Taylor Wimpey

Elm Close, Sturminster Newton

Odour Assessment

January 2015

Move Forward with Confidence

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Document Control Sheet

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Submitted to	Mark Fitzgerald	Mark Fitzgerald
Prepared by	Ben Warren (Project Manager)	Jamie Clayton (Project Manager)
Signature		
Approved by	Mark Chapman (Technical Director)	Antony Wiatr (Principal Consultant)
Signature		
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Executive Summary

Bureau Veritas UK has been commissioned by Taylor Wimpey PLC to undertake an assessment of odour from Sturminster Newton Sewage Treatment Works (STW), using odour source sampling and predictive modelling, to determine the geographical extent of the area between the existing residential properties in Elm Close and the SWT where there would be a minimal risk of new residents experiencing odour annoyance. The STW operators, Wessex Water (WW), would be consultees on any future planning application for development on this parcel of land adjacent to the STW.

The assessment consisted of a sampling survey of odour emissions from the STW, followed by atmospheric dispersion modelling to assess the impact of odour in the area around the STW. Emission rates derived from the odour source sampling were used in the dispersion modelling.

The assessment has applied criteria where no residential units should be exposed to odour concentrations of greater than 3 ou_E/m^3 as the 98th percentile of hourly averages, in line with published guidance (CIWEM[4] and IAQM[5]) and relevant planning decisions (Mogden and Stanton)[5]. This does not mean that odours would never be detectable within the allocated land; rather, it represents a situation where objectionable odours are considered to be infrequent enough to not present annoyance.

Based on the results of the assessment, it is recommended that to ensure with a reasonable degree of confidence that incoming residents are not exposed to odour concentrations of greater than 3 ou_E/m^3 as the 98th percentile of hourly averages, development should only proceed in the green hatched area of Figure 4.

1 Introduction

1.1 Scope of Assessment

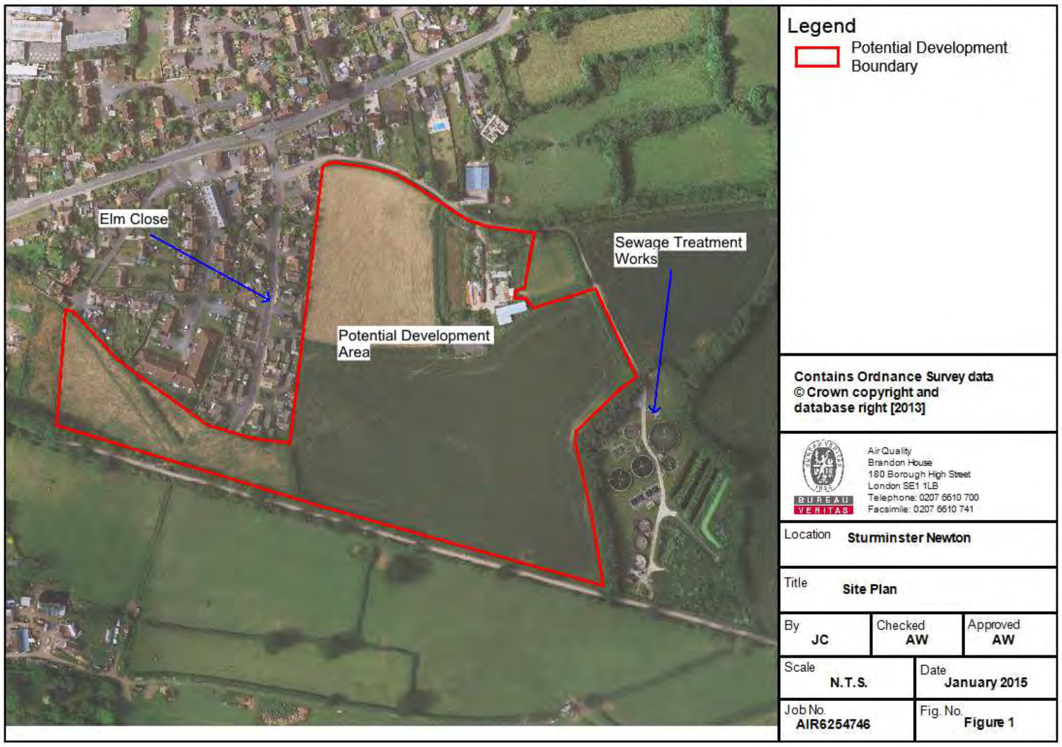
Bureau Veritas UK has been commissioned by Taylor Wimpey PLC to undertake an assessment of odour from Sturminster Newton Sewage Treatment Works (STW). The purpose of the assessment is to determine the geographical extent of the area between the existing residential properties in Elm Close and the STW where there would be a minimal risk of new residents experiencing odour annoyance. The locality under consideration is shown in Figure 1.

The assessment comprises a quantitative survey of odour emissions from the STW, followed by an atmospheric dispersion modelling study to assess the impact of odour in the area around the STW.

The report contains the following chapters:

- Assessment Criteria - details the guidance and legislation against which odour is assessed;
- Methodology - details the approach used for the source sampling and dispersion modelling;
- Assessment of Odour Emissions - details the results of the source sampling and emission rates used as inputs for the modelling study;
- Dispersion Modelling Results - details the results of the dispersion modelling study displaying the results in contoured form; and
- Conclusions and Recommendations – presents the conclusions of the odour assessment and any recommendations, if appropriate.

Figure 1 – Site Plan



2 Assessment Criteria

There are no UK statutory standards or levels against which odour impacts can be assessed, as the impact of an odour involves many complex psychological and socio-economic factors. The Environment Agency (EA) has given special consideration to the measurement and assessment of odours, based on the endpoint of 'annoyance'. Technical Guidance Note H4 on Odour Management[1] sets out the EA's general approach to the assessment of odours, which can also be applied to installations not regulated by the EA, e.g. STWs.

Where odours arising from STWs are giving rise to complaints in the local community, control is typically enforced by the local authority with reference to the statutory nuisance regulations detailed in Part III of the Environmental Protection Act 1990. Statutory nuisances can be defined as "*any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance*". Every local authority is required to inspect its area periodically to check for statutory nuisances, and investigate any complaints. Where a local authority is satisfied that a statutory nuisance exists, a notice is served requiring the abatement of the nuisance.

Atmospheric dispersion modelling is a useful technique for comparing different options for odour control. From the predicted odour *exposure*, a view must be formed on whether it is likely to cause odour *annoyance.* Making this judgement requires numerical benchmark criteria. The latter are the foundation for assessing the impact of any pollutant using predictive modelling, but for odour this is uniquely complex.

In Technical Guidance H4, the EA has set out numerical benchmark criteria derived from the empirical relationship between odour exposure and annoyance (measured by a community survey). The EA advocates the prediction of the 98th percentile of 1-hour mean of odour concentrations. The UK odour benchmarks are based on historical research in the Netherlands which associated these 98th percentile concentrations (in various offensiveness bands) with 10% of the population reporting annoyance.

2.1 Quantifying Odour Impacts

Unlike other nuisance parameters, such as decibels for noise, odours are not generally additive[2] and therefore a "new" odour cannot be added to an existing background or "ambient" odour level to give a figure for total odour. The human brain responds to odour by 'screening out' those odours which are always present or those that are in context to their surroundings. For example, it is therefore likely that an individual will be more tolerant to an odour from a factory in an industrial area rather than in the countryside. The human brain will also develop a form of acceptance to a constant background of local odours.

The perception of the impact involves not only the strength of the odour (measured/predicted by its concentration), but also its **F**requency, **I**ntensity, **D**uration, **O**ffensiveness (the unpleasantness at a particular intensity) and **L**ocation of the receptor. These attributes, known collectively as the **FIDOL** factors, determine whether odour emissions are likely to cause problems for neighbours, and need to be incorporated into (or otherwise accounted for in) the numerical benchmark criteria.

Odour concentration results are expressed in European odour units per cubic metre (ou_E/m^3), which equates to the number of dilutions to the detection threshold. Under laboratory conditions, an odour concentration of 1 ou_E/m^3 is by definition 'detectable', but its source/character would not necessarily be readily identifiable. An odour concentration of 3 ou_E/m^3 is frequently classed as one which is 'recognisable', i.e. its character could be described (e.g. meat, offal, herbal, etc.).

Very unpleasant odours (e.g. rotting meat, offal) have the potential to cause offence at the point of detection (1 ou_E/m^3) if the frequency is high enough. Conversely, more pleasant odours (e.g. mint) are likely to cause offence only at higher concentrations.

[1] Environment Agency Technical Guidance Note H4 – Odour Management. March 2011

[2] Environment Agency (2002) DRAFT Horizontal Guidance for Odour Part 1 - Regulation and Permitting

To account for the relative unpleasantness of different odour types, three bands of numerical benchmarks are detailed within Technical Guidance H4:

- 1.5 ou_E/m^3 - 'most offensive';
- 3 ou_E/m^3 - 'moderately offensive'; or
- 6 ou_E/m^3 - 'less offensive'.

Thus, before the numerical benchmarks can be compared against the modelled odour concentrations, an assessment must be made as to which of these unpleasantness bands applies to the odours in question.

In respect of odours, the 'detection threshold' is the concentration at which an odorous chemical or mixture can be just detected. This is usually assessed as an average for populations, because individual people will have very different sensitivities. The 'recognition threshold' is the concentration at which an odour can be identified. This is typically several times the detection threshold. Annoyance is typically experienced when the recognition threshold of an unpleasant odour is breached, and this can lead to a nuisance.

2.2 Odour Guidance in the Water Industry

Defra provides advice to local authorities and STW operators for the avoidance of odour nuisance in the Code of Practice on Odour Nuisance from STW[3] as follows;

> *"The occupiers of any new development are likely to expect and demand high amenity standards and this could result in complaints."*

The Code of Practice, however, does not provide guidance on what are acceptable odour annoyance criteria, in terms of odour concentrations. The Chartered Institution of Water and Environmental management (CIWEM) have produced guidance[4] relating to annoyance criteria in relation to odour concentrations. CIWEMs position on odour impact criteria can be summarised as follows;

> *"CIWEM considers that the following framework is the most reliable that can be defined on the basis of the limited research undertaken in the UK at the time of writing:*
>
> > *C_{98}, 1-hour >10 ou_E/m^3 - complaints are highly likely and odour exposure at these levels represents an actionable nuisance;*
> >
> > *C_{98}, 1-hour >5 ou_E/m^3 - complaints may occur and depending on the sensitivity of the locality and nature of the odour this level may constitute a nuisance; and*
> >
> > *C_{98}, 1-hour <3 ou_E/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."*

2.3 Case Law

Support for the use of the 98th percentile concentration metric can be found in a High Court case and several other planning decisions, as detailed in the Institute of Air Quality Management (IAQM) Guidance on the assessment of odour for planning[5]. In the case relating to odour nuisance at Mogden STW in west London, the Judge concluded the following in paragraph 992 of his judgement:

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[3] Defra (2006) Code of Practice on Odour Nuisance from Sewage Treatment Works.

[4] CIWEM (2012) Position Policy Statement – Control of Odour

[5] Institute of Air Quality Management (2014) - Guidance on the assessment of odour for planning

> *"I have to consider whether the odour which has been caused by particular odours has amounted to a nuisance in law and, if so, to assess damages for that nuisance. It is clear that odour concentrations below 1.5 ou_E per m^3 would not be considered to be a nuisance but I must bear in mind the fact that, on the basis of my findings, there are a number of processes at Mogden STW which Thames Water carry out and which do not give rise to Allen negligence but clearly give rise to odour emissions. It is therefore the additional odour nuisance caused by matters for which Thames Water are liable under Allen which I must consider. Such an assessment has no precise mathematical correlation with odour concentration figures and the application of a particular figure is difficult in this case because there has been no modelling of the odour conditions for which I have held Thames Water liable. I would be reluctant to find nuisance if the odour concentration was only 1.5 ou_E per m^3 but as the odour concentration rises to 5 ou_E per m^3 I consider that this is the area where nuisance from Mogden STW would start and that by the time that 5 ou_E per m^3 or above is reached nuisance will certainly be established."*

In relation to the case of a STW at Stanton near Bury St Edmunds, the inspector concluded the following in paragraph 55:

> *"The parties accepted that annoyance levels producing complaints are subjective and can arise both at levels below 1.5 ou_E per m^3 and from events in the 2% frequency. The existence of complaints does not necessarily demonstrate an unacceptable loss of amenity, but a lack of any is important in terms of the CoP. It is material in this case. On balance, and taking the relevant advice, decisions and practice into account, it seems to me that the appropriate threshold for this type of small STW is more than the 1.5 ou_E per m^3 now promoted by Anglian Water and the Council. I consider that a more appropriate threshold in this case is 3-5 ou_E per m^3, the level of the Defra guidance's "faint odour".*

Note, the Inspector's report appears to have misinterpreted the evidence presented and is using data presented as a 98th percentile to compare with a faint level of odour.

2.4 Odour Criteria for Planning

The IAQM produced Guidance[5] on the assessment of odour for planning in 2014. The IAQM guidance seeks to assist practitioners involved in odour assessment for planning. It states, however, that it *"is not intended to replace existing guidance produced by the environment agencies for environmental permitting (EP) purposes or where a specific assessment method is already provided within existing guidance."*

Section 5 of the IAQM guidance[5] provides an overview of odour assessment criteria presently used in the UK and points to be considered when undertaking an odour assessment. Although the IAQM guidance does not provide specific concentration metrics for different types of odour, it states the following:

> *"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 per m^3 as a 98th percentile of hourly mean odour concentrations."*

The guidance states however that it is incumbent on the responsible practitioner to exercise good professional judgement in selecting an appropriate odour assessment criterion for any particular case and providing justification for the selection.

On this basis, an odour concentration of 3 ou_E/m^3 as the 98th percentile of hourly averages has been considered appropriate for this assessment, in order to ascertain the area suitable for residential development around the Sturminster Newton site. This criteria is supported by the CIWEM guidance[4], which details that at less than 3 ou_E/m^3 complaints will be unlikely, and the conclusions of the nuisance cases in relation to STWs at Mogden and Stanton (detailed above)[5].

3 Methodology

3.1 Odour Sampling

A sampling method employing a Lindvall Hood was used to measure odour emissions from sources at Sturminster Newton STW. Triplicate sampling of each source was undertaken by Silsoe Odours on Wednesday 4th July 2012. The sources to sample were defined using information provided by Wessex Water (WW), and final choices of sampled sources representative of a particular treatment method and size were made on the day of the survey. All sources were area sources.

A floating cover (the Lindvall Hood) is ventilated at a known rate with activated carbon filtered air. Samples of the outlet odour streams are collected and analysed. The increase in odour concentration between inlet and outlet is caused by odour emitted from the source under investigation. Odour emission rates can be calculated from the odour concentration and measured hood ventilation rate. This technique was also used on filter bed surfaces.

3.2 Odour Concentration Measurement

Odour samples were analysed within 24 hours of sampling at the UKAS accredited Silsoe Odours laboratory in Bedfordshire using procedures set out in the British and European Standard for olfactometric analysis (BS EN 13725:2003).

Odour concentrations were measured using a dynamic dilution olfactometer with a forced choice method of sample presentation to an odour panel. Usually six dilutions of each sample, differing from each other by a factor of 1.6, are presented to the panellists previously selected within the limits set out in the standard (BS EN 13725:2003). Dilutions are made using odour-free air supplied by a compressor fitted with carbon filters and an air dryer.

The olfactometer has two sniffing ports, one containing the diluted sample air and the other, odour-free air. For each presentation panellists indicate via a keyboard which port they think is delivering the odorous air. The olfactometer quantifies the concentration of odour in air samples by diluting the air sample under test with known ratios of odour-free air. The diluted samples are presented to the panel to determine the odour threshold value. This is the odour concentration just perceived by 50% of the panel via a statistical analysis of the dilution test results.

For area sources, where emission rates are measured over an emitting surface, then emission rates can be expressed independently of the emitting area, on a per unit area basis, that is as odour units emitted per second per square metre of emitting area ($ou_E/m^2/s$).

3.3 Dispersion Model

The US Environmental Protection Agency (EPA) regulatory dispersion model AERMOD (version 7.9.1) has been used for this study. AERMOD is a ‘new-generation’ air dispersion model[6], which incorporates the latest understanding of boundary layer meteorology and air flows.

3.4 Meteorological Data

Dispersion of releases from area sources such as those at a STW are dependent to a large extent on the prevailing meteorological conditions at the time of release. AERMOD employs hourly meteorological data, which is configured for AERMOD by the AERMET pre-processor.

For this study, meteorological data with all the parameters required for dispersion modelling were available from Hurn, Bournemouth Airport (Table 1), approximately 20 miles from Sturminster

[6] Cimorelli, A.J. e al (2004), AERMOD: Description of Model Formulation. EPA 454/R-03-004. US Environmental Protection Agency, Research Triangle Park, North Carolina 27711

Newton and therefore considered representative of local weather conditions. Data capture is good (>90%) for all years considered, and the data meets the quality control criteria for dispersion modelling as set out in Atmospheric Dispersion Modelling Liaison Committee (ADMLC) guidance.

Table 1 - Meteorological data for Hurn (Bournemouth Airport)

Height of Station Above Sea Level	30m		
Station Code	GB0741A		
	Number of Hours Missing Data (% Useable Data)		**Calm Hours (Wind Speeds Less than 1 m/s)**
Years Available	2007	205 (97.7%)	142
	2008	8 (99.9%)	125
	2009	98 (98.9%)	116
	2010	72 (99.2%)	177
	2011	9 (99.9%)	60

The annual wind roses for the years 2007 – 2011 are shown in Appendix A. It is clear from the wind roses that there are dominant south-westerly and westerly components.

3.5 Sensitivity Analysis

The sensitivity of the modelling predictions to the use of different years of meteorological data has been investigated.

It is noteworthy that the variation in predicted concentrations arising from choice of meteorological year is within the ranges generally found when comparing different years of meteorological data. A sensitivity analysis reported by Defra[7] found that the annual mean modelled prediction can vary by 30% depending on the choice of meteorological year, with short averaging periods and higher percentile statistics (e.g. 98th percentile of 1-hour means) showing greater differences between meteorological years.

To investigate the sensitivity of the dispersion model to choice of meteorological year, the model was run separately for five meteorological years (2007 to 2011 inclusive) to generate the output statistic most relevant for this study, i.e. the 98th percentile of 1-hour means.

3.6 Receptor Grid

A regularly-spaced grid covering the area around the site has been included in the model. The height of all gridded receptors was set at 1.5 m, to represent inhalation for odour exposure.

The grid covers an area of 660 m by 540 m with a grid resolution of 15 m, including the entirety of the potential development land between Elm Close and the STW. Isopleths have been interpolated from modelled results using the rectangular (bilinear) method, which is suitable where data points are regularly spaced in a linear pattern.

3.7 Model Scenarios

One odour emission scenario has been modelled representing the current works as follows.

[7] Defra 2003, Local Air Quality Management Technical Guidance Note LAQM.TG(03), Annex 3

- Inlet works (INLE) with screening;
- Primary settlement tanks (2 rectangular - SED1_01/02, 1 circular - SED1_03);
- Biological filters (3 circular - FIL1_01, FIL1_02 and FIL1_03);
- Humus tanks (1 circular - HUM1_05, 4 rectangular - HUM1_01/02/03/04);
- Sludge tanks (2 circular - SS2_01, SS2_02);
- Storm tanks (STO2_01); and
- Final Effluent Lagoon (LAGN01).

3.8 Upgraded Works

WW has indicated that improvements may be required to the Sturminster Newton STW at some point to accommodate future growth in the catchment. However, WW have stated that any changes at the site will not be commissioned until April 2016 at the earliest, if at all. It is therefore not possible at this point in time to make any prediction around future emissions from the Sturminster Newton STW due to pending site improvements. This assessment therefore considers only current emissions from the STW.

4 Assessment of Odour Emissions

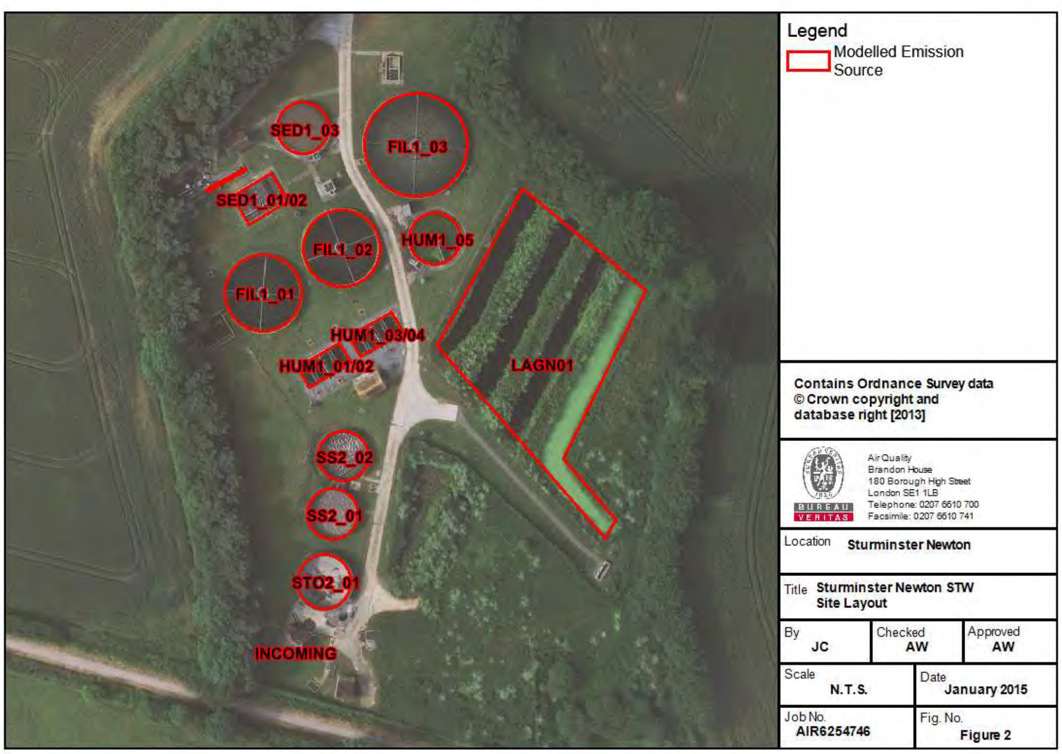
4.1 Odour Survey Results

The odour survey was carried out on Wednesday 4th July 2012. Full details are presented in Appendix B. The STW site schematic is shown in Figure 2. Odour emission rates are shown in Table 2.

Table 2 - Odour Emission Rates from Sturminster Newton Sources

Sampling Time of Day	Sample Source and Position	Geometric Mean Odour Concentration of the Sample (ou_E/m^3)	Odour Emission Rate ($ou_E/m^2/s$)
11:42	Inlet channel (INLE)	182	9.24
10:38	PST (SED1 03)	68	0.57
11:09	PST (SED1 02)	155	1.60
09:55	Humus (HUM1 05)	50	0.42
13:10	Humus tank (HUM1 03)	363	3.02
12:22	Filter bed (FIL1 01)	102	0.26
13:22	Sludge tank (SST2 01)	5,421	45.04

Figure 2 - Sturminster Newton STW Site Layout



Dynamic dilution olfactometry is not currently practical on a continuous basis for any source. The inability to accurately quantify the odour's temporal variation, and difficulties in correlating the source variation with time-varying meteorology in the dispersion modelling, is the most significant source of uncertainty in the majority of odour assessments.

The day of the survey was a mixture of overcast and sunny weather, with spells of light rain. The survey followed an extended period of heavy rainfall; therefore, odorous compounds in water-based treatment units are likely to be heavily diluted and odour emission rates are likely to be lower than during drier periods. Conversely, odour emission rates are likely to be higher from wet sludge in the sludge tank than dry sludge as a result of increased evaporation. Also, emissions from the sludge tank under normal conditions are likely to be reduced by the crust layer at the top of the sludge. On the sampling day, this was broken to enable worst-case odour sampling.

The three strongest odour sources sampled in terms of odour emission rate were:

- Sludge tanks;
- Inlet channel; and
- Square humus tank (worst-case tank was sampled, which may have been operating incorrectly, increasing odour concentrations).

4.2 Modelled Emission Sources

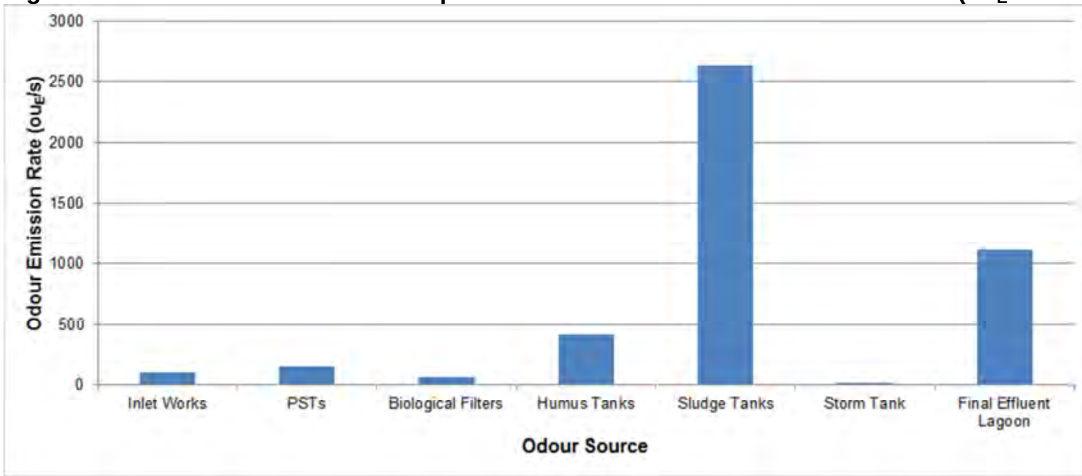
This source information was combined with details of the location and size of individual sources to build the dispersion model, as shown in Table 3 and Figure 3.

Table 3 - Sturminster Newton – Source Emission Rates

Source Name	Height (m)	X	Y	Radius (m)	Length (m)	Width (m)	Emission Rates	
							$ou_E/m^2/s$	ou_E/s
INCOMING	0	379485	114029	-	5.9	0.6	9.24	33
INLE	0	379467	114139	-	10.5	0.7	9.24	68
SED1_01/02	0	379477	114131	-	11	7.8	1.6	137
SED1_03	0.5	379490	114154	6.3	-	-	0.57	18
FIL1_01	1.8	379480	114114	9.3	-	-	0.26	18
FIL1_02	1.8	379499	114125	9.3	-	-	0.26	18
FIL1_03	0	379517	114150	12.5	-	-	0.26	32
HUM1_01/02	0	379491	114092	-	11.8	5.6	3.02	200
HUM1_03/04	0	379504	114099	-	11.8	5.6	3.02	200
HUM1_05	0	379522	114128	6.3	-	-	0.42	13
SS2_01	2.5	379497	114061	6.1	-	-	45.04	1316
SS2_02	2.5	379500	114075	6.1	-	-	45.04	1316
STO2_01	2.5	379495	114045	6.6	-	-	0.42	14
LAGN01	0	379522	114102	-	62	43	0.42	1120

The calculated comparable odour emission rates for all process units are presented in Figure 3. The total odour emitted from Sturminster Newton STW was calculated to be 4,502 ou_E/s. The assessment has shown that the Sludge Tanks are the dominant odour source on the site with an emission rate which equates to approximately 58.5% (2,633 ou_E/s) of the total odour emitted from the site.

Figure 3 - Sturminster Newton - Comparable Emission Rates for Odour Sources (ou_E/s



5 Dispersion Modelling Results

Dispersion modelling has been undertaken using measured odour emission rates (Table 2 and Figure 3) and five years of hourly sequential meteorological data from Bournemouth Weather Station (2007-2011) to predict the resulting odour exposure area around the Sturminster Newton STW.

As detailed previously, the CIWEM[4] Position Policy Statement states that at concentrations less than 3 ou_E/m^3 as the 98th percentile of hourly averages;

> *"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."*

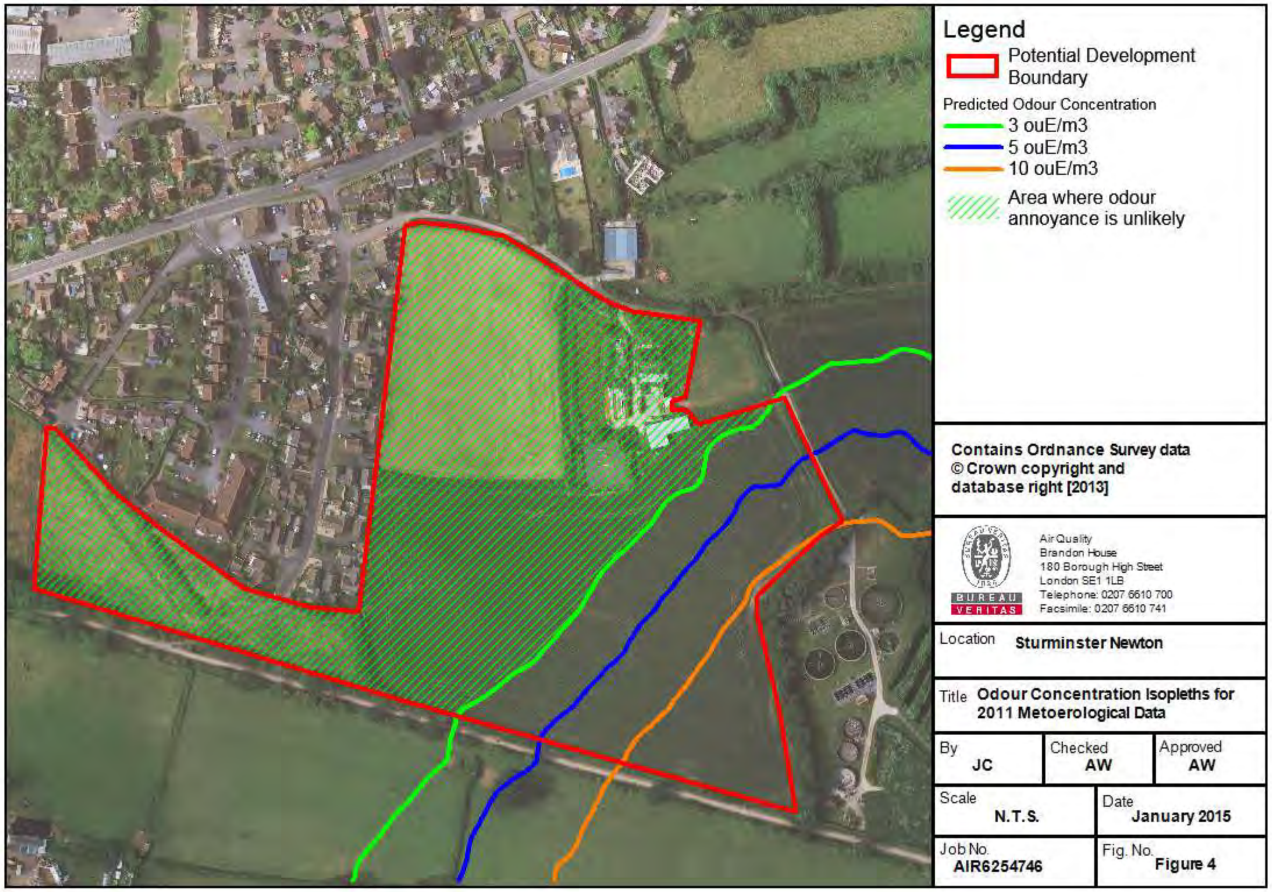
The meteorological year associated with the smallest area of the potential development site that complies with the 3 ou_E/m^3 as the 98th percentile of hourly averages has therefore been used to identify the worst case assessment year for odour dispersion. The predicted odour results for the five meteorological years considered were as follows:

- 2007 – 60,990 m^2 below 3.0 ou_E/m^3 as the 98th percentile of hourly averages;
- 2008 – 57,710 m^2 below 3.0 ou_E/m^3 as the 98th percentile of hourly averages;
- 2008 – 52,380 m^2 below 3.0 ou_E/m^3 as the 98th percentile of hourly averages;
- 2010 – 53,780 m^2 below 3.0 ou_E/m^3 as the 98th percentile of hourly averages; and
- 2011 – 51,490 m^2 below 3.0 ou_E/m^3 as the 98th percentile of hourly averages;

The meteorological year yielding the worst odour dispersion is therefore 2011 and results from this meteorological year are subsequently reported in this report as the worst case assessment year.

Predicted odour concentrations for the worst case meteorological data (2011) are presented in Figure 4. Results for all other meteorological years are provided in Appendix C.

Figure 4 – Sturminster Newton - Predicted Odour Concentrations for Meteorological Year 2011 (ou_E/m^3 as the 98th percentile of hourly averages)



6 Conclusions and Recommendations

Bureau Veritas has undertaken an odour assessment to predict the area of land suitable for residential development around Sturminster STW. The assessment has assumed criteria where no residential units should be exposed to odour concentrations of greater than 3 ou_E/m^3 as the 98th percentile of hourly averages in line with published guidance (CIWEM[4] and IAQM[5]) and relevant planning decisions (Mogden and Stanton)[5].

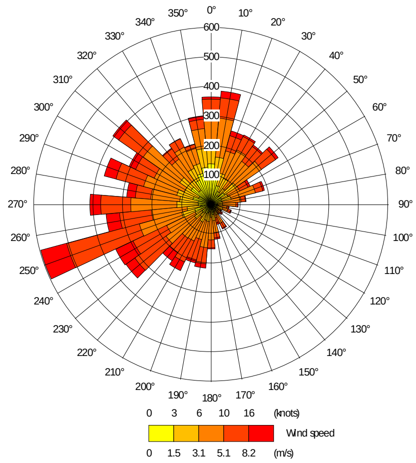
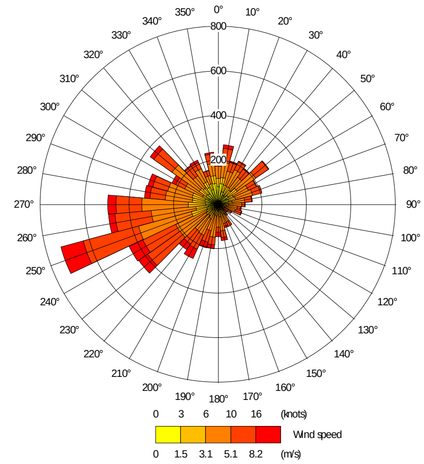
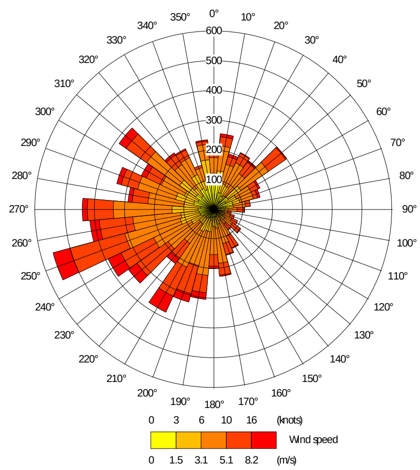
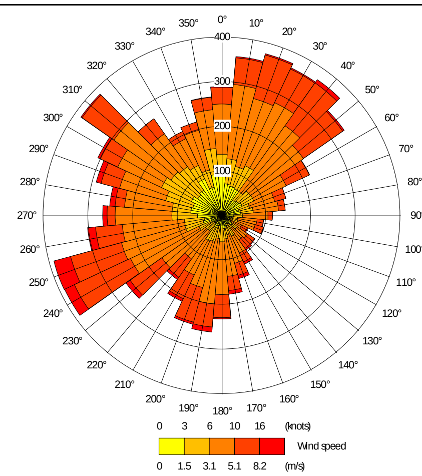
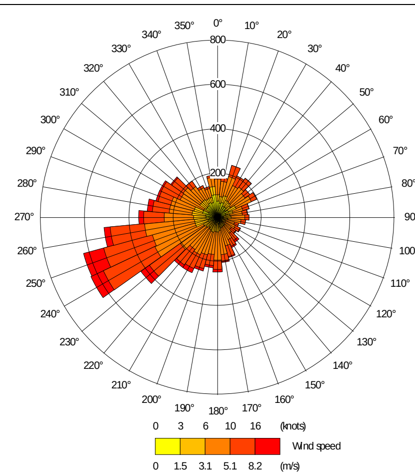
Based on the results of the assessment, it is recommended that to ensure with a reasonable degree of confidence that incoming residents are not exposed to odour concentrations of greater than 3 ou_E/m^3 as the 98th percentile of hourly averages, development should only proceed in the green hatched area of Figure 4.

As a further recommendation, odour sampling indicates that the sludge storage tanks are by far the strongest odour source at the STW. These sources therefore have the greatest impact on the distance of the 3 ou_E/m^3 as the 98th percentile odour isopleths from the STW. It may therefore be possible to agree an abatement strategy with WW, such as covering the sludge tanks, to reduce odour emissions and decrease the likelihood of odour annoyance in the land available for development. This is likely to require significant capital investment from WW, which they may seek to fund through contributions from local housing developments.

It is recommended that based on the findings of this report, any future development of the STW and abatement options are discussed in detail with WW in order to agree a strategy to maximise the residential development opportunities of the available land.

Appendices

Appendix A – Bournemouth Wind Roses

Bournemouth Weather Station 2007	Bournemouth Weather Station 2008
	
Bournemouth Weather Station 2009	**Bournemouth Weather Station 2010**
	
Bournemouth Weather Station 2011	
	

Appendix B – Odour Source Sampling

COMMERCIAL - IN CONFIDENCE

SILSOE ODOURS Ltd

Building 42 Wrest Park, Silsoe,

Bedfordshire, MK45 4HP.

0609

REPORT

to

Bureau Veritas Consulting

Report of an Odour survey at Sturminster Newton Sewage Treatment Works On 4th July 2012

6 July 2012 | **Client**

Produced by:-

Robert Sneath CEnv MIAgrE
Silsoe Odours Ltd
Building 42 Wrest Park, Silsoe,
Bedfordshire, MK45 HP.
01525 860222

Ben Warren
Bureau Veritas
Brandon House
180 Borough High Street
LONDON SE1 1LB

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1. Introduction

Silsoe Odours Ltd has been commissioned by Ben Warren of Bureau Veritas. on behalf of a property developer to conduct an survey of odour emissions from the Sturminster Newton Sewage Treatment Works. The sewage treatment works is located east of the town. Sampling was carried out on the 4 July 2012

Odour emissions from the facility have been assessed and quantified by Silsoe Odours Ltd. The odour emission figures obtained will be used by Bureau Veritas in an atmospheric dispersion modelling study in order to assess the impact of odour in the area around the plant.

2. Sampling and analysis methods

2.1 Odour Sampling

All odour samples were collected using inert FEP sampling tube, with stainless steel fittings, into PET sample bags. Inert materials are used to avoid sample contamination or leakage. A range of sampling techniques is used to collect samples from the different sources on sewage works to quantify odour concentrations and emission rates. Consecutive triplicate samples are taken from each individual source in order to reduce the range of the confidence limits of the odour analysis.

Odour emission rates are calculated from the product of an odour concentration and a ventilation rate, both of which can usually be fairly readily measured from point sources such as an odour control stack outlet. Different techniques have to be used to quantify odour emissions rates for more complex sources, such as the open area sources represented by settlement tanks and final tanks, where there is no defined confinement and no control of ventilation.

A covering method employing a Lindvall Hood was used to measure odour emissions from area sources. A floating cover (the Lindvall Hood) is ventilated at a known rate with activated carbon filtered air. Samples of the outlet odour streams are collected and analysed. The increase in odour concentration between inlet and outlet is caused by odour emitted from the covered surface. Odour emission rates can be calculated from the odour concentration and measured hood ventilation rate. This technique is also used on filter bed surfaces.

2.2 Odour concentration measurement

Odour samples are analysed on the day following sampling at the UKAS accredited Silsoe Odours laboratory in Bedfordshire using procedures set out in the British and European Standard for olfactometric analysis (BS EN 13725:2003).

Odour concentrations are measured using a dynamic dilution olfactometer with a forced choice method of sample presentation to an odour panel. Usually six dilutions of each sample, differing from each other by a factor of 1.6, are presented to the panellists previously selected within the limits set out in the standard (BSEN13725). Dilutions are made using odour-free air supplied by a compressor fitted with carbon filters and an air dryer.

The olfactometer has two sniffing ports, one containing the diluted sample air and the other, odour-free air. For each presentation panellists indicate via a keyboard which port they think is delivering the odorous air. The olfactometer quantifies the concentration of odour in air samples by diluting the air sample under test with known ratios of odour-free air. The diluted samples are presented to the panel to determine the odour threshold value. This is the odour concentration just perceived by 50% of the panel via a statistical analysis of the dilution test results. Odour concentration results are expressed in European odour units per cubic metre (ou_E/m^3), which equates to the number of dilutions to the detection threshold. The odour concentration of an undiluted sample which is at threshold level is defined as 1 ou/m^3.

2.3 Odour Emissions Rates

Odour emission rates are calculated from the product of an odour concentration (ou_E/m^3) and a ventilation rate (m^3/s), both of which can usually be fairly readily measured from ventilated point sources such as an odour control stack outlet. Thus the units of odour emissions are odour units per second (ou_E/s – from $ou_E/m^3 \times m^3/s = ou_E/s$).

For area sources, where emission rates are measured over an emitting area of liquid, then emission rates can be expressed independently of the emitting area, on a per unit area basis, that is as odour units emitted per second per square metre of emitting area ($ou_E\ m^{-2}\ s^{-1}$). Thus total emissions for a tank of a known surface area can be calculated from the product of the surface area of the tank and the area specific emission rate ($ou_E\ m^{-2}\ s^{-1} \times m^2 = ou_E s^{-1}$)

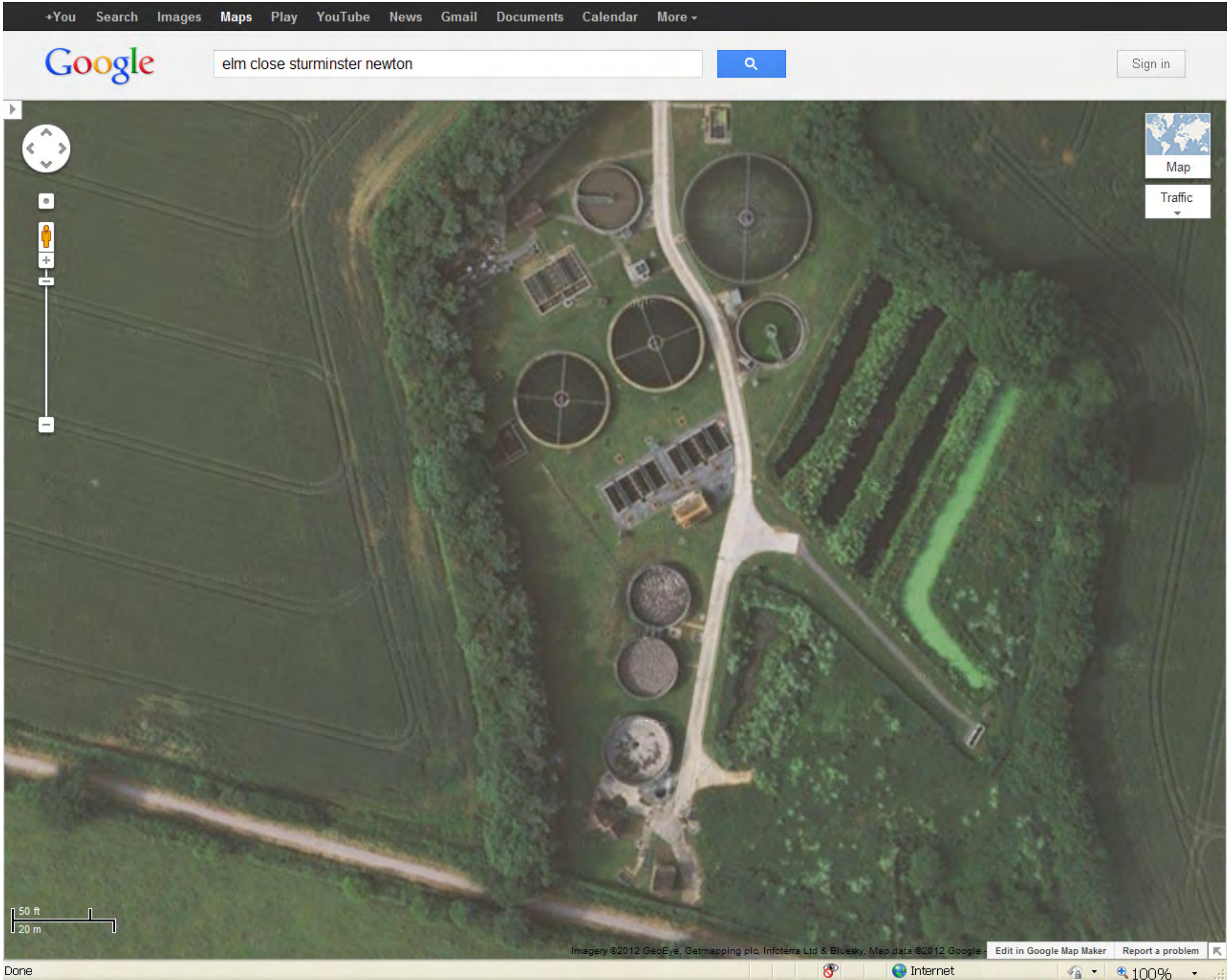
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Figure 1. Sturminster Newton Site with sampling sources identified

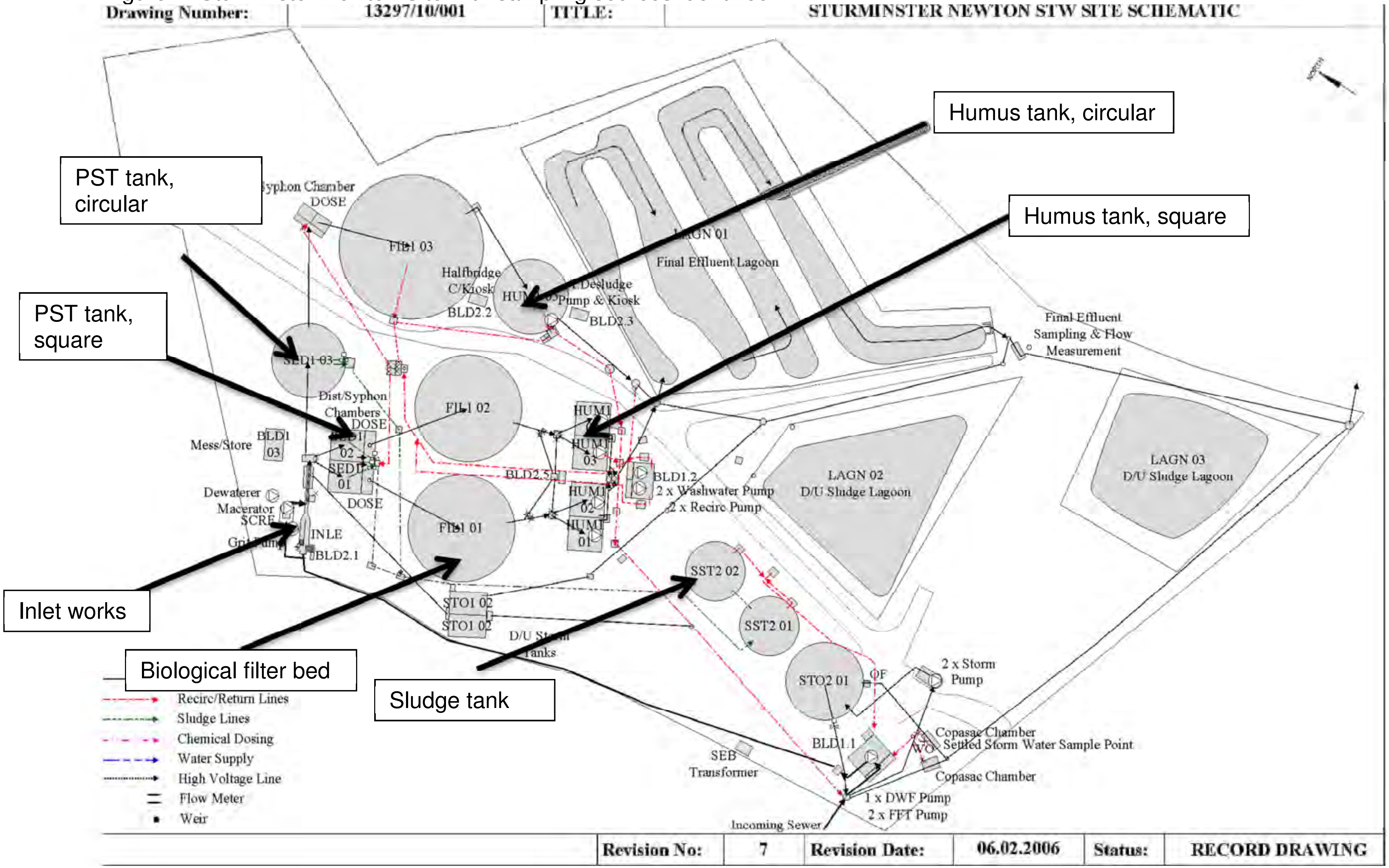


Fig 2, The Lindvall type hood collecting surface emissions (on another site) from a settling tank, fan and filter on the wall the 1m^2 hood connected with Nalophan NA tube

Fig 3, The Lindvall type hood collecting surface emissions from a sludge settlement tank.

3. Odour sources and emission rates

3.1 Odour Sources

Odour sources on this works consisted mainly of open tanks and biological filter beds. The inlet works was in the open on the west side of the site fed by pump from the inlet building at the south of the site.. The site layout and sources sampled are shown in Fig 1. The Lindvall hood is shown in Figs 2 and 3 in use on a PST and a sludge tank.

Table 1 Odour concentrations and Jerome measurements of H_2S of the samples collected from the Sturminster Newton sources

Samples collected 04/07/2012 at:		Sample No.	Sample Source and Position	Odour Panel Threshold $ou_E\ m^{-3}$	Jerome H_2S, ppm	
09:55		20120705 SN1	Humus, circular	56	0	
10:00		20120705 SN2	Humus, circular	44	0	
10:05		20120705 SN3	Humus, circular	50	0	
10:35		20120705 SN4	PST, circular	0.0	0.001	
10:40		20120705 SN5	PST, circular	63	0.001	
10:45		20120705 SN6	PST, circular	74	0.002	
11:10		20120705 SN7	PST, square	1,107	0.100	
11:15		20120705 SN8	PST, square	647	0.075	
11:15		20120705 SN9	PST, square	527	0.045	
11:40		20120705 SN10	Inlet channel	248	0.007	
11:55		20120705 SN11	Inlet channel	246	0.005	
11:55		20120705 SN12	Inlet channel	99	0.007	
12:20		20120705 SN13	Filter bed smell	111	0.005	
12:30		20120705 SN14	Filter bed smell	109	0.003	
12:35		20120705 SN15	Filter bed smell	89	0.004	
13:10		20120705 SN16	Humus tank, square	476	0.042	
13:15		20120705 SN17	Humus tank, square	574	0.017	
13:20		20120705 SN18	Humus tank, square	175	0.015	
13:40		20120705 SN19	Sludge tank	6,103	0.15	
13:40		20120705 SN20	Sludge tank	4,873	0.13	
13:45		20120705 SN21	Sludge tank	5,357	0.12	
14:00		20120705 SN22	Carbon filter	0.0	0	

3.2 Estimation of Odour Emission Rates

A summary of the estimated odour emission rates from the various tanks and filters at the site are provided in Table 1. All the emission rates were estimated from the Lindvall Hood method of sample collection Fig. 2.

Table 2. A summary of odour emission rates from **Sturminster Newton** *surface sources*

Sampling Time	Sample Source and Position	Geometric mean odour concentration of the sample $ou_E m^{-3}$	Odour emission rate, $ou_E m^{-2} s^{-1}$
11:42	Inlet channel	182	9.24
10:38	PST, circular	68	0.57
11:09	PST, square	155	1.60
09:55	Humus, circular	50	0.42
13:10	Humus tank, square	363	3.02
12:22	Filter bed, small	102	0.26
13:22	Sludge tank	5,421	45.04

APPENDIX 1 Report of odour concentrations from the Odour Laboratory

SILSOE ODOURS Ltd

Building 42 Wrest Park, Silsoe, Bedfordshire, MK45 4HP.

Acuity Tests for: Bureau Veritas,

Sturminster Newton on 5th July 2012

0609

APPENDIX 1 Report of odour concentrations from the Odour Laboratory

Contract Report Number:	CR/SO931/12/BV002
Customer Reference:	PO No. A1932AGGX5594250F76
Measurements carried out by:	C P Schofield, J Liddle
1. Contact:	Ben Warren, Bureau Veritas Brandon House, Borough High Street London Se1 1LB. 0207 661 0732 Mobile: +44 (0) 773 650 8480
2. Odour source:	Sewage Treatment Works
3. Sampler: *	R. Sneath
4. Sampling date: *	04 July 2012
5. Laboratory Temperature and CO_2	23.2°C, 579 ppm
6. Measurement date:	05 July 2012
7. Presentation mode:	Forced choice
8. Olfactometer:	PRA Odournet B.V. Serial number OLFACTON-E
9. Pre-Dilution Gas Meter:	Kimmon Model SK25 Ser No 0003171
10. Reference odorant/accepted reference value	n-butanol. 60 ppm/ 40ppb
11. Calibration Status of Laboratory	Accuracy, Aod = 0.151 Repeatability r = 0.240
12. Method:	Following Odour Lab Procedure OL1 which incorporates BSEN13725 "Air quality – Determination of odour concentration measurement by dynamic olfactometry".
13. Special remarks:	None
14. Approved by	Compiled by
R.W. Sneath Head of Laboratory.	C.P. Schofield, Manager of Laboratory

"This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF communiqué dated 18 June 2005)"

15. Results:

Table 1: Results for Sturminster Newton odours analysed on 5th July 2012

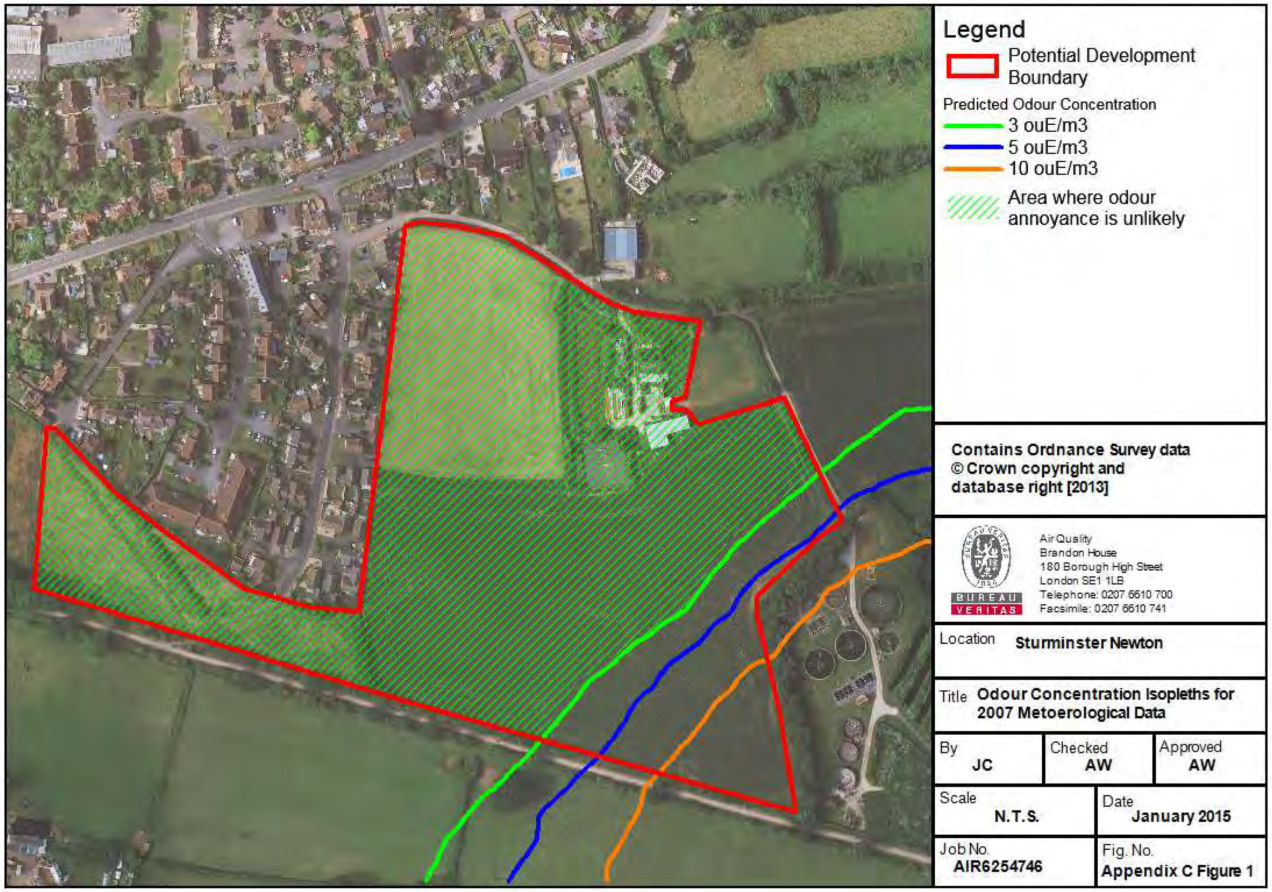
Samples collected 04/07/2012 at:	Samples analysed 05/07/2012 at:	Sample No.	Sample Source and Position	Odour Panel Threshold $ou_E\ m^{-3}$	Pre-dilution	Odour concentration of the sample $ou_E\ m^{-3}$ (including pre-dilution)
09:55	09:18	20120705 SN1	Humus, circular	56	None	56
10:00	09:28	20120705 SN2	Humus, circular	44	None	44
10:05	09:43	20120705 SN3	Humus, circular	50	None	50
10:35	11:02	20120705 SN4	PST, circular	0.0	None	0.0
10:40	11:14	20120705 SN5	PST, circular	63	None	63
10:45	11:29	20120705 SN6	PST, circular	74	None	74
11:10	13:59	20120705 SN7	PST, square	1,107	None	1,107
11:15	14:06	20120705 SN8	PST, square	647	None	647
11:15	14:26	20120705 SN9	PST, square	527	None	527
11:40	11:46	20120705 SN10	Inlet channel	248	None	248
11:55	11:58	20120705 SN11	Inlet channel	246	None	246
11:55	12:50	20120705 SN12	Inlet channel	99	None	99
12:20	13:04	20120705 SN13	Filter bed smell	111	None	111
12:30	13:23	20120705 SN14	Filter bed smell	109	None	109
12:35	13:40	20120705 SN15	Filter bed smell	89	None	89
13:10	09:59	20120705 SN16	Humus tank, square	476	None	476
13:15	10:19	20120705 SN17	Humus tank, square	574	None	574
13:20	10:43	20120705 SN18	Humus tank, square	175	None	175
13:40	14:43	20120705 SN19	Sludge tank	6,103	None	6,103
13:40	14:54	20120705 SN20	Sludge tank	4,873	None	4,873
13:45	15:07	20120705 SN21	Sludge tank	5,357	None	5,357
14:00	08:59	20120705 SN22	Carbon filter	0.0	None	0.0

Deviation from the standard
None

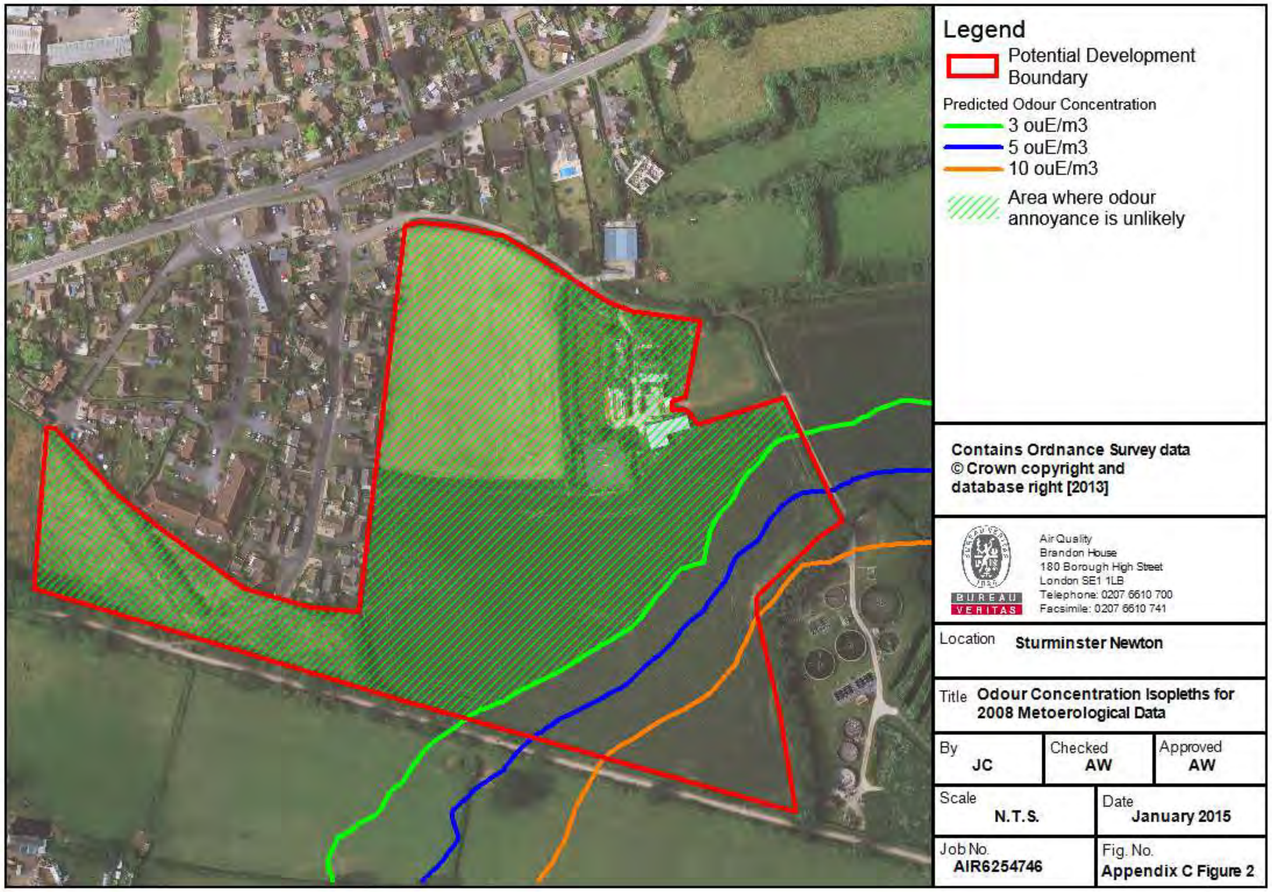
The following data is not covered by our UKAS Accreditation
None

Appendix C – Odour Concentration Isopleths

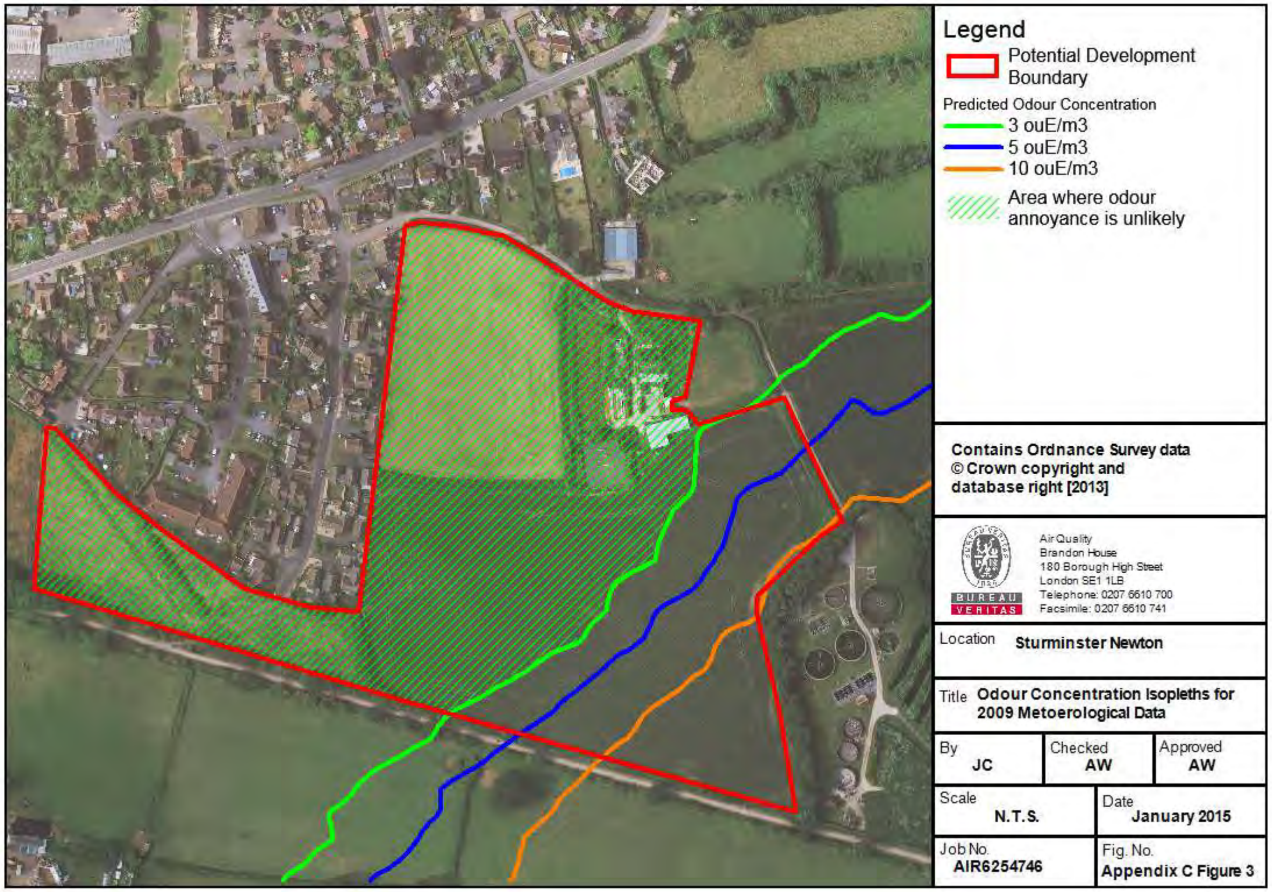
Appendix C Figure 1 – Sturminster Newton - Predicted Odour Concentrations for Meteorological Year 2007 (ou_E/m^3)



Appendix C Figure 2 – Sturminster Newton - Predicted Odour Concentrations for Meteorological Year 2008 (ou_E/m^3)



Appendix C Figure 3 – Sturminster Newton - Predicted Odour Concentrations for Meteorological Year 2009 (ou_E/m^3)



Appendix C Figure 4 – Sturminster Newton - Predicted Odour Concentrations for Meteorological Year 2010 (ou_E/m^3)