Sonja Smith

From: Gavin Clabby
Sent: 03 November 2009 10:14
To: Sonja Smith
Subject: FW: W0192-03 Licence Application
Attachments: OMI Rilta Environmental OIA Ver 2.pdf

Sonja,

As discussed, please find attached Odour Assessment Report sent to me by email from Rilta Environmental. Their licence W0192-02 is currently in for review and this is info which may be relevant to odour-related conditions in any future licence. Ana said it was fine to dispense with hardcopies, providing you thought it was ok to so.

Regards

Gavin

Gavin Clabby

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From: Hussey, Colm [mailto:Colm.Hussey@rilta.ie]
Sent: 23 October 2009 16:57
To: Gavin Clabby
Subject: W0192-03 Licence Application

Gavin,

Please find the odour assessment completed by 'Odour Monitoring Ireland' attached.

Can I also make a couple of quick points in terms of the Licence content which has on occasion caused some confusion with some of our customers?

- The use of the term 'hydrocarbon waste treatment centre' has been highlighted by a number of customers when bringing in aqueous waste, so we would appreciate if both terms were referenced to and covered by a description such as 'hazardous waste treatment centre' would be used when referring to the treatment plant. (I do appreciate that the Agency may have got the 'hydrocarbon' term from the EIA we completed!)
- The use of EWC codes as detailed in the current Licence has also caused confusion with customers; for example 'waste containing oil' is given the EWC code 16 07 08, which is actually 'tank cleaning waste containing oil'. As discussed on the phone earlier, due to the 'process' derived nature of EWC codes, we can end up with a vast array of waste streams coming in for treatment. Therefore, I would ask that the Agency omit the reference to EWC codes from the main part of Table A2 and refer to Attachment H.1 of the application (as is the current situation).
- In a similar vein, many customers query that, although we are Licenced to accept 'hazardous waste', it is not defined as such what hazardous wastes may be treated. I would ask that the Agency would include a footnote in Table A2 to indicate that aqueous waste streams as detailed in 'Attachment H.1' of the application may be accepted for treatment subject to laboratory approval.

Not so much of an existing issue is that of standard methods of analysis (chemical or otherwise) which may be referenced Schedule C. As we have done much investigative work into oil treatment/analysis in particular, we have found that different regulatory bodies may reference different standard analysis methods, which although almost identical, may cause some confusion to certain bodies. As Rilta, in the main have adopted the 'ASTM' methods (though not exclusively), we would ask that the Agency will allow (whether it be by 'footnote' or otherwise) that a suitable alternative or equivalent standard method may be used, when testing groundwater/effluent/oil etc.

I realise that these are fairly minor points, but I would like to nip some issues in the bud before a PD is reached. Should you require any clarification on the above, by all means give me a shout on 0879176264.

Best regards,

Colm

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ODOUR IMPACT ASSESSMENT OF RILTA ENVIRONMENTAL LTD LOCATED IN GREENOGUE BUSINESS PARK, RATHCOOLE COUNTY DUBLIN

PERFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF RILTA ENVIRONMENTAL LTD

PREPARED BY:	Dr. Brian Sheridan
ATTENTION:	Mr. Colm Hussey
DATE:	14th May 2009
REPORT NUMBER:	2009A175 (2)
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1. Executive Summary

Odour Monitoring Ireland was commissioned by the Rilta Environmental Ltd to carry out an odour impact assessment of the existing operations carried out in Rilta Environmental Ltd located in Greenogue Business Park, Rathcoole, Co. Dublin. The purpose of this assessment was to determine the potential for the generation of odour impact on the surrounding population from operations at waste transfer station and processing facility. The existing plant is licensed in accordance with Waste licence W0192-02 to receive up to 111,000 tonnes of non hazardous / hazardous waste streams for processing / transfer at the facility. The system consists of a number of distinct reception buildings and equipment. In terms of odours, the liquid waste reception building and the drum division are most significant. Other minor sources include the sludge drainage pit, cleaning of truck wash and contaminated soil storage with each of these sources easily controllable through on site management of open doors and clean down. Odours from the liquid reception building are mainly as a result of tankered liquid which is deposited within this building for chemical waste water treatment. Odours from the drum division are made up of low odour intensity solvent odours from the Paint spray booth stack, drying oven stack and drum washer stack. In addition the reception of certain drum types which include highly odoriferous perfumes are also a significant source of odours. Odour that escape to the headspace of the each building are quickly flushed from the building through open doorways as a result of wind pressure effects on the building forcing the odourous air from the building through the open doorway and also as a result of thermal effects upon the building air headspace. These two doorways are normally operated open. The drum division building is fitted with 5 roof mounted ventilation fans each capable of expelling a minimum of 43,000 m^3/hr of building headspace air. These are currently operated for 2 hours each morning and such odourous headspace air from the building and expel at roof level to atmosphere.

In terms of the odour audit, six odour sources were assessed to include the Paint spray booth stack, drum washer stack, drying tunnel stack, sludge drainage pit (area source), building headspace of the liquid waste reception building and drum division. Odour emission rates were calculated from measured olfactometry data and measured and estimated volumetric airflow rate data. The positive displaced volumetric airflow rate from the building was calculated using building characteristics and input factors from the Warren Springs model while the volumetric airflow rate for the five roof mounted fans was taken from fan specifications. All other sources were measured in accordance with EN13284-1:2002 including a review do previously measured data (i.e. compliance monitoring). Odour dispersion modelling using AERMOD Prime (07026) was used to perform an impact assessment of the existing operations and proposed operations assuming that certain management techniques are implemented.

Following measurement and development of odour emission rates, two data sets for odour emission rates were calculated to determine the potential odour impact of Rilta Environmental Ltd during its existing and proposed operations with the incorporation of addition odour management techniques. These included:

Ref Scenario A: Predicted overall odour emission rate from existing Rilta Environmental Ltd named site operations (*see Table 4.2*).

Ref Scenario B: Predicted overall odour emission rate from Rilta Environmental Ltd operations with the incorporation of odour management protocols (*see Table 4.3*).

Aermod Prime was used to determine the overall odour impact of Rilta Environmental Ltd operation located in Rathcoole, Co. Dublin as set out in odour impact criteria presented in *Table 3.1* and *3.2*. The output data was analysed to calculate:

Ref Scenario A:

- Predicted odour emission contribution of overall existing Rilta Environmental Ltd operation (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (*see Figure 8.2*).
- Predicted odour emission contribution of existing doorways (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (*see Figure 8.3*).
- Predicted odour emission contribution of existing Sludge drainage pit (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (*see Figure 8.4*).
- Predicted odour emission contribution of existing Fans 1 to 5 (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.5*).
- Predicted odour emission contribution of existing emission points A1 to A3 (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.6*).

This odour impact criterions were chosen for the existing Rilta Environmental Ltd operations in order to ascertain the level of existing impact to the surrounding industrial population in the vicinity of the facility.

Ref Scenario B:

- Predicted odour emission contribution of overall proposed Rilta Environmental Ltd operation with odour management protocols implemented (*see Table 4.3*) to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (*see Figure 8.7*).
- Comparison between predicted odour emission contribution of overall existing and proposed Rilta Environmental Ltd operation to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (*see Figure 8.8*)

These computations give the odour concentration at each Cartesian grid receptor location that is predicted to be exceeded for 2% (175 hours) of six years of hourly sequential meteorological data (Dublin Airport 2001 to 2006). Dublin Airport meteorological stations was used as it provided for worst case dispersion estimates. Casement Aerodrome suffers severely from south westerly / north easterly plume spread which biases the results especially when assessing receptors in close proximity to a site. Individual sensitive receptors and 20 metre spaced boundary receptors were also established within the modelling assessment for each scenario.

It was concluded from the study that:

<u>Scenario A</u>

- In accordance with odour impact criterion in *Table 3.2*, and in keeping with current recommended odour impact criterion in this country, it is predicted that receptors in the vicinity of the existing Rilta Environmental Ltd operation will perceive long-term odour impacts. Receptors located to the North, East, South and West of the facility will perceive an odour concentration greater than 3.0 Ou_E/m^3 at the 98th percentile of hourly averages for 6 years of hourly sequential meteorological data when the facility is in operation (*see Figure 8.2*).
- The predominant odour impact from the existing facility is a result of fugitive odour emissions from the tankered liquid reception building and drum division building open

doorways as a result of the positive displacement of odours from the headspace of the building and sludge drainage pit (*see Figure 8.3 and 8.4*). Maximum ground level concentrations of up to 68 and 27 Ou_E/m^3 at the 98th percentile of hourly averages for 6 years of hourly sequential meteorological data for open doorways and the sludge drainage pit, respectively. Ground level impact concentrations from the roof mounted fans 1 to 5 and emission points A1 to A3 are less significant with significant lower impact concentrations predicted in the vicinity of the facility (i.e. maximum ground level concentrations of 2.37 and 3.0 Ou_E/m^3 at the 98th percentile of hourly averages for six years of hourly sequential meteorological data for emission points Fan 1 to 5 and A1 to A3 grouped) (*see Figures 8.5 and 8.6*).

Scenario B

- A number of initial mitigation measured are proposed to reduce the odour impact from the facility. Following implementation, the effectiveness of these measures will need to be assessed through close examination of the complaints records generated by the close by receptors. Therefore it is essential that the proposed mitigation measures are implemented in full from the start in order to clearly define the improvements in odour impact in the immediate area. This would appear to be the most practical approach from the start which may negate the installation of expensive odour abatement equipment. These included:
  1. Ensuring that all doorways are maintained in a closed position and only opened when a truck needs to assess the facility building. The door should be closed if the truck can fit inside the building. This is especially important for the liquid waste reception building due to its close proximity to the complaining neighbour.
  2. Ensure the sludge drainage pit is cleaned up immediately following tipping of sludge. If this cannot be achieved then the sludge area should be covered with flexible cover. The area should ideally be operated clean due to its close proximity to the complaining neighbour.
  3. As doors will be closed it will be necessary to operate the roof fans for longer periods of time to ensure the air quality within the headspace of the building is in line with HSE requirements. In order to take account of this increased odour concentration within the headspace of the building and following consultation with Rilta Environmental staff, the model assessed the likely impact of emissions if Fans 1 to 5 were operated for a period of 4 hours as opposed to the period of 2 hours which currently occurs on the existing site.
- In accordance with odour impact criterion in *Table 3.2*, and in keeping with current recommended odour impact criterion in this country, a significant reduction in the perceived odour impact will be achieved in the vicinity of Rilta Environmental Ltd operations following the implementation of proposed odour management protocols. As can be observed in *Figures 8.7 and 8.8*, there will be a significant reduction in the odour plume spread as a result of changing the odour emission source characteristics. Odour generated within the facility will be expelled at an emission pint height of approximately 11 metres which lends itself to better dispersion and dilution. Receptors located to the west and North West of the facility should note an improvement in perceived odour concentration.
- In order to assess on the ground the effectiveness of this approach, careful interaction between the complaining receptors and Rilta Environmental Ltd staff will be required. These minimisation scenarios will need to be implemented in full and maintained in operation at all times in order to observe the improvements. Following an assessment period of 2 months and analysis of trends in complaints data, the effectiveness can be assessed and this may negate the implementation of expensive negative air extraction upon the liquid reception building where the most significantly offensive odours are generated at present.

The following recommendations were developed during the study:

1. Odour management, minimisation and mitigation procedures as discussed within this document in general will need to be implemented at the operating facility in order to minimise any odour impact in the surrounding area.
2. Maintain existing good housekeeping practices at high level (i.e. keep yard area clean, weight bridge clean, closed-door management strategy (including personnel doors) to eliminate positive displacement of odours from building, maintain sludge drainage pit area clean (always) and implement an odour management plan for the operators of the facility (i.e. to ensure full implementation and maintenance of odour management systems).
3. Ensure interaction between Rilta Environmental Ltd staff and complaining receptors to assess effectiveness of implemented strategy. If notable difference not achieved, then consideration towards enclosing of tankered liquid storage area and implementation of negative air extraction is performed to minimise the escape of these offensive odour.
4. Develop a strategy upon the drum division to minimise the release of perfumes from a single waste stream in the drum division. The strategy of handling and processing of this waste stream should be performed in such a manner to minimise emissions in general from this waste stream during handling.

2. Introduction

Odour Monitoring Ireland was commissioned by Rilta Environmental Ltd to perform an odour audit and predictive odour impact assessment of the existing facility utilising dispersion modelling software Aermod Prime (ver. 07026). In addition, a predictive modelling scenario run was completed for proposed odour minimisation steps for the facility operations. Like the majority of industries, the operation of the current waste transfer and processing facility is faced with the issue of preventing odours causing impact to the public at large.

In order to obtain site specific odour emission data for the site, an odour audit was performed utilising odour sampling and measurement techniques in accordance with EN13725:2003 European Standard on olfactometry. Utilising the existing site design and site specific odour emission data; dispersion-modelling techniques were used to establish the predictive odour impact on the surrounding population for the existing operations and following the implementation of a number of key odour minimisation steps.

Two odour emission scenarios were developed to take account of the existing operation and proposed design with implemented odour minimisation strategies. These odour emission rates and specified source characteristics were inputted into Aermod Prime in order to determine the overall odour impact from the existing and proposed facility design. Individual source modelling was performed in order to assess which odour source(s) contributed greatest to the odour impact area in the existing scenario.

It was concluded from the study that the existing operating waste transfer and processing facility will result in long term odour impact during routine operations (*see Figure 8.2*). The main source contribution to this odour impact was fugitive emissions from open doorways on the tankered liquid reception building and drum division building grouped (*see Figure 8.3*) and the sludge drainage pit (*see Figure 8.4*). Emissions from the operation of the roof Fans 1 to 5 and scheduled emission points A1 to A3 were less significant (*see Figures 8.5 and 8.6*). Following the implementation of odour management and minimisation protocols as recommended in this report, it is predicted that the overall odour impact from the facility can be significantly reduced (*see Figures 8.7 and 8.8*). In order to assess the effectiveness of the proposed odour minimisation strategy, close liaison between the facility management and the complaining receptors will be required. Full implementation of the closed door management strategy and clean operation of the sludge drainage pit will be required to observe the benefits. This should be assessed for a minimum period of 2 months following which the requirements of implementation of negative air ventilation from the offensive odours from the tankered liquid reception building can be decided upon. This assessment was performed in accordance with currently recommended international guidance and practice for the assessment of odours.

3. Materials and Methods

This section will describe the materials and methods used throughout the study period.

3.1. Odour sampling and analysis

3.1.1. Collection of point source odour samples from emission sources A1, A2, A3 and buildings headspace

In order to obtain air samples for odour assessment, a static sampling method was used where air samples were collected in 60 litre pre-conditioned Nalophan^{NA} bags using a vacuum sampling device over a thirty-minute period. The sampler operates on the 'lung principle', whereby the air is removed from a rigid container around the bag by a battery powered SKC vacuum pump at a rate of 2 *l* min^{-1}. This caused the bag to fill through a stainless steel and PTFE tube whose inlet is placed in the odour stream, with the volume of sample equal to the volume of air evacuated from the rigid container.

3.1.2. Area source – sludge drainage pit

In order to measure the odour emission rate from lagoon and area odour surfaces a calibrated wind tunnel method was used. This calibrated sampling hood allowed for the accurate determination of odour emission rate from the surface of the tanks. In combination with the point source static sampling method a 60-litre sample over a thirty-minute period was obtained (Jiang et al., 2002, USEPA, 1998).

3.1.3. Olfactometry

Olfactometry using the human sense of smell is the most valid means of measuring odour (Dravniek et al, 1986) and at present is the most commonly used method to measure the concentration of odour in air (Hobbs et al, 1996). Olfactometry is carried out using an instrument called an olfactometer. Three different types of dynamic dilution olfactometers exist:

- Yes/No Olfactometer
- Forced Choice Olfactometer
- Triangular Forced Choice Olfactometer.

In the dynamic dilution olfactometer, the odour is first diluted and is then presented to a panel of screened panellists of no less than four (CEN, 2003). Panellists are previously screened to ensure that they have a normal sense of smell (Casey et al., 2003). According to the CEN standard this screening must be performed using a certified reference gas *n*-butanol. This screening is applied to eliminate anosmia (low sensitivity) and super-noses (high sensitivity). The odour analysis has to be undertaken in a low odour environment such as an air-conditioned odour free laboratory. Analysis was performed within 12 hours of sampling.

3.1.4. Measurement of odour threshold concentration

A T08 dynamic dilution olfactometer was used to determine the odour threshold concentration of the emission sources. The odour threshold concentration is defined as the dilution factor at which 50% of the panel can just detect the odour. Only those panel members who pass screening tests with *n*-butanol (certified reference gas, CAS 72-36-3) and who adhered to the code of behaviour will be selected as panellists for olfactometry measurements (CEN, 2003).

The odour threshold concentration is calculated according to the response of the panel members and is displayed in Ou_E m^{-3}, which referred to the physiological response from the panel equivalent to that elicited by 123μg m^{-3} n-butanol evaporated in one cubic metre of neutral gas (CEN, 2003). Odour units are considered a dimensionless unit, but the pseudo-dimensions of Ou_E m^{-3} have been commonly used for odour dispersion modelling, in place of 'grams m^{-3}' (Sheridan, 2003).

3.1.5. What is an odour unit?

The odour concentration of a gaseous sample of odourant is determined by presenting a panel of selected screened human panellists with a sample of odourous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units (Ou_E m^{-3}).

Simply, one odour unit is the concentration of an odourant, which induces an odour sensation to 50% of a screen panel

Although odour concentration is a dimensionless number, by analogy, it is expressed as a concentration in odour units per cubic metre (Ou_E m^{-3}), a term which simplifies the calculation of odour emission rate. The European odour unit is that amount of odourant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and is equivalent to 123ug of n-butanol evaporated in one cubic meter of neutral gas at standard conditions (CEN, 2003).

3.1.6. Measurement of volumetric airflow rate

Using a calibrated L/S type pitot manometer, the volumetric airflow rate of odourous air that passes through exhaust stacks of emission point A1, A2 and A3 was determined in accordance with ISO EN13284-1:2002. For emission points Fans 1 to 5, fan specifications were used to determine the maximum airflow volume from each fan.

In order to ascertain the volumetric airflow rate as a result of the wind positive pressure on the building envelope which will result in fugitive air release through the open doorways (as they are operate in open mode normally), an adoption of the Warren Springs and Albright and Hellickison model was used whereby, the total area of potential release was estimated based on the door open size and fitted to the model equation with an average high wind speed for this area of Ireland. An average wind flow of 5 m/s was taken from a combination of meteorological file analysis and data presented by the Irish Meteorological Society.

The following equation was used: Q_1=0.75 AU/2

Where Q_1 = infiltration rate (m^3/s)
A = infiltration area (m^2)
U = wind speed (m/s)
2 = half of the door is assumed to be an inlet and half of the door is assumed to be an outlet

The overall volumetric airflow rate from each identified process is presented in *Table 4.1*.

3.1.7. Odour emission rate calculation.

The measurement of the strength of a sample of odourous air is, however, only part of the problem of quantifying odour. Just as pollution from a stack is best quantified by a mass emission rate, the rate of production of an odour is best quantified by the odour emission rate.

For a chimney or ventilation stack, this is equal to the odour threshold concentration (Ou_E 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 threshold odour limit (Ou_E s^{-1}). The odour emission rate can be used in conjunction with dispersion modelling in order to estimate the approximate radius of impact or complaint (Hobson et al, 1995).

The overall odour emission rate from each identified process is presented in *Table 4.3 and 4.4* for each of Scenarios A and B.

3.2. Dispersion modelling

3.2.1. Atmospheric dispersion modelling of odours: 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 odours 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 odour emission rate from the source is known, (Ou_E 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 odours and to correlate with complaints; secondly, in a "reverse" mode, to estimate the maximum odour emissions which can be permitted from a site in order to prevent odour complaints occurring; and thirdly, to determine which process is contributing greatest to the odour 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, odour control systems and intensive agricultural processes (Sheridan et al., 2002).

3.2.2. AERMOD Prime

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).

3.2.3. Establishment of odour impact criterion for odours

Odours from waste transfer and processing operations arise mainly from the volatilisation of odourous gases from:

- The handling of the inlet waste material,
- Emissions and volatilisation of odours from the processing activity itself.
- Inefficient odour management and minimisation systems operation and design including, poor housekeeping, open doorways, poor building fabric in terms of air tightness, inefficient gas extraction and odour management system design and operation.

Some of the compounds emitted are characterised by their high odour intensity and low odour detection threshold (*see Section 9.5*). A sample of a report carried out in the Netherlands, United Kingdom and USA ranking generic and environmental odours according to the like or dislike by a group of people professionally involved in odour management is illustrated in *Table 3.1* (EPA, 2001, Environment Agency, 2002). Although not scientifically based, it is interesting to observe the results of such studies.

Table 2.1. Ranking of environmental odours according to like and dislike (i.e. similar odour hedonic tone).

Generic odours	**Hedonic score[1] Dravnieks, 1994**	**Ranking[2]**	**Ranking[2]**	**Ranking[2]**	**Environmental odours**	**Ranking[2]**	**Ranking[2]**	**Ranking[2]**
Descriptor	**USA**	**UK median**	**UK mean**	**NL mean**	**Descriptor**	**NL mean**	**UK mean**	**UK Median**
Roses	3.08	4	4.4	3.4	*Bread Factory*	**1.7**	**2.5**	**1**
Coffee	2.33	3	4.5	4.6	Coffee Roaster	4.6	3.9	2
Cinnamon	2.54	4	4.9	6	Chocolate Factory	5.1	4.6	3
Mowed lawn	2.14	4	4.9	6.4	Beer Brewery	8.1	7.7	6
Orange	2.86	4	5.2	5.8	**Fragrance & Flavour Factory**	**9.8**	**8.5**	**8**
Hay	1.31	7	6.9	7.5	Charcoal Production	9.4	9.2	8
Soap	0.96	8	7.8	7.3	Green Fraction composting	14	10.3	9
Brandy		9	8.8	7.8	Fish smoking	9.8	10.5	9
Raisins	1.56	8	8.8	7.9	Frozen Chips production	9.6	11	10
Beer	0.14	9	9.5	9.3	Sugar Factory	9.8	11.3	11
Cork	0.19	10	10	10.5	**Car Paint Shop**	**9.8**	**11.7**	**12**
Peanut Butter	1.99	10	10.4	11.1	**Livestock odours**	**12.8**	**12.6**	**12**
Vinegar	-1.26	14	13.3	14.8	Asphalt	11.2	12.7	13
Wet Wool	-2.28	14	14	14.1	Livestock Feed Factory	13.2	14.2	15
Paint	-0.75	15	14	14.4	**Oil Refinery**	**13.2**	**14.3**	**14**
Sauerkraut	**-0.6**	**15**	**14.6**	**12.8**	Car Park Bldg	8.3	14.4	15
Cleaning Agent	**-1.69**	**15**	**14.7**	**12.1**	**Wastewater Treatment**	**12.9**	**16.1**	**17**
Sweat	-2.53	18	16.6	17.2	Fat & Grease Processing	15.7	17.3	18
Sour Milk	-2.91	19	18	17.5	Creamery/milk products		17.7	10
Cat's Pee	-3.64	19	18.8	19.4	Pet Food Manufacture		17.7	19
Sewer odour	**-3.68**	-	-	-	Brickworks (burning rubber)		17.8	18
-	-	-	-	-	Slaughter House	17	18.3	19
-	-	-	-	-	**Landfill**	**14.1**	**18.5**	**20**

Notes: *Source: Draft Odour H4-Part 1, Integrated Pollution Prevention and Control (IPPC). (2004). Environment Agency, Bristol, UK.*
[1] The higher the positive "value", the more pleasant the odour descriptor and similarly below, the greater the negative value, the more unpleasant the odour descriptor
[2]Ranking in order of dislike ability.

There are a number of processes detailed in *Table 2.1* which based on experience and measurements such odours would have similar dislike ability to the facility in question. As the facility handles solvent based product, fragrance and flavourings, landfill leachate and other waste water such as oil sludge, a dislike ability between 9.8 and 14.10 would fit the model. As can be observed from *Table 3.1*, and using the Dutch based ranking system, Fragrance and Flavouring, Car Paint shop, Oil refinery, and Wastewater treatment plants have a mean raking of between 9.8 and 13.20 in terms of dislike. Other odours with similar mean dislike ranking include Livestock odour (i.e. intensive pig/poultry production). Generic odours such as Sauerkraut and Cleaning agents have also similar dislike abilities to these odours. Dravnieks *et al.*, 1994 performed hedonic tone ranking of generic odours including Sauerkraut, Cleaning agents and Sewer odour and obtained a mean hedonic score of –0.60, –1.69 and –3.68, respectively. There is a clear trend in these studies whereby both mean ranking of dislike ability and hedonic scoring provide subjective ranking of odours and their respective ability to cause offensive/complaint. It would appear that when the hedonic tone of the odour reached a specific level, the odour hedonic tone decreases rapidly to small increases in odour threshold concentration (i.e. small increases in odour threshold concentrations will cause a large change in the perceived odour offensiveness). Such trends have been observed by Odour Monitoring Ireland in a laboratory-based environment. It has been suggested that when an odour reached an odour intensity level of 3 (distinct) and a mean hedonic score of –2 (unpleasant), an odour will become offensive and cause odour complaint. This scoring level can be assessed through the use of olfactometric techniques in a laboratory based environment whereby the odour concentration level corresponding to an odour intensity level of 3 and a hedonic tone of –2 can be determined. This methodology of analysis is very important in spot-checking odour abatement systems. By implementing hedonic tone assessment techniques on source odour samples, the odour threshold concentration responsible for causing on odour complaint following dynamic dilution can be determined. VDI Guidelines 3882 Part 2 – Determination of odour Hedonic tone specifies a methodology for such an assessment.

3.2.4. Commonly used odour annoyance criteria utilised in dispersion models

An odour impact criterion defines the odour threshold concentration limit value above baseline in ambient air, which will result in an odour stimulus capable of causing an odour complaint. There are a number of interlinked factor which causes a nearby receptor (i.e. resident) to complain. These include:

- Odour threshold concentration, odour intensity and hedonic tone-defined measurable parameters at odour source,
- Frequency of odour-how frequently the odour is present at the receptor location,
- Duration of odour-how long the odour persists at the receptor location,
- Physiological-previous experiences encountered by receptor, etc.

By assessing these combined interlinked factors, the ability for a facility to cause odour complaint can be determined. As odour is not measurable in ambient air due to issues in sampling techniques, limit of detections for olfactometers and the inability to monitor continuously, therefore dispersion models become useful tools in odour impact assessments and odour risk analysis. Dispersion modelling also allows for the assessment of proposed changes in processes within the facility without actually having to wait for the processes to be changed (i.e. predictive analysis).

When utilising dispersion models for impact assessment, specific impact criterion (odour concentrations) need to be established at receptors. For odour assessment in general terms, this is called an odour impact criterion, which defines the maximum allowable ground level concentration (GLC) of odour at a receptor location for a particular exposure period (i.e. $\leq 3.0\ Ou_E\ m^{-3}$ at the 98^{th} percentile of hourly averages). Commonly used odour annoyance criteria in Ireland, UK, Netherlands and other world wide countries are illustrated in *Table 3.2*. The odour concentration, % odour exposure at this odour concentration, the dislike ability, the dispersion model and industry it applies are presented (*see Table 3.2*).

Table 2.2. Odour annoyance criterion used for environmental odours.

Country	Odour conc. limit ($Ou_E\ m^3$)	Percentile value (%)	Average time (minutes)	Industry type	Dispersion model	Type area it applies	Dislike ability (see *Table 3.1*	Application of criterion
Ireland	≤6.0[1]	98th	60	Intensive pig production	Complex 1	Limit value for new pig production units	12.80	For all pig production units in Ireland
Ireland	≤3.0[1]	98th	60	Intensive pig production	Complex 1	Limit value for existing pig production units	12.80	For all pig production units in Ireland
Ireland	≤1.50[2]	98th	60	Slaughter house	Complex 1/ISC ST3	Limit value for new slaughter house facilities	17.0	Limit value for new slaughter house facilities
Ireland	≤1.50[3]	98th	60	Balbriggan WWTP	ISC Prime/ISC ST3	Limit value at sensitive receptor locations	12.90	Limit value for existing facility at sensitive receptor locations.
UK	≤1.50[4]	98th	60	WWTP	ADMS/ AERMOD	Indicative odour exposure criterion for licensing	12.90	IPPC H4 Guidance Notes Part 1-Regulation and Permitting, Environment Agency
Ireland	≤3.0[3]	98th	60	Enniscorthy WWTP	ISC Prime/ISC ST3	Limit value at sensitive receptor locations	12.90	Limit value for existing facility at sensitive receptor locations.
UK	≤5.0[4]	98th	60	WWTP-Newbiggin by the Sea Planning	ADMS	Used as a limit value prevent odour impact associated with WWTP	12.90	Planning application-Newbiggin by the Sea
UK	≤1.50[4]	98th	60	Livestock feed factory	ADMS/ AERMOD	Indicative odour exposure criterion for licensing	13.20	IPPC H4 Guidance Notes Part 1-Regulation and Permitting, Environment Agency
UK	≤1.50[4]	98th	60	Oil refinery	ADMS/ AERMOD	Indicative odour exposure criterion for licensing	13.20	IPPC H4 Guidance Notes Part 1-Regulation and Permitting, Environment Agency
UK	≤3.0[5]	98th	60	Landfill activities	Complex 1	Odour exposure criterion developed through laboratory based odour intensity studies and complaint correlation	14.10	Longhurst et al 1998 for Landfill planning application
NL	≤3.50[6]	98th	60	WWTP	Complex 1	Limit value to prevent odour nuisance existing plant	12.90	Industry sector specific air quality criterion for odours in Netherlands
NL	≤1.50[6]	98th	60	WWTP	Complex 1	Limit value to prevent odour nuisance new plant	12.90	Industry sector specific air quality criterion for odours in Netherlands

Notes: [1] denotes reference BAT Note development for intensive agriculture sector, EPA, Johnston Castle, Wexford.
[2] denotes EPA, (2004). BAT Notes for the Slaughterhouse sector, EPA, Johnston Castle, Wexford.
[3] denotes Odour limit values used during EIA application for WWTP's.
[4] denotes Environment Agency, (2002). Technical Guidance Notes IPPC H4-IPPC, Horizontal Guidance for Odour, Part 1-Regulation and Permitting. Environment Agency, Bristol, UK.
[5] denotes Magette, W., Curran, T., Provolo, G., Dodd, V., Grace, P., and Sheridan, B., (2002). BAT Note for the Pig and Poultry Sector. EPA, Johnston Castle, Wexford.
[6] denotes EPA, 2001. Odour Impacts and Odour emissions control for Intensive Agriculture. R&D Report Series no. 14. EPA, Johnston Castle, Wexford

Table 3.2. illustrates the range of odour impact criterion used in Ireland, UK, Netherlands, and other worldwide communities. The impact criterion accepted in Ireland and UK are based on research performed in Netherlands over the mid 80's and early 90's. In the late 90's the UK Environment Agency performed some research on validating those standards developed in Netherlands through studies performed in the UK. The main aims of these studies were for the developing of guidance notes on odour for licensing procedures under the EPA Act 1992. Over the last decade, these impact criterions have been providing protection to the community at large in the vicinity of such facilities. There is a general trend in odour impact criterion and dislike ability presented in *Table 3.1*. As can be observed in *Table 3.1 and 3.2*, the more offensive the odour is perceived, the lower the acceptable ambient odour concentration above baseline. Odours such as bakery odours are considered less offensive than pig production facilities and this is observed through the relative dislike ability and also the odour impact criterion established to limit nuisance. Fragrance and Flavouring, Car Paint shop, Oil refinery, and Wastewater treatment plants etc. have similar dislike ability to intensive pig production facilities and therefore it would be rational to suggest a similar odour impact criterion to intensive pig production facilities. Other factors that require consideration include the location of the facility, the surrounding sensitive receptors, and amount of odour mitigation to be implemented into the overall design. For example in Ireland, pig production facilities are generally located in rural environments, whereby sensitive receptors in the vicinity of the facility are working in similar livestock operations and therefore do not consider the perceived odour as offensive as say a person not familiar with the odour. In this facility, it is located within an industrial estate where workers would be normally working to a set day and would not be habituating the premises. Taking this into account, it is proposed that:

- All sensitive locations and areas of amenity should be located outside the 3.0 $Ou_E\ m^{-3}$ at the 98th percentile of hourly averages over 6 years of meteorological data.

This proposed odour impact criterion is sufficiently conservative to provide protection to the community at large taking into account latest suggested odour impact criterion by environmental agencies in Ireland, UK and Netherlands.

3.3. Meteorological data.

Dublin airport meteorological station Year 2001 to 2006 inclusive was used for the operation of Aermod Prime. This allowed for the determination of dispersion for 6 years of meteorological data for the determination of overall odour impact from the existing and proposed operations on the surrounding population. Dublin Airport was chosen over Casement Aerodrome due to the biased north easterly south westerly plume profile generated by this met station.

Section 11 presents the windrose and tabular statistics for Dublin meteorological station for years 2001 to 2006.

3.4. Terrain data.

Topography affects in the vicinity of the site were accounted for in the model using post processed topographical data taken from Ordnance Survey Ireland (i.e. post processed through AerMap). All building wake effects are accounted for in the modelling scenarios (i.e. building effects on point sources) as this can have a major effect on the odour plume dispersion at short distances. This was performed using the Prime algorithm.

4. Results

This section will present the results obtained from the study.

4.1. Volumetric airflow rate measurements

Table 4.1 presents the results for the volumetric airflow rate estimation and calculation for each emission points.

Table 4.1. Calculated and estimated volumetric airflow rate results from monitoring survey.

Emission point identity	Area (m^2)	Airflow velocity (m/s)	Temperature (K)	Volumetric airflow rate (Nm^3/hr)	Notes
A1	0.126	5.0	293.15	2108	-
A2	0.40	6.30	315.15	7860	-
A3	0.067	11.10	293.15	2520	-
Fan1	0.899	-	293.15	40,066	Taken from fan specification document
Fan 2	0.899	-	293.15	40,066	Taken from fan specification document
Fan 3	0.899	-	293.15	40,066	Taken from fan specification document
Fan 4	0.899	-	293.15	40,066	Taken from fan specification document
Fan 5	0.899	-	293.15	40,066	Taken from fan specification document
Drum division building doorway[1]	44.22	5.0 (wind speed avg)	293.15	278,112	Based on formula contained in Odour control: A concise guide, Warren Springs Laboratory & Albright & Hellickison 2000.
Tankered liquid reception building doorway[1]	58.355	5.0 (wind speed avg)	293.15	367,004	Based on formula contained in Odour control: A concise guide, Warren Springs Laboratory & Albright & Hellickison 2000.

Notes: [1] denotes that the approximate area of infiltration was calculated using the engineering drawing of the building.

4.2. Odour emission dataset for existing Scenario A and proposed Scenario B

Two data sets for odour emission rates were calculated to determine the potential odour impact of the existing and proposed facility operations utilising site specific individual source odour emission data and characteristics gathered onsite. These scenarios included:

Ref Scenario A: Predicted overall odour emission rate from existing Rilta Environmental Ltd site operations (*see Table 4.2*).

Ref Scenario B: Predicted overall odour emission rate from Rilta Environmental Ltd operations with the incorporation of additional odour management and minimisation protocols (*see Table 4.3*).

Aermod Prime (07026) was used to determine the overall odour impact of the Rilta Environmental Ltd operation located in Rathcoole, Co. Dublin as set out in odour impact criteria presented in *Table 3.1* and *3.2*.

Table 4.2 illustrates the results of the olfactometry testing performed on each emission point site and the headspace air of the buildings. In addition area flux sampling was performed on the sludge drainage pit. This data was used in conjunction with the volumetric airflow rate contained in *Table 4.1* to calculate the overall odour emission rate in Ou_E/s for the existing site. In addition, the odour character of each tested sample was noted. The odour character of the headspace air of the tankered liquid reception building and the sludge drainage pit were considered more offensive in nature in comparison to all other sources. These should be examined first in terms of minimising odour impact. Samples were taken within the headspace building when all doors were closed for a period of 1 hour and for the tankered liquid reception building while liquid was been pumped from a tanker.

Table 4.2. Predicted overall odour emission rate from existing Rilta Environmental Ltd facility design (ref Scenario A).

Emission point identity	Airflow rate (m^3/hr)	Diameter (m)	Area (m^2)	Airflow rate (m^3/s)	Odour threshold conc (Ou_E/m^3)	Odour emission rate (Ou_E/s)	Frequency of operation
A1	2,262	0.40	0.126	0.63	1,689	1,061	Operational 4 hrs/day
A2	9,068	0.714	0.400	2.52	3,649	9,191	Operational 4 hrs/day
A3	2,705	0.293	0.067	0.75	2,483	1,865	Operational 4 hrs/day
Roof Fan 1	43,000	1.07	0.899	11.94	323	3,858	Operational 2 hrs/day
Roof Fan 2	43,000	1.07	0.899	11.94	323	3,858	Operational 2 hrs/day
Roof Fan 3	43,000	1.07	0.899	11.94	323	3,858	Operational 2 hrs/day
Roof Fan 4	43,000	1.07	0.899	11.94	323	3,858	Operational 2 hrs/day
Roof Fan 5	43,000	1.07	0.899	11.94	323	3,858	Operational 2 hrs/day
Door 1 - Drum division building	82.91	-	44.22	82.91	323	26,780	Normally open - Operational 8 hrs/day
Door 2 - Liquid waste reception building	109.41	-	58.36	109.41	645	70,569	Normally open - Operational 8 hrs/day
-	-	-	-	-	-	-	-
Sludge drainage pit	-	-	34.75	-	47.25	1,642	Continuous emission
-	-	-	-	-	-	-	-
Total odour emission rate (Ou_E/s)	-	-	-	-	-	**130,400**	-

Table 4.3 illustrates the overall odour emission rate from the proposed Rilta Environmental Solutions facility operations with the implementation of optimised odour minimisation strategies. The overall source odour emission is predicted to be at or less than 2,821 Ou_E/s. This odour emission rate is based on a number of mitigation assumptions that will require to be implemented into the existing facility design. These are discussed in detail in foot notes in *Table 4.4* of this document.

Table *4.3.* Predicted overall odour emission rate from proposed Rilta Environmental Ltd facility design with the incorporation of enhanced odour management protocols (ref Scenario B).

Emission point identity	Airflow rate (m^3/hr)	Diameter (m)	Area (m^2)	Airflow rate (m^3/s)	Odour threshold conc (Ou_E/m^3)	Odour emission rate (Ou_E/s)	Frequency of operation
A1	2,262	0.40	0.126	0.63	1,689	1,061	Operational 4 hrs/day
A2	9,068	0.714	0.400	2.52	3,649	9,191	Operational 4 hrs/day
A3	2,705	0.293	0.067	0.75	2,483	1,865	Operational 4 hrs/day
Roof Fan 1	43,000	1.07	0.899	11.94	646[1]	7,716	Proposed operation 4 hrs/day
Roof Fan 2	43,000	1.07	0.899	11.94	646[1]	7,716	Proposed operation 4 hrs/day
Roof Fan 3	43,000	1.07	0.899	11.94	646[1]	7,716	Proposed operation 4 hrs/day
Roof Fan 4	43,000	1.07	0.899	11.94	646[1]	7,716	Proposed operation 4 hrs/day
Roof Fan 5	43,000	1.07	0.899	11.94	646[1]	7,716	Proposed operation 4 hrs/day
Total odour emission rate (Ou_E/s)	-	-	-	-	-	**42,982**	-

Notes: [1] denotes that it is assumed that the odour threshold concentration within the headspace of the Drum division building will double as a result of keeping the doors closed. This is sufficiently conservative to take account of emissions since the odour measurement perform on the existing building was performed when the doors were closed for a 1 hour period.

Table 4.4. Comparison in odour emission rates for the existing and proposed Rilta Environmental Ltd facility operations.

Scenario identity	Odour emission rate ($Ou_E\ s^{-1}$)	Difference between Scenarios
Scenario A-Existing Facility operations	130,400	0
Scenario B-Proposed Facility operations	42,982	3 times lower

Due to proposed implementation of optimised odour management procedures, there is an overall odour emission decrease of 3.0 times lower. As those sources managed are volume and area odour sources, with high odour intensity and offensive hedonic tone (i.e. pleasant/unpleasant), a large reduction in odour impact area should be achieved. This is assuming the effective implementation which is paramount to avoiding the installation of expensive negative air odour abatement equipment.

4.3. Results of odour dispersion modelling for Rilta Environmental Ltd operation

Aermod Prime (07026) was used to determine the overall odour impact of the existing and proposed Rilta Environmental Ltd operation located in Rathcoole, Co. Dublin at as set out in odour impact criteria in *Table 3.1* and *3.2*. The output data was analysed to calculate:

Ref Scenario A:

- Predicted odour emission contribution of overall existing Rilta Environmental Ltd operation (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 $Ou_E\ m^{-3}$ (*see Figure 8.2*).
- Predicted odour emission contribution of existing doorways (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 $Ou_E\ m^{-3}$ (*see Figure 8.3*).
- Predicted odour emission contribution of existing Sludge drainage pit (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 $Ou_E\ m^{-3}$ (*see Figure 8.4*).
- Predicted odour emission contribution of existing Fans 1 to 5 (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 $Ou_E\ m^{-3}$ (*see Figure 8.5*).
- Predicted odour emission contribution of existing emission points A1 to A3 (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 $Ou_E\ m^{-3}$ (*see Figure 8.6*).

This odour impact criterions were chosen for the existing Rilta Environmental Ltd operations in order to ascertain the level of existing impact to the surrounding industrial population in the vicinity of the facility.

Ref Scenario B:

- Predicted odour emission contribution of overall proposed Rilta Environmental Ltd operation with odour management protocols implemented (*see Table 4.3*) to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 $Ou_E\ m^{-3}$ (*see Figure 8.7*).
- Comparison between predicted odour emission contribution of overall existing and proposed Rilta Environmental Ltd operation to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 $Ou_E\ m^{-3}$ (*see Figure 8.8*)

These computations give the odour concentration at each Cartesian grid receptor location that is predicted to be exceeded for 2% (175 hours) of six years of hourly sequential meteorological data (Dublin Airport 2001 to 2006). Dublin Airport meteorological station was used as it provided for worst case dispersion estimates. Casement Aerodrome suffers severely from south westerly / north easterly plume spread which biases the results especially when assessing receptors in close proximity to a site. Individual sensitive receptors and 20 metre spaced boundary receptors were also established within the modelling assessment for each scenario.

This will allow for the predictive analysis of any potential impact on the neighbouring sensitive locations while the facility is in operation. It will also allow the operators of the facility site to assess the effectiveness of their odour abatement/minimisation strategies. The intensity of the odour from two or more sources from the facility operation will depend on the strength of the initial odour threshold concentration from the sources and the distance downwind at which the prediction and/or measurement is being made. Where the odour emission plumes from a number of sources combine downwind, then the predicted odour concentrations may be higher than that resulting from an individual emission source. It is important to note that various odour sources have different odour characters. This is important when assessing those odour sources to minimise and/or abate. Although an odour source may have a high odour emission rate, the corresponding odour intensity (strength) may be low and therefore it is easily diluted. Those sources that express the same odour character, as an odour impact should be investigated first for abatement/minimisation before other sources are examined as these sources are the driving force behind the character of the perceived odour.

5. Discussion of results

This section will discuss the results obtained during the study.

5.1. Odour plume dispersal for existing Rilta Environmental Ltd facility operations

The plotted odour concentrations of ≤ 3.0 Ou_E m^{-3} for the 98^{th} percentile for the existing Rilta Environmental Ltd operation is illustrated in *Figure 8.2*. As can be observed, it is predicted that an odour plume radial spread of up to 200 metres will be recorded in the vicinity of the existing plant operations for all sources. In accordance with odour impact criterion in *Section 3.3.4*, and in keeping with currently recommended odour impact criterion in this country, long term odour impact will be perceived by receptors to the north, east south and west of the facility.

Predictive odour modelling was performed of the individual odour emission grouped source in the facility. As can be observed in *Figures 8.3, 8.4, 8.5 and 8.6*, it is predicted that the combined tankered liquid waste building doorways and sludge drainage pit odour emissions contribute greatest to overall odour plume spread while the scheduled emission points A1 to A3 and roof fans 1 to 5 contribute least to odour plume spread. Based on this assessment, those sources that contribute greatest to odour impact should be minimisation first. In addition, the hedonic tone of the odours from the tankered liquid reception building and the sludge drainage pit are most offensive.

5.2. Odour plume dispersal for proposed Rilta Environmental Ltd facility operations with odour minimisation protocols implemented

The plotted odour concentrations of ≤ 3.0 Ou_E m^{-3} for the 98^{th} for the proposed Rilta environmental Ltd operations is illustrated in *Figures 8.7 and 8.8*. As can be observed, the overall odour plume spread from the facility will be greatly reduced through the elimination of fugitive odour release and through the improvement in dispersion from the site. It is predicted that odour plume spread is small on the western boundary of the facility with a radial spread of approximately 50 metres. The odour plume spread from the facility is significantly reduce to the north and north west of the facility where predominate complaints are been generated.

The odour minimisation procedures should be implemented in full in order to assess the benefits of these management strategies. Close liaison between the management at Rilta Environmental facility and the complainants should be performed in order to ascertain the level of reduction on odour impact for a period of 2 months minimum. If no notable improvements are achieved, the implementation of containment and negative air extraction and treatment may be required for the tankered liquid reception building. This therefore stresses the importance of ensuring the considered strategy is implemented and that general housekeeping to include closed door strategy are implemented adequately.

6. Conclusions

A worst-case odour emission scenario was modelled using the atmospheric dispersion model Aermod Prime. A worst-case odour emission data set was used to predict any potential odour impact in the vicinity of the existing and proposed facility operations. Odour impact potential was discussed for the existing and proposed operation of the facility with the implementation of mitigation protocols.

It was concluded from the study that:

Scenario A

- In accordance with odour impact criterion in *Table 3.2*, and in keeping with current recommended odour impact criterion in this country, it is predicted that receptors in the vicinity of the existing Rilta Environmental Ltd operation will perceive long-term odour impacts. Receptors located to the North, East, South and West of the facility will perceive an odour concentration greater than 3.0 Ou_E/m^3 at the 98th percentile of hourly averages for 6 years of hourly sequential meteorological data when the facility is in operation (*see Figure 8.2*).
- The predominant odour impact from the existing facility is a result of fugitive odour emissions from the tankered liquid reception building and drum division building open doorways as a result of the positive displacement of odours from the headspace of the building and sludge drainage pit (*see Figure 8.3 and 8.4*). Maximum ground level concentrations of up to 68 and 27 Ou_E/m^3 at the 98th percentile of hourly averages for 6 years of hourly sequential meteorological data for open doorways and the sludge drainage pit, respectively. Ground level impact concentrations from the roof mounted fans 1 to 5 and emission points A1 to A3 are less significant with significant lower impact concentrations predicted in the vicinity of the facility (i.e. maximum ground level concentrations of 2.37 and 3.0 Ou_E/m^3 at the 98th percentile of hourly averages for six years of hourly sequential meteorological data for emission points Fan 1 to 5 and A1 to A3 grouped) (*see Figures 8.5 and 8.6*).

Scenario B

- A number of initial mitigation measured are proposed to reduce the odour impact from the facility. Following implementation, the effectiveness of these measures will need to be assessed through close examination of the complaints records generated by the close by receptors. Therefore it is essential that the proposed mitigation measures are implemented in full from the start in order to clearly define the improvements in odour impact in the immediate area. This would appear to be the most practical approach from the start which may negate the installation of expensive odour abatement equipment. These included:
    1. Ensuring that all doorways are maintained in a closed position and only opened when a truck needs to assess the facility building. The door should be closed if the truck can fit inside the building. This is especially important for the liquid waste reception building due to its close proximity to the complaining neighbour.
    2. Ensure the sludge drainage pit is cleaned up immediately following tipping of sludge. If this cannot be achieved then the sludge area should be covered with flexible cover. The area should ideally be operated clean due to its close proximity to the complaining neighbour.
    3. As doors will be closed it will be necessary to operate the roof fans for longer periods of time to ensure the air quality within the headspace of the building is in line with HSE requirements. In order to take account of this increased odour concentration within the headspace of the building and following consultation with Rilta Environmental staff, the model assessed the likely impact of emissions if Fans 1 to 5 were operated for a period of 4 hours as opposed to the period of 2 hours which currently occurs on the existing site.

- In accordance with odour impact criterion in *Table 3.2*, and in keeping with current recommended odour impact criterion in this country, a significant reduction in the perceived odour impact will be achieved in the vicinity of Rilta Environmental Ltd operations following the implementation of proposed odour management protocols. As can be observed in Figures 8.7 and 8.8, there will be a significant reduction in the odour plume spread as a result of changing the odour emission source characteristics. Odour generated within the facility will be expelled at a emission pint height of approximately 11 metres which lends itself to better dispersion and dilution. Receptors located to the west and north west of the facility should note an improvement in perceived odour concentration.
- In order to assess on the ground the effectiveness of this approach, careful interaction between the complaining receptors and Rilta Environmental Ltd staff will be required. These minimisation scenarios will need to be implemented in full and maintained in operation at all times in order to observe the improvements. Following an assessment period of 2 months and analysis of trends in complaints data, the effectiveness can be assessed and this may negate the implementation of expensive negative air extraction upon the liquid reception building where the most significantly offensive odours are generated at present.

7. Recommendations

The following recommendations were developed during the initial study:

1. Odour management, minimisation and mitigation procedures as discussed within this document in general will need to be implemented at the operating facility in order to minimise any odour impact in the surrounding area.
2. Maintain existing good housekeeping practices at high level (i.e. keep yard area clean, weight bridge clean, closed-door management strategy (including personnel doors) to eliminate positive displacement of odours from building, maintain sludge drainage area clean (always) and implement an odour management plan for the operators of the facility (i.e. to ensure full implementation and maintenance of odour management systems).
3. Ensure interaction between Rilta Environmental Ltd staff and complaining receptors to assess effectiveness of implemented strategy. If notable difference not achieved, then consideration towards enclosing of tankered liquid storage area and implementation of negative air extraction is performed to minimise the escape of these offensive odour.
4. Develop a strategy upon the drum division to minimise the release of perfumes from a single waste stream in the drum division. The strategy of handling and processing of this waste stream should be performed in such a manner to minimise emissions in general from this waste stream during handling.

8. *Appendix I* - Odour dispersion modelling contour results

8.1. Site layout and location

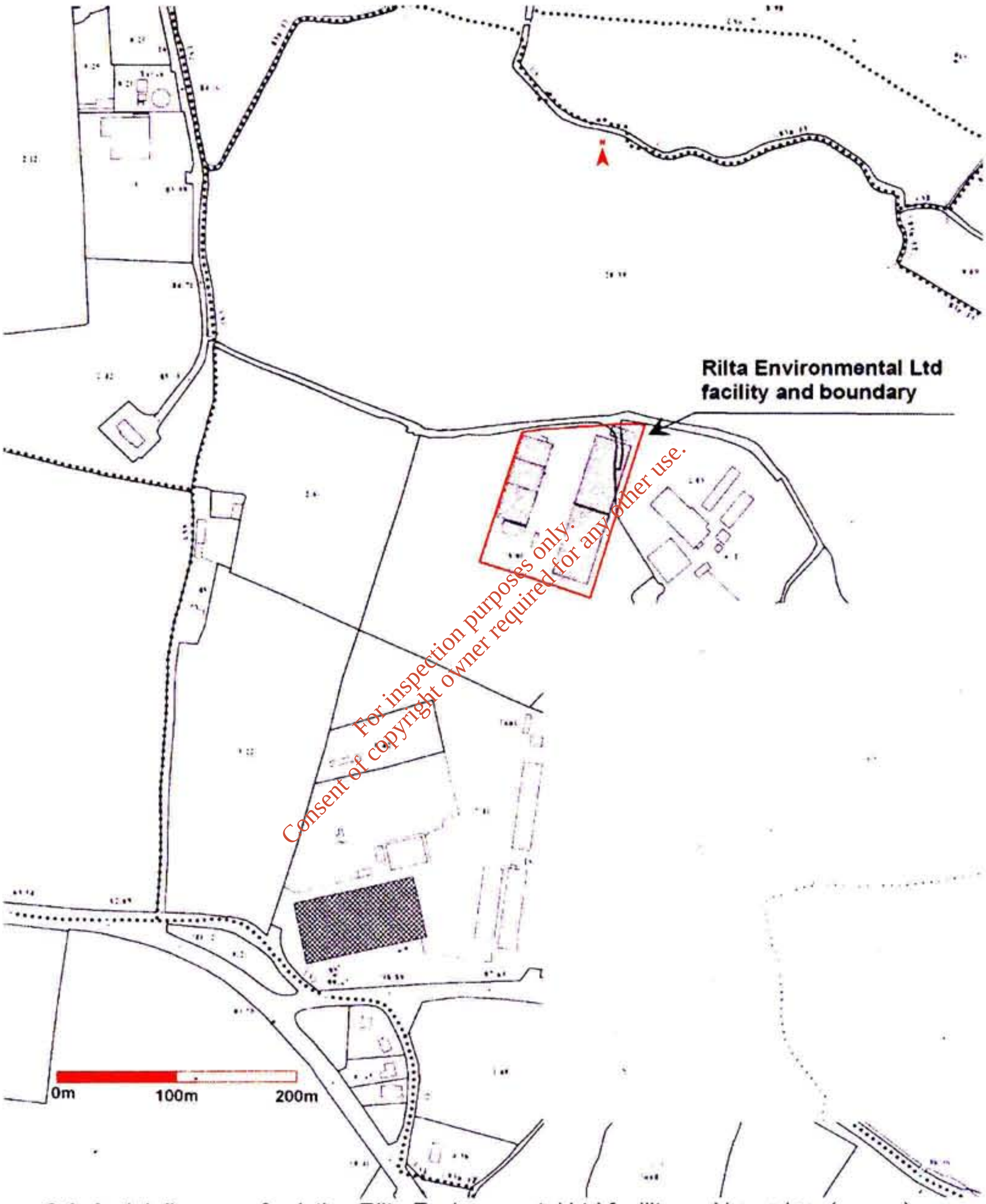

Figure 8.1. Aerial diagram of existing Rilta Environmental Ltd facility and boundary ( ).

Predicted odour contour plots for existing odour emissions from Rilta Environmental Ltd located in Greenogue Business Park, Rathcoole, Co. Dublin.

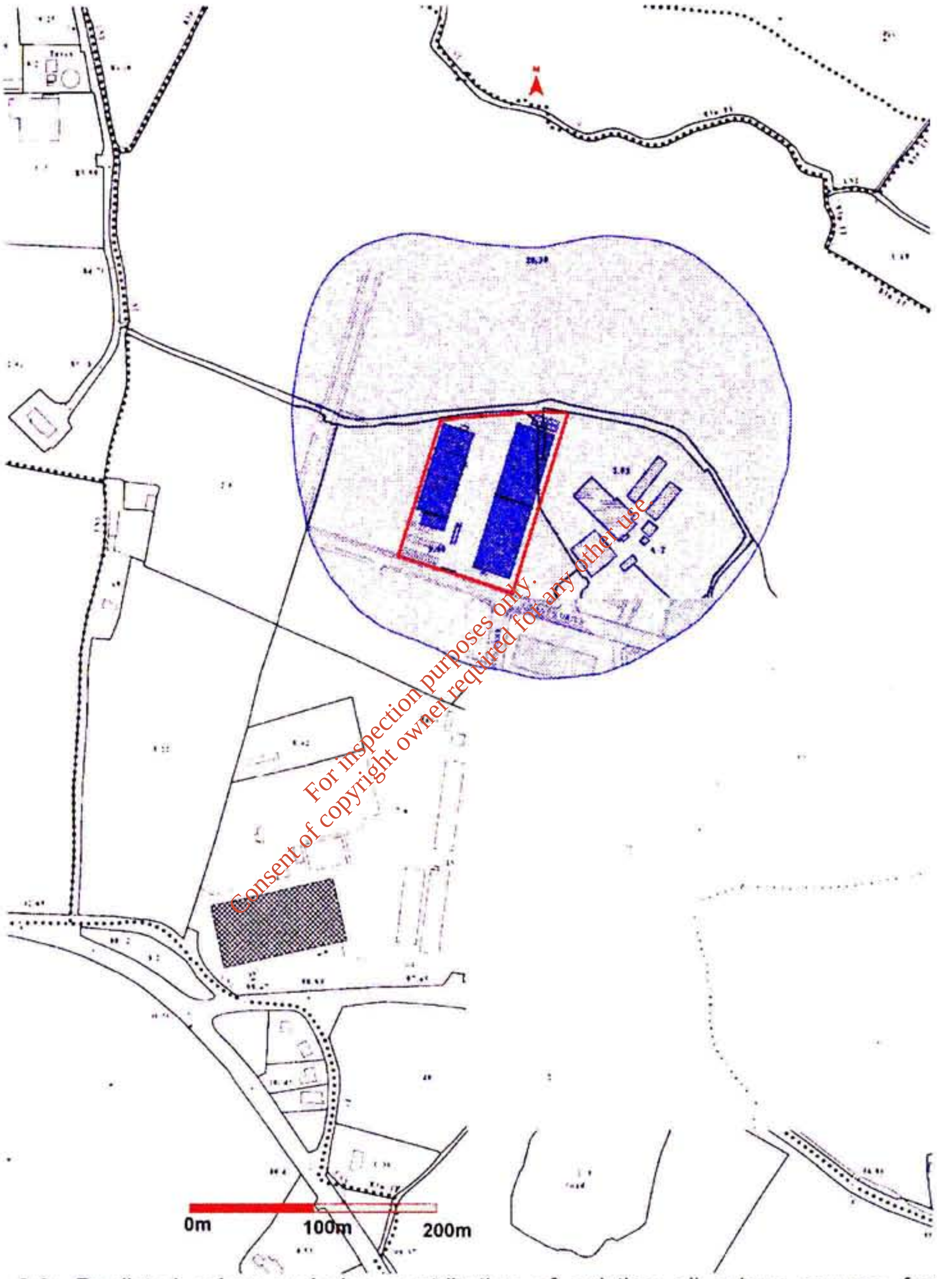

Figure 8.2. Predicted odour emission contribution of existing all odour sources from Rilta Environmental Ltd operation to odour plume dispersal for Scenario A at the 98[th] percentile for odour concentrations ≤ 3.0 Ou_E m^{-3} (——).

The shaded area presents exposure which is greater than or equal to the specified odour concentration for the specified percentile value for 6 years of meteorological data.

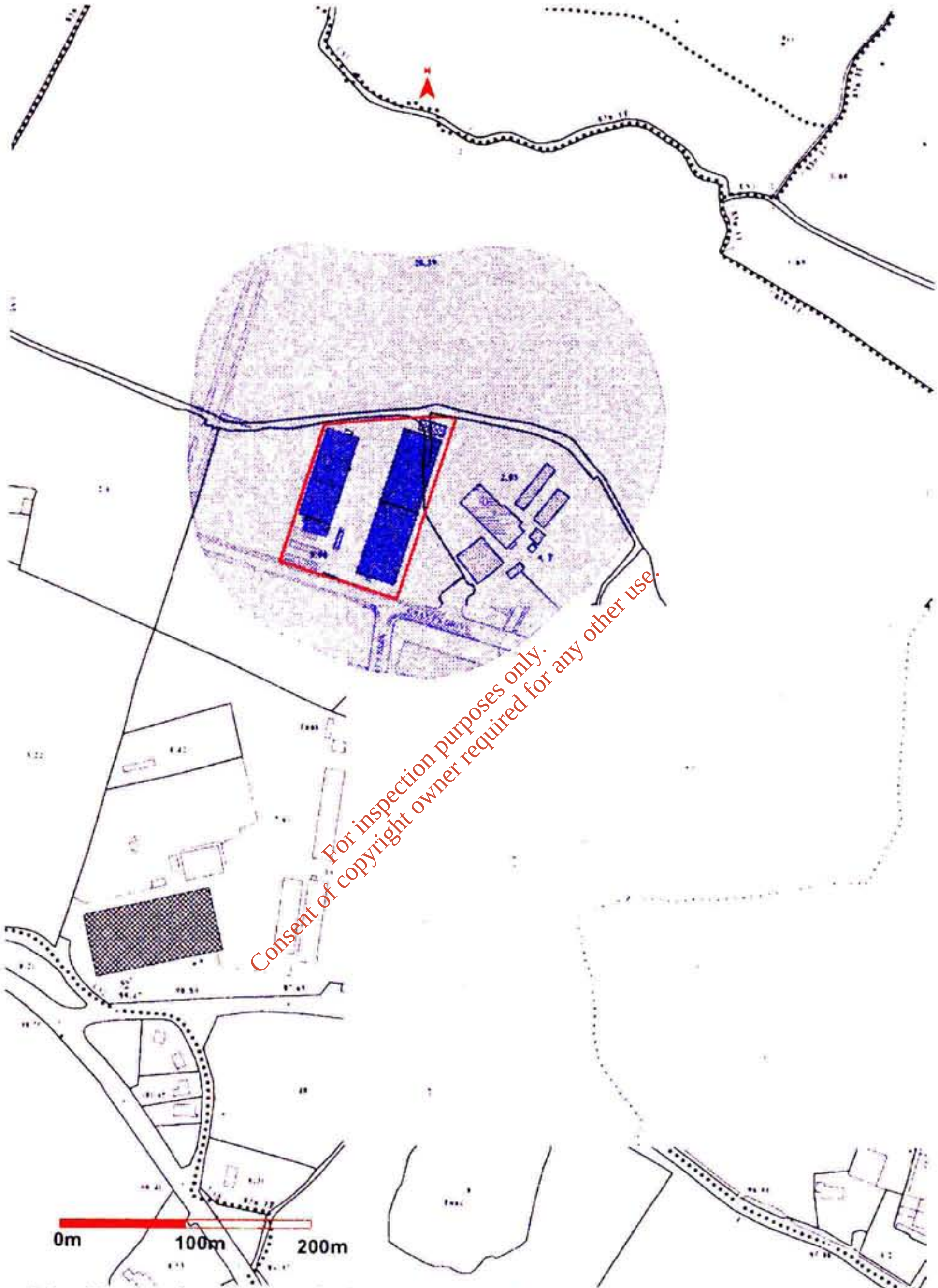

Figure 8.3. Predicted odour emission contribution of existing open doorways from Rilta Environmental Ltd operation to odour plume dispersal for Scenario A at the 98th percentile for an odour concentrations ≤3.0 Ou_E m^{-3} (—).

The shaded area presents exposure which is greater than or equal to the specified odour concentration for the specified percentile value for 6 years of meteorological data.

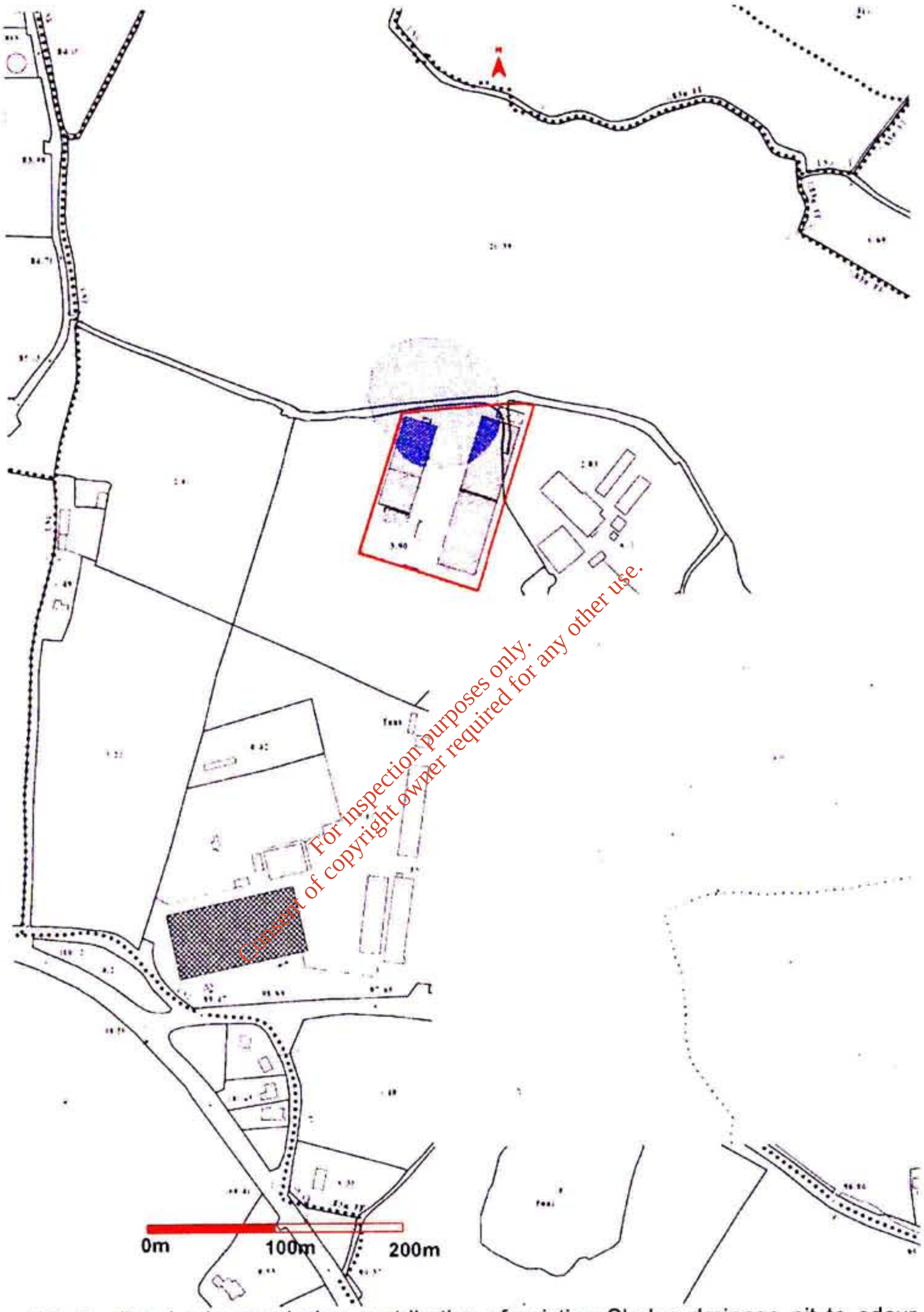

Figure 8.4. Predicted odour emission contribution of existing Sludge drainage pit to odour plume dispersal for Scenario A at the 98th percentile for odour concentrations ≤ 3.0 Ou_E m^{-3} (——).

The shaded area presents exposure which is greater than or equal to the specified odour concentration for the specified percentile value for 6 years of meteorological data.

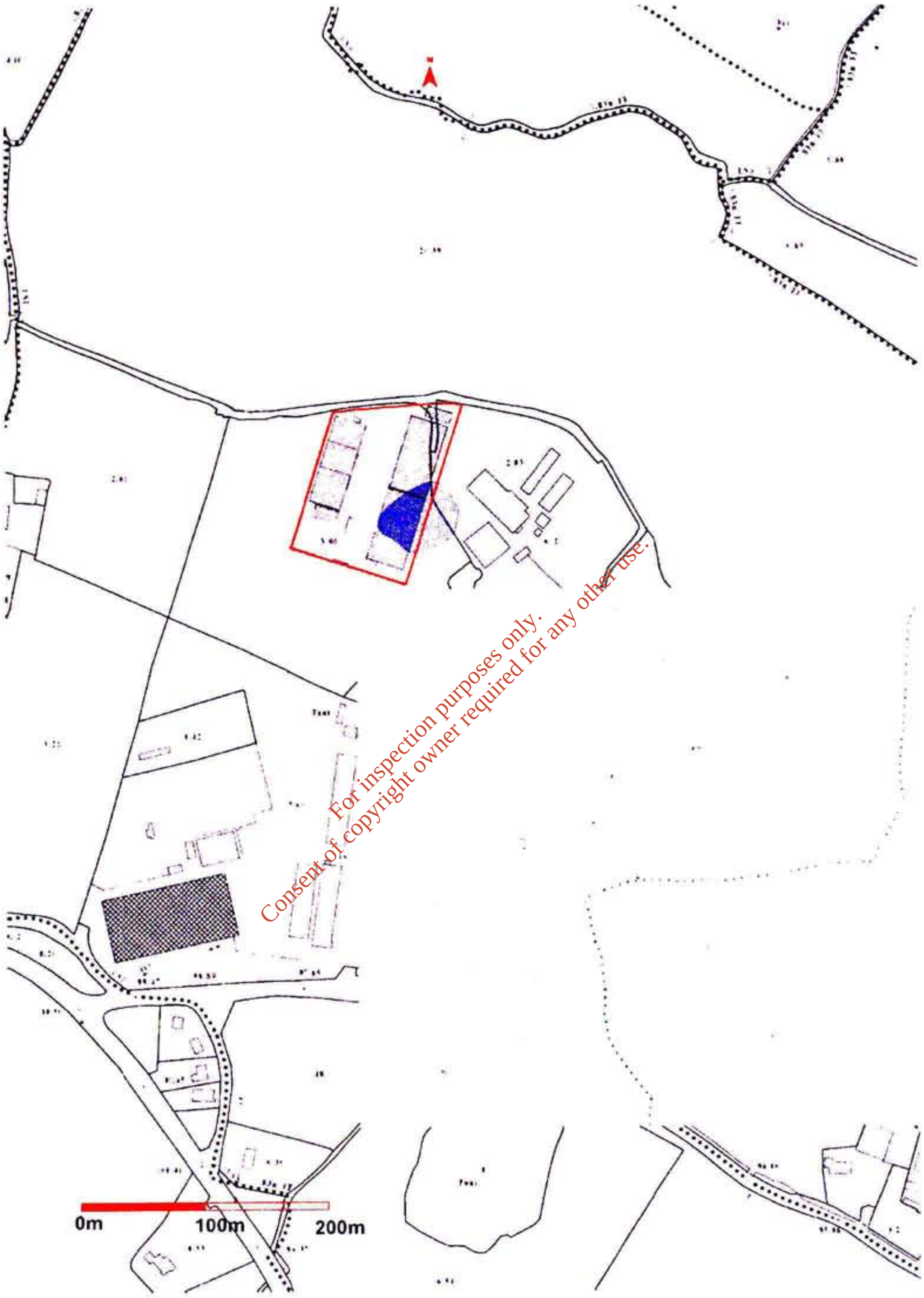

Figure 8.5. Predicted odour emission contribution of existing Fans 1 to 5 to odour plume dispersal for Scenario A at the 98[th] percentile for odour concentrations ≤ 1.50 Ou_E m^{-3} (——).

The shaded area presents exposure which is greater than or equal to the specified odour concentration for the specified percentile value for 6 years of meteorological data.

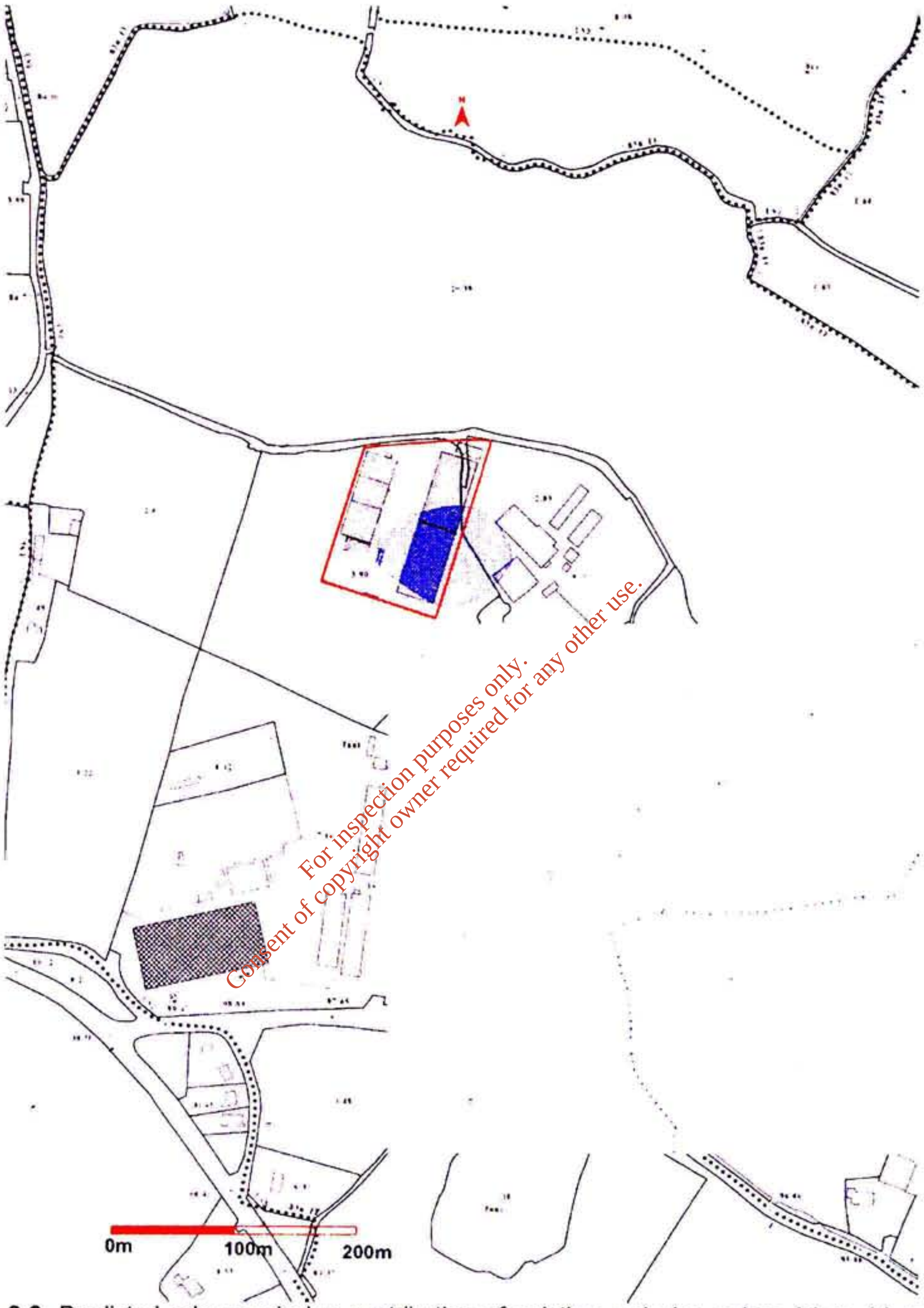

Figure 8.6. Predicted odour emission contribution of existing emission points A1 to A3 to odour plume dispersal for Scenario A at the 98th percentile for odour concentrations ≤ 1.50 Ou_E m^{-3} (—).

The shaded area presents exposure which is greater than or equal to the specified odour concentration for the specified percentile value for 6 years of meteorological data.

Predicted odour contour plots for proposed odour emissions from Rilta Environmental Ltd located in Greenogue Business Park, Rathcoole, Co. Dublin.

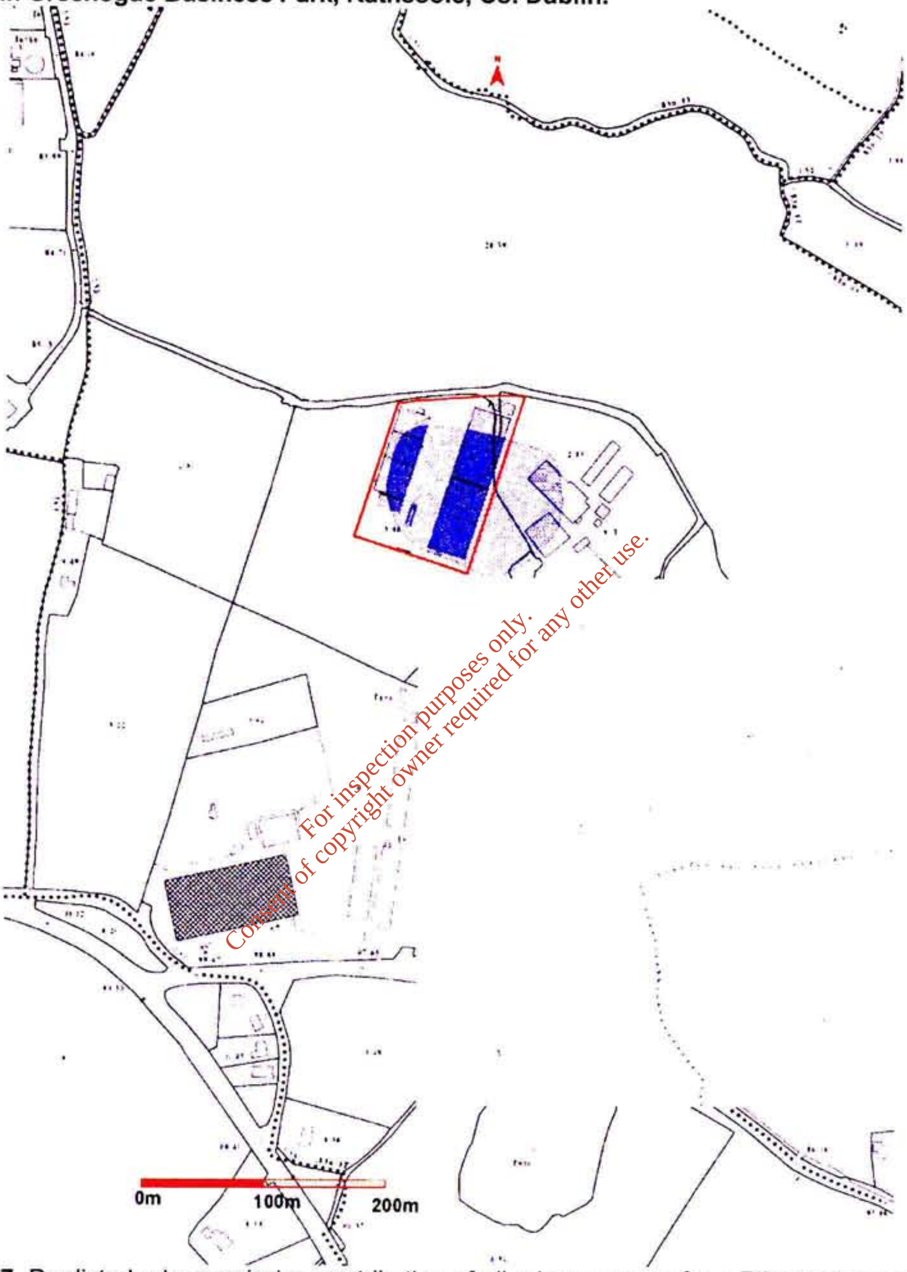

Figure 8.7. Predicted odour emission contribution of all odour sources from Rilta Environmental Ltd proposed operations to odour plume dispersal for Scenario B at the 98th percentile for odour concentrations $\leq 3.0\ Ou_E\ m^{-3}$ (━).

The shaded area presents exposure which is greater than or equal to the specified odour concentration for the specified percentile value for 6 years of meteorological data.

Figure 8.8. Comparison between predicted odour emission contribution of existing (——) and proposed (——) odour emissions from Rilta Environmental Ltd operations to odour plume dispersal at the 98th percentile for an odour concentrations ≤ 3.0 Ou_E m^{-3}.

9. *Appendix II* - Information on odours pertaining to Rilta Environmental Ltd odour impact assessment.

9.1. Legislation pertaining to odours in Ireland

The Public Health Act of 1878 introduced legislation to control nuisance in Ireland, but its execution only became viable after the implementation of the Planning and Development Act (1963) (Scannell, 1995). Any industry producing a nuisance was controlled under these regulations and subsequent pressure from environmental lobby groups together with the development of scientific measurement techniques made it practical to quantify and control the release of gaseous environmental pollutants from these enterprises.

Odour impact from a processes on the surrounding vicinity may be considered a nuisance. Section 107 of the Public Health Act 1878 states that "sanitary authorities are bound to inspect their district for nuisances. Upon the receipt of any information respecting the existence of a statutory nuisance, the sanitary authority is obliged, if satisfied of the existence of the nuisance, to serve an abatement notice on the person by whose act or default the nuisance arises or continues or, if such a person cannot be found, on the owner or occupier of the premises on which the nuisance arises" (Scannell, 1995).

In order to control the possible pollution effects of large developments, relevant legislation was enacted under the Environmental Protection Agency (EPA) Act of 1992. Private and public sector developers of certain types and sizes of projects are required under section 72(4) of the EPA Act (1992) to submit a copy of an Environmental Impact Statement. If the project is of a class listed in Part II of the first schedule to the 1989 EIA regulations but does not exceed the threshold or criteria specified, the planning authority must require an Environmental Impact Statement (EIS) if it considers the project is likely to have a significant impact on the environment. One of those impacts relates to odour and is defined as environmental pollution in section 4(2) of the EPA Act (1992), as to cause a nuisance through noise or odour and/or adversely affect the countryside or place of special interest (Scannell, 1995).

Waste licensing and Integrated Pollution Control Licensing (IPC) (now IPPC) for specified facility types was implemented in 1996 by the EPA and the related guidance note was termed BATNEEC (Best Available Technology Not Entailing Excessive Cost) (i.e. now BAT which complement the BATNEEC Notes) (EPA, 1996). It set out specific conditions for these specific industries (i.e. Intensive Agricultural Production, Landfills, Waste transfer stations, etc) to be implemented in order to comply with the environmental requirements of the EPA. Minimisation of odour emissions and complaints is one of the requirements of the BATNEEC Guidance Note for industries likely to cause odour emissions. For example, a typical IPC license/Waste license condition states "that there shall be no emission to the atmosphere of environmental significance and that all operations on site shall be carried out in a manner such that air emissions and/or odours do not result in significant impairment and/or interference with amenities beyond the site boundary and at odour sensitive locations in the area" (EPA, 1996).

Local authorities and the EPA have responsibility for ensuring enterprises meet their planning and environmental requirements. Where these facilities are found to be causing odour nuisance, local government enforces Section 29 of the 1987 Air Pollution Act and serves the offenders with an abatement notice. If the facility is licensed as an IPC or Waste enterprise, the EPA can enforce the conditions of the license and either serves the facility with non-compliances for odour detected beyond the site boundary or prosecute the facility and seek a high court injunction to close the facility. Verification for the presence of odour nuisance usually encompasses the licensing officer visiting the facility and detecting the odour beyond the boundary.

Although not directly related to this project, in December 2005, the Department of Environment published Statutory Instrument (SI) 787 for the regulation of odours and noise from WWTP's and associated processes. The main conclusions to be drawn from this SI 787 of 2005 include:

"A sanitary authority shall ensure that in formulating and approving plans for a waste water treatment plant to be provided by the authority or on its behalf the plant is so designed and constructed as to ensure that it avoids causing nuisance through odours or noise",

"A sanitary authority shall ensure that any waste water treatment plant under the sanitary authority's control is so operated and maintained as to ensure that it avoids causing nuisance through odours or noise".

It would also appear that SI 787 provides jurisdiction to the EPA to regulate WWTP for such nuisances and enforce the EPA Act 1992 *"For the purpose of Article 3(b) of these Regulations, the Agency shall be required to ensure compliance of waste water treatment plants with the requirements of the said Article 3(b), and the provisions of section 63 of the Environmental Protection Agency Act 1992 (No. 7 of 1992) shall apply accordingly".*

As part of SI 787 of 2005 *"the planning authority where granting permission for a development in accordance with section 34 of the Act of 2000 consisting of the provision of a waste water treatment plant attach such conditions to the permission as may be, in the opinion of the authority and having regard to the function of the Agency under Article 4 of these Regulations, necessary to ensure that the plant is so operated and maintained as to ensure that it avoids causing nuisance through odours or noise".*

Additionally, in considering a appeal to planning, Board Pleanala *"shall include such conditions as may be necessary in its opinion to ensure that the plant is so operated and maintained as to avoid causing nuisance through odours or noise".*

Although it is not unusual for statutory instruments not to include numerical values for the control of odour nuisance, it is apparent that there should not be odour nuisance from WWTP's in Ireland and so should be designed and operated to eliminate odour nuisance (Sheridan, 2002).

9.2. Characterisation of odour.

The sense of smell plays an important role in human comfort. The sensation of smell is individual and unique to each human and varies with the physical condition of the person, the odour emission conditions and the individual's odourous education or memory. The smell reaction is the result of a stimulus created by the olfactory bulb located in the upper nasal passage. When the nasal passage comes in contact with the odourous molecules, signals are sent via the nerve fibres where the odour impressions are created and compared with stored memories referring to individual perceptions and social values. Since the smell is individual some people will be hypersensitive and some will be less sensitive (ansomia). Therefore, the sense of smell is the most useful detection technique available as it specialises in synthesising complex gas mixtures rather than analysing the chemical compound (Sheridan, 2000).

9.3. Odour qualities

An odour sensation and complaint consists of a number of inter-linked factors. These include:

- Odour threshold/concentration,
- Odour intensity,
- Hedonic tone,
- Quality/Characteristics
- Component characteristics

The odour threshold concentration dictates the concentration of the odour in Ou_E m^{-3}. The odour intensity dictates the strength of the odour. The Hedonic quality allows for the determination of pleasantness/unpleasantness. Odour quality/characteristics allow for the comparison of the odour to a known smell (i.e. turnip, like dead fish, flowers). Individual chemical component identity determines the individual chemical components that constitute the odour (i.e. ammonia, hydrogen sulphide, methyl mercaptan, carbon disulphide, etc.). Once odour qualities are determined, the overall odour impact can be assessed. This odour impact assessment can then be used to determine if an odour minimisation strategy is to be implemented and if so, which technology. Additionally, by suitably characterising the odour through complaint logs, the most likely source of the odour can be determined. This allows for the implementation of immediate odour mitigation techniques to prevent such emission in the future.

9.4. Perception of emitted odours.

Complaints are the primary indicators that odours are a problem in the vicinity of any facility. Perceptions of odours vary from person to person, with several conditions governing a person's perception of odour:

- **Control:** A person is better able to cope with an odour if they feel it can be controlled.
- **Understanding:** A person can better tolerate an odour impact if they understand its source.
- **Context:** A person reacts to the context of an odour as they do to the odour itself (i.e. WWTP odour source due to sewage).
- **Exposure:** When a person is constantly exposed to an odour:
    - They may lose their ability to detect that odour. For example, a plant operator who works in the facility may grow immune to the odour *or*
    - There tolerance to the odour grows smaller and they complain more frequently.

From these criteria, we can predict that odour complaints are more likely to occur when:

- A new facility locates in areas where people are unfamiliar with facilities;
- When a new process establishes within the facility (i.e. anaerobic digestion processes);
- Or when an urban population encroaches on an existing facility.

The ability to characterise odours being emitted from the facility will help to develop a better understanding of the impact of the odour on the surrounding vicinity. It will also help to implement and develop better techniques to minimise/abate odours using existing technologies and engineering design. The correct recording of odour complaints data is very important to resolving any odour impact.

9.5. Characteristics of odours - general

Odours from facilities arise mainly from the uncontrolled release and volatilisation of compound from the handling of material and release of odours from the processing of the material within the facility. Most of these compounds have very low odour threshold concentrations as illustrated in *Table 9.2.*

Different concentrations and mixtures of these compounds can intensify or reduce odour threshold concentration, determined as synergism and antagonism respectively. Hobbs et al., (2002) performed studies on various odours commonly found in pig odour. From his study he concluded that 4-methyl phenol had a negative effective on perceived odour concentration when mixed with other odourant.

Table 9.1. Odour detection thresholds of wastewater odour precursors.

Chemical component	Threshold Conc. (mg m^{-3})	Odour character
Ammonia	0.03-37.8	Pungent, sharp, irritating
Methylamine	0.0012-6.1	Fishy, Putrid Fishy
Trimethylamine	0.00026-2.1	Fishy, Pungent fishy
Dimethylamine	0.34 ppmv	Putrid fishy
Ethylamine	0.27 ppmv	Ammonia like
Triethylamine	0.48 ppmv	Fishy
Pyridine	0.66 ppmv	Sour, putrid fishy
Indole	0.0006-0.0071	Faecal, nauseating
Skatole	0.00035-0.00078	Faecal, nauseating
Hydrogen Sulphide	0.0005-0.002	Rotten eggs
Methyl mercaptan	0.0000003-0.038	Rotten cabbage
Ethyl mercaptan	0.000043-0.00033	Decaying cabbage/flesh
Propyl mercaptan	0.0001 ppmv	Intense rotten vegetables, Unpleasant
Allyl mercaptan	0.0001 ppmv	Garlic, coffee
Benzyl mercaptan	0.0003 ppmv	Skunk, unpleasant
Thiocresol	0.449 ppmv	Skunk
Dimethyl disulphide	0.000026 ppmv	Rotten vegetables
Carbon disulphide	0.0077-0.0096 ppmv	Rubber, intense sulphide
Acetic acid	0.024 to 0.120	Vinegar
Butyric acid	0.0004-42	Rancid
Valeric acid	0.0008-0.12	Sweaty, rancid
Propionic acid	0.028 ppmv	Rancid, pungent
Hexanoic acid	0.018 to 0.096	sharp, sour, rancid odour, goat-like odour
Formaldehyde	0.05 to 1.0 ppm	Pungent, medicinal
Acetone	0.067 ppmv	Pungent, fruity, sweet
Butanone	0.128	Sweet, solventy
Acetophenone	0.05 to 0.10 ppmv	Sweet pungent odour of orange blossom or jasmine
Limonene	0.063	Intense orange/lemons
Alpha Pinene	0.006 ppmv	Intense pine, fresh
THN Tetrahydronaphthalene	-	Meat

O'Neill & Phillips et al. (1992) and Suffet at al., 2004.

Although only indicators of odour emission from a process, knowing which compound precursors that are responsible for odour is useful in designing control techniques for the minimisation and abatement of these gases. Technologies such as carbon filtration rely on the binding efficiency of the carbon (Van der Waals forces and molecular sieving) and knowing the gas constituents will help isolate the best carbon to perform the task. For example, Hydrogen sulphide because of its molecular size will not bind efficiently to activated carbon. By impregnating the carbon with potassium/sodium hydroxide chemisorption can be used to efficiently bind and hold on to the Hydrogen sulphide. Another reason for knowing Volatile Organic Compounds (VOC's) concentration present in air stream is to propose the best technology. Chemical scrubbers are good for low VOC's steady stream processes while high VOC concentration non-steady stream processes will not be as affectively treated with chemical scrubbers although many stages of treatment can be provided to buffer out the cyclic loading (but at greater operating expense).

9.6. Odour management plan – Standard Practice

The Odour Management Plan (OMP) is a core document that is intended to detail operational and control measures appropriate to management and control of odour at the site. The format of the OMP should provide sufficient detail to allow operators and maintenance staff to clearly understand the operational procedures for both normal and abnormal conditions.

An Odour Management Plan (OMP) should be prepared for all processes. The OMP should also include sufficient feedback data to allow site management (and regulatory inspectors) to audit site operations. An example of some of the issues to be considered is summarised as follows. More detailed guidance is provided with this document.

- A summary of the site and facility process, odour sources and the location of receptors,
- Details of the site management responsibilities and procedures for reporting faults, Identifying maintenance needs, replenishing consumables, complaints procedure,
- Odour critical plant operation and management procedures (e.g. correct use of plant, process, materials; checks on plant performance, maintenance and inspection,
- Operative training,
- Housekeeping,
- Maintenance and inspection of plant (both routine and emergency response),
- Spillage management procedures,
- Record keeping – format, responsibility for completion and location of records,
- Emergency breakdown and incident response planning including responsibilities and mechanisms for liaison with the local people and regulatory body.
- Public relations.

The Odour Management Plan is a living document and should be regularly reviewed and upgraded. It should form the basis of a document Environmental and Odour Management system for the operating site. The Odour Management System documentation should define the roles of the Plant Operator and staff and sets out templates in relation to the operating of the facility and reporting procedures to be employed. Requirements for the Odour management plan should be implemented thought out the site with a branched management system implemented in order to share responsibility around the site. The head manager should ensure all works are performed in accordance with the OMP. The OMP will be integrated in the overall Environmental Management System/Performance management system.

The facility should develop and implement a detailed odour management plan for the actual as built plant and put into operation before commencement of treatment of waste at the facility. The particular odour risks should be detailed within the OMP. In assessing these risks, it must be taken into account that response to odours is almost immediate. In order to manage these odour detection and complaint risks, a number of actions may be considered:

- Plan high-risk activities in periods where receptor sensitivity to annoyance is low like during wet weather when they are indoors, or during colder winter months, or during early morning/late evenings during periods of low atmospheric turbulence, etc.
- Consider providing standby capacity, etc.

9.7. Containment and ventilation/extraction of odours – Standard Practice

The containment and ventilation/extraction of odour from facilities should consider the following as a minimum:

9.7.1. Covers

Covers should consider the following design notes before been installed.

- Covers should be sealed as far as possible. Inspection /access hatches should be sufficiently durable so that they continue to be effectively sealed for the design life of a piece of plant. Considerable care and attention to detailed design is required to provide adequate sealing of covers, particularly if passive ventilation to odour treatment is to be effective
- For tank surfaces the recently developed floating covers can be considered. These are produced from sections of hard foam material or fitted using soft foam that hardens in situ. Such covers can accommodate moving equipment, and can be replaced on a regular basis. Such covers do not require extraction and treatment.
- Overflow and discharge pipes should be designed and constructed to prevent a route for air under covers being discharged to the atmosphere.
- Design should withstand wind loadings, static loads due to snow or ice accumulation
- Equipment should be located in a small area to which suitable platform access is provided. Facilities to allow access of personnel onto covers should not be provided, and warning notices posted.
- Materials for covers and supports, and any equipment below the cover should be resistant to corrosion. Reinforced thermoplastic-based covers should have been considered at a minimum as very aggressive atmospheres may develop below the covers.
- Where possible, design should be such that equipment needed below covers can be easily and quickly removed to minimise time when covers need to be opened.
- To prevent the displacement of highly odorous air through gaps or hatches in the cover and ensure that all air is vented through odour treatment. Badly sealed or broken hatches will act as significant points of odour emission. Even small openings, such as the openings around cable-duct entry points, have been observed as significant sources of odour emission from tanks.
- Air displaced during filling will take the route of least resistance and may not pass through odour treatment systems, unless ventilated to maintain a negative pressure. Therefore, if any passive based odour treatment technology is to be used the cover must be 100% effectively sealed. The application of negative ventilation will also prevent significant odour emissions during cover opening.

9.7.2. Ventilation

Ventilation should consider the following design notes before been installed.

- All buildings containing odourous processes will need some form of ventilation. It should be assumed that this ventilation air in most circumstances will require odour treatment.
- The effective local encapsulation and extraction of process equipment, with the aim to reduce emissions to the atmosphere of the containment building, improves the indoor air quality. The odour concentration in the general indoor air can be improved using this approach to the point where odour treatment of the general air is not required. Treating a more limited flow from the local extraction system is a favoured and more economical option.
- Odour releasing units within a building should be locally enclosed, and a proportion of the required ventilation air drawn from the body of the building towards the odorous unit to ensure odours do not escape into the body of the building.

- Ventilation of a building should maintain a slight negative pressure. This negative ventilation will depend on the effectiveness of sealing of processes and provide a safe working environment in accordance with published occupational exposure limits, and to prevent an odour problem. By enclosing processes the emissions of aerosols and odours area minimised into the main body of the building where it could affect working conditions
- It may be advantageous to have two streams of ventilation air: one of low-volume and high-odour, drawn from the odour producing unit which can be pre-treated prior to mixing with the other stream of remaining ventilation air (high volume and low or no, odour), with possible provision of 'polishing' to reduce odours to a minimum.
- In buildings, ventilation systems and zoning of areas are designed to avoid development of potentially hazardous (explosive or toxic) atmospheres. There are no firm guidelines and rates vary widely across the Europe.
- Design of the ventilation and odour control system may need to take in to account the handling of potentially hazardous gases, and the zone requirements of the area in which it is installed. This will avoid risks associated with hazardous gases and to provide equipment suitable for the zone requirement.
- In a covered process tank, ventilation is required only to contain and collect odours and should be kept to a minimum, whilst maintaining a slight negative pressure. Ventilation rates in this case are typically three to four air changes per hour of the volume of the headspace of the tank, and should be no less than the maximum filling rate. Smaller pump sumps which are subjected to turbulent liquid flows and instantaneously pump flows should consider at least 10 to 12 AC/Hr and should be no less than the maximum filling rate. Do not over-design the air-extraction rate. Odour removal processes tend to work more effectively at lower flow-rates
- The sitting of emergency vents and initiation of emergency ventilation should be carefully considered.

10. References

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11. *Appendix III* - Meteorological data examined and used in the dispersion modelling exercise

Table 11.1. Tabular illustration of Dublin Airport meteorological files for Years 2001 to 2006 inclusive (6 years).

6 year Meteorological file for Dublin Airport 2001 to 2006 inclusive							
Dir \ Speed	**<= 1.54 m/s**	**<= 3.09 m/s**	**<= 5.14 m/s**	**<= 8.23 m/s**	**<= 10.80 m/s**	**> 10.80 m/s**	**Total**
0.0	0.67	0.50	0.99	0.44	0.07	0.02	2.70
22.5	0.15	0.48	1.04	0.48	0.16	0.00	2.31
45.0	0.11	0.31	1.27	0.67	0.21	0.01	2.57
67.5	0.07	0.24	1.55	0.86	0.38	0.05	3.15
90.0	0.13	0.44	2.28	0.95	0.31	0.11	4.22
112.5	0.17	0.68	2.62	0.80	0.16	0.04	4.48
135.0	0.22	0.79	4.10	2.61	0.76	0.14	8.63
157.5	0.22	0.70	2.39	1.61	0.58	0.08	5.58
180.0	0.20	0.45	1.30	0.77	0.32	0.05	3.09
202.5	0.17	0.42	2.26	2.14	0.93	0.23	6.15
225.0	0.19	0.62	4.21	4.53	2.18	0.61	12.34
247.5	0.20	0.64	4.91	5.29	2.73	0.87	14.63
270.0	0.19	0.73	5.39	4.27	2.00	0.63	13.20
292.5	0.19	0.68	4.23	2.13	0.66	0.13	8.03
315.0	0.26	0.53	2.77	1.33	0.26	0.04	5.20
337.5	0.23	0.37	1.51	0.78	0.15	0.04	3.07
Total	**3.39**	**8.58**	**42.82**	**29.66**	**11.86**	**3.04**	**99.36**
Calms	-	-	-	-	-	-	**0.56**
Missing	-	-	-	-	-	-	**0.08**
Total	-	-	-	-	-	-	**100.00**

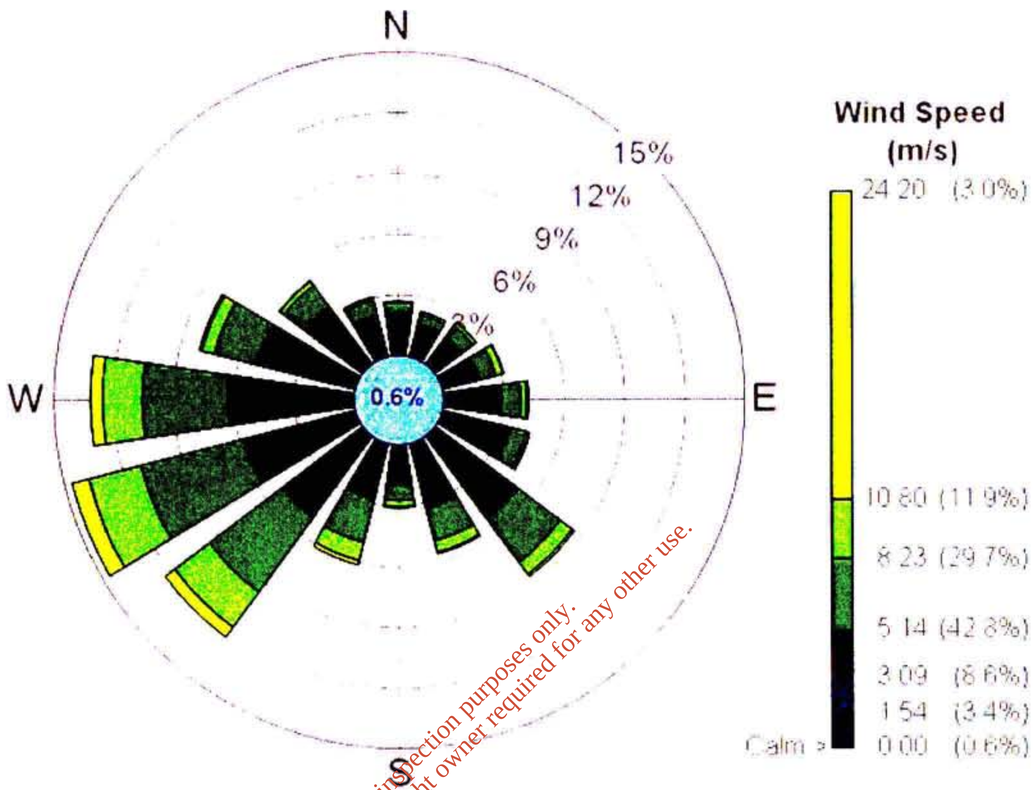

Figure 11.1. Windrose illustration of meteorological files Dublin Airport 2001 to 2006 inclusive.