Review of the Odour Assessment produced by Redmore Environmental for the planning application to build an Anaerobic Digestor (AD) at Streetly Hall Farm

Abstract

The Odour Assessment for the proposed anaerobic digestor (AD) plant at Streetly Hall Farm, conducted by Redmore Environmental, exhibits several methodological limitations and conceptual oversights that raise substantial concerns about its reliability and accuracy. Crucially, the assessment operates within a framework lacking statutory limits for ambient odour concentrations in the UK, resulting in the absence of obligatory continuous odour monitoring by the plant operator.

A central issue in the assessment is the subjective classification of site odours as "moderately offensive," employing a standard benchmark level of 3.0 ou_E/m^3 as 98th percentile of 1 hour mean concentrations, which **the Environment Agency (EA) has specifically criticised as "not so robust"**. This standard benchmark is not based on detailed and odour-specific dose-response studies, instead being generalized from one study performed in the Netherlands over 20 years ago, on pig odours. Additionally, the assessment's approach to odour strength, suggesting that concentrations below 1.0 ou_E/m^3 are barely detectable, is fundamentally flawed, as 1.0 ou_E/m^3 is the **detection threshold** where 50% of people can detect the odour. Some nearby residential areas are predicted, by the dispersion modelling, to be **well above the 1.0 ou_E/m^3 detection threshold**, which means that more than 50% of residents in these areas **will experience odours daily**. A critical limitation of the predictions is that there are **no quantitative estimates of the uncertainty** around these predictions (e.g. standard deviation or confidence intervals), contrary to good modelling and scientific practices. Without estimates of uncertainty, the predicted 98th percentile 1-hour average odour concentration exposure levels at each receptor location are **arguably meaningless**.

Moreover, the dispersion modelling uses **input odour emission rates that are at least one order of magnitude lower** than those reported by peer-reviewed scientific literature and used by other planning applications for similar AD sites in the UK. Furthermore, the dispersion modelling **does not include critical odour sources** that are typically used by other planning applications for similar AD sites in the UK, such as those from liquid digestate transport tankers, slurries, dirty water lagoon, solid digestate and digestate off-take points. This further underestimates the odour impact of the site. In addition, the use of input meteorological data from a distant location, **25 km away with different geographical topology**, further compounds these inaccuracies, overlooking site-specific local wind patterns and conditions.

Overall, the use of inappropriately low odour emission rates, unaccounted odour sources and lack of site-specific meteorological data, lead to predictions by the dispersion model that are a **gross underestimation of potential odour impact on the surrounding communities.**

Important Background and Context

There is no statutory limit in the UK for ambient odour concentrations[1]. There are also no obligations for continuous odour monitoring by the plant operator. Hence, it falls on the victims of odour emissions to demonstrate loss of amenity, which becomes a difficult task due to the lack of statutory protections/limits on odour concentrations in the UK.

The odour assessment, produced by Redmore Environmental, subjectively **assumes** that odours from the site be classified as "moderately offensive". Based on this, Redmore Environmental have used an odour benchmark level of 3.0 ou_E/m^3 as the 98th percentile of 1-hour (C98, 1-hour) average concentrations. What this means in non-technical language is that impact from odours will be classified as "**negligible**" or "**slight**" if the dispersion modelling predicts any odour concentrations at chosen locations to be **less than 3.0 ou_E/m^3.**

Although this assumption is standard industry practice, the **Environment Agency (EA) has recognised its limitations and flaws**. In fact, the EA has highlighted that the benchmark level of 3.0 ou_E/m^3 for 'moderately offensive" odours is "**not so robust"**[2]. This benchmark level was "*not* derived from bespoke dose-response studies of industrial odours of different unpleasantness. Rather, the concentration values chosen were based on dose-response curves for receptors of differing sensitivities to [pig] odours"[3] in the Netherlands over 20 years ago. Thus, the EA has questioned the appropriateness of generalizing this benchmark[4].

Furthermore, the odour assessment asserts that "an odour at a strength of 1ou_E/m^3 is in reality so weak that it would not normally be detected outside the controlled environment of an odour laboratory by the majority of people". This is obviously flawed, as it does not account for the relative offensiveness/unpleasantness of the odour(s) in question, as highlighted by the EA[5].

While there is a clear relationship between odour concentration in air and its detectability by the human nose, what matters is not how strongly one can smell the odour, but rather how offensive/unpleasant the odour is at the **point of detection**[6] (defined as 1.0 ou_E/m^3) to individuals exposed to it. This is recognised by the EA[7]; the EA has thus discussed the use of hedonic scores.

Hedonic scores of different odours can be more informative[8], which account for the particular characteristics of each odour. For example, manure (which is a key feedstock for this AD plant) has a hedonic score of -3.36; for perspective, the hedonic score of "cadaverous (dead animal)" is -3.75 and "wet dog" is -2.28. The table below[9] gives insight into how hedonic scores are interpreted. Hedonic scores have **not been factored** into the findings of the dispersion modelling.

The modelling determined that some residential areas) experienced a maximum predicted 98th percentile 1-hour average odour concentration of 1.87 - 2.87 ou_E/m^3, the impacts of which are subjectively interpreted as "**slight**". In view of the fact that 1.0 ou_E/m^3 is the point of detection

Standard hedonic scale

Hedonic score	Description of relative pleasantness
-4	extremely unpleasant
-3	
-2	
-1	
0	neither unpleasant nor pleasant
1	
2	
3	
4	extremely pleasant

[1] Review of odour character and thresholds, EA, 2007 and Guidance on the Assessment of Odour for Planning v1.1, IAQM, 2018.
[2] Review of odour character and thresholds, EA, 2007
[3] Review of odour character and thresholds, EA, 2007; original study conducted in the Netherlands by Bongers et al, 2001
[4] Review of odour character and thresholds, EA, 2007
[5] Review of odour character and thresholds, EA, 2007
[6] Review of odour character and thresholds, EA, 2007
[7] Review of odour character and thresholds, EA, 2007
[8] Review of odour character and thresholds, EA, 2007
[9] Review of odour character and thresholds, EA, 2007

(**detection threshold**) of an odour[10], The EA provides important clarifying information of what this means[11]:

"It is important to recognise that published odour detection thresholds apply to population averages, *not* to individuals. At the odour detection threshold (whether for individual chemical species or mixtures), 50% of the population would be likely to detect the odour while the other 50% would not. **Within the half of the population who can detect the odour, some may even find it strong enough to be <u>offensive</u>**."

In view of this, it is obvious that people living in these locations will routinely detect odours from the plant, likely on a daily basis and multiple times per day. Moreover, in every year modelled, the predicted 98th percentile 1-hour average odour concentration for Streetly Hall Cottages and New Hall is **well above 1.0 ou_E/m^3**; hence, it is evident that far more than 50% of people surrounding areas will experience odours regularly. In fact, the relationship between an odour's concentration in air and the proportion of people finding it offensive is **exponential**[12], which means that as odour levels rise, there is an even bigger rise in how offensive they become. Furthermore, it is well recognised by local residents that the tranquil villages of **Streetly End and Horseheath sit downstream of the prevailing wind of the site**. Hence, this would significantly enhance odour dispersion to Streetly End and Horseheath, a site-specific meteorological feature unaccounted for by the modelling, as input meteorological data come from an observation station 25 km away (see section 3: Inappropriate Input Meteorological Data below).

In light of this and the fact that feedstocks (manure, slurry, poultry litter) of the AD plant have specifically low hedonic scores, it is likely that many people will find the odours significantly offensive, making it unreasonable to classify odours from the plant as "moderately offensive". Furthermore, the authors of the report **<u>do not provide any estimates of uncertainty (e.g. standard deviations or confidence intervals etc.) of their predicted 98th percentile 1-hour average odour concentration exposure levels at each receptor location, contrary to good modelling and scientific practices</u>**[13]. Without estimates of uncertainty, the predicted 98th percentile 1-hour average odour concentration exposure levels at each receptor location are **<u>arguably meaningless</u>**. Furthermore, Balsham is not even considered as an odour receptor by the dispersion model; in fact, there are no North Westerly receptors considered in the dispersion modelling.

Finally, Redmore Environmental performed dispersion modelling for only five years: 2016, 2017, 2018, 2019, 2020. There is no discussion as to how and why these particular years where chosen. The EA recommends using **<u>at least</u>** five years of meteorological data for dispersion modelling[14]. Given the significant risks posed by the AD plant to local communities, it would be reasonable to model more than five years to increase the validity of the model's predictions, as part of a risk-based approach. Indeed, the projected **operating life of the plant is 25-40 years**[15]; in light of this, the use of only five years **dramatically underestimates the potential impact of the site**. Furthermore, as Redmore Environmental produced the report in 2023, they should have also modelled 2021 and 2022, but they seem to arbitrarily stop at 2020 without explanation, contrary to odour assessments of other UK AD proposals that model the preceding five years from the date of assessment being made (for examples see footnotes, [16], [17]).

With these problems in mind, the subsequent text covers **three further critical issues** that undermine the dispersion modelling and odour assessment's validity.

[10] Review of odour character and thresholds, EA, 2007
[11] Review of Dispersion Modelling for Odour Predictions, EA, 2007
[12] Review of Dispersion Modelling for Odour Predictions, EA, 2007
[13] Review of Dispersion Modelling for Odour Predictions, EA, 2007
[14] H4: Odour Management, EA, 2011.
[15] Chris Covey stated this on 18 November 2023 at the Village Hall FAQ session in West Wickham.
[16] Air Quality Assessment for the Lower Drayton Farm Anaerobic Digestion Plant by Earthcare Technical Ltd
[17] Odour Assessment, Coleshill Anaerobic Digestion Facility by REC Ltd

1: Methodological Flaws and Emission Rate Underestimation

As per guidance issued by the EA[18] "odour modelling requires **good quality** assessments of emission rates". Hence, it is expected that emission rates used by dispersion modelling, are based on peer-reviewed scientific literature[19]. However, the odour assessment produced by Redmore Environmental uses odour emission rates that are highly dissimilar from those found in peer-reviewed scientific literature, being largely copied from other planning applications for AD plants. The key three emission rates used as inputs for the dispersion modelling are:

Emission Source	Odour Emission Rate	Unit	Reference
Liquid digestate	1.0	$ou_E/m^2/s$	Multi-method Monitoring of Odor Emissions in Agricultural Biogas Facilities, Jacques Nicolas, Gilles Adam, Yolanda Ubeda, Anne-Claude Romain, University of Liège and Universidad Politécnica de Valencia, 2013
Maize, rye, barley, sugar beet, fodder beet, grass and other whole crops	20.0	$ou_E/m^2/s$	An Odour Impact Study for a Proposed Agricultural Anaerobic Digester at Cleat Hill Farm, Haunton, ADAS. **Non peer-reviewed, low quality source**
Cattle manure	0.8	$ou_E/m^2/s$	Odour Impact Assessment for a proposed Biomass AD Facility near Kenninghall, Norfolk, produced by Odournet UK Ltd. **Non peer-reviewed, low quality source**

To assess the quality of these specific odour emission rates, a literature search was performed online using key words and phrases including: "odour emission rate/flux, specific odour emission rate of cattle manure, slurry, digestate lagoon". A number of relevant peer-reviewed scientific articles were found, that provide **good quality** odour emission rates which are summarised below:

Emission Source	Odour Emission Rate	Reference
Cattle manure (dairy) storage	5.1-32 $ou/m^2/s$	Casey et al. 2006[20]
Cattle manure (beef) storage	7.2 $ou/m^2/s$	
Cattle manure (beef) storage	7.32 $ou/m^2/s$	Jacobson et al. 2005[21]
Cattle manure (dairy, concrete tank) storage	32.2 $ou/m^2/s$	
Cattle manure (dairy, earthen basin) storage	26.9 $ou/m^2/s$	
Cattle (dairy)	0.3 – 35.8 $ou_E/m^2/s$	Mielcarek and Rzeźnik, 2015[22]
Slurry	70 $ou/m^2/s$	Nicolas et al. 2013[23]
Liquid digestate tank (pig slurry and energy crops)	3.4 $ou_E/m^2/s$	Zilio et al. 2020[24]
Liquid digestate tank (pig + cow slurry, and energy crops)	9.8 $ou_E/m^2/s$	

It is evident from examination of the available peer-reviewed scientific literature that odour emission rates of given emission sources can vary significantly. However, it is also evident that Redmore Environmental has used odour emission rates that are significantly lower (**by at least**

[18] H4: Odour Management, EA, 2011.
[19] Review of Dispersion Modelling for Odour Predictions, EA, 2007
[20] Casey *et al.*, AIR QUALITY AND EMISSIONS FROM LIVESTOCK AND POULTRY, *Pp. 1-40 in Animal Agriculture and the Environment: National Center for Manure and Animal Waste Management White Papers. J. M. Rice, D. F. Caldwell, F. J. Humenik, eds. 2006. St. Joseph, Michigan: ASABE. Pub. Number 913C0306.*
[21] Jacobson *et al.*, DEVELOPMENT OF THE OFFSET MODEL FOR DETERMINATION OF ODOR-ANNOYANCE-FREE SETBACK DISTANCES FROM ANIMAL PRODUCTION SITES: PART I. REVIEW AND EXPERIMENT, Transactions of the ASAE. American Society of Agricultural Engineers · November 2005
[22] Mielcarek and Rzeźnik, Odor Emission Factors from Livestock Production, Pol. J. Environ. Stud. Vol. 24, No. 1 (2015), 27-35
[23] Nicolas et al, Multi-method Monitoring of Odor Emissions in Agricultural Biogas Facilities, 2013
[24] Zilio et al, Evaluation of ammonia and odour emissions from animal slurry and digestate storage in the Po Valley (Italy), Waste Management, 2020

one order of magnitude) than most rates in published peer-reviewed scientific literature, especially for cattle manure and liquid digestate. Furthermore, there is no consideration of the odour emission rate of **slurry**, which is listed as a feedstock in the planning statement. Specific points for emission sources of concern are discussed below:

Cattle manure: Previous odour dispersion models for AD planning proposals in the UK have used odour emission rates for cattle manure of **20 $ou_E/m^2/s$** (see footnote[25]), which is much more in line with the peer-reviewed scientific literature[26] on the subject. Hence, **the odour emission rate used by Redmore Environmental of 0.8 $ou_E/m^2/s$ is 25 times lower than cattle manure emission rates used by other AD planning proposals**. Furthermore, the odour assessment states that the cattle manure will be "stored in an uncovered clamp" and models odour emissions from a total area of 800 m^2 of exposed manure. However, the site layout does not delineate any manure storage clamps, only indicating a total of four "silage clamps", the smallest of which has an area of 2362.5 m^2 (112.5 m x 21.0 m). Assuming one of these is used to store manure, there is a potential exposed area of manure of 2362.5 m^2. It is well-described in the scientific literature that exposed storages have significantly higher emission rates than similar sources in covered/protected storages[27].

Slurry: The planning statement includes **slurry** as a feedstock, and the transport statement projects an input of 5,000 tonnes of this feedstock per year to the site. There is no indication if and how slurry will be stored and processed on site. Odour emissions from slurry (which are known to be more severe/offensive than other feedstocks (see Nicolas et al and Casey et al) are not accounted for by the dispersion modelling. In fact, the study by Nicolas *et al.* (which Redmore Environmental uses as a key data source for their liquid digestate emission rates) reports that the odour emission rate of slurry can reach 70 $ou/m^2/s$. Hence, a potentially highly significant source of odour emissions is ignored by the dispersion modelling (more odour emission sources have been ignored, see section 2: Unaccounted Odour Emission Sources below).

Liquid digestate: The emission rate of liquid digestate of 1.0 $ou_E/m^2/s$ used by Redmore Environmental is taken from Nicolas *et al* to represent the emission rate from the digestate lagoon. They have then reduced this emission rate by 90% due to the digestate lagoon being covered. However emission rate of 1.0 $ou_E/m^2/s$ reported by Nicolas *et al* is that of liquid digestate in a **tank**, not liquid digestate in a lagoon. Odour emission rates from digestate lagoons are likely to be significantly higher due a larger surface area than a tank. It is well-described in the scientific literature that odour emissions increase proportionally as a function of wind speed[28]. Furthermore, odour emission rates from liquid digestate storage tanks measured by Zilio et al, are **up to 10 times higher** than Nichols et al, depending on the exact digestate composition. Hence, the emission rate of 1.0 $ou_E/m^2/s$ for the liquid digestate lagoon, which is further reduced by 90% and then used by Redmore Environmental, is likely to be an underestimate.

[25] Air Quality Assessment for the Lower Drayton Farm Anaerobic Digestion Plant by Earthcare Technical Ltd
[26] Mielcarek and Rzeźnik, Odor Emission Factors from Livestock Production, Pol. J. Environ. Stud. Vol. 24, No. 1 (2015), 27-35
[27] Heber et al, (2000) *A buoyant convective flux chamber for measuring liquid surface emissions*, Odors/VOC Emissions Conference , Cincinnati, OH.
[28] Heber et al, (2000) *A buoyant convective flux chamber for measuring liquid surface emissions*, Odors/VOC Emissions Conference , Cincinnati, OH.

2: Unaccounted Odour Emission Sources

The dispersion model does not account for critically important odour emission sources that are typically used by other planning applications for similar AD sites in the UK. Such additional odour sources are expected to dramatically increase the odour impact of the site and associated activities:

1. **Odours released during importation of feedstocks:** There is no assessment of odours released from feedstocks (manures, slurries, poultry litter, silage) **as they are being transported through local villages and on the A1307** to the site. Manures, silage and slurry are planned to be delivered to the site using a tractor and trailer (as per the planning statement) from farms all over the area. As up to 25% of HGV traffic is projected to pass through local villages, this will generate significant odours in the immediate vicinity of residences and constitute a significant nuisance.
2. **Odours released from dirty water lagoon:** Odour emissions from the **805,000 litre** dirty water lagoon have not been included in the dispersion modelling, contrary to odour assessments of similar AD proposals[29].
3. **Odours released from off-take points:** Odour emissions intermittently released from the **liquid digestate off-take points** have not been included in the dispersion modelling, contrary to odour assessments of similar AD proposals[30].
4. **Export of liquid digestate by transportation tankers:** The planning statement specifically states that digestate will be "transported by tanker". Odour emissions from air expelled during **filling of digestate transportation tankers** for transport have not been accounted for by the dispersion modelling, contrary to odour assessments of similar AD proposals[31]. As the tankers fill with digestate, air laden with odours is rapidly displaced and expelled into the local environment. This would constitute a large bolus of odour emissions. The plant will produce **30,000,000 litres** of liquid digestate. The proposed digestate storage lagoon has a capacity of **15,260,000 litres** (**over 6 Olympic-sized swimming pools**). The capacity of digestate transportation tankers can vary, but common capacities range from 28,000 – 40,500 litres. Hence, it is anticipated that **hundreds** of digestate transportation tankers will be required to service the output of liquid digestate from the site. Furthermore, **transportation of digestate via such tankers will lead to odour emissions on the roads used, as the tankers travel through local villages and on the A1307**.
5. **Solid digestate:** the plant will produce **20,000 tonnes** of solid digestate. It is unclear from the planning statement how solid digestates will be stored and/or utilized. Will these be stored on site and/or dried? Will these be utilised on nearby farmland and/or exported off site by transportation tankers? There are odour emissions associated with storing, drying and exportation of solid digestate off site. None of these have been accounted for in the modelling.
6. **Slurry:** as previously mentioned, the planning statement includes **slurry** as a feedstock, yet odour emissions from slurry (which are known to be more severe/offensive than other feedstocks (see Nicolas et al and Casey et al) are not accounted for by the dispersion modelling.
7. **Conversion of liquid digestate to solid fertilizer:** the planning statement specifically states that the liquid digestate "may also be converted to a solid fertiliser for application to the land alongside the solid digestate." There are no details in the planning statement as to how, where and when this will occur and with what frequency. The transformation of liquid digestate to solid fertilizer is another industrial process; if transformation of liquid digestate to solid fertilizer occurs on site, there will be significant odour emissions that have not been accounted for.
8. **Poultry Odour Abatement system:** The proposal does not provide specifications for the odour abatement system that will be used when poultry litters are handled and

[29] Air Quality Assessment for the Lower Drayton Farm Anaerobic Digestion Plant by Earthcare Technical Ltd
[30] Air Quality Assessment for the Lower Drayton Farm Anaerobic Digestion Plant by Earthcare Technical Ltd
[31] Odour Assessment, Coleshill Anaerobic Digestion Facility by REC Ltd

processed. It is widely recognised that odour abatement systems for poultry litters do not completely eliminate these odours, but rather decrease them. As poultry litter is one of the most odorous feedstocks, with very high odour emission rates (77 ou/m^2/s)[32], the paucity of details in the planning statement as to exactly how odours from poultry litter will be mitigated, is highly concerning.

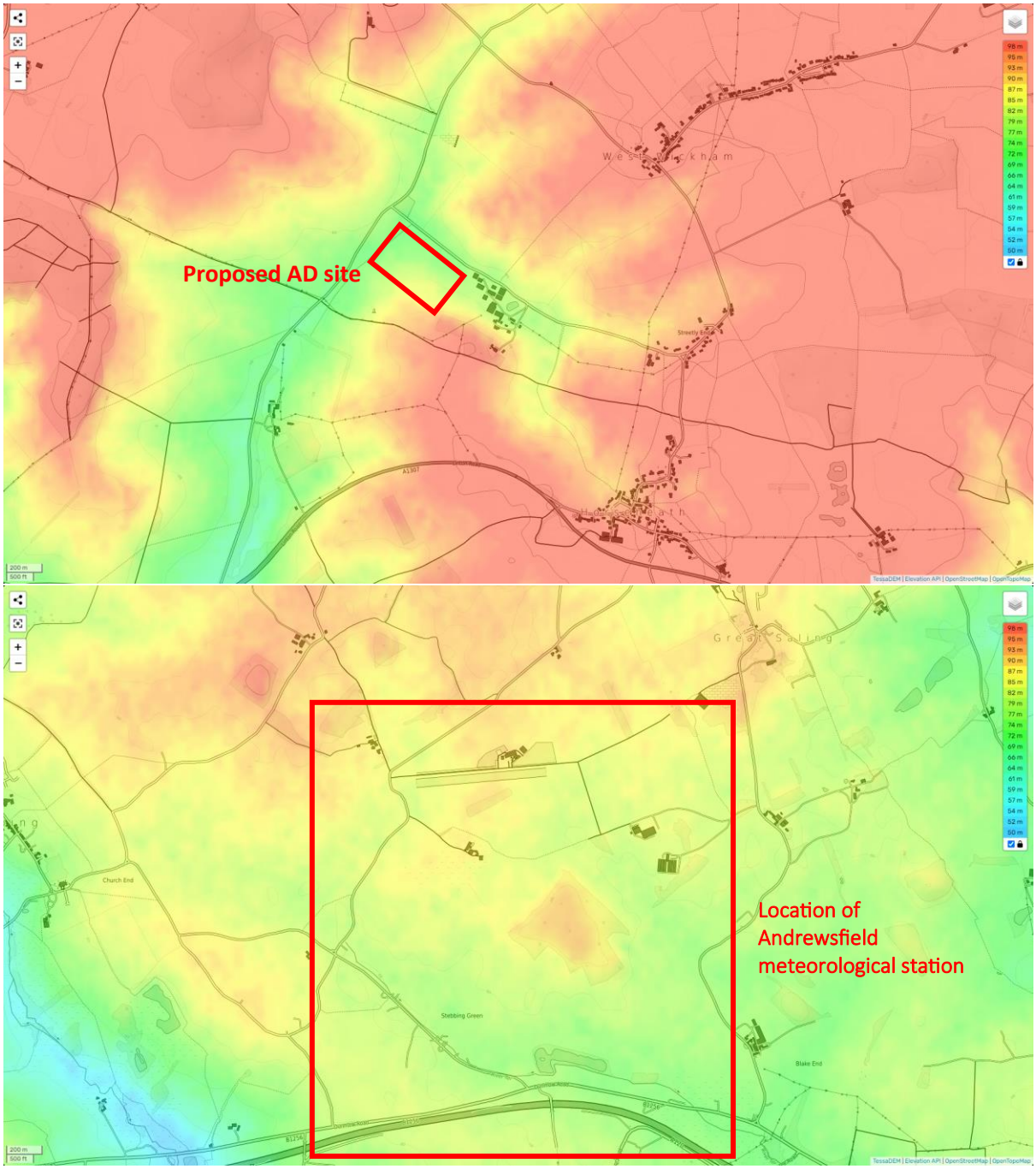
3: Inappropriate Input Meteorological Data

The meteorological data used in the dispersion model comes from an observation station located **25km south** of the proposed site of the AD plant. This is obviously very far away and calls into question the relevance of these data to the proposed AD site location. Anecdotally, the area surrounding West Wickham, Streetly End and adjacent villages is known to be generally more windy and hilly than the wider Cambridgeshire area. Higher wind speeds are known to increase odour emission rates[33]. Furthermore, it is well recognised by local residents that the tranquil village of **Streetly End and Horseheath sit downstream of the prevailing wind of the site**. Hence, this would significantly enhance odour dispersion to Streetly End and Horseheath, a site-specific meteorological feature unaccounted for by the modelling.

From inspection of topological maps (see maps below) of the proposed AD site and observation station from which meteorological data is used, it is obvious that the area surrounding **the proposed AD site is more topologically varied** (up to 20 m difference in height) than the observation station's, which would influence wind speeds. Furthermore, the proposed AD site sits in a natural depression, where wind speeds might be impacted by surrounding elevations (much like a funnel or corridor), whereas the area surrounding the observation station is flat. Hence, it may be possible that the local geography of the area could expose the proposed AD site to significantly different wind speeds, which would modulate odour emission rates and dispersion distances. In fact, the EA has stated[34] that "meteorological data obtained from a Met. Office observing station and used for dispersion modelling may not always reflect very localised conditions for example a valley location producing its own inversions. **These conditions would not be picked up even by 5 or more years of meteorological data from a remote observing station**". From the topological maps, it is clear that the proposed AD site is reminiscent of a shallow valley. In view of these specific local features, guidance from the EA[35] states that **site specific** data should be used for modelling. This would necessitate collection of meteorological data from the local area over an acceptable time frame.

[32] Sniffer ER26: Final Report, SCAIL-Agriculture update
[33] Heber et al, (2000) *A buoyant convective flux chamber for measuring liquid surface emissions*, Odors/VOC Emissions Conference , Cincinnati, OH.
[34] Review of Dispersion Modelling for Odour Predictions, EA, 2007
[35] H4: Odour Management, EA, 2011.

Topological Maps:



https://en-gb.topographic-map.com/

4: General Points:

Regarding paragraph 1.2.3. It is anticipated that about 70% of feedstock will come from Streetly Hall Farm, however, there are no assurances/guarantees this will be the case and there are no conditions set to ensure this figure is adhered to. Furthermore, there are plans to obtain feedstock from "industrial processing facilities"; these facilities are not defined and may provide scope for more offensive feedstocks to be transported to and concentrated in the local area.

Regarding paragraph 1.2.6 Details of how the air is treated to decrease odours from poultry litters are lacking in the assessment. What exact treatments are planned and are industrial chemicals involved? If so, which chemicals and what measures are in place to contain them and prevent escape into the local environment? What quantities of such chemicals will be on site and how will they be stored? What are the emissions from these chemicals and how does his impact air quality? What chemical disposal measures are in place?

Regarding paragraph 2.4.4 on page 6 of the odour assessment cites Odour Guidance for Local Authorities, DEFRA, 2010; however, this document was withdrawn in 2017 and the information it contains is now out of date. This highlights a lack of attention to detail and raises the possibility of further outdated inputs potentially being used in the dispersion modelling.