Northumbrian Water Ltd

Dispersion Modelling of Odour Releases from Howdon STW Including Gas to Grid Plant

May 2014

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	Name	**Signature**	**Position**	**Date**
Author	Ben Anstee		Principal Consultant	
Reviewed by	Jeff Hood		Senior Consultant	
Approved by				

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Dispersion Modelling of Odourous Releases from Howdon STW including gas to grid plant

1.0 Introduction

The Environmental Statement for the Howdon Advanced Anaerobic Digestion (AAD) plant was submitted to the planning authority by Montgomery Watson (MWH). This assessment uses the same set of input data as the original MWH model but also includes the additional releases as estimated for the gas to grid plant. Rather than introducing an additional point source for the waste gas releases, it is proposed that the plant utilises an existing odour control plant (OS10-12) to abate and disperse the waste gases from the gas to grid process plant. As with the original assessment, point source releases have only been considered, and their impact has been modelled using the USEPA ISC-AERMOD dispersion modelling package supplied by Lakes Environmental. The latest version of the AERMOD model (Version 8.5.0) and meteorological pre-processor has been used to generate the predictions for the scenarios considered.

The results of the assessment are presented in the form of contour plots (98^{th} %tiles of hourly mean figures), which can be compared with the odour exposure benchmarks as detailed within the Odour Policy Position Statement issued by the Chartered Institute of Water and Environmental Management (CIWEM). Northumbrian Water is committed to a 'No detriment' approach with regard to odour impact from the site and comparisons have been made with predictions using the 'Post AAD' input data as modelled for the original planning application.

The assessment has been performed by Northumbrian Water Scientific Services.

1.1 Aims of the Assessment

The aim of the assessment was to predict the odour impact under the following scenarios:

i) Post-AAD releases using MWH emissions data as used in original application
ii) Post-AAD releases plus estimated releases from OS10-12 with gas to grid plant

The impact of the site as a whole has been modelled and has been compared with the odour exposure benchmarks suggested by CIWEM and the 'Post AAD' scenario as modelled the original planning application.

1.2 Methodology

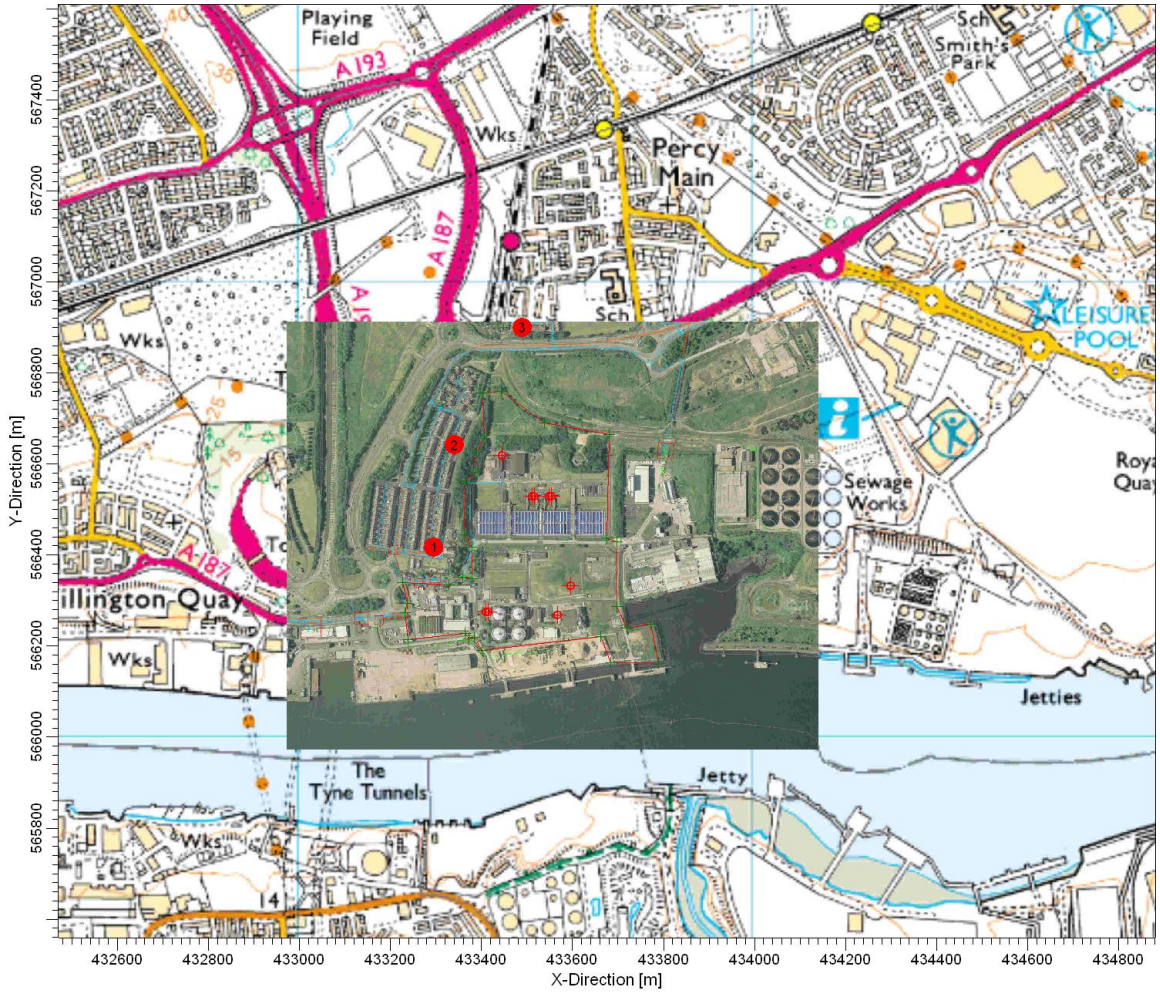
The approach taken to determine odour impact is as follows:

- Obtain meteorological data from the nearest representative observation station covering 5 typical years (2000 to 2004) – Newcastle was identified for this assessment as this is the closest site that provides a complete data set;
- Obtain digital terrain and base map information from the Ordnance Survey for the area surrounding the site (Next Map Britain DTM 10m grid utilised in model);
- Obtain emissions data for the release points – point sources using the standard 'Lung method' with Olfactometic analysis (measured 2005 to 2012);
- Obtain estimations of future releases – OS10-12 assumed to emit the same odour concentration but at a higher flow rate with the inclusion of the gas to grid plant
- Determine release point geometry and dimensions of buildings that may affect dispersion;
- Identify sensitive receptors such as residential properties
- Make predictions of the ground level concentrations due to emissions from the site using a recognised atmospheric dispersion model, ISC-AERMOD, used for the assessment incorporating the effects of terrain and site buildings on atmospheric dispersion;
- Compare the estimated odour concentrations with the relevant exposure criteria/benchmarks issued by CIWEM;
- Make conclusions on the impact of the overall site when compared to the 'Post AAD' scenario as modelled for the original planning application.

2.0 Description of the Site and Environs

Howdon WWTW is located on the north bank of the Tyne, east of Wallsend and close to the community of East Howdon. The site is one of NWL's largest sites, handling predominantly municipal effluent, but with a number of trade discharges. The main cluster of residential receptors lies to the west of the site in East Howdon which is only 100m away from the closest point source and 75m away from the covered primary tanks. Percy Main lies to the north of the plant, but is more distant. The site is situated on two terraces which reduce in elevation from the north down to the river with a more steeply sloping area to the north of the site.

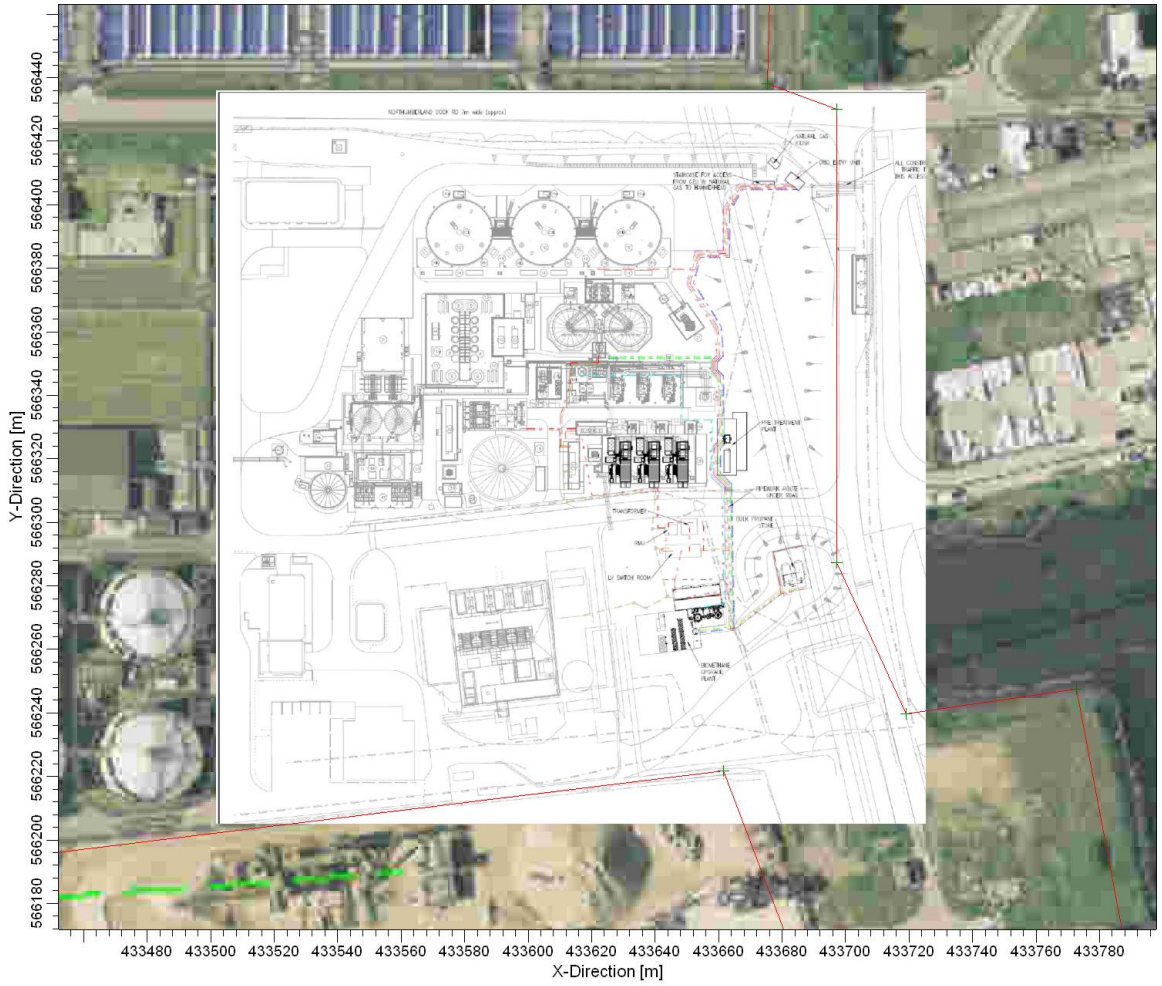
The location of the works is shown below with the main point sources of odour and site boundary outlined in red. Key receptors considered are indicated by the numbered red circles.



Receptor Number	Receptor name	X-Coord (m)	Y-Coord (m)	Direction from Site
1	Residential Receptor – Chatton Street, East Howdon	433294	566418	W
2	Residential Receptor – Baird Avenue, East Howdon	433340	566642	NW
3	Residential Receptor – St Stephen's Way, Percy Main	433489	566900	N

The Advanced Anaerobic Digester (AAD) project has recently been completed. The AAD plant includes its own dedicated odour control unit (dual stage biofilter and solid sorbent polishing) which treats air from the key odourous areas including the centrifuge building, cake import, THP feed silos and the digested sludge tank. One of the key benefits of the plant is that it allows the cessation of lime stabilisation at the Agrivert centrifuge plant as the digested sludge is stabilised and pasteurised. This has been one of the principle odour sources on the site and the nature of the odour was particularly acrid. The removal of the lime stabilisation process has had significant benefits.

The layout and position of the new plant is shown below along with the AAD plant. The Pre-treatment plant lies to the east of the static engines and the upgrade plant to the east of the cake loading bay.

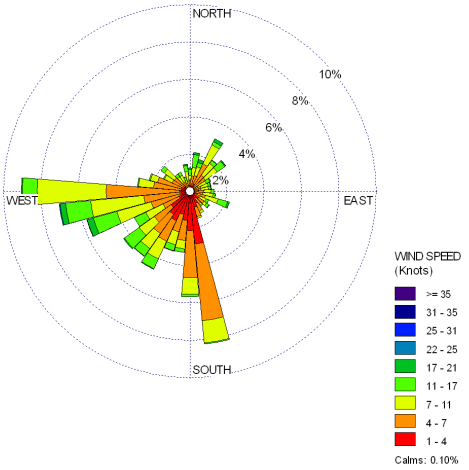


The point sources (odour control units) considered within the assessment are as follows.

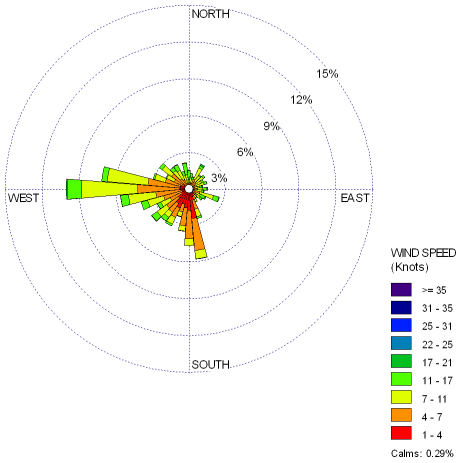
Reference No.	Source	X-Coord (m)	Y-Coord (m)
OS1	Chemical scrubber – Inlet Works	433445	566619
OS2	Chemical scrubber – Primary Tanks	433511	566530
OS3	Chemical scrubber – Primary Tanks	433516	566530
OS4	Chemical scrubber – Primary Tanks	433549	566530
OS5	Chemical scrubber – Primary Tanks	433554	566530
OS8	Chemical scrubber – Sludge storage/transfer	433410	566275
OS9	Chemical scrubber – Sludge storage/transfer	433415	566275
OS10-12	Triple stage chemical scrubber – Agrivert sludge centrifuge and cake handling	433567	566268
OS14-15	Dual stage biofilter and solid sorbent polishing unit – AAD plant	433596	566333

In addition to the above, there are two chemical scrubbers (OS6 & 7) serving the covered aeration lanes – these are not currently in use and are not considered within the assessment.

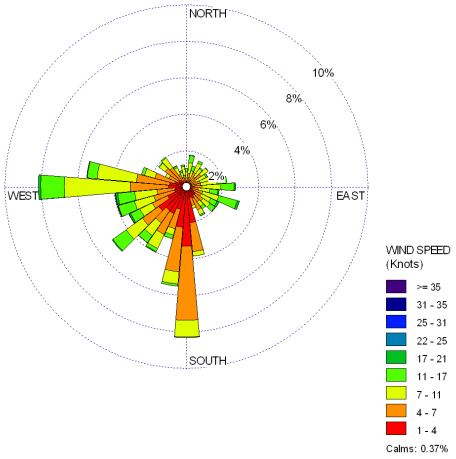
The prevailing wind in the area as indicated by the Newcastle wind roses below are from the west and south. The Newcastle city centre site is no longer operational, but was the closest recognised observation station to the site providing a complete data set including cloud cover. It is still thought to provide the most representative data for the area.



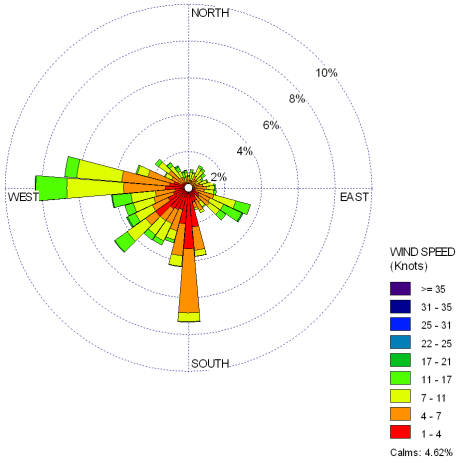
Wind rose for 2000 Data



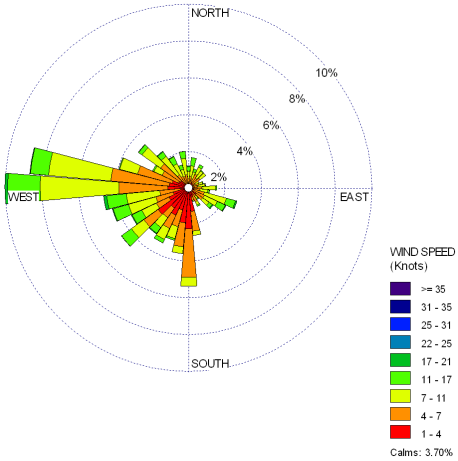
Wind rose for 2001 Data



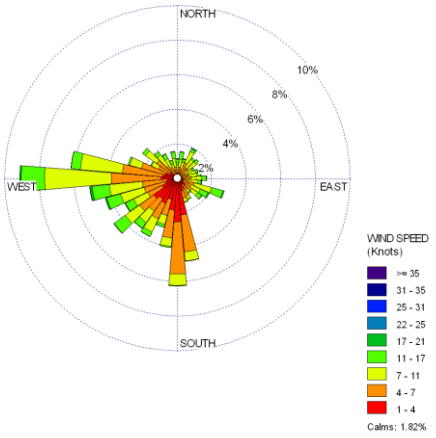
Wind rose for 2002 Data



Wind rose for 2003 Data



Wind rose for 2004 Data



Wind Rose for combined 2000 to 2004 data

3.0 Criteria for the Assessment

CIWEM has issued a policy document detailing benchmark figures for receptor positions that are typically accepted for the water industry.

The following statement and criteria are recommended by CIWEM based on research within the water industry:

> The main source of research into odour impacts in the UK has been the wastewater industry and the most in-depth study published study in the UK of the correlation between of modelled odour impacts and human response (dose-effect) was published by UK Water industry Research (UKWIR) in 2001. This was based on a review of the correlation between reported odour complaints and modelled odour impacts in relation to 9 wastewater treatment works in the UK with ongoing odour complaints. The findings of this research (and subsequent UKWIR research) indicated the following:
>
> - At modelled exposures of below $C_{98,\ 1\text{-hour}}$ $5ou_E/m^3$, complaints are relatively rare, at only 3% of the total registered;
> - At modelled exposures between $C_{98,\ 1\text{-hour}}$ $5ou_E/m^3$ and $C_{98,\ 1\text{-hour}}$ $10ou_E/m^3$, a significant proportion of total registered complaints occur; 38% of the total;
> - The majority of complaints occur in areas of modelled exposure greater than $C_{98,\ 1\text{-hour}}$ $10ou_E/m^3$, 59% of the total.
>
> The $C_{98,\ 1\text{-hour}}$ $5ou_E/m^3$ impact criterion has since been accepted as being appropriate in a number of WwTW planning applications for avoidance of significant risk of annoyance and a low risk of nuisance (e.g. Newbiggin, JS Bloor Ltd Leighton Linslade, etc).
>
> **Odour Impact Criteria – CIWEM's Position**
> Given the differing odour impact criteria available, the selection of the most appropriate criterion should be determined by the objective of the assessment (whether this be against a standard of avoidance of nuisance or 'significant pollution') and the nature of the odour under assessment.
>
> It is, therefore, the view of CIWEM that these and other odour impact criteria should be regarded as indicative guidelines and cannot be applied as over-arching statutory numerical standards. CIWEM considers that the following framework is the most reliable that can be defined on the basis of the limited research undertaken in the UK at the time of writing:
>
> - $C_{98,\ 1\text{-hour}}$ $>10ou_E/m^3$ - complaints are highly likely and odour exposure at these levels represents an actionable nuisance;
> - $C_{98,\ 1\text{-hour}}$ $>5ou_E/m^3$, - complaints may occur and depending on the sensitivity of the locality and nature of the odour this level may constitute a nuisance
> - $C_{98,\ 1\text{-hour}}$ $<3ou_E/m^3$, - 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.

Any modelled results that project exposures above these benchmark levels, after taking uncertainty into account, indicates the likelihood of unacceptable odour pollution.

The values of the contours presented in Appendix I have been set at levels to allow comparisons against these criteria.

4.0 Existing Background Concentrations

There is currently no available data on the background concentrations of odour in the area.

5.0 Modelling Details and Predictions

5.1 Emissions Data for the Site

The odour control plant (OS10-12) was designed with spare capacity to allow for additional extraction if required and further capacity has been generated by the changes to the final dewatering plant which no longer includes extraction from the lime stabilisation process. The plant has been operating under the design flow rates for the revised processes and the additional capacity will be utilised for the gas to grid waste gases. The unit will be configured to ensure that there will be no detriment to the odour concentrations currently released. These flow changes and the associated release rates have been taken into account and used to model the impact for each scenario.

The tables in Appendix II detail the release data used for each scenario modelled.

In the absence of details on the variability of the releases that may occur due to seasonal differences, it is assumed that the measured emissions occur 24 hours per day, 365 days per year.

The figures used represent point source emissions only and do not take into consideration any fugitive, volume or area source emissions. On the Howdon site, all odourous sources are covered or contained within buildings and are, therefore, assumed to be fully extracted or contained with no significant emissions.

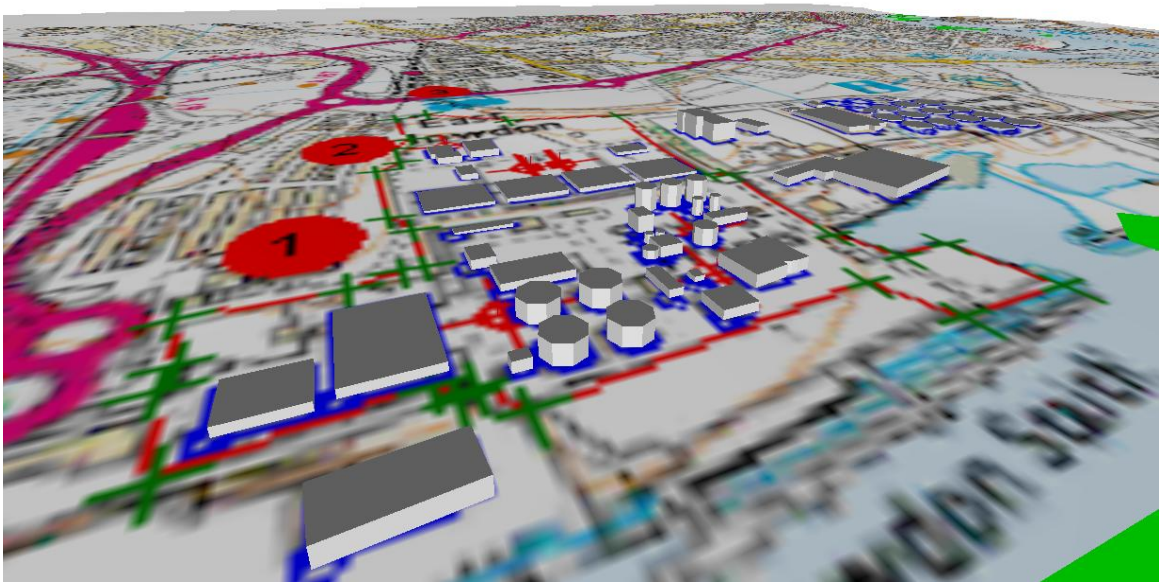
5.2 Modelling Details

The ISC-AERMOD dispersion model has been used to generate the contour maps in Appendix I. This model has been used extensively for assessing air quality impacts from EPR sites and is accepted as an appropriate air quality modelling tool by the EA, SEPA and local authorities. It is the regulatory model used by the USEPA.

Topographic features can have a significant effect on the dispersion of pollutants, especially when the gradient exceeds 1 in 10. Next Map DTM topography data with a 10m grid spacing and an accuracy of approximately 1m has been utilised to generate elevations of receptors, buildings and sources.

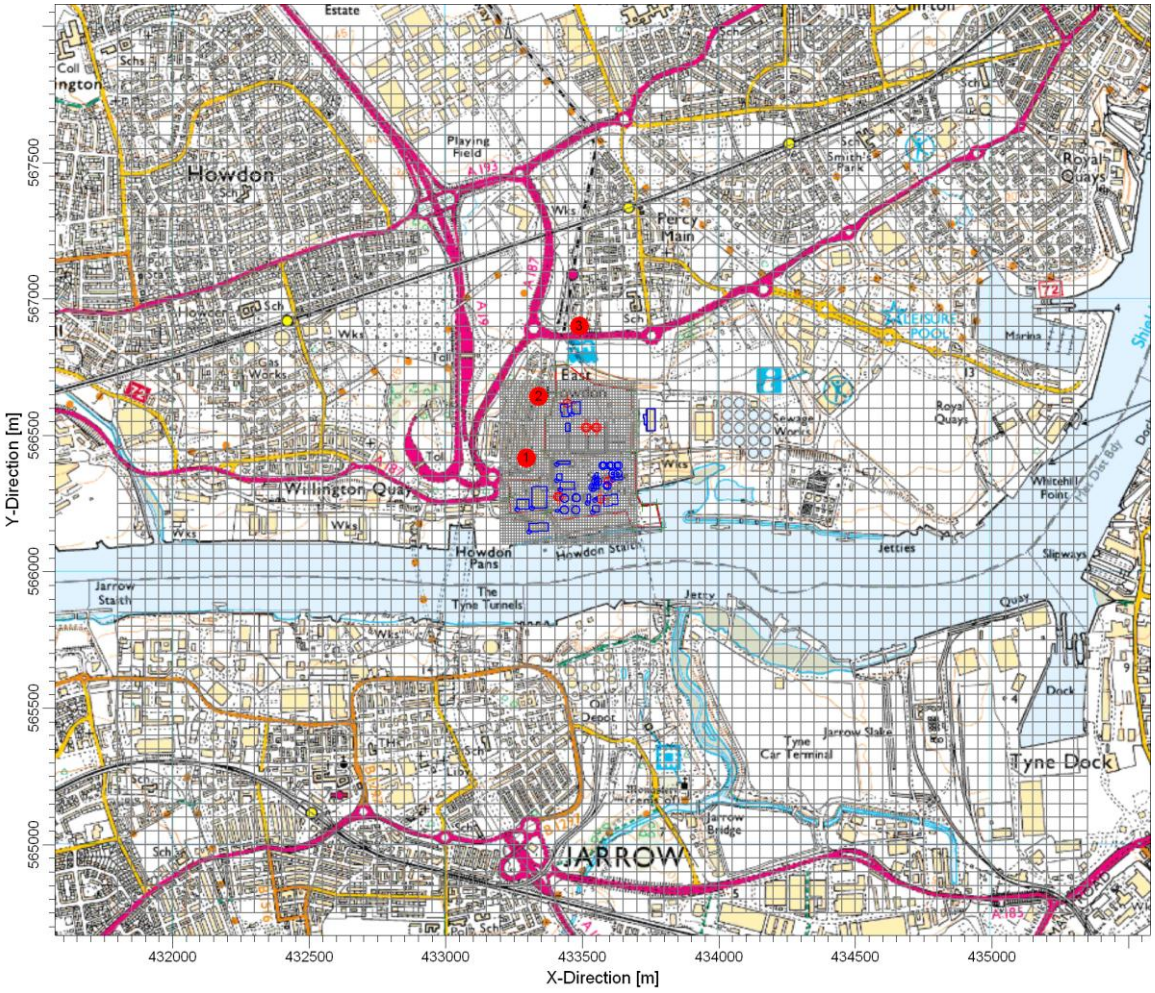
5-years of meteorological data was used from the Newcastle observation station as supplied by The Met Office (2000 to 2004). This data is thought to be representative of the met conditions experienced by the site and no additional adjustment for local topography has been made. The AERMET pre-processor provided the surface and profile files for the model. As the site is located in an area of dense residential development, the urban option was selected within the model which introduces additional heating from properties. Seasonal surface roughness, Albedo figures and Bowen Ratios were used for the areas surrounding the site representing the local landscape.

All major site structures on the site were input into the model. The topography and schematic of the structures are indicated by the 3D visualisation below:



No other specialised model treatments such as short-term (puff) releases were used in this assessment.

The area surrounding the site was modelled as a number of uniform receptor grids. A grid spacing of 50m was used for more distant areas, decreasing to 10m closer to the site. The nested grids are illustrated below.



Screening runs were performed for each year of met data to determine the worst case year for dispersion. This was determined to be 2003, and this year of met data has been used for each detailed modelling run.

The uncertainty associated with dispersion models is difficult to quantify, and short-term concentrations in particular may be subject to large uncertainties. The inclusion of terrain files and building downwash algorithms will also increase the overall uncertainty budget. In addition to the model itself, there are also uncertainties associated with background data which may be as much as ±50%. However, the AERMOD model is well validated by the USEPA, and as such, dispersion modelling is probably the most useful tool for plume visualisation and for allowing comparison of the effects of changing process parameters.

5.3 Prediction of Odour Impact

The predicted odour concentrations for each scenario as determined by the ISC-AERMOD model for the worst meteorological year (2003), are presented in Appendix I.

The 98th%tile of hourly mean odour concentrations have been calculated, and can be compared against the CIWEM odour exposure benchmarks in order to indicate whether disturbance can be expected.

The configuration of the output plots in Appendix I have taken these benchmark figures into account and specific contours have been provided accordingly.

The predicted 98th%tile of hourly mean concentrations at the receptor positions for each scenario are provided below. The maximum boundary figures are also provided.

		98th%tile of hourly means (OU/m3) - 2003 Met data (Newcastle)	
Receptor No.	Location	With AAD - MWH Input Data	With Gas to Grid
1	Chatton Street, East Howdon	1.3	1.3
2	Baird Avenue, East Howdon	2.4	2.4
3	St Stephen's Way, Percy Main	2.2	2.2
	Max boundary	4.0	4.0

The modelled data indicates an insignificant change (no change to 1 decimal place) in the concentrations at the boundary and receptor positions which represents a no detriment situation.

6.0 Conclusions

The assessment has considered the potential odour impact of the proposed Gas to Grid Plant based on the comparison of modelled figures generated using the 'With AAD' data used by MWH for the original planning application and the predicted figures with the inclusion of the new plant.

The impact has been modelled using the USEPA ISC-AERMOD dispersion modelling package supplied by Lakes Environmental. The latest version of the AERMOD model (Version 8.5.0) and meteorological pre-processor has been used to generate the predictions for the scenarios considered.

The figures are based on point source emissions only and do not take into consideration any fugitive, volume or area source emissions. On the Howdon site, all odourous sources are covered or contained within buildings and are, therefore, assumed to be fully extracted or contained with no significant emissions. The impact at the works boundary and the nearest residential receptors have been considered.

Under both scenarios, the model predicts that the $5OU_E/m^3$ (as a 98^{th}%tile of hourly means) CIWEM benchmark figure is not exceeded at the boundary and the $3OU_E/m^3$ (as a 98^{th}%tile of hourly means) is not exceeded at receptor positions. The latest modelled figures provide very similar predictions to those generated by MWH which indicates that the model has been set up in an equivalent manner.

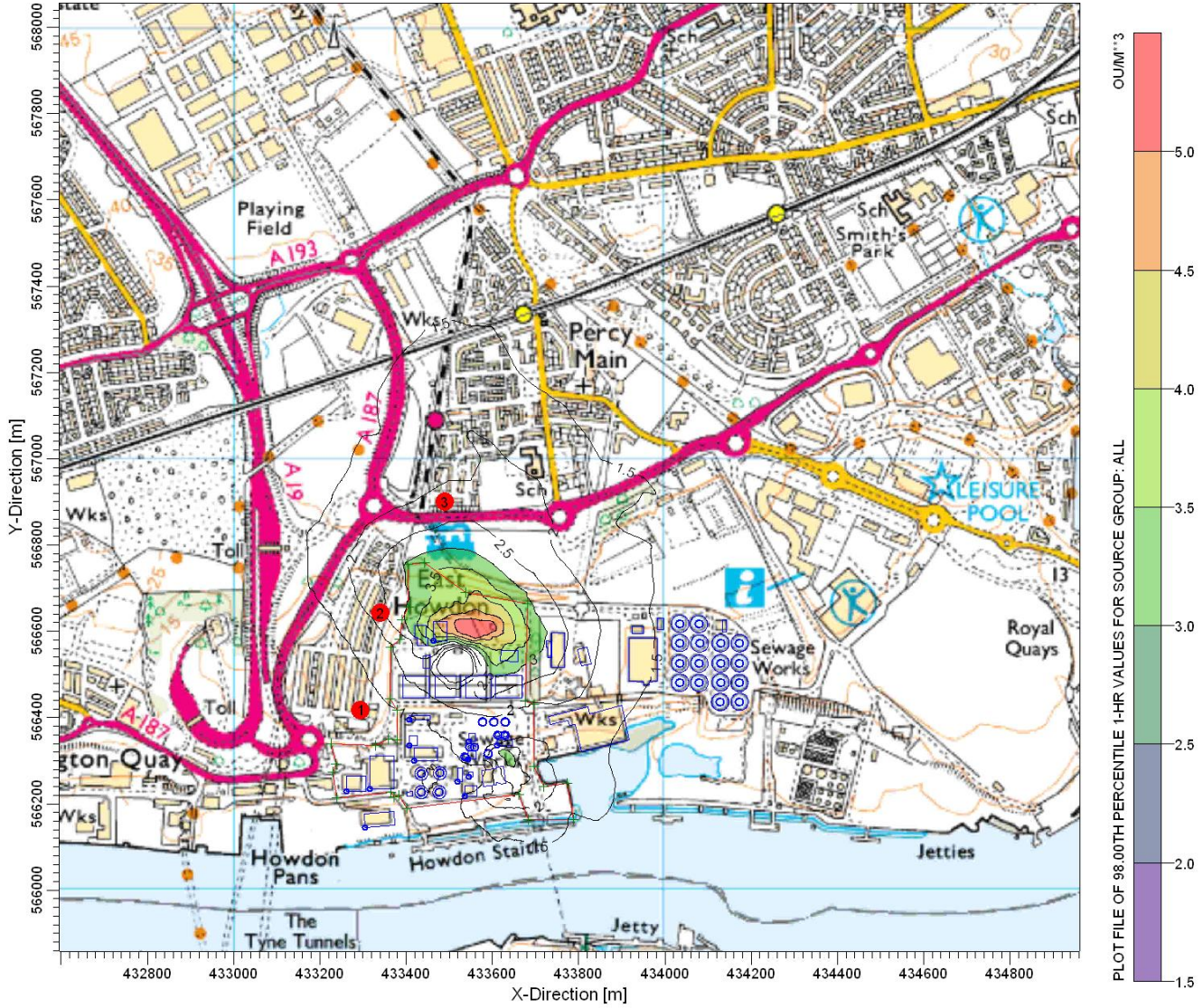
With the inclusion of the 'with Gas to Grid' plant, the model predicts an insignificant change (no change when expressed to 1 decimal place) in the 98^{th}%tile concentrations at all receptor locations and at the site boundary. This represents a 'no detriment' situation when compared with the predictions using the same input data as modelled for the original planning application.

7.0 References

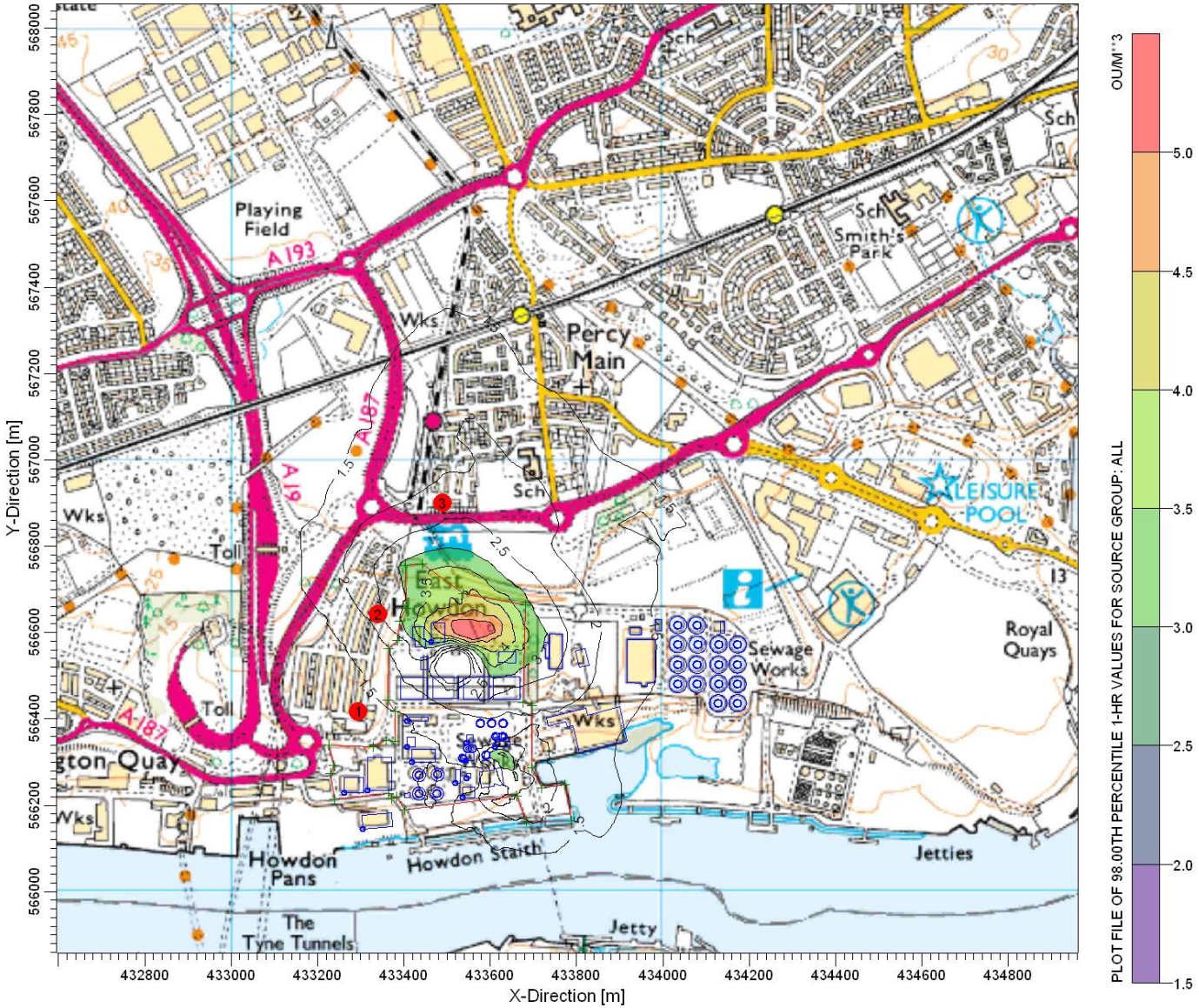
- CIWEM, Odour Policy Statement, February 2011

Appendix I Concentration Contour Maps

98th%tile of hourly mean odour concentrations – Current scenario with AAD, based on MWH Data Set. All Point Sources, 2003 Newcastle Met Data



98th%tile of hourly mean odour concentrations – Future scenario with gas to grid plant. All Point Sources, 2003 Newcastle Met Data



Appendix II Odour Release Data for Modelled Scenarios

How don STW - Odour releases

Scenario: With AAD - Current situation

Release Point	Odour Concentration (OU_E/m^3)	Odour Emissions (OU_E/s)	Gas temperature (deg C)	Gas temperature (K)	Diameter of duct at release point (m)	Area of Duct at release point (m2)	Volumetric flow rate (m3/s)	Efflux velocity actual (m/s)	Emission Point Height (m)
OS1	500	14250	15	288	1.55	1.89	28.5	15.1	15
OS2	1385	15554	15	288	0.98	0.75	11.23	15.0	12
OS3	1385	15554	15	288	0.98	0.75	11.23	15.0	12
OS4	1385	15554	15	288	0.98	0.75	11.23	15.0	12
OS5	-	-	-	-	0.98	0.75	-	-	12
OS8	1500	2325	15	288	0.51	0.20	1.6	7.6	16
OS9	1500	2325	15	288	0.51	0.20	1.6	7.6	16
OS10-12	2000	5680	15	288	0.60	0.28	2.8	10.1	12
OS14-15	1000	2360	15	288	0.45	0.16	2.4	15.0	16
GtG Waste Gas stack									

How don STW - Odour releases

Scenario: With AAD & GtG - Emissions from OS10-12

Release Point	Odour Concentration (OU_E/m^3)	Odour Emissions (OU_E/s)	Gas temperature (deg C)	Gas temperature (K)	Diameter of duct at release point (m)	Area of Duct at release point (m2)	Volumetric flow rate (m3/s)	Efflux velocity actual (m/s)	Emission Point Height (m)
OS1	500	14250	15	288	1.55	1.89	28.5	15.1	15
OS2	1385	15554	15	288	0.98	0.75	11.23	15.0	12
OS3	1385	15554	15	288	0.98	0.75	11.23	15.0	12
OS4	1385	15554	15	288	0.98	0.75	11.23	15.0	12
OS5	-	-	-	-	0.98	0.75	-	-	12
OS8	1500	2325	15	288	0.51	0.20	1.6	7.6	16
OS9	1500	2325	15	288	0.51	0.20	1.6	7.6	16
OS10-12	2000	7940	15	288	0.60	0.28	4.0	14.1	12
OS14-15	1000	2360	15	288	0.45	0.16	2.4	15.0	16