



Bloor Homes, Jelson Homes and Barwood Land

Earl Shilton Sewage Treatment Works

Baseline Odour Assessment



This report was prepared by WSP Environment & Infrastructure Solutions UK Limited (formerly known as Wood Environment & Infrastructure Solutions UK Limited), company registration number 02190074, which is carrying out these services as a subcontractor and/or agent to Wood Group UK Limited

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Executive summary

WSP Environment & Infrastructure Solutions UK Limited (WSP - formerly Wood Environment & Infrastructure Solutions UK Limited) was commissioned by Bloor Homes, Jelson Homes and Barwood Land to review and establish the current odour baseline at the site of the proposed urban extension through detailed dispersion modelling of odour emissions from Earl Shilton Sewage Treatment Works (STW).

As proposals for the urban extension 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.

An odour impact assessment for Earl Shilton STW were previously undertaken in 2011. Since the site undertook several upgrades in 2019, a review of the odour assessment was required.

The results of the 2021 odour impact assessment predicted odour concentrations at existing and future sensitive receptors above the 3, 5 and 10 $\text{ou}_\text{E}/\text{m}^3$ odour criteria, represented as $\text{C}_{98,1\text{hr}}$, at several locations. This suggests there is a risk of odour complaints from the proposed residential areas. However, although existing residential areas are located within zones which may be expected to result in complaints, there have been no complaints received by Hinckley & Bosworth Borough Council (HBBC) relating to odour from the Earl Shilton STW for the past 10 years. This suggests that the predicted odour concentrations are higher than the odour concentrations observed at the existing receptors.

Odour modelling has been updated using Numerical Weather Prediction (NWP) data, as the Church Lawford Met Office site used previously, is approximately 25 km south of Earl Shilton, and while this is closest Met site, it is not considered to be representative of local conditions. The updated modelling using more representative NWP meteorological data suggests that there will be no exceedances of the 3 $\text{ou}_\text{E}/\text{m}^3$ odour criteria at existing receptors.

The odour baseline was validated using with sniff tests in 2022. The sniff tests indicate that odours were only present immediately adjacent to the STW or downwind. This indicates that some of the future receptors in the urban extension could be impacted by the STW operations. However, these locations are expected to be reserved for employment purposes only and not for residential dwellings.

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1. Introduction

1.1 Background

WSP Environment & Infrastructure Solutions UK Limited (formerly Wood Environment & Infrastructure Solutions UK Limited) was commissioned by Bloor Homes, Jelson Homes and Barwood Land to review and establish the current odour baseline through detailed dispersion modelling of odour emissions from Earl Shilton Sewage Treatment Works (STW).

As proposals for the urban extension 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 residential receptors being new build houses approximately 125m north-west of the site boundary.

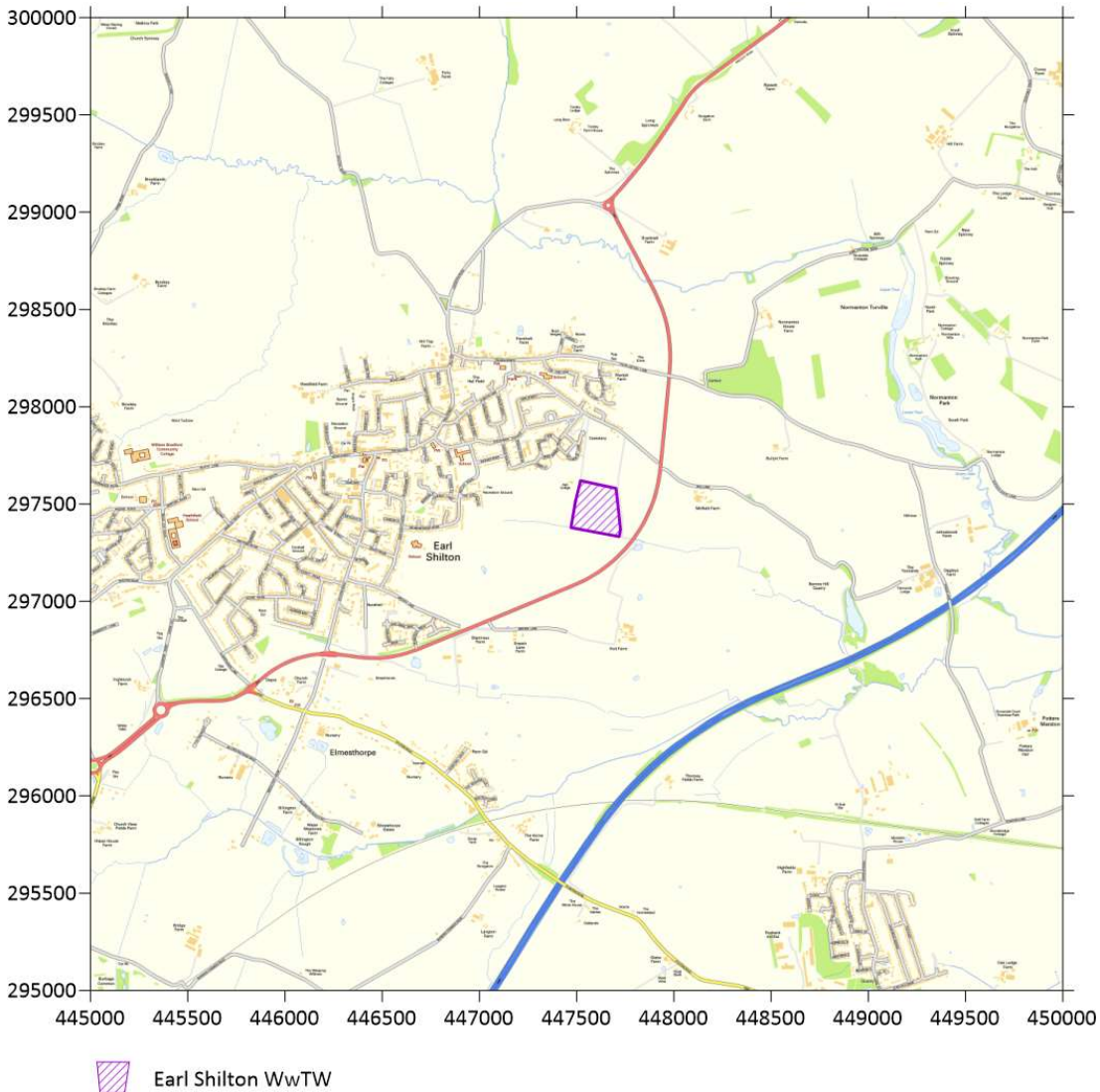
An odour impact assessment for Earl Shilton STW was previously undertaken in 2011. A review of the odour assessment was required, as the STW site had undergone several upgrades in 2019.

The 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 (Primary Settlement Tanks (PSTs));
- secondary treatment (Activated Sludge Plant (ASP)); and
- Tertiary treatment (Final Settlement Tanks (FSTs)).

The upgrade in 2019, resulted 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.

Figure 1.1 indicates the location of the works and the new layout of the STW is displayed in Figure 3.5.

Figure 1.1 Site Location

1.2 Purpose of this report

The purpose of this updated assessment is to describe the baseline odour assessment undertaken for Earl Shilton STW using Numerical Weather Prediction (NWP) data, conduct 'sniff tests' and assess its impact on the proposed residential and industrial areas.

2. Legislation, guidance and odour criteria

This section describes the regulatory framework for odour in England and the available technical guidance.

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.

Odour concentration is expressed as European odour units per cubic metre at standard conditions for olfactometry (ou_E/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.

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.

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:

- **F**requency of detection - the number of exposures to an odour within a given time frame
- **I**ntensity as perceived - the magnitude of the perception of the odour
- **D**uration - the time period during which the odour exposure occurs
- **O**ffensiveness - this is a qualitative judgement to describe the odour
- **L**ocation – 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

2.1 Legislation

Environmental Protection Act 1990

Sections 79, 80 and 82 of the 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 nuisances 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.*

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

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 hydrogen sulphide (H₂S) concentrations from both point sources and fugitive releases.

Environmental Permitting (England and Wales) Regulations, 2019, as amended

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.

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

Policies and measures are specified in the Earl Shilton and Barwell Area Action Plan (2014)⁴.

Policy 22 – Development and Design

¹ Environmental Protection Act 1990, The Stationary Office, reprinted 2004

² Environmental Permitting (England and Wales) Regulations 2013

³ Environmental Permitting (England and Wales) Regulations 2019

⁴ <https://www.hinckley-bosworth.gov.uk/downloads/file/4332/earl-shilton-and-barwell-area-action-plan-and-appendices-adopted-23-september-2014>

“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

This desk-based odour dispersion modelling approach complies with the guidance documents outlined in this section.

Defra code of practice on odour nuisance from sewage treatment works

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.

Defra odour guidance for local authorities

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

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).

⁵ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69223/pb11833-sewageodour-cop.pdf

⁶ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69305/pb13554-local-auth-guidance-100326.pdf

⁷ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296737/geho0411btqm-e-e.pdf

Institute of Air Quality Management (IAQM) guidance on the assessment for odour planning (v1.1)

The IAQM published guidance in 2018⁸ 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.

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.”*

This guidance has been used to determine the sensitivity for residential receptors in this assessment.

2.3 Odour assessment criteria

Background

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

In 2002, the Environment Agency (EA) published a draft copy of its Horizontal Guidance Document H4¹⁰ 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.

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 less offensive odours 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.

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 STW 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.

⁸ IAQM (2018) Guidance on the assessment for odour planning.

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.

¹⁰ Environment Agency (2002) DRAFT Horizontal Guidance for Odour Part 1 - Regulation and Permitting.

The Chartered Institute of Water and Environmental Management (CIWEM) has issued a Policy Position Statement¹¹ 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.

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:

- $C_{98, 1hr} 10 \text{ ou}_E/\text{m}^3$ - complaints are highly likely and odour exposure at these levels represents an actionable nuisance;
- $C_{98, 1hr} 5 \text{ ou}_E/\text{m}^3$ - complaints may occur and depending on the sensitivity of the locality and nature of the odour this level may constitute a nuisance; and
- $C_{98, 1hr} <3 \text{ ou}_E/\text{m}^3$ - 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.

Research in the Netherlands¹² has highlighted the complexity of the assessment of odours from STWs. It states that situations exist where $5 \text{ ou}_E/\text{m}^3$ has been achieved and no complaints have been received, yet cases also exist where $1 \text{ ou}_E/\text{m}^3$ has been achieved and complaints were still 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 receptor¹³.

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 works¹⁴. Wood'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 decision¹⁵ where $5 \text{ ou}_E/\text{m}^3$ as the 98th percentile of hourly averages or above is reached, "*nuisance will certainly be established*".

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 benchmarks for this assessment.

¹¹ Policy Position Statement – Control of Odour. CIWEM, September 2012

¹² Information Centre for the Environment (2001). *Netherlands Emission Guidelines for Air*. InfoMil.

¹³ 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.

¹⁴ McGovern, JE, Clarkson, CR (1994). The Development of Northumbrian Waters Approach to Odour Abatement for Sewage Facilities.

¹⁵ Citation EWHC 3253 (2011), *Dobson & Others vs Thames Water Utilities Ltd*. High Court of Justice.

3. Methodology

3.1 Dispersion modelling

Model

This study uses the ADMS 5 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.

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).

ADMS has been used extensively to predict odour impacts from STWs and was therefore considered appropriate for the odour assessment.

Surface characteristics

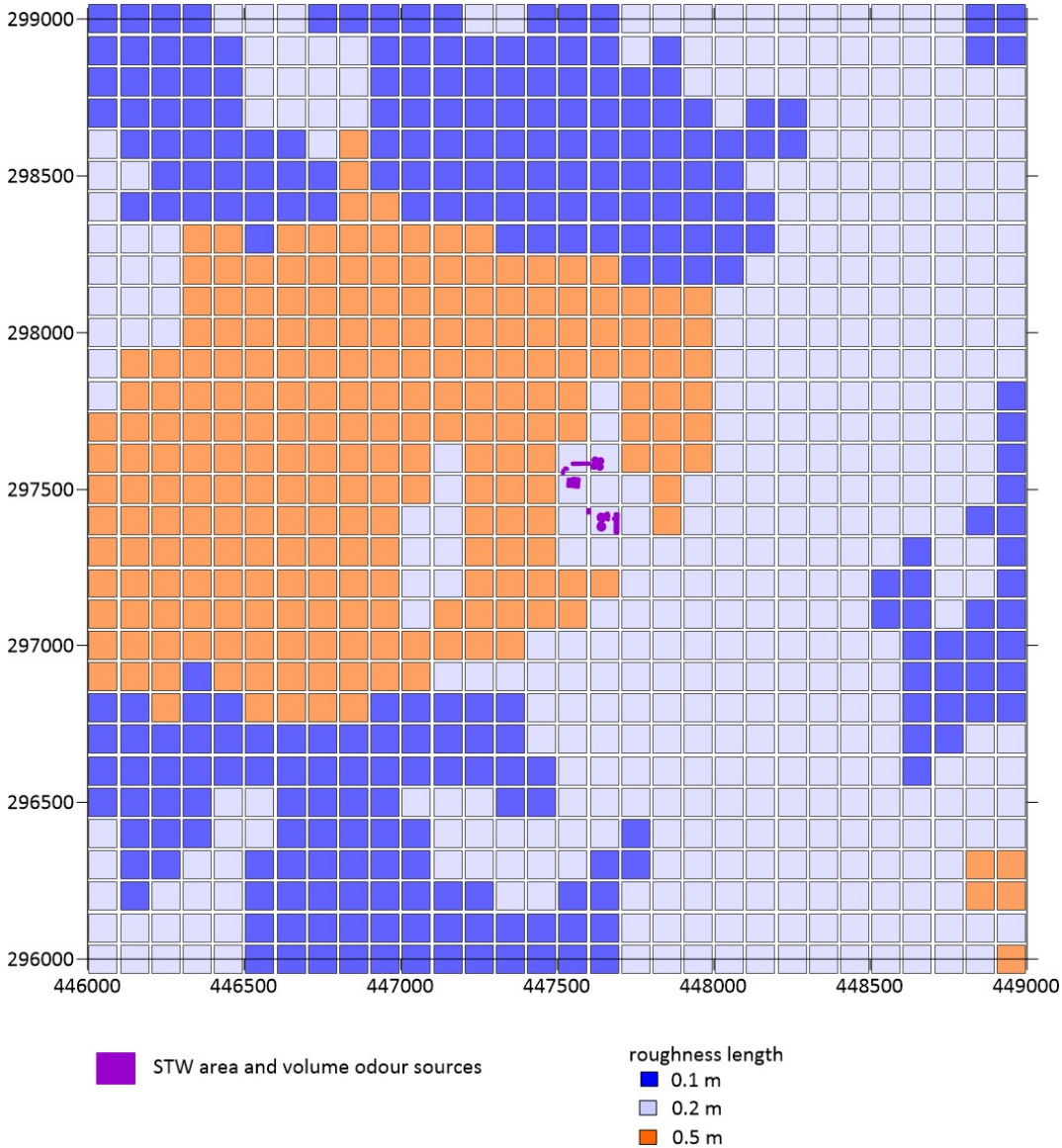
The predominant surface characteristics and land use in a model domain have an important influence in determining turbulent fluxes and, hence, the stability of the boundary layer and atmospheric dispersion. Factors pertinent to this determination are detailed below.

Surface roughness length

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.

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.

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

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

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

The nearest weather station is at Church Lawford airport, approximately 25 km 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 2019 NWP data to allow a direct comparison. The main advantages of using NWP data is that it should be more representative of the site, especially when weather stations are not particularly close, as is the case in this instance. The NWP data also appears to have faster wind speeds with more wind from the west.

Figure 3.2 shows the wind rose for 2019 meteorological data, while Figure 3.3 illustrates the 2019 NWP data. The wind is generally from the South West and South South West direction for both wind roses.

Figure 3.2 Church Lawford wind rose for year 2019

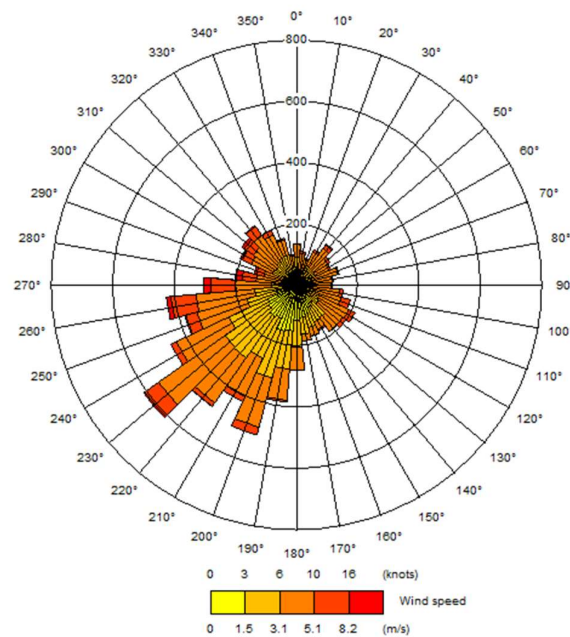
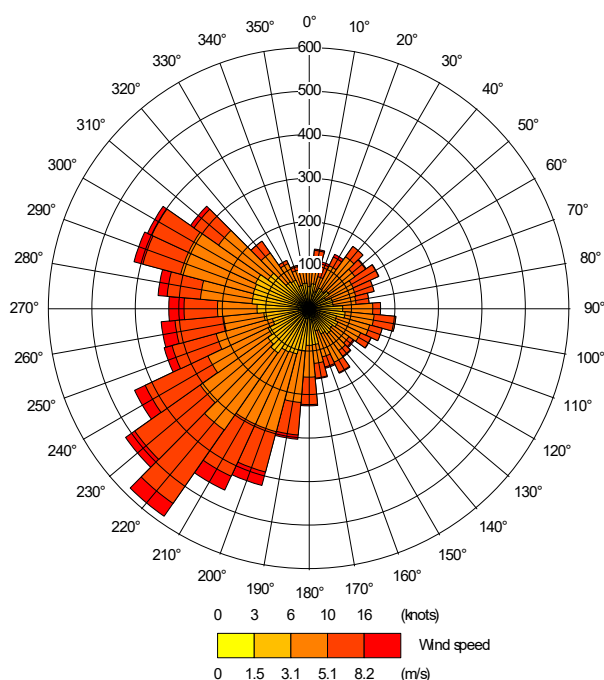


Figure 3.3 NWP Wind rose for year 2019

Receptors

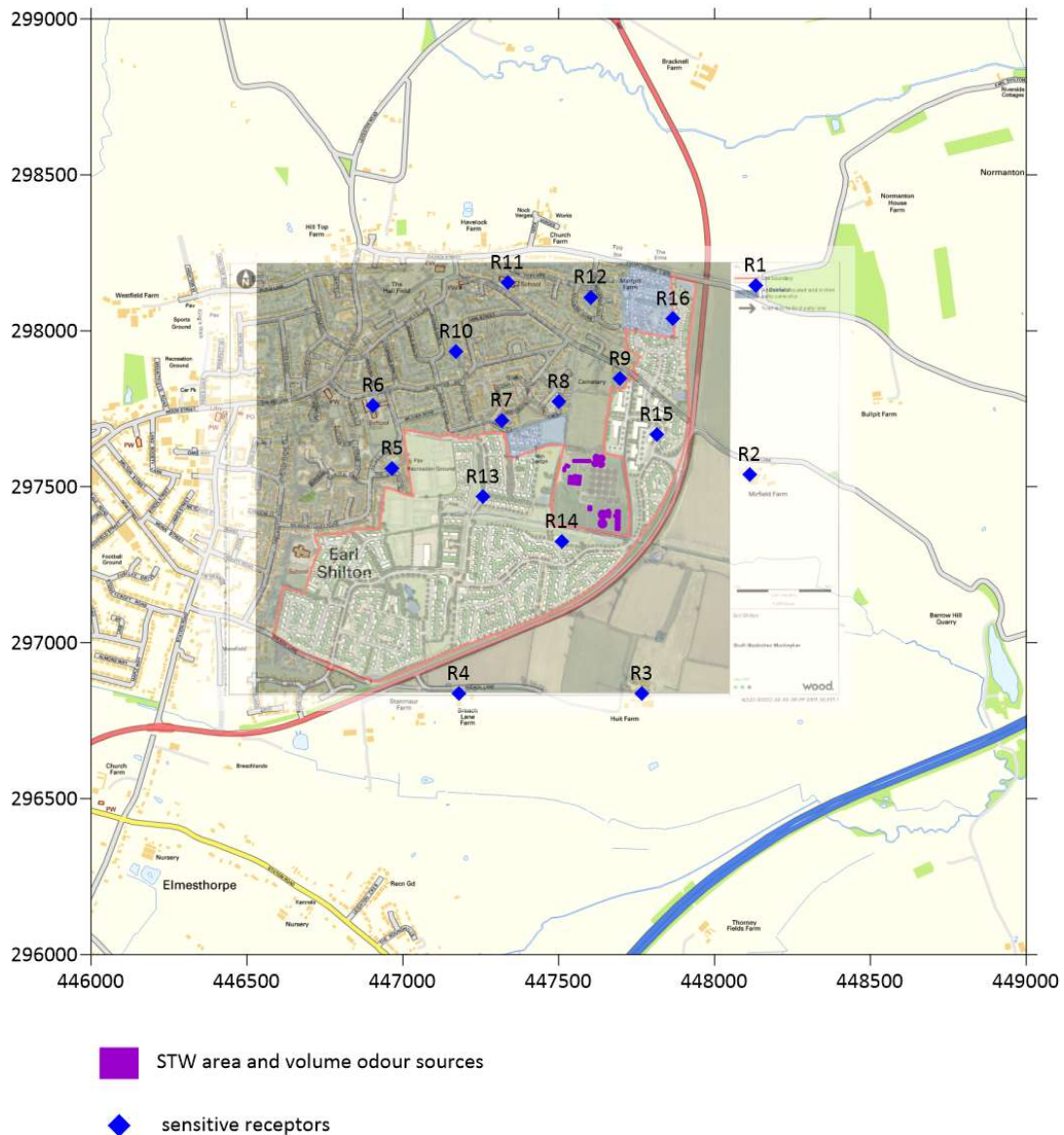
This assessment calculated odour concentrations at gridded receptors on a 3 km cartesian grid with 60 m resolution centred on the STW.

Specific receptor points were selected at existing highly sensitive residential locations (e.g. residential properties, schools) and at proposed highly sensitive residential locations and moderately sensitive industrial locations. The limit of the proposed development is indicated on Figure 3.4 as a red line. Specific receptor points are listed in Table 3.1 and plotted on Figure 3.4.

Table 3.1 Modelled Sensitive Receptors

Receptor ID	Description of receptor	X (m)	Y (m)
R1	Residential - Oakfield	448132	298146
R2	Residential- Mirfield Farm	448113	297539
R3	Residential – Huit Farm	447767	296837
R4	Residential – Lane Farm	447180	296837
R5	Residential – The Leecrofts	446967	297559
R6	School – St Simon and St Jude	446906	297761
R7	Residential – Parry Close	447318	297713
R8	Residential – Columbus Lane	447501	297772

Receptor ID	Description of receptor	X (m)	Y (m)
R9	Residential – Mill Lane	447698	297846
R10	Residential – Avenue North	447172	297933
R11	School – St Peters Voluntary	447336	298155
R12	Residential – King Richard's Hill	447603	298108
R13	Future Residential – West of site	447258	297468
R14	Future Residential – South of Site	447511	297324
R15	Future Industrial – North of site	447816	297667
R16	Future Residential – North of site	447868	298038

Figure 3.4 Modelled sensitive receptor locations

Modelled odour emission rates

Scenario

The model scenario included in this assessment represents the existing 2020 site layout (after upgrade of the site with ASPs in 2019).

An olfactometry monitoring survey was undertaken 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. Emission factors representative of each source were derived from the assessment undertaken by Odournet for Severn Trent Water in 2010¹⁶. These emissions factors were derived on the basis of the findings of the site review undertaken on 21 October 2010,

¹⁶ Odournet, 2010. Desktop odour impact assessment for proposed upgrade schemes at Earl Shilton STW, November 2010 (STRW10B_draft4)

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.

This model scenario was run for a five-year period (2015-2019) of meteorological data from Church Lawford weather station.

Assumptions

Based on the Odournet report 2010¹⁶ and data information received from Severn Trent Water, the following assumptions were made:

From 2019, the following changes and upgrades have been completed and in operation:

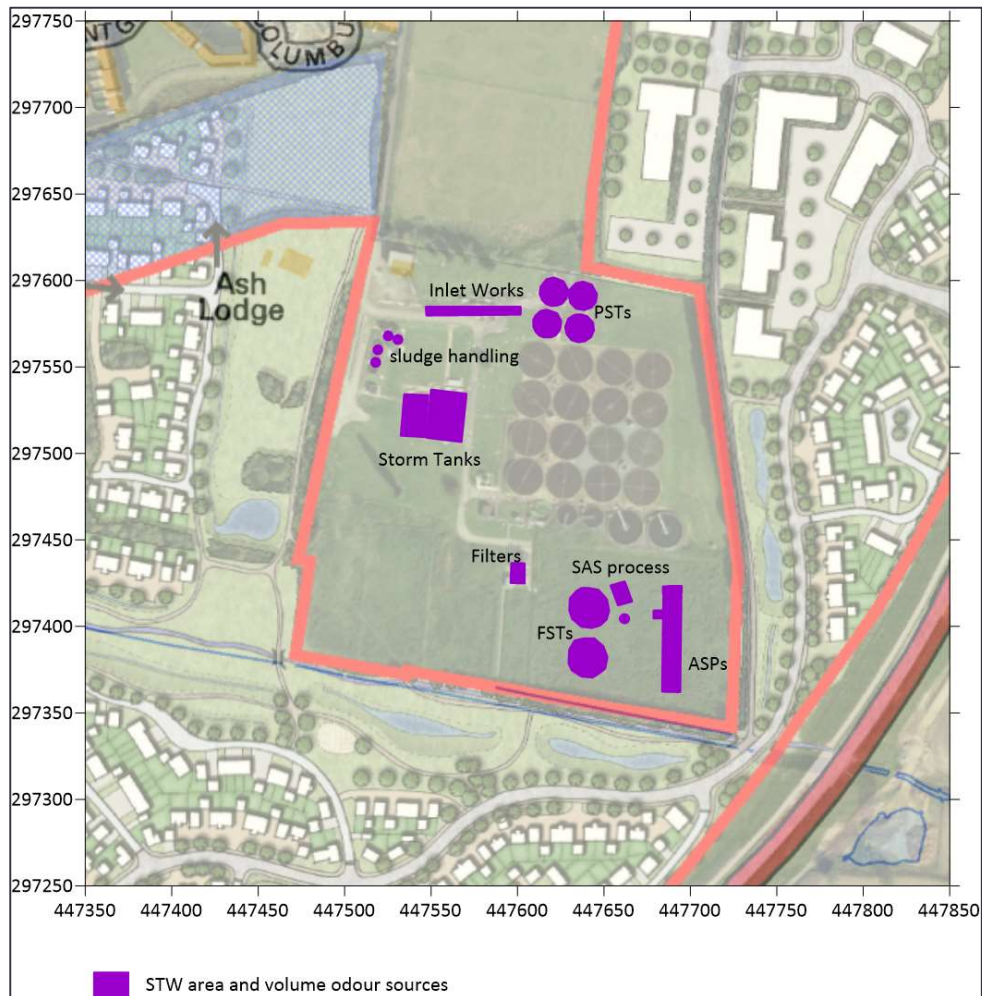
- Two new FSTs were built;
- ASP was built;
- Refurbishment of Four PSTs; and
- Sixteen filter beds and humus tanks were decommissioned and replaced by the ASP.

The following assumptions are made for the operation of the site:

- 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 (May to October included) and were reduced by a factor of five during the autumn and winter months (November to April). The reduction in emission rate reflects the dilution effects of increased rain water and reduction in odorous emissions due to lower ambient temperature; and
- All other sources were assumed continuous.

Modelled sources

Modelled sources are shown in Figure 3.5. Table 3.2 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 works treating an influent with a low to moderate emission potential.

Figure 3.5 Modelled sources**Table 3.2 Baseline Odour Emissions**

Sources	Number of tanks	Type of source	Release height (m)	Total Area / volume (m ² / m ³)	Emission rates (in ouE/m ² /s (for Area sources) and in ouE/m ³ /s (for Volume sources)	Emission rates in ouE/s
Inlet works	1	Area	0	243	20	4860
PSTs	4	Area	0	782.72	10	7827
Storm Tanks	2	Area	0	884.3	6.7	5925
ASP	1	Area	4	566.7	1	567
Anoxic zone	1	Area	4	30.4	3	91
Ras mix chamber	1	Area	4	9.4	1	9

Sources	Number of tanks	Type of source	Release height (m)	Total Area / volume (m ² / m ³)	Emission rates (in ouE/m ² /s (for Area sources) and in ouE/m ³ /s (for Volume sources))	Emission rates in ouE/s
New Ras pumping station	1	Area	4	21.02	1	21
New SAS thickener building	1	Volume	5	489.51 m ³	0.36 ouE/m ³ /s	176
New Surplus Activated Sludge (SAS) tank	1	Area	4	18.465	1.75	32
FSTs	2	Area	0.5	800.3	1	800
Sludge wells	2	Area	1	34.645	20	693
Sludge handling tanks	2	Area	4	34.56	40	1382
Cloth filters	1	Volume	3	254.7	0.18 ouE/m ³ /s	46

The cumulative emission rate for all sources at the site is 22,430 ouE/s. The major source is the PSTs, which represents approximately 35% of the total emissions, followed by the storm tanks (26%) and the Inlet Works (22%). The remaining sources contribute 17% of the total emissions.

Model uncertainty

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.

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.

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.

3.2 Sniff Tests

Approach

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.

The odour assessors are instructed to have stopped eating or smoking at least 30 minutes before the measurement. At each measuring point the measuring procedure lasts 5-10 minutes and comprises the registration of the odour frequency, the assessment of the odour intensity and description of the odour as well as a short description of the wind and weather conditions.

Table 3.3 Odour intensity scale (IAQM, 20141)

Odour Strength	Intensity Level	Comments
No odour/not perceptible	0	No odour when compared to the clean site
<i>The Odour Detection Threshold (ODT) of 1 $ou_e \cdot m^{-3}$ is somewhere between 0 and 1</i>		
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
Distinct	3	The odour character is barely recognisable
<i>VDI 3940 says that the recognition threshold intensity is generally 3-10 times higher than the ODT (i.e. 3-10 $ou_e \cdot m^{-3}$)</i>		
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

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 (IAQM, 20141)

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

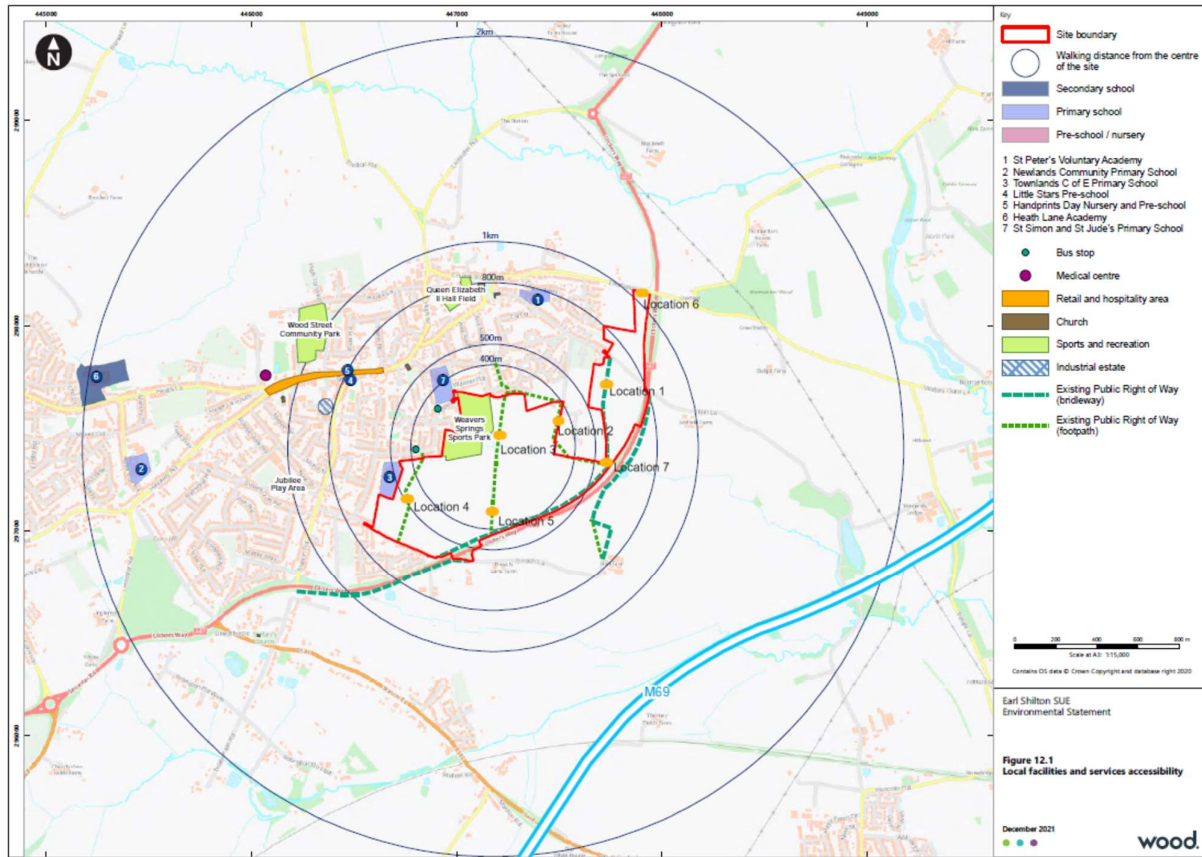
Locations

Seven sample locations were chosen on the site of the proposed development, all of them within a short distance of the 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 in September 2022.

The seven locations are presented in Table 3.5 and Figure 3.6.

Table 3.5 Surveyed 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

Figure 3.6 Odour survey locations


4. Dispersion modelling results

Table 4.1 provides the results as maximum of 98th percentile of hourly average odour concentrations ($C_{98,1hr}$) over the five-year period at each sensitive receptor modelled.

Table 4.1 Maximum $C_{98,1hr}$ odour concentration over five years modelled (2015-2019)

Receptor ID	Description of receptor	Maximum $C_{98,1hr}$ (ou_E/m^3)	Year	2019 NWP Maximum $C_{98,1hr}$ (ou_E/m^3)
R1	Residential - Oakfield	2.2	2017	0.28
R2	Residential- Mirfield Farm	1.0	2017	0.55
R3	Residential – Huit Farm	0.4	2018	0.12
R4	Residential – Lane Farm	0.3	2016	0.13
R5	Residential – The Leecrofts	0.4	2016	0.25
R6	School – St Simon and St Jude	0.2	2016	0.21
R7	Residential – Parry Close	1.4	2019	0.82
R8	Residential – Columbus Lane	10.9	2016	1.38
R9	Residential – Mill Lane	15.4	2017	1.23
R10	Residential – Avenue North	0.7	2019	0.25
R11	School – St Peters Voluntary	1.9	2016	0.19
R12	Residential – King Richard's Hill	3.6	2019	0.38
R13	Future Residential – West of site	1.4	2016	0.56
R14	Future Residential – South of Site	4.6	2016	0.90
R15	Future Industrial – North of site	10.7	2019	1.75
R16	Future Residential – North of site	4.7	2017	0.48

Church Lawford meteorological data

These results show that the $C_{98,1hr}$ exceeds the 5 and 10 ou_E/m^3 criterion at three sensitive receptors and the 3 ou_E/m^3 criterion is exceeded at six sensitive receptors. The maximum $C_{98,1hr}$ of 15.4 ou_E/m^3 is predicted at sensitive receptor R9 (Mill Lane) in 2017.

The highest predicted odour concentrations, at sensitive receptors, occur when the 2017 meteorological dataset is used in the model, with the 2016 dataset predicting the second highest concentrations. Figure 4.1 and Figure 4.2 present the predicted isopleth concentrations for 2017

and 2016, with contour intervals of 10, 5 and 3 ou_E/m³. The C_{98,1hr} 10 ou_E/m³ odour contour interval extends across the proposed industrial area, with the C_{98,1hr} 5 and 3 ou_E/m³ odour contour interval extending across the proposed residential areas to the east and north of the STW.

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 may occur at receptors R8 (Columbus Lane), R9 (Mill Lane) and R15 (Future industrial)). This would also depend on the sensitivity of the area for receptors with odour concentrations, represented as C_{98,1hr}, larger than 3 ou_E/m³ i.e. receptor R12 (King Richard's Hill) and Future Residential areas R14 and R16.

Complaints are unlikely to occur for receptors with odour concentrations, represented as C_{98,1hr}, lower than 3 ou_E/m³.

However, the HBBC Environmental Health Officer (EHO) stated that no complaints have been received relating to odour from the Mill Lane STW in Earl Shilton, within the past 10 years. This would suggest that the predicted odour concentrations are larger than what is observed at existing residential receptors or residential areas that are less sensitive to the odour concentrations from the STW, are located near agricultural land.

Odour modelling assessments are highly sensitive to the input data used, such as emission rates and meteorological data. This assessment was undertaken using library data, representing a low to moderate level of odour emissions, from the STW derived from Odournet's 2010 assessment for Severn Trent Water and were selected to provide a worst-case assessment approach.

NWP meteorological data

The updated results using 2019 NWP data suggests that there will be no exceedances of the 3 ou_E/m³ criterion.

Figure 4.1 $C_{98,1hr}$ for the baseline and future scenarios, using 2017 meteorological data (ouE/m^3)

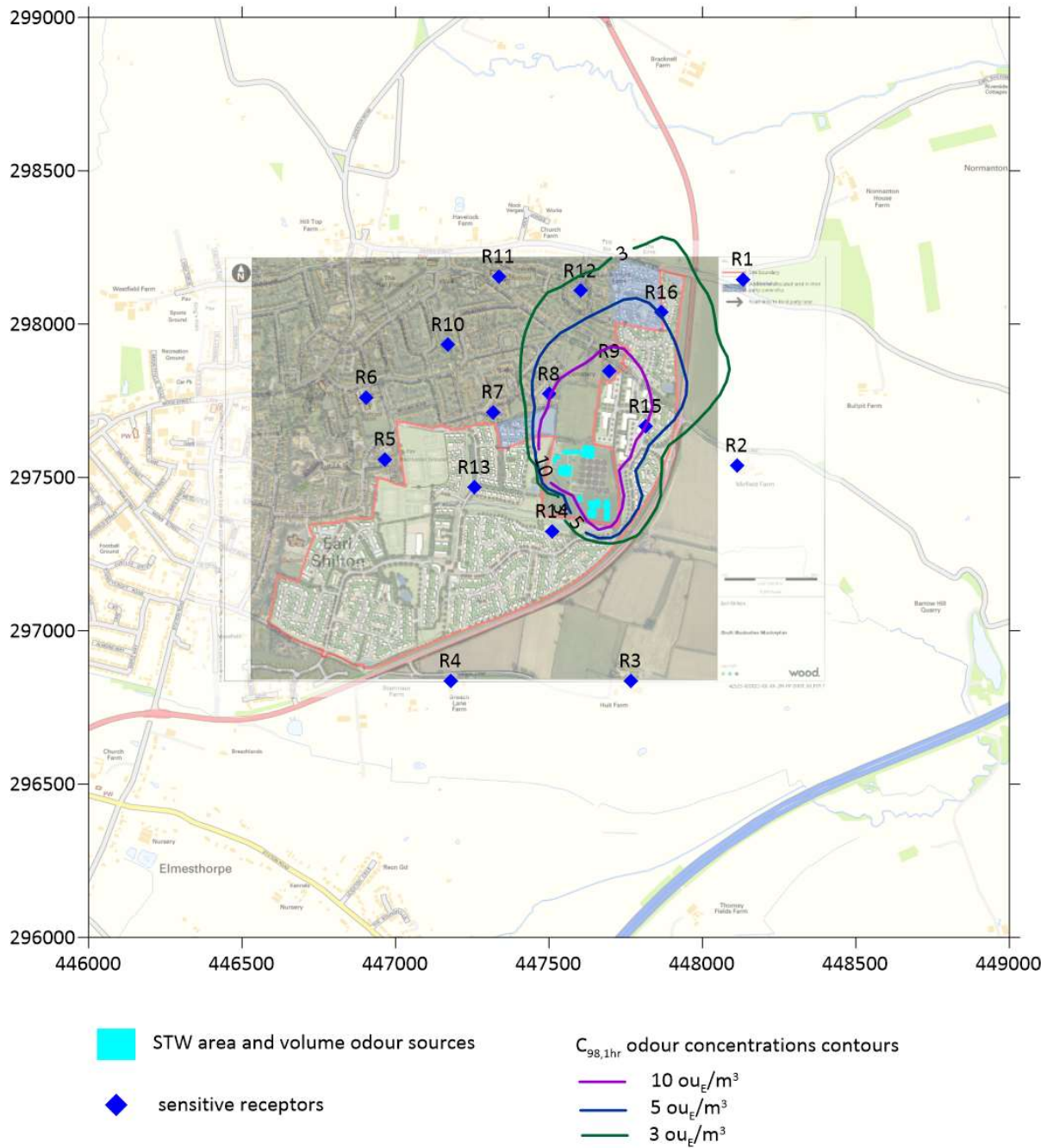
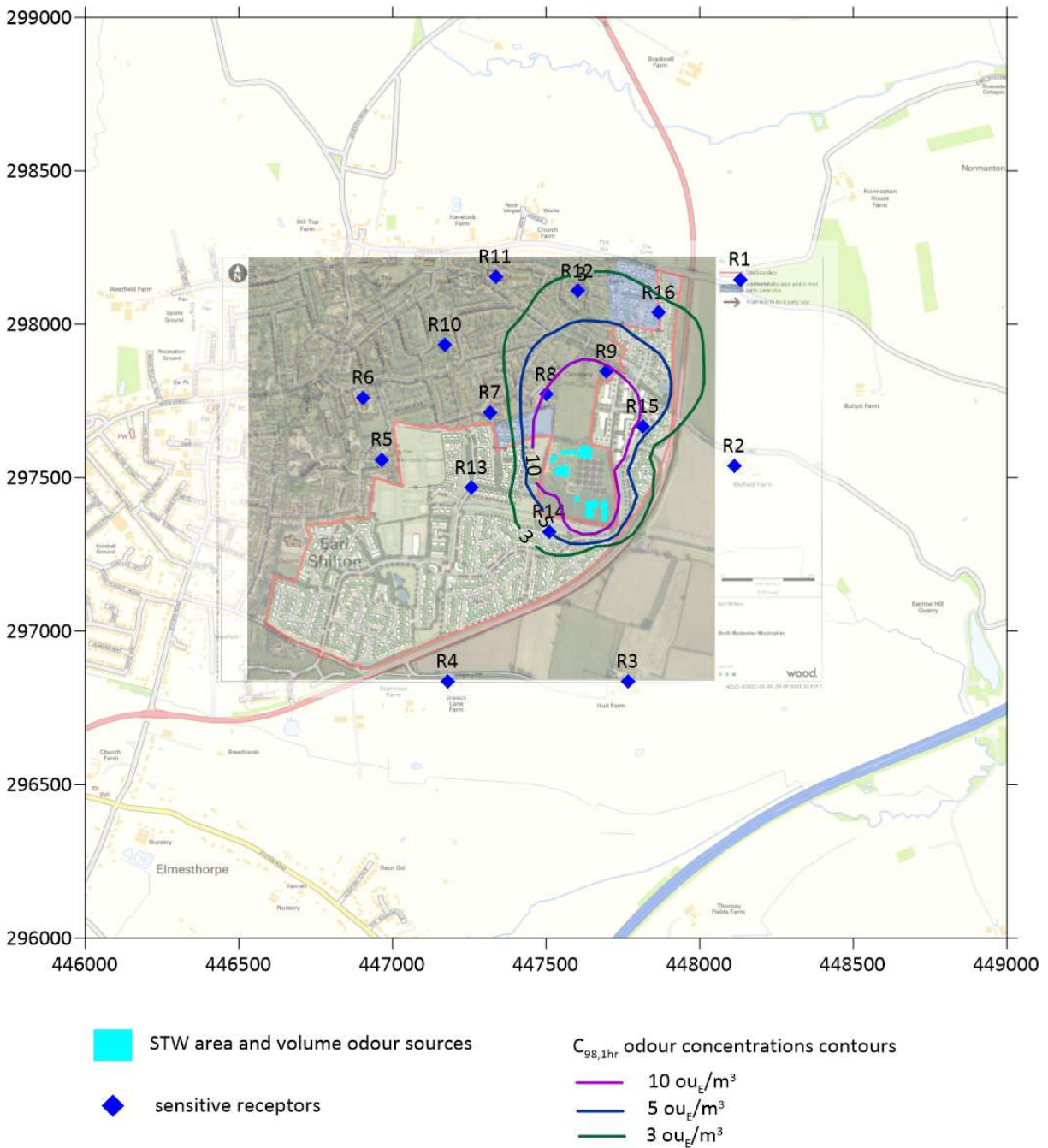


Figure 4.2 $C_{98,1hr}$ for the baseline and future scenarios, using 2016 meteorological data (ou_E/m^3)



5. Sniff Tests

summarises the conditions under which the odour sniff tests were undertaken, and the results at each location. The full set of preliminary results is presented in Appendix A.

Table 5.1 Details of sniff tests

ID	Wind Strength (Beaufort Scale)	Wind Direction (blowing from)	Average Temp. (°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

The odour exposure at the sample locations in the vicinity of the 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 STW, with location 2 adjacent to the boundary. Location 7 is predominantly downwind and consistently had the highest odours. However, these locations are not expected to be residential. Instead they are proposed for areas of employment. No “odour time” (where the odour intensity was perceived to be 4 or greater) was experienced at locations 1 or 2. With limited “odour time” at site 7.

At all of the other locations, the highest odour was considered to be slight or weak, with the average odour being very weak. It is however noted that all of the odours were waste-related.

Therefore, the odour exposure due to the STW at the proposed residential locations can be mostly considered negligible, however, there are areas adjacent to the treatment works or downwind where it would be prudent to ensure that there is a large enough buffer distance.

6. Conclusion

Detailed dispersion modelling has been undertaken with five years of meteorological data (2015-2019) from the Church Lawford meteorological station. The dispersion modelling indicated that the 2017 meteorological data resulted in the worst-case scenario for the STW. This modelling was updated using more representative NWP data, which has indicated that the odour results are lower than with the Church Lawford data.

The results of the original odour impact assessment predict odour concentrations at existing and future sensitive receptors above the 3, 5 and 10 ou_E/m³ odour criteria, represented as C_{98,1hr}, at several locations. This suggested there is a risk of odour complaints from the proposed residential areas. However, the updated results using 2019 NWP data indicate that there are no exceedances of the 3 ou_E/m³ odour criteria, represented as C_{98,1hr}, at any of the existing sensitive receptor locations.

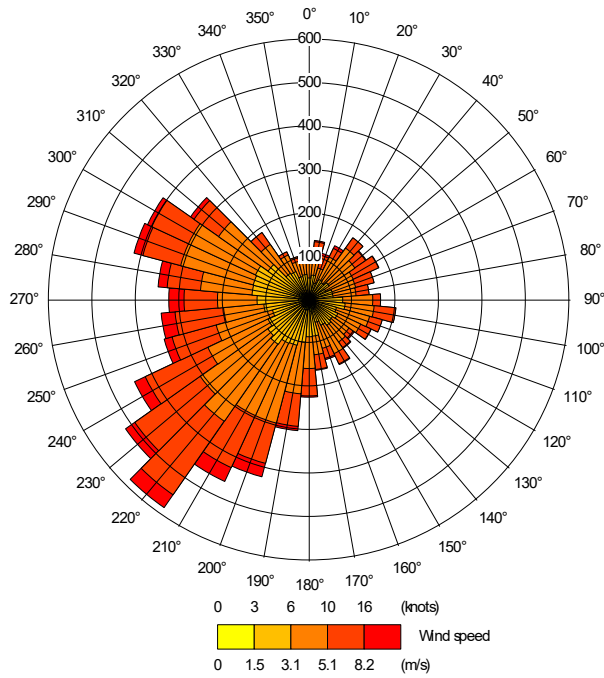
Although existing residential areas are located within zones which may result in complaints as identified using the Church Lawford meteorological data, there have been no complaints received by the HBBC relating to odour from the Earl Shilton STW for the past 10 years. This suggests that the predicted odour concentrations using the Church Lawford met data are significantly higher than the odour concentrations observed at the existing receptors. This indicates that the NWP meteorological data is more representative for the local area.

The validation of the odour baseline with sniff tests in 2022 has also indicated that odours were only present immediately adjacent to the STW or downwind. This indicates that some of the future receptors could be impacted by the STW operations. However, these locations are proposed for employment not residential uses, indicating that residents will not be impacted by the STW operations.

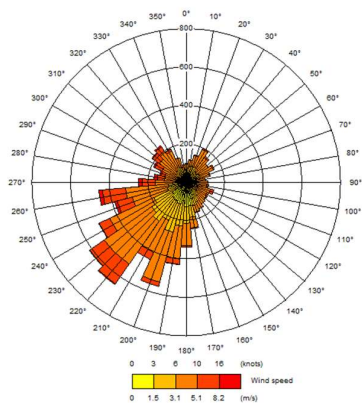
Appendix A

Wind Roses

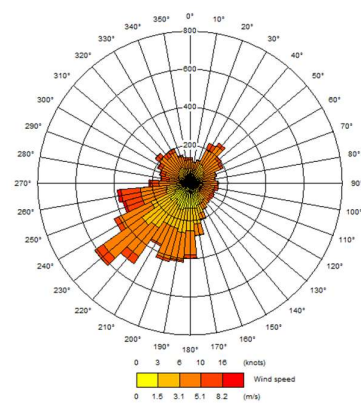
2019 NWP Data



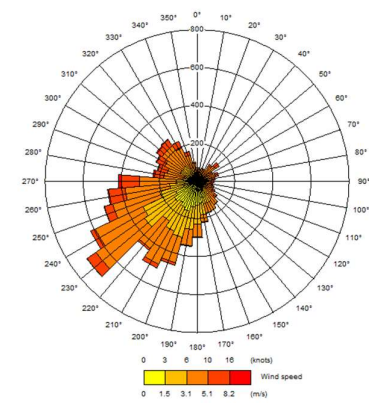
2015 Church Lawford



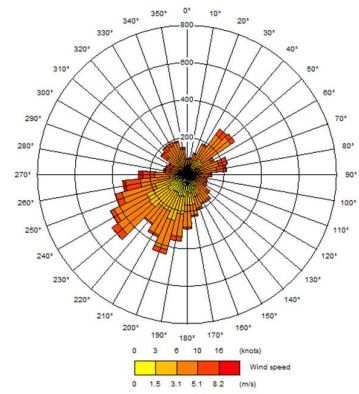
2016 Church Lawford



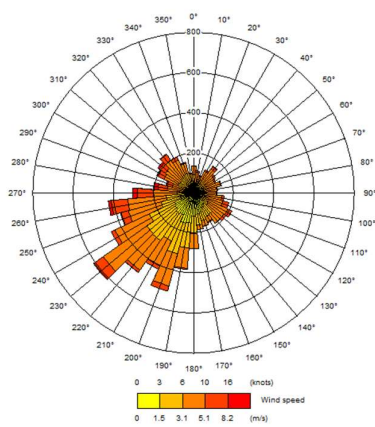
2017 Church Lawford



2018 Church Lawford



2019 Church Lawford



Appendix B

$C_{98th,1hr}$ odour concentrations contour plots for all years modelled (2015 – 2019)

Figure B-1 $C_{98th,1hr}$ for the baseline and future scenarios, using 2015 meteorological data (ouE/m^3)

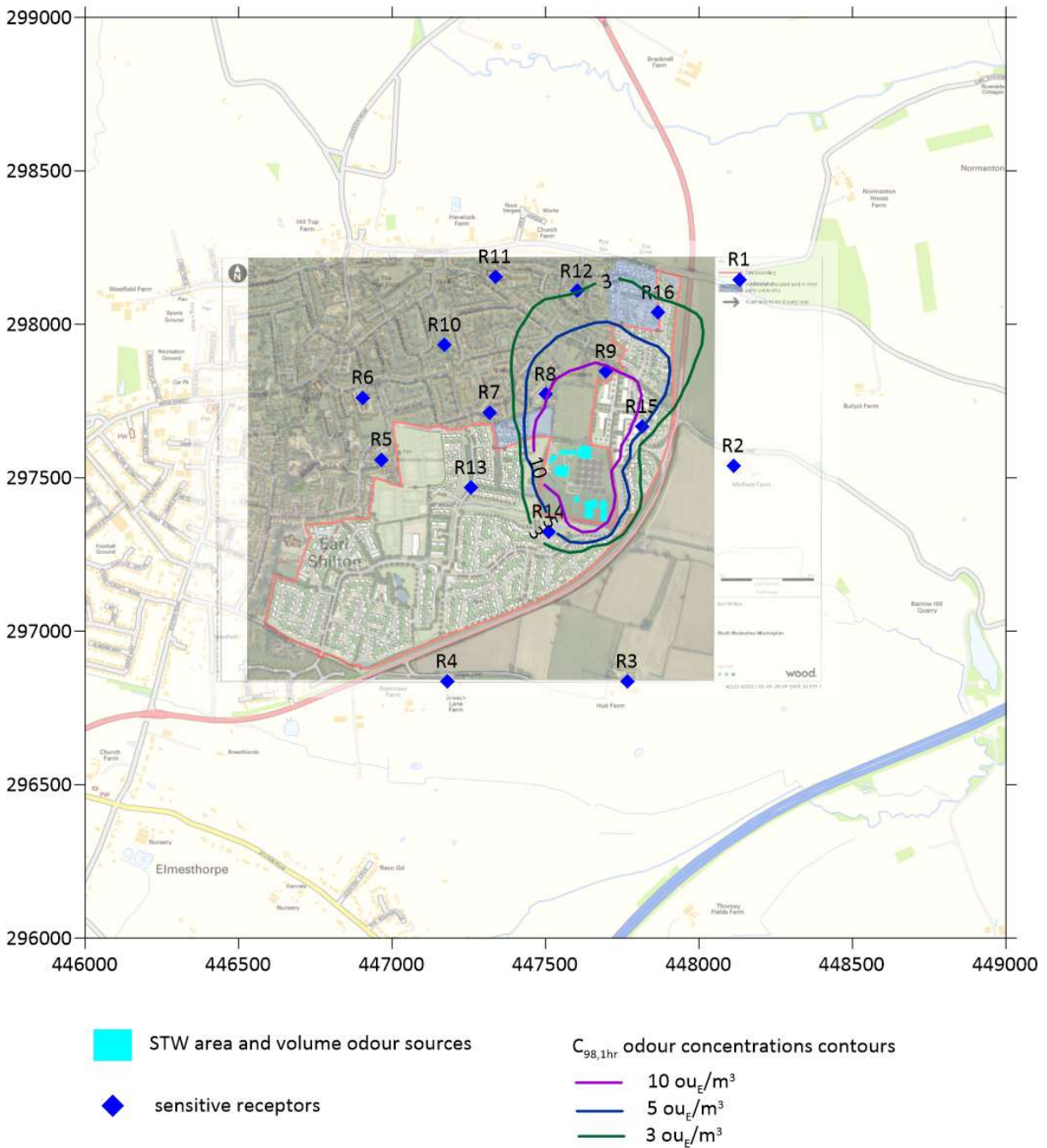
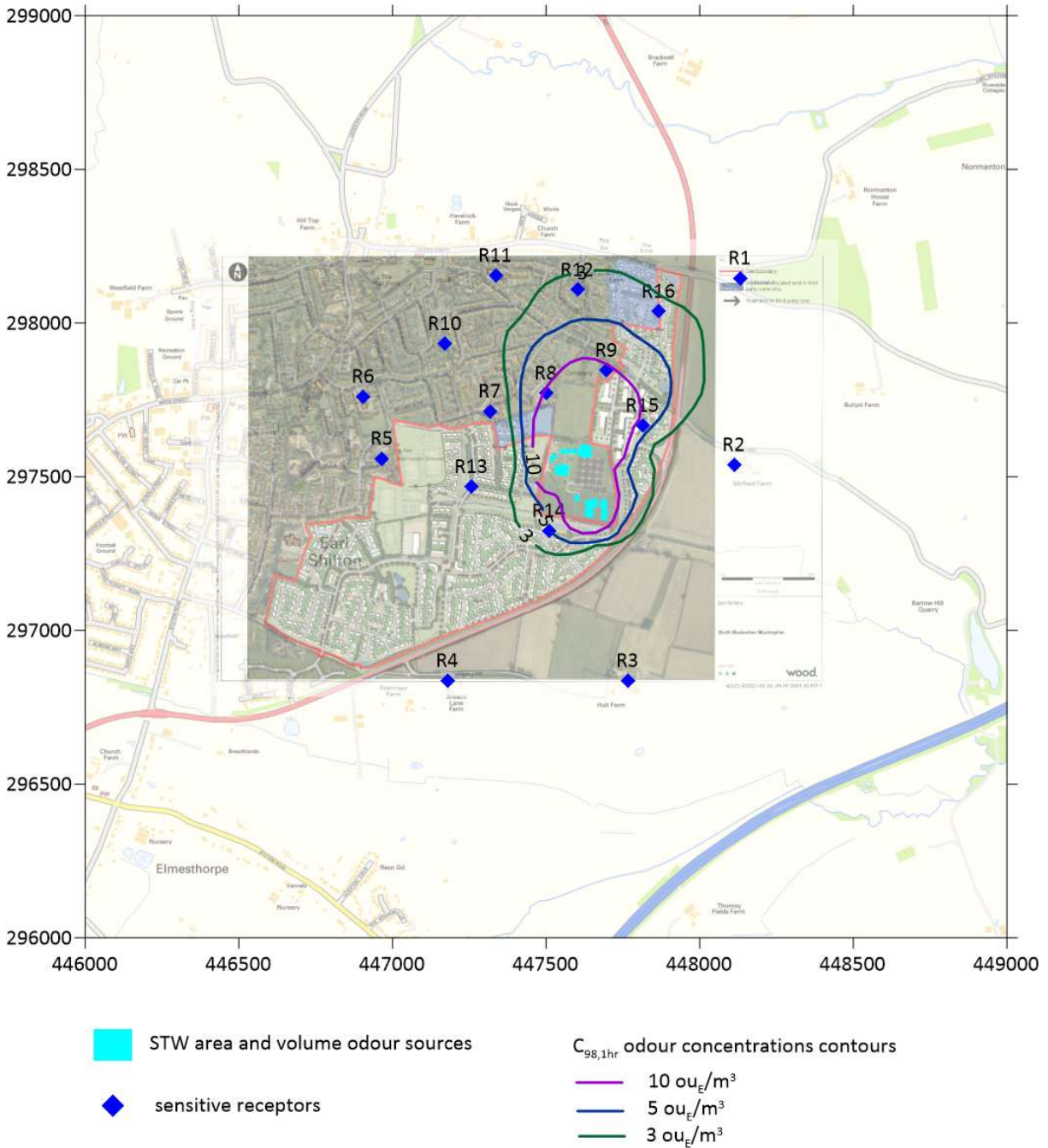


Figure B-2 $C_{98th,1hr}$ for the baseline and future scenarios, using 2016 meteorological data (ou_E/m^3)



◆ sensitive receptors

 $10 \text{ ou}_E/\text{m}^3$
 $5 \text{ ou}_E/\text{m}^3$
 $3 \text{ ou}_E/\text{m}^3$

Figure B-4 $C_{98th,1hr}$ for the baseline and future scenarios, using 2018 meteorological data (ou_E/m^3)

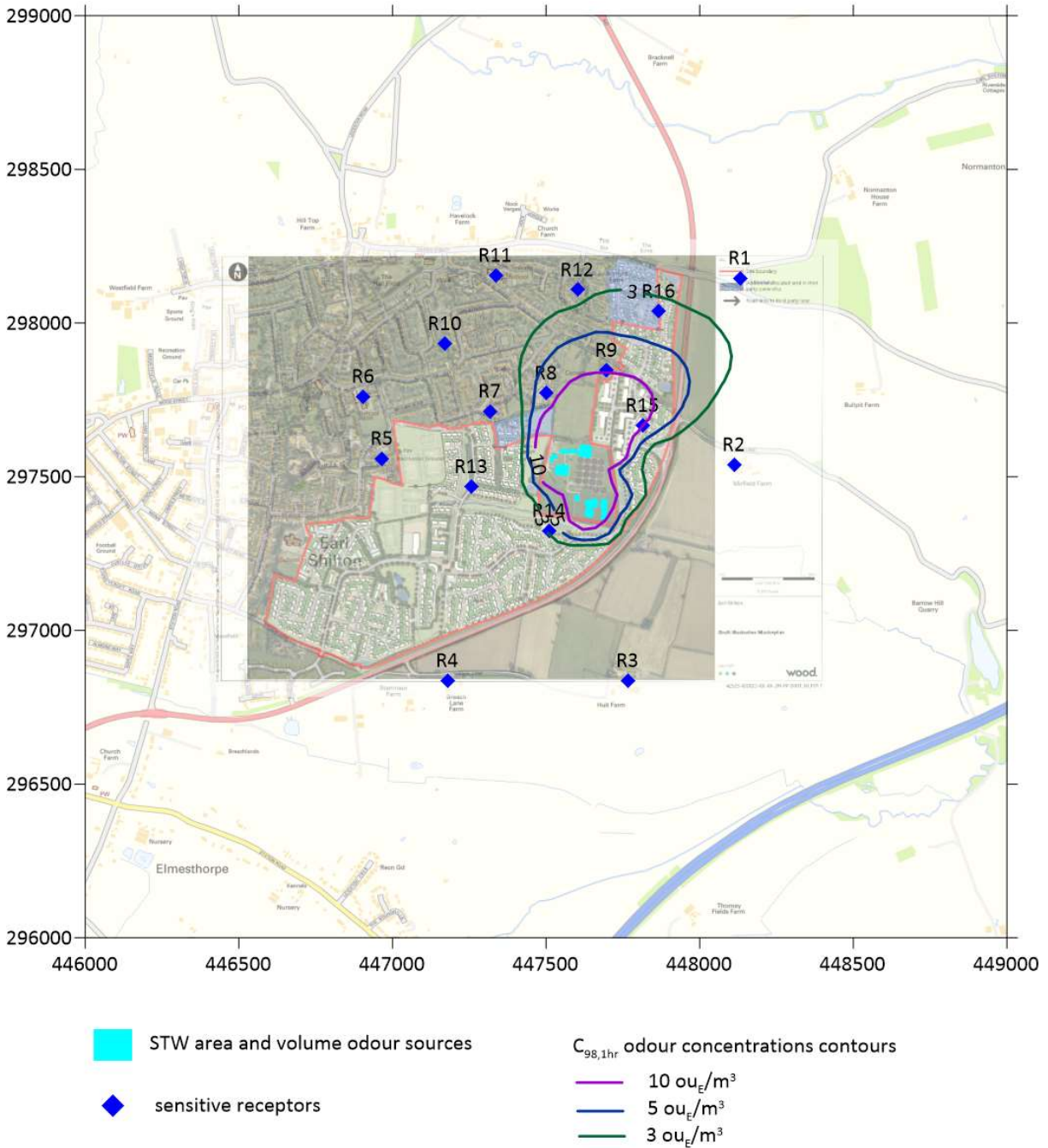
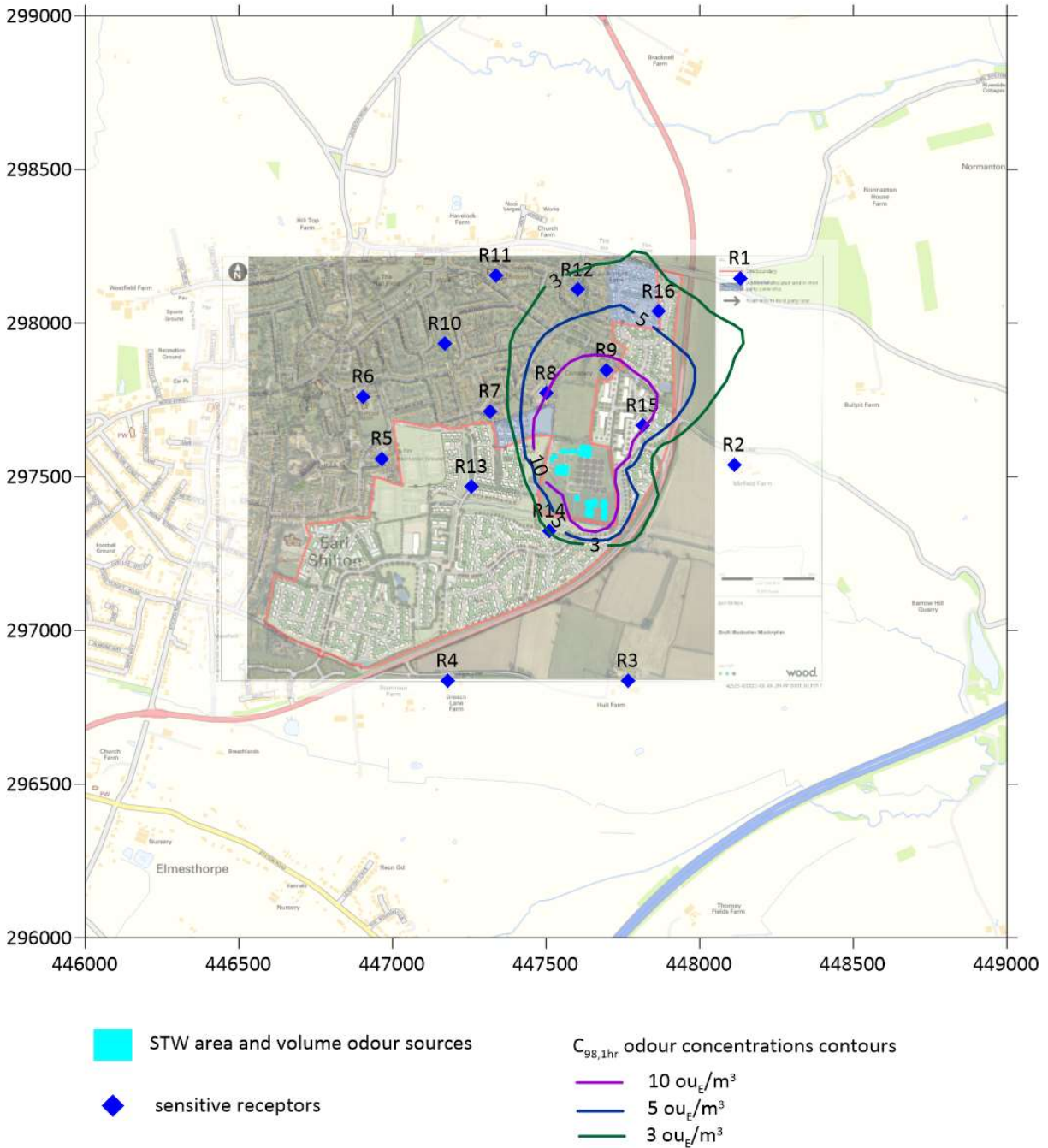


Figure B-5 $C_{98th,1hr}$ for the baseline and future scenarios, using 2019 meteorological data (ou_E/m^3)



Appendix C

Full Sniff Test Results

Table C1 Results from 1st Sniff Test – 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 C2 Results from 2nd Sniff Test – 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 C3 Results from 3rd Sniff Test – 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
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 C4 Results from 4th Sniff Test – 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.

