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ODOUR AND AIR QUALITY IMPACT ASSESSMENT OF IDENTIFIED PROCESSES LOCATED IN ERAS ECO LTD, FOXHOLE, YOUGHAL, CO. CORK.

PERFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF O CALLAGHAN MORAN AND ASSOCIATES LTD

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This document is submitted as part of an air quality and odour impact assessment of Eras Eco Ltd carried out on behalf of O Callaghan Moran and Associates Ltd. The results reported are representative of source specifics contained in the report.

Respectively submitted,

Brian Sheridan B.Sc. M.Sc. (Agr) Ph.D (Eng).

For and on behalf of Odour Monitoring Ireland™

Executive summary

Odour Monitoring Ireland Ltd was commissioned by O Callaghan Moran and Associates Ltd to perform an air quality impact assessment of their proposed facility operation utilising dispersion modelling AERMOD Prime 15181 in accordance with AG 4 guidance document. Pollutant emission rates were estimated from a review of historical monitoring data, existing IPC licence limits and equipment supplier emission limit values for the specific processes to be located in Eras Eco Ltd, Foxhole, Youghal, Co. Cork.

Following detailed dispersion modelling and screening of the emission from the identified processes, all predicted pollutant ground level concentrations were compared to limit values contained in SI 180 of 2011, Directive 2008/50/EC, AG4 guidance document and TaLuft 2002.

The following conclusions were formed during the study. Greater detail can be found within the document and it is recommended that the document be read in full. These include:

1. Process emission estimation and dispersion modeling was performed on emissions from the existing and proposed processes to be located in Eras Eco Ltd, Foxhole, Youghal, Co. Cork.
2. Dispersion modeling was performed in accordance with best international practice and AG4 guidance document on dispersion modelling with a minimum of five years of hourly sequential meteorological data from Cork 2008 to 2012 inclusive was used in the dispersion modeling assessment. AERMOD Prime 15181 was utilised for the dispersion modelling assessment.
3. With regard to Carbon monoxide, the maximum GLC + Baseline for CO from the operation of the facility is 1,119 $\mu g/m^3$ for the maximum 8-hour averaging period. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 2000/69/EC and 2008/50/EC, this is up to 90% lower than the set limits.
4. With regard to Oxides of nitrogen, the maximum GLC+Baseline for NO_2 as NO_X for the 99.79th percentile for a 1-hour averaging period was 92 $\mu g/m^3$. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is up to 54% lower than the set limits. An annual average was also generated for Scenario 3. When compared to the impact criteria, the annual average NO_2 air quality impact for Scenario 3 is up to 10% lower than the limit.
5. With regard to Sulphur dioxide, the maximum GLC+Baseline for SO_2 from the operation of the facility is 93 and 56 $\mu g/m^3$ for the maximum 1-hour averaging period at the 99.73th percentile and 24-hour averaging period at the 99.18th percentile, respectively. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is from 73 to 53% lower than the set limits established for the 1 hour and 24 hour assessment criteria. An annual average was also generated for Scenario 6 to allow comparison with the SI 180 of 2011 and 2008/50/EC. When compared the annual average SO_2 air quality impact criterion is 10% lower than the impact criterion.
6. With regard to Total Particulates as PM_{10}, the maximum GLC+Baseline for PM as PM_{10} for Scenario 7 from the operation of the facility is 10 $\mu g/m^3$ for the 90.4th percentile for a 24-hour averaging period. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is from 36% lower than the set limits. An annual average was also generated for Scenario 8 and 9 to allow comparison with the SI 180 of 2011 and 2008/50/EC for PM_{10} and $PM_{2.5}$. When compared the annual average PM_{10} and $PM_{2.5}$ air quality impact criterion is 32 and 47% lower than the impact criterion.
7. With regard to Hydrogen chloride, the maximum GLC+Baseline for HCL for the 98th percentile for a 1-hour averaging period was 8.20 $\mu g/m^3$. When combined predicted and baseline conditions are compared to the TaLuft S Limit values laid out in TaLuft 2002, this is up to 91% lower than the set limits. An annual average was also

generated for Scenario 10. When compared to the impact criteria contained in H1 guidance document, the annual average HCL air quality impact for Scenario 10 is up to 89% lower than the limit.

8. With regard to Hydrogen fluoride, the maximum GLC+Baseline for HF for the 98th percentile for a 1-hour averaging period was 0.78 μg/m^3. When combined predicted and baseline conditions are compared to the TaLuft S Limit values laid out in TaLuft 2002, this is up to 74% lower than the set limits. An annual average was also generated for Scenario 12. When compared to the impact criteria contained in TaLuft 2002, the annual average HF air quality impact for Scenario 12 is up to 34% lower than the limit.
9. With regard to TNMVOC as benzene, the maximum GLC+Baseline for TNMVOC as benzene for the annual averaging period was 2.49 μg/m^3. When combined predicted and baseline conditions are compared to the proposed Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 2008/50/EC, this is up to 50% lower than the proposed set limits.
10. With regard to Odour, the odour plume spread from the facility is small and remains close to the facility. In addition the predicted ground level concentration at all residential receptors is approximately 66% lower (0.70 Ou_E/m^3) than the odour impact criterion. Therefore it is predicted that the proposed facility design will not lead to odour impact in the vicinity of the facility with all residential receptors perceiving an odour concentration less than 1.50 Ou_E/m^3 at the 98th percentile of hourly averages for worst case meteorological year Cork 2012.
11. Based on the predicted emissions and emission limit value guarantees, the proposed operation of the Eras Eco Ltd facility located in foxhole, Youghal, Co. cork will not breach stated air quality regulations when in operation.

1. Introduction and scope

1.1 Introduction

Odour Monitoring Ireland Ltd was commissioned by Eras Eco Ltd to perform an odour and air quality dispersion modelling assessment of the proposed emissions from the waste recycling facility located in Eras Eco Ltd, Foxhole, Youghal, Co. Cork. Pollutant emission data was taken from historical reports, IPC licence limits and from process emission data from equipment suppliers. Various existing and proposed emission points will lead to the generation of specific pollutants and by using atmospheric dispersion modelling, the potential impact of these pollutants are assessed and compared to relevant ambient odour and air quality objectives and limits including SI 180 of 2011 and the methodology contained within the Irish EPA publication "Odour impacts and odour emissions controls for Intensive Agricultural Facilities" the Environment Agency Horizontal Guidance notes for Odour, Parts 1 and 2 and AG4 Guidance document on Dispersion modelling. These documents laid out general methodologies for assessing the risks with odours and pollutants from the site. Background air quality data was obtained from available baseline air quality data generated by the Irish EPA and other referenced publications.

The main compounds assessed included Carbon monoxide (CO), Oxides of nitrogen (NO_X as NO_2), Sulphur dioxide (SO_2), Total Particulate matter (PM as PM_{10} and $PM_{2.5}$), Total Organic Carbon as Non methane Volatile organic compounds, Hydrogen fluoride and chloride and Odour. Average modelling scenarios were performed to allow for comparison with relevant air quality impact criteria as described in *Section 2.8*. These included 1-hour mean, 8-hour mean, 24-hour mean, Annual mean and maximum number of exceedences expressed as percentiles (see *Table 2.1 and 2.2*). All processes and source characteristics as outlined within the emission tables (*see Table 3.1 to 3.5*) was utilised to construct the basis of the dispersion model. Five years of hourly sequential meteorological data (Cork 2008 to 2012 inclusive) was used within the dispersion model in order to provide statistical significant conservative ground level concentration estimates. The worst case year was Cork 2012.

This report presents the materials and methods, results and discussion and conclusions formed throughout the study.

1.2 Scope of the study

The main objective of the odour and air quality impact assessment is to ascertain whether the levels of emissions from the facility will result in ground level impact in the vicinity of the site operations. Ground level impact refers to the impact at ground level in excess of the air quality impact criteria contained in *Section 2.8* of this document.

The methodology adapted involved a number of distinct steps. These included:

- Calculation of emission rates for such air components from measured and historical data for each process including PC licence limits;
- Prediction of ground level concentrations (GLC's) of compounds dispersed from the stack sources located within the facility;
- Comparison between dispersed GLC's + Background concentrations (*see Section 4 and 5*) and relevant air quality objectives and limits for these air pollutants.

1.3 Model assumptions

The approach adopted in this assessment is considered a worst case investigation in respect of emissions to the atmosphere from a facility.

These assumptions used within the dispersion modelling assessment include:

- Emissions to the atmosphere from the process operation were assumed to occur simultaneously 24 hrs each day over a standard year.
- The Particulate matter is treated as an ideal gas and therefore no removal due to deposition (wet or dry) is accounted for in modelling scenarios,
- The total particulate matter emitted from the stack sources is assumed to be all PM_{10} or $PM_{2.5}$. This is unlikely since varying particulate fraction size will be emitted from the process (up to less than 10μm particle diameter),
- Maximum GLC's + Background were compared with relevant air quality objects and limits;
- Five years of hourly sequential meteorological data from Cork 2008 to 2012 inclusive was used in the modelling screen which will provide statistical significant results in terms of the short and long term assessment. The worst case year for Cork was 2012 and was used for data analysis. This is in keeping with current national and international recommendations (EPA Guidance AG4). In addition, AERMOD incorporates a meteorological pre-processor AERMET PRO. The AERMET PRO meteorological preprocessor requires the input of surface characteristics, including surface roughness (z0), Bowen Ratio and Albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of Albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10km from the meteorological station for Bowen Ratio and Albedo and to a distance of 1km for surface roughness in line with USEPA recommendations.
- AERMOD Prime (15181) dispersion modelling was utilised throughout the assessment in order to provide the most reliable dispersion estimates.
- All building wake affects (e.g. buildings within the site) were assessed within the dispersion model.
- 10 m spaced topographical data was inputted into the model.

2. Materials and methods

This section will describe the materials and methods used within the study.

2.1 Emission input data

Emission input data for the existing processes on site was taken from a review of historical monitoring data and IPC licence limits which was published and sent to the Irish EPA as part of licence compliance. Existing process emission points include:

- Emission point AEP1 – Boiler
- Emission point AEP2 – Biofilter

For proposed emission points, emission data was taken from manufacturers and process suppliers, existing licences utilising such equipment and historical monitoring of similar processes on other licences facilities. Proposed process emission points include:

- Emission point AEP3 – New Odour control unit Materials Recovery building and Anaerobic digestion plant
- Emission point AEP4 – Combined Heat and Power gas utilisation engines emission point

All volume flow, emission concentrations and mass emission rate data for each emission point AEP1 to AEP4 is included in *Section 3* of this document.

2.2 Atmospheric dispersion modelling of air quality: What is dispersion modelling?

Any material discharged into the atmosphere is carried along by the wind and diluted by wind turbulence, which is always present in the atmosphere. This process has the effect of producing a plume of air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation. Atmospheric dispersion modelling has been applied to the assessment and control of emissions for many years, originally using Gaussian form ISCST 3 and more recently utilising advanced boundary-layer physics models such as ADMS and AERMOD (Keddie et al. 1992). Once the compound emission rate from the source is known, (g s^{-1}), the impact on the vicinity can be estimated. These models can effectively be used in three different ways: firstly, to assess the dispersion of compounds; secondly, in a “reverse” mode, to estimate the maximum compound emissions which can be permitted from a site in order to prevent air quality impact occurring; and thirdly, to determine which process is contributing greatest to the compound impact and estimate the amount of required abatement to reduce this impact within acceptable levels (McIntyre et al. 2000). In this latter mode, models have been employed for imposing emission limits on industrial processes, control systems and proposed facilities and processes (Sheridan et al., 2002).

2.3 Atmospheric dispersion modelling of air quality: dispersion model selection

The model chosen in this study was AERMOD Prime (EPA Version 15181). The AERMOD model was developed through a formal collaboration between the American Meteorological Society (AMS) and U.S. Environmental Protection Agency (U.S. EPA). AERMOD is a Gaussian plume model and replaced the ISC3 model in demonstrating compliance with the National Ambient Air Quality Standards (Porter et al., 2003) AERMIC (USEPA and AMS working group) is emphasizing development of a platform that includes air turbulence structure, scaling, and concepts; treatment of both surface and elevated sources; and simple and complex terrain. The modelling platform system has three main components: AERMOD, which is the air dispersion model; AERMET, a meteorological data pre-processor; and AERMAP, a terrain data pre-processor (Cora and Hung, 2003).

AERMOD is a Gaussian steady-state model which was developed with the main intention of superseding ISCST3 (NZME, 2002). The AERMOD modeling system is a significant departure from ISCST3 in that it is based on a theoretical understanding of the atmosphere rather than depend on empirical derived values. The dispersion environment is characterized by turbulence theory that defines convective (daytime) and stable (nocturnal) boundary layers instead of the stability categories in ISCST3. Dispersion coefficients derived from turbulence theories are not based on sampling data or a specific averaging period. AERMOD was especially designed to support the U.S. EPA's regulatory modeling programs (Porter at al., 2003)

Special features of AERMOD include its ability to treat the vertical in-homogeneity of the planetary boundary layer, special treatment of surface releases, irregularly-shaped area sources, a three plume model for the convective boundary layer, limitation of vertical mixing in the stable boundary layer, and fixing the reflecting surface at the stack base (Curran et al., 2006). A treatment of dispersion in the presence of intermediate and complex terrain is used that improves on that currently in use in ISCST3 and other models, yet without the complexity of the Complex Terrain Dispersion Model-Plus (CTDMPLUS) (Diosey et al., 2002). Additional utilities associated with the dispersion model allow computation of ground level concentrations of pollutants over defined statistical averaging periods, consideration of building wake/downwash effects in the vicinity of the assessed facility.

2.4 Odour and Air quality impact assessment criteria

The predicted air quality impact from the operation of the processes is compared to relevant odour and air quality objectives and limits. Air quality standards and guidelines referenced in this report include:

- SI 180 of 2011 Air Quality legislation,
- Irish EPA 2002 and Environment Agency 2002 Guideline limit of less than 1.50 Ou_E/m^3 at the 98^{th} percentile of hourly averages for high to medium risk odours.
- EPR H1 Environmental Risk Assessment Part 2 – Assessment of point source releases and cost benefit analysis, Environment Agency 2008.
- AG4, 2010. Air dispersion modelling from industrial installations guidance note (AG4), Irish EPA, 2010.

Air quality is judged relative to the relevant Air Quality Standards, which are concentrations of pollutants in the atmosphere, which achieve a certain standard of environmental quality. Air quality Standards are formulated on the basis of an assessment of the effects of the pollutant on public health and ecosystems.

In general terms, air quality standards have been framed in two categories, limit values and guideline values. Limit values are concentrations that cannot be exceeded and are based on WHO guidelines for the protection of human health. Guideline values have been established for long-term precautionary measures for the protection of human health and the environment. European legislation has also considered standards for the protection of vegetation and ecosystems.

Where ambient air quality criteria do not exist as in the case for some of the substances of interest, it is usual to use $1/100^{th}$ of the occupational exposure limit (OEL) for an eight-hour reference period to compare with the annual average predictions. The one-hour predictions are generally compared with a standard derived from $1/40^{th}$ of the Short Term Exposure Limit (STEL). Occupational exposure limits are published by the Occupational Safety and Heath Authority (i.e. EH 40).

The relevant air quality standards are presented in *Tables 2.1 and 2.2*.

2.5 Air Quality Guidelines for classical pollutants in Ireland and Europe

Table 2.1 illustrates the guideline and limit values for air quality pollutants in Ireland.

Table 2.1. EPA, EU and Irish Limit values laid out in the SI 180 of 2011.

POLLUTANT	Objective			
	Concentration[2]	Maximum No. Of exceedences allowed[3]	Exceedence expressed as percentile[3]	Measured as
Carbon monoxide (CO)	10 mg m^{-3}	None	100[th] percentile	Running 8 hour mean
Nitrogen dioxide and oxides of nitrogen	200 µg m^{-3} NO_2 40 µg m^{-3} NO_2	18 times in a year --	99.79[th] percentile --	1 hour mean Annual mean
Sulphur dioxide (SO_2)	350 µg m^{-3} 125 µg m^{-3} 20 µg m^{-3}	24 times in a year 3 times in a year --	99.73th percentile 99.18[th] percentile --	1 hour mean 24 hour mean Annual mean and winter mean (1[st] Oct to 31[st] March
Particulates (PM_{10})	50 µg m^{-3} 40 µg m^{-3}	35 times in a year None	90.40[th] percentile	24 hour mean Annual mean
Particulates ($PM_{2.5}$)	25 µg m^{-3} – Stage 1 20 µg m^{-3} – Stage 2	None None	-- --	Annual mean Annual mean

Table 2.2. Guideline and limit values for other pollutants as taken from EPR H1, Part 2, TaLuft 2002 and EH40 Notes 2005.

POLLUTANT	**Objective**			
	Concentration	**Maximum No. Of exceedences allowed**	**Exceedence expressed as percentile**	**Measured as**
Hydrogen chloride[1, 3]	100 µg m^{-3} 20 µg m^{-3}	175 times in a year --	98^{th} percentile --	1 hour mean Annual mean
Hydrogen fluoride[2, 3]	160 µg m^{-3} 3 µg m^{-3} 0.30 µg m^{-3}	0 times in a year 175 times in a year None	100^{th} percentile 98^{th} percentile --	1 hour mean 1 hour mean Annual mean
Total non-methane VOC (as benzene)[4]	< 5 µg m^{-3} as benzene	None	--	Annual mean
Odour[5]	<1.50 Ou_E/m^3	175 times in a year	98^{th} percentile	1 hour mean

Notes: [1, 2] denotes taken from EPR H1 Environmental Risk Assessment Part 2 – Assessment of point source releases and cost benefit analysis, Environment Agency 2008.
[3] denotes taken from TaLuft 2002.
[4] denotes taken from Directive 2000/69/EC.
[5] denotes taken from AG4, 2010. Air dispersion modelling from industrial installations guidance note (AG4), Irish EPA, 2010.

2.6 Existing Baseline classical air pollutant Air Quality

The EPA has been monitoring national Air quality from a number of sites around the country. This information is available from the EPA's website. The values presented for PM_{10}, SO_2, NO_2, and CO give an indication of expected urban / rural emissions of the compounds listed in *Table 2.1* excluding odour. *Table 2.3* illustrates the baseline data expected to be obtained from suburban area. Since Eras Eco Ltd is located in a suburban area it would be considered located in a Zone C/D area according to the EPA's classification of zones for air quality. Traffic and industrial related emissions would be medium and it would be expected that air quality in the region would be average to good.

In addition, baseline data for Hydrogen chloride and fluoride was gathered from a review of published monitoring work performed on other industrial facilities.

Table 2.3. Baseline air quality data used to assess air quality impact criterion in Zone C/D region in Ireland - 2014.

Reference air quality data-Source identity	Zone C (worst case baseline)	Zone D (worst case baseline)	Details
Particulate matter-PM_{10} Annual mean (µg m^{-3})-	21	22	Measured 2014
Particulate matter-$PM_{2.5}$ Annual mean (µg m^{-3})-	16	13	Measured 2014
Nitrogen dioxide-NO_2 Annual mean (µg m^{-3})	16	13	Measured 2014
Sulphur dioxide-SO_2 Annual average (µg m^{-3})	5	4	Measured 2014
Carbon monoxide-CO Annual mean (µg m^{-3})	200	500	Measured 2014
Benzene	0.09	--	Measured 2014
Hydrogen chloride [1]	--	0.50 (Nobber, Co. Meath)	Measured 2009
Hydrogen fluoride[1]	--	0.030 (Nobber, Co. Meath)	Measured 2009

Notes: [1] denotes taken from Air quality impact assessment – College Proteins, Nobber, Co. Meath, Porter et al., 2010.

2.7 Meteorological data

Five years of hourly sequential meteorological data from Cork 2008 to 2012 inclusive was chosen for the modelling exercise. A schematic wind rose and tabular cumulative wind speed and directions of all years are presented in *Section 8*. All years of met data was screened to provide more statistical significant result output from the dispersion model. The worst case year Cork 2012 was used for data presentation. This is in keeping with national and international recommendations on quality assurance in operating dispersion models and will provide a worst case assessment of predicted ground level concentrations based on the input emission rate data. Surface roughness, Albedo and Bowen ratio were assessed and characterised around each met station for AERMET Pro processing.

2.8 Terrain data

Due to the fact that Eras Eco Ltd is located in complex terrain a terrain file was included in the dispersion modelling assessment. A 10 metre Cartesian grid spaced topographical data was obtained from Eras Eco Ltd and used to create a 10 metre Cartesian grid *.DEM file for use in Aermap software within AERMOD Prime.

2.9 Building wake effects

Building wake effects are accounted for in modelling scenarios (i.e. all existing and proposed building features located within the facility) as this can have a significant effect on the compound plume dispersion at short distances and can significantly increase GLC's in close proximity to the facility.

3. Results-Emission testing.

The historical measurement data, results and review or existing and proposed IPC licence limits for the existing and proposed emission source exhaust stacks for the site are presented in *Tables 3.1 to 3.5.*

3.1 Pollutant emission characteristics for emission points AEP1 to AEP4

Table 3.1 summarises the volume flow rate, pollutant concentration and mass emission rate of pollutant from the emission point. This data was utilised in conjunction with source characteristics contained in *Table 3.5* for the dispersion modelling exercise to assess the radius of impact of the facility.

Table 3.1. Volume flow rates, flue gas concentrations and mass emission rates of pollutants for emission point AEP1 - Boiler.

Source identity – AEP1 - boiler	Units	Volumetric airflow rate (Nm^3/hr)	Mass emission rate (g/s)
Carbon monoxide	mg/Nm^3	<1,000	3.22
Oxides of nitrogen	mg/Nm^3	<250	0.806
Total particulates	mg/Nm^3	<20	0.064
Odour	Ou_E/m^3	<1,000	3,576 Ou_E/s
Hydrogen sulphide	mg/Nm^3	<5.0	0.016
Volume flow rate	Nm^3/hr	11,600	--
Temperature	Kelvin	449	--

Table 3.2. Volume flow rates, flue gas concentrations and mass emission rates of pollutants for emission point AEP2 – Biofilter.

Source identity – AEP2 – biofilter	Units	Volumetric airflow rate (Nm^3/hr)	Mass emission rate (g/s)
Odour	Ou_E/m^3	<1,500	833Ou_E/s
Hydrogen sulphide	mg/Nm^3	<5.0	0.0027
Volume flow rate	Nm^3/hr	2,000	--
Temperature	Kelvin	303	--

Table 3.4. Volume flow rates, flue gas concentrations and mass emission rates of pollutants for emission point AEP3 – Materials Recovery Building Odour control unit.

Source identity – AEP3 – MRB OCU	Units	Volumetric airflow rate (Nm^3/hr)	Mass emission rate (g/s)
Odour	Ou_E/m^3	<1,000	8,300Ou_E/s
Volume flow rate	Nm^3/hr	29,980	--
Temperature	Kelvin	303	--

Table 3.5. Volume flow rates, flue gas concentrations and mass emission rates of pollutants for emission point AEP4 – AD CHP plant.

Source identity – AEP4 – AD CHP Plant	Units	Volumetric airflow rate (Nm^3/hr)	Mass emission rate (g/s)
Carbon monoxide	mg/Nm^3	<1,400	2.411
Oxides of nitrogen	mg/Nm^3	<500	0.861
Sulphur dioxide	mg/Nm^3	<500	0.861
Total particulates	mg/Nm^3	<140	0.241
Hydrogen chloride	mg/Nm^3	<50	0.086
Hydrogen fluoride	mg/Nm^3	<5.0	0.0086
Total Organic Carbon (Methane)	mgC/Nm^3	<1,000	1.722
Total non methane VOC's	mg/Nm^3	<75	0.124
Hydrogen sulphide	mg/Nm^3	<5.0	0.00861
Volume flow rate	Nm^3/hr	6,200	--
Temperature	Kelvin	723	--

3.2. Dispersion model input data – Source characteristics

Table 3.5 illustrates the source characteristics utilised within the dispersion model. Grid reference location, stack height (A.G.L), maximum volume flow and temperature of the emission point are presented within this table for reference purposes.

Table. 3.5 Stack source characteristics for Eras Eco Ltd emission points AEP1 to AEP4.

Source identity – AEP1 to AEP4	AEP1	AEP2	AEP3	AEP4
X grid coordinate (m)	209709.9	209730.1	209626.5	209623
Y grid coordinate (m)	79775.4	79811.2	79739.2	79732
Stack height (m)	16.50	2.75	15	19
Temperature (Kelvin)	449	303	303	723
Stack tip diameter (m)	0.80	0.22	0.80	0.65
Efflux velocity (m/s)	10.52	16.20	16.51	18.80
Volumetric airflow rate (Nm^3/hr)	11,600	2,000	29,980	6,200
Actual volumetric airflow rate (Am^3/hr)	19,078	2,219	33,725	22,500
Elevation (m)	2.0	2.0	2.0	2.0

3.3 Emission rate calculations and mass emission rates

The contaminant concentration from a stack is best quantified by a mass emission rate. For a chimney or ventilation stack, this is equal to the compound concentration (mg m^{-3}) of the discharge air multiplied by its flow-rate (m^3 s^{-1}). It is equal to the volume of air contaminated every second to the concentration limit (mg s^{-1}). The mass emission rate (g s^{-1}) is used in conjunction with dispersion modelling in order to estimate the approximate radius of impact. All data used in the dispersion modelling exercise was obtained through in stack measurement. *Tables 3.1 to 3.4* illustrates the volume flow values and stack concentration values used to calculate mass emission rates for *each Scenario* from the exhaust stack of the emission points. All data is based on historical measured emissions.

This data was used in conjunction with the source characteristics stated in *Table 3.5* to estimate the radius of impact for the particular pollutant.

3.4 Dispersion modelling assessment

AERMOD Prime (15181) was used to determine the overall ground level impact of emission points – AEP1 to AEP4 located in Eras Eco Ltd. These computations give the relevant GLC's at each 50-meter X Y Cartesian grid receptor location that is predicted to be exceeded for the specific air quality impact criteria. A total Cartesian + individual receptors of 961 points was established giving a total grid coverage area of 2.25 square kilometres around the emission point.

Five years of hourly sequential meteorological data from Cork Airport (Cork Airport 2008 to 2012 inclusive) and source characteristics (including emission date contained in *Tables 3.1 to 3.4*) were inputted into the dispersion model for all parameters.

In order to obtain the predicted environmental concentration (PEC), background data was added to the process emissions. In relation to the annual averages, the ambient background concentration was added directly to the process concentration. However, in relation to the short-term peak concentrations, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK Environment Agency advises that an estimate of the maximum combined pollutant concentration can be obtained by adding the maximum short-term concentration due to emissions from the source to twice the annual mean background concentration.

3.5 Dispersion model Scenarios

AERMOD Prime (USEPA ver. 15181) was used to determine the overall odour and air quality impact of the facility operations.

Fifteen distinct scenarios were assessed within the dispersion model. The output data was analysed to calculate the following:

Ref Scenario 1: Predicted Carbon monoxide emission contribution of exhaust stacks located in Eras Eco Ltd to 8 hr average Carbon monoxide plume dispersal at the 100th percentile for an Carbon monoxide concentration of less than or equal to 500 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.2*).

Ref Scenario 2: Predicted Oxides of nitrogen emission contribution of exhaust stacks located in Eras Eco Ltd to 1 hr average Oxides of nitrogen plume dispersal at the 99.79th percentile for an Oxides of nitrogen concentration of less than or equal to 53 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.3*).

Ref Scenario 3: Predicted Oxides of nitrogen emission contribution of exhaust stacks located in Eras Eco Ltd to Oxides of nitrogen plume dispersal at the Annual average for an Oxides of nitrogen concentration of less than or equal to 18 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.4*).

Ref Scenario 4: Predicted Sulphur dioxide emission contribution of exhaust stacks located in Eras Eco Ltd to Sulphur dioxide plume dispersal at the 99.73th percentile of an 1 hour average for an Sulphur dioxide concentration of less than or equal to 60 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.5*).

Ref Scenario 5: Predicted Sulphur dioxide emission contribution of exhaust stacks located in Eras Eco Ltd to Sulphur dioxide plume dispersal at the 99.18th percentile of an 24 hour average for an Sulphur dioxide concentration of less than or equal to 30 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.6*).

Ref Scenario 6: Predicted Sulphur dioxide emission contribution of exhaust stacks located in Eras Eco Ltd to Sulphur dioxide plume dispersal for the Annual average for an Sulphur dioxide concentration of less than or equal to 12 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.7*).

Ref Scenario 7: Predicted Total particulates emission contribution of exhaust stacks located in Eras Eco Ltd to Total particulates as PM10 plume dispersal at the 90.40th percentile of an 24 hour average for an Total particulates concentration of less than or equal to 4.70 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.8*).

Ref Scenario 8: Predicted Total particulates emission contribution of exhaust stacks located in Eras Eco Ltd to Total particulates as PM10 plume dispersal at the Annual average for a Total particulates concentration of less than or equal to 3 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.9*).

Ref Scenario 9: Predicted Total particulates emission contribution of exhaust stacks located in Eras Eco Ltd to Total particulates as PM2.5 plume dispersal at the Annual average for a Total particulates concentration of less than or equal to 3 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.10*).

Ref Scenario 10: Predicted Hydrogen chloride emission contribution of exhaust stacks located in Eras Eco Ltd to 1 hr average Hydrogen chloride plume dispersal at the 98th percentile for an Hydrogen chloride concentration of less than or equal to 4 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.11*).

Ref Scenario 11: Predicted Hydrogen chloride emission contribution of exhaust stacks located in Eras Eco Ltd to Hydrogen chloride plume dispersal at the Annual average for a Hydrogen chloride concentration of less than or equal to 1.0 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.12*).

Ref Scenario 12: Predicted Hydrogen fluoride emission contribution of exhaust stacks located in Eras Eco Ltd to 1 hr average Hydrogen fluoride plume dispersal at the 98th percentile for an Hydrogen fluoride concentration of less than or equal to 0.60 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.13*).

Ref Scenario 13: Predicted Hydrogen fluoride emission contribution of exhaust stacks located in Eras Eco Ltd to Hydrogen fluoride plume dispersal at the Annual average for a Hydrogen fluoride concentration of less than or equal to 0.10 µg/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.14*).

Ref Scenario 14: Predicted TNMVOC (as benzene) emission contribution of exhaust stacks located in Eras Eco Ltd to TNMVOC (as benzene) plume dispersal at the Annual average for a TNMVOC (as benzene) concentration of less than or equal to 2.0 $\mu g/m^3$ for worst case meteorological year Cork 2012 (*see Figure 7.15*).

Ref Scenario 15: Predicted Odour emission contribution of exhaust stacks located in Eras Eco Ltd to 1 hr average Odour plume dispersal at the 98^{th} percentile for an Odour concentration of less than or equal to 1.50 Ou_E/m^3 for worst case meteorological year Cork 2012 (*see Figure 7.16*).

These computations give the odour and air quality concentration at each 50-meter x y Cartesian grid receptor location that is predicted to be exceeded for the expressed percentile for five years of screened hourly sequential meteorological data for Cork (worst case year Cork 2012) to allow for comparison with the ground level concentration limits contained in *Tables 2.1 and 2.2*.

This will allow for the predictive analysis of any potential impact on the neighbouring sensitive locations while the facility is in operation.

4. Results of Dispersion modelling exercise

This section will present the results of the dispersion modelling.

AERMOD GIS Pro Prime (Ver. 15181) was used to determine the overall classical air pollutant odour and air quality impact of Eras Eco Ltd emission points (AEP1 to AEP4).

Various averaging intervals were chosen to allow direct comparison of predicted GLC's with the relevant the relevant air quality assessment criteria as outline in *Section 2.8*. In particular, 1-hour, 24 hour and annual average GLC's of the specified pollutants were calculated at 50 metres distances from the site over a fine and coarse grid extent of 2.25 kilometres squared. Relevant percentiles of these GLC's were also computed for comparison with the relevant pollutant Air Quality Standards to include those outlined in *Tables 2.1 and 2.2.*

In modelling air dispersion of NOx from combustion sources, the source term should be expressed as NO_2, e.g., NOx mass (expressed as NO_2). Some of the exhaust air is made up of NO while some is made up of NO_2. NO will be converted in the atmosphere to NO_2 but this will depend on a number of factors to include Ozone and VOC concentrations. In order to take account of this conversion the following screening can be performed.

Use the following phased approach for assessment:

Worse case scenario

35% for short-term and 70% for long-term average concentration should be considered. If PEC (process contribution + "relevant background concentration") exceeds the relevant air quality objective.

Table 4.1 illustrates the tabular results obtained from the assessment for Cork meteorological station 2012 for:

- Worst case scenario (for NO_X only).

Maximum predicted GLC's are presented within this table to allow for comparison with limit values.

Table 4.1 illustrates the tabular results obtained from the assessment. Maximum predicted GLC's are presented within this table to allow for comparison with limit values contained in *Tables 2.1 and 2.2*.

Table 4.1. Tabular illustration of predicted GLC's in the vicinity of Eras Eco Ltd in accordance with odour and air quality limit and guideline values contained in *Tables 2.1 and 2.2*.

Identity	Compound identity	Maximum predicted conc. - ($\mu g\ m^{-3}$)	Percentile value (%)
Scenario 1 -Maximum 8 hour concentration	CO	619	100th
Scenario 2 - Maximum 1 hour concentration	NO_X	60	99.79th
Scenario 3 - Maximum Annual average concentration	NO_X	20	Annual average
Scenario 4 - Maximum 1 hour concentration	SO_2	83	99.73th
Scenario 5 - Maximum 24 hr concentration	SO_2	51	99.18th
Scenario 6 - Maximum Annual average concentration	SO_2	13	Annual average
Scenario 7 - Maximum 24 hr concentration	PM_{10}	10	90.40th
Scenario 8 - Maximum Annual average concentration	PM_{10}	5	Annual average
Scenario 9 - Maximum Annual average concentration	$PM_{2.5}$	5	Annual average
Scenario 10 - Maximum 1 hr concentration	HCL	7.20	98th
Scenario 11 - Maximum Annual average concentration	HCL	1.67	Annual average
Scenario 12 - Maximum 1 hour concentration	HF	0.72	98th
Scenario 13 - Maximum annual average concentration	HF	0.167	Annual average
Scenario 14 - Maximum Annual average concentration	TNMVOC as benzene	2.40	Annual average
Scenario 15 - Maximum 1 hr concentration (at nearest sensitive receptor)	Odour	0.70	98th
Scenario 16 – Maximum Annual average concentration	H_2S	1.30	Annual average

4.1 Assessment of existing air quality impacts

Table 4.2 presents the comparison between model predictions for odour and air quality impacts, baseline air quality concentrations for the compounds and the percentage impact of the air quality criterion. As can be observed all predicted GLC's are within the odour and air quality impact criterions for all assessed compounds.

Table 4.2. Comparison between predicted GLC's + baseline national air quality data and limit values contained in Tables 2.1 and 2.2.

Identity	Compound	Maximum predicted GLC –Scenario 1 ($\mu g\ m^{-3}$)	Baseline conc. value ($\mu g\ m^{-3}$)[1,3]	Baseline + Maximum predicted GLC ($\mu g\ m^{-3}$)	Impact criterion ($\mu g\ m^{-3}$)[2]	% of Criterion
Scenario 1 -Maximum 8 hour concentration	CO	619	500	1119	10,000	11.19
Scenario 2 - Maximum 1 hour concentration	NO_X	60	32	92	200	46.00
Scenario 3 - Maximum Annual average concentration	NO_X	20	16	36	40	90.00
Scenario 4 - Maximum 1 hour concentration	SO_2	83	10	93	350	26.57
Scenario 5 - Maximum 24 hr concentration	SO_2	51	5	56	125	44.80
Scenario 6 - Maximum Annual average concentration	SO_2	13	5	18	20	90.00
Scenario 7 - Maximum 24 hr concentration	PM_{10}	10	22	32	50	64.00
Scenario 8 - Maximum Annual average concentration	PM_{10}	5	22	27	40	67.50
Scenario 9 - Maximum Annual average concentration	$PM_{2.5}$	5	16	21	40	52.50
Scenario 10 - Maximum 1 hr concentration	HCL	7.2	1.0	8.2	100	8.20
Scenario 11 - Maximum Annual average concentration	HCL	1.67	0.50	2.17	20	10.85
Scenario 12 - Maximum 1 hour concentration	HF	0.72	0.060	0.78	3.0	26.00
Scenario 13 - Maximum annual average concentration	HF	0.167	0.030	0.197	0.30	65.67
Scenario 14 - Maximum Annual average concentration	TNMVOC as benzene	2.4	0.090	2.49	5.0	49.80
Scenario 15 - Maximum 1 hr concentration (at nearest sensitive receptor)	Odour	0.7	--	0.7	1.50	46.67
Scenario 14 - Maximum Annual average concentration	H_2S	1.3	--	1.3	--	--

Notes:
[1] denotes based on data presented in *Table 2.1*
[2] denotes for impact criterion *see Table 2.1 and 2.2*
[3] denotes that the short-term concentration was added to twice the annual average as recommended by the Environment Agency.

5. Discussion of results

This section will discuss the results obtained throughout the study.

5.1 Carbon monoxide (CO) air quality impact – Scenario 1

The results for the potential air quality impact for dispersion modelling of CO based on the emission rates in *Tables 3.1 to 3.4* is presented in *Tables 4.1, 4.2* and *Figure 7.2*. As can be observed in *Table 4.2,* the maximum GLC + Baseline for CO from the operation of the facility is 1,119 $\mu g/m^3$ for the maximum 8-hour averaging period. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 2000/69/EC and 2008/50/EC, this is up to 90% lower than the set limits (*see Table 4.2*).

5.2 Oxides of nitrogen (NO_2) air quality impact – Scenario 2 and 3.

The results for the potential air quality impact for dispersion modelling of NO_X as NO_2 based on the emission rates in *Tables 3.1 to 3.4* is presented in *Tables 4.1, 4.2 and Figures 7.3 to 7.4.* As can be observed in *Table 4.2,* the maximum GLC+Baseline for NO_2 as NO_X for the 99.79th percentile for a 1-hour averaging period was 92 $\mu g/m^3$. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is up to 54% lower than the set limits.

An annual average was also generated for Scenario 3. When compared to the impact criteria, the annual average NO_2 air quality impact for Scenario 3 is up to 10% lower than the limit (*see Table 4.2*).

5.3 Sulphur dioxide (SO_2) air quality impact – Scenario 4, 5 and 6

The results for the potential air quality impact for dispersion modelling of SO_2 based on the emission rates in *Tables 3.1 to 3.4* is presented in *Tables 4.1, 4.2* and *Figures 7.5 to 7.7*. As can be observed in *Table 4.2,* the maximum GLC+Baseline for SO_2 from the operation of the facility is 93 and 56 $\mu g/m^3$ for the maximum 1-hour averaging period at the 99.73th percentile and 24-hour averaging period at the 99.18th percentile, respectively. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is from 73 to 53% lower than the set limits established for the 1 hour and 24 hour assessment criteria.

An annual average was also generated for Scenario 6 to allow comparison with the SI 180 of 2011 and 2008/50/EC. When compared the annual average SO_2 air quality impact criterion is 10% lower than the impact criterion.

5.4 Total Particulates (PM) as PM_{10} air quality impact – Scenarios 7, 8 and 9

The results for the potential air quality impact for dispersion modelling of PM as $PM_{10/2.5}$ based on the emission rates in *Tables 3.1 to 3.4* is presented in *Tables 4.1, 4.2 and Figures 7.8, 7.9 and 7.10*. As can be observed in *Table 4.2,* the maximum GLC+Baseline for PM as PM_{10} for Scenario 7 from the operation of the facility is 10 $\mu g/m^3$ for the 90.4th percentile for a 24-hour averaging period. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is from 36% lower than the set limits.

An annual average was also generated for Scenario 8 and 9 to allow comparison with the SI 180 of 2011 and 2008/50/EC for PM_{10} and $PM_{2.5}$. When compared the annual average PM_{10} and $PM_{2.5}$ air quality impact criterion is 32 and 47% lower than the impact criterion.

5.5 Hydrogen chloride air quality impact – Scenarios 10 and 11

The results for the potential air quality impact for dispersion modelling of HCL based on the emission rates in *Tables 3.1 to 3.4* is presented in *Tables 4.1, 4.2 and Figures 7.11 to 7.12.* As can be observed in *Table 4.2,* the maximum GLC+Baseline for HCL for the 98th percentile for a 1-hour averaging period was 8.20 μg/m^3. When combined predicted and baseline conditions are compared to the TaLuft S Limit values laid out in TaLuft 2002, this is up to 91% lower than the set limits.

An annual average was also generated for Scenario 11. When compared to the impact criteria contained in H1 guidance document, the annual average HCL air quality impact for Scenario 11 is up to 89% lower than the limit (*see Table 4.2*).

5.6 Hydrogen fluoride air quality impact – Scenarios 12 and 13

The results for the potential air quality impact for dispersion modelling of HF based on the emission rates in *Tables 3.1 to 3.4* is presented in *Tables 4.1, 4.2 and Figures 7.13 to 7.14.* As can be observed in *Table 4.2,* the maximum GLC+Baseline for HF for the 98th percentile for a 1-hour averaging period was 0.78 μg/m^3. When combined predicted and baseline conditions are compared to the TaLuft S Limit values laid out in TaLuft 2002, this is up to 74% lower than the set limits.

An annual average was also generated for Scenario 13. When compared to the impact criteria contained in TaLuft 2002, the annual average HF air quality impact for Scenario 13 is up to 34% lower than the limit (*see Table 4.2*).

5.7 Total non methane Volatile organic compounds (as benzene) air quality impact – Scenario 14

The results for the potential air quality impact for dispersion modelling of TNMVOC as benzene based on the emission rates in *Tables 3.1 to 3.4* is presented in *Tables 4.1, 4.2 and Figure 7.15.* As can be observed in *Table 4.2,* the maximum GLC+Baseline for TNMVOC as benzene for the annual averaging period was 2.49 μg/m^3. When combined predicted and baseline conditions are compared to the proposed Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 2008/50/EC, this is up to 50% lower than the proposed set limits.

5.8 Odour air quality impact air quality impact – Scenario 15

The plotted odour concentrations of ≤ 1.50 Ou_E/m^3 for the 98th percentile for the facility is illustrates in *Tables 4.1, 4.2* and *Figure 7.16*. As can be observed, the odour plume spread from the facility is small and remains close to the facility. In addition the predicted ground level concentration at all residential receptors is approximately 66% lower (0.70 Ou_E/m^3) than the odour impact criterion presented in *Table 2.2*.

Therefore it is predicted that the proposed facility design will not lead to odour impact in the vicinity of the facility with all residential receptors perceiving an odour concentration less than 1.50 Ou_E/m^3 at the 98th percentile of hourly averages for worst case meteorological year Cork 2012.

6. Conclusions

The following conclusions were drawn from the dispersion modelling assessment: Greater detail can be found within the document and it is recommended that the document be read in full.

1. Process emission estimation and dispersion modeling was performed on emissions from the existing and proposed processes to be located in Eras Eco Ltd, Foxhole, Youghal, Co. Cork.
2. Dispersion modeling was performed in accordance with best international practice and AG4 guidance document on dispersion modelling with a minimum of five years of hourly sequential meteorological data from Cork 2008 to 2012 inclusive was used in the dispersion modeling assessment. AERMOD Prime 15181 was utilised for the dispersion modelling assessment.
3. With regard to Carbon monoxide, the maximum GLC + Baseline for CO from the operation of the facility is 1,119 $\mu g/m^3$ for the maximum 8-hour averaging period. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 2000/69/EC and 2008/50/EC, this is up to 90% lower than the set limits.
4. With regard to Oxides of nitrogen, the maximum GLC+Baseline for NO_2 as NO_X for the 99.79th percentile for a 1-hour averaging period was 92 $\mu g/m^3$. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is up to 54% lower than the set limits. An annual average was also generated for Scenario 3. When compared to the impact criteria, the annual average NO_2 air quality impact for Scenario 3 is up to 10% lower than the limit.
5. With regard to Sulphur dioxide, the maximum GLC+Baseline for SO_2 from the operation of the facility is 93 and 56 $\mu g/m^3$ for the maximum 1-hour averaging period at the 99.73th percentile and 24-hour averaging period at the 99.18th percentile, respectively. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is from 73 to 53% lower than the set limits established for the 1 hour and 24 hour assessment criteria. An annual average was also generated for Scenario 6 to allow comparison with the SI 180 of 2011 and 2008/50/EC. When compared the annual average SO_2 air quality impact criterion is 10% lower than the impact criterion.
6. With regard to Total Particulates as PM_{10}, the maximum GLC+Baseline for PM as PM_{10} for Scenario 7 from the operation of the facility is 10 $\mu g/m^3$ for the 90.4th percentile for a 24-hour averaging period. When combined predicted and baseline conditions are compared to the Irish guideline/limit values and EU Limit values laid out in the EU Daughter directive on Air Quality 99/30/EC and 2008/50/EC, this is from 36% lower than the set limits. An annual average was also generated for Scenario 8 and 9 to allow comparison with the SI 180 of 2011 and 2008/50/EC for PM_{10} and $PM_{2.5}$. When compared the annual average PM_{10} and $PM_{2.5}$ air quality impact criterion is 32 and 47% lower than the impact criterion.
7. With regard to Hydrogen chloride, the maximum GLC+Baseline for HCL for the 98th percentile for a 1-hour averaging period was 8.20 $\mu g/m^3$. When combined predicted and baseline conditions are compared to the TaLuft S Limit values laid out in TaLuft 2002, this is up to 91% lower than the set limits. An annual average was also generated for Scenario 10. When compared to the impact criteria contained in H1 guidance document, the annual average HCL air quality impact for Scenario 10 is up to 89% lower than the limit.
8. With regard to Hydrogen fluoride, the maximum GLC+Baseline for HF for the 98th percentile for a 1-hour averaging period was 0.78 $\mu g/m^3$. When combined predicted and baseline conditions are compared to the TaLuft S Limit values laid out in TaLuft 2002, this is up to 74% lower than the set limits. An annual average was also generated for Scenario 12. When compared to the impact criteria contained in TaLuft 2002, the annual average HF air quality impact for Scenario 12 is up to 34% lower than the limit.
9. With regard to TNMVOC as benzene, the maximum GLC+Baseline for TNMVOC as benzene for the annual averaging period was 2.49 $\mu g/m^3$. When combined predicted and baseline conditions are compared to the proposed Irish guideline/limit values and

EU Limit values laid out in the EU Daughter directive on Air Quality 2008/50/EC, this is up to 50% lower than the proposed set limits.

10. With regard to Odour, the odour plume spread from the facility is small and remains close to the facility. In addition the predicted ground level concentration at all residential receptors is approximately 66% lower (0.70 Ou_E/m^3) than the odour impact criterion. Therefore it is predicted that the proposed facility design will not lead to odour impact in the vicinity of the facility with all residential receptors perceiving an odour concentration less than 1.50 Ou_E/m^3 at the 98^{th} percentile of hourly averages for worst case meteorological year Cork 2012.
11. Based on the predicted emissions and emission limit value guarantees, the proposed operation of the Eras Eco Ltd facility located in foxhole, Youghal, Co. cork will not breach stated air quality regulations when in operation.

7. *Appendix I* - Contour plots for dispersion modelling assessment (Process contributions only)

Odour, Carbon monoxide, Oxides of nitrogen, Sulphur dioxide and Total particulates percentile and annual average contour plots are illustrated in this section. Contour plots are only supplied in this section for illustrative purposes only.

7.1. Site layout and location

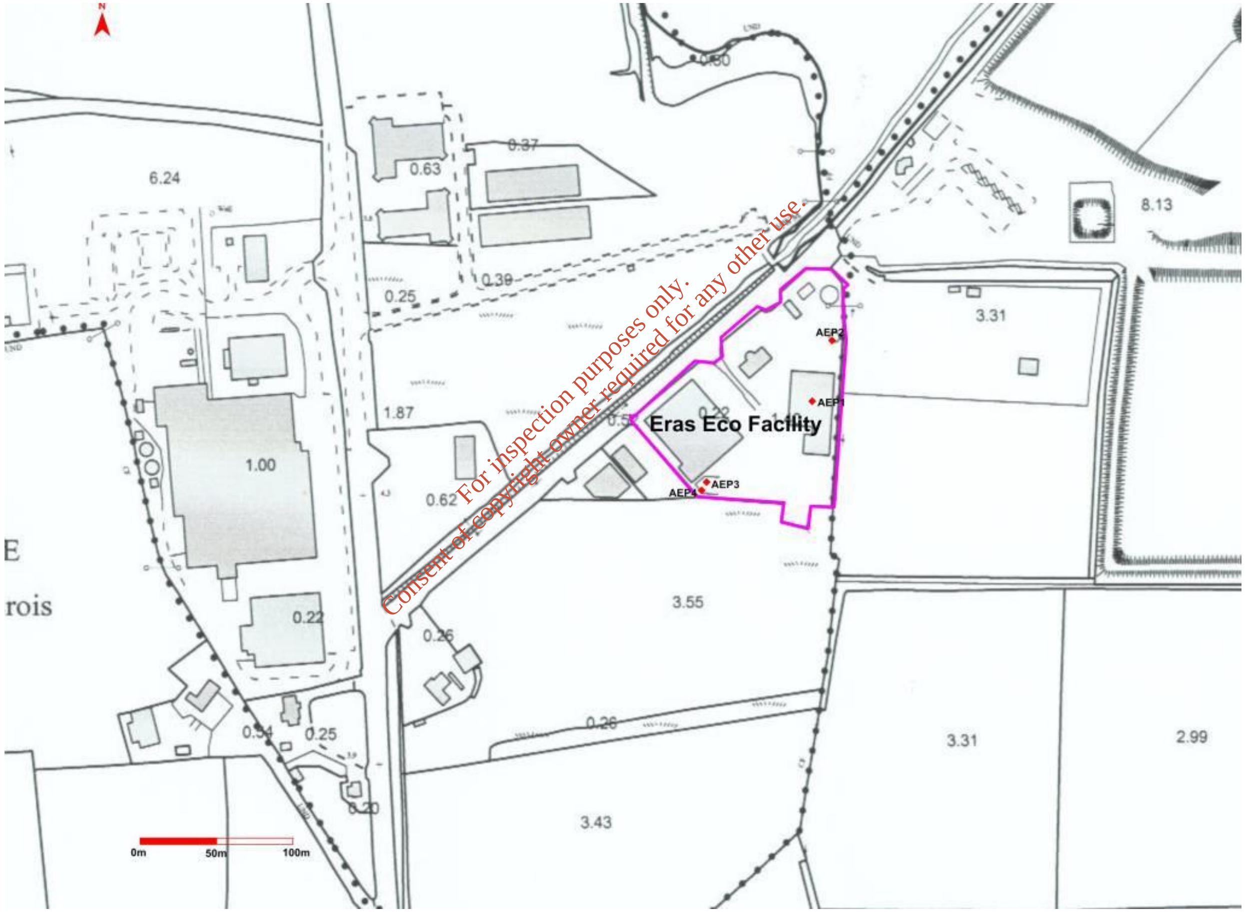

Figure 7.1. Aerial facility layout map showing Eras Eco Ltd location and boundary ( ) and relative locations of emission points AEP1 to AEP4.

7.2. Dispersion modelling contour plots for Scenario 1

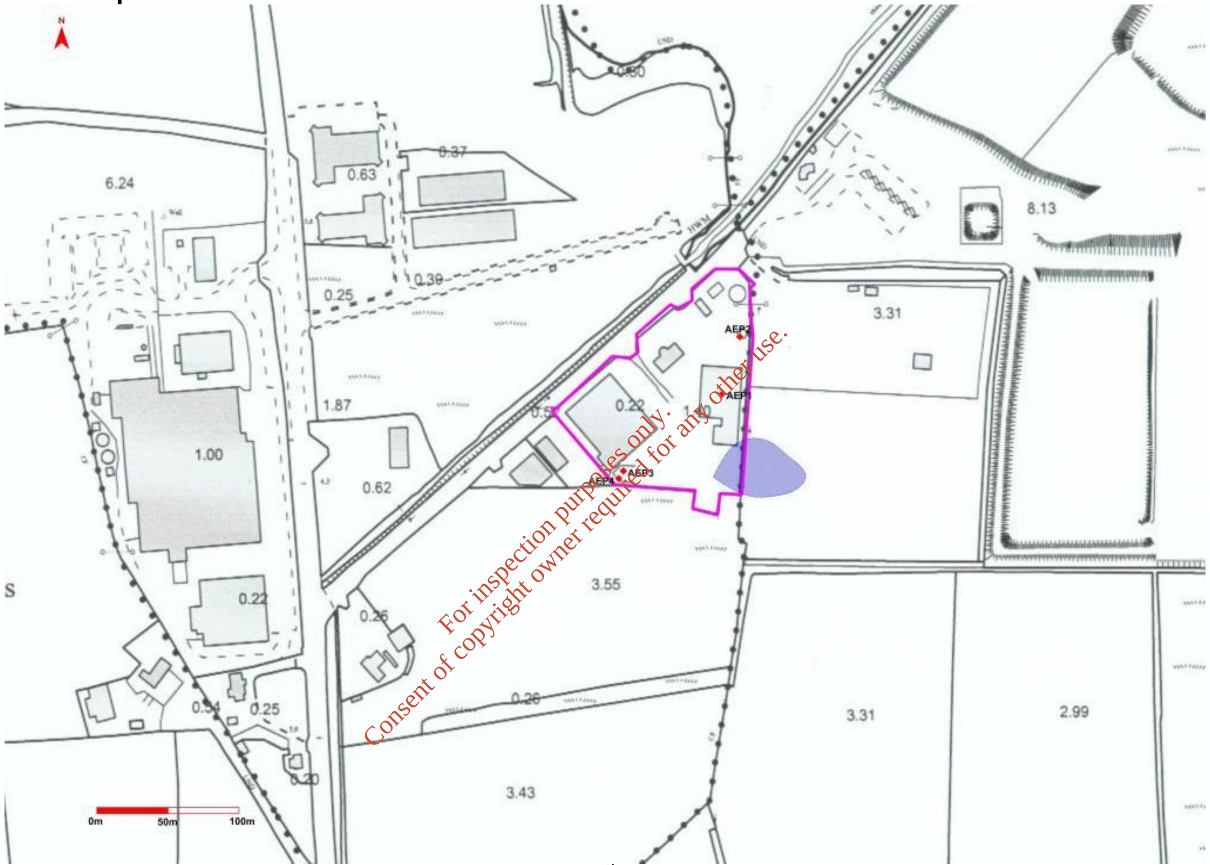

Figure 7.2. Predicted Carbon monoxide plume spread for Scenario 1 at the 100th percentile of 8 hourly averages for Carbon monoxide concentrations of ≤ 500 µg/m³ (▬▬).

7.3. Dispersion modelling contour plots for Scenario 2

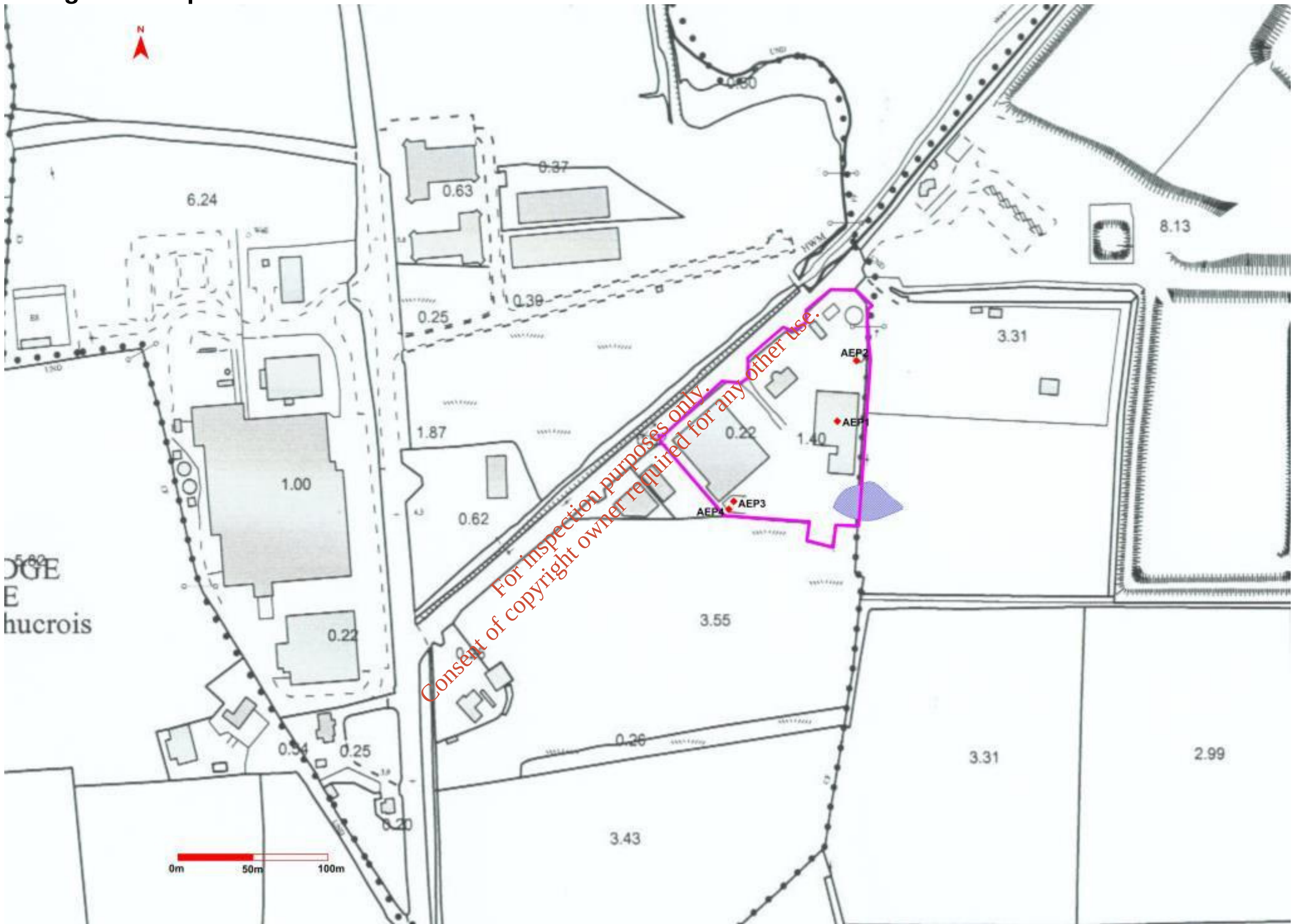

Figure 7.3. Predicted Oxides of nitrogen plume spread for Scenario 2 at the 99.79th percentile of hourly averages for Oxides of nitrogen concentrations of ≤ 53 µg/m^3 ( ).

7.4. Dispersion modelling contour plots for Scenario 3

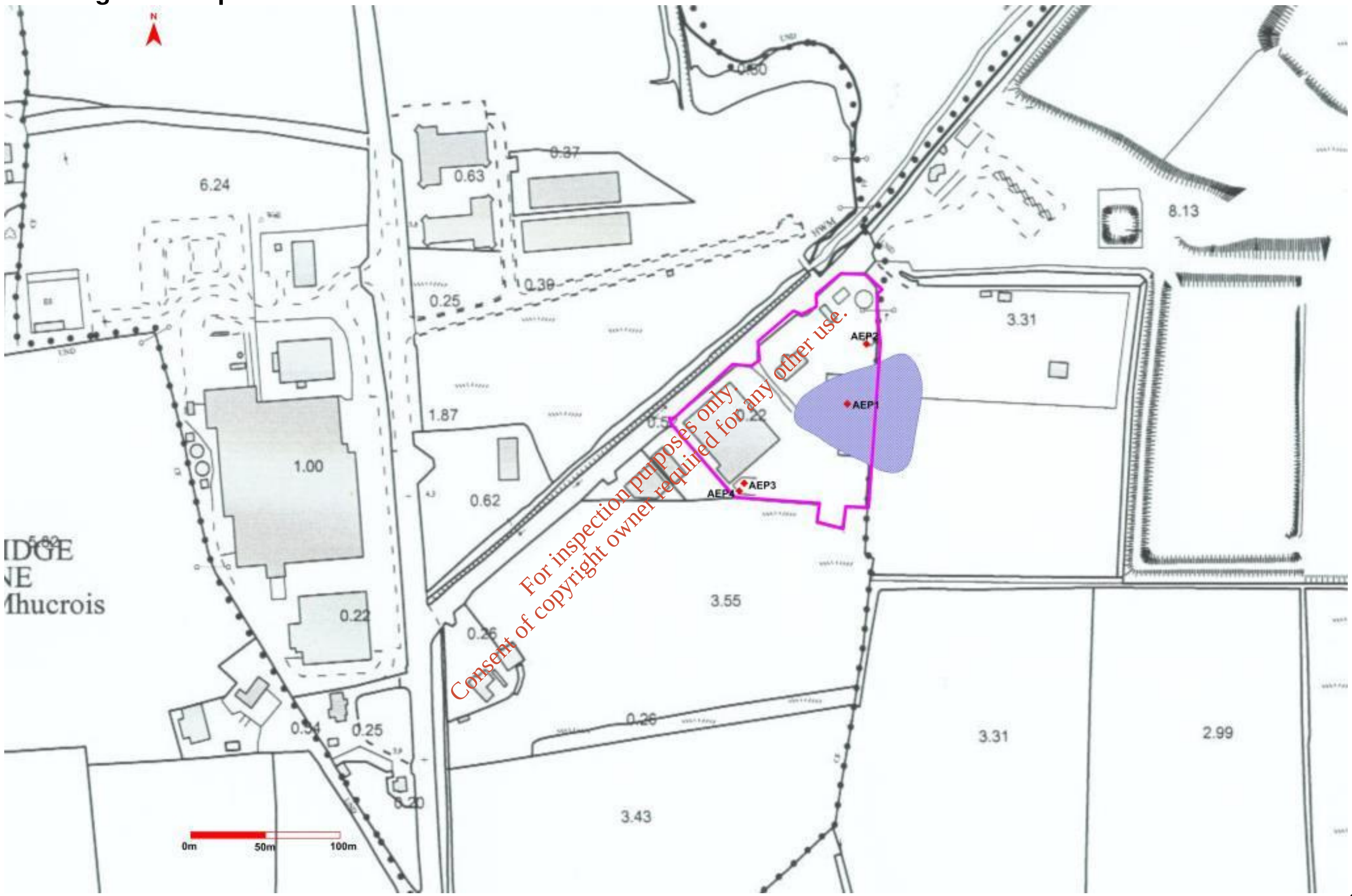

Figure 7.4. Predicted Oxides of nitrogen plume spread for Scenario 3 for the annual average for Oxides of nitrogen concentration of ≤ 17 µg/m^3 ( ).

7.5. Dispersion modelling contour plots for Scenario 4

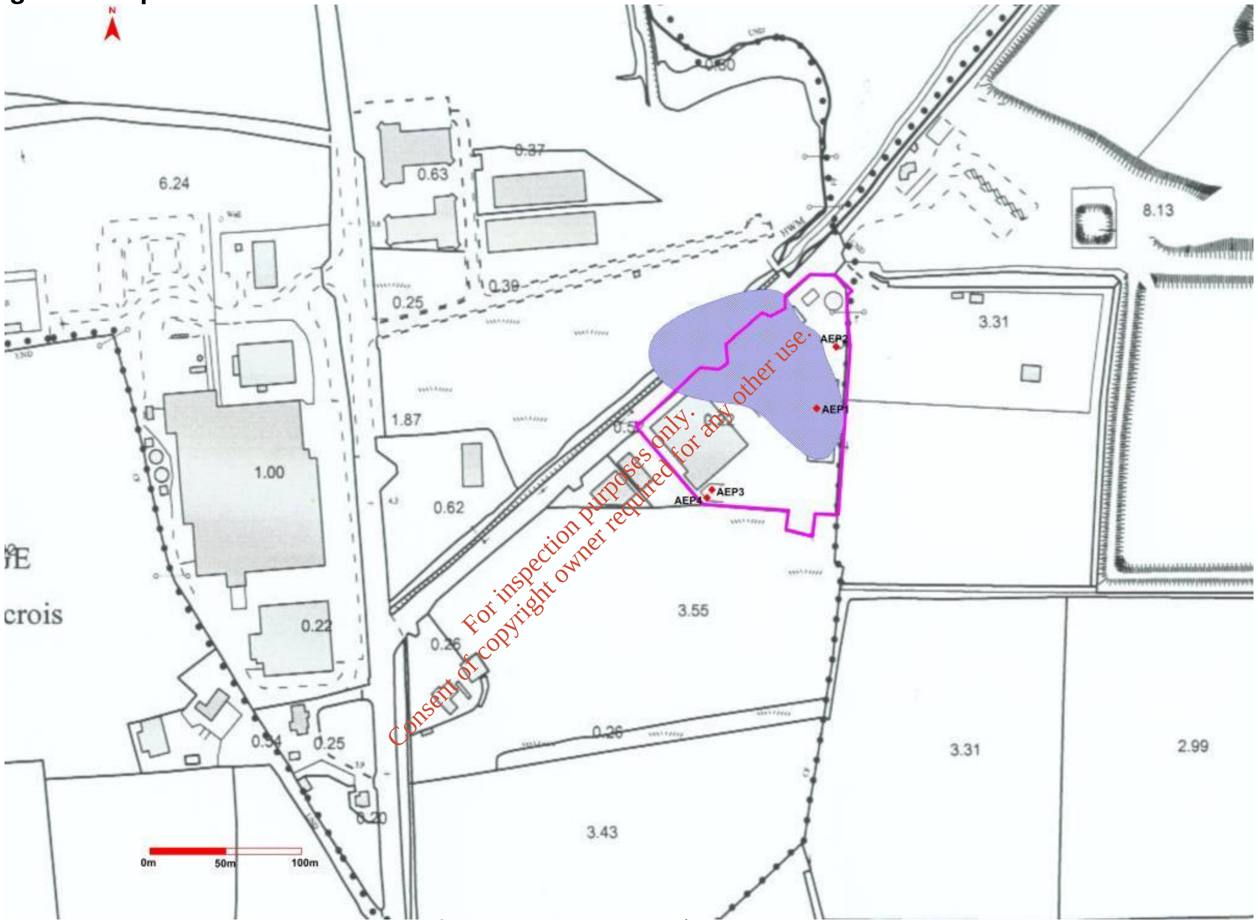

Figure 7.5. Predicted SO_2 ground level concentration of ≤60 µg/m^3 (━━) at the 99.73th percentile of 1-hour averaging period for Scenario 4.

7.6. Dispersion modelling contour plots for Scenario 5

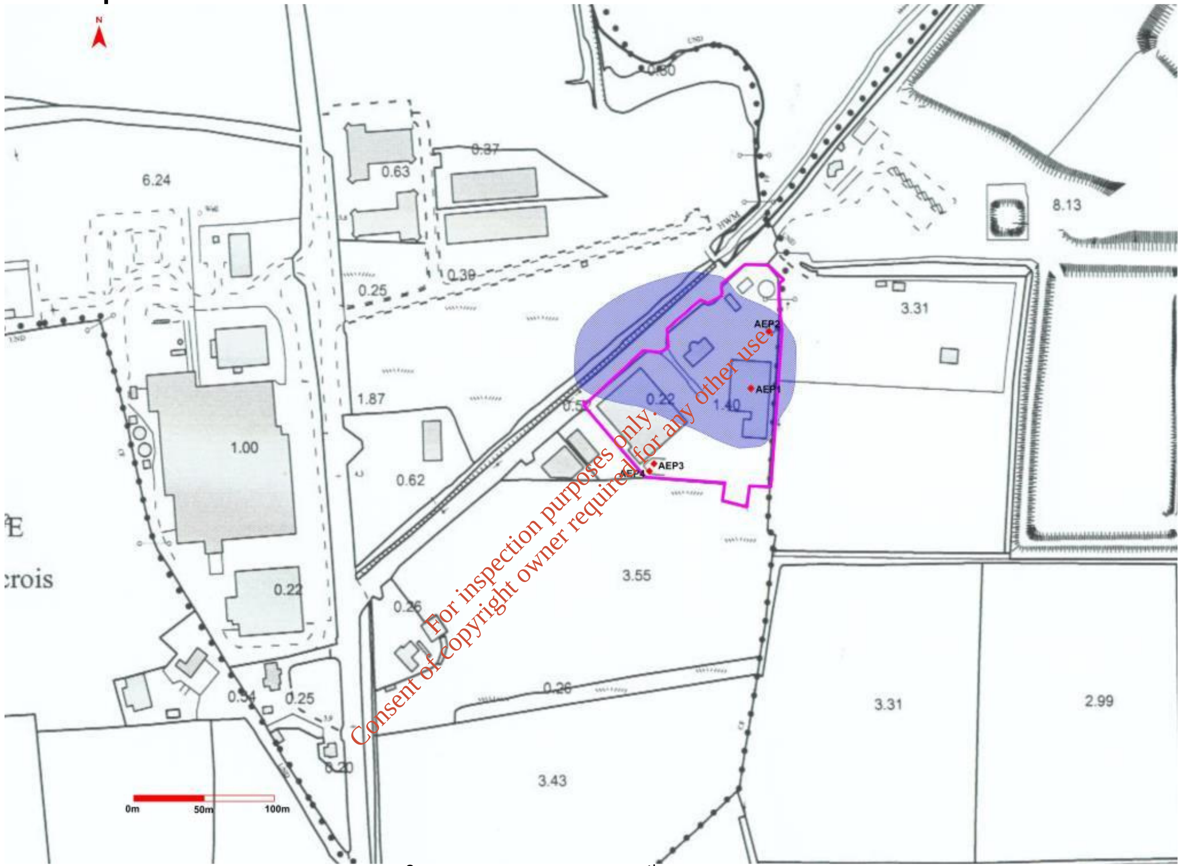

Figure 7.6. Predicted SO_2 ground level concentration of ≤30 µg m^{-3} ( ) at the 99.18th percentile of 24-hour averaging period for Scenario 5.

7.7. Dispersion modelling contour plots for Scenario 6

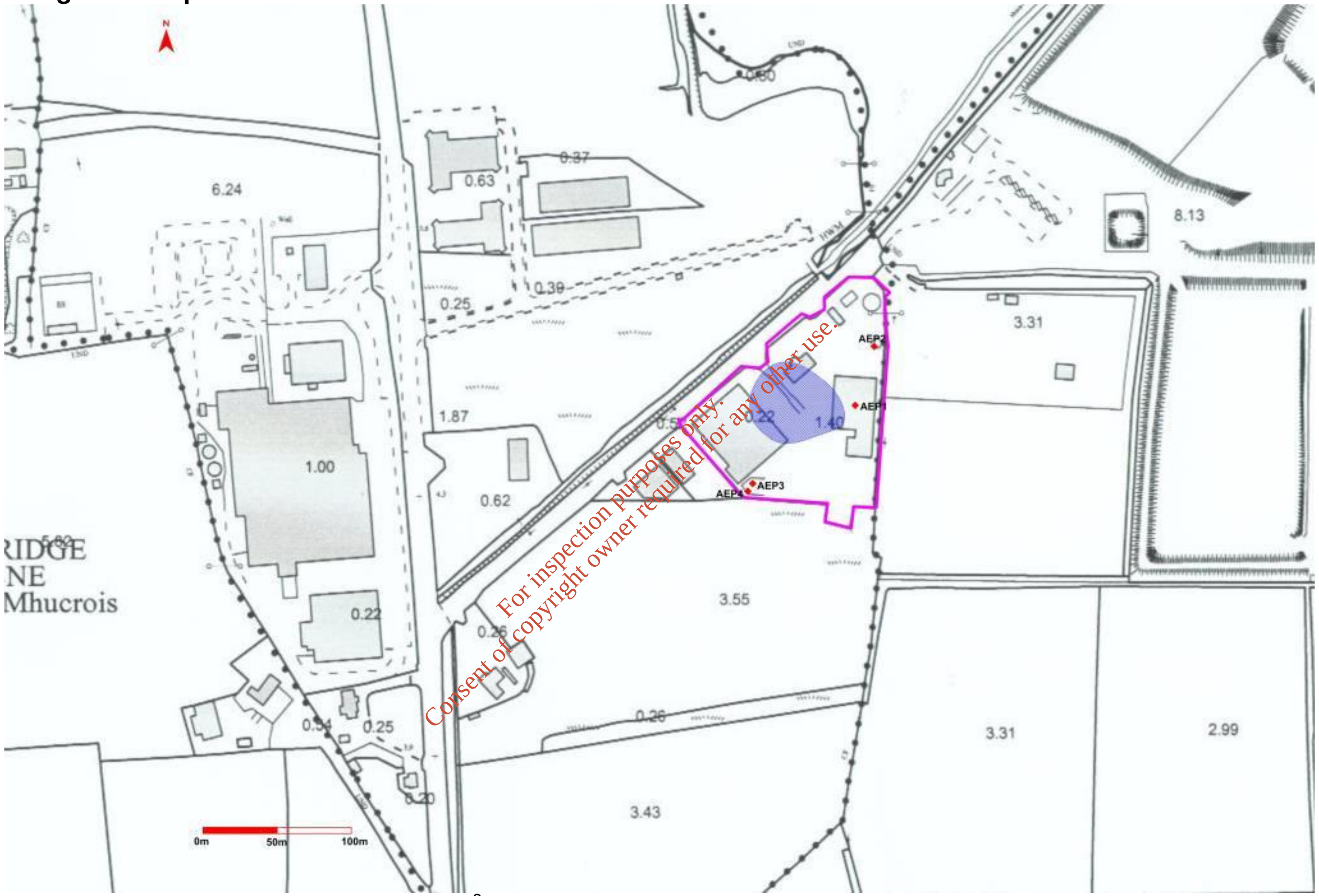

Figure 7.7. Predicted SO_2 ground level concentration of ≤12 µg/m³ ( ) for the annual averaging period for Scenario 6.

7.8. Dispersion modelling contour plots for Scenario 7

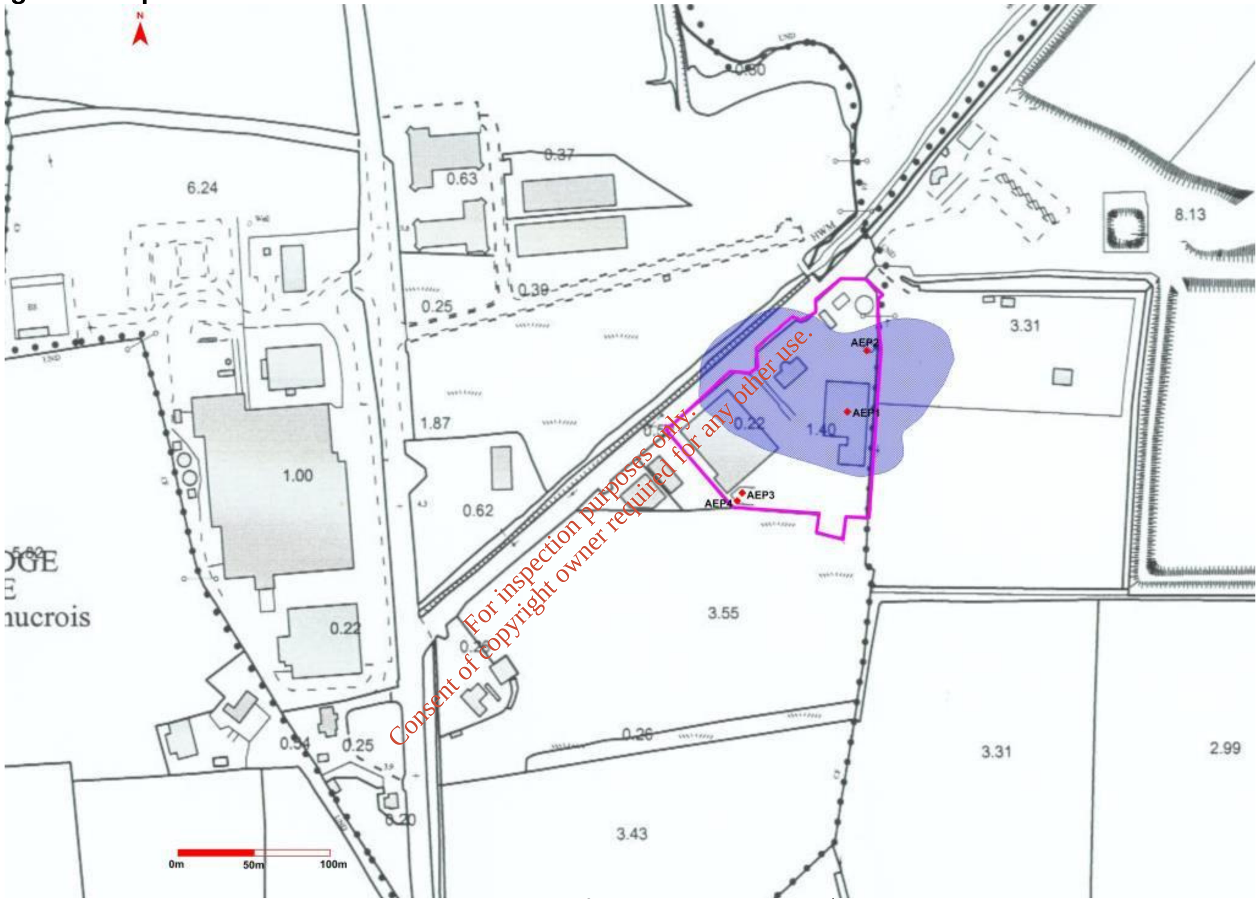

Figure 7.8. Predicted Particulate matter ground level concentration of ≤7 μg/m^3 ( ) at the 90.04th percentile of 24 hour averaging period for Scenario 7.

7.9. Dispersion modelling contour plots for Scenario 8

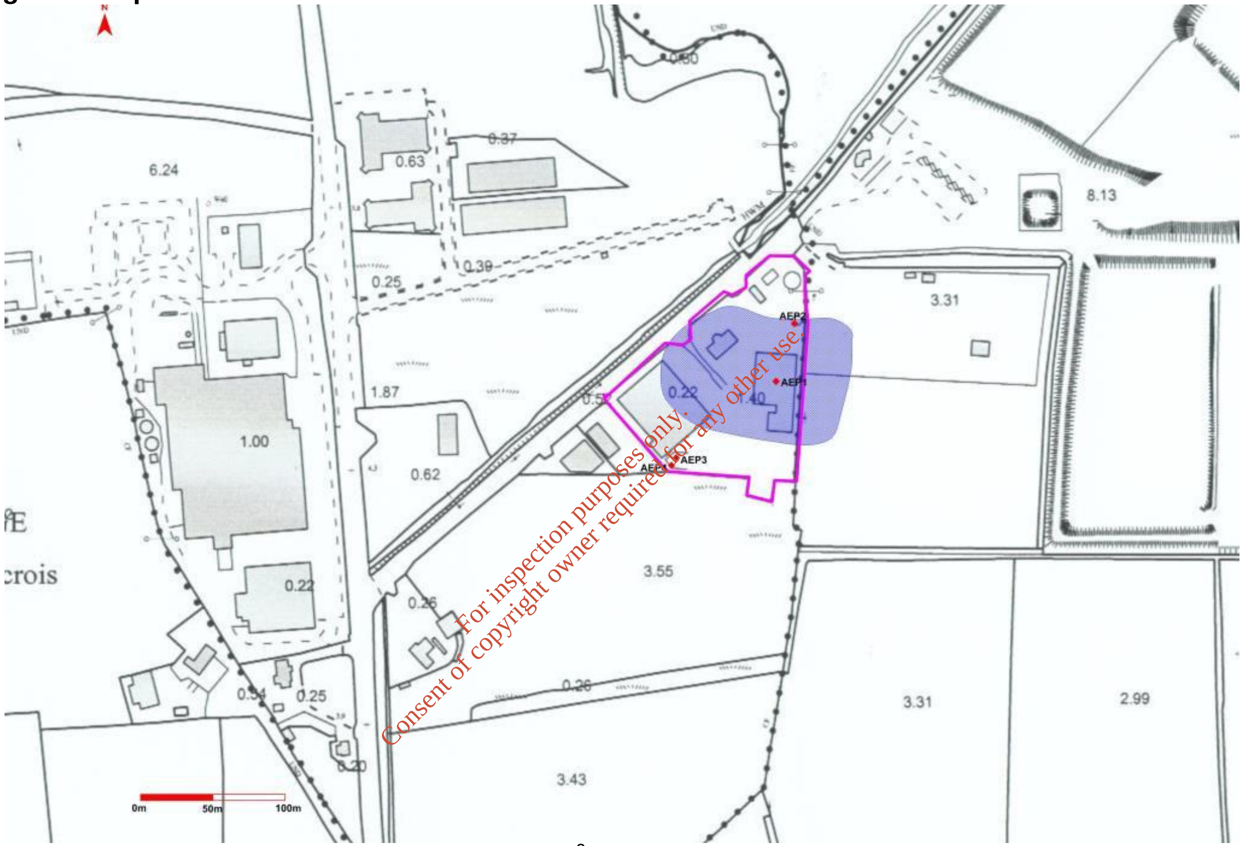

Figure 7.9. Predicted Particulate matter ground level concentration of ≤3 μg/m³ ( ) at the annual averaging period for Scenario 8.

7.10. Dispersion modelling contour plots for Scenario 9

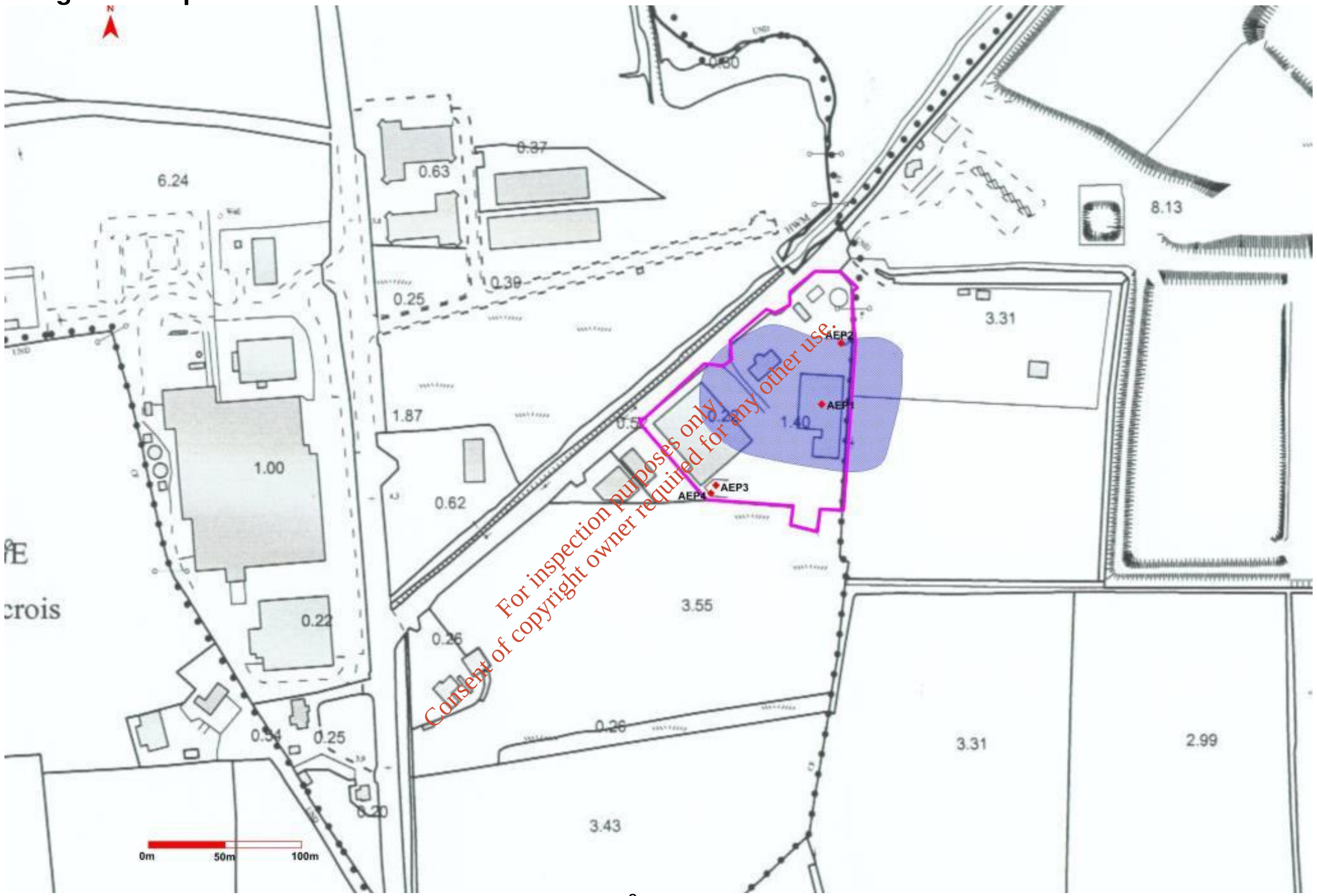

Figure 7.10. Predicted Particulate matter ground level concentration of ≤3 $\mu g/m^3$ ( ) at the annual averaging period for Scenario 9.

7.11. Dispersion modelling contour plots for Scenario 10

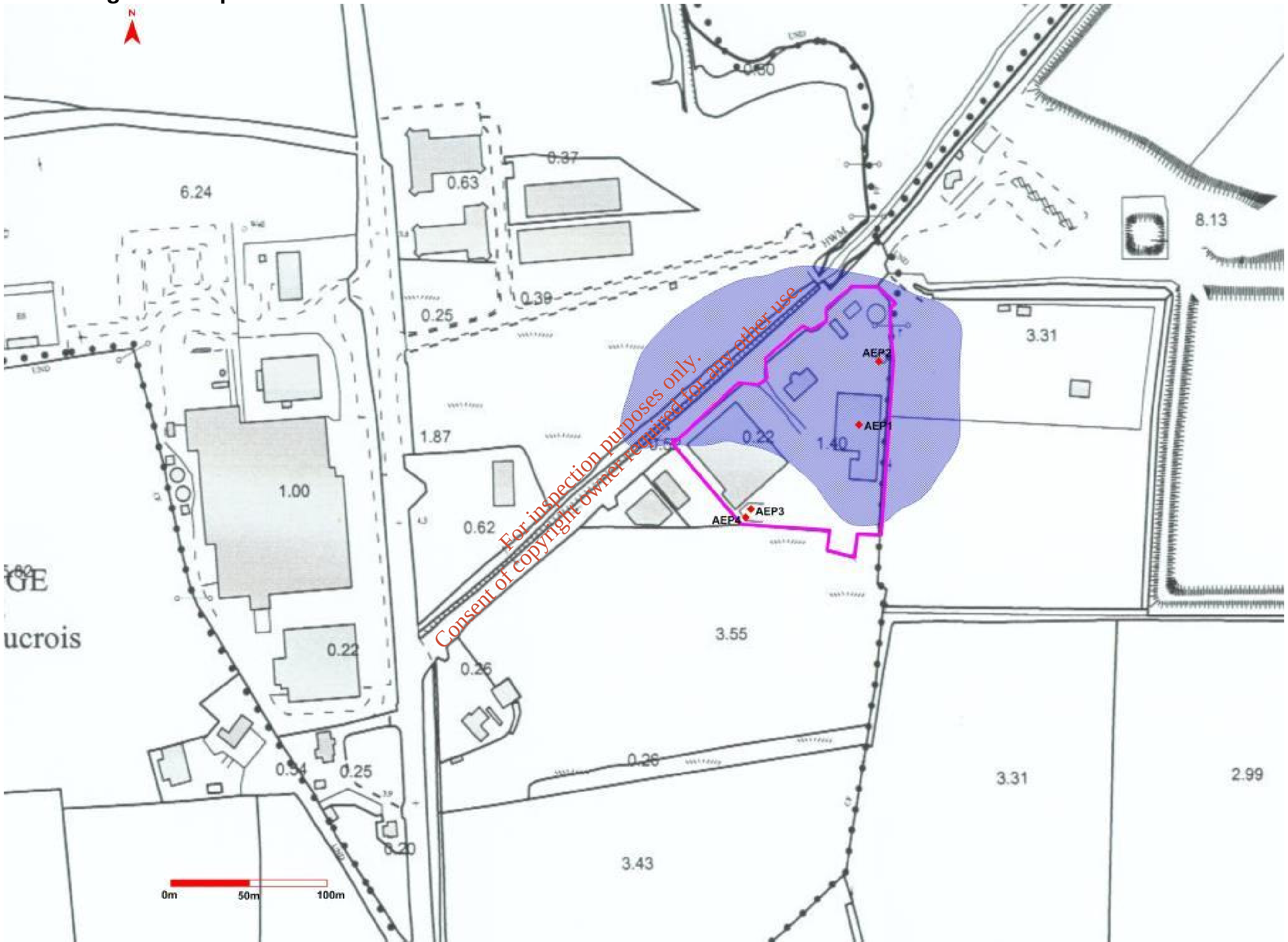

Figure 7.11. Predicted HCL ground level concentration of ≤4 µg/m^3 ( ) at the 98th percentile of 1-hour average period for Scenario 10.

7.12. Dispersion modelling contour plots for Scenario 11

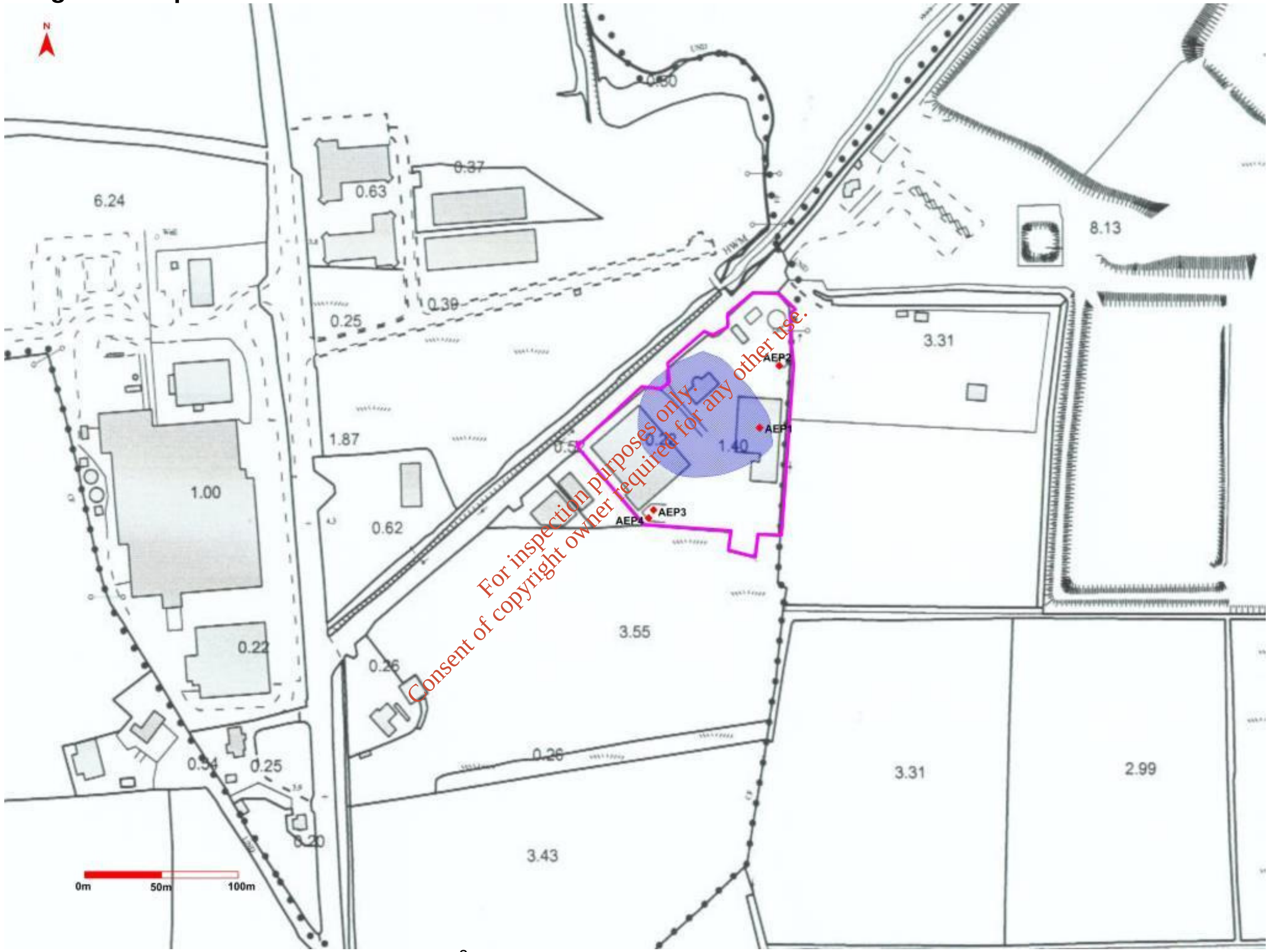

Figure 7.12. Predicted HCL ground level concentration of ≤1 μg/m³ ( ) at the annual averaging period for Scenario 11.

7.13. Dispersion modelling contour plots for Scenario 12

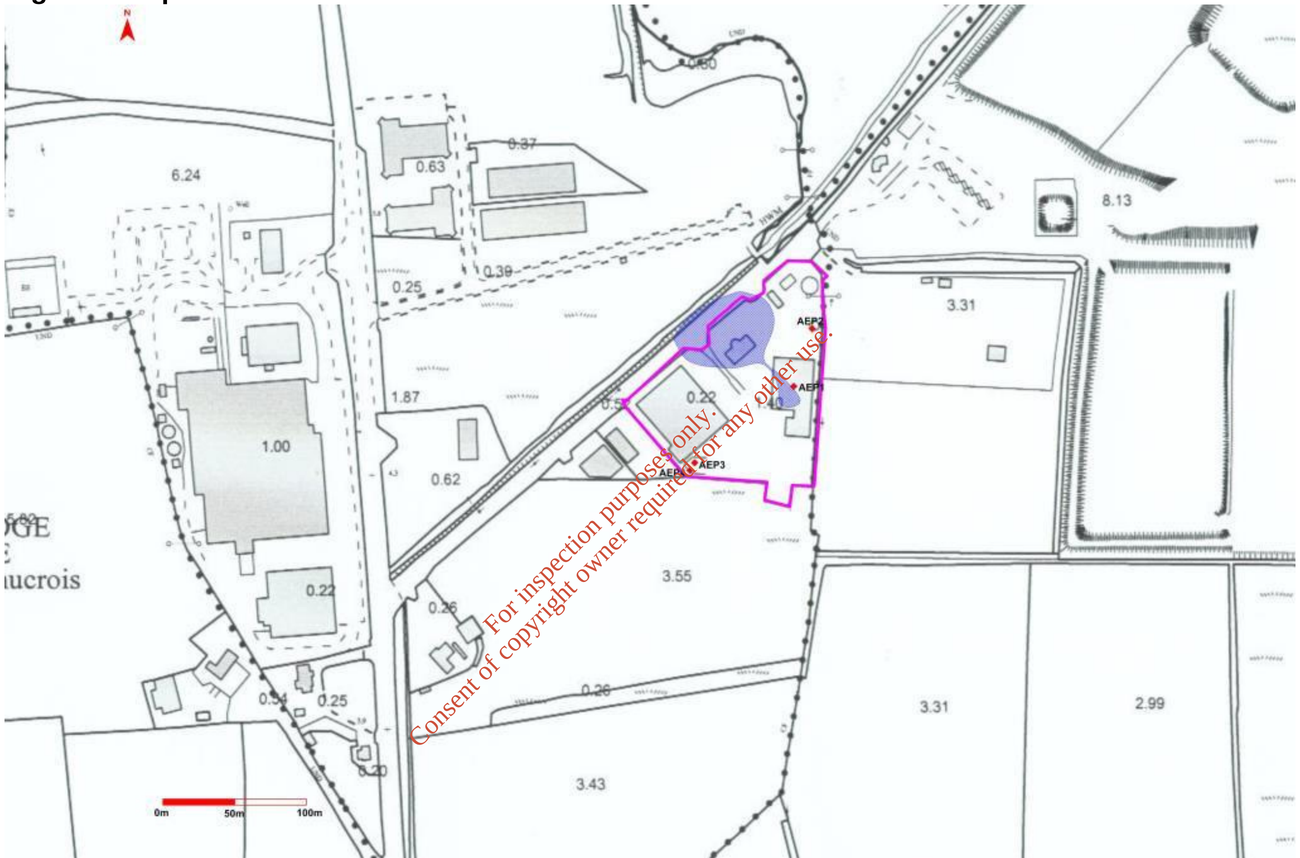

Figure 7.13. Predicted HF ground level concentration of ≤0.60 µg/m^3 ( ) at the 98th percentile of 1-hour average period for Scenario 12.

7.14. Dispersion modelling contour plots for Scenario 13

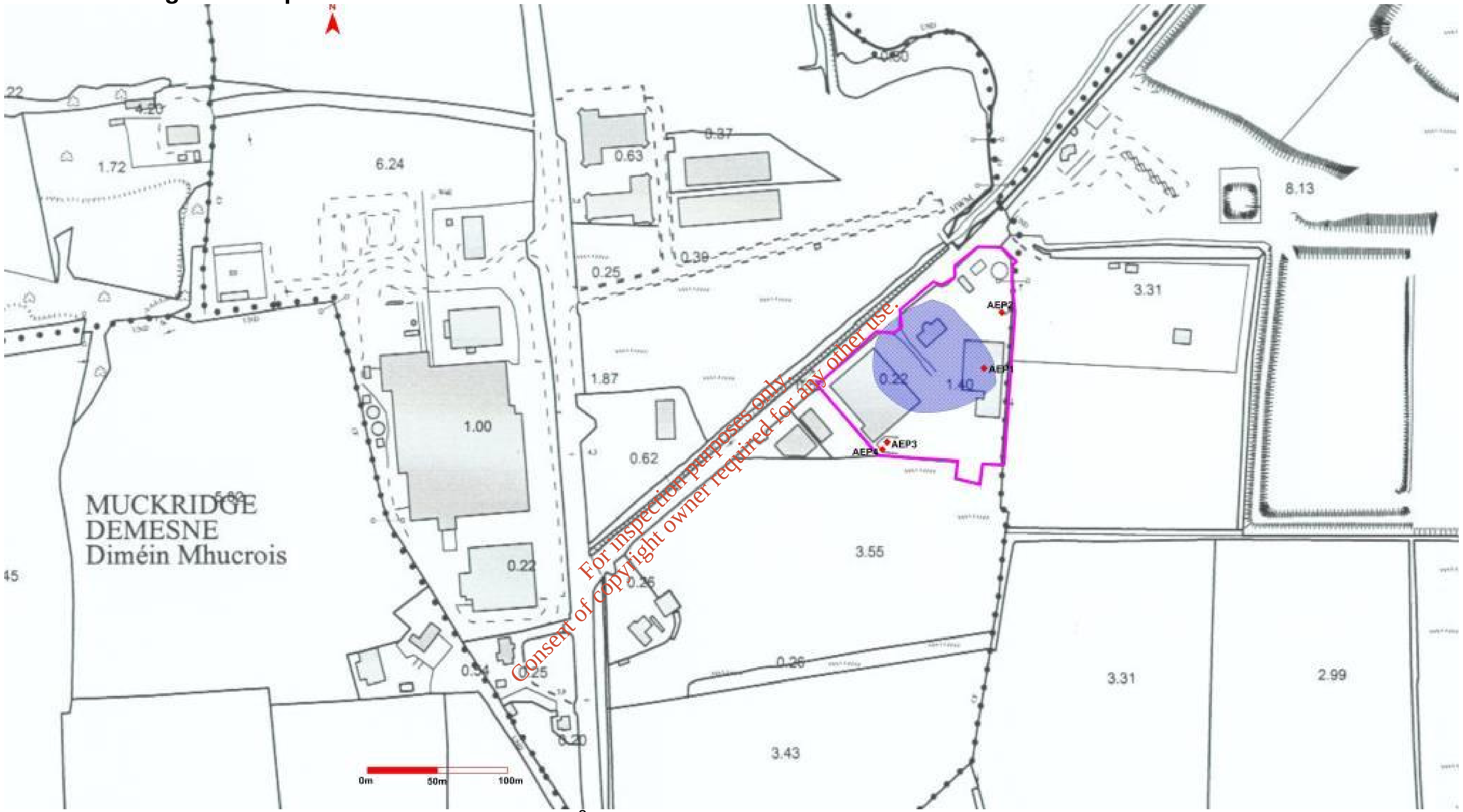

Figure 7.14. Predicted HF ground level concentration of ≤0.10 μg/m^3 ( ) at the annual averaging period for Scenario 13.

7.15. Dispersion modelling contour plots for Scenario 14

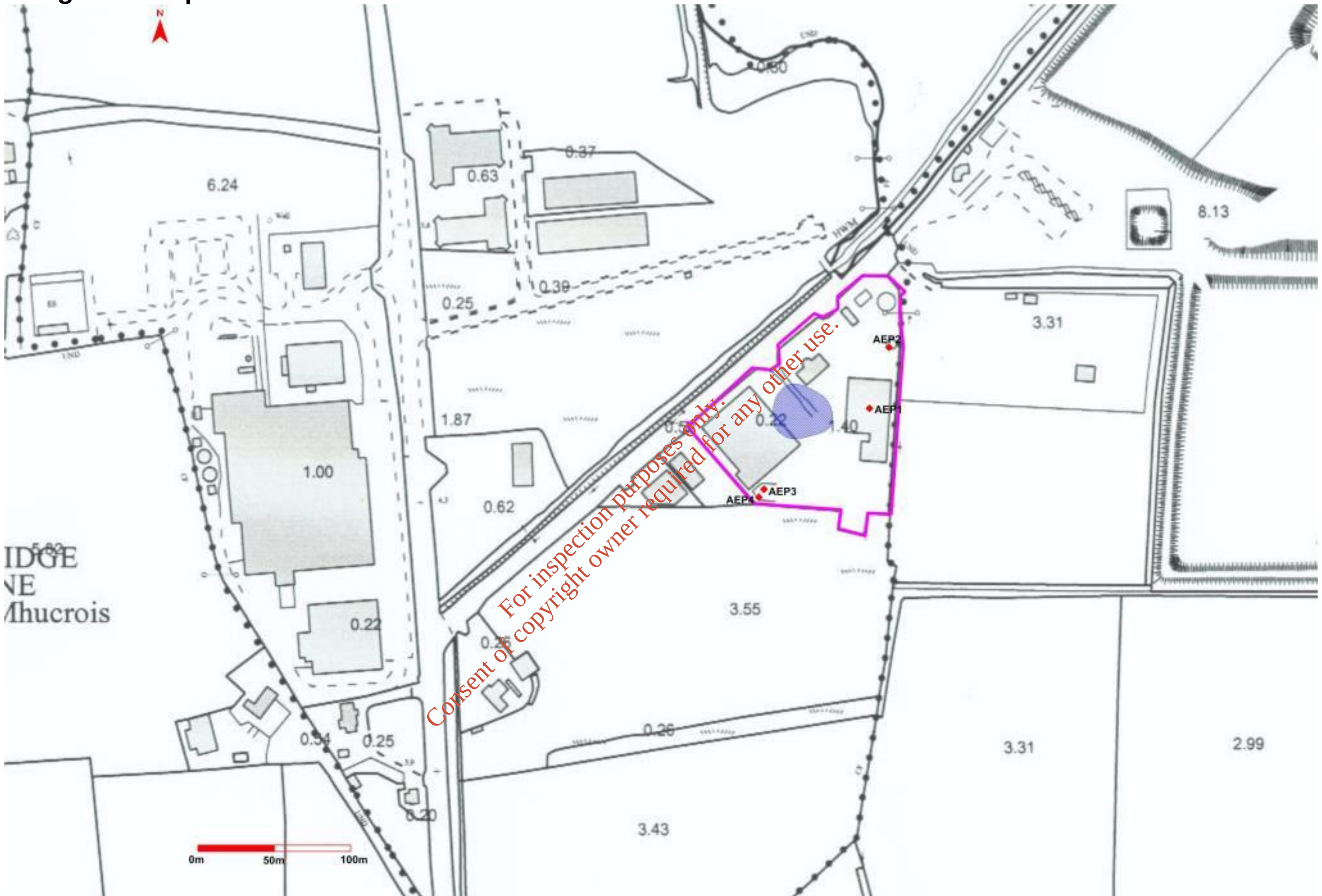

Figure 7.15. Predicted TNMVOC (as benzene) ground level concentration of ≤2.0 $\mu g/m^3$ ( ) at the annual average period for Scenario 14.

7.16. Dispersion modelling contour plots for Scenario 15

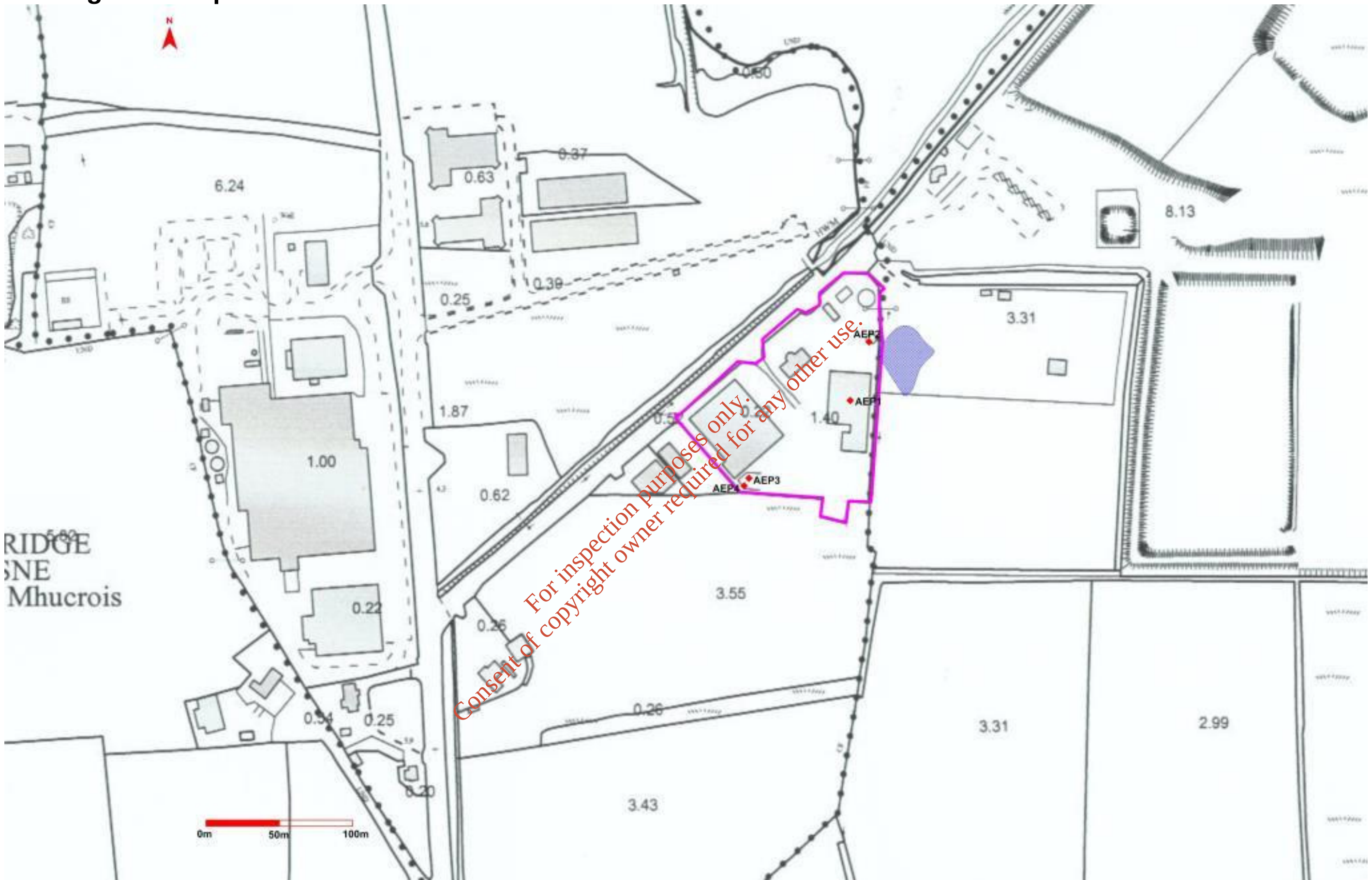

Figure 7.16. Predicted Odour ground level concentration of ≤1.50 Ou_E/m^3 ( ) at the 98th percentile of 1-hour average period for Scenario 15.

7.17. Dispersion modelling contour plots for Scenario 16

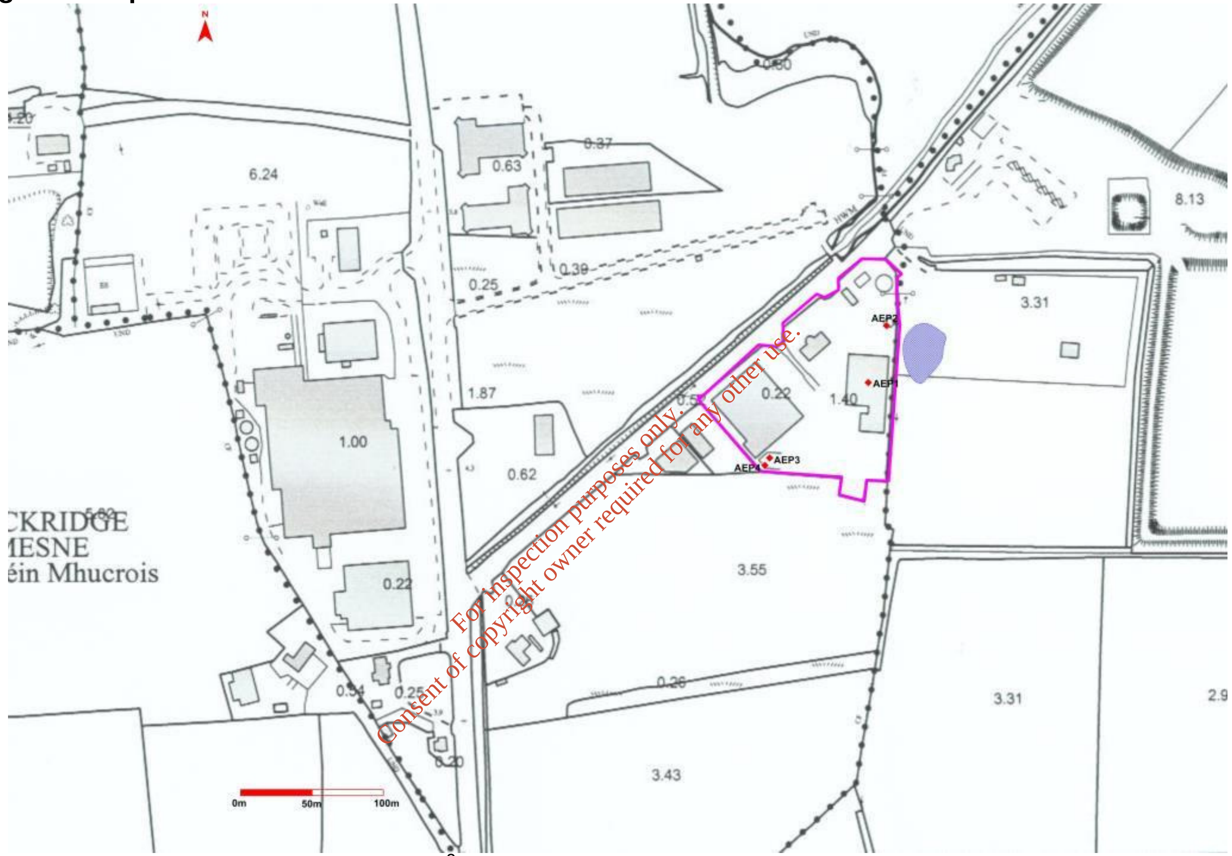

Figure 7.17. Predicted H_2S ground level concentration of ≤1.0 µg/m^3 ( ) at the annual average period for Scenario 16.

8. *Appendix II -* Meteorological data used within the Dispersion modelling study.

8.1 Meteorological file Cork airport 2008 to 2012 inclusive

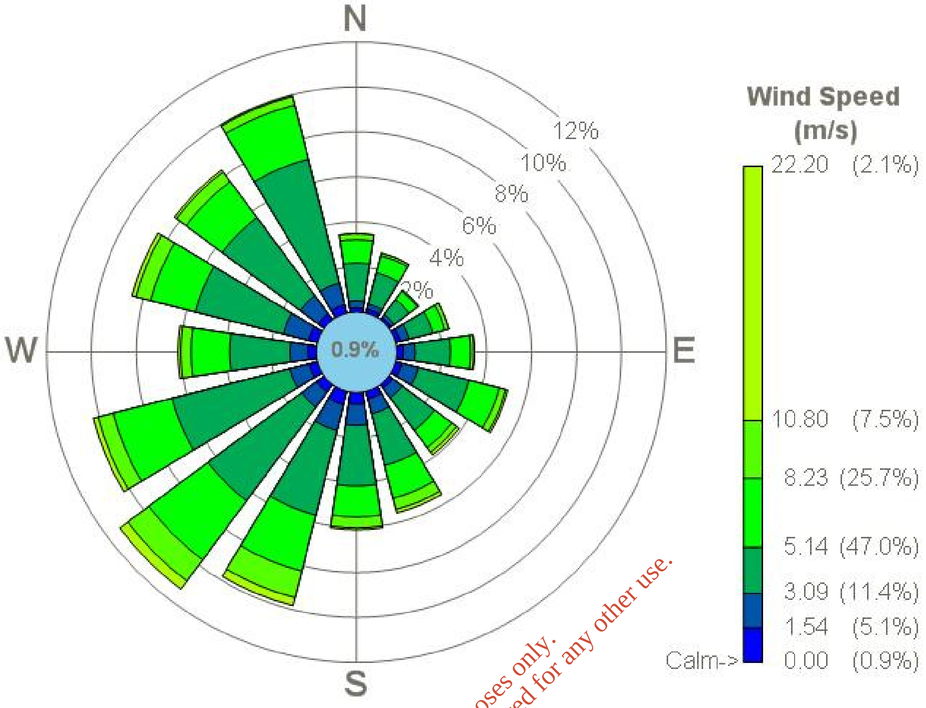

Figure 8.1. Schematic illustrating windrose for meteorological data used for atmospheric dispersion modelling, Cork 2008 to 2012 inclusive.

Table 8.1. Cumulative wind speed and direction for meteorological data used for atmospheric dispersion modelling, Cork 2008 to 2012 inclusive.

Cumulative Wind Speed Categories							
Relative Direction	**> 1.54**	**>3.09**	**>5.14**	**>8.23**	**> 10.80**	**< 10.80**	**Total**
0.0	0.18	0.31	1.68	1.03	0.26	0.01	3.48
22.5	0.18	0.22	1.44	0.78	0.12	0.00	2.75
45.0	0.12	0.17	0.83	0.46	0.05	0.00	1.64
67.5	0.20	0.41	1.09	0.55	0.18	0.00	2.45
90.0	0.28	0.53	1.58	0.89	0.15	0.03	3.45
112.5	0.28	0.76	2.33	1.38	0.30	0.10	5.15
135.0	0.20	0.52	1.81	0.96	0.26	0.15	3.89
157.5	0.34	0.69	2.36	1.50	0.51	0.16	5.57
180.0	0.51	0.95	2.69	1.38	0.49	0.08	6.10
202.5	0.60	1.18	3.88	2.56	1.22	0.37	9.83
225.0	0.42	0.83	5.19	3.28	1.17	0.45	11.33
247.5	0.37	0.89	5.40	2.70	0.70	0.22	10.28
270.0	0.35	0.81	2.68	1.72	0.47	0.12	6.15
292.5	0.40	1.16	4.04	2.05	0.68	0.18	8.50
315.0	0.33	1.00	4.32	2.00	0.53	0.11	8.29
337.5	0.38	0.99	5.69	2.48	0.39	0.05	9.98
Total	**5.13**	**11.42**	**47.02**	**25.73**	**7.47**	**2.05**	**98.82**
Calms	**-**	**-**	**-**	**-**	**-**	**-**	**0.93**
Missing	**-**	**-**	**-**	**-**	**-**	**-**	**0.24**
Total							**100.00**