'Guidance on the assessment of odour for planning' IAQM (2014);
- Chartered Institute for Water and Environmental Management (CIWEM) Policy Statement (2011);
- Odour Control in Sewage Treatment (Technical Reference Document 01/WW/13/3) UK Water Industry Research (UKWIR) (2001); and
- Planning Precedent Decisions

3.2. Odour Background

3.2.1. Odour Definition

The DEFRA guidance defines odour as:

"An odour is the organoleptic attribute perceptible by the olfactory organ on sniffing certain volatile substances. It is a property of odorous substances that make them perceptible to our sense of smell. The term odour refers to the stimuli from a chemical compound that is volatilised in air. Odour is our perception of that sensation and we interpret what the odour means. Odours may be perceived as pleasant or unpleasant. The main concern with odour is its ability to cause a response in individuals that is considered to be objectionable or offensive.

Odours have the potential to trigger strong reactions for good reason. Pleasant odours can provide enjoyment and prompt responses such as those associated with appetite. Equally, unpleasant odours can be useful indicators to protect us from harm such as the ingestion of rotten food. These protective mechanisms are learnt throughout our lives. Whilst there is often agreement about what constitutes pleasant and unpleasant odours, there is a wide variation between individuals as to what is deemed unacceptable and what affects our quality of life."

Odour is perceived by our brains in response to chemicals present in the air we breathe. Odour is the effect that those chemicals have upon us. Humans have a particularly developed sense of smell and they can detect odour even when chemicals are present in very low concentrations. Most odours are a mixture of many chemicals that interact to produce what we detect as an odour.

Different life experiences and natural variation in the population can result in different sensations and emotional responses by individuals to the same odorous compounds. Because the response to odour is synthesised in our brains, other senses such as sight and taste, and even our upbringing, can influence our perception of odour and whether we find it acceptable, objectionable or offensive

3.2.2. Odour Units

The concentration at which an odour is just detectable to a 'typical' human nose is referred to as the 'threshold' concentration. At the detectability threshold, the concentration of an odour is so low

that it is not recognisable as any specific odour at all, but the presence of some very faint, odour can be sensed when the 'sample' odour is compared to a clean, odour-free sample of air.

Odours are a complex mixture of compounds and the concentration of the mixture is expressed in European odour units per cubic metre ($\text{ou}_{\text{E}}\text{m}^{-3}$ or $\text{ou}_{\text{E}}/\text{m}^3$) as defined by European standard BSEN 13725:2003 'Air quality. Determination of odour concentration by dynamic olfactometry'.

An odour at strength of $1 \text{ou}_{\text{E}}\text{m}^{-3}$ would only be detectable within the confines of an odour laboratory by the majority of the population. As odour concentrations increase, they become more noticeable. The following published guideline values⁵ provide context to odour concentrations;

- $1\text{ou}_{\text{E}}\text{m}^{-3}$ = the point of detection;
- $5\text{ou}_{\text{E}}\text{m}^{-3}$ = is a faint odour;
- $10\text{ou}_{\text{E}}\text{m}^{-3}$ = is a distinct odour.

In the general environment however, the population are exposed to levels of 'background' odours from road traffic, vegetation and numerous other activities which can produce background odour concentrations between 5 to $60\text{ou}_{\text{E}}\text{m}^{-3}$.

The units for exposure to odour is given in terms of a percentile of averages over the course of a year. The current accepted method of assessing the impact of odour concentration in the UK at present is a 98th percentile (C_{98}) of hourly averages. This allows for 2% (175 hours) of the year to be above the limit criterion.

3.2.3. Odour Exposure

Before an adverse effect (such as disamenity, annoyance, nuisance or complaints) can occur, there must be odour exposure. For odour exposure to occur all three links in the source-pathway-receptor chain must be present:

- An emission source - a means for the odour to get into the atmosphere.
- a pathway - for the odour to travel through the air to locations off site, noting that:
 - anything that increases dilution and dispersion of an odorous pollutant plume as it travels from source to receptor will reduce the concentration at the receptor, and hence reduce exposure.
 - increasing the length of the pathway (e.g. by releasing the emissions from a high stack or at a distance) will – all other things being equal – increase the dilution and dispersion.
- The presence of receptors (people) that could experience an adverse effect, noting that people vary in their sensitivities to odour.

The scale of exposure (the impact) is determined by the parameters collectively known as the FIDO factors (Frequency, Intensity, Duration and Offensiveness; these are described in **Table 3.1**. The magnitude of the effect experienced is determined by the scale of exposure (**FIDOL**) and the sensitivity of the receptor (**L**, denoting the location, which is often taken to be a surrogate for the sensitivity and incorporates the social and psychological factors that can be expected for a given

⁵ IPPC H4 'Odour Management', Environment Agency (2011)

community.) **Figure 3.1** depicts how the human appraisal of the **FIDOL** factors and social and psychological factors determines whether an odour has an adverse odour impact and an objectionable effect. Different combinations of the **FIDO** factors can result in different exposures at a location. For example, odours may occur as a one-off, as frequent short bursts, or for longer, less-frequent periods, and may be said to give ‘acute’ or ‘chronic’ exposures respectively.

Table 3.1: Description of the FIDOL factors

Frequency	How often an individual is exposed to odour
Intensity	The individual’s perception of the strength of the odour
Duration	The overall duration that individuals are exposed to an odour over time.
Odour unpleasantness	Odour unpleasantness describes the character of an odour as it relates to the ‘hedonic tone’ (which may be pleasant, neutral or unpleasant) at a given odour concentration/intensity. This can be measured in the laboratory as the hedonic tone, and when measured by the standard method and expressed on a standard nine-point scale it is termed the hedonic score.
Location	The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor. The ‘Location’ factor can be considered to encompass the receptor characteristics, receptor sensitivity, and socio-economic factors.

Source: IAQM, 2014

3.2.4. Adverse Effects of Odour

The odour effect to be concerned with is the negative appraisal by a human receptor of the odour exposure. This appraisal, occurring over a matter of seconds or minutes, involves many complex psychological and socio-economic factors. Once exposure to odour has occurred, the process can lead to adverse effects such as loss of amenity, annoyance, nuisance and possibly complaints. It is important to emphasise the technical differences* between annoyance and nuisance:

- Annoyance – the adverse effect occurring from an immediate exposure; and
- Nuisance – the adverse effect caused cumulatively, by repeated events of annoyance.

Accordingly, in determining whether a site is suitable for development it is important to understand the scale of the potential odour, over what period it may occur and importantly whether it will migrate from the source to the receptor on a regular basis such as to cause a loss of amenity or nuisance.

Table 3.2: Receptor sensitivity to odours

High sensitivity receptor	Surrounding land where: <ul style="list-style-type: none"> •Users can reasonably expect enjoyment of a high level of amenity; and •People would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Examples may include residential dwellings, hospitals, schools/education and tourist/cultural.
Medium sensitivity receptor	Surrounding land where: <ul style="list-style-type: none"> •Users would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or •People wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Examples may include places of work, commercial/retail premises and playing/recreation fields.
Low sensitivity receptor	Surrounding land where: <ul style="list-style-type: none"> •The enjoyment of amenity would not reasonably be expected; or •There is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Examples may include industrial use, farms, footpaths and roads.

Source: IAQM, 2014

3.2.5. Odour from Sewage Treatment Works

There are many chemical species that have been detected in sewage treatment works odours. In addition to hydrogen sulphide and other pollutants such as ammonia, there are a wide variety of organic sulphides and organic nitrogen-based compounds along with some oxygenated organic compounds and organic acids.

In addition to these compounds, there are many potential substances which may be released depending upon the quality of the influent, for example if it includes industrial effluent. The range of contaminants potentially present in industrial effluent is extensive but those which are likely to be of concern are already odorous liquids (such as sewage from food production), warm effluent which may accelerate anaerobic conditions and volatile organic compounds such as solvents and petroleum derivatives. The primary odours from sewage treatment works are biogenic due to the degradation of organic matter by microorganisms under anaerobic conditions. The development of anaerobic conditions in sewage is often referred to as 'septicity'. Septicity can be onset by elevated temperature, high biological oxygen demand, high sulphate levels and the presence of reducing chemicals. Anaerobic activity leads to the production of methane, hydrogen sulphide (H₂S), ammonia (NH₃), organic sulphur, thiols (mercaptans), amines, indole and skatole. During the fermentation phase of anaerobicity, volatile fatty acids, alcohols, aldehydes and ketones can be produced.

However, odour which is not typical of anaerobic conditions can also be generated by other mechanisms in a treatment works including:

- Volatile substances in the influent such as petroleum derivatives, solvents;
- Air stripping of volatile compounds and odours particularly from industrial effluent often at inlet works or during aeration;
- Aerobic odours – which are often described as a 'musty' odour; and

- Ammonia odour from reactions after liming of sludges or when sludges become re-wetted.

Hydrogen sulphide is often referred to as the cause of odour from sewage treatment works. Whilst hydrogen sulphide may be a principal component of the odour cocktail, there are other compounds which cannot be ignored. Because it is relatively easy to measure, H₂S is often used as a target indicator for odour but there are important limitations to this technique.

3.3. Odour Standards and Benchmarks

There are a number of sources of ‘standards’ for odour unit concentrations and the assessment of impacts. Malodours from STW (particularly where sludge is used and processed) are considered to be potentially highly offensive and therefore careful consideration should be given to the placement of potential receptors. Due to the lack of response from Thames Water, the UK Water Industry Research “Table 5.1 - Emission rate estimates from sewage and sludge treatment processes” has been utilised.

3.3.1. Planning Precedents

There are a number of planning precedents that are able to inform this assessment. The first of these is the Newbiggin-by-the-Sea⁶ Planning Inspectorate decision in 1993. The appeal addressed what was an appropriate odour exposure limit at a sensitive receptor and the appeal concluded that: “Whilst a particularly sensitive person could detect an emission level as low as 20u_{EM}⁻³, it seems to be that adoption of a level of 50u_{EM}⁻³ for the appeal site is both reasonable and cautious.”

The decision in this Planning Inspectorate case was the origin of the now well-established empirical standard of 50u_{EM}⁻³ (98th percentile - C_{98, 1-hour}), which has been widely used in the sewage sectors in the UK to assess the likelihood of community annoyance. This impact criteria has been successfully applied within similar assessments, where odour from STW has been assessed at adjacent residential receptors^{7,8,9}.

3.3.2. IAQM Guidance (2014)

The 2014 IAQM document provides guidance on the odour impacts for planning purposes. As such, it gives details of relevant descriptors of effects and impacts, so that modelled odour concentrations can be quantified. **Table 3.3** compares the receptor sensitivity and relative odour exposure and provides a magnitude of effect.

Table 3.3: IAQM suggested descriptors for magnitudes of odour effects

		Receptor Sensitivity		
		Low	Medium	High
Odour Exposure	Very Large	Moderate	Substantial	Substantial
	Large	Slight	Moderate	Substantial
	Medium	Negligible	Slight	Moderate
	Small	Negligible	Negligible	Slight
	Negligible	Negligible	Negligible	Negligible

⁶ Department of the Environment (July 1993) Appeal by Northumbrian Water Ltd: *Land Adjacent to Spital Burn, Newbiggin-by-the-sea, Northumberland*. Case ref: APP/F2930/A/92 206240.

⁷ Planning Inspectorate – Appeal Reference: APP/P0240/A/09/2110667

⁸ Planning Inspectorate – Appeal Reference: APP/E3525/A/11/2145235.

⁹ High Court of Justice (2011). EWHC 3253 (TCC).

3.3.3. Assessment of Community Response to Odorous Emissions

Environment Agency (EA) Research and Development Technical Report P4-095/TR (2002) provides a scientific background to assist in identifying defensible numerical limits for regulating exposure to odours in the UK. This report recognises that the $C_{98, 1\text{-hour}} < 5 \text{ ou}_{\text{EM}^{-3}}$ exposure level is currently applied in the UK with the legal objective of avoiding nuisance. Not all aspects of sewage treatment have the potential to generate odour which is likely to be offensive and therefore have the potential to generate complaints. However, in this assessment, all sources of potential odour have been assessed in the dispersion modelling.

3.3.4. UKWIR Research¹⁰

The UK Water Industry Research (UKWIR) organisation undertook research into the correlation between modelled odour impacts and the spatial distribution of odour complaints in the areas surrounding nine STW in the UK. The report includes the likely amount of complaints for a given odour concentration and concludes:

“The main source of research into odour impacts in the UK has been the sewage industry and the most in-depth study published in the UK of the correlation between modelled odour impacts and human response (dose-effect) was published by UK Water Industry Research (UKWIR) in 2001. This was based on a review of the correlation between reported odour complaints and modelled odour impacts in relation to 9 sewage treatment works in the UK with ongoing odour complaints. The findings of this research (and subsequent UKWIR research) indicated the following:

- *At modelled exposures of below $C_{98, 1\text{-hour}} 5 \text{ ou}_{\text{EM}^{-3}}$, complaints are relatively rare, at only 3% of the total registered;*
- *At modelled exposures between $C_{98, 1\text{-hour}} 5 \text{ ou}_{\text{EM}^{-3}}$ and $C_{98, 1\text{-hour}} 10 \text{ ou}_{\text{EM}^{-3}}$, a significant proportion of total registered complaints occur; 38% of the total;*
- *The majority of complaints occur in areas of modelled exposure greater than $C_{98, 1\text{-hour}} 10 \text{ ou}_{\text{EM}^{-3}}$, 59% of the total.”*

Therefore, the UKWIR research findings are consistent with the ‘Newbiggin’ standard and other planning precedents (**Section 3.3.1**) as any potential odour impact and annoyance is effectively controlled for the vast majority of the population at a 98th percentile hourly mean odour impacts of $5 \text{ ou}_{\text{EM}^{-3}}$ or less.

3.3.5. Environment Agency H4 Odour Guidance

The EA published guidelines on odour regulation, assessment and control (H4: Odour Management) in March 2011. In Appendix 3 (of H4), modelled odour concentration benchmark levels are presented for odours of varying degrees of offensiveness.

The guidance recommends that preferably five years (and a minimum of three), should be used to calculate the 98th percentile of the hourly mean odour concentrations, to assess varying meteorological conditions.

¹⁰ Odour Control in Sewage Treatment (Technical Reference Document 01/WW/13/3) UK Water Industry Research (UKWIR) (2001)

3.3.6. Chartered Institute for Water and Environmental Management (CIWEM)

CIWEM released a Policy Position Statement regarding odour in February 2011. The statement provides appropriate assessment criteria and benchmarks to determine the potential for odour nuisance and was as follows:

“Given the differing odour impact criteria available, the selection of the most appropriate criterion should be determined by the objective of the assessment (whether this be against a standard of avoidance of nuisance or ‘significant pollution’) and the nature of the odour under assessment. It is, therefore, the view of CIWEM that these and other odour impact criteria should be regarded as indicative guidelines and cannot be applied as over-arching statutory numerical standards. CIWEM considers that the following framework is the most reliable that can be defined on the basis of the limited research undertaken in the UK at the time of writing:

- *$C_{98, 1-hour} > 10 \text{ou}_E/\text{m}^3$ – complaints are highly likely and odour exposure at these levels represents an actionable nuisance;*
- *$C_{98, 1-hour} > 5 \text{ou}_E/\text{m}^3$, – complaints may occur and depending on the sensitivity of the locality and nature of the odour this level may constitute a nuisance; and*
- *$C_{98, 1-hour} < 3 \text{ou}_E/\text{m}^3$, – complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution or significant detriment to amenity unless the locality is highly sensitive or the odour highly unpleasant in nature.”*

4. ASSESSMENT METHODOLOGY

4.1. Sniff Testing Methodology

The potential odours were assessed against a fixed framework as detailed in **Appendix 2**, which covers weather conditions, odour intensity, strength, frequency and characteristics. A number of locations were identified for assessment to account for typical odour exposure depending on the wind speed and direction. Each location was assessed for a fixed period of time (10 minutes) to enable the assessment of frequency.

The methodology of the assessment was agreed with Veronique Bensadou of Grondon Waste Management Ltd. Information was requested from Thames Water (4th December 2019), however Thames Water were not willing to cooperate with providing any information to ACCON (emails attached in **Appendix 5**).

4.1.1. Assessment Quality Assurance

To ensure that the odour assessment was carried out to a satisfactory standard the following quality assurance steps were taken:

- A suitably qualified and trained odour assessor (assessed against EN13725);
- An objective method of describing and measuring odours
- A standardised monitoring process and data reporting

In addition, the quality of the assessment was managed by utilising the following guidelines as detailed in 'Guidance on the assessment of odour for planning' IAQM, (2014):

- The odour assessor should not carry out the assessment if they have a cold, sore throat, sinus trouble, etc;
- The odour assessor should not be hungry or thirsty;
- The odour assessor should not work within half an hour of the end of their last meal;
- The odour assessor should not smoke or consume strongly flavoured food or drink, including coffee, for at least half an hour before the field odour survey is carried out, or during the survey;
- The odour assessor should not consume confectionery or soft drinks for at least half an hour before the field odour survey is carried out, or during the survey;
- Scented toiletries, such as perfume/aftershave should not be used on the day of the field odour survey;
- The vehicle used during the field odour survey should not contain any deodorisers;
- If the odour assessor has had to travel a long distance, then a rest period should be taken before starting the survey; and
- To reduce the likelihood of odour fatigue, assessors should always carry out the field odour survey before making any works site visit, inspection or walk-through survey.

4.2. Dispersion Modelling Methodology

The dispersion model used in this assessment is Breeze AERMOD. AERMOD is a steady-state Gaussian dispersion model that represents the current state-of-science and promulgated dispersion model

The model calculates downwind pollutant concentration in the surrounding area for each hour of the day over the period of meteorological data. Statistics on the frequency and concentration of pollutants at the receptor sites are based upon the hourly calculations.

The AERMOD dispersion modelling tool has been utilised to determine the baseline odour emission levels in the vicinity of the operational Banbury Sewage Treatment Works and specifically on land proposed for residential development.

The detailed dispersion modelling has been used to predict the ground level concentration of odour and has been undertaken in accordance with the Environment Agency's best practice methodology for dispersion modelling¹¹. This includes the use of 5-years of hourly sequential consecutive meteorological data from a representative meteorological station. Modelled odour concentrations are presented graphically so that the inter-year variability can be visualised. In addition, the results from individual meteorological years have been determined by the maximum concentrations (as outlined in the IAQM guidance) to produce a worst-case assessment. **Appendix 1** details the meteorological data used in this assessment.

4.3. Model Uncertainty and Limitations

This assessment has utilised a range of precautionary measures and assumptions that aim to provide a worst-case assessment so as not to under-predict ground level concentrations. This has been achieved by assuming the STW is operational for all hours and utilising 5-years of meteorological data. This is likely to result in an overestimation of the likely odour concentrations and therefore the concentrations presented within this assessment are worst-case.

The dispersion model cannot take into account fugitive odours such as non-consented discharges or plant maintenance. However, any odours produced within these times would probably be of short duration and would only be likely to impact the development under adverse meteorological conditions. Although all care has been taken to verify the odour emission data, obtained from the UKWIR, Thames Water have not responded to our request for data.

4.4. Odour Benchmarks

As outlined in **Section 3.2.4**, receptor sensitivity and possible exposure to potential odours will vary depending on the land-use of the site. The land use will change the expectation of users of the land depending on the level of amenity and the time spent at the location.

As such, this assessment has considered the following criteria when assessing the impacts of the STW on the proposed development. This will enable the quantification of a 'stand-off' distance from the STW depending on the land-use and sensitivity of the proposed receptor. The criteria have been determined by the recommendations of the CIWEM, IAQM guidance and planning precedents outline in **Section 3.3**.

¹¹ Environment Agency – Air Quality Modelling and Assessment Unit (AQMAU). *Air dispersion modelling report requirements (for detailed air dispersion modelling)*

- High sensitivity receptors – considered suitable for any development, including residential: Applied benchmark of less than $C_{98, 1\text{-hour}} 30\text{ou}_E/\text{m}^3$;
- Medium sensitivity receptors – considered suitable for places of work, commercial/retail premises and playing/recreation fields: Applied benchmark of greater than $C_{98, 1\text{-hour}} 30\text{ou}_E/\text{m}^3$ but less than $C_{98, 1\text{-hour}} 50\text{ou}_E/\text{m}^3$; and
- Low sensitivity receptors – considered suitable for non-sensitive uses where exposure would be only transient, e.g. industrial use, farms, footpaths, car-parks and roads: Applied benchmark of greater than $C_{98, 1\text{-hour}} 50\text{ou}_E/\text{m}^3$.

4.5. IAQM – Significance Criteria

The impact significance has been determined based upon the IAQM matrix and descriptors as presented within **Table 3.1**. **Table 4.1** outlines the relationship between the modelled odour exposure level and the relevant receptor sensitivity. It should be noted that **Table 4.1** below is a conservative estimate of the impacts based on highly offensive odours. Therefore, less offensive odours may require a higher level of exposure to elicit the same response.

Table 4.1: IAQM odour effect descriptors for impacts predicted by modelling

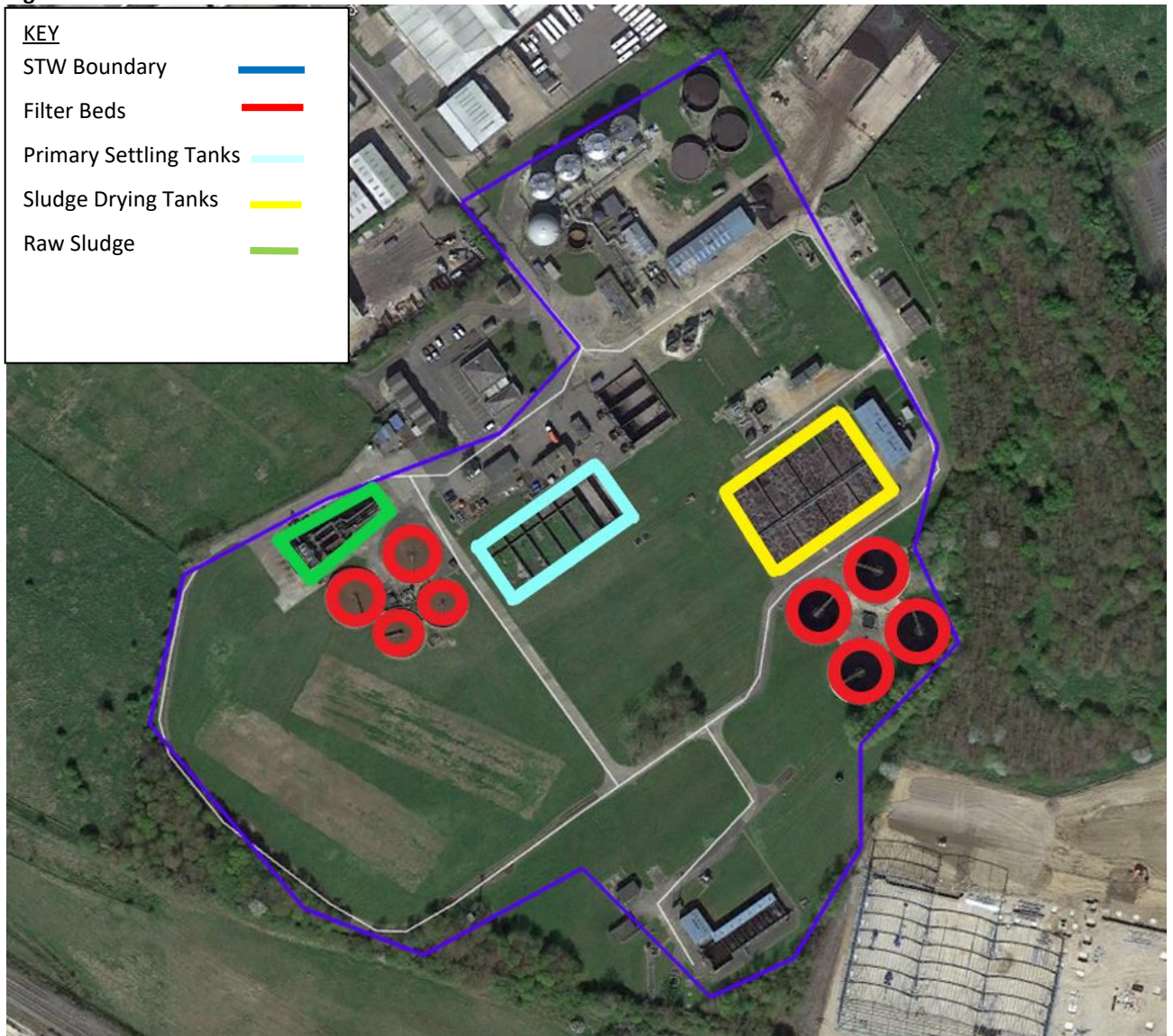
Odour Exposure Level ou_E/m^3	Receptor Sensitivity		
	Low	Medium	High
>10	Moderate	Substantial	Substantial
5 - <10	Moderate	Moderate	Substantial
3 - <5	Slight	Moderate	Moderate
1.5 - <3	Negligible	Slight	Moderate
0.5 - <1.5	Negligible	Negligible	Slight
<0.5	Negligible	Negligible	Negligible

5. QUANTIFICATION OF ODOUR EMISSIONS

5.1. STW Process Overview

The proposed development is located to the east of the Banbury in Oxfordshire. The current proposals (outlined in **Figure 1.1**) are for residential dwellings located on land at Merton Street in Banbury. The sewage treatment works is located 170m to the neast of the proposed development.

Figure 5.1: Odour Sources within the STW



As identified in **Figure 5.1**, the STW contains varied reactor types throughout the treatment/recycling process. All of the reactors are open to the atmosphere (except for the anaerobic digestion tanks) and are considered to be operational at all times to create a worst-case scenario. Thames Water has not provided a breakdown of the treatment processes. Therefore, the processes have been estimated utilising aerial photographs and Goole Earth, including:

- Location;

- Size;
- Exposed area;
- Odour release height; and
- Odour emission rate (using UKWIR values).

There are approximately 4 No. processes within the STW that have the potential to generate odours and they are as follows:

- Filter Beds - Low malodour potential;
- Primary Settling Tanks - Low to medium malodour potential;
- Sludge Drying Tanks - Low to medium malodour potential; and
- Raw Sludge - High malodour potential.

5.2. Odour Emission Rates

Thames Water would not respond to our request for information, therefore the odour emission rates were derived from the following sources:

- UKWIR¹² published emission rates.

UKWIR 'Typical' values for the reactors that have a high malodour potential as these odour emission rates are considered to predict a more reasonable definition of the worst-case scenario due to the small-scale sludge use within the STW.

The model has utilised of UKWIR 'Low' values for the reactors within the STW. The use of 'Low' emission values is in line with observations made during the on-site 'sniff testing'.

This assessment considers the reactors listed below to be operating constantly, which will contribute to a worst-case scenario, and will take into account seasonal variations in demand.

5.3. Dispersion Model Input Data

This assessment considers the reactors listed below to be operating constantly which will contribute to a worst-case scenario and will take into account seasonal variations in demand. **Table 5.1** outlines the data that was used in the dispersion model.

¹² UK Water Industry Research (UKWIR) (2001), Odour Control in Sewage Treatment – *Technical Reference Document 01/WW13/3*

Table 5.1: Dispersion Model Input Data

Reactor Type/ Odour Source	Input Variable				Data Source
	Emission Rate (ou _E /m ² /s)	Total Area (m ²)	Release Height (m)	Number of Reactors	
Filter Beds	7.5	314	1	8	UKWIR (High)
Primary Settling Tanks	7.5	1,800	1	5 full 2 empties	UKWIR (High)
Sludge Drying Tanks	25	1,400	1	8	UKWIR (High)
Raw Sludge	710	12	4	1	UKWIR (Typical)

6. DISPERSION MODEL INPUT DATA

6.1. Modelling Scenarios

This assessment considers the number of exceedances of the 1-hour mean. The 98th percentile will be applied to the 1-hour concentrations which assess if the 1-hour mean is exceeded for more than 2% of the year (175 hours). Five years of meteorological data have been used in the assessment to determine odour levels under a range of likely meteorological conditions.

6.2. Assumptions

It has been assumed that the STW is operational 24-hours per day, 365-days per year in order to create a reasonable worst-case scenario with respect to odour emissions. All reasonable care has been taken to assess the validity and suitability of data from external sources.

6.3. Meteorological Data

Atmospheric Dispersion Modelling (ADM) Ltd and Thames Water were consulted in order to determine the most appropriate meteorological station for the proposed development. The meteorological data controls the direction of dispersion through the wind direction; the dilution and subsequent spread of odours through the wind speed; and the turbulence and atmospheric stability. As stated previously, Thames Water declined to contribute to any involvement in the study. ADM Ltd determined that Church Lawford meteorological station was the most appropriate station, which is approximately 37km north of the proposed development and the STW. Five consecutive years of hourly-sequential observation data from the Church Lawford meteorological station, covering the period 2014 – 2018, inclusive, were obtained. The use of 5-years of meteorological data prevents results being skewed by infrequent meteorological conditions that would provide a false indication of ‘average conditions’.

The prevailing wind (as identified in **Appendix 1**) is typically from the south-west, with the majority of the wind occurring between the south and west sectors. **Table 6.1** outlines the key statistics for each year of meteorological data. The data capture (in terms of the percentage of calm hours and missing hours) is less than 10% in every meteorological year used in this assessment and therefore, within acceptable limits.

Table6.1: Annual Meteorological Statistics

Year	Wind Speeds <1.54 m/s (%)	Calm Hours (%)	Missing Data (%)
2014	22.69	0.70	0.18
2015	21.04	0.49	0.86
2016	24.46	1.08	0.44
2017	22.32	1.03	0.79
2018	20.01	2.56	4.42

Table 6.2: Maximum Modelled Concentrations (98th %ile, 1 hour)

Year	Closest Sensitive Receptor (on proposed site)	Grid
2014	3.86	144.32
2015	2.74	59.63
2016	3.80	183.77
2017	2.70	195.86
2018	3.30	171.27

As the land surrounding the proposed development and STW is relatively uniform, the dispersion site variables outlined in **Table 6.2** remain consistent throughout the modelled area.

6.4. Building Effects

Dispersion models are not capable of modelling the effects of buildings upon area source emissions, which are the only source of emissions at the Banbury Sewage Treatment Works. As such, effects such as building downwash have not been considered or applied in this assessment.

In addition, barriers to dispersion such as the trees surrounding the STW and any potential objects on the boundary of the proposed development are not able to be modelled and therefore contribute to maintaining a worst-case scenario.

6.5. Receptor Locations

The sensitive residential receptors are located along the boundary of the proposed development site.

7. RESULTS

7.1. Qualitative Assessment

A qualitative odour assessment was carried out on the 27th November 2019. Whilst, any qualitative assessment can only ever represent a 'snapshot in time' of the operational and meteorological conditions on the day, it does provide useful observations in respect of how odorous the STW is and the extent to which odour could migrate offsite

The two people carrying out the sniff testing on the site have previously had their detection threshold tested by Spectrum Environmental Limited and Silsoe Odours Limited. Their detection threshold was determined at 36.5ppb and 29.9ppb respectively for n-butanol (EN13725). What this means in practice is that both assessors have a range of odour sensitivity that covers the general population. Therefore, their judgements can be relied upon to determine the extent to which odour might be considered offensive such as to result in a nuisance or a loss of amenity to potential occupiers of the proposed property.

As access to the sewage treatment works was not possible, sniff testing was carried out at the boundaries of the sewage treatment works and at the boundary of the proposed development. **Appendix 3.2** outlines each of the locations where sniff testing was carried out. **Table 7.1** outlines meteorological conditions on the day of the site visit. These conditions are typical of this area as identified by the wind roses in **Appendix 1**.

Table 7.1: Meteorological Conditions on Assessment Days

Date	Average Temperature	Average Wind Speed	Average Wind Direction
27th November	10°C – 11°C	1-2 m/s	WNW

Odour was slight at Receptors 2 and 4, but odour could not be definitively linked to the STW. At all other locations, there were no instances of odour detection or identification.

As such, it is highly unlikely that odours will reach the proposed development, at least 170m away from the nearest odour source, even when the wind direction is north-easterly. No odour was detected downwind from the odour source.

A detailed breakdown of the test, conditions and subsequent findings is provided in **Appendix 2**.

7.2. Qualitative Assessment

Table 7.2 identifies the highest annual 98th percentile odour concentration at each sensitive receptor location during the worst of the five years of modelled data. There are no exceedances of the C_{98, 1-hour} 30uE/m³ benchmark at any residential receptor.

When the concentrations identified in **Table 7.2** are compared against the IAQM impact matrix (**Table 4.1**), the impacts at the proposed residential dwellings are considered to be *moderate*. However, given that the IAQM impact descriptors are conservative and that there are various objects that will limit the dispersion of odours (such as the trees surrounding the STW and the natural hedgerows that are likely to form the development boundary), the odour concentrations and resultant impacts are likely to be in practice significantly lower.

Table 7.2: Highest Annual 98th Percentile Hourly Mean Odour Concentrations (2014)

Receptor	Floor (Height)	Receptor Description and Potential Sensitivity	Highest 98 th Percentile Hourly Mean Concentration (ou _E /m ³) 2014	Impact Descriptor
DR1	Ground (1.5m)	Residential Façade (High Sensitivity)	3.71	Moderate
DR2			3.21	Moderate
DR3			2.95	Moderate
DR4			1.72	Moderate
DR5			1.40	Negligible
DR6			1.31	Negligible

Appendix 4 identifies the 98th Percentile 1-hour odour concentration contours for the worst-case year (2014). The 3ou_E/m³ contour encroaches approximately 200m into the proposed development site.

Given the worst-case modelling and assessment and the site visit having detected little to no odour, it is highly likely that the predicted concentrations will not be realised.

The research carried out by UKWIR states that “At modelled exposures of below C_{98, 1-hour} 5ou_Em⁻³, complaints are relatively rare, at only 3% of the total registered”. Given that all modelled receptor locations on the proposed development are predicted to be below 5ou_Em⁻³, it is highly unlikely that the STW will be a nuisance or prove to be a detriment to the amenity for future residents.

Additionally, CIWEM state that at C_{98, 1-hour} <3ou_E/m³ “complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution or significant detriment to amenity unless the locality is highly sensitive or the odour highly unpleasant in nature”. As such, the proposed development with the proposed residential properties is considered to be suitable and should not be constrained by odour.

8. CONCLUSIONS

The STW is located to the east of the proposed development site and therefore odours will not regularly reach the proposed development as the prevailing wind is from the south-west. In addition, the presence of a significant buffer (170m) between the proposed development site boundary and the STW boundary ensures that there is significant dilution between source and receptor even under adverse meteorological conditions.

A qualitative assessment of odour from the existing sewage treatment works has been carried out to determine whether the proximity of the proposed residential development could result in nuisance occurring to occupiers of the proposed properties. It should be noted that the pleasantness/unpleasantness of an odour and the ability to detect an odour is very subjective and can change from person to person.

The detailed dispersion modelling concluded that at all of the proposed residential receptor locations (high sensitivity receptors), the 98th percentile hourly mean odour concentrations are below the 50_{UE}/m³ benchmark and as such the STW is not anticipated to have an adverse impact on the proposed residential development. The odour contours (**Appendix 5**) identify that the 30_{UE}/m³ contour encroaches on to the east of the proposed development site during the worst-case year.

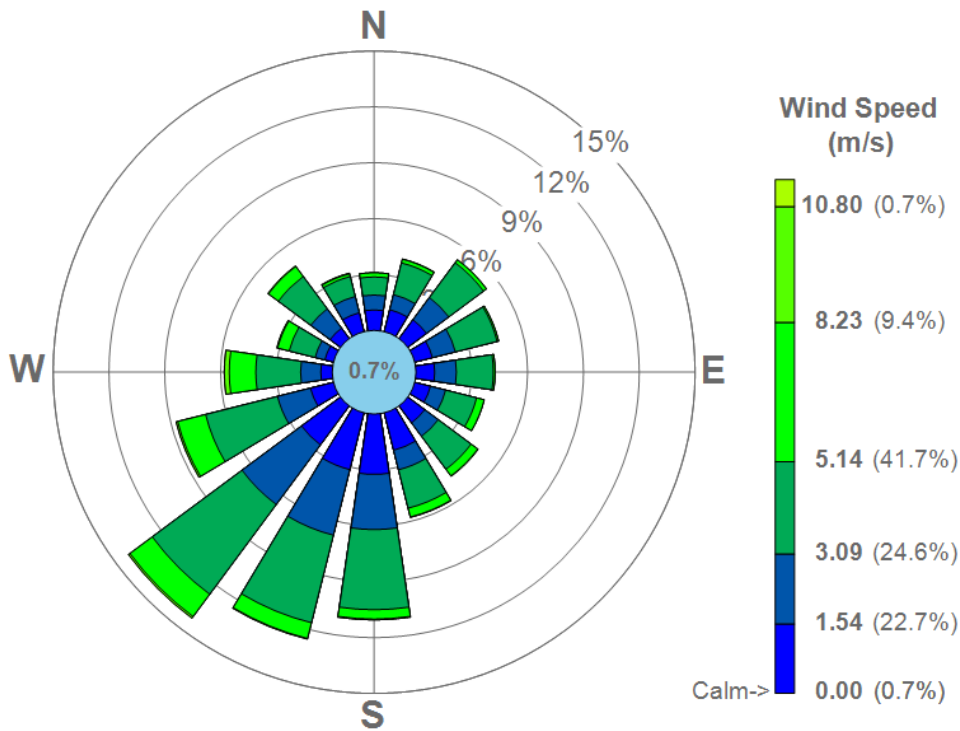
The dispersion modelling has considered multiple years of meteorological data and has used worst-case assumptions where possible. This includes excluding various objects that are not possible to be modelled and which are likely to reduce the dispersion of odours towards the proposed development (i.e. the trees surrounding the STW).

The combination of sniff testing and dispersion modelling has created a broad assessment of the potential odour from the STW and the potential impact on the proposed development. As such, it is not considered that the STW would cause a loss of amenity, annoyance, nuisance or complaints for future occupiers of the residential development on the proposed site. Accordingly, there is no requirement for mitigation measures to be implemented.

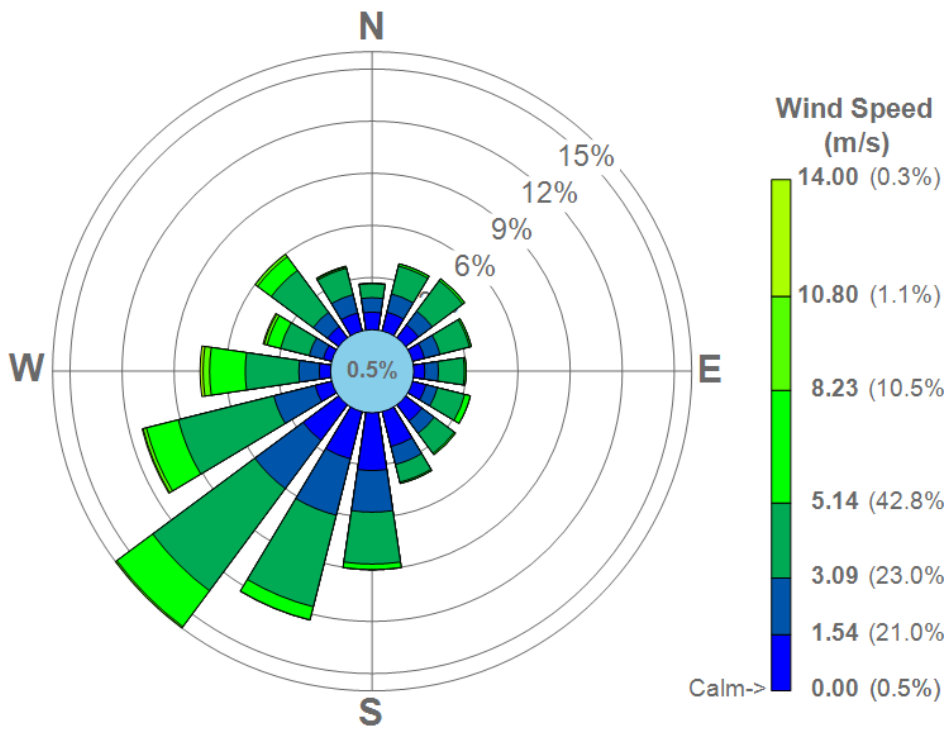
APPENDICES

Appendix 1: Meteorological Data – 2014 to 2018 Wind Roses

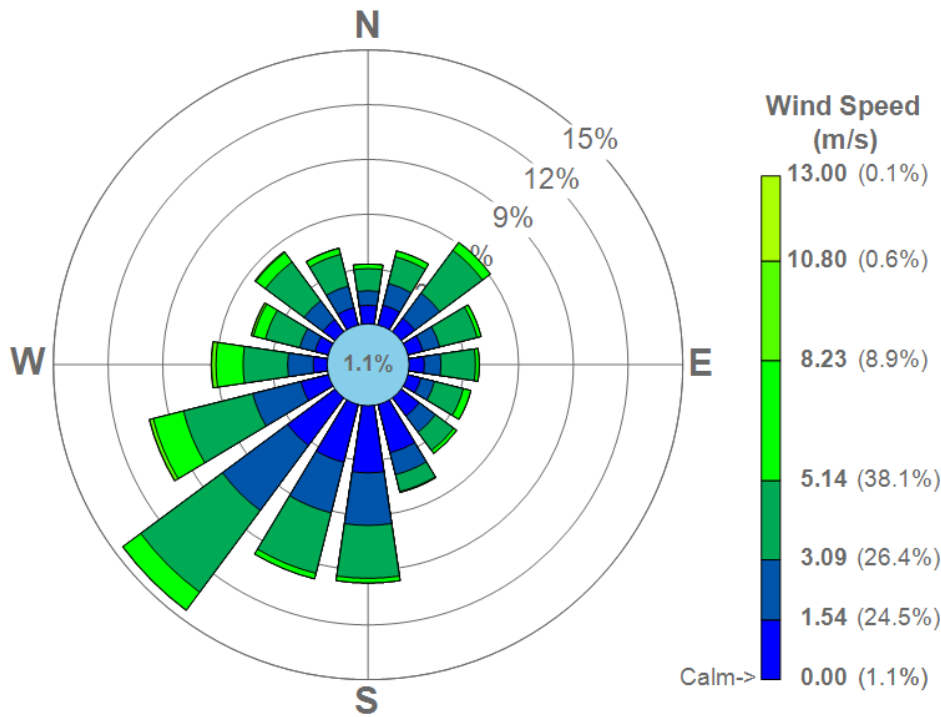
2014



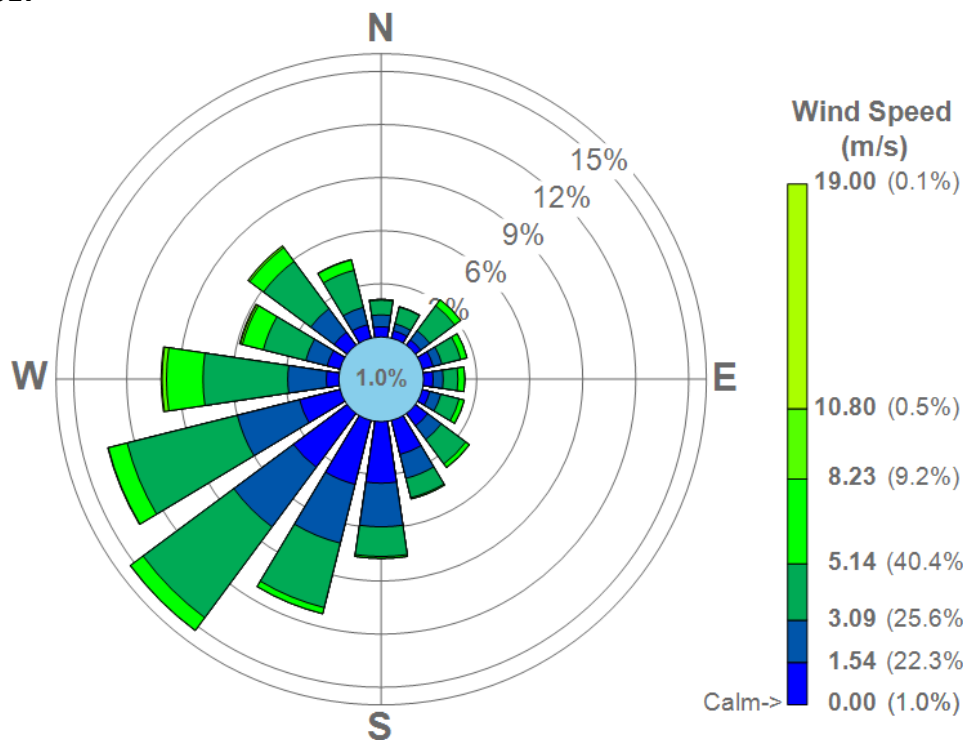
2015



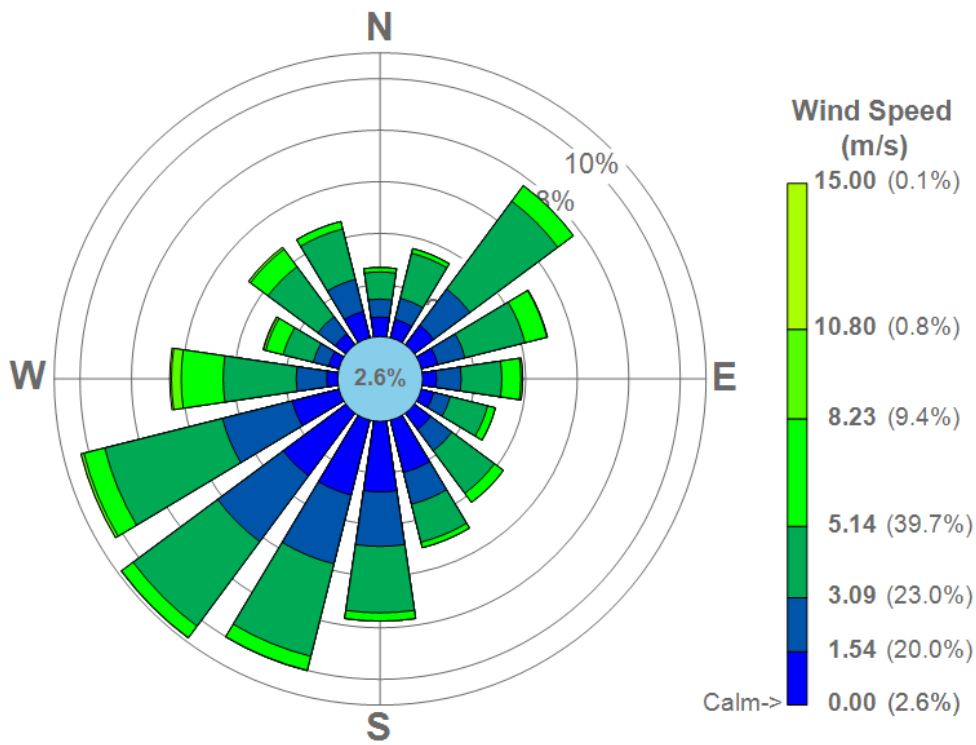
2016



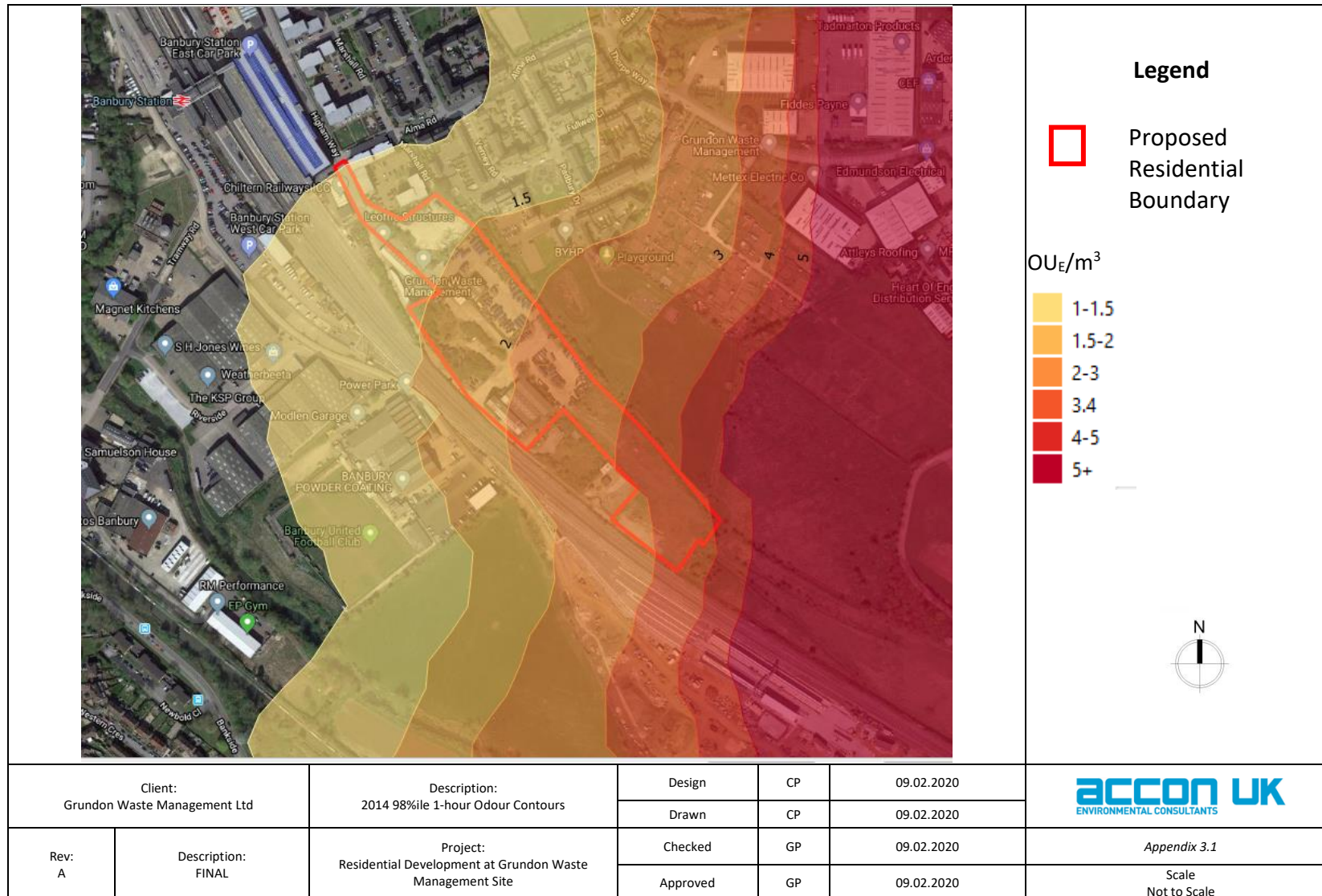
2017



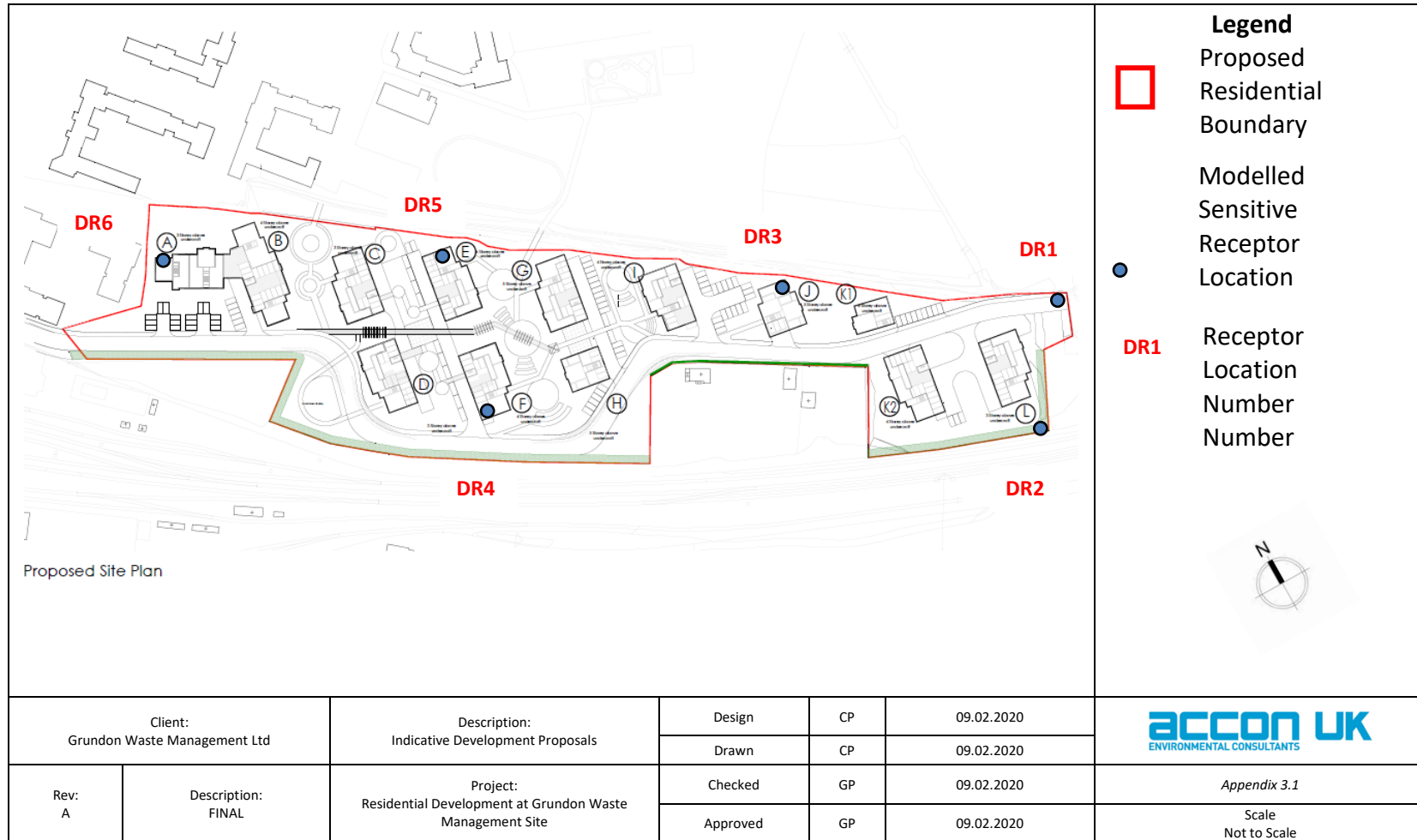
2018



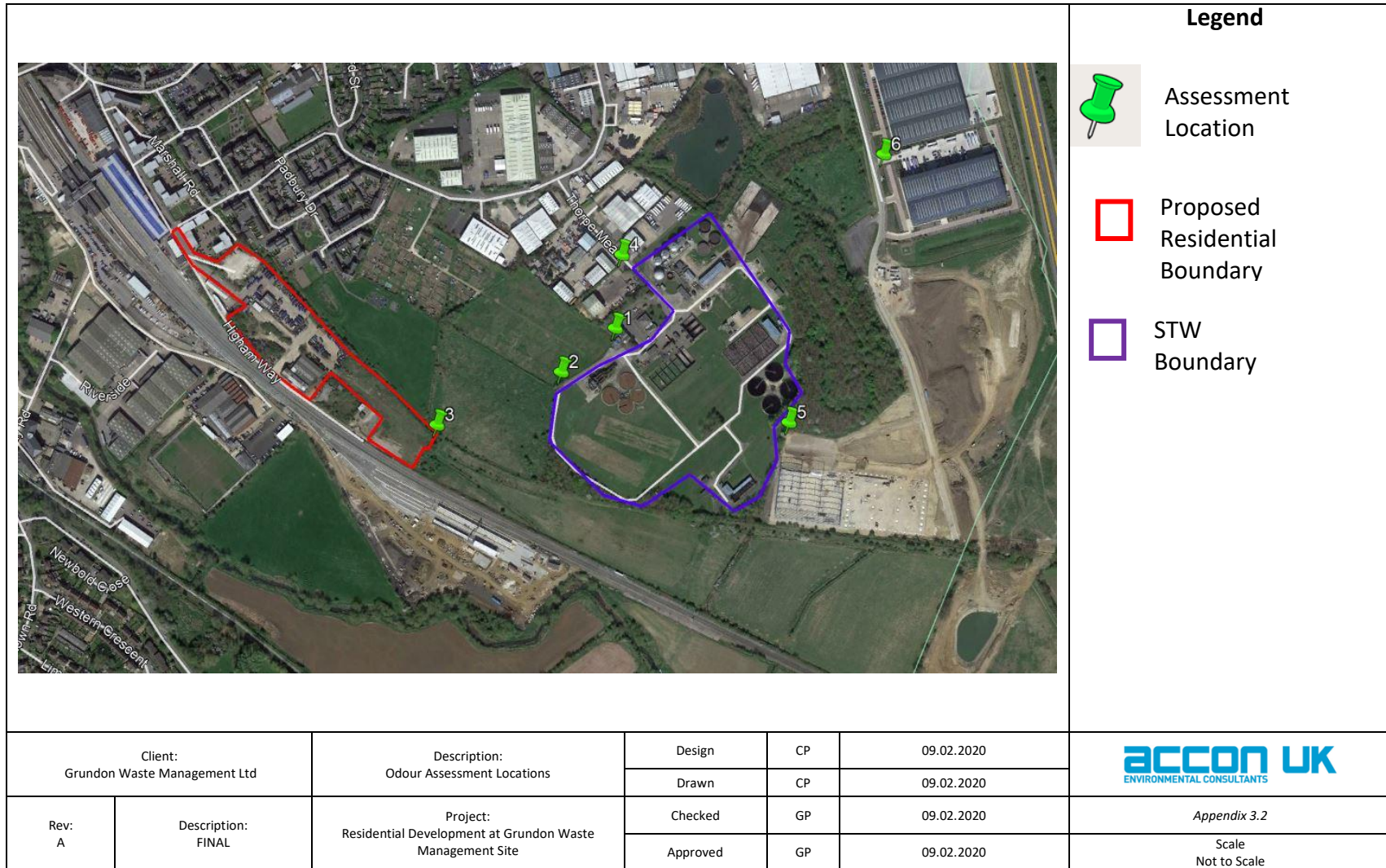
Appendix 2: 2014 98%ile 1-hour Odour Contours



Appendix 3.1: Indicative Development Proposals and Dispersion Modelling Receptor Locations



Appendix 3.2: Sniff Testing Locations



Appendix 4: Odour Report Forms – ‘Sniff Tests’

Odour Report Form – Adapted from IPPC H4 ‘Odour Management’, Environment Agency (2011)

Odour Report Form	Date: 27.11.2019	Project: Residential Development at Grondon Waste Management Site		
Test Location	1.	2.	3.	4.
Time	11:33	11:43	12:14	12:33
Weather Conditions	Dry Sunny	Dry Sunny	Dry Sunny	Dry Sunny
Temperature	11°	11°	11°	11°
Wind Speed/Direction	2-3 m/s ESE	2-3 m/s ESE	2-3 m/s ESE	2-3 m/s ESE
Distance to Source	20m NW	Boundary of Banbury STW	Closest part of the proposed development site	At the entrance to Banbury STW
Plant Operational?	Yes	Yes	Yes	Yes
Intensity (VDI 3882, Part 14)	2	0	0	1
Duration	Constant	-	-	Constant
Notes and Odour Characteristics	Not unpleasant	-	-	Not necessarily STW

Intensity Ref: German Standard VDI 3882, Part 14

0 No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour, **4** Strong odour, **5** Very strong odour,
6 Extremely strong odour

Odour Report Form – Adapted from IPPC H4 ‘Odour Management’, Environment Agency (2011)

Odour Report Form	Date: 27.11.2019	Project: Residential Development at Grundon Waste Management Site		
Test Location	5.	6	7.	8.
Time	12:50	13:00		
Weather Conditions	Overcast	Overcast		
Temperature	10°C	10°C		
Wind Speed/Direction	2-3 m/s ESE	2-3 m/s ESE		
Distance to Source	Site boundary	230m east of the STW boundary		
Plant Operational?	Yes	Yes		
Intensity (VDI 3882, Part 14)	-	-		
Duration	-	-		
Notes and Odour Characteristics	-	-		

Intensity Ref: German Standard VDI 3882, Part 14

- 0** No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour, **4** Strong odour, **5** Very strong odour,
6 Extremely strong odour

Appendix 5: Correspondence from Thames Water

Christine Park

From: Graham Parry
Sent: 05 December 2019 10:39
To: Mark Berry; veronique.bensadou@grundon.com
Cc: Christine Park
Subject: FW: Banbury Sewage Treatment Works (STW) - Odour Assessment

Please see the response that I have had from Thames Water in respect of my requesting a marked up plan. It would appear that they are unwilling to engage with us without bringing on board their appointed consultants.

I will try one more time to engage with him otherwise we will press ahead with our odour assessment.

Best regards,

Graham

Graham A Parry
Managing Director

ACCON UK
ENVIRONMENTAL CONSULTANTS

EIA • Noise • Vibration • Air Quality • Lighting • Ecology



ACCON UK Limited
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Mobile: 07754 596789
Website: www.accon-uk.com

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From: Mark Dickinson [mailto:Mark.Dickinson@thameswater.co.uk]
Sent: 04 December 2019 12:37
To: Graham Parry <graham.parry@accon-uk.com>
Subject: RE: Banbury Sewage Treatment Works (STW) - Odour Assessment

Hi Graham

Apologies if I wasn't clear

We are happy to work with the Developer (their appointed consultants) in the production of a joint study to a Thames Water specification by a Thames Water appointed consultant.

Thames Water will not support third parties in the production of independent odour assessment of a Thames Water asset

Regards Mark

Mark Dickinson

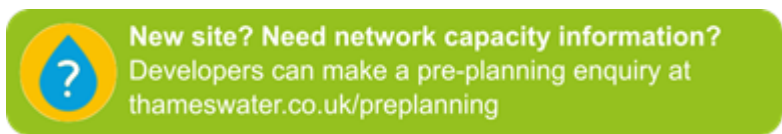
Developer Services – Development Planning Manager

Mobile 07747 640591

mark.dickinson@thameswater.co.uk

Maple Lodge STW, Denham Way, Rickmansworth, WD3 9SQ

Find us online at developers.thameswater.co.uk



From: Graham Parry <graham.parry@acon-uk.com>

Sent: 04 December 2019 11:49

To: Mark Dickinson <Mark.Dickinson@thameswater.co.uk>

Subject: RE: Banbury Sewage Treatment Works (STW) - Odour Assessment

Mark,

Many thanks for your response however what we requested was:

accordingly I would be obliged if you could provide me with a plan identifying the various odour sources e.g. the open inlet, preliminary treatment and primary treatment open assets, the cake pad area etc.

Is it possible to provide the above information as my client requires ACCON to carry out a wholly independent assessment of potential odour risk from the treatment works?

Should you require any clarification then please do not hesitate to contact me.

Best regards,

Graham

Graham A Parry
Managing Director



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From: Mark Dickinson [<mailto:Mark.Dickinson@thameswater.co.uk>]
Sent: 03 December 2019 09:37
To: Graham Parry <graham.parry@accon-uk.com>
Cc: veronique.bensadou@grundon.com
Subject: RE: Banbury Sewage Treatment Works (STW) - Odour Assessment

Hi Graham

Apologies this appears to slipped through the net

We would welcome the opportunity to work with the Developer of the site to understanding how odours from our Banbury STW may affect the proposed development

We do not however allow third party organisations access to our sites to produce independent Odour assessments. Where a Developer requires support in understanding the odour emissions from one of our sites, TW will on behalf of the Developer arrange for one its odour specialists to undertake a full sample survey at the Developers costs.

The window for full sampling has now closed and won't reopen until late spring 2020. I would be happy to contact the specialist involved to provide a quote for when the window reopens.

We have previously been asked about the use of Library values for Banbury STW however we are unable to offer a library sample study at Banbury STW for the following reasons.

1. Banbury Sewage Treatment Works (STW) receives effluent from multiple highly odorous and high strength trade sources. This will impact the intensity, tone and variability of site odour notable from the open Inlet, Preliminary Treatment and Primary Treatment assets in a way that is likely to be unique to that specific STW
2. The selection of library values is somewhat arbitrary, for example the common source of values in the public domain as the UKWIR Reference Guide for Odour allows a variation of one or more orders of magnitude across the span of look up values for any given unit process.

Below is a typical process for undertaking a sample survey

Stage 1 (probably 6 – 8 weeks from bullet.

1. Developer asks Thames Water (TW) for quotes from its approved contractor

2. Contractor provide quotes free of charge
3. Developer instruct TW to undertake the work
4. TW ask for payment from Developer (Odour specialist costs + 10% TW costs + VAT)
5. Developer makes payment to TW
6. TW confirm receipt payment
7. TW confirm operation of site and any likely future upgrade work
8. TW raise PO with Odour specialist
9. Odour specialist undertake works
10. Odour specialist produce draft report
11. TW and Developer comment on report and agree final version
12. Report is issued in final version indicating what land is developable based on the 3 isopleth contour for residential development 6 isopleth for offices (see IAQM)

Stage 2 (probably 4 – 6 weeks) only applicable if dwellings affected by odours.

1. Developer asks for mitigation to be investigated (if odours affect developable land)
2. Most odorous sources identified and typical mitigation calculated
3. Model re run based on mitigation provided
4. Revised Odour contours recalculated
5. Mitigation option provided to engineering for costing
6. Costings provided

Stage 3 (probably 12 – 18 months)

1. Developer decides what level of mitigation they want
2. Legal's and capital costs agreed
3. Developer funds
4. Mitigation delivered

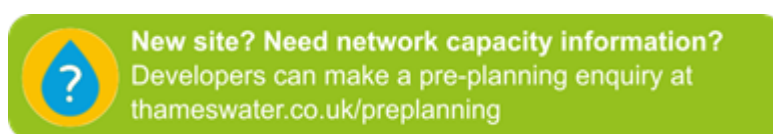
I presume the above is self-explanatory however should you wish to discuss further please do get in touch

Regards Mark

Mark Dickinson

Developer Services – Development Planning Manager
Mobile 07747 640591
mark.dickinson@thameswater.co.uk

Maple Lodge STW, Denham Way, Rickmansworth, WD3 9SQ
Find us online at developers.thameswater.co.uk



From: Graham Parry <graham.parry@accon-uk.com>
Sent: 29 November 2019 17:37
To: Mark Dickinson <Mark.Dickinson@thameswater.co.uk>
Cc: veronique.bensadou@grundon.com
Subject: FW: Banbury Sewage Treatment Works (STW) - Odour Assessment

Mark,

Could you please indicate as to when we might receive the requested information in the email below.

Should you have any queries then please do not hesitate to contact me.

Best regards,

Graham

Graham A Parry
Managing Director



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From: Graham Parry

Sent: 17 November 2019 11:21

To: Mark.Dickinson@thameswater.co.uk

Subject: Banbury Sewage Treatment Works (STW) - Odour Assessment

Mark,

I understand that you have previously been involved in providing advice in respect of an appropriate odour assessment in respect of the Banbury STW. ACCON have been appointed to carry out an odour assessment in respect of a proposed nearby residential development and accordingly I would be obliged if you could provide me with a plan identifying the various odour sources e.g. the open inlet, preliminary treatment and primary treatment open assets, the cake pad area etc.

If there is a cost associated with providing the plan then we will be willing to pay any reasonable costs.

Best regards,

Graham

Graham A Parry
Managing Director



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