



Bloor Homes, Jelson Homes and Barwood
Strategic Land LLP

EARL SHILTON SEWAGE TREATMENT WORKS

Odour Modelling Assessment





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EXECUTIVE SUMMARY

WSP UK Ltd (WSP) (formerly Wood Group UK Ltd) has been commissioned by Bloor Homes, Jelson Homes and Barwood Strategic Land II LLP to review and establish the current odour baseline at Earl Shilton through detailed dispersion modelling of odour emissions from Earl Shilton Sewage Treatment Works (STW).

As proposals for the urban extension of Earl Shilton include land directly surrounding the Earl Shilton STW, a baseline odour assessment is required to determine whether the proposed development area would be affected by odour emissions from the STW. The STW is located at the easterly extent of the town of Earl Shilton, with the closest existing residential receptors being new build houses approximately 125m north-west of the site boundary.

The Earl Shilton STW was previously modelled by WSP (then AMEC) in 2011 and an odour impact assessment was written. Since the site undertook several upgrades in 2019, a review of the odour assessment was required.

The odour modelling assessment has been updated using Numerical Weather Prediction (NWP) data. NWP data is considered more representative of local conditions because when obtained, the site's exact National Grid Reference location is used. This allows the influence of other parameters (such as terrain and surface roughness) to be accounted for reducing the need for professional judgement when inputting the parameters for both the met site and modelled site.

The masterplan has been developed to ensure that all residential dwellings are located outside of the $C_{98,1hr} 3 \text{ ouE/m}^3$ contour. The masterplan has been amended to ensure only parking remains within the $C_{98,1hr} 5 \text{ ouE/m}^3$ for the employment areas. It has been confirmed that the employment closest to the STW is most likely to consist of uses such as storage/ distribution rather than offices.

Validation of the odour emissions and odour model has been undertaken in 2022 using site specific olfactometry sampling. Based on the sniff tests carried out, odour exposure from the STW at the proposed residential locations can be mostly considered negligible. The modelled odour concentrations included in Figure 5-1, show that the 3 ouE/m^3 contour line does not encroach on the residential properties. The contour in the figure shows the maximum modelled concentration for each point over the five year assessment period, and therefore it can be assumed that an appropriate 'buffer' has been considered.

It should be noted that there have been no complaints received by Hinckley and Bosworth Borough Council (HBBC) relating to odour from the Earl Shilton STW for the past 10 years from any of the existing sensitive receptors.

1 INTRODUCTION

1.1 BACKGROUND

- 1.1.1. WSP UK Ltd (WSP) (formerly Wood Group UK Ltd) has been commissioned by Bloor Homes, Jelson Homes and Barwood Strategic Land II LLP to review and establish the current odour baseline at Earl Shilton through detailed dispersion modelling of odour emissions from Earl Shilton Sewage Treatment Works (STW).
- 1.1.2. As proposals for the urban extension of Earl Shilton include land directly surrounding the Earl Shilton STW, a baseline odour assessment is required to determine whether the proposed development area would be affected by odour emissions from the Earl Shilton STW. The Earl Shilton STW is located at the easterly extent of the town of Earl Shilton, with the closest existing residential receptors being new build houses approximately 125 m north-west of the site boundary.
- 1.1.3. The Earl Shilton STW was previously modelled by WSP (then AMEC) in 2011 and an odour impact assessment was written. Since the site undertook several upgrades in 2019, a review of the odour assessment was required.
- 1.1.4. The Earl Shilton STW is operated by Severn Trent Water Ltd and comprises a single stream treatment works with flows initially passing through an inlet works with screenings and grit removal. The flows then pass through a three-tiered treatment process as follows:
 - Primary treatment including Primary Settlement Tanks (PSTs);
 - Secondary treatment including Activated Sludge Plant (ASP); and
 - Tertiary treatment including Final Settlement Tanks (FSTs).
- 1.1.5. An upgrade in 2019 resulting in the ASP treatment and associated Surplus Activated Sludge (SAS) treatment replacing the percolating filters and humus. In addition to the above, tankers export sludge for offsite treatment.
- 1.1.6. Figure 1-1 shows the site location.



Figure 1-1 - Site Location

1.2 PURPOSE OF THIS REPORT

- 1.2.1. The purpose of the updated report is to detail the baseline odour assessment undertaken for Earl Shilton STW using dispersion modelling, detail the results of olfactometry sampling and assess the impacts of the Earl Shilton STW on the proposed residential and industrial areas.

2 LEGISLATION, GUIDANCE AND ODOUR CRITERIA

2.1 LEGISLATION

ENVIRONMENTAL PROTECTION ACT 1990

- 2.1.1. Sections 79, 80 and 82 of the Environmental Protection Act (EPA) 1990¹ deal with the matter of Statutory Nuisance. This empowers local authorities to conduct surveys of their administrative areas and, if an authority considers that an odour nuisance has occurred and/or is likely to re-occur, then it has a duty to declare this and issue an Abatement Notice, requiring the owner/operator of the trade premises causing the odour to abate it within a certain time scale. Section 79 of the EPA defines the types of nuisance that can arise and the most applicable categories to odour are:
- Fumes or gases emitted from premises so as to be prejudicial to health or a nuisance; and
 - Any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance.
- 2.1.2. The operator of the premises can appeal against the Abatement Notice, using a defence that Best Practicable Means (BPM) are being applied.

ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2013

- 2.1.3. The 2010/75 EU Directive was transposed into Environmental Permitting Regulations (EPR) for England and Wales in 2013². Environmental permitting regulations were put in place to administer the permitting of installations that were likely to have the potential to generate significant impacts upon the environment. In some cases, this can include effluent treatment plants where significant quantities (>50 tonnes/day) of non-hazardous wastes are biologically or physico-chemically treated for disposal. Environmental Permits commonly contain Conditions that require installation operators to meet certain limits for discharge of emissions to atmosphere, including H₂S concentrations from both point sources and fugitive releases.

ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2019, AS AMENDED

- 2.1.4. The 2019 regulations³ update the 2013 regulations and ensures the regulations remain fully operable post Brexit. There are no changes to the permit requirements for facilities treating greater than 50 tonnes per day of non-hazardous wastes for disposal.

¹ The National Archives (1990). *Environmental Protection Act 1990* [online]. Available at: [Environmental Protection Act 1990 \(legislation.gov.uk\)](https://www.legislation.gov.uk/ukpga/1990/43/contents) [Accessed September 2023].

² The National Archives (2013). *The Environmental Permitting (England and Wales) (Amendment) Regulations 2013* [online]. Available at: [The Environmental Permitting \(England and Wales\) \(Amendment\) Regulations 2013 \(legislation.gov.uk\)](https://www.legislation.gov.uk/uksi/2013/1224/contents/make) [Accessed September 2023].

³ The National Archives (2019). *The Environmental Permitting (England and Wales) (Amendment) (EU Exit) Regulations 2019* [online]. Available at: [The Environmental Permitting \(England and Wales\) \(Amendment\) \(EU Exit\) Regulations 2019 \(legislation.gov.uk\)](https://www.legislation.gov.uk/uksi/2019/1224/contents/make) [Accessed September 2023].

- 2.1.5. In 2018, a revision of the Best Available Technology (BAT) conclusions was published to provide an update of best available techniques for treating waste and BAT associated emission levels (BAT-AELs), including a BAT-AELs for odour concentrations to be applied for channelled emissions.

EARL SHILTON AND BARWELL AREA ACTION PLAN

- 2.1.6. Policies and measures are specified in the Earl Shilton and Barwell Area Action Plan (2014)⁴. Review of the document highlights the following relevant policies:
- Policy 22 – Development and Design: *“Developments will be permitted providing that the following requirements are met: It does not adversely affect the privacy and amenity of nearby residents and occupiers of adjacent buildings, including matters of lighting, air quality (including odour), noise, vibration and visual intrusion; The amenity of occupiers of the proposed development would not be adversely affected by activities in the vicinity of the site.”*
 - Paragraph 5.11 of the action plan: *“The design of the Weavers Meadow development must factor in the need to provide an appropriate buffer between the principal sources of odour within the Earl Shilton Waste Water Treatment Works and the development of sensitive land uses such as residential, education, community and employment uses within the SUE. A buffer of 100 metres is advised.”*
 - Paragraph 9.16 of the action plan: *“The Earl Shilton Wastewater Treatment works include a number of sources of odour that have been identified by Severn Trent Water through a FIDOL Report. In consultation with the Environmental Health Department It was advised that careful masterplanning is required to ensure that development does not take place within 100m of the primary sources of odour that have been identified by Severn Trent Water.”*

2.2 GUIDANCE

DEFRA CODE OF PRACTICE ON ODOUR NUISANCE FROM SEWAGE TREATMENT WORKS

- 2.2.1. This guidance⁵ was produced in 2006 and has now been withdrawn, but still contains useful information for odour assessments. It was aimed at environmental health practitioners, the public and sewage treatment works operators. The overall objective of the guidance is to achieve a balance between reasonable and best practice management of the treatment processes by the operator, understanding on the part of the public and effective regulation by local authorities.

⁴ Hinckley and Bosworth Borough Council (2014). *Earl Shilton and Barwell area action plan and appendices – adopted 23 September 2014* [online]. Available at: [Earl Shilton and Barwell area action plan \(AAP\) - post examination | Hinckley & Bosworth Borough Council \(hinckley-bosworth.gov.uk\)](https://www.hinckley-bosworth.gov.uk/earl-shilton-and-barwell-area-action-plan-aap-post-examination) [Accessed September 2023].

⁵ Department for Environment Food and Rural Affairs (2006). *Code of Practice on Odour Nuisance from Sewage Treatment Works* [online]. Available at: [\[Withdrawn\] Code of practice on odour nuisance from sewage treatment works - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/28144/Code_of_Practice_on_Odour_Nuisance_from_Sewage_Treatment_Works.pdf) [Accessed September 2023].

DEFRA ODOUR GUIDANCE FOR LOCAL AUTHORITIES

- 2.2.2. This guidance⁶ was published in 2010 by Defra and is aimed at providing local authorities with an over-arching guide as to how odour issues should be investigated, prevented and managed. It is not specific to the wastewater industry.

IPPC CROSS SECTOR GUIDANCE

- 2.2.3. In 2011, the Environment Agency published its H4 horizontal guidance on odour⁷, which is to be applied to installations permitted under the Environmental Permitting Regulations (EPR). This provides guidance to installation operators on how to comply with the Conditions in their Environmental Permits. This guidance is relevant to sites regulated by the Environment Agency (EA).

INSTITUTE OF AIR QUALITY MANAGEMENT (IAQM) GUIDANCE ON THE ASSESSMENT FOR ODOUR PLANNING

- 2.2.4. The IAQM published guidance⁸ in 2018 for assessing odour impacts for planning purposes. The guidance presents useful tools for assessing odour, odour assessment criteria and how to draw conclusions from assessment results.
- 2.2.5. The guidance states that “*IAQM is of the opinion that the practitioner should observe, from the various scientific studies, case law and practical examples of the investigation of odour annoyance cases, that in any specific case, an appropriate criterion could lie somewhere in the range of 1 to 10 ou_E/m³ as a 98th percentile of hourly mean odour concentrations.*”
- 2.2.6. This guidance has been used to determine the sensitivity for residential receptors in this assessment.

2.3 ODOUR ASSESSMENT CRITERIA

BACKGROUND

- 2.3.1. In 1993 a public inquiry into Newbiggin-by-the-Sea Wastewater Treatment Works (WwTW) established an ambient odour annoyance standard of 5 ou/m³, expressed as a 98th percentile of hourly average modelled values (C_{98,1hr}) at a particular location over a calendar year⁹. This annoyance standard has been used as an assessment criterion both by the UK water industry and odour assessment practitioners in the UK. The protocol used for the determination of odour at the time of the 1993 public inquiry was a Dutch standard that used a particular concentration of an odorous chemical in air to screen panellists for sensitivity. Since the advent of the European

⁶ Department for Environment Food and Rural Affairs (2010). *Odour Guidance for Local Authorities* [online]. Available at: [Odour guidance for Local Authorities \(publishing.service.gov.uk\)](https://publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/364822/odour-guidance-for-local-authorities.pdf) [Accessed September 2023].

⁷ Environment Agency (2011). *Additional guidance for H4 Odour Management: How to comply with your environmental permit* [online]. Available at: [How to comply \(publishing.service.gov.uk\)](https://publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/364822/odour-guidance-for-local-authorities.pdf) [Accessed September 2023].

⁸ Institute of Air Quality Management (2018). *Guidance on the assessment of odour for planning* [online]. Available at: [odour-guidance-2014.pdf \(iaqm.co.uk\)](https://iaqm.co.uk/wp-content/uploads/2014/06/odour-guidance-2014.pdf) [Accessed September 2023].

⁹ This equates to experiencing odours above 5 ou/m³ (now 2.5 ou_E/m³), regarded as a faint odour, for only 2% of the hours in a year – approximately 175 hours. For the remainder of the time, the odour experienced would be less than faint.

standard on olfactometry, the sensitivity of the test has changed, with the original Dutch standard of 5 ou_E/m³ being equivalent to the European standard of 2.5 ou_E/m³.

- 2.3.2. In 2002, the Environment Agency (EA) published a draft copy of its Horizontal Guidance Document H4⁷ and, in 2011, a final version. This includes a graduated scale of “indicative odour thresholds”, depending upon the perceived offensiveness of the odour, as follows:
- 1.5 ou_E/m³ (C_{98,1hr}) for the most offensive odours;
 - 3.0 ou_E/m³ (C_{98,1hr}) for less offensive odours; and
 - 6.0 ou_E/m³ (C_{98,1hr}) for the least offensive odours.
- 2.3.3. These were derived from studies in Holland on the offensiveness of odours from intensive pig farming in rural areas. It is generally considered that sewage treatment works odours fall into the middle category (3.0 ou_E/m³), unless there is septic wastewater or sludge on the site, in which case the most stringent criterion of 1.5 ou_E/m³ would apply.
- 2.3.4. These thresholds were designed to be applied to those industrial processes regulated under the EPR and it was not clear, initially, how or whether these would apply to the water industry. In the event, this has now been clarified to a certain extent and there are a number of WwTW sites across the UK that are permitted and regulated by the EA, although this normally covers only those operations relating to sludge treatment and import of wastes.
- 2.3.5. The Chartered Institute of Water and Environmental Management (CIWEM) has issued a Policy Position Statement outlining its position regarding the control of odour and the likely level of impact as indicated by modelling studies. This statement is frequently used by the water industry as the basis of assigning acceptable criteria for odour impact assessments.
- 2.3.6. Within the statement, CIWEM indicates that odour impact criteria should be regarded as indicative guidelines and should not be applied as statutory numerical standards. Based on research undertaken in the UK at the time the statement was issued, the body considered that the following framework of C_{98, 1hr} criteria were the most reliable indicators of the likelihood of complaints associated with wastewater treatment facilities:
- C_{98, 1hr} 10 ou_E/m³ - complaints are highly likely and odour exposure at these levels represents an actionable nuisance;
 - C_{98, 1hr} 5 ou_E/m³ - 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, 1hr} < 3 ou_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.
- 2.3.7. Research in the Netherlands¹⁰ has highlighted the complexity of the assessment of odours from WWTWs. It states that situations exist where 5 ou_E/m³ has been achieved and no complaints have been received, yet cases also exist where 1 ou_E/m³ has been achieved and complaints were still

¹⁰ Rijkswaterstaat Environment (2007). *Netherlands Emissions Guidelines for Air* [online]. Available at: [Netherlands Emission Guidelines for Air - Rijkswaterstaat Environment \(rwsenvironment.eu\)](https://www.rwsenvironment.eu/en/air-quality/emissions-guidelines-for-air) Accessed September 2023].

received. Here, the Netherlands Emission Guidelines for Air considers that the exposure concentration where complaints escalate is at concentrations above $2.5 \text{ ou}_E/\text{m}^3$ as the 98th percentile of hourly averages. An appropriate criterion could lie anywhere between $1 \text{ ou}_E/\text{m}^3$ and $10 \text{ ou}_E/\text{m}^3$ as the 98th percentile of hourly averages at a critical receptor¹¹.

- 2.3.8. For many sewage treatment works and sludge treatment centres in the UK and Ireland, dispersion modelling output has been assessed against an odour annoyance criterion whereby no critical receptor shall be exposed to a concentration of more than $5 \text{ ou}_E/\text{m}^3$ 98th percentile of hourly averages as a result of emissions from a sewage treatment works¹². WSP's extensive experience of applying and designing to this criterion over the last 15 years for sewage and sludge treatment schemes indicates that, where compliance occurs, complaints with respect to odour are unlikely. The use of the $5 \text{ ou}_E/\text{m}^3$ as the 98th percentile of hourly averages has been confirmed in a recent High Court decision¹³ where $5 \text{ ou}_E/\text{m}^3$ as the 98th percentile of hourly averages or above is reached, "*nuisance will certainly be established*".
- 2.3.9. As Earl Shilton STW does not comprises any sludge treatment, it is considered a moderately offensive odour (H4 odour guidance and IAQM guidance) and both $5 \text{ ou}_E/\text{m}^3$ and $3 \text{ ou}_E/\text{m}^3$ as the 98th percentile of hourly averages are used as benchmark for this assessment.

¹¹ Hall, D. L., McIntyre, A. E., (2004). The Derivation of Odour Standards and their Role and the Foundation of Odour Management Plans for Planning Regulation. In Proceedings of the Second National Conference Volume Two September 2004. Ed N. J. Horan.

¹² McGovern, JE, Clarkson, CR (1994). The Development of Northumbrian Waters Approach to Odour Abatement for Sewage Facilities.

¹³ Citation EWHC 3253 (2011), Dobson & Others vs Thames Water Utilities Ltd. High Court of Justice.

3 METHODOLOGY

3.1 DISPERSION MODEL

MODEL SETUP

Model

- 3.1.1. This study uses the ADMS 6 model, which was developed in the UK by Cambridge Environmental Research Consultants (CERC) in collaboration with the Meteorological Office, National Power and the University of Surrey. ADMS is termed a 'new generation' model, parameterising stability and turbulence in the planetary boundary layer (PBL) by the Monin-Obukhov length and the boundary layer depth. This approach allows the vertical structure of the PBL to be more accurately defined than by the stability classification methods of earlier dispersion models such as R91 or ISC.
- 3.1.2. Like R91 and ISC, ADMS adopts a symmetrical Gaussian profile of the concentration distribution in the vertical and crosswind directions in neutral and stable conditions. However, unlike R91 or ISC, the ADMS vertical concentration profile in convective conditions adopts a skewed Gaussian distribution to take account of the heterogeneous nature of the vertical velocity distribution in the Convective Boundary Layer (CBL).
- 3.1.3. ADMS has been used extensively to predict odour impacts from Wastewater Treatment Works (WwTWs) and STWs and was therefore considered appropriate for the odour assessment.

Surface characteristics

- 3.1.4. The predominant surface characteristics and land use in a model domain have an important influence in determining turbulent fluxes and, hence, the stability of the boundary layer and atmospheric dispersion. Factors pertinent to this determination are detailed below.

Surface roughness length

- 3.1.5. The surface roughness length represents the aerodynamic effects of surface friction and is defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing in the boundary layer.
- 3.1.6. The surface roughness length is related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas.
- 3.1.7. A spatially variable surface roughness length was used for this assessment as shown in Figure 3-1, which takes into consideration the proposed residential and industrial area.

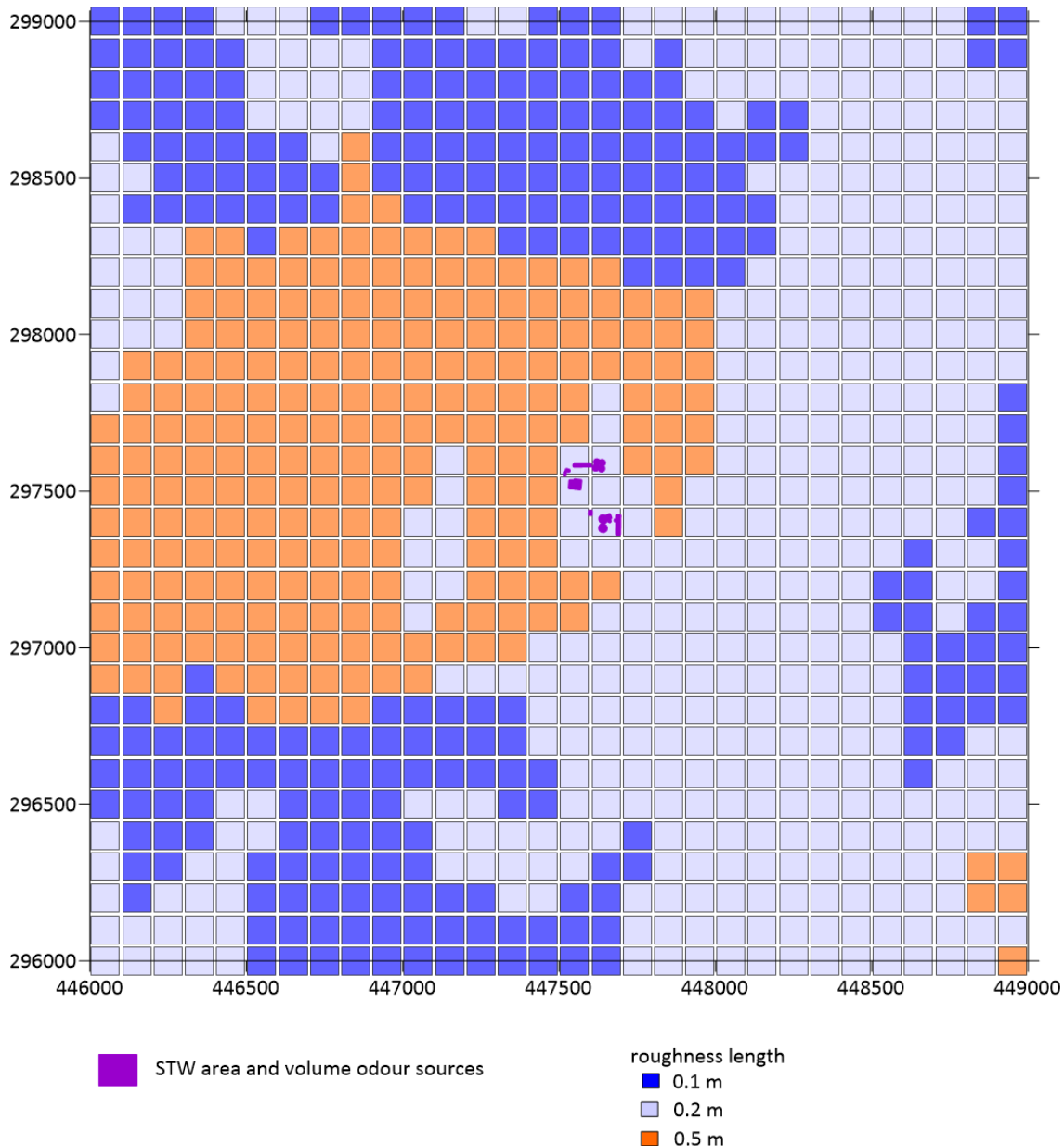


Figure 3-1 - Variable surface roughness length (m)

Terrain

- 3.1.8. The presence of elevated terrain can significantly affect ground level concentrations of pollutants emitted from elevated sources such as stacks. Terrain in the region of Earl Shilton STW is flat. A review of ordnance survey mapping for the area shows that within 1km of the site the terrain rises by less than 10m, therefore, terrain was not included in the model.

Buildings

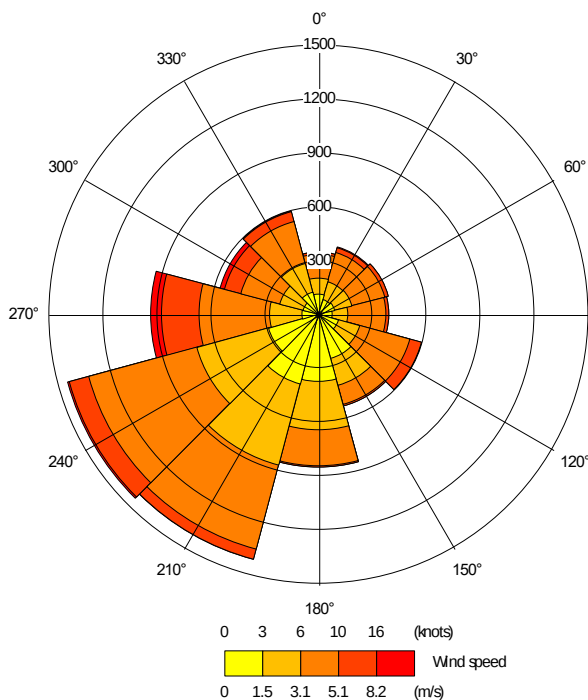
- 3.1.9. Any large object has an impact on atmospheric flow and air turbulence within the locality of the object. This can result in maximum ground level concentrations that are significantly different (generally higher) from those encountered in the absence of buildings. The building 'zone of influence' is generally regarded as extending a distance of 5L (where L is the lesser of the building

height or width) from the foot of the building in the horizontal plane and three times the height of the building in the vertical plane. Buildings can influence the air flow from only point sources in gaussian dispersion model such as ADMS. As there are no point sources in this assessment, no buildings were modelled.

Meteorological data

- 3.1.10. The nearest weather station is at Church Lawford airport, approximately 25km south of the site. The dispersion model was run using five years of meteorological data from 2015 to 2019. The updated model was run using NWP data for years 2018 to 2022.
- 3.1.11. NWP data is considered more representative of local conditions because when obtained, the sites exact National Grid Reference location is used. This allows the influence of other parameters (such as terrain and surface roughness) to be accounted reducing the need of professional judgement when inputting the parameters for the meteorological site.
- 3.1.12. Figure 3-2 shows the 2019 wind rose for Church Lawford airport weather station and the 2019 wind rose for the NWP data. As shown in the figures, the wind is primarily originating from the south west for both locations. The NWP data also has north westerly winds.
- 3.1.13. Wind roses for all five years for both Church Lawford and NWP data are shown in Appendix B.

Church Lawford 2019



NWP data 2019

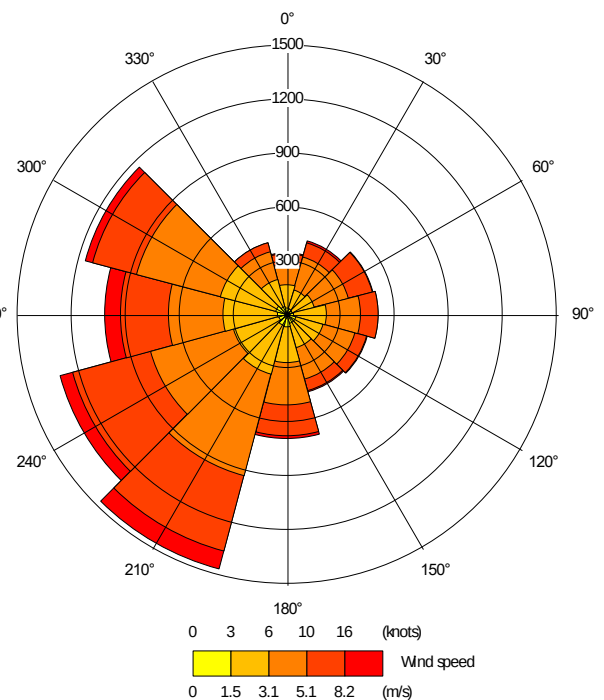


Figure 3-2 - Windrose for Church Lawford and NWP 2019

Receptors

- 3.1.14. The assessment calculated odour concentrations at gridded receptors on a 3km cartesian grid with 60 m resolution centred on the Earl Shilton STW.
- 3.1.15. Figure 3-3 shows the modelling domain.



Figure 3-3 - Modelled domain

MODEL UNCERTAINTY

- 3.1.16. Dispersion modelling is inherently uncertain, but it is nonetheless a useful tool in visualising the plume footprint and prediction of ground level concentrations. The use of dispersion models has been widely used in the UK for both regulatory and compliance purposes for several years and is an accepted approach for this type of assessment.
- 3.1.17. However, in order to try to counter this inherent uncertainty, a number of steps are taken to calibrate the model inputs to a “worst-case” position, such that the model outputs should be at or close to the upper bound of the likely results. These include:
- Assumptions in the model that the processes will be emitting odour for most sources at the maximum measured rates continuously throughout the year; and
 - Repeating the modelling with five years of hourly sequential meteorological data and reporting the year which yields the highest results.

- 3.1.18. Some factors cannot be included in the dispersion modelling exercise; these predominantly include infrequent abnormal operations. During these periods, it is expected that the odour emissions could be elevated for a short period of time.

ANALYSIS APPROACH

- 3.1.19. The masterplan includes numerous land uses including employment and residential. Table 3-1 shows the IAQM's guide of receptor sensitivity to odours⁸.
- 3.1.20. For the sensitivity of people to odour, the IAQM recommends that professional judgement is used to identify where on the spectrum between high and low sensitivity a receptor lies, taking into account the general principles shown in the table.

Table 3-1 – Receptor sensitivity to odour

Sensitivity	Surrounding land where:
High sensitivity receptor	- 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	- 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	- 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.

- 3.1.21. As Earl Shilton STW does not comprises any sludge treatment, it is considered a moderately offensive odour (H4 odour guidance and IAQM guidance) and both 5 ou_E/m³ and 3 ou_E/m³ as the 98th percentile of hourly averages are used as benchmark for this assessment.
- 3.1.22. The proposed odour effect descriptors for impacts predicted by modelling for moderately offensive odours⁸ are shown in Table 3-2.

Table 3-2 – Proposed odour effect descriptors for impacts predicted by modelling for 'moderately offensive' odours

Odour exposure level (C _{98 1hr} , ou _E /m ³)	Receptor sensitivity		
	Low	Medium	High
≥10	Moderate	Substantial	Substantial
5-<10	Slight	Moderate	Moderate

Odour exposure level ($C_{98\ 1hr}$, ouE/m^3)	Receptor sensitivity		
	Low	Medium	High
3-<5	Negligible	Slight	Moderate
1.5-<3	Negligible	Negligible	Slight
0.5-<1.5	Negligible	Negligible	Negligible
≤ 0.5	Negligible	Negligible	Negligible

3.2 SNIFF TESTS

BACKGROUND

- 3.2.1. With respect to odours, whether a particular odour will cause an annoyance reaction from human beings in their normal everyday environment is determined by a number of different but interacting factors, including:
- The concentration of the odour in the atmosphere;
 - The nature of the odour (how objectionable it is perceived to be); and
 - How frequently it occurs and for how long.
- 3.2.2. Odour concentration is expressed as European odour units per cubic metre at standard conditions for olfactometry (ouE/m^3) as compared to a European reference concentration of a known standard odourant in air (n-butanol). The odour concentration, in simple terms, is the number of times an odorous sample of air has to be diluted with odour free air to reach its odour threshold. Exposure is usually quantified in terms of a frequency of occurrence over a year of hourly average concentrations above a certain odour concentration limit.
- 3.2.3. Odours are not generally additive in the same way as other parameters such as decibels for noise. This reflects the way in which the brain responds to odour. The human brain has a tendency to “screen out” those odours which are always present or those that are in context to their surroundings. For example, an individual is more likely to be tolerant of an odour from a factory in an industrial area than in the countryside. The human brain will also develop a form of acceptance to a constant background of local odours.
- 3.2.4. With regard to the concentrations of odour in the atmosphere that can be detected and recognised by the human olfactory system, and the levels which would cause annoyance or give rise to complaint, there are clearly a number of factors involved. These factors are commonly associated with the FIDOL acronym:
- Frequency of detection - the number of exposures to an odour within a given time frame
 - Intensity as perceived - the magnitude of the perception of the odour
 - Duration - the time period during which the odour exposure occurs
 - Offensiveness - this is a qualitative judgement to describe the odour
 - Location – the type of receptor will determine its sensitivity to odour, e.g. residential properties are likely to be associated with greater sensitivity than industrial locations

- 3.2.5. Specific guidance for assessing odour effects for installations subject to the provisions of the Environmental Permitting (England and Wales) Regulations 2010, as amended 2013, is provided by the Environment Agency in its Horizontal Guidance Note H4.
- 3.2.6. An olfactory response to an odorant will typically occur due to transient peaks or fluctuations in concentrations over very short periods of time, typically in the order of 1 minute or less. However, H4 provides odour benchmarks based on achievement of a 1 hour mean concentration, not to be exceeded for more than 2% of a year (i.e. a 98th percentile 1-hour mean value). The H4 odour benchmarks can be considered to represent a criterion for 'no reasonable cause for annoyance', rather than a benchmark representative of detection.
- 3.2.7. In H4, odour generating processes are grouped into three categories dependent upon their perceived offensiveness:
- Highly offensive - processes involving animal or fish remains, brickworks, creamery, fat and grease processing, wastewater treatment, oil refining, livestock feed factory;
 - Moderately offensive - intensive livestock rearing, fat frying (food processing), sugar beet processing, these are odours which do not obviously fall within the HIGH or LOW categories; and
 - Less offensive - chocolate manufacture, brewery, confectionery, fragrance and flavourings, coffee roasting, bakery.
- 3.2.8. Annoyance thresholds are then prescribed based on the 98th percentile of hourly averaged odour concentrations during the year and dependent upon the offensiveness of the process, as described above:
- Highly offensive = $1.5 \text{ ou}_E/\text{m}^3$;
 - Moderately offensive = $3.0 \text{ ou}_E/\text{m}^3$; and
 - Less offensive = $6.0 \text{ ou}_E/\text{m}^3$.

METHODOLOGY

- 3.2.9. A sniff test is a sensory test which requires the trained field operative to measure the odour magnitude as odour intensity subjectively using the odour intensity scale shown in Table 3-3. Each sniff test consists of an assessor visiting locations of interest, with regard to sensitive receptors and sources, and recording odour intensity, character, unpleasantness, frequency and duration. The assessor breathes normally, inhaling ambient air samples through the nose at regular intervals (every 10 seconds, to give 30 samples over a 5-minute observation period). For each sample, the odour intensity was recorded.

Table 3-3 – Odour intensity scale

Odour strength	Intensity level	Comments
No odour/ not perceptible	0	No odour when compared to the clean site
The Odour Detection Threshold (ODT) of $1 \text{ ou}_E/\text{m}^3$ is somewhere between 0 and 1		
Slight/ very weak	1	There is probably some doubt as to whether the odour is actually present
Slight/ weak	2	The odour is present but cannot be described using precise words or terms

Odour strength	Intensity level	Comments
Distinct	3	The odour character is barely recognisable
VDI 3940 says that the recognition threshold intensity is generally 3-10 times higher than the ODT (i.e. 3-10 ouE/m³)		
Strong	4	The odour character is easily recognisable
Very strong	5	The odour is offensive. Exposure to this level would be considered undesirable
Extremely strong	6	The odour is offensive. An instinctive reaction would be to mitigate against further exposure

- 3.2.10. From the sample data recorded, odour pervasiveness was assessed (as a percentage of odour time) and the average odour intensity (I_{mean}) was calculated. Table 3-4 is then used to assess the odour effect.

Table 3-4 – Matrix to assess odour exposure

Average intensity (I_{mean})	Percentage odour time ($t \geq 4$) during the test				
	$\leq 10\%$	11 to 20%	21 to 30%	31 to 40%	$\geq 41\%$
6	Large	Very large	Very large	Very large	Very large
5	Medium	Large	Large	Very large	Very large
4	Small	Medium	Medium	Large	Large
3	Small	Medium	Medium	Medium	Medium
2	Small	Small	Medium	Medium	Medium
1	Small	Small	Small	n/a	n/a

APPROACH

- 3.2.11. Sniff tests were carried out in 2022. Seven sample locations were chosen on the site of the proposed development, all of them within a short distance of the Earl Shilton STW. At each location, a total of 30 samples were taken over a five-minute observation period, with the odour intensity recorded for each sample. The sniff tests were undertaken by Charles Kwok and Aidan Mahony, both Environmental Consultants on four different occasions. Both Charles and Aidan have been classified under BSEN13725 as having ‘average sensitivity’ to odour during olfactometric testing by a recognised laboratory, meaning that they are likely to perceive odour like the ‘average person’.
- 3.2.12. The seven locations are presented in Figure 3-4 and Table 3-5.

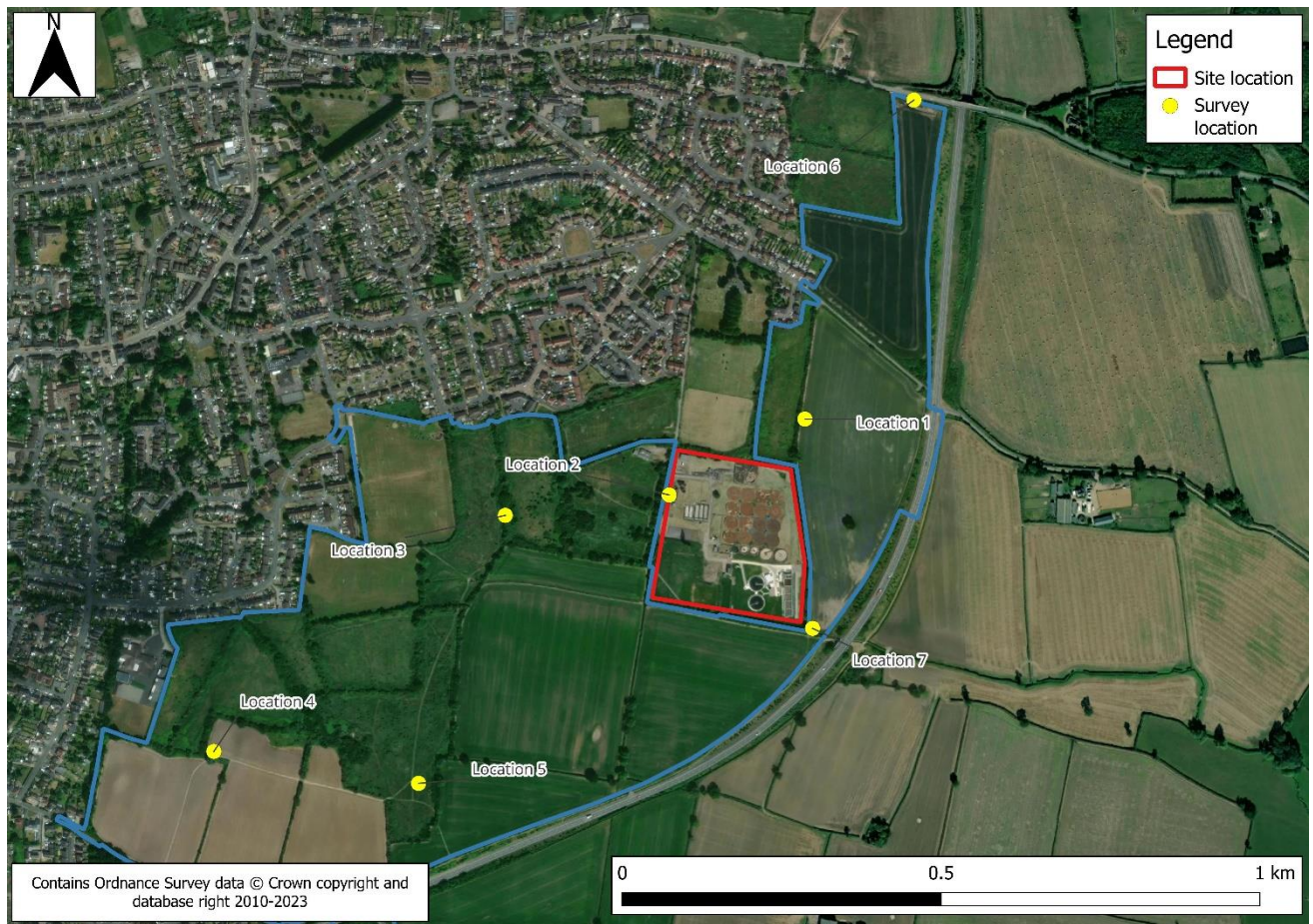


Figure 3-4 - Survey locations

Table 3-5 – Survey locations

ID	X (m)	Y (m)
Location 1	447720	297664
Location 2	447507	297545
Location 3	447250	297513
Location 4	446793	297143
Location 5	447114	297093
Location 6	447891	298164
Location 7	447732	297336

4 MODELLED ODOUR EMISSION RATES

4.1 SCENARIO

- 4.1.1. The modelled scenario included in this assessment represents the existing 2020 site layout (after the 2019 upgrade of the site).
- 4.1.2. An olfactometry monitoring survey was undertaken by Amec in 2011. However, since the site was upgraded in 2019, it was concluded that the emission factors derived from the site-specific survey will not be applicable for this assessment.
- 4.1.3. Emission factors representative of each source were derived from the assessment undertaken by Odournet for Severn Trent Water in 2010¹⁴. These emissions factors were derived on the basis of the findings of the site review undertaken on 21 October 2010, with reference to data from Odournet's extensive reference library of specific odour emissions collected from sewage treatment operations in the UK to represent low to moderate odour emissions from the site.
- 4.1.4. This model scenario was run for a five-year period (2018-2022) of meteorological data using NWP meteorological data.

4.2 ASSUMPTIONS

- 4.2.1. Based on the Odournet report and information received from Severn Trent Water, the following changes and upgrades have been confirmed to be completed and in operation:
 - Two new FSTs were built;
 - ASP was built;
 - Refurbishment of four PSTs; and
 - 16 filter beds and the humus tanks were decommissioned and replaced by the ASP.
- 4.2.2. The following assumptions were made in the modelling scenario:
 - Only two out of the three sludge tanks are operational at the same time;
 - The storm tanks fill simultaneously, and any remaining sediment is promptly sluiced with final effluent delivered using 'Tipping-Bucket Momentum Washout' system and additional manual cleaning, if necessary, after every storm event. The storm tanks were assumed to fill once a week in autumn and winter and kept empty in spring and summer months (a total of 24 days a year). The duration of storm events was assumed to be 24 hours;
 - Maximum emissions are applied to Inlet works and PSTs during the spring and summer months (April to September) and were reduced by a factor of five during the autumn and winter months (October to March). The reduced in emission rates reflect the dilution effects of increased rainwater and reduction in odorous emissions due to lower ambient temperature; and
 - All other sources were assumed continuous.

¹⁴ Odournet (2010). *Desktop odour impact assessment for proposed upgrade schemes at Earl Shilton STW, November 2010 (STRW10B_draft4)*.

4.3 MODELLLED SOURCES

4.3.1. Modelled sources are shown in Figure 4-1. Table 4-1 details all sources and emission rates included in the model. The emission rates for the sources are taken from the 2010 Odournet report which reflects a STW with a low to moderate emission potential.

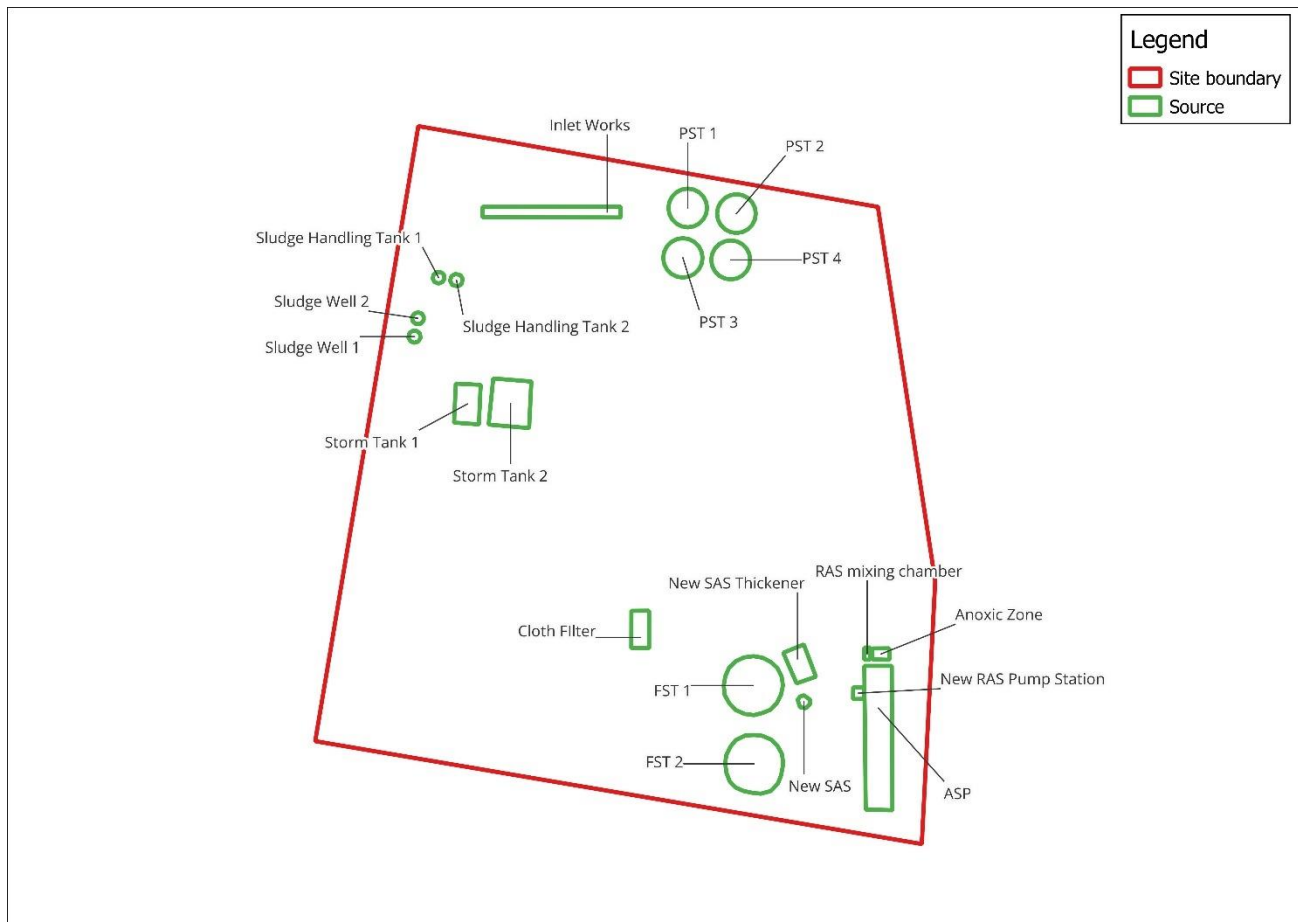


Figure 4-1 - Modelled sources

Table 4-1 – Modelled sources

Source	Number	Type	Release height (m)	Total area/ volume (m ² / m ³)	Emission rates (ou _E /m ² /s / ou _E /m ³ /s)	Emission rate (ou _E /s)
PSTs	4	Area	0.0	706.90	10.00	7069.00
Inlet Works	1	Area	0.0	215.50	20.00	4310.00
Sludge Wells	2	Area	1.0	31.86	20.00	637.20
Sludge Handling Tanks	2	Area	4.0	31.77	40.00	1270.80

Source	Number	Type	Release height (m)	Total area/ volume (m ² / m ³)	Emission rates (ou _E /m ² /s / ou _E /m ³ /s)	Emission rate (ou _E /s)
Storm Tanks	4	Area	0.0	706.90	10.00	7069.00
Cloth Filters	1	Area	0.0	215.50	20.00	4310.00
FST	2	Area	1.0	31.86	20.00	637.20
New SAS	2	Area	4.0	31.77	40.00	1270.80
New SAS Thickener	2	Area	0.0	828.00	6.70	5547.60
ASP	1	Volume	3.0	145.41	1.12E-02	1.63
Anoxic Zone	2	Area	0.5	800.50	1.00	800.50
RAS mixing chamber	1	Area	4.0	16.91	1.75	29.59
New RAS Pump Station	1	Volume	5.0	533.50	4.10E-02	21.89

4.3.2. The cumulative emission rate for sources at the site is 20,378 ou_E/s. The major source is the PSTs, which represent approximately 35% of the total emissions, followed by the storm tanks (27%) and the inlet works (21%). The remaining sources contribute approximately 17% of the total emissions.

5 DISPERSION MODELLING RESULTS

- 5.1.1. Figure 5-1 shows the maximum modelled odour concentration from all five years (2018 to 2022) overlaid with a revised masterplan. The updated results using NWP meteorological data suggests that no residential dwellings on the masterplan are expected to breach the $C_{98,1hr}$ 3 ou_E/m³ criterion.
- 5.1.2. Parking for the employment buildings lie within the 5 ou_E/m³ contour. However, due to the nature of use, this area is considered as 'low sensitivity'. This is because there will be transient exposure, where 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.
- 5.1.3. Employment buildings north and north west of the Earl Shilton STW lie within the 5 and 3 ou_E/m³ contour. It is proposed that the within the 3 ou_E/m³ contour line would most likely be used for storage and distribution, and therefore people will not be expected to be present in these locations for extended periods of time.
- 5.1.4. Following CIWEM indicators for the likelihood of complaints associated with wastewater treatment facilities, complaints are highly likely for receptors with odour concentrations, represented as $C_{98,1hr}$, larger than 10 ou_E/m³. Based on the modelling results this would indicate that complaints are highly unlikely at any of the proposed new receptors.
- 5.1.5. Complaints are unlikely to occur for proposed new receptors at locations where modelled odour concentrations are lower than $C_{98,1hr}$ 3 ou_E/m³. Hinckley & Bosworth Borough Council (HBBC) Environmental Health Officer (EHO) stated that they have not received any complaints relating to odour from the Earl Shilton STW, within the past 10 years.
- 5.1.6. Contour plots with contour intervals of 10, 5, 3 and 1.5 ou_E/m³ for all years are shown in Appendix C. 2021 and 2022 show the highest modelled concentrations. The $C_{98,1hr}$ 10 ou_E/m³ odour contour interval extends across the proposed parking area. The $C_{98,1hr}$ 1.5 ou_E/m³ odour contour interval extends across the proposed residential areas to the east and north of the Earl Shilton STW.



Figure 5-1 - 98th percentile odour contours (ou_E/m^3) at Earl Shilton STW (maximum over the 2018 to 2022 period)

6 SNIFF TESTS

6.1 RESULTS

- 6.1.1. Table 6-1 summarises the conditions under which the odour sniff tests were undertaken, and the location of the highest odour levels detected. The full set of results is presented in Appendix D.

Table 6-1 – Details of sniff test conditions

ID	Wind Strength (Beaufort Scale)	Wind Direction (blowing from)	Average Temperature (°C)	Date	Time	Maximum Intensity Score	Average Intensity Score
Location 1	5	SSE	13	16/09/2022	13:30 – 13:35	3 - Distinct	3 – Distinct
Location 2	5	SSE	13	16/09/2022	14:20 – 14:25	3 - Distinct	2 – Slight/weak
Location 3	1	SW	N/A	28/09/2022	10:18 – 10:28	2 – Slight/weak	1 – Slight/very weak
Location 4	1	SW	N/A	28/09/2022	11:17 – 11:20	2 – Slight/weak	1 – Slight/very weak
Location 5	1	SW	N/A	28/09/2022	10:43 – 10:53	2 – Slight/weak	1 – Slight/very weak
Location 6	1	SW	N/A	28/09/2022	11:56 – 12:11	2 – Slight/weak	1 – Slight/very weak
Location 7	5	SSE	13	16/09/2022	13:50 – 13:55	4 - Strong	3 – Distinct

- 6.1.2. The odour exposure at the sample locations in the vicinity of the Earl Shilton STW was at its highest at locations 1, 2 and 7. All three of these locations are less than 500m from the boundary of the Earl Shilton STW, with location 2 adjacent to the boundary. Location 7 is predominantly downwind and has consistently had the highest odours. However, these locations are proposed for areas of employment rather than residential.
- 6.1.3. The maximum intensity score for locations 3 to 6 was considered to be 'slight' or 'weak', with the average odour intensity score being 'very weak'. It should be noted that all of the odours were wastewater related.
- 6.1.4. The odour exposure due to the Earl Shilton STW at the proposed residential locations can be mostly considered negligible. However, consideration of these results should be made when amending the masterplan to ensure that there is a large enough buffer for employment and residential areas that are adjacent to the Earl Shilton STW or downwind.

- 6.1.5. The $30\mu\text{E}/\text{m}^3$ contour line shown in Figure 5-1 uses the maximum modelled concentration for each point over 2018 to 2022. By using the maximum modelled concentration, it shows a worst case scenario, and therefore it can be assumed that it includes an appropriate 'buffer' zone.

7 CONCLUSION

- 7.1.1. Detailed dispersion modelling was undertaken using five years of meteorological data (2015 to 2019) from Church Lawford airport weather station. The dispersion modelling from the previous assessment indicated that 2017 meteorological data resulted in the worst-case modelling concentrations for the Earl Shilton STW.
- 7.1.2. The model was updated using more representative NWP data for 2018 to 2022 and the results are presented in this report. Using site-specific meteorological data resulted in lower modelled odour concentrations than the Church Lawford meteorological data.
- 7.1.3. The results of the original odour impact assessment predicted there would be exceedances of the $C_{98,1hr}$ $3 \text{ ou}_E/\text{m}^3$ at both the existing and future sensitive receptors. This suggests there may be a risk of odour complaints from the proposed residential areas. The updated modelled results (using NWP meteorological data) indicates that it is unlikely that there will be any exceedances of the $C_{98,1hr}$ $3 \text{ ou}_E/\text{m}^3$ odour criteria at any of the proposed receptor locations.
- 7.1.4. There have been no complaints received by the HBBC relating to odour from the Earl Shilton STW from the past 10 years at any of the existing receptors.
- 7.1.5. The site specific olfactometry sampling carried out in 2022 suggested that strong odours were only present adjacent to the Earl Shilton STW or downwind. These locations are expected to be reserved for employment purposes only and not for residential dwellings but does highlight the potential of future receptors being impacted by the Earl Shilton STW operations.
- 7.1.6. The masterplan has been developed to ensure that all residential dwellings are outside of the $3 \text{ ou}_E/\text{m}^3$ contour. The masterplan has also been amended so that for the employment areas that are above the $5 \text{ ou}_E/\text{m}^3$ odour contour, only parking remains in those areas and therefore, it is not likely that sensitive human receptors would be spending significant amounts of time in this area. It should also be noted that the employment buildings closest to the Earl Shilton STW are most likely to consist of uses such as storage/ distribution rather than offices.

Appendix A

GLOSSARY



In dealing with the assessment and control of odour, there are a number of technical terms that are used by professionals in the field which may not be immediately transparent to the lay person. Included below in Table A-1 is a selection of the common terms and concepts of common usage, together with explanations of their meanings.

Table A-1 – Terminology

Term	Meaning
Odour	The property of a substance, in this case ambient air that gives it a particular scent or smell. Odours can be characterised as pleasant, neutral or unpleasant.
Odour Units	The way in which odour is quantified. In simple terms, 1 odour unit is taken to be the limit of detection for an odour by a person with a normal sense of smell. This is determined by a panel of people with “calibrated” noses and is enumerated when half of the panel members cannot tell the difference between clean air and a sample of diluted odorous air. 5 odour units is judged to be a faint odour and 10 odour units is a distinct odour.
Odour assessment	The process by which the environmental impact of odours is evaluated, typically involving measurement of the emission strength and modelling to determine the extent and magnitude of the impact.
Odour nuisance	A legal term, whereby odour is deemed to be present at such a level and frequently enough to give rise to a nuisance under the provisions of the Environmental Protection Act, 1990.
Odour annoyance	A technical term, indicating the point at which a person finds an odour annoying, as distinct from a nuisance.
Odour abatement	Any method by which odour emissions to the atmosphere may be reduced; typical technologies include adsorption onto activated carbon, bio-filtration or liquid adsorption.
Odour concentration	The amount of odour presents in cubic metre of sample gas at standard conditions. The odour concentration is measured in European odour units (ou_E/m^3). The odour concentration at the detection threshold is defined to be $1 \text{ ou}_E/\text{m}^3$. If an odour sample has been diluted in an olfactometer by a factor of 10,000 to reach the 50% detection threshold, then the concentration of the original sample is 10,000 odour units.
Odour sensitive receptor	The closest building or installation where odour annoyance may occur, such as residential homes, school, hospital, overnight facility for holidays, etc.
Odour unit	The amount of odorant(s) that, when evaporated into 1 cubic metre of neutral gas at standard conditions, elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM), evaporated in one cubic metre of neutral gas at standard conditions.
Olfactometer	Apparatus in which a sample of odorous gas is diluted with neutral gas in a defined way and presented to an odour panel under reproducible conditions.
Odour Modelling	Use of a mathematical dispersion model software code, in combination with meteorological data, odour emission rates and locational information, to simulate the way in which odour emitted into air disperses and dilutes in the atmosphere.

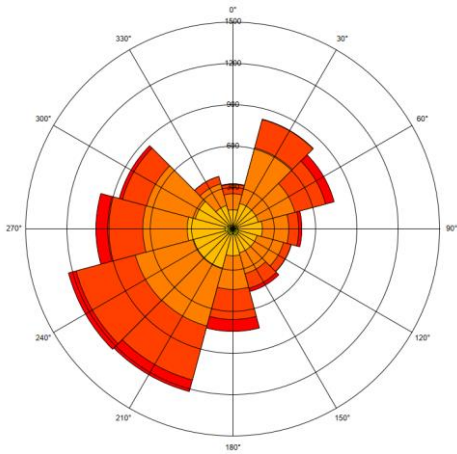
Appendix B

WIND ROSES

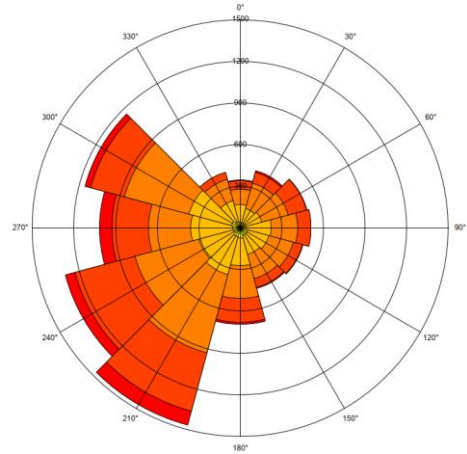


Figure B-1 - Windroses for NWP data 2018 to 2022

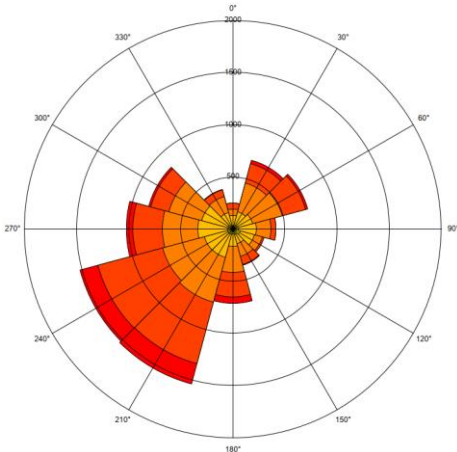
2018



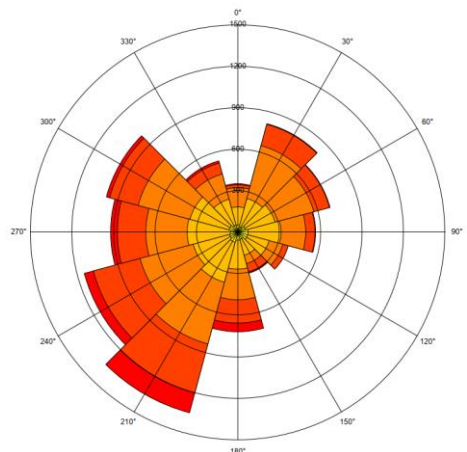
2019



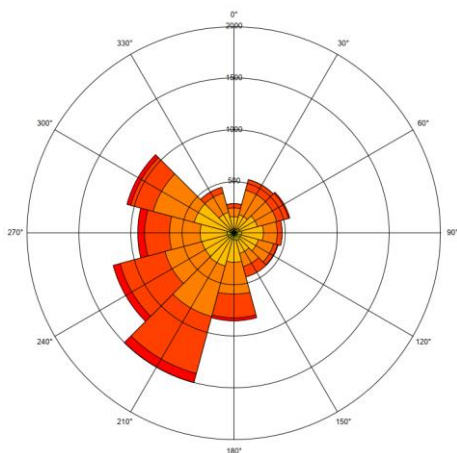
2020



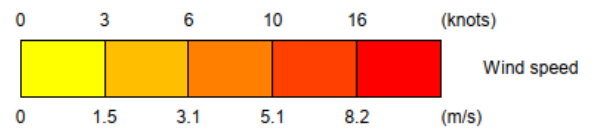
2021



2022

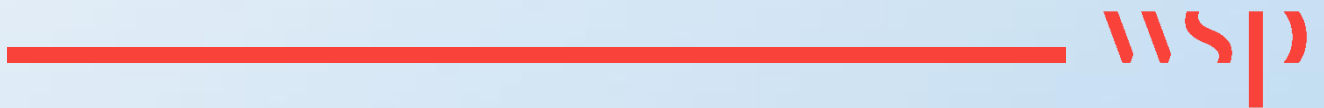


Legend



Appendix C

C98,1HR ODOUR CONCENTRATIONS CONTOUR PLOTS (2018 TO 2022)



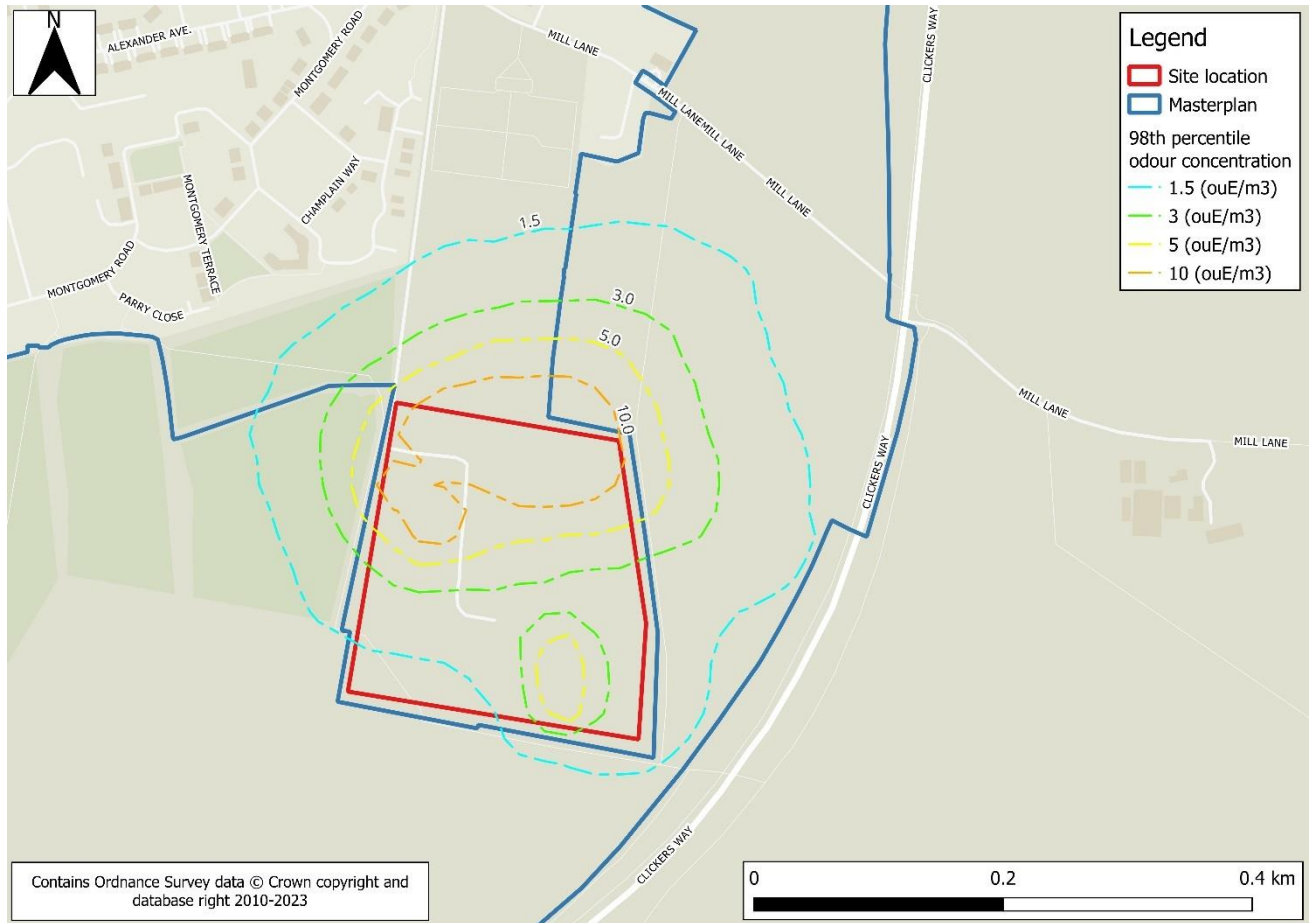


Figure C-1 - 98th percentile odour contours (ouE/m³) at Earl Shilton STW 2018

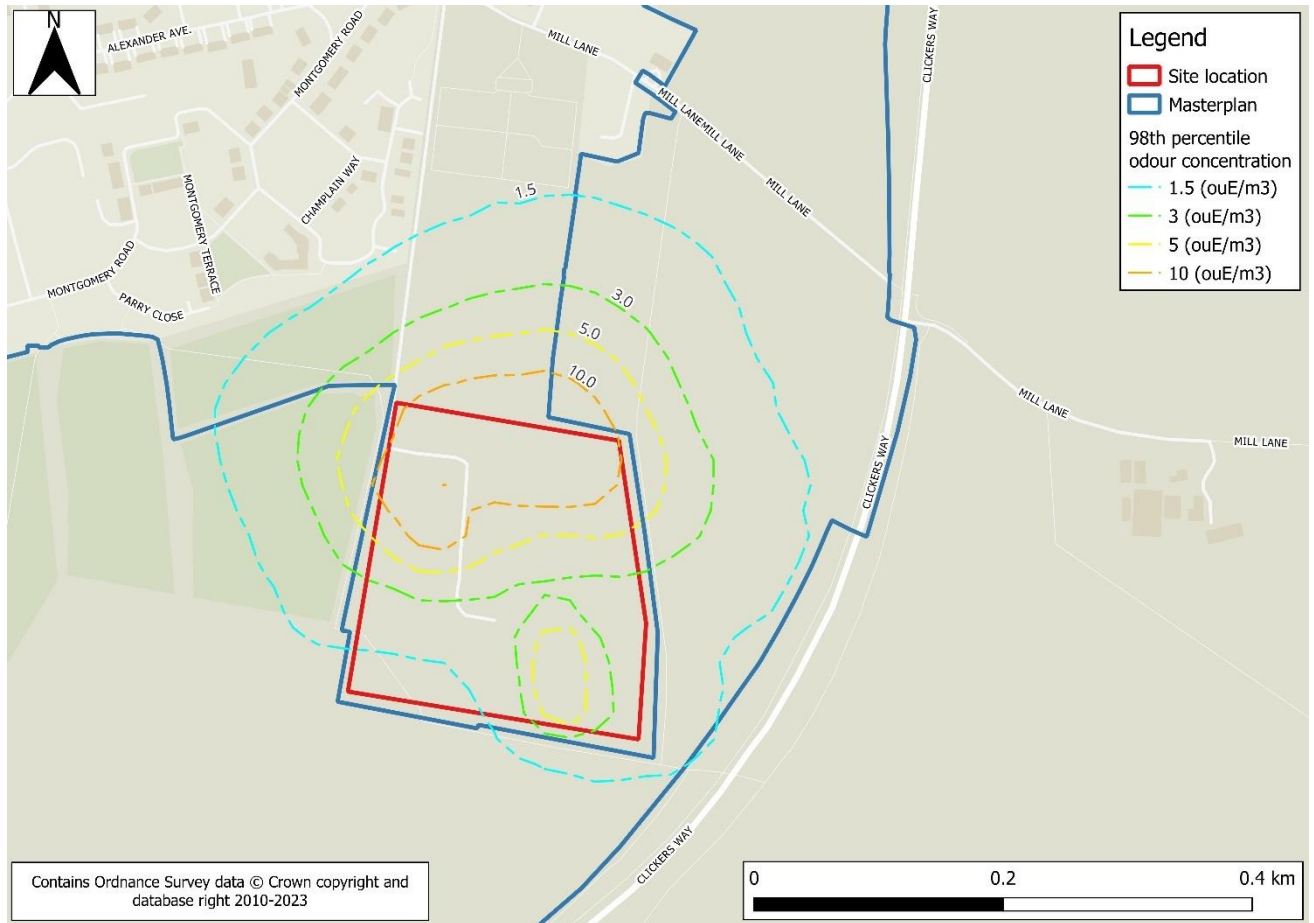


Figure C-2 - 98th percentile odour contours (ouE/m³) at Earl Shilton STW 2019

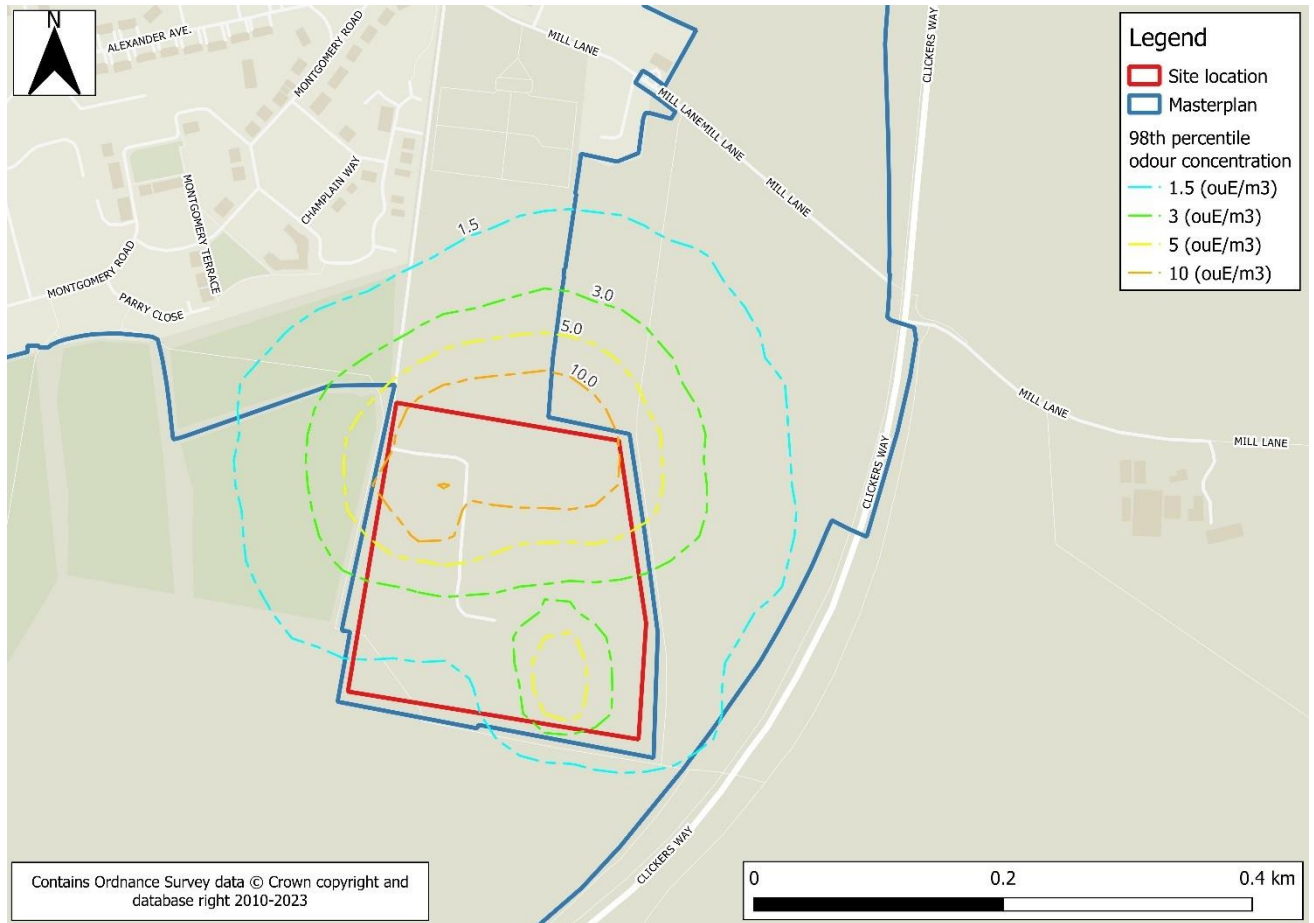


Figure C-3 - 98th percentile odour contours (ouE/m³) at Earl Shilton STW 2020

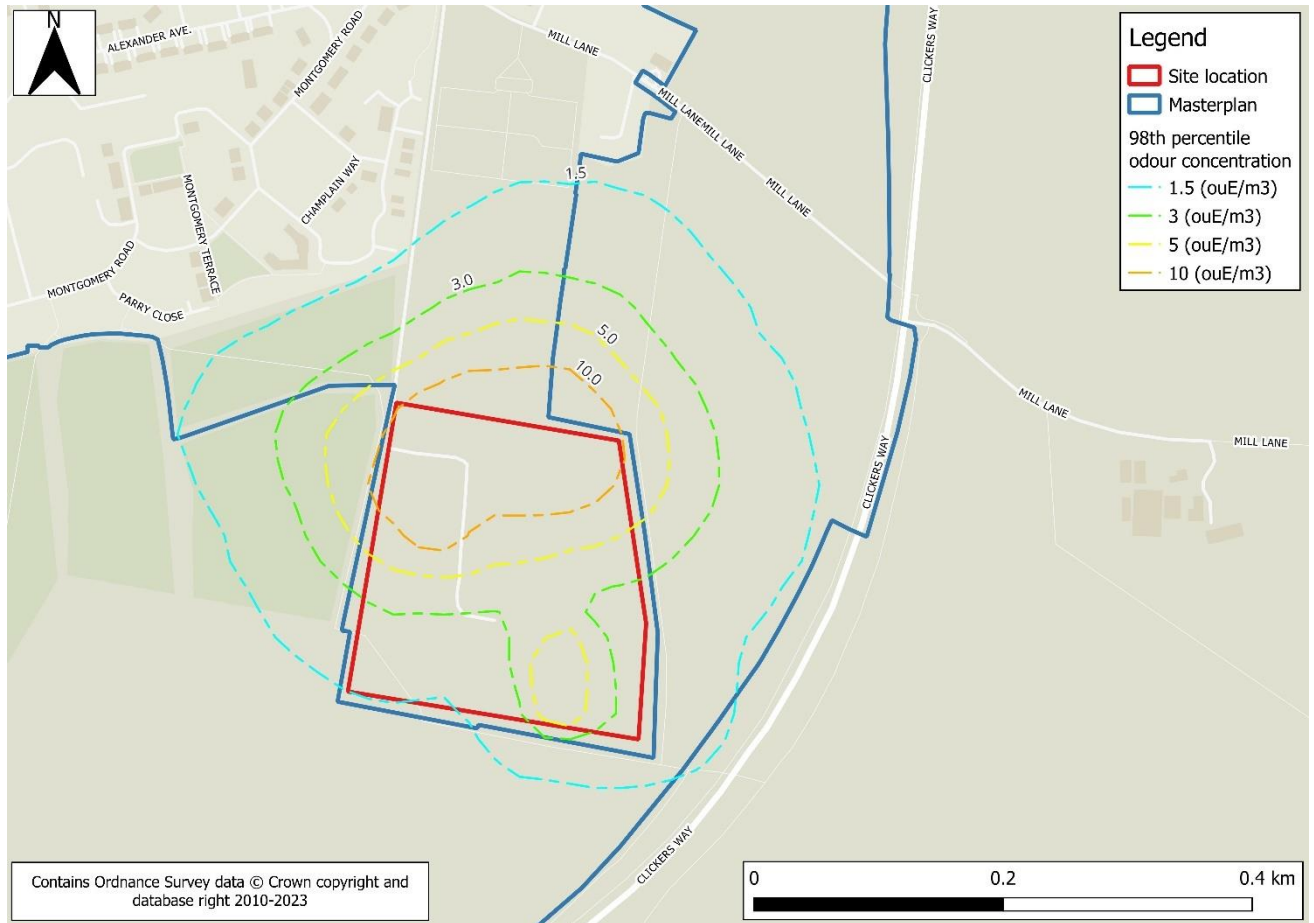


Figure C-4 - 98th percentile odour contours (ouE/m³) at Earl Shilton STW 2021

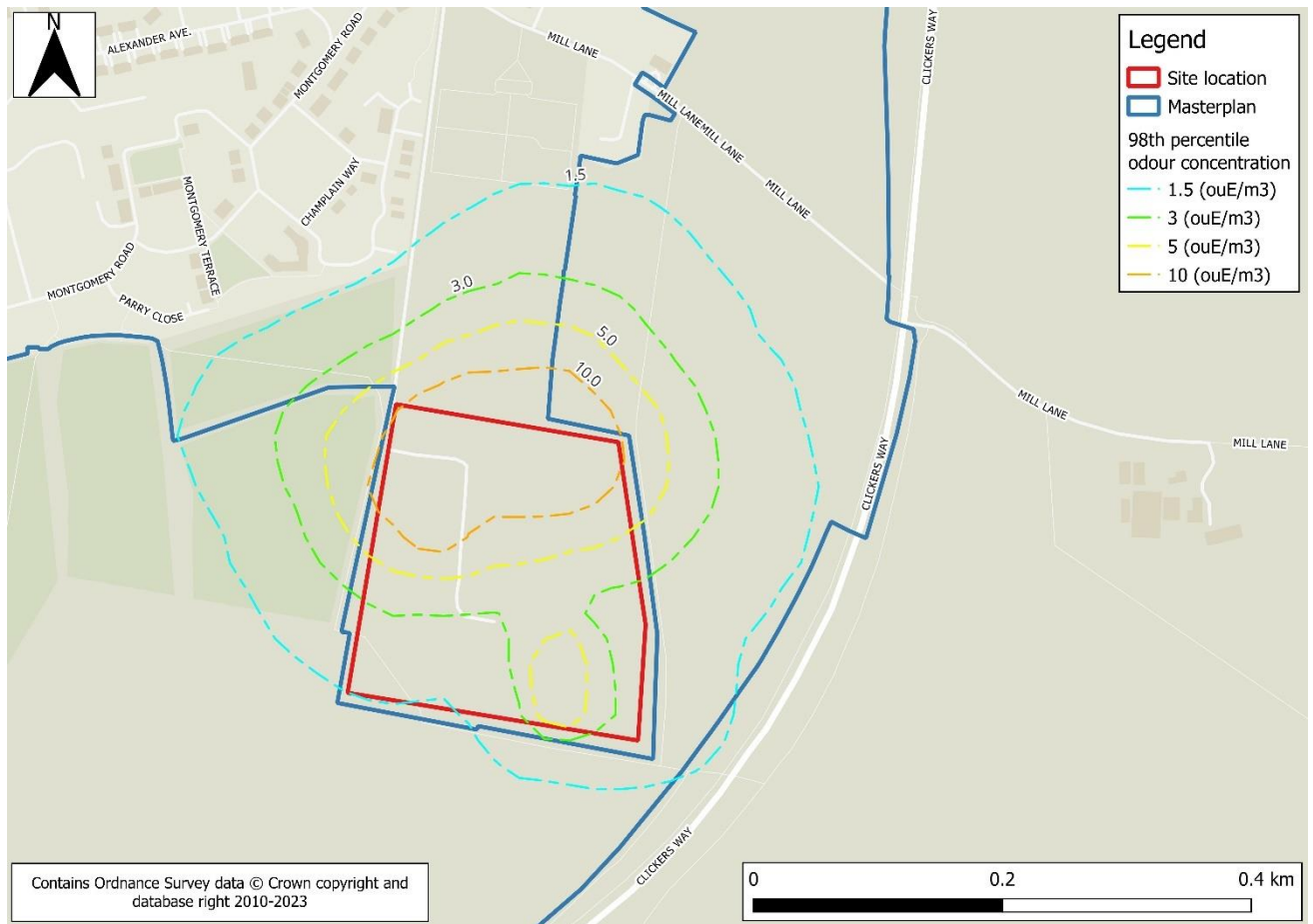


Figure C-5 - 98th percentile odour contours (ouE/m³) at Earl Shilton STW 2022

Appendix D

FULL SNIFF TEST RESULTS

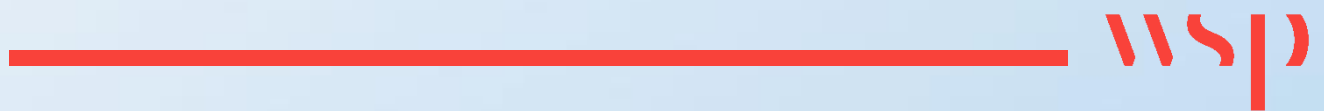


Table D-1 – Results from sniff test 1 – 16th September 2022 (am)

Sample	Maximum Intensity Score	Average Intensity Score	Odour Time	Odour Exposure
1	3 - Distinct	2 – Weak	0%	Small
2	3 - Distinct	2 – Weak	0%	Small
3	1 – Very weak	0 – No odour	0%	Negligible
4	0 – No odour	0 – No odour	0%	Negligible
5	0 – No odour	0 – No odour	0%	Negligible
6	0 – No odour	0 – No odour	0%	Negligible
7	4 – Strong	3 – Distinct	43%	Medium

Note: Odour time is the amount of time where the odour intensity was perceived to be 4 or greater.

Table D-2 – Results from sniff test 2 – 16th September 2022 (pm)

Sample	Maximum Intensity Score	Average Intensity Score	Odour Time	Odour Exposure
1	3 – Distinct	3 – Distinct	0%	Small
2	3 – Distinct	2 – Weak	0%	Small
3	0 – No odour	0 – No odour	0%	Negligible
4	0 – No odour	0 – No odour	0%	Negligible
5	0 – No odour	0 – No odour	0%	Negligible
6	0 – No odour	0 – No odour	0%	Negligible
7	4 – Strong	3 – Distinct	20%	Medium

Note: Odour time is the amount of time where the odour intensity was perceived to be 4 or greater.

Table D-3 – Results from sniff test 3 – 21st September 2022

Sample	Maximum Intensity Score	Average Intensity Score	Odour Time	Odour Exposure
1	3 – Distinct	2 – Weak	0%	Small
2	2 – Weak	1 – Very Weak	0%	Small
3	2 – Weak	1 – Very Weak	0%	Small
4	2 – Weak	1 – Very Weak	0%	Small

Sample	Maximum Intensity Score	Average Intensity Score	Odour Time	Odour Exposure
5	2 – Weak	1 – Very Weak	0%	Small
6	2 – Weak	1 – Very Weak	0%	Small
7	4 – Strong	2 – Weak	3%	Small
Note: Odour time is the amount of time where the odour intensity was perceived to be 4 or greater.				

Table D-4 – Results from sniff test 4 – 28th September 2022

Sample	Maximum Intensity Score	Average Intensity Score	Odour Time	Odour Exposure
1	2 – Weak	1 – Very Weak	0%	Small
2	3 – Distinct	2 – Weak	0%	Small
3	2 – Weak	1 – Very Weak	0%	Small
4	2 – Weak	1 – Very Weak	0%	Small
5	2 – Weak	1 – Very Weak	0%	Small
6	2 – Weak	1 – Very Weak	0%	Small
7	3 – Distinct	2 – Weak	0%	Small
Note: Odour time is the amount of time where the odour intensity was perceived to be 4 or greater.				



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