Article 13 (Parts 7 – 10)

Part 7 – For the EIS Update, provide copies of the individual reports prepared by specialist consultants

The individual reports prepared by specialist sub-consultants are included as Attachment 07_4084 7.1 and 07_4084 7.2 to this section. These include the ecology report, prepared by Scott Cawley, and the odour dispersion model, prepared by AWI/Enpure. The remaining parts of the updated EIS, i.e. Air Quality, Noise and Water, were not prepare as individual reports, but as one overall report, into which the aforementioned reports were inserted. Therefore, there are no separate reports for these aspects of the EIS.

Part 8 – Clarify the population equivalent details for which the impacts were assessed.

The impacts were assessed for the p.e. (population equivalent) for which the original EIA/EIS assessed, i.e. for 148,500 p.e. This is what the wastewater treatment plant has been designed to assess and no changes to the design or p.e. have been made since the original assessment.

Part 9 – Provide additional details on the mitigation measures for odours

The additional details on the mitigation for odours from the WWTP have been addressed in Sections 3 and 4 of Article 12. Please refer for details.

Clarify whether the odour baseline assessment data was incorporated into the odour dispersion model

Odour Standards

In the absence of specific Irish EPA guidance on odour from WWTPs, available guidance from the UK has historically been adopted[1-3]. During the 1990's in the UK, it was generally accepted that odour concentrations of between 5 and 10 OU_E/m^3 would give rise to a faint odour only, and that only a distinct odour (concentration of >10 OU_E/m^3) could give rise to a nuisance[3]. In 1990, a survey of the populations surrounding 200 industrial odour sources in the Netherlands showed that there were no justifiable complaints when 98%ile compliance with an odour exposure standard of a "faint odour" (5-10 OU_E/m^3) was achieved[3].

Several European countries have recently set standards for odour. The Netherlands has set differentiated target values between 0.5 – 3.5 OU_E/m^3 as a 98th%ile for industrial sources.

The UK in it's recent guidance documents[4-5] has set an indicative odour exposure criteria for waste water treatment works of 1.5 OU_E/m^3 as a 98th%ile. This indicative criterion can then be adjusted to allow for relevant local factors. In the current case, the medium density nature of the facility would allow a more lenient exposure criteria to be applied.

Recently, the EPA has set a target value and two limit values for use in pig production units[6]. The target value is 1.5 OU_E/m^3 as a 98th%ile at all sensitive locations. In relation to

limit values, a value of 3.0 OU_E/m^3 as a 98th%ile has been set for new pig production units whilst for existing facilities a value of 6.0 OU_E/m^3 as a 98th%ile has been set.

Background Levels

The existing background odour in any particular location will be dominated by the influence of the specific location in which the site is located. Urban areas are often dominated by traffic fumes, coastal areas are dominated by sea spray and seaweed odours whilst agricultural sources will be dominated by manure, silage and other agricultural activities.

In terms of the background, or baseline odour, although an existing background odour is always present, odours are not generally additive i.e. a "new" odour cannot be added to an existing background odour to give a "total" odour. This is a result of the brain's ability to screen out existing odours and detecting a much lower "new" odour against this background. Thus, the existing odour is effectively ignored in the olfactometry assessment[4].

The recent UK IPPC Odour guidance states[4]:

"*Odours are not generally additive in the same way as noise. A "new" odour cannot be added to an existing background or "ambient" odour level to give a figure for total odour. This reflects the way in which the brain responds to odour. The brain has a tendency to "screen out" those odours which are always present or those that are normal to that environment; this might take the form of a tolerance to a constant background of local odours. An intermittent or fluctuating or new odour can stand out against this background. Normal background odours such as from traffic, grass cutting, plants etc, indeed the "normal" medley of "environmental" odours amounts to anything from 5 to 40ou/m^3. A new odour at much lower concentration can still be noticeable against this background*."

Secondly, even if we try to monitor the existing odour, there are several serious drawbacks:

- Yang & Hobson (2000)[7] examined the issue of determining odour emission rates from sources with low odour concentrations. The paper estimated that existing background sources can range from 100 – 200 OU_E/m^3 and thus for any measurement below 200 OU_E/m^3 the results are potentially meaningless and thus can not be distinguished statistically from the background value. Furthermore, the paper found that for measurements slightly above this background value (200 OU_E/m^3), many samples are required in order to get a statistically sound result. For example, at 25% above background (250 OU_E/m^3) 64 samples are required while at twice the background level (400 OU_E/m^3) seven sampled are required in order to statistically differentiate the result from background levels.

- The UK Guidance[4] also states that "*It should be noted that there are very large uncertainties associated with the collection and analysis of ambient air samples, even if the concentration is sufficiently high for subsequent testing/assessment*".

- Measurements of odour becomes even more difficult at concentrations below 50 OU_E/m^3 because of background odours in sample bags which can often be of this magnitude[5].

Conclusions

Odour standards are generally in the range of 1-5 OU_E/m^3 and thus in modelling odour from a WWTP a very small increases in odour is being assessed. Therefore, although baseline odour monitoring was carried out, it was purely for the purpose to highlight if there were existing potential odour issues in the vicinity of the site, and not for the purpose of the odour dispersion modelling that was carried out for the WWTP. As stated, odours are not additive and thus incorporating the baseline study into the odour dispersion model would have been meaningless.

Part 10 – Provide a map showing the WWTP site boundary and the cSAC boundary

An aerial photograph showing the WWTP, the site red line boundary and any overlap between the two is included as Figure 07_4084 10.1. An O.S. map showing the same detail is included as Figure 07_4084 10.2. The actual WWTP does not approach the southern boundary and will not impinge on the salt march area during operation of the plant.

As can be seen from the plates (1 & 2) below (taken from the ecology section of the EIS Update), the southern boundary of the construction works does not impinge on the salt marsh area (edge of construction area marked by green wire fence), with the exception of the area to the southwest of the site, where the discharge outfall pipe is being laid.

Plate 1 – Southern Edge of Construction Area of WWTP Site

Plate 2 – Southwest Area of WWTP Site, showing Hardcore Road works

References

(1) Warren Spring Laboratory, 1980. "Odour Control – a concise guide", F.F.H. Valentine and A.A. North (Eds)
(2) C.R. Clarkson and T.H. Misselbrook, 1991. "Odour emissions from Broiler Chickens" in "Odour Emissions from Livestock Farming", Elsevier Applied Science Publishers London
(3) J.E. McGovern, C.R. Clarkson, 1994. in "The Development of Northumbrian Water Limited's Approach to Odour Abatement for Wastewater Facilities", Proceedings of Symposium on Odour Control and Prevention in the Water Industry
(4) Environment Agency (2004) IPPC H4 Horizontal Guidance for Odour Part 1- Regulation and Permitting.
(5) Environment Agency (2004) IPPC H4 Horizontal Guidance for Odour Part 2 – Assessment and Control.
(6) EPA & OdourNet UK, 2000 "Odour Impacts and Odour Emission Control Measures for Intensive Agriculture"
(7) Yang & Hobson, (2000) Odour nuisance – advantages and disadvantages of a quantitative approach, Water Science & Technology Vol.41 No. 6 pp. 97-106.

scott cawley

WATERFORD WASTE WATER TREATMENT PLANT
WASTE LICENCE APPLICATION

ADDENDUM TO FLORA AND FAUNA CHAPTER

Prepared for
AWN CONSULTING LTD
March 2008

1.0 INTRODUCTION

1.1 Overview

This report has been prepared by Scott Cawley, Environmental Consultants to update the ecological information provided in the EIS published in 1998 in relation to the Waterford Waste Water Treatment Plant. This report is therefore an Addendum to the EIS and should be read in the context of this document.

1.2 Scope of Addendum

The following aspects of the development have been updated:

- Update on ecology baseline data where relevant, based upon a site visit undertaken in March 2008.
- Update on nature protection legislation relevant to the development.

1.3 Methodology

A qualitative baseline study of the subject site was carried out on the 3rd March 2008 to verify the condition of the site. The previous surveys were carried out by the Aquatic Services Unit in June 1998 and are described in Appendix E of the Environmental Impact Statement. The permitted development has been constructed since February 2007 and is almost complete. The 2008 surveys examined areas remaining around the construction area and compared it to descriptions made in the 1998 Report.

During the 2008 surveys, the site visit included a study of the floral and faunal composition encountered. This combined with desktop consultations of the following resources produced this Addendum as presented.

- O.S. maps for Co. Waterford and Kilkenny.
- Site layout plans.
- National Parks and Wildlife Service Database of designated areas and protected and threatened species.

The proposed development site was surveyed using the methodology of the Heritage Council Habitat Survey Guidelines (Draft 2005). The principal habitats present within the site were identified and classified using the Heritage Council's A Guide to Habitats in Ireland (Fossitt, 2000). Since the site was surveyed in winter it was impossible to identify all floral species occurring within the site so only the identifiable flora have been recounted in this report.

Floral nomenclature follows An Irish Flora (Webb, Parnell & Doogue, 1996) for Latin names and the Census Catalogue of the Flora of Ireland (Scannell & Synnott, 1987) for common names. Nomenclature for horticultural species follows the Royal Horticultural Society's Encyclopaedia of Garden Plants (Brickell, 1998).

Faunal identifications were confirmed using the following sources:
The Macmillan Guide to Birds of Britain & Europe, Macmillan 1998,
The Complete Guide to Ireland's Birds (2002), Dempsey E. & O'Cleary. M. Gill & Macmillan.
Exploring Irish Mammals, Dúchas The Heritage Service 2001.

As opposed to floral investigations, the surveying of faunal usage of subject lands cannot be based upon direct sightings alone. The presence of fauna is substantiated through the detection of field signs such as tracks, habitats, markings, feeding signs, and droppings, as well as by direct observation. Likewise, bird species present on site are recorded along with any notable avifauna habitats, droppings, or tracks. The likely species were assessed in relation to the habitats present within the site.

1.4 Update on Receiving Environment

1.4.1 Records of Designated sites

The 1998 Report summarised in the EIS acknowledges the proposed Natural Heritage Areas near Island View and Belmont House covering salt marsh adjacent to the site. However these sites have been superseded by the designation of the entire channel of the River Suir as the Lower River Suir candidate Special Area of Conservation (cSAC) under the Habitats Directive. Excerpts from the site synopsis for this site (which was designated in 2005) are provided below:

"The Lower Suir cSAC site consists of the freshwater stretches of the River Suir immediately south of Thurles, the tidal stretches as far as the confluence with the Barrow/Nore immediately east of Cheekpoint in Co. Waterford and many tributaries including the Clodiagh in Co. Waterford, the Lingaun, Anner, Nier, Tar, Aherlow, Multeen and Clodiagh in Co. Tipperary.

The site is a candidate SAC selected for the presence of the priority habitats on Annex I of the E.U. Habitats Directive - alluvial wet woodlands and Yew Wood. The site is also selected as a candidate SAC for floating river vegetation, Atlantic salt meadows, Mediterranean salt meadows, old oak woodlands and eutrophic tall herbs, all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive - Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Crayfish, Twaite Shad, Atlantic Salmon and Otter.

Salt meadows occur below Waterford City in old meadows where the embankment is absent, or has been breached, and along the tidal stretches of some of the in-flowing rivers below Little Island. There are very narrow, non-continuous bands of this habitat along both banks. More extensive areas are also seen along the south bank at Ballynakill, the east side of Little Island, and in three large salt meadows between Ballynakill and Cheekpoint. The Atlantic and Mediterranean sub types are generally intermixed. The species list is extensive and includes Red Fescue (Festuca rubra), Oraches (Atriplex spp.), Sea Aster (Aster tripolium), Sea Couch Grass (Elymus pycnanthus), frequent Sea Milkwort (Glaux maritima), occasional Wild Celery (Apium graveolens), Parsley Water-dropwort (Oenanthe lachenalii), English Scurvygrass (Cochlearia anglica) and Sea Arrowgrass (Triglochin maritima). These species are more representative of the Atlantic sub-type of the habitat. Common Cord-grass (Spartina anglica), is rather frequent along the main channel edge and up the internal channels. The legally protected (Flora (Protection) Order, 1999) Meadow Barley (Hordeum secalinum) grows at the landward transition of the saltmarsh. Sea Rush (Juncus maritimus), an indicator of the Mediterranean salt meadows, also occurs.

The site is of particular conservation interest for the presence of a number of Annex II animal species, including Freshwater Pearl Mussel (Margaritifera margaritifera and M. m. durrovensis), Freshwater Crayfish (Austropotamobius

pallipes), Salmon (Salmo salar), Twaite Shad (Alosa fallax fallax), three species of Lampreys - Sea Lamprey (Petromyzon marinus), Brook Lamprey (Lampetra planeri) and River Lamprey (Lampetra fluviatilis) and Otter (Lutra lutra). This is one of only three known spawning grounds in the country for Twaite Shad.

Parts of the site have also been identified as of ornithological importance for a number of Annex I (EU Birds Directive) bird species, including Greenland White-fronted Goose (10), Golden Plover (1490), Whooper Swan (7) and Kingfisher. Figures given in brackets are the average maximum counts from 4 count areas within the site for the three winters between 1994 and 1997. Wintering populations of migratory birds use the site. Flocks are seen in Coolfinn Marsh and also along the reedbeds and saltmarsh areas of the Suir. Coolfinn supports nationally important numbers of Greylag Geese on a regular basis. Numbers between 600 and 700 are recorded.

Other species occurring include Mallard(21), Teal (159), Wigeon (26), Tufted Duck (60), Pintail (4), Pochard (2), Little Grebe (2), Black-tailed Godwit (20), Oystercatcher (16), Lapwing (993), Dunlin (101), Curlew (195), Redshank (28), Greenshank (4) and Green Sandpiper (1). Nationally important numbers of Lapwing (2750) were recorded at Faithlegg in the winter of 1996/97. In Cabragh marshes there is abundant food for surface feeding wildfowl which total at 1,000 or so in winter. Widgeon, Teal and Mallard are numerous and the latter has a large breeding population - with up to 400 in summer.

In addition, less frequent species like Shoveler and Pintail occur and there are records for both Whooper and Bewick's swans. Kingfisher, a species that is listed on Annex I of the EU Birds Directive, occurs along some of the many tributaries throughout the site Landuse at the site consists mainly of agricultural activities including grazing, silage production, fertilising and land reclamation. The grassland is intensively managed and the rivers are therefore vulnerable to pollution from run-off of fertilisers and slurry. Arable crops are also grown. Fishing is a main tourist attraction on stretches of the Suir and some of its tributaries and there are a number of Angler Associations, some with a number of beats. Fishing stands and styles have been erected in places. Both commercial and leisure fishing takes place on the rivers. The Aherlow River is a designated Salmonid Water under the EU Freshwater Fish Directive. Other recreational activities such as boating, golfing and walking are also popular.

Several industrial developments, which discharge into the river, border the site including three dairy related operations and a tannery.

The Lower River Suir contains excellent examples of a number of Annex I habitats, including the priority habitat Alluvial Forest. The site also supports populations of several Annex II animal species and a number of Red Data Book animal species. The presence of two legally protected plants (Flora (Protection) Order, 1999) and the ornithological importance of the river adds further to the ecological interest of this site."

The permitted development site overlaps with the cSAC boundary as the boundary extends half-way into the salt marsh and runs parallel to the shoreline. However none of the areas affected by construction of the plant appear to have significantly affected the salt marsh. The exception to this would be the construction of the hardcore road across the salt marsh at the eastern end of the site which encroaches a small degree upon the edge of the cSAC.

Of greater significance is the construction of the discharge pipe and the discharge itself. The permission to discharge may require the completion of an

'appropriate assessment' under Article 6 of the Habitats Directive. This type of assessment requires the competent authority to assess the impact of the development on the conservation objectives for the cSAC. The National Parks and Wildlife Service have prepared Conservation Management Plans for most cSACs which contain the Management Objectives for each site.

Other sites designated under the Habitats and Birds Directives within 5km of the site include the River Barrow and Nore cSAC that joins the Suir less than 5km downstream. The King's Channel, less than 3km downstream to the south west is a proposed Natural Heritage Area under the Wildlife Act 1976 as amended in 2000.

1.4.2 Records of Protected Species

Reference to the NPWS database of protected species was not made in the 1998 Ecology Report. The report does record several species that are noted as nationally-rare including the Hard-rush hybrid (*Juncus x diffusus*) and the Hybrid Sea Couch (formerly called *Elytrigia x oliveri* and now called *Elytrigia x drucei*). Neither of these species is protected under the Flora Protection Order 1999 which replaces early Orders in 1980 and 1987.

Species records for protected flora within the 10km x 10km square (S61) occupied by the site as shown in Table 1.1

Table 1.1: Species Records in the Vicinity of the Shellfish Site

Species	Common Name	Location	Full grid	Recorded date	Red Data Book
Groenlandia densa	Opposite-leaved Pondweed	Gaul's Mill	S61	1866	Vulnerable
Hordeum secalinum	Meadow Barley	Blenheim Hill	S645104	04/10/1994	Vulnerable
Hordeum secalinum	Meadow Barley	River Barrow Rochestown	S6919	05/07/1990	Vulnerable
Hordeum secalinum	Meadow Barley	River Barrow Ballinlaw ferry	S671169	12/08/1992	Vulnerable
Hordeum secalinum	Meadow Barley	River Barrow Ballinlaw ferry	S671169	1889	Vulnerable
Hordeum secalinum	Meadow Barley	Blenheim Hill	S645104	1889	Vulnerable
Hordeum secalinum	Meadow Barley	Belmont House	S634117	1972	Vulnerable
Hordeum secalinum	Meadow Barley	Fisherstown	S6817	1982	Vulnerable
Hordeum secalinum	Meadow Barley	Blenheim Hill	S645104	1993	Vulnerable
Hordeum secalinum	Meadow Barley	King's Channel	S642109	1996	Vulnerable
Hordeum secalinum	Meadow Barley	Fisherstown	S6817	25/06/1990	Vulnerable
Hordeum secalinum	Meadow Barley	River Barrow Rochestown	S6919	26/07/1995	Vulnerable
Hordeum	Meadow	Belmont	S634117	29/07/1991	Vulnerable

secalinum	Barley	House			
Puccinellia fasciculata	Tufted Salt-marsh Grass	Ringville	S676180	1997	Rare
Stachys officinalis	Betony	Rochshire Hill	S6010	1906	Vulnerable
Stachys officinalis	Betony	Waterford	S6010	1856	Vulnerable

Whilst all of these are protected by law, none have been recorded in the 1998 or 2008 studies.

1.4.3 Habitats present in 2008 Surveys

Habitats present in 1998 included hedgerows, wet grassland, agricultural grassland, wet woodland, salt marsh (Upper and Lower) and a freshwater stream.

The access road to the site from the entrance to the IDA lands to the north has been constructed. The site itself to the south of Springfield House has been almost entirely covered in development or in screening bunds to the south east and south of the development. Therefore the main habitats lost as a result of the development are the areas of poached meadow to the south of Springfield House. The photographs below show the site in March 2008.

Photo 1: South west corner of site showing upper salt marsh.

Photo 2: Looking north from southern edge of site to Springfield House.

Photo 3: Carr habitat around impounded lagoon with new hardcore route along path of discharge pipe on right.

It was not the purpose of this Addendum to audit the predictions of the 1998 EIS and due to the very wet conditions on site in the salt marsh, access to this area was not permitted by the Contractor for health and safety reasons. Also, the time of year of the 2008 survey would preclude against accurate identification of the Couch and Hard Rush hybrids so this was not attempted.

1.5 Update on Legislation protecting Habitats and Species

The following legislation exists in Ireland to protect against harm to valuable habitats or species:

- Wildlife Act 1976
- Wildlife (Amendment) Act 2000
- EC Habitats Directive 92/43/EEC
- EC Birds Directive 79/409/EEC
- European Communities (Natural Habitats) Regulations 1997 (amended 2005)
- Shellfish Waters Directive (79/923/EEC)
- Flora Protection Order 1999
- Live Bivalve Molluscs (Production Areas) Designation, 2006

Other legislation pertaining to Environmental Impact Assessment (e.g. EC 97/11/EC) has also been enacted within Ireland since the previous EIS was published.

The regulations that are relevant to the permitted development are described in Table 1.2.

Table 1.2 Current Legislation applicable to the WWTP – Ecology Related

Instrument	Requirement	Relevant Activity	Implications
European Communities (Natural Habitats) Regulations 1997 (Para. 15) – implements the EC Habitats Directive.	Activity within cSAC requires assessment to be made of effects on site's conservation objectives.	Discharge of treated effluent and any other works in cSAC area e.g. laying pipe.	Appropriate Assessment may be required before National Parks and Wildlife Service can approve activity. Screening Study and consultation with NPWS is recommended.
Forthcoming designation of Cheekpoint as Shellfish Waters under Shellfish Waters Directive (79/923/EEC)	Required to meet certain water quality standards in certain areas.	Effects of discharge of treated effluent and run-off from site.	The designation process has just commenced and therefore there is no information on the geographic limits of the proposed designation or the specific standards that will be required. However the standards are likely to be those stated in the Shellfish Waters Directive which is used as one of the standards in the EIS. The EIS states that this standard will be met in all shellfish beds areas downstream of the discharge.

Live Bivalve Molluscs (Production Areas) Designation, 2006.	Designates Waterford Harbour as an area where molluscs may be taken for human consumption by hand and sets certain coliform limits on their content. Bivalves from Waterford Harbour must be cleaned prior to human consumption.	Effects of discharge of treated effluent.	The 1998 EIS states that the status of the bivalves in the Waterford Harbour will not be altered by the proposed development.

In relation to the forthcoming designation of parts of the Suir Estuary, such as Cheekpoint, as Shellfish Waters under the Shellfish Waters Directive (79/923/EEC), the designations have not yet been confirmed and were not available for the purpose of this assessment.

Discussions on the 13th March, 2008, between Paul Scott of Scott Cawley Ltd and Dr Karen Creed (EPA), who is on the Working Group for the designations of the new Shellfish Waters. Dr Creed indicated that the general locations were identified but have not been mapped out in detail and are not yet available to the public. According to Dr Creed (*pers comm*) the designation process has started and she is meeting colleagues in Brussels in the near future to discuss these designations.

However the implications and requirements of this legislation (Live Bivalve Molluscs (Production Area), 2006) are shown in the table above.

In relation to the initial start-up period (3-4 months), the potential for the change in location of wastewater discharge from the existing discharge points to the new outfall to result in a negative impact on the ecology of the area was considered. Although the designations of the shellfish waters have not yet been confirmed, it appears that Cheekpoint will be the closest designation, and it is not believed that the change in the discharge location so far upstream (approximately 3 km) will have a negative impact over this short period.

Enpure Ltd
Odour Dispersion Report
Waterford WwTW
C1197

Issue	Date	Description	By	Checked	App.
1	10 April 2008	Contract Issue	RJM	TJB	DGG

Contents **Page No.**

Figures **Page No.**

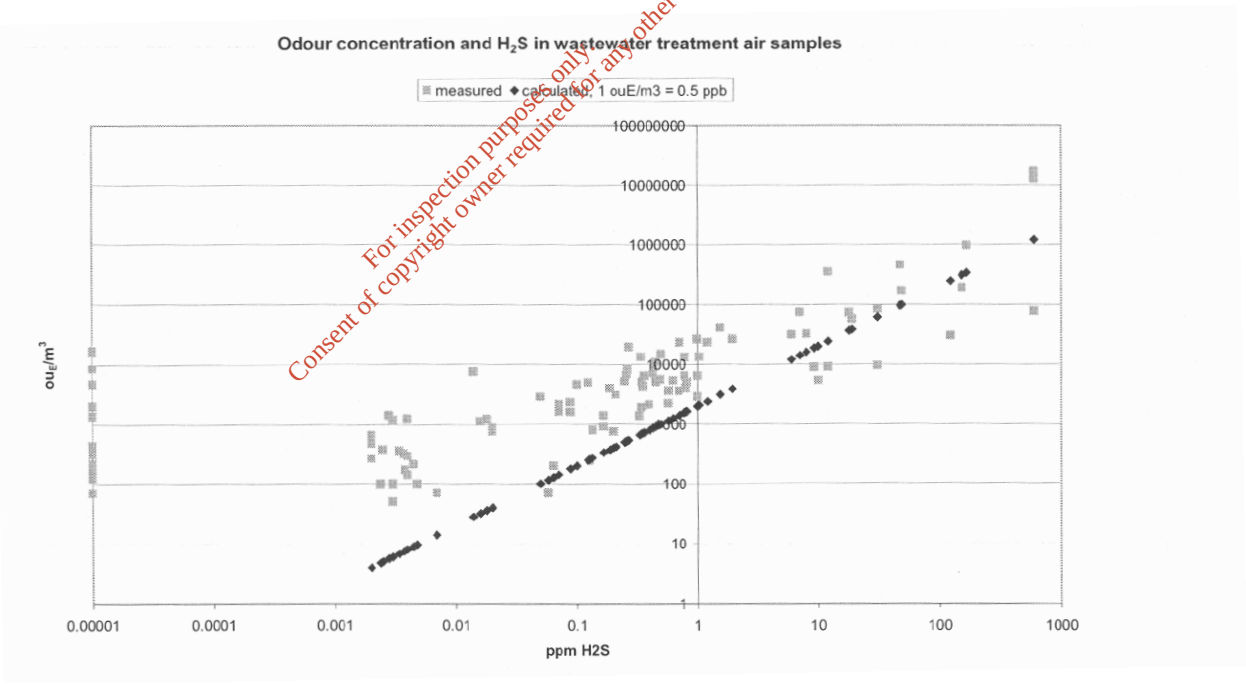
Tables **Page No.**

1. BACKGROUND AND SCOPE

Waterford WwTW will be installed on a new site at Gorteens, County Kilkenny, Republic of Ireland. An odour consent has been specified as a short-term average of 3 ou_E m^{-3} and 5 ou_E m^{-3} at the site boundary (or any receptor position), as a 95th percentile and at any time figure respectively, above background odour. In addition, there is a requirement to achieve 10 times less than these hourly-average short term concentrations at the nearest sensitive receptors. That is 0.3 ou_E m^{-3} as a 95th percentile and 0.5 ou_E m^{-3} at any time.

Note that a background hydrogen sulphide odour survey was carried out prior to construction with the results presented in the appendix. Traditionally, odour units have been converted to an H_2S equivalent. The commonly used conversion is 0.5 ppb of H_2S equates to 1 ou_E m^{-3}. This does however; assumes that all odours are caused by H_2S which is obviously not the case. Figure 1-1 shows that below 10 ppb if H_2S is converted to odour using this ratio, the concentration of odour can be under estimated. Using the lowest mean value recorded during the survey (2.86 ppb) and applying an odour threshold of 0.5 ppb to 1 ou_E m^{-3} this equates to 6 ou_E m^{-3}. When analysed in a laboratory using olfactometry testing, odour concentrations can typically range from 15 – 200 ou_E m^{-3}.

Figure 1-1 - The relationship between H_2S and odour concentration in wastewater treatment and sludge air samples, for the full range of 0.1 to 600 ppm. H_2S below detection threshold has been plotted as 0.01 ppb.



From: Chemicals as Odour Predictors: What Causes the Odour Deficit?, AP van Harreveld & M Stoaling, OdourNet UK Ltd, Odours. What a Nuisance Conference, 2002.

1.1. OLFACTOMETERY

Olfactometry is the measurement of the response of human assessors to olfactory stimuli and so can be highly subjective; different people find different odours offensive at different concentrations. For human assessors a combination of physiological reception and psychological interpretation convert an odour into an odour impression. In order to increase the reproducibility and objectivity of odour impressions, selected and screened human receptors are used. The CEN/TC264/WG2 (prEN 17325) standard sets out repeatability

requirements which are expressed as a log factor and, in simple terms, the standard permits a repeatability factor of up to 3 for 95% of analyses. In effect this means that the difference between the results of analyses of two identical samples should not vary by more than a factor of about three. The CEN standard defines a robust procedure where an odour sample is collected and progressively diluted and tested to the point that half of the panel detect an odour, this is defined as the odour threshold or 1 $ou_E\ m^{-3}$. The panel reply either 'yes' or 'no' to the question 'can you detect an odour?'. This makes it increasingly difficult to accurately determine odour concentrations much below 20 $ou_E\ m^{-3}$ without large numbers of samples. Some olfactometers are unable even to dilute samples down to these low concentrations.

1.2. DISPERSION MODELLING

Dispersion modelling aims to predict the impact to a receptor of an odour source or sources by calculating the theoretical transport of gaseous odorants. Following an emission into the atmosphere, two factors are important in determining the extent of the subsequent dispersion; wind velocity and atmospheric stability. Due to the number of calculations required to predict odour dispersion the modelling is carried out using a computer model. The model used by ENPURE Ltd is ADMS 3.3, developed by Cambridge Environmental Research Consultants (CERC).

ADMS 3.3 is a Gaussian dispersion model which predicts concentration profiles in the y (crosswind) and z (height) directions. ADMS 3.3 includes the facility to model the effect of buildings, local topography, multiple sources, exit velocity and meteorology. Other users of ADMS 3.3 include the Environmental Agency (EA) in England and Wales, and the Scottish Environmental Protection Agency (SEPA) in Scotland.

2. MODEL PARAMETERS

Waterford WwTW is assumed to be on the line of latitude 52:15:27N with surface roughness = 0.3 (equivalent to agricultural).

All gaseous odour emissions are assumed to have a temperature of the ambient conditions, specific heat capacity (Cp) = 1,012 J kg^{-1} $°C^{-1}$, molecular weight (MW) = 28.96 g $mole^{-1}$ and density (ρ) = 1.225 kg m^{-3}.

2.1. BUILDINGS

Buildings are defined as any structure which has a significant effect on the dispersion of pollutants. The main effect is to entrain pollutants into the cavity region in the immediate leeward side of the building, bringing them rapidly down to ground level. As a consequence, concentrations near the buildings are increased but decreased further away.

ADMS 3.3 models multiple buildings as one single equivalent building for each wind direction in the .met file, the height of which is the height of the building specified as the main building.

Table 2-1: Waterford WwTW Buildings

	X_c [m]	Y_c [m]	Height [m]	Length [m]	Width [m]	Angle[1] [°]
Inlet building	112168	265211	8	30.4	20.6	107.2
Sludge building	112206	265049	7	51	15.8	105.9
Admin building	112375	265122	7	21.8	9.2	105.9
Sludge holding tanks	112238	265070	9	28.8	12	107.4
Sludge digesters	112206	265079	13	30.1	13.3	107.4

[1] As measured from North, clockwise to the longest edge.

Importantly, where buildings are selected, as is often the case for WwTW, area sources must be input as equivalent point sources.

2.2. SOURCES AND EMISSIONS

It is proposed to cover or house all equipment, pumping stations, etc. associated with the inlet works and preliminary treatment facilities to contain odorous releases. The primary tanks are also covered and extracted. A connection from the covers or housing is routed to a common ductwork header and extracted to the odour abatement equipment (OCU1). A separate system is used to extract and treat odours arising from the sludge treatment process (OCU2).

The inputted odour sources to the model are; Belview pumping station, the storm tanks, selector and aeration tanks, final settlement tanks, digested sludge holding tank and two odour control unit outlet stacks. The Model does not take into account odorous emissions that might arise from existing areas of plant or equipment outside the site boundary.

The air discharge rate from the odour abatement systems are calculated from extraction rates from individual odorous sources based on various methodologies, the sum of which would be the total discharged to atmosphere. In this case, the air stream discharge rates are 13815 m^3 h^{-1} and 5042 m^3 h^{-1} from OCU1 and OCU2 respectively under normal operating conditions. The proposed stack locations are adjacent to the preliminary treatment building

and adjacent to the pasteurization plant, the exact location of which can be seen in drawing No. C1197-3002.

A limitation of the ADMS 3.3 model is that it cannot simultaneously model large area sources (e.g. aeration ditches, primary sedimentation tanks, storm tanks, etc.) and buildings. The model used in this study simulated the large area source (storm water tank) as a series of point sources. This process has been verified as an equivalent method of modelling.

There are six main sources of odour considered by the dispersion model:

- Odour control stacks which emits treated air at high velocity. The discharge air of stack 1 is the remains of foul air drawn from the inlet works, screening and grit handling and primary settlement tanks after odour treatment. The odour control design flow and load to this unit is 13815 $m^3 h^{-1}$ and 19 ppm H_2S, equivalent to 63533 $ou_E m^{-3}$. The reduction of odour across the treatment stage has been guaranteed as 99% as H_2S; this equates to an odour removal of 97%. A design emission of 28663 $ou_E m^{-2} s^{-1}$ has been selected as the model input. Therefore the odour release with a stack height of 10 m and exit velocity 15.0 m s^{-1} has been modelled from the stack 1.

The discharge air of stack 2 is the remains of foul air drawn from the sludge holding tanks, sludge thickeners, sludge dewaterers and liquor return PS after odour treatment. The odour control design flow and load to this unit is 5042 $m^3 h^{-1}$ and 49 ppm H_2S, equivalent to 97976 $ou_E m^{-3}$. The reduction of odour across the treatment stage has been guaranteed as 99% as H_2S; this equates to an odour removal of 95%. A design emission of 69317 $ou_E m^{-2} s^{-1}$ has been selected as the model input. Therefore the odour release with a stack height of 8 m and exit velocity 14.1 m s^{-1} has been modelled from the stack 2.

Table 2-2: Odour Stack Point Source

	Source Height [m]	Diameter [m]	X_p [m]	Y_p [m]
OCU1 Stack	10	0.57	112172	265163
OCU2 Stack	8	0.36	112252	265089

- Belview pumping station is vented by a tank breather pipe and is modelled as single point source due to the presence of buildings. The vent pipe is modelled as 1 point sources with design emission of 1850 $ou_E m^{-2} s^{-1}$. The odour release rate has been modelled as 0.1 $m^3 s^{-1}$ and the emission rate as 33 $ou_E s^{-1}$.

Table 2-3: Belview Pumping Station Point Source

	Source Height [m]	Diameter [m]	X_p [m]	Y_p [m]
Belview Pumping Station	0.1	0.15	112403	265133

- Selector tank distribution chamber (Sel) is an area source and is modelled as a group of point sources due to the presence of buildings. The distribution chamber is modelled as 9 point sources with design emission of 0.2 ou_E m^{-2} s^{-1}. The odour release rate has been modelled as 0.021 m^3 s^{-1} and the emission rate as 4 ou_E s^{-1} per point.

Table 2-4: Selector Tank Distribution Chamber Point Sources

Point Source	Source Height	Equivalent circular diameter	X_p	Y_p
	[m]	[m]	[m]	[m]
SEL1	2	5.2	112324	265083
SEL2	2	5.2	112337	265079
SEL3	2	5.2	112334	265069
SEL4	2	5.2	112321	265072
SEL5	2	5.2	112331	265081
SEL6	2	5.2	112328	265071
SEL7	2	5.2	112323	265078
SEL8	2	5.2	112329	265076
SEL9	2	5.2	112336	265074

Aeration tank (AS) is an area source and is modelled as a group of point sources due to the presence of buildings. The tank is modelled as 24 point sources with design emission of 0.2 ou_E m^{-2} s^{-1}. The odour release rate has been modelled as 0.094 m^3 s^{-1} and the emission rate as 19 ou_E s^{-1} per point.

Table 2-5: Aeration Tank Point Sources

Point Source	Source Height	Equivalent circular diameter	X_p	Y_p
	[m]	[m]	[m]	[m]
AS1	1	10.9	112351	265101
AS2	1	10.9	112389	265090
AS3	1	10.9	112373	265032
AS4	1	10.9	112335	265043
AS5	1	10.9	112359	265099
AS6	1	10.9	112366	265097
AS7	1	10.9	112374	265094
AS8	1	10.9	112381	265092
AS9	1	10.9	112346	265082
AS10	1	10.9	112353	265079
AS11	1	10.9	112361	265077
AS12	1	10.9	112368	265075
AS13	1	10.9	112376	265073
AS14	1	10.9	112384	265071
AS15	1	10.9	112340	265062
AS16	1	10.9	112348	265060
AS17	1	10.9	112356	265058
AS18	1	10.9	112363	265056
AS19	1	10.9	112371	265054
AS20	1	10.9	112378	265051
AS21	1	10.9	112343	265041
AS22	1	10.9	112350	265039
AS23	1	10.9	112358	265036
AS24	1	10.9	112365	265034

- Storm tanks (ST) is an area source and is modelled as a group of point sources due to the presence of buildings. The two tanks are modelled as 9 point sources with design emission of 0.125 ou_E m^{-2} s^{-1}. The odour release rate has been modelled as 0.64 m^3 s^{-1} and the emission rate as 4.8 ou_E s^{-1} per point.

Table 2-6: Storm Tank Point Sources

Point Source	Source Height	Equivalent circular diameter	X_p	Y_p
	[m]	[m]	[m]	[m]
ST11	1	7	112206	265131
ST12	1	7	112197	265131
ST13	1	7	112215	265131
ST14	1	7	112199	265124
ST15	1	7	112206	265122
ST16	1	7	112213	265124
ST17	1	7	112199	265138
ST18	1	7	112206	265140
ST19	1	7	112213	265138
ST21	1	7	112231	265124
ST22	1	7	112222	265124
ST23	1	7	112240	265124
ST24	1	7	112224	265117
ST25	1	7	112231	265115
ST26	1	7	112238	265117
ST27	1	7	112224	265131
ST28	1	7	112231	265133
ST29	1	7	112238	265131

- FST is an area source and is modelled as a group of point sources due to the presence of buildings. The four FST's are modelled as 9 point sources with design

emissions of 0.1 ou_E m^{-2} s^{-1}. The odour release rate has been modelled as 0.23 m^3 s^{-1} and the emission rate as 11 ou_E s^{-1} per point.

Table 2-7: Final Settlement Tank Point Sources

Point Source	Source Height	Equivalent circular diameter	X_p	Y_p
	[m]	[m]	[m]	[m]
FST1A	1	12	112293	265015
FST2A	1	12	112277	265015
FST3A	1	12	112309	265015
FST4A	1	12	112282	265004
FST5A	1	12	112293	264999
FST6A	1	12	112304	265004
FST7A	1	12	112282	265026
FST8A	1	12	112293	265031
FST9A	1	12	112304	265026
FST1B	1	12	112331	265004
FST2B	1	12	112315	265004
FST3B	1	12	112347	265004
FST4B	1	12	112320	264993
FST5B	1	12	112331	264988
FST6B	1	12	112342	264993
FST7B	1	12	112320	265015
FST8B	1	12	112331	265020
FST9B	1	12	112342	265015
FST1C	1	12	112373	264993
FST2C	1	12	112357	264993
FST3C	1	12	112389	264993
FST4C	1	12	112362	264982
FST5C	1	12	112373	264977
FST6C	1	12	112384	264982

FST7C	1	12	112362	265004
FST8C	1	12	112373	265009
FST9C	1	12	112384	265004
FST1D	1	12	112417	264973
FST2D	1	12	112401	264973
FST3D	1	12	112433	264973
FST4D	1	12	112406	264962
FST5D	1	12	112417	264957
FST6D	1	12	112428	264962
FST7D	1	12	112406	264984
FST8D	1	12	112417	264989
FST9D	1	12	112428	264984

- Digested sludge holding tank (DSHT) is an area source and is modelled as a group of point sources due to the presence of buildings. The DSHT is modelled as 9 point sources with design emission of 14 ou_E m^{-2} s^{-1}. The odour release rate has been modelled as 0.29 m^3 s^{-1} and the emission rate as 239 ou_E s^{-1} per point.

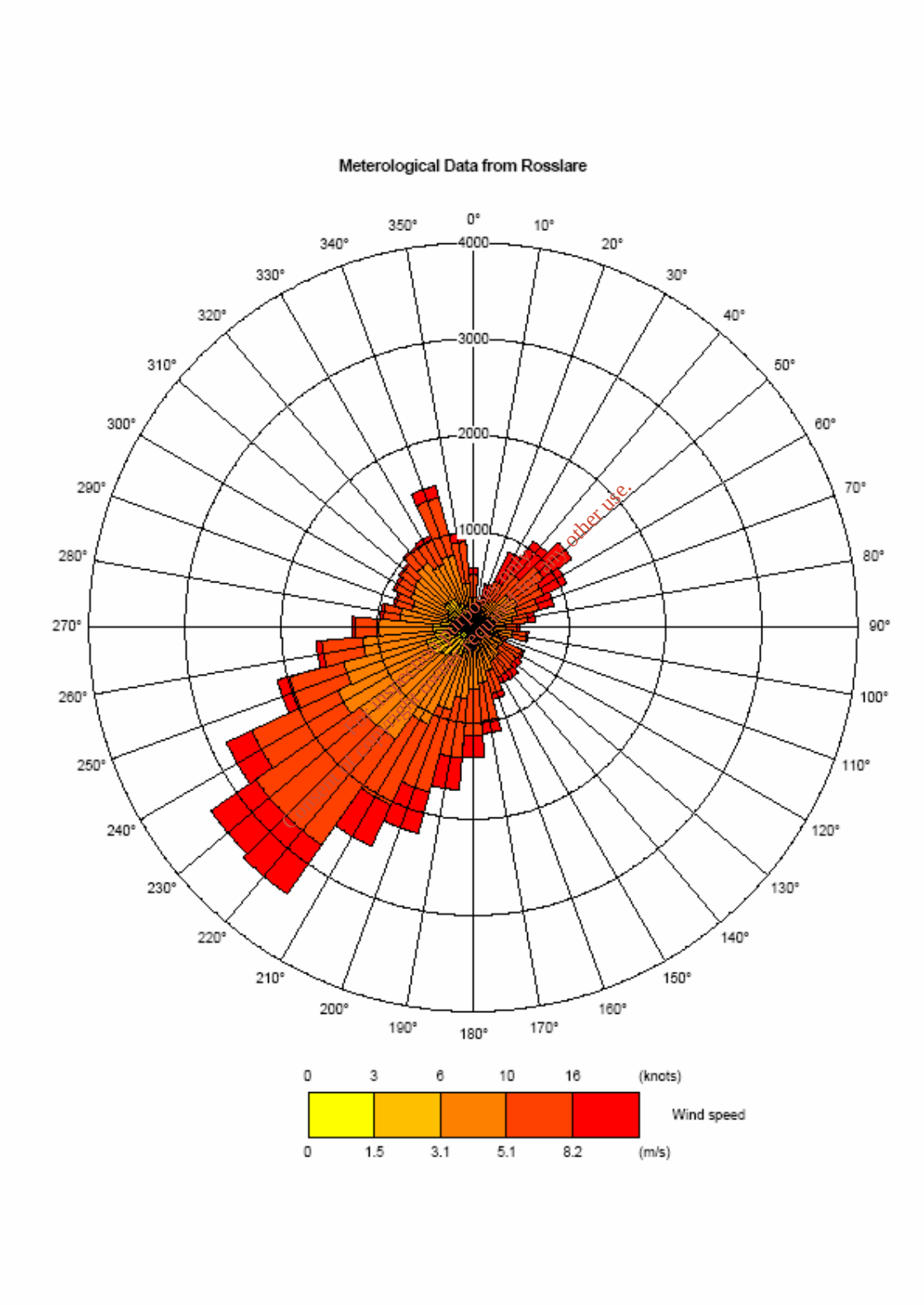
Table 2-8: Digested Sludge Holding Tank Point Sources

Point Source	Source Height	Equivalent circular diameter	X_p	Y_p
	[m]	[m]	[m]	[m]
DSHT1	9	4.7	112230	265073
DSHT2	9	4.7	112224	265073
DSHT3	9	4.7	112236	265073
DSHT4	9	4.7	112226	265069
DSHT5	9	4.7	112230	265067
DSHT6	9	4.7	112234	265069
DSHT7	9	4.7	112226	265077
DSHT8	9	4.7	112230	265079
DSHT9	9	4.7	112234	265077

2.3. METEOROLOGICAL DATA

The chosen synoptic station; that is one that records data on an hourly basis, such as air and soil temperatures, rainfall, wind, pressure, weather, cloud, visibility, humidity, sunshine is at Rosslare, County Wexford, Republic of Ireland. Although there are closer weather recording stations to the site, these are climate stations; which only record meteorological elements on a daily basis, such as rainfall, maximum and minimum temperatures and some record soil and earth temperatures, sunshine, solar radiation and evaporation. Five years of historical data are available spanning November 2001 to October 2006 inclusive. Figure 2-1 shows a summary of the meteorological data as a wind rose.

Figure 2-1: Wind Rose for Rosslare Met Weather Station



3. RESULTS AND CONCLUSIONS

The odour abatement equipment is designed so that, during operation of the works, the air discharged from the site shall not increase the short-term odour concentration by more than 3 ou_E m^{-3} as the 95th percentile and 5 ou_E m^{-3} at anytime, at the nearest sensitive receptor or anywhere on the boundary of the site. The specification states the short-term odour concentration at the receptor positions shall be assumed to be a factor of ten greater than the hourly-averages predicted by the dispersion model. It follows that the maximum allowable hourly-averaged odour concentration at the receptor positions shall be a factor of ten less than the guaranteed short-term average values. Therefore a long term limit ten times less than stipulated has been used as the desired condition at three receptor positions, A, B and C. This represents 0.3 ou_E m^{-3} as a 95th percentile and 0.5 ou_E m^{-3} at any time.

This model has also be used to determine the maximum allowable odour emission rate from the stack, which shall be converted to a hydrogen sulphide (H_2S) concentration and a suitable stack discharge height for effective dispersion. The H_2S concentration shall used to monitor and satisfy the performance requirements for the take-over tests of the odour abatement equipment, according to the equation below: -

$$C_s = C_t \times E/UK$$

Where:

C_s	-	hydrogen sulphide concentration in stack gas, ppb
C_t	-	threshold concentration of hydrogen sulphide, 0.5 ppb
E	-	maximum allowable odour emission rate (OU/s)
U	-	flow rate of the air from the stack (m^3/s)
K	-	ratio of the total TON of the stack air to the TON contributed by the H_2S in the stack air

(Equation taken from Employer's Requirements, Volume 4, Section 7.11.2.)

Preliminary and Primary Treatment Odour Control Unit

$C_s = 0.5 \times 7314/ (3.84 \times 5)$ OCU 1

$C_s = 190$ ppb

Therefore the short term stack hydrogen sulphide emission will be < 50 ppb.

Sludge Treatment Odour Control Unit

$C_s = 0.5 \times 6861/ (1.4 \times 5)$ OCU 2

$C_s = 490$ ppb

Therefore the short term stack hydrogen sulphide emission will be < 50 ppb.

The short term concentrations of hydrogen sulphide in the stack gas shall be automatically and continuously and periodically recorded. The upper 98 percentile value of these stack sample readings shall be less than the C_s shown above (Employer's Requirements, Volume 4, Section 7.11.2).

The contour plots (as shown on drawings C1197-3008/9) show that under normal operating conditions, the isopleths corresponding to 3 ou_E m^{-3} (95th percentile, 1-hour average) and 5 ou_E m^{-3} (anytime, 1-hour average) does not extend to or beyond the site boundary.

Similarly, at Receptors A and B (C being more distant from the site, beyond Receptor A) the contour plots show that under normal operating conditions, the isopleth corresponding to 0.3 ou_E m^{-3} (95th percentile, 1-hour average) does not extend to their location. Also the receptors are within the isopleth for 0.5 ou_E m^{-3} (anytime, 1-hour average), indicating it is not exceeded.

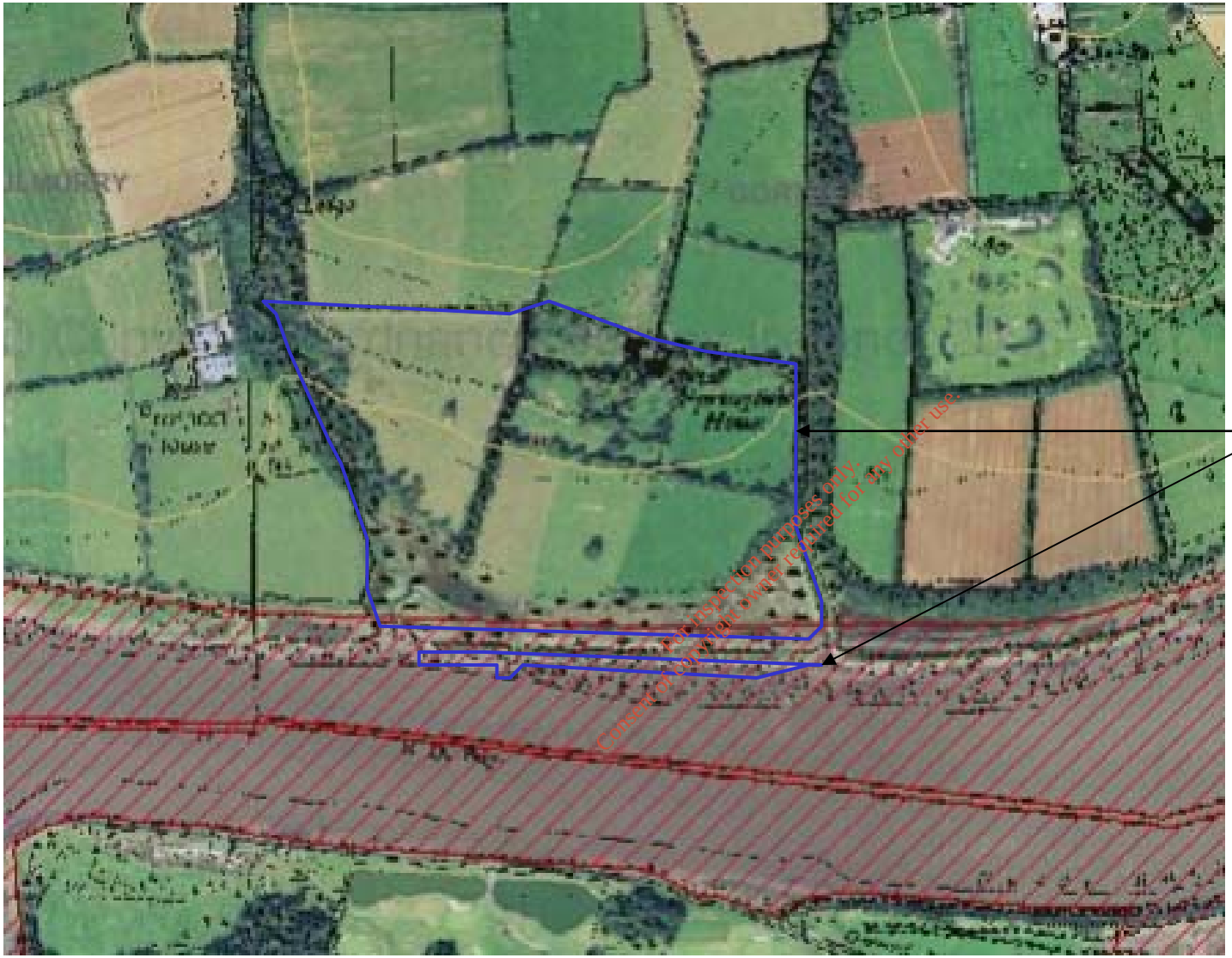
Therefore it can be concluded that simple dispersion following odour abatement equipment treating the collected odours will be sufficient to prevent any odour nuisance from occurring outside the works.

Odour dispersion modelling has demonstrated that for the stated emission rates from the odour control unit outlet stacks, the odour levels at the boundary and at specific receptors will be compliant. Therefore the stack locations chosen give good dispersion.

4. APPENDICES

4.1. BASELINE ODOUR SURVEY

Please refer to document ref: Ref: ECS2363 – April 2007 issued separately.



Project

Waterford WWTP Waste Licence Application

Reference

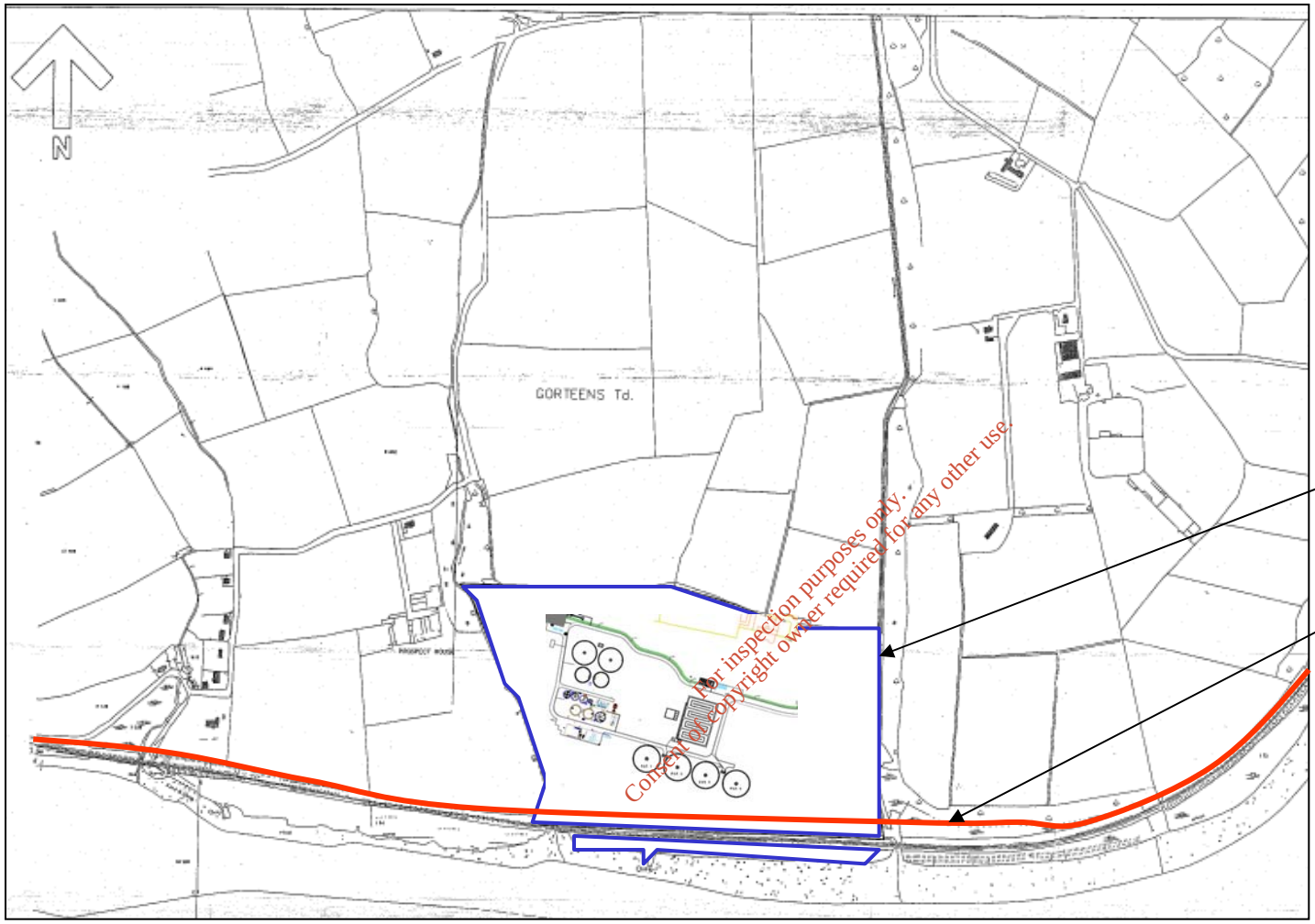
07_4084

Figure 07_4084 10.1

Aerial Photograph showing Boundary of cSAC overlapping Site Boundary

awnconsulting

Unit 5, ATS Building, Carrigaline Industrial Park, Carrigaline, Co. Cork
T: +353 21 438 7400 F: +353 21 483 4617



Scale 6inch:1 mile (approx. 1:10,560)

Project

Waterford WWTP Waste Licence Application

Reference

07/4084

Figure 07_4084 10.2

O.S. Map showing location of Facility

awnconsulting

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