APPENDIX A

MATHEMATICAL MODELLING OF RIVER SUIR

(34 PAGES)

Appendix A

Mathematical Modelling of Water Quality

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MATHEMATICAL MODELLING OF WATER QUALITY

A.1 INTRODUCTION

One of the principal environmental impacts associated with the proposed Waterford Main Drainage Scheme will be the resultant changes in water quality in the Suir Barrow Nore Estuary and in particular the River Suir in the vicinity of Waterford City. The likely changes in water quality have been quantified in this section based on analysis of the results produced from the application of the computer based mathematical model of the Suir Barrow Nore Estuary.

An assessment of the impacts associated with stormwater discharges to the River Suir and John's River from existing and proposed storm overflows within the City Catchment has also been carried out with the aid of the model. Furthermore, the environmental considerations regarding the quantity of stormwater which may be overflowed at the Waterpark Pumping Station have been examined based on the results of the mathematical model simulations. These issues are discussed in more detail in Appendix C.

A.2 DEVELOPMENT AND APPLICATION OF THE MATHEMATICAL MODEL.

A.2.1 Development of the Mathematical Model

As part of the project for drafting the Water Quality Management Plan for the Suir Barrow Nore Estuary a mathematical model was developed by An Foras Forbartha (McGettigan and Stapleton 1986). Subsequently the Environmental Research Unit was requested to refine this model with a view to carrying out a number of simulations of the effects of existing and potential future wastewater discharges from Waterford City and its environs. The model was recalibrated using the data collected in the Hydrographic Survey which was specifically undertaken for the Waterford Main Drainage Scheme. The model was then refined to allow for simultaneous modelling of continuous and intermittent discharges and the dispersion and decay of chemical and bacteriological constituents not previously modelled for the WQMP. The model was verified against results of the surveys of the Suir Barrow Nore Estuary undertaken by the Regional Water Laboratory (Neill 1990 and 1992).

A.2.2 Application of the Model

Following completion of recalibration and verification, the model was applied to eight load cases representing existing and future discharge conditions in Waterford City. The eight load cases modelled can be described as follows:-

Load Case 1	Present industrial and urban wastewater discharges (reference Case 1).
Load Case 2	Future industrial and urban wastewater discharges (reference Case 2)
Load Case 3	Treated effluent discharge from proposed treatment plant combined with a partially treated industrial discharge from Dawn Meats (Present Loads) (Design Case 1).
Load Case 4	Treated effluent discharge from proposed treatment plant combined with a partially treated industrial discharge from Dawn Meats (Future Loads) (Design Case 2).
Load Case 5	Combined treated effluent discharge from treatment plant (future loads) (Design Case 3).
Load Case 6	Treated effluent discharge (Future Loads) combined with storm overflow discharges and storm discharge >3DWF from Waterpark Pumping Station (Design Case 4).
Load Case 7	Treated effluent discharge (Future Loads) combined with storm overflow discharges and storm discharge >6DWF from Waterpark Pumping Station (Design Case 5).
Load Case 8	Treated effluent discharge (Future Loads) combined with storm overflow discharges and storm discharge >9DWF from Waterpark Pumping Station (Design Case 6).

Load Case 1 represents present untreated and partially treated wastewater discharges to the River Suir from urban and industrial sources within the Waterford City catchment. Load Case 2 represents the corresponding loads following future urban and industrial expansion to the year 2025. As such this load case represents the likely discharges which would be occurring in the future if a wastewater treatment facility were not provided.

Load Cases 3 and 4 represent the present and design treated effluent loads following implementation of the proposed scheme. These cases also include a separate partially treated effluent discharge from the Dawn Meats plant. Load Case 5 represents the combined treated effluent loads from the proposed treatment facility were the Dawn Meats industrial loads included in the treatment scope.

Load Cases 6, 7 and 8 represent the discharges likely to occur under the proposed scheme during wet weather conditions. In each case treated effluent from the proposed treatment facility will be accompanied by simultaneous discharges from existing and proposed storm overflow chambers. Through these three load cases, the quantity of storm water discharged from the Waterpark Pumping Station is varied from in excess of 3 DWF to in excess of 9 DWF.

Subsequent to this work being carried out, it was considered desirable that the assessment of alternative wastewater treatment plant sites should take into account potential industrial development adjacent to the proposed new port facility at Belview which resulted in the location of the most likely site for the proposed wastewater treatment plant being changed from Abbeylands to Gorteens. For the Abbeylands site option the mathematical model simulations of treated effluent discharges were based on an outfall located in the deep water channel of the River Suir opposite Waterpark Pumping Station. For the Gorteens site option however, it would not be feasible in terms of engineering and economic considerations to locate the wastewater treatment plant outfall at this location. An alternative location, in the main channel north-east of Little Island, was therefore identified as being the optimum location for a treated wastewater discharge from a treatment plant on the Gorteens site.

For this new treated effluent outfall loction it was necessary to rerun Loads Cases 3 and 4. An examination of the environmental impacts associated with locating the proposed outfall adjacent to Gorteens as opposed to Waterpark Pumping Station is discussed later in this Appendix.

A.3 WATER QUALITY CRITERIA AND STANDARDS

A.3.1 Environmental Quality Objective (EQO)

The Technical Committee on Effluent and Water Quality Standards (1978) suggests that national water quality management policies in Ireland should employ the Environmental Quality Objectives (EQO) approach as the most appropriate strategy for the setting of effluent standards. This approach implies the use of the waste assimilation capacity of the water body in question i.e. the amount of waste which may be discharged while maintaining water quality within the limits or objectives specified. Such an approach should ensure efficient use of water resources and maximum benefit from capital expenditure on wastewater treatment facilities.

The use of the EQO approach requires that water quality standards or objectives be set for the receiving waters. These standards are derived from the water quality criteria which define the conditions which are consistent with optimum exploitation of a particular water use.

A.3.2 Standards to be Observed

In terms of the Waterford Main Drainage Scheme the standards which are to be observed are those defined in Vol.4 of the Draft Water Quality Management Plan for the Suir Barrow Nore Estuary. The recommended standards contained in the WQMP are based on the water quality criteria from the three main USEPA Reports (1972, 1976 and 1980), the EC Directives concerning the quality of Bathing Water (76/160/EC), EC Directive on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life (78/659/EC) and EC Directive on the Quality Required for Shell Fish Waters (79/492/EC), and on the Memorandum Nr. 1 The Water Quality Guidelines issued by the DOE (1978). The preliminary list of water quality standards for the Suir Barrow Nore Estuary for selected parameters as contained in the WQMP is shown in Table A.1.

Subsequent to Vol. 4 of the Draft Water Quality Management Plan being published in 1985 a number of additional EC Directives have been adopted which have significant implications for discharge control and water quality standards. Those relevant to the present Waterford Main Drainage Scheme and its impact on the Suir Barrow Nore Estuary are as follows:-

Table A.1

Preliminary List of Water Quality Standards for the Suir Barrow Nore Estuary for selected parameters.

Parameter	Units	Water Quality Standards
Aesthetic Qualities		(a) for The Estuary as a whole : All waters should be free from substances attributable to other discharges that : - settle to form objectionable deposits, - float as debris, scum, oil, or other matter to form nuisances, - produce objectionable colour, odour, taste or turbidity, - injure or are toxic or produce adverse physiological responses in humans, animals or plants, - produce undesirable or nuisance aquatic life. (b) for the protection of important bathing areas : - all such bathing waters should be free of tarry residues and floating materials including wood, plastic articles, bottles, containers of glass, plastic, rubber or any other substance, waste or splinters.
Ammonia	**mg / l N**	for the tidal freshwater parts of The Estuary. As a general guideline : for un-ionised ammonia of not more than 0.004 mg / l N in 95 % of samples. for total ammonia of not more than 0.3 mg / l N in 95% of samples. Mandatory standard : for un-ionised ammonia of not more than 0.02 mg / l N in 95 % of samples. for total ammonia of not more than 0.8 mg / l N in 95% of samples.
Bacteria	**MPN / 100 ml**	(a) for the protection of recognised bathing waters : Total Coliforms A concentration of 5,000 per 100 ml in 80% of samples. Faecal Coliforms A concentration of 1,000 per 100 ml in 80% of samples. Faecal Streptococci A concentration of 300 per 100 ml in 90% of samples. *Salmonella* *Salmonella* to be absent from 90% of samples. (b) for the protection of shellfish waters : Faecal Coliforms A concentration of 300 per 100ml in 75% of samples from shellfish intervalvular fluid and from waters in which live shellfish directly edible by man (provisional standard).

Table A.1 (Contd.)

Parameter	Units	Water Quality Standards
B.O.D.	**mg / l**	B.O.D. should not be more than 4 mg / l in 95% of samples.
Disolved Oxygen	**mg / l O_2**	(a) for The Estuary as a whole : (i) General standard of not less than 7 mg / l in 50% of samples. (ii) General standard of not less than 5 mg / l in 95% of samples. (iii) No samples to have less than 4 mg / l. (b) for Shellfish Growing Areas : As a general guideline D.O. should be not less than 80% saturation at all times. Mandatory standard D.O. should be not less than 70% saturation at all times. (c) for important bathing areas : As a general guideline D.O. should be in the range 70 - 120% saturation during the bathing season (May to September, approx.).
Mixing Zones		Maximum dimension of mixing area should not exceed 10% of cross-sectional area of the waterway
Oxidised Nitrogen	**mg / l N**	Nitrate should be not more than 1.0 mg / l N in 95% of samples (as a guideline and only in outer estuary).
Oil & Grease (Petroleum Hydro-carbons)		(a) To protect aquatic life : Petroleum products should not be present in quantities as to : (i) form visible films on the surface of the water or form coating on the substratum, (ii) impart a detectable 'hydrocarbon' taste to edible finfish or shellfish, (iii) produce harmful effect in finfish and shellfish, (iv) have deleterious effect on other aquatic life. (b) for important bathing areas : General guideline of not more than 0.3 mg / l for mineral oils, General standard that no film be visible on the surface of the water and no odour should occur.

From "Water Quality Management Plan; Suir, Barrow, Nore Estuary".

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- EC Council Directive concerning Urban Wastewater treatment 21 May 1991 (91/271/EEC).
- EC Council Directive laying down the health conditions for the production and the placing on the market of live bivalve molluscs, 3 July 1991 (91/492/EEC).

The water quality standards to be observed for the Waterford Main Drainage Scheme therefore, will also include the specific requirements of the above Directives.

Throughout the following sections, the predicted impacts on water quality as defined by the results of the mathematical model are assessed in relation to the relevant water quality standards. Particular attention is paid to the likely impacts on the most important water quality - 'sensitive' beneficial uses of the estuary i.e. the fishery of salmonids, shell fish culturing and bathing.

A.4 PREDICTED CHANGES IN WATER QUALITY

A.4.1 Basis for Quantification

A.4.1.1 General

The changes in water quality which may be expected to occur in the River Suir and the Suir Barrow Nore Estuary, following implementation of the proposed Waterford Main Drainage Scheme have been quantified by comparing the results obtained from modelling both the existing and proposed scheme discharges. It is important to note that the application of the mathematical model will only predict the changes in water quality as opposed to predicting ultimate levels of the individual pollutant constituents. The model does not take into account background chemical or bacteriological levels which may exist due to other contributing factors, e.g. natural run-off from farmlands and discharges from boats/ships etc. From the results of the Harbour Water Quality Surveys carried out during 1991 and 1992 however, estimates of existing baseline and background levels have been obtained which may be added to the levels predicted by the model.

A.4.1.2 Existing and Future Discharges

The existing outfall point for the Waterford Scheme is opposite the Waterpark Pumping Station, where adequate depth of water is available for disposal of effluent in mid channel.

In addition, existing outfalls on the Kilkenny side of the river are located in the same general area. The stretch of estuary from Reginald's Tower to the separation of the estuary into two channels at Little Island, has a depth of water at low tide of between 6 and 10m.

Apart from some deterioration in the water quality of the river resulting from the above mentioned outfalls, no significant adverse conditions have arisen since their installation.

Discharge from the proposed Waterford Main Drainage Scheme will involve a single point source of treated effluent entering the River Suir via a submerged outfall at a location in the main channel north east of Little Island. Under the proposed scheme the main city discharge will be accompanied by a partially treated industrial discharge from the Dawn Meats plant at Granagh. For the alternative wastewater treatment plant site option at Abbeylands, the treated effluent would discharge to a location adjacent to the existing Waterpark Pumping Station outfall. The locations of the existing and proposed outfalls within the Scheme catchment are shown in Figure A.1

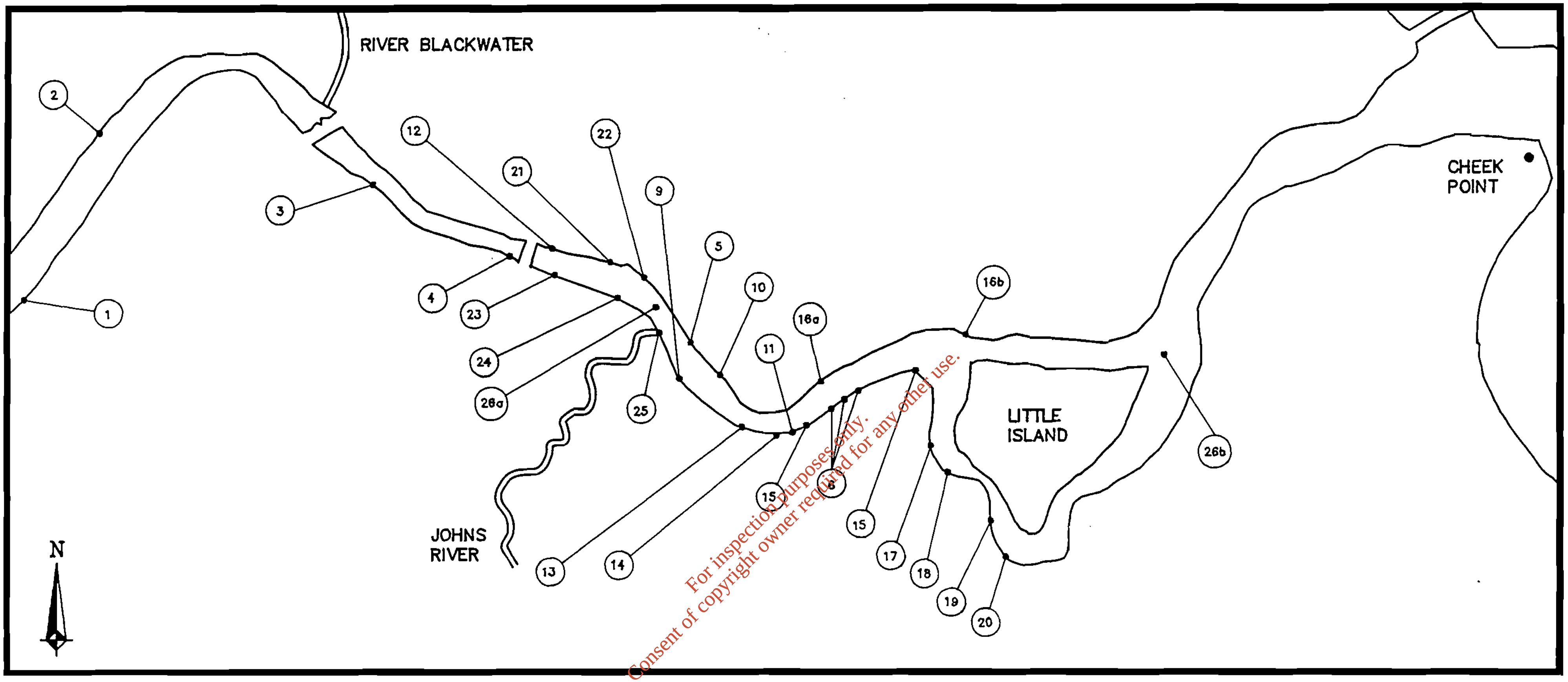
The mathematical model results for the proposed scheme load cases therefore represent the direct impact on water quality due to the Dawn Meats and proposed treatment plant discharges only. In the case of the existing scheme the results are an estimate of the proportion of the existing baseline constituent levels which can be attributed to the discharge of untreated and partially treated wastewaters from the Waterford City catchment.

On this basis, a direct comparison of the simulations of both the existing and proposed discharge conditions will yield a quantative assessment of the net changes in the river and estuary water quality.

Although the total dry weather flows (present and future) discharging to the River Suir under the proposed Main Drainage Scheme will be equivalent to those for the existing scheme, the pollutant loads will be considerably reduced following treatment and will be discharged as a single point source. Modelling of the proposed scheme assumes full secondary treatment of the total wastewater load from the scheme catchment area. Nutrient removal or disinfection of the wastewater has not been included in the determination of the final discharge loads.

A.4.1.3 Water Quality Parameters

The main parameters associated with treated and untreated urban wastewater discharges are BOD_5, Phosphorus, Nitrogen and Coliform



EXISTING INDUSTRIAL OUTFALLS	
No.	LOCATION
1.	KNOCK HOUSE
2.	GRANNAGH
3.	GRACEDIEU EAST
4.	RICE BRIDGE
5.	CHRISTENDOM
6–8.	REGIONAL HOSPITAL
9.	WATERPARK
10.	RATHCULLIHEEN
11.	GLENVILLE
12.	FERRYBANK

EXISTING URBAN OUTFALLS	
No.	LOCATION
13–15.	GLENVILLE,SYCAMORE,FRESHFIELD
16.	KING'S CHANNEL
16a.	ABBEY PARK
16b.	SLIEVERUE
17.	MARIAN TERRACE
18.	BALLYNAKILL
19–20.	VOLAN,ISLAND VIEW
9.	WATERPARK
21.	FERRYBANK
22.	ROCKLANDS,ROCKSHIRE
23.	BRIDGE ST. TO BARRON STRAND
24.	CONDUIT LANE & JOHN'S RIVER
25.	JOHN'S RIVER–STORM OVERFLOWS

PROPOSED WASTEWATER TREATMENT PLANT OUTFALL OPTIONS.	
No.	LOCATION
26a.	ABBEYLANDS
26b.	GORTEENS

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Figure A.1 : Locations of existing urban and industrial outfalls and proposed wastewater treatment plant outfall options.

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Bacteria. For the present investigation the dispersion and decay of BOD_5 and Coliform Bacteria was simulated for each of the eight load cases previously described. Phosphorus was modelled as Total Phosphorus for load cases 1 to 5 and was treated as a conservative parameter i.e. non-decaying. Similarly, nitrogen was modelled in terms of Kjeldahl Nitrogen for load cases 1 to 5 and again treated as a conservative non-decaying parameter.

For the purpose of this assessment, quantification of the net changes in river and estuary water quality is based primarily on comparisons of the predicted BOD_5 and Coliform Bacteria levels. The parameters BOD_5 and Coliform Bacteria have been taken as the basis for comparison because the dispersion and decay of these parameters can be modelled more accurately than the other constituents and their resultant levels can more readily be assessed for compliance with the relevant water quality standards.

A.4.1.4 BOD_5 Simulations

Simulation of the existing scheme is based on continuous untreated and partially treated dry weather discharges from each of the existing main outfalls within the scheme catchment area. The concentration of BOD_5 varies from outfall to outfall but the overall mean value is 305 mg/l under present loading and 284 mg/l under future design loading.

Following full secondary treatment the concentration of BOD_5 ultimately discharging from the proposed plant will be maintained at or below 20 mg/l under both present and future conditions.

The decay of BOD_5 following release to the receiving waters is generally modelled based on a constant decay coefficient. This decay coefficient has been shown in literature to only range between 0.15 and 0.2/day. An average decay coefficient of 0.18/day has been used for this study and is applicable to both the untreated and secondary treated effluent discharges.

A.4.1.5 Coliform Bacteria Simulations

There are two principal groups of Coliform Bacteria; the Faecal Coliforms (comprising mainly the bacterium Escherichia Coli) and the Total Coliform group, that includes the Faecal Coliforms and comprises mainly species of the genera Citrobacter, Enterobacter, Escherichia and Klebsiella. The former are exclusively faecal in origin, whereas the latter, although commonly found in faeces also occur naturally in unpolluted soils and waters.

The modelling of the dispersion and decay of Coliform Bacteria for the present study has been based on the Total Coliform Group. The quantity of Total Coliforms discharging at each of the existing outfalls has been quantified according to a raw wastewater concentration of 5 x 10^7 Total Coliforms/100ml. This concentration is only applicable to the domestic and commercial portions of the total wastewater loads. The industrial contribution is assumed to have no bacteriological content.

The 5 x 10^7 counts/100ml concentration for Total Coliforms in raw urban wastewater has been adopted based on the following:-

- Although the concentration of Total Coliforms in raw urban wastewater has been shown in literature to vary considerably, a report detailing a number of British coastal sites showed a clear seasonal trend with average Total Coliform concentrations of about $5x10^6$ counts/100ml in winter to $5x10^7$ counts/100ml in summer. The concentration adopted for the present study can therefore be considered representative of summer conditions.

- Analysis of flow proportional samples of the raw urban wastewater taken in Waterford City in July 1993 yielded a Total Coliform concentration of $4.3x10^7$ counts/100ml.

- The results from the modelling of the existing scheme using an initial concentration of 5 x 10^7 Total Coliforms/100ml show good agreement with measured Total Coliform levels in the River Suir in the vicinity of Waterford City (see Table A.2).

Although Coliform Bacteria have been modelled in the present study in terms of Total Coliforms, the results of the individual simulations may also be used to predict Faecal Coliform levels by employing a fixed ratio between the two Coliform Bacteria groups. For the purpose of the present investigation a ratio of 5 Total Coliforms to 1 Faecal Coliform has been used, implying a concentration of 1 x 10^7 Faecal Coliforms/100ml in the raw urban wastewater.

The ratio of 5 Total Coliforms to 1 Faecal Coliform has been adopted based on the following:-

- A concentration of 1 x 10^7 Faecal Coliforms/100ml compares with a general figure of $1x10^7$ E-Coli/100ml, as Faecal Coliforms comprise mainly of the bactericum E-Coli.

- The ratio adopted is consistent with the ratio of Total to Faecal Coliforms concentrations adopted in the EC Directive concerning

Table A.2

Comparison of modelled Total and Faecal Coliform Levels with measured levels at locations in the River Suir for T90 values of 6 hours and 12 hours.

Sampling / Prediction Points	Total Coliforms / 100 ml			Faecal Coliforms / 100 ml		
	Measured Mean Total Coliform Levels	Modelled Mean Total Coliform Levels T90 = 6 Hrs.	Modelled Mean Total Coliform Levels T90 = 12 Hrs.	Measured Mean Faecal Coliform Levels	Modelled Mean Faecal Coliform Levels T90 = 6 Hrs.	Modelled Mean Faecal Coliform Levels T90 = 12 Hrs.
50	3,420	2,963	5,393	653	593	1,079
51 c	6,460	5,191	7,806	1,258	1,038	1,561
52	* *	4,756	7,538	* *	951	1,508
53	6,188	2,994	5,583	1,383	599	1,117
57	* *	1,938	4,090	* *	388	818
55	* *	2,055	4,247	* *	411	849
59	2,772	658	1,824	586	132	365
60 a	* *	197	657	* *	39	131
63	* *	2	18	* *	0	4
64	132	0	4	50	0	1

- For locations of sampling / prediction points see Figure A.3

- Modelled values are based on neap tide conditions and a 95 percentile river flow.

- Measured values are based on results from Kilkenny Regional Water Laboratory , Water Quality Studies 1991.
  Samples taken on 4 / 6 / 1991 (mean tide , 95 percentile river flow).
  Samples taken on 31 / 7 / 1991 (mean tide , 95 percentile river flow).
  Samples taken on 11 / 9 / 1991 (spring tide , 95 percentile river flow).

* * Indicates that no measured values were available at these points.

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the Quality of Bathing Waters (76/160/EEC) and the subsequent EC Regulations (SI Nr. 84 of 1988) on this Directive.

- Analysis of flow proportionate samples of the raw urban wastewater taken in July 1993 yielded a Faecal Coliform concentration of $1.1x10^7$ counts/100ml.

- The results from the modelling of the existing scheme using an initial concentration of $1 x10^7$ Faecal Coliforms/100ml show good agreement with measured Faecal Coliform levels in the River Suir in the vicinity of Waterford City (See Table A.2).

The mortality of Coliforms in the receiving waters is, amongst other factors, a function of temperature, solar radiation, sedimentation and nutrient related effects. The rate of decay of Coliforms is generally expressed as a T_{90} i.e. the time taken for 90% of the micro-organisms to die off. Reviews of a number of studies have shown that, with few exceptions, the T_{90} value is never less than 4 hours. Again, wide variations in decay rates for raw wastewater are found in literature. The greater the T_{90} value the greater the possibility of coliforms existing in the river and estuary a long distance from the source.

For the purpose of the present study, an initial T_{90} of 6 hours was used for modelling the decay of Coliform Bacteria associated with the existing raw wastewater discharges. Load Case 1, which defines the existing industrial and urban discharges from the scheme catchment area to the River Suir was run for Total Coliform Bacteria where tidal conditions were modelled as neap tides and river flows as 95 percentile. The results of this simulation were then compared with the Total Coliform concentrations measured by the Kilkenny Regional Water Laboratory during the 1991 summer surveys. A direct comparison of the measured values and those modelled using a T_{90} of 6 hours is included in Table A.2

It should be noted that, while the mathematical model simulation is based on tidal conditions characterised by a repeating neap cycle, the measured values correspond to 3 dates where tidal conditions were characterised by mean cycles on the first two dates and a spring cycle on the third date. River flows on all three dates however were approximately equal to the 95 percentile conditions used in the model simulation.

Based on the results presented in Table A.2 it is clear that for both Total and Faecal Coliforms the modelled concentrations in the vicinity of the main city outfalls (Waterford Bridge to John's River) are within 20% of the measured concentrations. This represents good agreement under the circumstances and would suggest that the initial concentrations adopted for Total and Faecal Coliforms are quite accurate. Downstream of the main City outfalls however, between John's River and Cheek Point, the modelled Total and Faecal Coliform levels are only about 20 to 50% of the measured values. This would suggest that the T_{90} value of 6 hours is too short and that in reality the Coliform Bacteria are surviving for a longer period of time and therefore at longer distances from their source of entry to the river.

Another factor which must be considered is the difference in tidal conditions between that used in the model simulation and those which were occurring on the dates of the water quality sampling. The mean and spring tides prevailing during the survey dates would have a greater carrying capacity on the ebb than that of the neap tide used in the model simulation. Consequently it is likely that Coliform Bacteria associated with the raw wastewater discharges from Waterford City are carried further downstream in a shorter period of time on the ebb of mean and spring tides than on the ebb of neap tides.

It should also be borne in mind that the modelled values do not include background Coliforms levels which make up a proportion of the measured values. It is estimated however that background Coliform levels in the Suir Barrow Nore Estuary are low in comparison with the levels generated due to existing untreated and partially treated urban wastewater discharges.

At a location in the outer estuary, off Creadon Head for example, it can be expected that urban wastewater discharges from Waterford City and environs will not impact upon bacteriological levels in this area. A measured mean Total Coliform concentration of 26 counts/100ml and a measured Mean Faecal Coliform concentrations of 7 counts/100ml off Creadon Head can therefore only be attributed to other sources and thus can be considered representative estimates of background Coliform levels in the estuary.

In order to model, as accurately as possible, the bacteriological impacts of the existing untreated wastewater discharges it was decided to increase the T_{90} value associated with the raw wastewater from 6 hours to 12 hours. Load Case 1, which defines the existing industrial and urban wastewater discharges from the scheme catchment area to the River Suir, was therefore rerun for Total Coliform Bacteria with a T_{90} of 12 hours. The results of this simulation were again compared with the Total Coliform concentrations measured by the Kilkenny Regional Water Laboratory. Table A.2 shows a direct comparison of these results which also includes the modelled values for a T_{90} of 6 hours and the corresponding values for measured and modelled Faecal Coliform Bacteria.

Based on a T_{90} value of 12 hours the modelled results again show good agreement with the measured values in the vicinity of the main city outfalls. Further downstream, at Giles Quay, the modelled mean Total Coliform levels for a T_{90} of 12 hours is 5,582 counts/100 ml. This compares with a measured value of 6,188 counts/100 ml at the same location.

In terms of Faecal Coliforms, the modelled mean concentration at Giles Quay of 1,117 counts/100ml compares with a measured mean concentration of 1,383 counts/100ml. Clearly these figures demonstrate very good agreement under the circumstances. The slight under estimations of the modelled figures can be attributed to the factors discussed above i.e.:-

- The difference in tidal conditions associated with the modelled simulations and those prevailing on the water quality survey dates.

- The presence of background Coliform Bacteria in the measured concentrations.

Based on the results presented in Table A.2 therefore, it can be concluded that a T_{90} value of 12 hours is representative of the decay of Coliform Bacteria following raw urban wastewater discharges to the River Suir.

From a review of relevant literature, it is evident that following full secondary treatment, the concentrations of Coliform Bacteria will be reduced by at least 90%. Recent research in this area by the WRc [15] [16] has indicated that on average the concentration of Faecal Coliforms in secondary treated urban wastewaters varies between 1×10^3 counts/100ml and 1×10^5 counts/100ml. This would suggest that with an initial concentration of 1×10^7 Faecal Coliforms/100ml the percentage removal across the secondary treatment process would be in excess of 99%. For the present investigation a conservative removal efficiency of 90% has been adopted for both Total and Faecal Coliform Bacteria.

Apart from removing at least 90% of Coliform Bacteria, full secondary treatment will also influence the T_{90} value of the remaining bacteria. Through the secondary treatment process only the weaker organisms are killed off and it is estimated that the T_{90} value for the remaining organisms can be doubled. For the purpose of this investigation a T_{90} value of 24 hours is used to model the decay of Total and Faecal Coliforms associated with a secondary treated wastewater.

A.4.2 Interpretation of Model Results

A.4.2.1 Results Presentation

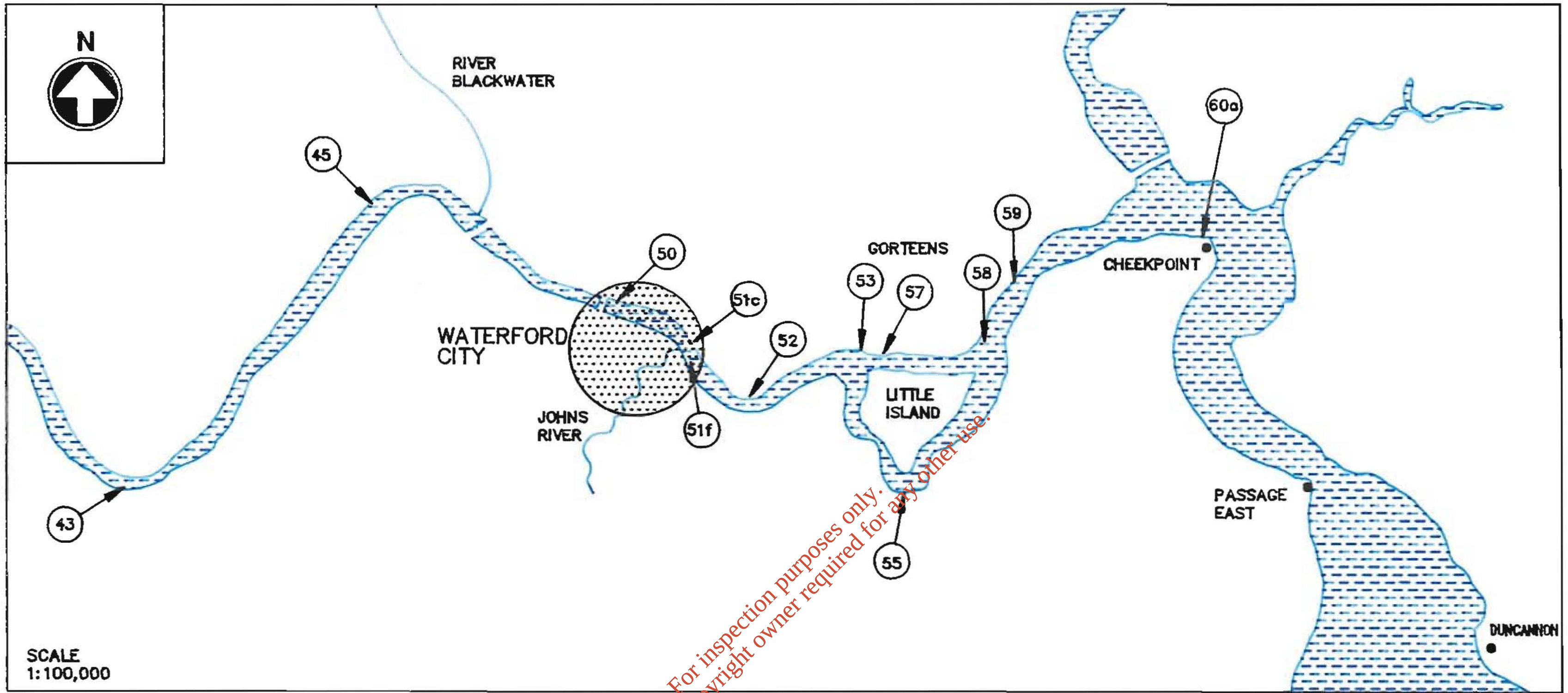
For both the existing scheme and proposed scheme model simulations, present and future design loading conditions have been assessed under a tidal regime characterised by a repeating neap cycle and river flow characterised by 95 percentile conditions, as specified in the Water Quality Management plan. The dispersion and decay of Coliform Bacteria has also been assessed under the conditions of spring tides and average river flows.

Output from the model runs as presented in this discussion is in the form of tabulated comparisons of maximum, mean and minimum values, for the existing and proposed schemes, at specific locations in the River Suir and the Suir Barrow Nore Estuary. The positions at which model predictions have been outputted were chosen to coincide with the water quality sampling points used in the preparation of the Water Quality Management Plan and in the water quality studies carried out since. The locations of the water quality sampling/prediction points used for both BOD_5 and Coliform Bacteria are shown in Figures A.2 and A.3.

A.4.2.2 BOD Levels

Table A.3 is a direct comparison of the maximum, mean and minimum predicted BOD_5 levels resulting in the estuary from the existing and proposed scheme discharges under present loading conditions. It should be noted that the predicted levels as presented do not include background levels which may exist due to other contributing factors. The corresponding comparison of the existing and proposed schemes under future design loading is given in Table A.4.

Table A.5 includes an estimate of the ultimate BOD_5 levels, including background values, which might be expected to prevail in the estuary following implementation of the proposed scheme. The existing background BOD_5 values at each of nine locations have been calculated by subtracting the values predicted by modelling the existing scheme from the baseline values measured during the water quality studies carried out by the Kilkenny Regional Water Laboratory between June and September 1991. Both the measured and predicted values for this exercise have



Station No.	Sampling/Prediction Point	Station No.	Sampling/Prediction Point
43	Mount Congreve	53	Giles Quay
45	Granny Castle	57	Little Island
50	Waterford Bridge	55	Kings Channel(Ballymaclode)
51c	Abbeylands	58	E.Confluence with King's Channel
51f	Waterpark Outfall	59	Glass House Quay
52	Smelting House	60a	Cheekpoint Pier

Figure A.2 Station Locations for water quality sampling/mathematical model predictions – BOD_5

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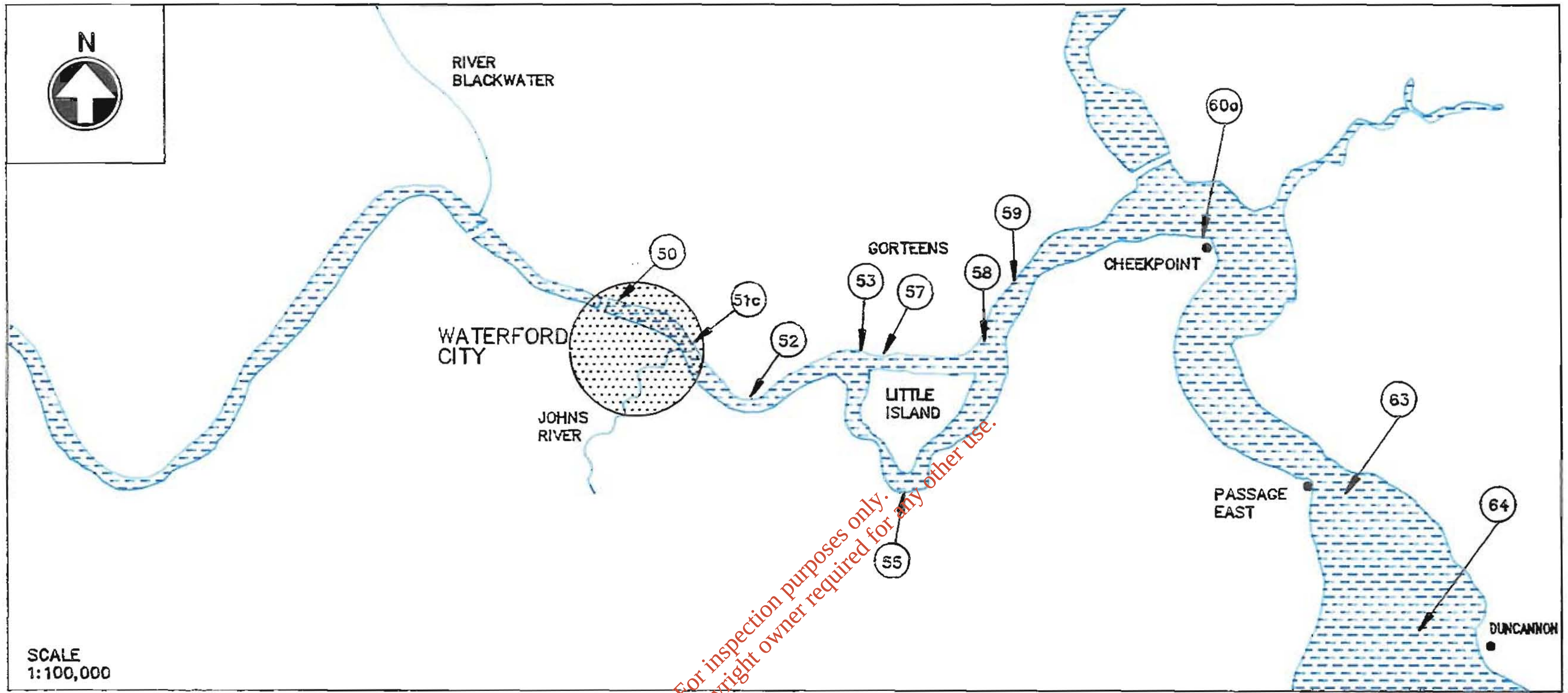
SPRINGVILLE HOUSE BLACKROCK ROAD CORK



Station No.	Sampling/Prediction Point	Station No.	Sampling/Prediction Point
50	Waterford Bridge	58	E.Confluence with King's Channel
51c	Abbeylands	59	Glass House Quay
52	Smelting House	60a	Cheekpoint Pier
53	Giles Quay	63	Spit Light Passage East
55	Kings Channel(Ballymaclode)	64	Duncannon
57	Little Island		

Figure A.3 Station Locations for water quality sampling/mathematical model predictions – Coliforms.

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Table A.3

Comparisons of predicted maximum , mean & minimum concentrations of BOD(mg/l) at locations in the River Suir.

Existing Scheme / Proposed Scheme - Present Loading.

Sampling / Prediction Point	Maximum BOD Values (mg/l)		Mean BOD Values (mg/l)		Minimum BOD Values (mg/l)	
	Existing scheme	Proposed scheme	Existing scheme	Proposed scheme	Existing scheme	Proposed scheme
43	0.5	0.03	0.2	0.02	0.0	0.00
45	0.8	0.04	0.5	0.03	0.1	0.02
50	0.9	0.04	0.7	0.04	0.5	0.03
51 c	0.9	0.04	0.7	0.04	0.5	0.03
51f	0.9	0.04	0.7	0.04	0.5	0.03
52	0.8	0.04	0.7	0.04	0.4	0.03
53	0.8	0.04	0.6	0.04	0.3	0.03
57	0.8	0.06	0.5	0.04	0.2	0.03
55	0.7	0.04	0.5	0.04	0.3	0.02
58	0.7	0.06	0.4	0.03	0.2	0.03
59	0.6	0.04	0.3	0.03	0.1	0.02
60 a	0.3	0.03	0.2	0.02	0.1	0.01

- 95 percentile river flow .
- Repeating neap tides .
- Background levels excluded .
- For locations of sampling / prediction points see Figure A.2

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Table A.4

Comparisons of predicted maximum , mean & minimum concentrations of BOD(mg/l) at locations in the River Suir.

Existing Scheme / Proposed Scheme - Future Loading.

Sampling / Prediction Point	Maximum BOD Values (mg/l)		Mean BOD Values (mg/l)		Minimum BOD Values (mg/l)	
	Existing scheme	Proposed scheme	Existing scheme	Proposed scheme	Existing scheme	Proposed scheme
43	0.6	0.04	0.2	0.02	0.0	0.00
45	1.1	0.06	0.7	0.04	0.2	0.03
50	1.1	0.06	0.9	0.05	0.7	0.04
51 c	1.1	0.06	0.9	0.05	0.6	0.04
51f	1.2	0.06	0.9	0.05	0.6	0.04
52	1.1	0.06	0.8	0.05	0.5	0.04
53	1.1	0.06	0.8	0.05	0.4	0.04
57	1.0	0.08	0.6	0.05	0.3	0.04
55	0.9	0.05	0.6	0.04	0.4	0.03
58	0.9	0.08	0.5	0.05	0.3	0.03
59	0.7	0.05	0.4	0.04	0.2	0.02
60 a	0.4	0.04	0.2	0.03	0.1	0.02

- 95 percentile river flow .
- Repeating neap tides .
- Background levels excluded .
- For locations of sampling / prediction points see Figure A.2

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Table A.5

Estimate of baseline BOD levels(mg/l) at locations in the River Suir following completion of the proposed scheme.

Sampling / Prediction Point	Measured mean BOD levels (mg/l)	Modelled mean BOD levels (mg/l) for existing discharges (untreated)	Estimated mean background BOD levels(mg/l)	Modelled mean BOD levels (mg/l) for future discharge (treated)	Estimated mean future baseline BOD levels(mg/l)
43	2.37	0.20	2.17	0.02	2.19
45	1.78	0.50	1.28	0.03	1.31
50	2.67	0.70	1.97	0.04	2.01
51 c	2.27	0.70	1.57	0.04	1.61
51f	* *	0.70	* *	0.04	* *
52	2.02	0.70	1.32	0.04	1.36
53	2.00	0.60	1.40	0.04	1.44
57	1.94	0.50	1.44	0.04	1.48
55	* *	0.50	* *	0.04	* *
58	2.02	0.40	1.62	0.03	1.65
59	2.18	0.30	1.88	0.03	1.91
60 a	* *	0.20	* *	0.02	* *

- For locations of sampling / prediction points see Figure A.2

- Modelled values are based on neap tide conditions and a 95 percentile river flow.

- Modelled values are based on results from Kilkenny Regional Water Laboratory, Water Quality Studies 1991.
  Samples taken on 4 / 6 / 1991 (mean tide , 95 percentile river flow).
  Samples taken on 31 / 7 / 1991 (mean tide , 95 percentile river flow).
  Samples taken on 11 / 9 / 1991 (spring tide , 95 percentile river flow).

* * Indicates that no measured values were available at these points.

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been averaged over high and low water conditions to ensure uniformity. The estimated ultimate BOD_5 levels at the nine locations have then been established by adding the values predicted by modelling the proposed scheme to the calculated background levels.

The ultimate BOD_5 levels presented in Table A.5 are therefore an estimate of the future baseline levels likely to exist immediately following implementation of the proposed scheme. It is academic to predict conditions under future loads (horizon year 2025) primarily because present baseline and background levels on which all predictions are based will not be applicable at that time.

Conclusions

The following is a summary of the main conclusions which can be drawn regarding the likely changes in BOD_5 levels in the River Suir and the Suir, Barrow, Nore Estuary.

(a) Implementation of the proposed scheme will result in an improvement in BOD_5 levels throughout the River Suir from Mount Congreve to Cheek Point.

(b) Even at the mouth of the proposed outfall pipe an improvement on existing BOD_5 levels will occur. The existing mean baseline BOD_5 level at this location has been measured at 2.02 mg/l. Following implementation of the proposed scheme it is anticipated that the baseline BOD_5 level at this point will reduce to a mean value of 1.65 mg/l.

(c) It is predicted that full secondary treatment of wastewater from Waterford City and environs under the proposed scheme will result in baseline BOD_5 levels being maintained well below 3 mg/l which will more than satisfy the 4 mg/l standard specified in the Water Quality Management Plan for the Suir Barrow Nore Estuary.

(d) Under present loading conditions no increase greater than 1 mg/l on background BOD_5 levels occurs due to the discharge of untreated and partially treated wastewater from the existing scheme. Under future loading conditions however, it is anticipated that the continued discharge of untreated and partially treated wastewater will raise the background BOD_5 levels by more than 1 mg/l over an area of the River Suir extending from Granny Castle to Little Island. This will contravene the recommendation of the Department of the

Environment Water Quality Guidelines (1978) which states that "effluent discharges which are calculated to raise the BOD_5 of the receiving water, outside the mixing zone, by more than 1 mg/l should be discouraged".

A.4.2.3 **Coliform Bacteria Levels**

Table A.6 is a direct comparison of the maximum, mean and minimum predicted Total Coliform levels resulting in the estuary due to the existing and proposed scheme discharges under present loading conditions. Again, background levels due to other contributing factors are not included in these levels. The corresponding comparison of Total Coliform levels under future design loading is given in Table A.7. Tables A.8 and A.9 contain direct comparisons of the maximum, mean and minimum predicted Faecal Coliform levels resulting in the estuary under present and future design loadings respectively.

In the interpretation of the mathematical model results presented in Tables A.6 to A.9 particular attention has been paid to the impacts of the existing and proposed urban wastewater discharges on the bacteriological water quality - sensitive areas in the estuary i.e. bathing waters and shell fish producing waters. Figure A.4 shows the locations of these areas in proximity to Waterford City.

The only areas in the Suir, Barrow, Nore Estuary currently designated as "Bathing Waters" are at Dunmore Strand and Councillor's Strand in Dunmore East and the beach at Duncannon. Other popular bathing areas at Arthurstown, Woodstown, Creadan. Booley Bay and Dollar Bay are not currently designated but may become so in the future.

No areas in the Suir Barrow Nore Estuary are currently designated for shell fish cultivation. However, mussels are presently being harvested by members of the local shell fish Co-Operative from a number of natural beds and newly reseeded beds between Cheek Point and Duncannon. The harvesting of shell fish in this part of the estuary is likely to expand in the future. The Water Quality Management Plan addresses this point as follows:- "The Estuary provides the only location in the south-east where suspension culture of shell fish could be carried out. Apparently the area of most potential for suspended culture is between Passage East and the Barrow/Suir confluence mostly along the western side but also along the eastern shore".

Table A.6

Comparisons of predicted maximum , mean & minimum concentrations of Total Coliforms (counts/100ml) at locations in the River Suir.

Existing Scheme / Proposed Scheme - Present Loading.

Sampling / Prediction Point	Max. T.Coli Levels / 100 ml		Mean T.Coli Levels / 100 ml		Min. T.Coli Levels / 100 ml	
	Existing scheme	Proposed scheme	Existing scheme	Proposed scheme	Existing scheme	Proposed scheme
50	18,300	1,117	5,393	444	604	9
51 c	23,310	1,196	7,806	525	4,644	44
52	13,790	1,275	7,538	605	1,182	78
53	10,590	1,409	5,583	691	874	165
57	8,727	3,245	4,090	1,098	232	356
55	8,120	868	4,247	542	738	375
58	* *	3,533	* *	1,768	* *	747
59	4,576	1,224	1,824	789	55	143
60 a	2,328	860	657	440	16	67
63	69	242	18	84	1	8
64	14	93	4	29	0	3

- 95 percentile river flow .
- Repeating neap tides .
- Background levels excluded .
- For locations of sampling / prediction points see Figure A.3

* * Predicted values for existing scheme not available at those points.

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Table A.7

Comparisons of predicted maximum , mean & minimum concentrations of Total Coliforms (counts/100ml) at locations in the River Suir.

Existing Scheme / Proposed Scheme - Future Loading.

Sampling / Prediction Point	Max. T.Coli Levels / 100 ml		Mean T.Coli Levels / 100 ml		Min. T.Coli Levels / 100 ml	
	Existing scheme *	Proposed scheme	Existing scheme *	Proposed scheme	Existing scheme *	Proposed scheme
50	26,092	1,592	7,613	633	861	12
51 c	33,238	1,705	11,043	747	6,599	62
52	19,618	1,817	10,752	861	1,746	111
53	15,050	2,008	8,011	984	1,324	235
57	12,598	4,624	5,921	1,565	351	507
55	11,586	1,237	6,111	773	1,048	534
58	* *	5,034	* *	2,517	* *	1,064
59	6,549	1,745	2,643	1,124	83	204
60 a	3,337	1,225	965	627	24	95
63	98	345	27	120	2	11
64	14	132	6	42	0	4

- 95 percentile river flow .
- Repeating neap tides .
- Background levels excluded .
- For locations of sampling / prediction points see Figure A.3

* Predicted future values for existing scheme scaled up from predicted present values.

* * Predicted values for existing scheme not available at those points.

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Table A.8

Comparisons of predicted maximum , mean & minimum concentrations of Faecal Coliforms (counts/100ml) at locations in the River Suir.

Existing Scheme / Proposed Scheme - Present Loading.

Sampling / Prediction Point	Max. F.Coli Levels / 100 ml		Mean F.Coli Levels / 100 ml		Min. F.Coli Levels / 100 ml	
	Existing scheme	Proposed scheme	Existing scheme	Proposed scheme	Existing scheme	Proposed scheme
50	3,660	223	1,079	89	121	2
51 c	4,662	239	1,561	105	929	9
52	2,758	255	1,508	121	236	16
53	2,118	282	1,117	138	175	33
57	1,745	649	818	220	46	71
55	1,624	174	849	108	148	75
58	* *	707	* *	354	* *	149
59	915	245	365	158	11	29
60 a	466	172	131	88	3	13
63	14	48	4	17	0	2
64	3	19	1	6	0	1

- 95 percentile river flow .
- Repeating neap tides .
- Background levels excluded .
- For locations of sampling / prediction points see Figure A.3

* * Predicted values for existing scheme not available at those points.

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Table A.9

Comparisons of predicted maximum , mean & minimum concentrations of Faecal Coliforms (counts/100ml) at locations in the River Suir.

Existing Scheme / Proposed Scheme - Future Loading.

Sampling / Prediction Point	Max. F.Coli Levels / 100 ml		Mean F.Coli Levels / 100 ml		Min. F.Coli Levels / 100 ml	
	Existing scheme *	Proposed scheme	Existing scheme *	Proposed scheme	Existing scheme *	Proposed scheme
50	5,218	318	1,523	127	172	2
51 c	6,648	341	2,209	149	1,320	12
52	3,924	363	2,150	172	349	22
53	3,010	402	1,602	197	265	47
57	2,520	925	1,184	313	70	101
55	2,317	247	1,222	155	210	107
58	* *	1,007	* *	503	* *	213
59	1,310	349	529	225	17	41
60 a	667	245	193	125	5	19
63	20	69	5	24	0	2
64	3	26	1	8	0	1

- 95 percentile river flow .
- Repeating neap tides .
- Background levels excluded .
- For locations of sampling / prediction points see Figure A.3

* Predicted future values for existing scheme scaled up from predicted present values.

* * Predicted values for existing scheme not available at those points.

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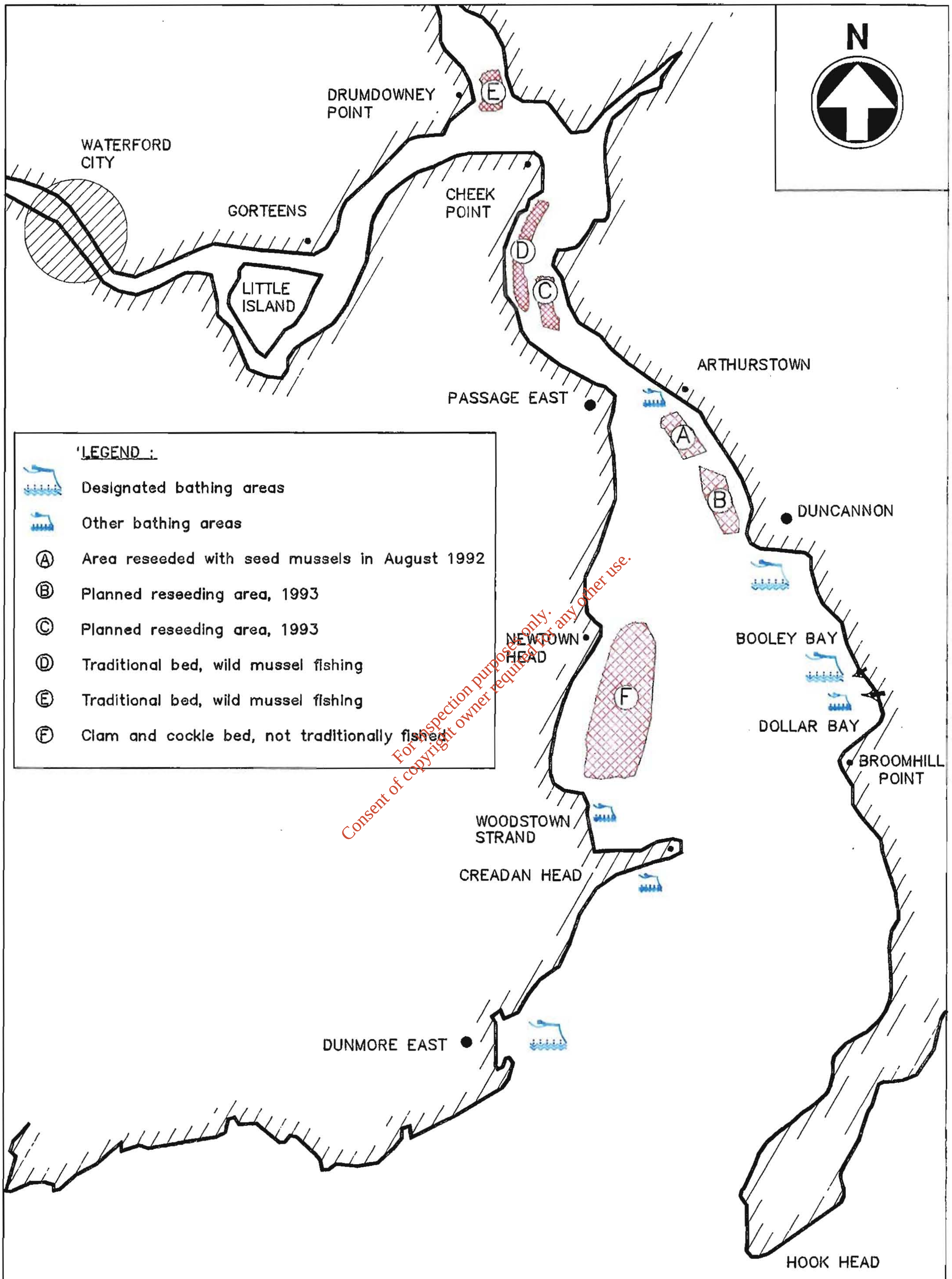

Figure A.4 : Locations of bathing areas and shellfish beds in the outer Suir, Barrow, Nore, Estuary.

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Conclusions

(a) Implementation of the proposed scheme will result in considerable improvements in the levels of Total and Faecal Coliforms throughout the stretch of the River Suir currently impacted upon by the existing scheme. A maximum concentration of 23,310 Total Coliforms/100 ml in the vicinity of Waterford City due to existing untreated discharges will reduce to a concentration of 1,196 Total Coliforms/100ml following the provision of full secondary treatment. At Cheek Point, the maximum Total Coliform concentration attributable to the existing discharges is estimated at 2,328 counts/100ml. Under the proposed scheme this level should be reduced by up to 75%.

(b) The proposed treated effluent discharge will have no impact on bacteriological levels in the vicinity of the designated bathing waters of Dunmore East for both present and future loading conditions. At Duncannon Beach the maximum predicted Total Coliform levels resulting from the proposed treated effluent discharge are 93 counts/100ml under present loads and 132 counts/100ml under future design loads. The corresponding predicted Faecal Coliform levels at this location are 19 counts/100ml and 26 counts/100ml under present and future loads respectively. Background values over and above the levels which will be generated by the treated effluent discharge are presently estimated at 26 Total Coliforms/100ml and 7 Faecal Coliforms/100ml. On this basis it can be concluded that the proposed scheme will not impact adversely on Coliform levels in the designated bathing waters of the Suir Barrow Nore Estuary which will be maintained well within the standards of 5,000 Total Coliforms/100ml and 1,000 Faecal Coliforms/100ml as stipulated in the Water Quality Management Plan and the EC Quality of Bathing Waters Regulations 1988.

(c) Apart from meeting the EC Quality of Bathing Water Regulations at the designated bathing areas, it is also likely the same standards will be met throughout the area of the estuary currently affected by raw wastewater discharges from Waterford City and environs. At present water quality in the River Suir from upstream of Waterford Bridge to downstream of Giles Quay is well outside the quality required for bathing waters. Under the proposed scheme water quality in this zone will comply with the bathing water standards.

Only in the immediate vicinity of the proposed outfall location north-east of Little Island i.e. over the mouth of the outfall pipe is it expected that the bathing water standards will be slightly exceeded. A predicted maximum Total Coliform concentration of 5,034 counts/100 ml and a maximum Faecal Coliform concentration of 1,007 counts/100 ml may occur at this location but only at low water conditions on a neap tide coinciding with 95 percentile river flows. Clearly these values only slightly exceed the EC Bathing Water Regulation Standards of 5,000 Total Coliforms/100 ml and 1,000 Faecal Coliforms/100 ml and furthermore will only occur for short periods of time on a very infrequent basis.

(d) A slight increase in bacteriological concentrations may occur in the zone downstream of Cheek Point between Passage East and Duncannon. The predicted average increases on Neap tides and low river flows are 66 Total Coliforms/13 Faecal Coliform per 100ml at Passage East and 25 Total Coliforms/5 Faecal Coliforms per 100ml at Duncannon. The increases that may occur in this zone are very small in comparison with the level of improvement which will be achieved in the River Suir. It is anticipated that the considerable improvement in bacteriological concentrations which will occur upstream of Passage East will more than offset the small localised increase.

(e) The standard required for waters in which live shell fish directly edible by man as stipulated in the relevant EC Directive (79/923/EEC) and the Water Quality Management Plan is not more than 300 Faecal Coliforms/100 ml in 75% of samples. The results of the mathematical model indicate that the proposed treated effluent discharge will not result in levels greater than 300 Faecal Coliforms at any location in the shell fish waters of the estuary between Drumdowney Point and Woodstown Strand.

The Department of Marine has also recommended a classification procedure for waters producing shellfish for export which is based on the U.S. National Shellfish Sanitation Programme. This classification has three categories: Approved (no purification necessary): Conditional (purification essential): restricted (pressure cooking essential). In the 1991 report on water quality in the Suir/Barrow/Nore Estuary (Neill 1992) it states that for shellfish water purposes, the stretch between Waterford and Cheekpoint is Restricted, the Duncannon/Passage East area is Conditional, the outer estuary is Approved.

Following implementation of the proposed scheme it is anticipated that the stretch between Waterford and Cheekpoint will improve to the conditional category except in the immediate vicinity of the outfall. It is further anticipated that status of the zones currently classified as Conditional and Approved will not alter following implementation of the proposed scheme.

The existing shell fish areas closest to the proposed discharge point at Gorteens are the traditional wild mussel beds at Drumdowney Point and south of Cheek Point. The mathematical model predicts maximum Faecal Coliform concentrations at Cheek Point Pier of 172 counts/100 ml under present loads and 245 counts/100 ml under future design loads. Again, it should be emphasised that these levels are maximum predicted values occurring on low water neap tides and 95 percentile river flows. Mean concentrations at Cheek Point Pier for the same conditions are 88 Faecal Coliforms/100 ml under present loads and 125 Faecal Coliforms/100 ml for future design loads.

Downstream of Cheek Point, predicted Faecal Coliform levels in the vicinity of all other traditional and newly reseeded shell fish beds are well within the 300 counts/100 ml standard.

A.5 ASSESSMENT OF AN ALTERNATIVE OUTFALL LOCATION

A.5.1 Background

As previously outlined, the assessment of the predicted changes in water quality has been based on a future treated effluent outfall discharging from a site in Gorteens to a location in the main channel of the River Suir north-east of Little Island. An alternative treated effluent outfall discharging from a site in Abbeylands to a location adjacent to the existing point of discharge from the Waterpark Pumping Station was also examined using the mathematical model. The results of the model simulations of this discharge have been compared with the results already analysed for a discharge from Gorteens. Through this comparison, the environmental advantages and disadvantages of locating the proposed outfall at Gorteens rather than Abbeylands have been established.

A.5.2 Mathematical Model Results

The results of the mathematical model indicate that the Abbeylands outfall would result in slightly higher BOD_5 levels (0.02 to 0.08 mg/l) in the River Suir than for the Gorteens outfall option. The difference in resultant bacteriological levels for the two outfall options is more significant however and has a greater bearing on the choice of the most suitable point of discharge.

Table A.10 shows comparisons of the predicted Total Coliform levels in the River Suir and Suir Barrow Nore Estuary for treated effluent discharges from the Abbeylands and Gorteens outfalls. The predicted values are for future loads only and correspond to neap tide conditions coinciding with 95 percentile river flow. Predicted Faecal Coliform levels can also be interpreted from this table by applying a fixed ratio of 5 Total Coliforms to 1 Faecal Coliform at each location.

A.5.3 Conclusions

The following are the main conclusions regarding the likely impacts on water quality due to an alternative treated effluent outfall located at Abbeylands:

(a) Although there is a greater depth of water available at the alternative outfall location, the Gorteens point of discharge demonstrates greater mixing and dispersion characteristics resulting in a larger number of initial dilutions for the treated effluent.

(b) The maximum predicted concentration of Total Coliforms resulting from a discharge at Abbeylands is 10,100 counts/100 ml occurring at the point of discharge at low water. The correesponding maximum predicted concentration of Total Coliforms due to the Gorteens outfall is 5,034 counts/100 ml.

(c) The alternative outfall for Abbeylands will result in lower concentrations of Coliform Bacteria in the vicinity of the shellfish beds located in the outer estuary. A maximum future concentration of 8 Faecal Coliforms/100 ml at Passage East compares with a maximum value of 69 Faecal Coliforms/100 ml at the same location due to a discharge at Gorteens.

It has previously been shown that the Gorteens outfall will not result in levels greater than 300 Faecal Coliforms/100 ml at any location in the shell fish waters of the estuary thereby satisfying the requirements of the Water Quality Management Plan. It can therefore be concluded that bacteriological levels resulting in the shell fish areas of the estuary due to discharges from both outfall options will be well within the required standards.

Table A.10

Comparisons of predicted maximum , mean & minimum concentrations of Total Coliforms (counts/100ml) at locations in the River Suir.

Gorteens Outfall / Abbeylands Outfall - Future Loads.

Sampling / Prediction Point	Max. T.Coli Levels / 100 ml		Mean T.Coli Levels / 100 m		Min. T.Coli Levels / 100 ml	
	Gorteens Outfall	Abbeylands Outfall	Gorteens Outfall	Abbeylands Outfall	Gorteens Outfall	Abbeylands Outfall
50	1,592	4,723	633	1,564	12	448
51 c	1,705	10,100	747	3,338	62	1,500
52	1,817	2,906	861	1,762	111	394
53	2,008	2,370	984	1,421	235	294
57	4,624	2,083	1,565	1,107	507	113
55	1,237	1,844	773	989	534	239
58	5,034	* *	2,517	* *	1,064	* *
59	1,745	1,264	1,124	525	204	37
60 a	1,225	674	627	201	95	14
63	345	39	120	13	11	1
64	132	14	42	5	4	1

- 95 percentile river flow .
- Repeating neap tides .
- Background levels excluded .
- For locations of sampling / prediction points see Figure A.3

* * Predicted values for Abbeylands outfall not available at this point.

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(d) Over a 1.8 km stretch of the River Suir from Waterford Bridge to upstream of Smelting House the Abbeylands outfall will result in maximum Total Coliform concentrations in excess of the 5,000 counts/100 ml standard stipulated in the EC Regulations on Bathing Waters. In the case of the Gorteens outfall, the bathing water standard for Total Coliforms is only marginally exceeded in an area immediately surrounding the point of discharge (i.e. over the mouth of the outfall pipe).

(e) Therefore from an overall water quality standpoint based on the above, the optimum location for an outfall from the proposed wastewater treatment plant is off Gorteen's as considerable improvements will occur in water quality in the River Suir Barrow Nore Estuary and in particular in the John River and the River Suir in the vicinity of Waterford City. In addition it ensures that the area identified as suitable for Shellfish Cultivation will be maintained with an improved status of water quality over much of the area.

APPENDIX B

INDUSTRIAL WASTEWATER SURVEY

(5 PAGES)

Appendix B

Industrial Wastewater Survey

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B.1 INDUSTRIAL WASTEWATER SURVEY

B.1.1 Objective

the main objective of the industrial wastewater survey was to enable a quantitative figure for the present total industrial load, both organic and hydraulic, to be determined. The figures obtained were reconciled with population and industrial development in the particular catchments.

B.1.2 Method

The survey comprised circulation of detailed questionnaires requiring information on industrial processes utilised, water consumption, historical data on wastewater flows and composition, inventory of all chemicals used and the extent of on-site treatment and monitoring facilities. In addition to the questionnaires on-site flow monitoring and sampling surveys were carried out at selected industries over their working day.

All licenced dischargers within the respective catchment areas were circularised and visited.

Certain unlicenced discharges were circularised to complement the information obtained from the licenced dischargers. these dischargers were located from business directories, local knowledge and water consumption lists provided by Waterford Corporation and Kilkenny County Council.

The detailed questionnaire and the extent of parameters chosen for the chemical analysis of samples of the wastewaters had the primary objectives of identifying the presence of inhibitors to a biological treatment system and also the level of nutrients present. A 100% response was received from industries.

The discharges were divided into 11 categories and in general the major dischargers in each category were surveyed. Flow proportional composite samples were taken from all the companies sampled.

B.1.3 Results

The results of the industrial wastewater survey are given in the following tables in terms of:-

- The total load for the entire scheme (Table B.1)
- Loading for each catchment area (Table B.2)
- Loading for each category (Table B.3)

TABLE B.1
WATERFORD MAIN DRAINAGE SCHEME
INDUSTRIAL WASTEWATER SURVEY

OVERALL TOTAL INDUSTRIAL LOAD FOR SCHEME

PARAMETER		TOTAL
Wastewater Flow	m3/d	6644 .46
BOD	kg/d	3059 .97
COD	kg/d	6635 .27
Suspended Solids (SS)	kg/d	1566 .31
Total Phosphorous	kg/d	62 .64
Orthophosphate	kg/d	12 .071
Kjeldahl Nitrogen	kg/d	139 .89
Organic Nitrogen	kg/d	34 .15
Nitrate & Nitrite	kg/d	202 .42
Ammonia	kg/d	79 .86
Chloride	kg/d	587 .35
Fats / Oils / Grease (FOG)	kg/d	294 .37
Sulphate	kg/d	1446 .94
Flouride	kg/d	99 .25
Zinc	kg/d	0 .37
Mercury	kg/d	0 .0041
Cadmium	kg/d	0 .13
Chromium	kg/d	0 .074
Copper	kg/d	0 .11
Lead	kg/d	30 .54
Silver	kg/d	0 .14
Iron	kg/d	0 .86
Manganese	kg/d	0 .052
Total Metals	kg/d	32 .46
Isopropyl Alcohol	kg/d	1 .20
Sulphide	kg/d	7 .73
Surfactants	kg/d	19 .89
Detergents	kg/d	0 .00
Cyanide	kg/d	0 .040
Phenols	kg/d	0 .0012
Potassium Ferricyanide	kg/d	0 .0012
Sodium Thiosulphate	kg/d	0 .012

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TABLE B.2
WATERFORD MAIN DRAINAGE SCHEME
INDUSTRIAL WASTEWATER SURVEY
INDUSTRIAL LOADS - AREA TOTALS

PARAMETERS		WATERPARK CATCHMENT WD 1	OUTSIDE WATERPARK CATCHMENT WD 2	FERRYBANK WD 3	KILKENNY KK	TOTAL
Wastewater Flow	m3/d	3461.64	756.00	87.72	2339.10	6644.46
BOD	kg/d	1999.53	421.50	16.27	622.67	3059.97
COD	kg/d	4626.66	693.96	33.30	1281.35	6635.27
Suspended Solids (SS)	kg/d	826.11	273.99	8.82	457.39	1566.31
Total Phosphorous	kg/d	9.046	5.14	0.63	47.83	62.64
Orthophosphate	kg/d	3.12	5.51	0.24	3.20	12.07
Kjeldahl Nitrogen	kg/d	36.49	35.54	0.98	66.89	139.89
Organic Nitrogen	kg/d	25.56	7.82	0.12	0.65	34.15
Nitrate & Nitrite	kg/d	146.59	3.29	0.044	52.50	202.42
Ammonia	kg/d	5.50	7.99	0.83	65.54	79.86
Chloride	kg/d	102.91	130.79	3.65	350.00	587.35
Fats / Oils / Grease (FOG)	kg/d	61.60	114.28	8.71	109.77	294.37
Sulphate	kg/d	1356.94			90.00	1446.94
Flouride	kg/d	99.25				99.25
Zinc	kg/d	0.35	0.021	0.000018	0.0045	0.37
Mercury	kg/d	0.0040			0.000008	0.0041
Cadmium	kg/d	0.00085			0.13	0.13
Chromium	kg/d	0.071	0.00006		0.003	0.074
Copper	kg/d	0.074	0.032	0.000053	0.0049	0.11
Lead	kg/d	30.50	0.025	0.000071	0.018	30.54
Silver	kg/d	0.024	0.11		0.0083	0.14
Iron	kg/d	0.44	0.18		0.24	0.86
Manganese	kg/d	0.028	0.021		0.002	0.052
Total Metals	kg/d	31.55	0.51	0.00014	0.41	32.46
Isopropyl Alcohol	kg/d	1.20				1.20
Sulphide	kg/d	7.73				7.73
Surfactants	kg/d	11.032	5.10	2.19	1.57	19.89
Detergents	kg/d					0.00
Cyanide	kg/d	0.040				0.04
Phenols	kg/d	0.0012				0.0012
Potassium Ferricyanide	kg/d	0.0012				0.0012
Sodium Thiosulphate	kg/d	0.012				0.012

TABLE B.3

WATERFORD MAIN DRAINAGE SCHEME
INDUSTRIAL WASTEWATER SURVEY
INDUSTRIAL LOADS - CATEGORY TOTALS

PARAMETER		BREWERIES	FOOD RELATED	MEAT PROCESSING	METAL RELATED	GLASS RELATED	CHEMICAL
Wastewater Flow	m3/d	629.00	450.00	2100.79	488.12	1725.00	1.10
BOD	kg/d	1549.20	320.00	578.46	154.81	9.65	1.12
COD	kg/d	3071.64	650.00	1111.32	814.79	18.22	20.91
Suspended Solids (SS)	kg/d	189.20	117.50	475.14	78.95	463.50	0.32
Total Phosphorous	kg/d	5.75	8.32	40.14	0.22	0.081	0.004
Orthophosphate	kg/d	1.77	1.013	3.63	0.15	0.036	
Kjeldahl Nitrogen	kg/d	20.85	26.48	50.60	0.27	0.68	
Organic Nitrogen	kg/d	20.34	1.49	6.56	0.083	0.67	
Nitrate & Nitrite	kg/d	0.035	14.50	41.25	145.80	0.69	0.004
Ammonia	kg/d	0.51	25.40	40.86	0.55	0.014	0.0008
Chloride	kg/d	85.58	330.00	121.95	2.95	10.10	0.32
Fats / Oils / Grease (FOG)	kg/d	6.80	7.97	162.069	3.64	2.63	0.055
Sulphate	kg/d		50.00	40.00	152.12	1204.50	0.32
Flouride	kg/d				22.00	77.25	
Zinc	kg/d		0.002		0.23	0.10	
Mercury	kg/d		0.000008		0.000012	0.000037	
Cadmium	kg/d		0.13		0.00078	0.000071	
Chromium	kg/d		0.003		0.057	0.012	
Copper	kg/d		0.002		0.016	0.034	
Lead	kg/d		0.017		0.031	30.45	
Silver	kg/d				0.0024		
Iron	kg/d		0.24		0.068	0.36	
Manganese	kg/d		0.002		0.0029	0.025	
Total Metals	kg/d		0.37		0.40	30.97	
Isopropyl Alcohol	kg/d						1.20
Sulphide	kg/d					7.73	
Surfactants	kg/d			1.23	0.17		
Detergents	kg/d						
Cyanide	kg/d				0.04		
Phenols	kg/d				0.0012		0.00004
Potassium Ferricyanide	kg/d				0.0012		
Sodium Thiosulphate	kg/d				0.012		

TABLE B.3 (Contd.)
WATERFORD MAIN DRAINAGE SCHEME
INDUSTRIAL WASTEWATER SURVEY
INDUSTRIAL LOADS - CATEGORY TOTALS

PARAMETER		HOSPITALS	GARAGES	LAUNDRIES	HOTELS	MISC.	TOTAL
Wastewater Flow	m3/d	647.30	138.23	34.42	338.00	92.50	6644.46
BOD	kg/d	187.72	45.20	16.87	62.19	134.75	3059.97
COD	kg/d	282.22	114.73	32.70	126.75	392.00	6635.27
Suspended Solids (SS)	kg/d	168.95	20.73	7.68	33.80	10.55	1566.31
Total Phosphorous	kg/d	5.31	0.069	0.32	2.43		62.64
Orthophosphate	kg/d	4.47	0.025	0.014	0.95	0.014	12.071
Kjeldahl Nitrogen	kg/d	29.78	1.78	1.10	3.75	4.60	139.89
Organic Nitrogen	kg/d	0.43	0.0077		0.12	4.46	34.15
Nitrate & Nitrite	kg/d	0.036	0.0025		0.044	0.065	202.42
Ammonia	kg/d	8.74	0.022	0.32	3.21	0.23	79.86
Chloride	kg/d	32.04	0.14		3.65	0.63	587.35
Fats / Oils / Grease (FOG)	kg/d	64.73	4.078	1.27	33.80	7.32	294.37
Sulphate	kg/d						1446.94
Flouride	kg/d						99.25
Zinc	kg/d	0.030	0.0028		0.0035	0.0019	0.37
Mercury	kg/d					0.004	0.0041
Cadmium	kg/d						0.13
Chromium	kg/d					0.0021	0.074
Copper	kg/d	0.043	0.0083		0.010	0.00015	0.11
Lead	kg/d	0.025	0.0024		0.014	0.0025	30.54
Silver	kg/d	0.14					0.14
Iron	kg/d	0.18	0.0038			0.0023	0.86
Manganese	kg/d	0.021	0.00065			0.0001	0.052
Total Metals	kg/d	0.65	0.020		0.028	0.033	32.46
Isopropyl Alcohol	kg/d						1.20
Sulphide	kg/d						7.73
Surfactants	kg/d	6.47	3.14	0.43	8.45		19.89
Detergents	kg/d						0.00
Cyanide	kg/d						0.04
Phenols	kg/d						0.0012
Potassium Ferricyanide	kg/d						0.0012
Sodium Thiosulphate	kg/d						0.012

APPENDIX C

ARCHAEOLOGICAL ASSESSMENT

(8 PAGES)

A3486/2/N

Archaeological Assessment

Wastewater Treatment Plant,

Gorteens

Co. Kilkenny

yes

RETURN TO PROJECT FILE AFTER USE

MARGARET GOWEN & CO. LTD / ARCHAEOLOGICAL PROJECTS

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Client E.G. Pettit & Company
Report by Jacinta Kiely

October 1998

Introduction

The planned construction of a wastewater treatment facility on the northern bank of the River Suir necessitated an EIS. Eachtra Archaeological Projects were contracted by E.G. Pettit & Co. to undertake an archaeological assessment of the area of the proposed development site. The report examines the archaeology in the townland of Gorteens within the area of the proposed development site and on the proposed access road and assesses the impact that the proposed development will have on that archaeology. The study area is located on the northern bank of the River Suir, to the west of the confluence of the Suir and the Barrow. It is immediately north of Little Island, an island in the River Suir. The River Suir borders the proposed development site to the south. The southern section of the proposed development site is wet and marshy, as are the northernmost fields.

Kilkenny County Council in association with Waterford Harbour Commissioners and The Industrial Development Authority published 'The Belview Area Action Plan, 1997' . The area of the proposed development site is located within the Belview area. '*The vision for Belview in the future is of an area of excellent environmental quality, accommodating a port, with its associated activities and infrastructure…further infrastructural provision is needed in order that the area should be able to achieve its development potential: (a) Waste water treatment facilities.' (Kilkenny County Council 1998, 2)*. Gorteens Castle and Springfield House are listed as Heritage Features to be protected in The Belview Area Action Plan.

Methodology

The following sources were consulted prior to the area being field walked.

1. The archaeological inventory of County Kilkenny
2. The S.M.R. map sheet KK047.
3. The 1st edition 6ins O.S. map, sheet 47.
4. The Topographical Files in the National Museum.
5. An aerial photograph of the area of the proposed development.

No information was recorded for the townland of Gorteens in the Topographical Files

Archaeological Sites

The area of the proposed development site and the area of the proposed access road were field walked. One archaeological site, a county house and associated features and two features, which may be archaeological in nature, are located in the area of the proposed development and on the line of the proposed access road (Fig 2).

Site 1 KK047-001

Gorteens Castle (in ruins) is located in a farmyard, to the north of the proposed development site (Fig 1, plate 1) and to the immediate south of the proposed access road.

Site 2

Springfield House is located at the northern side of the proposed development site. The ruined house and grounds are marked on the 1st edition O.S. map sheet KK047. There are a number of associated estate features visible within the area of the development site. A covered passage, aligned north – south, is located to the east of the house. A quay, marked on the 1st edition O.S. map sheet 47, is located on the bank of the river. Large numbers of mature trees and stone walls are visible within the environs of the house.

To the east of the northernmost field on the line of the proposed access road, a pond is illustrated on the 1st edition O.S. map within the copse of trees, a spring is marked at this location on the S.M.R. map. The area is very overgrown with scrub and mature trees.

Site 3

Located in the centre of the field to the west of Springfield House is a stand of trees, a number of large stones are located within the stand (plate 2). There is no visible trace of associated earthworks.

Site 4

In the field to the south of Springfield House is a large tree, *c.* 30m to the west of the tree are two linear ridges (plate 3). They are aligned north - south, are *c.* 20m apart and *c.* 20m long by 1m wide. These features maybe archaeological or geomorphological in nature.

The Impact of the Proposed Development

The impact on the archaeology, within the area of the proposed development, from ground disturbance works associated with the excavations for the proposed roadway, buildings, aeration and settlement tanks must be considered in two ways. The proposed development works can have an impact on the known and unknown archaeology of the area.

In the case of the known archaeology;

Site 1 Ground disturbance works associated with the excavation of the proposed access road may have an impact on buried auxiliary structures or features associated with Gorteens Castle. The original extent of the castle may have been more substantial than what is now visible.

Site 2 It is not proposed to demolish or alter in any way Springfield House. That said, the setting and landscape in the environs of a county house are an integral part of such a site. The proposed development works will have an impact on the environs of Springfield House.

Sites 3 & 4 Ground disturbance works associated with the excavation of roadways, buildings, and tanks will have an impact on both these sites, as they are located in the centre of the proposed wastewater treatment site.

In any area there exists the potential for buried archaeological sites i.e. sites with no visible remains above ground. The area of the proposed development is on the northern bank of the river Suir, adjacent to Little Island and the confluence of the Suir and the Barrow. Both these rivers were used as transportation routes in historic and prehistoric times. In addition Gorteens Castle is located in the immediate vicinity. A quay, marked on the 1st edition O.S. map is likely to have been associated with Springfield House. The potential for riverrine archaeology in the area of the proposed development is possible.

Description of Mitigation Measures

Ground disturbance works associated with the construction of a new access roadway (plate 4), buildings, aeration and settlement tanks on the northern bank of the river Suir will have an impact on the known and unknown archaeology of the area. The following mitigation measures are proposed:

1. A test trench on the line of the proposed access road in the environs of Gorteens Castle should be opened in advance of commencement of works in order to establish the extent of the castle.
2. Test trenches in the area of Sites 3 & 4 should be opened in advance of commencement of works to establish the nature and extent of the features noted. If the features are

archaeological in nature then a full - scale excavation would be necessary.

3. In light of the riverrine location of the proposed development all ground works should be monitored by an archaeologist.
4. All associated estate features due for demolition or alteration should be recorded in advance of commencement of works.

All recommendations are subject to the approval of The National Monuments Service, Duchas.

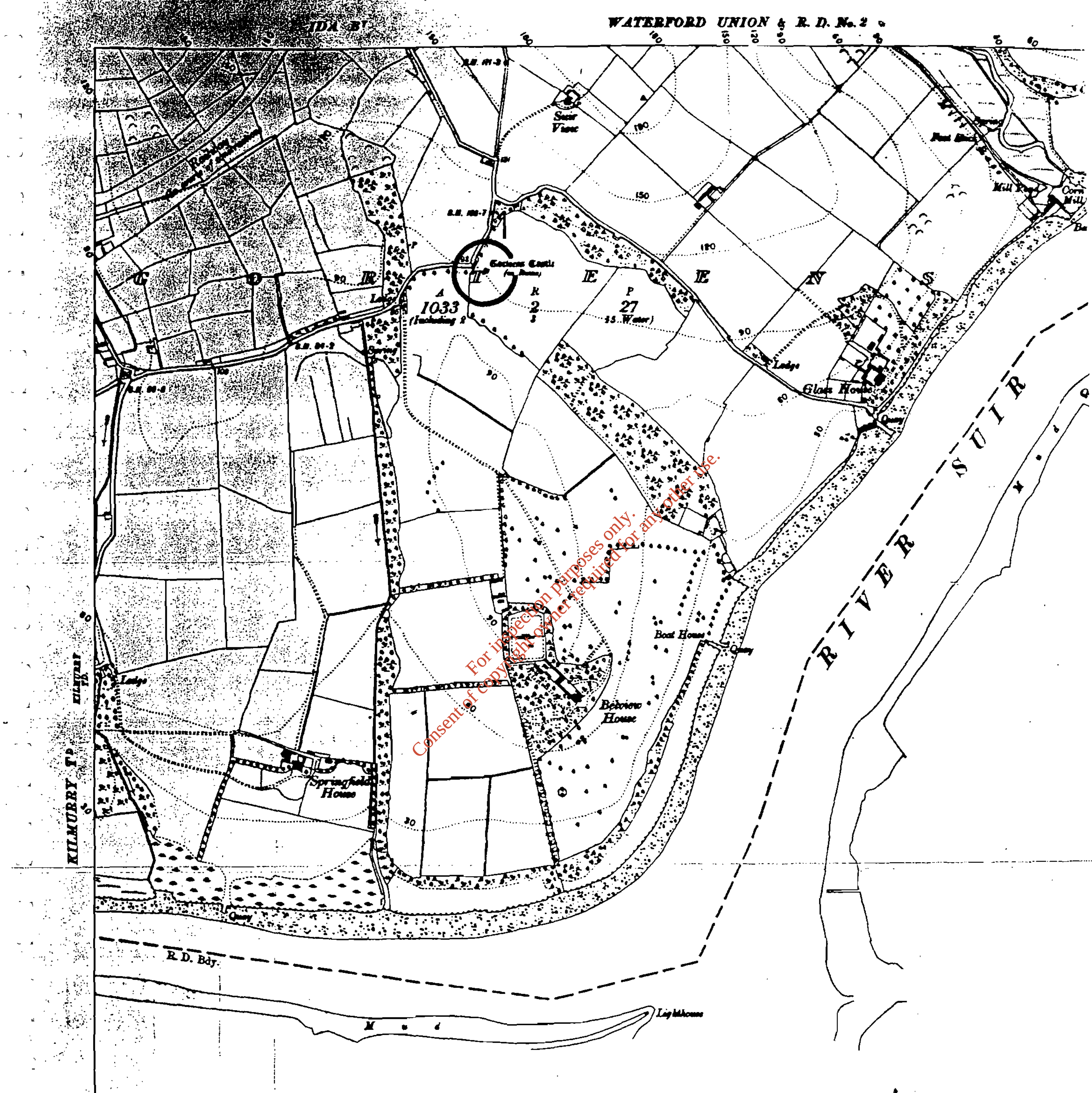

Figure 1 Portion of S.M.R. sheet 47

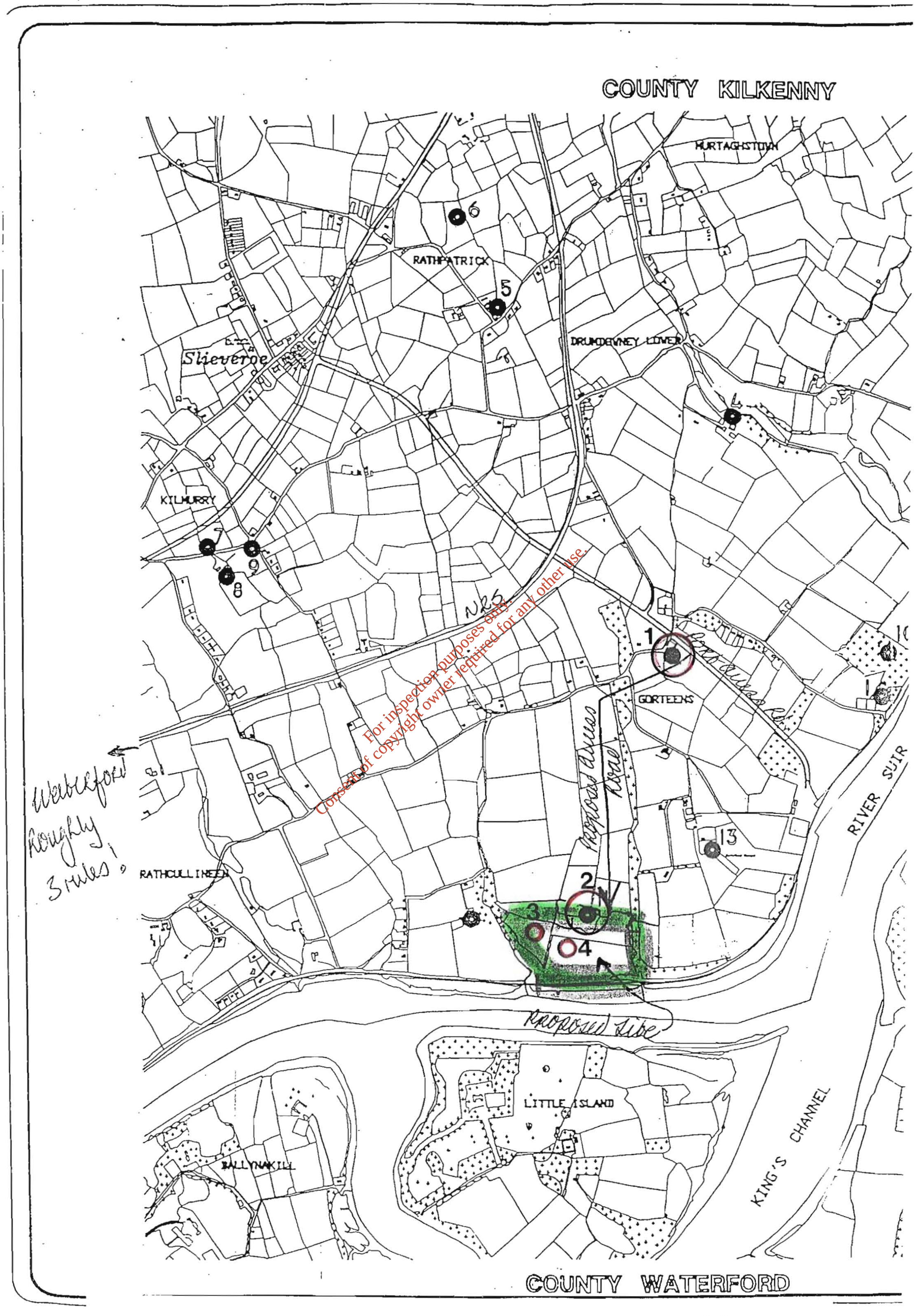

Figure 2 Area of Proposed Development, Proposed Access Road and Archaeological Sites

Plate 1 Gorteens Castle

Plate 2 Site 3

Plate 3 Site 4

Plate 4 The proposed access road

APPENDIX D

AIR QUALITY DISPERSION MODELLING

(19 PAGES)

AIR QUALITY IMPACT

Michael L. Bailey , Managing Director
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1.0 INTRODUCTION

1.1 General

A new wastewater treatment plant is proposed for collecting sewage from the city of Waterford and environs and as part of the environmental impact evaluation the proposed plant was assessed in relation to air quality impact. The proposed location of the treatment plant is at Gorteens , approximately 4km east of Waterford city.. This assessment was undertaken based on existing air quality, climatological characteristics of the site and the potential air quality impact of odorous emissions from the various components within the treatment plant. The potential concentrations of malodours resulting from the operation of the treatment plant were predicted based on air quality prediction modelling techniques.

1.2 Odours from treatment plants

Fresh wastewater arriving at a treatment plant via a properly constructed sewer system has a slight smell, normally described as musty in character. As long as a certain level of dissolved oxygen is maintained in the sewage anaerobic conditions will not take place. However, if the oxygen content of the sewage is used up then gases such as hydrogen sulphide, nitrogen and sulphur based organic compounds (mercaptans, ketones, amines, indoles and skatoles) are produced and a general septic condition occurs with typical pungent, putrid and nauseating odours being emitted.

Sulphide compounds which have very low levels of odour detection are a major component of odours from a waste water treatment plant. For example, hydrogen sulphide has an odour detection limit in the order of about 0.2-2 $\mu g/m^3$. Its characteristic smell of rotten eggs occurs at concentrations of about 3-4 times higher with odour nuisance complaints likely at even higher levels.

A sufficient detention time is required for the formation of anaerobic conditions and warm weather conditions above about 20C will also assist the rapid growth of anaerobic bacteria. The operation of a wastewater treatment plant involves many locations during the process where anaerobic conditions can occur; from poor maintenance of the inlet works, overloaded secondary treatment through to the dumping of the dewatered sludge in open skips prior to disposal off-site. In many cases the odour problem can be solved by regularly cleaning of channels and general maintenance whereas sometimes overloading or sludge treatment may necessitate more extensive mitigation measures such as covering and removing waste gases via an odour control system.

The majority of odour nuisance problems associated with wastewater treatment plants are due to the age of the plant or where the sewage loading arriving at the plant results in regular overloading of the facility. This tends to be the public perception of sewage treatment plants. However, with the modern technology available the plants can exist close to residential areas without causing any problems of odours in the surrounding area. Sophisticated continuous monitoring of the effluent flow through the plant to ensure an adequate flow and to prevent clogging, measurement of oxygen content and pH levels as well as the containment of the sludge in enclosed sludge digestors have greatly helped to reduce community nuisance.

The rate of emissions of potentially odorous inorganic and organic compounds from wastewater treatment tanks depend on the tank surface area, organic concentrations and BOD of the tank liquor, volatility of the compounds and the evaporation rate from the tank. The rate of evaporation is lower from a quiescent liquid surface than from a turbulent surface with higher air temperatures and/or wind speeds increasing the evaporation rate. The rate of anaerobic activity within the effluent is also affected by weather conditions such as air temperature and humidity so that odours tend to be greatest during dry warm weather conditions. these conditions may also be associated with periods of low effluent flow through the plant which can significantly affect the efficiency of the plant. Material left on the walls or deposited on the floor of the connecting channels can quickly become septic resulting in odorous emissions. Unless there is a strong upward movement within the tank the volume of the tank is not important compared to the surface area with respect to the emission rate since compounds near the floor of the tank will not quickly diffuse to the surface.

The perception of odour at some point downwind of an emission source depends on the type of odour compound and the air concentrations of the odorous gas. The measure used to quantify odour nuisance potential is the odour concentration (odour unit per cubic metre, o.u./m^3). An odour concentration of 1 o.u./m^3 is the level at which there is a 50% probability that, under laboratory conditions using a panel of qualified observers, an odour may be detected. At levels below 1 o.u./m^3 the concentration of the gaseous compound causing the odour in the air will be less than the detection level and so although the gas is still present in the air no odour will occur.

The intensity of an odour ranges from 1 o.u./m^3 = odour detection, 2= slight odour up to 5 o.u./m^3 where the odour is strong and easily recognisable with higher levels likely to result in nuisance complaints by the neighbouring community. Since duration of the odour also determines whether or not a nuisance situation may occur an odour concentration of greater than 5 o.u./m^3 is widely used as a criteria for predicting the potential for complaints over periods of 15-30 minutes.

2.0 LOCAL CLIMATOLOGY

2.1 Wind speed and direction

Wind speed and wind direction will affect the magnitude of any potential odour nuisance at a specific property in the surrounding area. At high winds any odour generated at the treatment plant will be rapidly dispersed in the air and so will quickly reach a concentration below which it is not detected. Conversely, during slack winds an odour plume from the plant may drift some distance before dilution of the odour is such as to be below the odour detection limit.

The nearest meteorological station is at Kilkenny (approx 40km to N) and long term results indicate that the prevailing wind direction is from a southerly direction with a secondary maximum for NW-N winds (Fig 1). The incidence of winds of 5m/s or less is about 80% of the year with speeds of <2 m/s (including calms) occurring aobut 32% of the time. Similar climatological data from Rosslare (50km to E) indicates a SW prevailing wind and a much lower incidence of low wind speeds (6% < 2m/s) caused by its coastal location. Given the valley topography of the River Suir and inland (14km from coast) location of the site the incidence of low wind spees would tend to be similar to the Kilkenny station instead of Rosslare and so the climatological records from the former site were used in the analysis.

The potential for odorous emissions is during the summer months when warm dry weather conditions can increase the rate of evaporation from exposed liquor surfaces. During the summer period (May- September) the incidence of wind speeds of < 2m/s is about 30% with calm conditions occurring for about 9%of the time. The percentage includes overcast weather as well as dry anticyclonic conditions. During the latter with clear skies, local esturarine breeze circulation patterns will tend to develop which will reduce the incidence of calm wind conditions.

The importance of any malodour from the treatment plant will depend on the direction of the wind during the period of odorous emission in relation to housing located in the area. There are no houses situated within 0.2 km of the proposed site boundary with the nearest being to the NE and also at a similar distance due west of the site boundary. To the north the nearest houses are about 0.9km from the site boundary with the nearest private property on Little Island (Waterford Castle) on Little Island about 0.55km from the southern boundary. Based on the long-term data for Kilkenny the wind will blow towards the houses located to the NE about 23% of the year and to the west for approximately 3% of the time. When only the low wind speeds of <3m/s are analysed the incidence is about 9% in the direction of the nearest houses to the NE and about 2% for the properties located to the west of the site. The pattern during the summer months gives a similar incidence. This relatively low frequency of wind speeds less than 3m/s includes occasions when the weather may be overcast, raining etc. (when the odour potential is much lower) than just during warm dry weather when the potential for malodours can increase.

The topography of the site and environs will exert a significant influence on the dispersion of any air emissions from the proposed site. The river Suir is about 300m wide with the ground rising in a northerly direction to 15m within 0.3km and 30m within 1.2km of the river bank. The sloping terrain will create localised wind flow during relatively calm wind conditions. Therefore under conditions likely to result in poor dispersion and the formation of a low temperature inversion in the area the wind flow will tend to be away from the nearest properties. The local climate will therefore tend to attenuate the impact of any odorous emissions in the direction of the local community.

2.2 Air temperature

The annual mean air temperature for the Waterford area is about 10.0 C with a range in daily averages of from about 5.5 C in January to 15.0 C in July. There would be a small number of days during the summer months when the maximum air temperature in this region of Ireland will exceed over 25 C especially during periods of dry anticyclonic weather conditions. The potential for an odour nuisance from the treatment plant will be greatest during this type of weather which will also tend to be associated with low flow conditions of the sewage from the town and neighbouring communities into the plant inlet works.

2.3 Atmospheric stability

An important climatological factor that affects the degree of dilution of any odorous emission from tank surfaces or other emission points within a wastewater treatment plant is the stability of the lower layers of the atmosphere. Stability is a measure of turbulence (horizontal and vertical air movement) and hence the degree of dispersion of an emission plume and so is a fundamental parameter in any dispersion modelling exercise. It is dependent on the relative importance of the wind speed and degree of solar insolation during the daytime or the rate of cooling of the air close to the ground at night-time. The categories normally used in defining the stability of the lower atmosphere range from unstable conditions, neutral and finally stable conditions. Neutral (D) stability is by far the most common type of stability category found in the Waterford region with an annual incidence of about 65%. This category occurs when the weather is cloudy, raining or windy and so this high incidence is typical of the prevailing Irish climate. Any malodour emission plume from a part of the plant will tend to rapidly disperse under this type of weather situation. On the other hand, during stable atmospheric conditions (categories E and F), which occur during the night-time due to the cooling of the air close to the ground leading to the formation of a low level inversion conditions, the dispersion of any emission plume will be poor. As a consequence emission from sources close to the ground cannot be dispersed and levels of air pollutants including any malodours can increase significantly. The annual incidence of stable conditions is about 20%.

3.0 RECEIVING ENVIRONMENT - EXISTING AIR QUALITY

The proposed location for the treatment plant is on a greenfield site on the northern bank of the River Suir about 4km downstream from Waterford city. The air quality is generally good within the site environs with the land-use comprising pasture and isolated residential properties beyond about 0.2 km from the site boundary. There is a large port development about 0.9-1km to the east of the site at Belview which mainly handles containerised freight. The number of fields surrounding the site are used for livestock and so there may also occasionally be odours generated during farming activities such as slurry spreading. With the low number of residential properties within the surrounding area the ambient air concentrations for smoke and sulphur dioxide in the locality of the proposed site will typically be less than a daily level of 25ug/m^3 and so well below the National Air Quality Standards (SI 244 of 1987)

4.0 PROJECT DESCRIPTION AND IMPACT ASSESSMENT

4.1 Plant size

The wastewater treatment plant at Gorteens is designed to cater for an influent capacity of about 150,000 person equivalent. The 25 year design of the plant is described in detail in the main report and may be summarised as follows in relation to the potential of certain components to generate odours.

- Inlet works building
- Storm water holding tank
- Primary settlement tanks
- Activated sludge treatment
- Final clarifiers
- Sludge thickening and storage
- Sludge bio-digestion and CHP for off-gases
- Sludge dewatering in an enclosed building

4.2 Inlet works

The inlet works of a sewage treatment plant can be a major source of odours due to the collection and deposition of solid matter in the wastewater. Screening devices can clog if not cleaned regularly and this can cause anaerobic conditions to occur. Grit chambers are also another possible source of odours from the organic coatings on the finer material collected or deposited in the channel due to low flow rates, especially during low flow conditions. The material collected if stored in an open skip for a number of days can also create offensive odours. In the design of this part of the plant the potential for these odour-forming aspects to arise need to be addressed.

The proposed plant design will significantly reduce any malodours from this part of the plant by housing the screening and grit/fat removal operation within enclosures. The air from the screen and grit enclosures will be extracted through an odour control system at a rate of about 4 air changes per hour. The screened material and grit removed from the influent to the plant will be washed and deposited in covered skips which will be kept within a building and removed in closed containers on a regular basis.

4.3 Storm water holding tank

These tanks will only be used during periods of high rainwater flow and so during these weather conditions the concentrations of solids in the wastewater will be low. The tank will provide retention for high flows. There is a potential for odorous emissions from material left on the walls of the tanks once the influent has been discharged. To eliminate this problem an automatic flushing system will be installed to flush the tanks once the storm water influent has been emptied.

Due to the limited usage of these tanks and the flushing of any material deposited on the tank floor the odour emissions will be negligible.

4.4 Primary Settlement Tanks

Three circular tanks, with dimensions of 34m, will be installed for primary treatment of the wastewater at the treatment plant. The potential for odours from these tanks depends on the BOD load of the influent, the rate of evaporation of odorous components from the surface of the influent and the turbulence at the overflow weirs. The surface area of liquor in the tanks rather than the depth of the tank is important in relation to odour potential. In addition the overflow weir at the far end of the tank results in the generation of turbulence as the liquor flows out over a drop of 0.3m to a collecting trough and this may be a source of odours, especially during warm weather conditions. A scraper to remove scum that may form on the surface of the tank will be incorporated in the design of the settlement tanks.

4.5 Activated Sludge treatment

Eight activated sludge treatment tanks will be installed, each one having dimensions of about 63 x 14m. The aeration system will consist of fine bubble diffused aeration from an array of subsurface diffuser heads located at the bottom of each of the tanks. Odour emissions from activated sludge treatment tanks are normally low since the aeration provides high levels of oxygen in the tank liquor so that most of the odorous compounds are oxidised and anaerobic reactions do not take place. Sub-surface aeration also greatly reduces the release of aerosols into the air compared to surface shaft propeller systems commonly found in older plants around the country.

4.6 Final Clarifiers

8 circular tanks for secondary settlement, with diameters of 29m are proposed. Due to the low BOD and relatively stable sludge from the activated sludge tanks the potential for further decay of the sludge and resulting odorous emissions is very low. In addition the liquor in the tanks covers the sludge and so this prevents odorous compounds reaching the surface. Evidence from existing wastewater treatment plants around Ireland indicates that odours from final clarifiers are very low and are normally not detected beyond a few metres from the tank sides.

4.7 Sludge Thickeners

Sludge will be thickened in picket fence thickening tanks prior to entering the sludge digestor. Open sludge thickener tanks can be a major source of odours especially if the draw-off of the bottom sludge and mixing causes turbulence in the liquor. The sludge thickening tanks will be covered with the air drawn off from the surface of each of the tanks and vented to atmosphere through an efficient odour control system. The potential for odorous emissions from the thickeners will be greatly reduced and under normal plant operation will not be detected beyond a few metres from the extract vent to the odour control system.

4.8 Sludge digestion

Anaerobic sludge digestion, involving the biological breakdown of the solids will take place in enclosed digestion tanks to stabilise the sludge. Modern anaerobic sludge digestors are both heated and mixed to provide uniform digestion throughout the digestor. With a residence time in the digestor of at least 12 days at a temperature of 35 C the digested sludge will be fully stabilised. Significant quantities of methane gas are generated during this process which will be used as a source of power within the treatment plant.

Odorous components present are broken down during the digestion process and significant quantities of methane gas (approx 60-70% by volume) are generated which will be used as a source of fuel for the CHP boiler. The remainder will be carbon monoxide and trace contaminants including hydrogen sulphide and nitrogen. The gases drawn-off from the sludge digestor will be stored in a gas-holder which will feed the CHP boiler. Hydrogen sulphide may produce acids when burnt and, if considered necessary, this compound will be removed by passing the gas through an adsorption system before the gas is used as a fuel. The digestion process and subsequent collection of the gases produced by the process is carried out by an enclosed system and consequently, emissions of odours from the sludge digestion tanks will be negligible.

Emissions from the CHP plantr will be vented through an exhaust stack adjacent to the boiler room and will typically be carbon dioxide, carbon monoxide and water vapour. Due to the removal of odorous components during the sludge digestion phase and scrubbing of hydrogen sulphide in the gas prior to burning no odours will occur from the CHP emissions.

4.9 Dewatering

The proposed system for treating the sludge is to dewater the sludge in belt presses or centrifuges. The location of the dewatering and thermal drying building is in the south western area of the site. The dewatering building will be completely enclosed with extraction of fumes from the work areas around the equipment. An adequate odour control system will be installed adjacent to the de-watering building. There will be a satisfactory number of air changes per hour (4-6) to prevent a build-up of malodorous fumes within the building and posing a threat to employees.

5.0 ODOUR DISPERSION MODELLING

5.1 Introduction

Short-term odour concentrations downwind of the proposed treatment plant site were computed using the Industrial Source Complex (ISC3) air quality gaussian dispersion model developed by the U.S. Environmental Protection Agency. This model is widely used for modelling the air quality impact of a wide range of different types of emission sources, including wastewater treatment plants. Calculations were carried out to predict the rate of dilution from the boundary of the plant to the property in the neighbourhood where a potential odour nuisance could arise.

Hourly climatological data from Kilkenny meteorological station was used to predict the maximum and 99.5 percentile short-term odour concentration values over a year. This percentile value gives the odour concentration at each receptor location that is predicted to be exceeded 0.5% (44 hours) of the year. This type of interpretation of the pattern of odour concentration around the plant using hourly climatological data over a year reflects the annual incidence of certain wind speeds and directions coupled with the different types of atmospheric stability.

Three design options were modelled to indicate the level of short-term odour concentrations that may be experienced in the surrounding area. The first option is where the complete primary settlement tanks were left uncovered. The second is where the primary tank peripheral overflow channels are covered and the air from the headspace ducted to the odour control system in the inlet works. The final option is complete covering of the primary settlement tanks.

5.2 Emission estimates

The emissions from the various tanks were treated as area emission sources as with the exhaust emissions from the odour control system as a point source. The emission rates used in the dispersion model were expressed in terms of the odour dilution factor rather than as a specific pollutant compound emission rate due to the mix of compounds that may be emitted. The unit of measurement was odour units per m^2 per second (o.u./m^2.sec) for the tank surfaces and odour units per second (o.u./s) from the odour control system extract vents. The following odour emission rates were used in the model:-

The total number of tanks included in the model are based on the works required under the design load for the plant and so includes future construction beyond the phase 1 when, for example, there will only be 2 primary sedimentation tanks compared 3 in total for the final stage.

i) Inlet Works

The air extracted from the building housing the screening and grit removal equipment and also the area for holding the covered skips for collecting the recovered material will pass through an odour control system. The estimated extraction rate for the screening and grit removal plant building is 22,540 m^3/hr (6.26 m^3/s). For the purpose of modelling the exhaust stack is 10m in height with an exit diameter of 0.7m. Based on the air volume being exhausted this gives an exit velocity of 16.3 m/s. An odour emission rate of 300 o.u./s was used in the modelling predictions. This is high given the modern design of the proposed inlet works and it is expected that the odour control emission rate will be substantially lower than this value so that odours are not detected beyond a few metres from the extract vent. However this value used in the model allows for a typical 'worst-case' scenario in the dispersion modelling exercise.

ii) Primary settlement tanks

The area of each of the 3 tanks is approximately 1090m^2 (including overflow channel) and based on a vertical exit velocity from the surface of the liquor of 7m/hr and a near-surface concentration of 100 o.u./m^3 the emission rate was estimated to be a maximum of 0.2 o.u./m^2.s. The increased turbulence around the tank overflow weir will result in significantly higher emissions with a corresponding higher vertical velocity. The odour emission rate from the overflow weir/channel was estimated to be about 16 o.u./m^2.s based on an odour concentration of 2000 o.u./m^3.

iii) Aeration tanks

The surface area of each of the diffused aeration tanks is about 890m^2 and based on a vertical exit velocity of about 7m/hr and a near surface concentration of 200 o.u./m^3 the emission rate was calculated to be 0.2 o.u./m^2.s.

iv) Final settlement tanks

The area of each of these tanks is approximately 750m^2 and based on a vertical exit velocity from the surface of the tank of 7m/hr and a near-surface concentration of 50 o.u./m^3 the emission rate was estimated to be a maximum of 0.1 o.u./m^2.s.

v) Sludge thickening tanks/dewatering building odour control system

The ventilation air for the sludge dewatering building and the air from sludge thickeners and storage tank head-space will be exhausted to atmosphere via the sludge building odour control system. A combined air flow rate of 10,000 m^3/hr which allows for 4 air changes per hour within the main rooms of the dewatering building and venting of the head-space air has been used in the modelling study. With a stack height of 10m and a stack diameter of 0.7m the exit velocity from this odour control unit is calculated to be 7.3 m/s. An odour emission rate of 300 o.u./s from this point emission source has been used in the modelling predictions.

5.3 Results of odour dispersion modelling

The intensity of an odour from various parts of the wastewater treatment plant will depend on the strength of the initial odour concentration from the surface of the tank or other emission source and the distance downwind at which the prediction, or indeed measurement, is being made. Where the odour emission plumes from a number of sources combine downwind then the predicted odour concentrations may be significantly higher than that resulting from an individual emission source. An odour concentration of 1 o.u./m^3 is the level at which there is a 50% probability that, under laboratory conditions using a panel of qualified observers, an odour may be detected. At levels below 1 o.u./m^3 the concentration of the gaseous compound causing the odour in the air will be less than the detection level and so although the gas is still present in the air no odour will occur.

The intensity of an odour ranges from 1 o.u./m^3 = odour detection, 2= slight odour up to 5 o.u./m^3 where the odour is strong and easily recognisable with higher levels likely to result in nuisance complaints by the neighbouring community. Since duration of the odour also determines whether or not a nuisance situation may occur an odour concentration of greater than 5 o.u./m^3 is widely used as a criteria for predicting the potential for complaints over periods of 15-30 minutes.

Sensitivity to an odour also depends on the location, for example an odour from agricultural related activities will be tolerated by the community longer in a rural setting than in an urban area.

The results of the modelling exercise are shown as odour concentration contour maps in Figs 2-7. The maximum short-term odour concentrations that are predicted for the three options are shown in Figs 2,3 and 4 for no cover, partial cover and complete covering of the primary settlement tanks respectively. The contour pattern indicates that the short-term odour concentrations near to the boundary of the treatment plant are predicted to be about 7-9 o.u./m^3 at the boundary of the site without any tank covering (Fig 2) but generally about 2-3 o.u./m^3 when the overflow channels and complete covering of the primary tanks are modelled (Figs 3 and 4). At the nearest houses to the west of the site the predicted level are much lower and in the order of 3-4 o.u/m^3 with predicted levels of 2-3 o.u./m^3 at the houses to the NE of the site. When the model is repeated for the option of partial covering there is a significant improvement in odour concentrations downwind in the direction of the nearest houses. Predicted short-term levels are about 1-2 o.u./m^3 at the nearest houses to the west and 1-1.5 o.u/m^3 at the properties to the NE when covering of the channels. Finally the results of completely covering the primary tanks gives a maximum level of about 1 o.u/m^3 at the nearest houses.

The corresponding examination of the predicted 99.5 percentile odour concentrations around the plant indicate that short-term odour levels at the houses within 0.5km of the site boundary will not exceed 1 o.u./m^3 (Fig 5-7) for all three options. However, near to the site boundary predicted 99.5 percentile concentrations are 2-2.5 o.u./m^3 when the option of no covers on the primary tanks is modelled.

The predicted odour concentrations at the nearest houses are low and although there are no National Standards the predicted odour concentrations would meet the Standards required in other European Countries such as the Netherlands. For new plants the Standard is that a concentration of 1 o.u./m^3 should be met for 99.5% of the year. This condition is satisfied in relation to the impact of odours emitted from the treatment plant at Gorteens. No adverse impact in terms of concentrations of odours is therefore likely to result in a nuisance beyond the boundary to the treatment plant.

It is evident from the analysis of the predicted air quality impact of odorous emissions from the proposed treatment plant that the potential for detection of odours at the boundary to the plant will be very low. However, the maximum predicted levels based on operating the primary tanks without any type of covering indicates that odours near the boundary and also at the houses to the west of the plant may result in a possible nuisance. Therefore covering of the primary settlement tank overflow channels is recommended as a minimum design consideration in reducing the potential for malodours beyond the plant boundary with complete covering of the tanks a further control measure.

6.0 AIR EMISSION CONTROL MEASURES

Control of odorous emissions from various parts of the treatment plant by dry or wet scrubbing odour control systems is a major part of the proposed upgrading of the plant. The methods include activated carbon dry scrubbing systems, wet gas scrubbing in a packed tower or the use of a biofilter which uses natural material, such as peat, as the absorption media. Ozone treatment whereby ozone impregnated water is introduced into a counter-current gas flow is another option that has been considered. The final method has not been agreed and may indeed incorporate a combination of scrubbing processes. However, the approved system will achieve a odour removal efficiency in excess of 95% so that emissions from the odour control units are minimised.

A number of important odour sources are to be incorporated into the design and operation of the proposed wastewater treatment plant.

i)The inlet works comprising the screening and grit collection systems will be enclosed and the air extracted via an odour control system. Automated screening and grit removal from the wastewater will take place and the collection skips will be covered and housed indoors. Access to the skips will be through doors which will only be opened during entry and departure of the truck for transporting the skip off-site.

ii) The storm-water tanks will be automatically flushed and cleaned to remove any deposits which could cause an odour once the tanks are emptied after the storm water conditions have abated. This will ensure no significant odours occur from this part of the plant.

iii) A sub-surface diffused aeration system rather than a surface shaft propeller system in the activated sludge secondary treatment will be used for supplying the air to the liquor. This system is now increasingly being used to supply oxygen to the tank liquor without generating excessive surface turbulence which can create significant malodours.

iv) The primary settlement tanks will be covered to eliminate the potential of malodours from this stage of the treatment process.

v) The sludge thickening tanks, sludge reception tank will be completely covered with an air handling system connected to an efficient odour control unit.

vi) Dewatering and digestion of the sludge is proposed and this method produces a stable product which is generally odourless and dust-free.

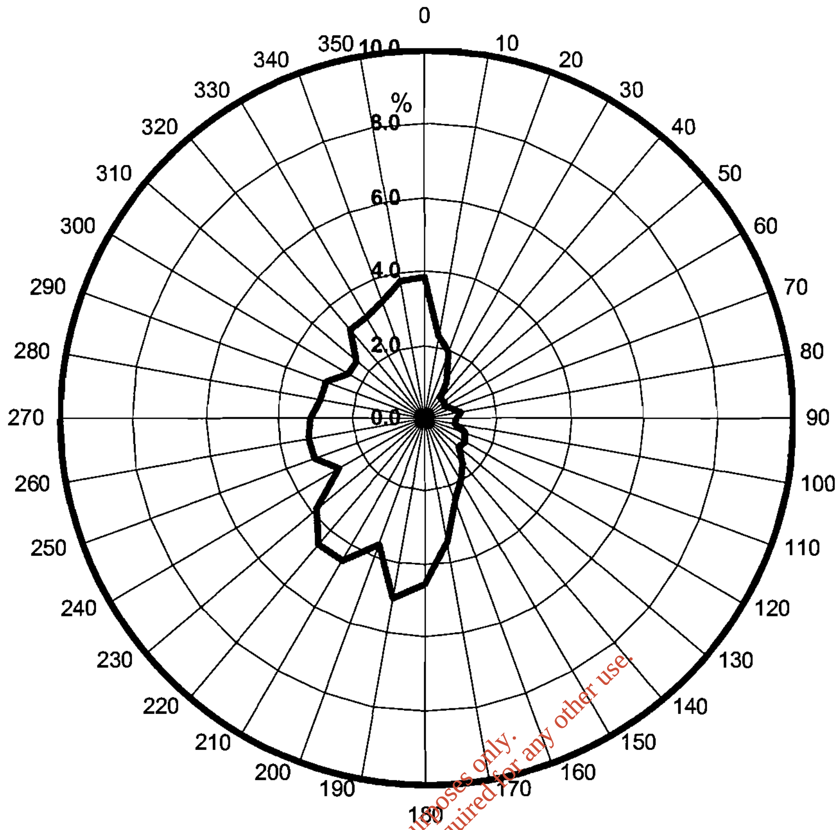
7.0 CONCLUSION

The proposed design of the wastewater treatment plant at Gorteens will ensure that odorous emissions from the inlet works and the sludge treatment parts of the plant are kept to a minimum. High efficiency odour control systems will be installed to remove malodours from the air extracted from the enclosed inlet works , dewatering building, sludge reception and sludge treatment tanks. All screened material and grit recovered from the preliminary treatment phase will be washed and stored in covered skips indoors at the inlet works prior to disposal off-site.

The primary settlement tanks will be covered and the use of sub-surface diffused aeration will also substantially reduce the formation of malodours. Diffused aeration systems for supplying oxygen for the activated sludge treatment significantly reduces the formation of aerosols compared to surface aeration systems commonly found in treatment works around the country.

Odour prediction dispersion modelling for the site indicates that the maximum concentrations in the vicinity of nearby houses are below those that are likely to create an odour nuisance. Detailed analysis over a year of the incidence of certain weather conditions indicates that for over 99.5% of the time predicted short-term (10-15 minutes) odour concentrations at nearby houses will be less than the odour detection limit. In other words no odour nuisance is predicted within the local community and so there will be no adverse impact on the air quality of the area resulting from the operation of the proposed treatment plant.

To ensure that the potential for malodours is kept to a minimum efficient plant management and good house-keeping procedures are vital in the successful operation of the proposed waste-water treatment plant. This requirement should be applied to all stages of the plant operation, from the receipt of sewage at the inlet works to ensuring that sludge is treated and stored correctly prior to disposal off-site so that further anaerobic reactions and hence odorous emissions are prevented at all times.



HOURLY WIND DIRECTION FREQUENCY - ALL WIND SPEEDS

Direction	Percentage Occurrence of Wind Speeds (m/s)					
	<2	2-3	3-5	6-8	>9	All
350-10	3.6	2.8	2.2	0.1	<0.1	9.79
20-40	1.4	0.7	0.9	0.1	0.0	3.73
50-70	0.8	05	0.5	<0.1	0.0	2.08
80-100	0.9	0.7	0.7	<0.1	0.0	2.63
110-130	1.4	1.0	0.9	0.0	0.0	3.56
140-160	1.8	1.5	1.8	0.1	<0.1	6.07
170-190	2.1	2.5	3.3	0.7	0.3	13.00
200-220	2.3	2.4	3.2	1.0	0.4	12.57
230-250	1.8	2.1	2.7	0.6	0.2	9.72
260-280	1.3	1.7	2.7	0.6	0.3	9.26
290-310	1.2	1.5	2.1	0.5	0.2	7.64
320-340	2.3	2.5	2.9	0.2	<0.1	9.68
Calms	10.2					10.24
Total	**32.40**	**20.00**	**23.82**	**4.07**	**1.49**	**100.00**

FIG 1: FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR HOURLY OBSERVATIONS AT KILKENNY (1986-92)

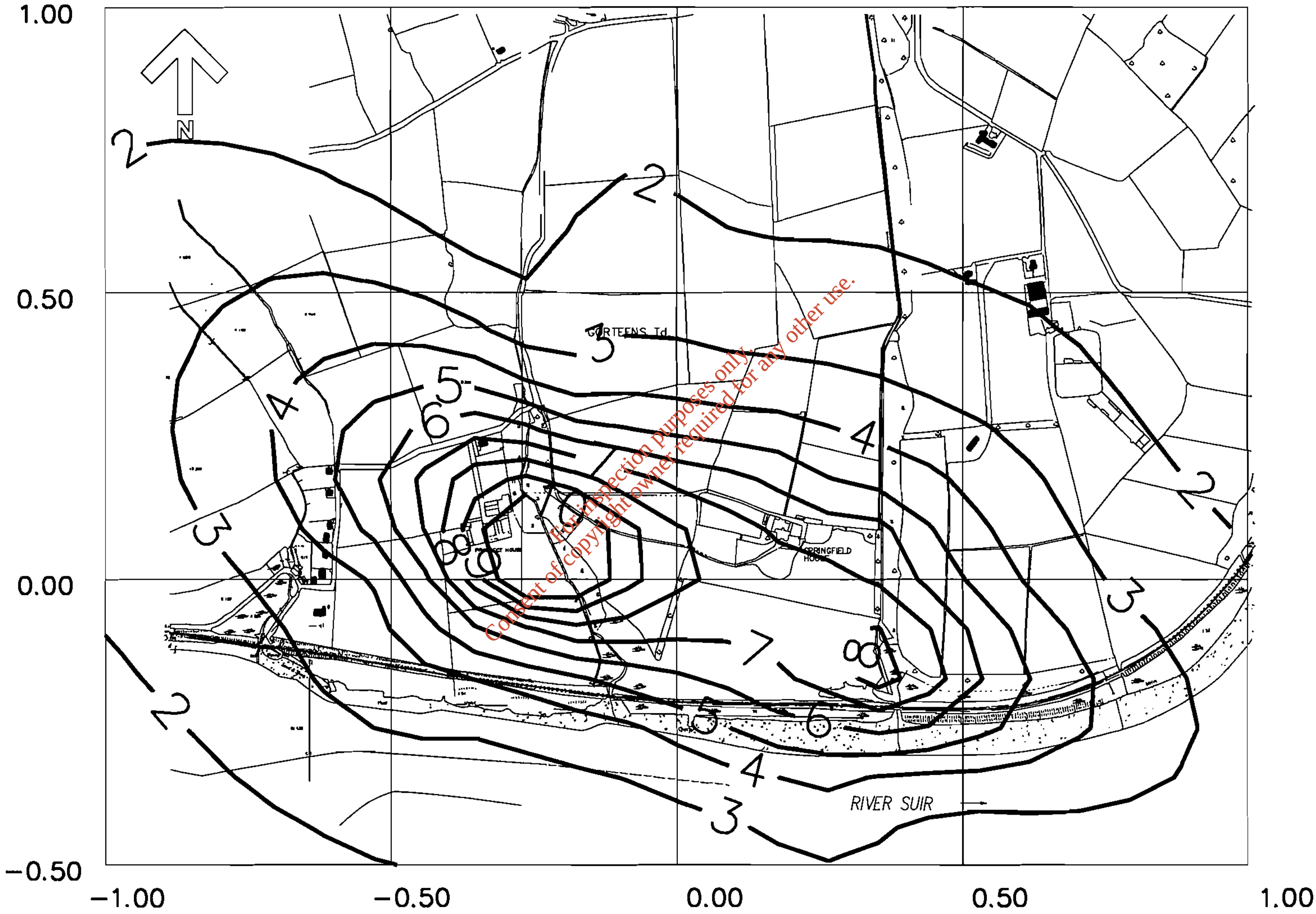


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FIG 2. - Predicted maximum short-term odour concentrations over a year-no covering on primary settlement tanks (o.u./m3)

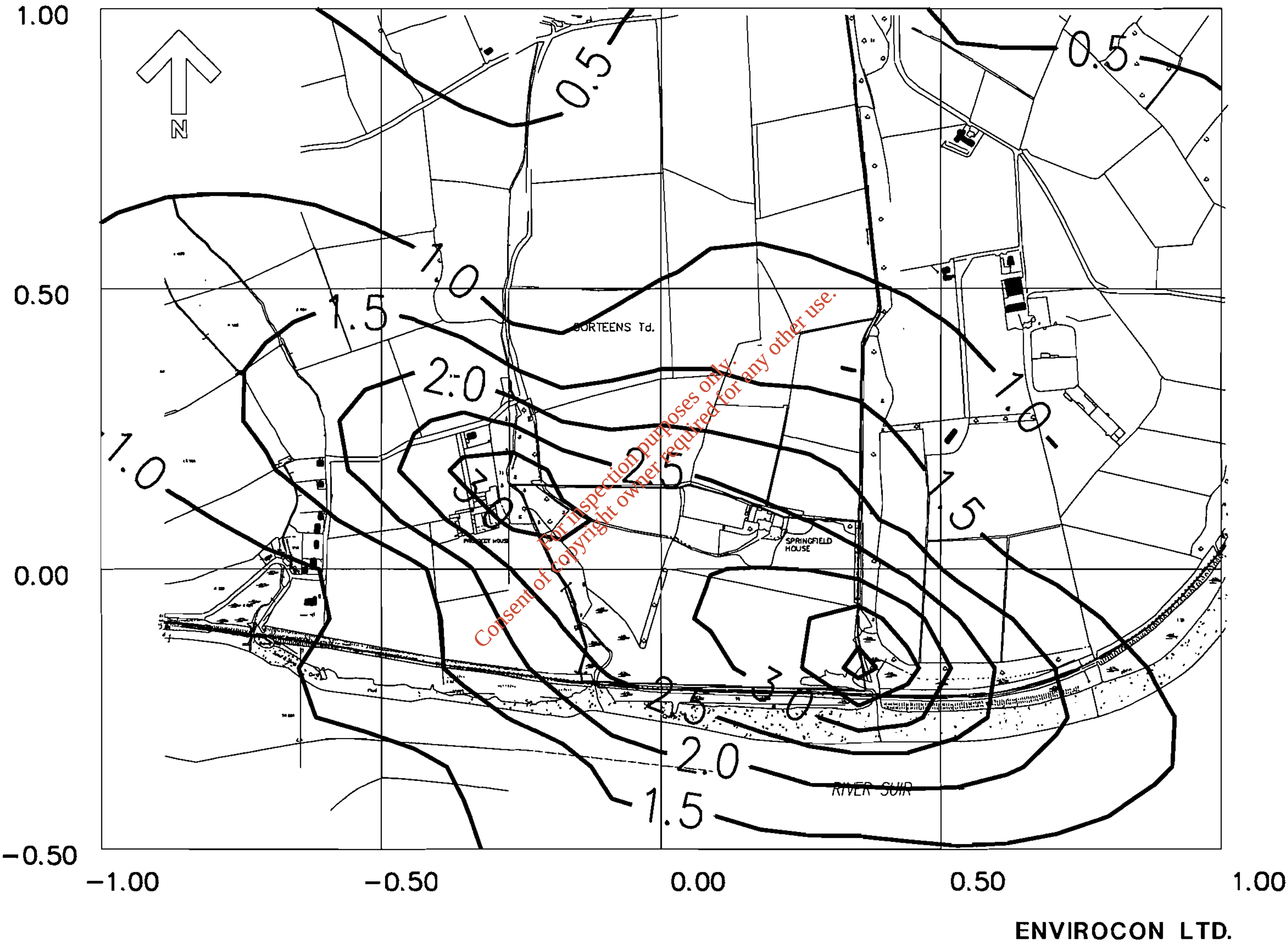

FIG 3.-Predicted maximum short-term odour concentrations over a year - primary settlement tank channels covered (o.u./m3)

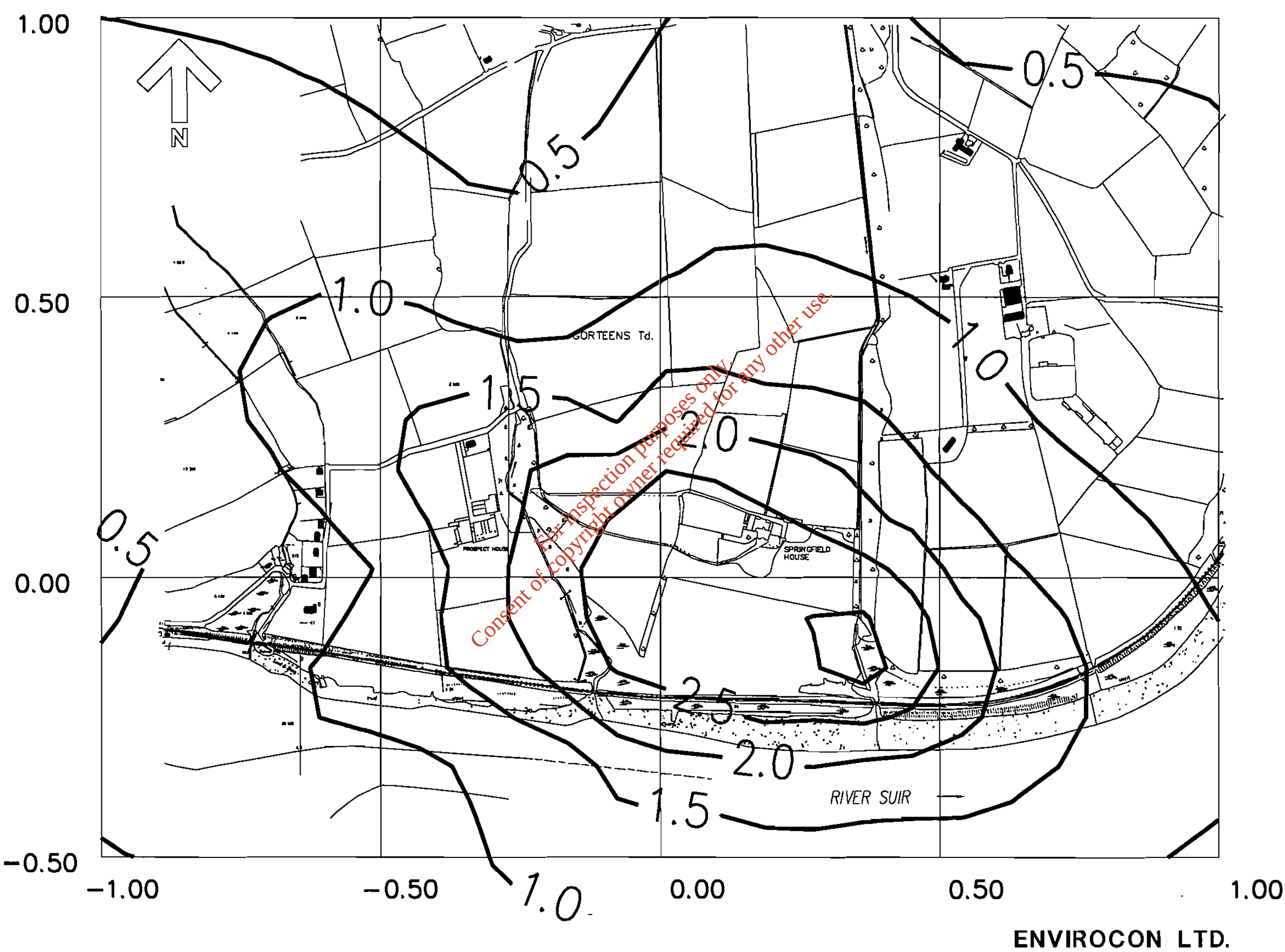

FIG 4. - Predicted maximum short-term odour concentrations over a year - primary settlement tanks covered (o.u./m3)

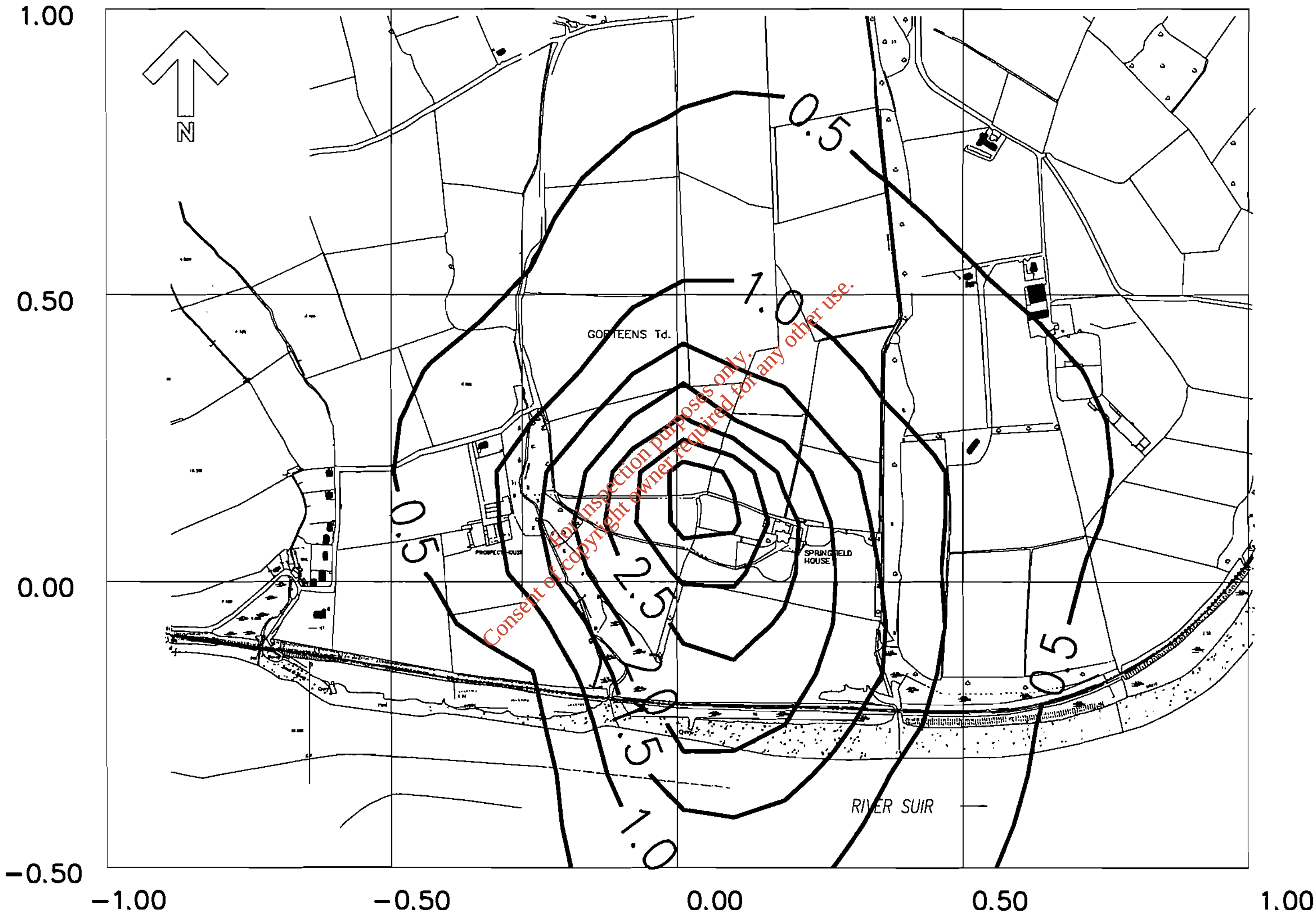

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FIG 5.-Predicted 99.5 percentile of short-term odour concentrations over a year-no covering on primary settlement tanks (o.u./m3)

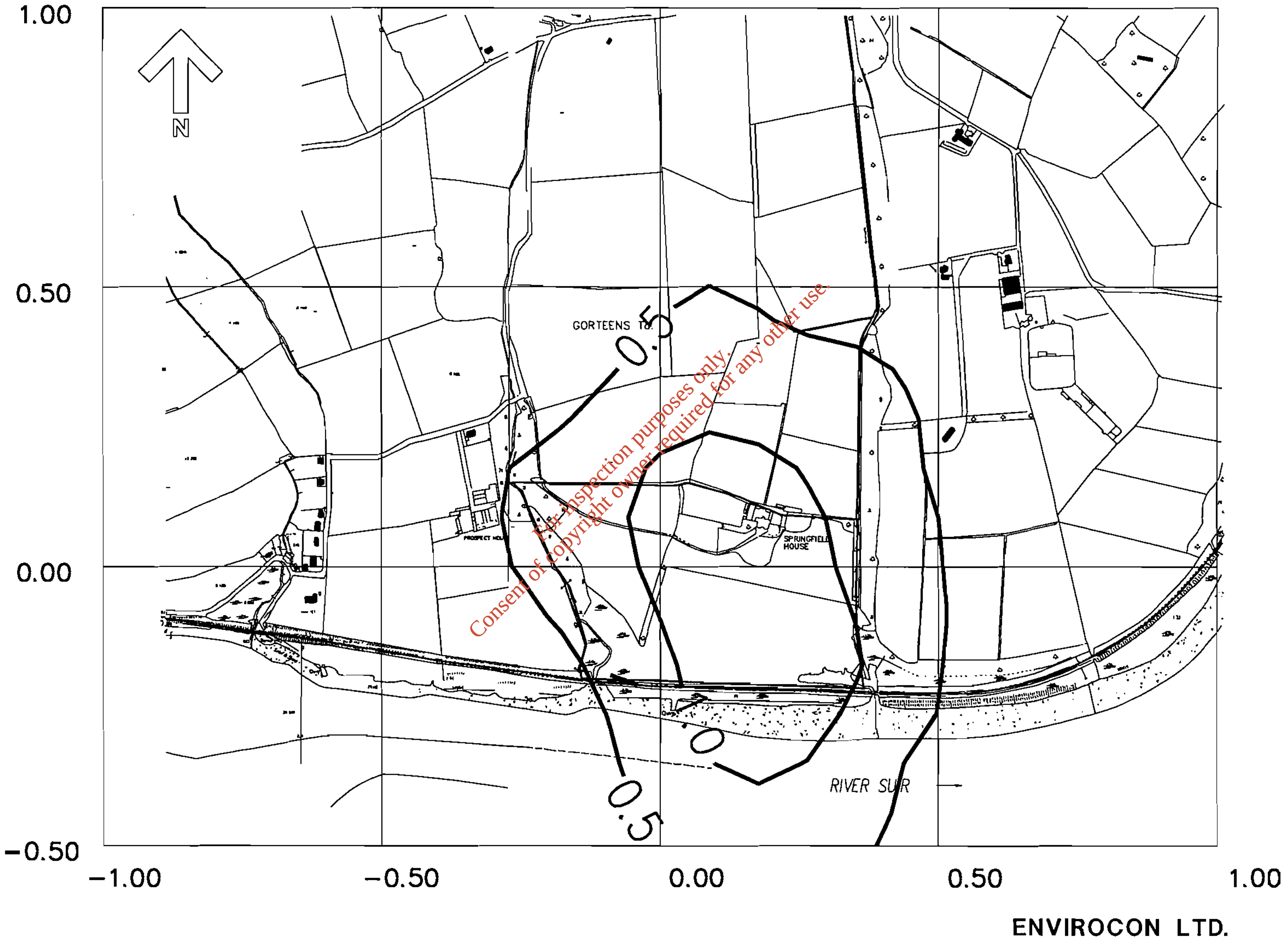

FIG 6. – Predicted 99.5 percentile of short–term odour concentrations over a year–primary settlement tank channesl covered (o.u./m3)

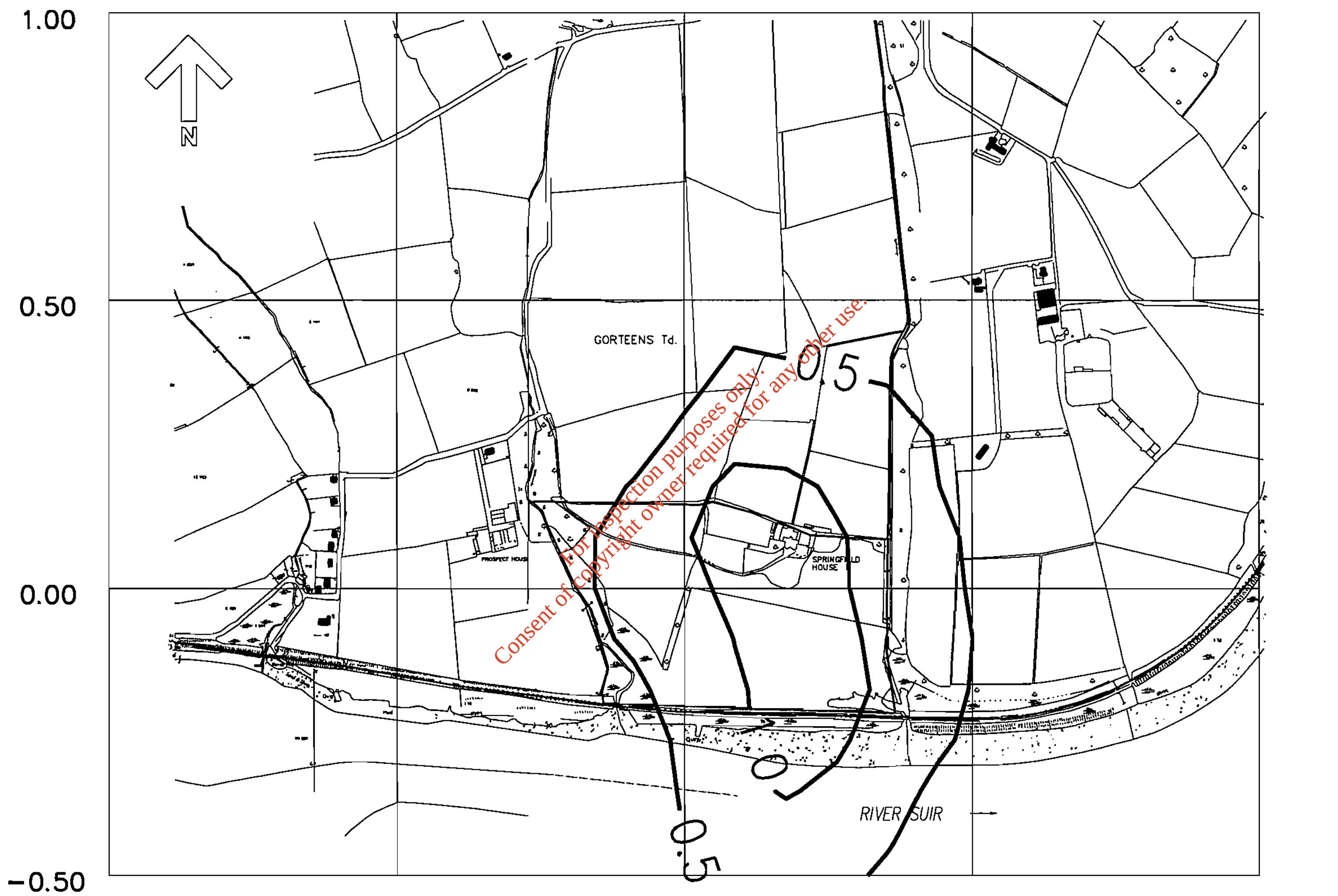

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FIG 7. – Predicted 99.5 percentile of short–term odour concentrations over a year –primary settlement tanks covered (o.u./m3)

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APPENDIX E

FLORA AND FAUNA IN THE CIVINITY OF

THE WATERFORD MAIN DRAINAGE SCHEME

(25 PAGES)

A3486-N-R-03-A

Aquatic

Services

Unit

Springfield House Wastewater Treatment Plant

Flora & Fauna Impact Survey

(June 1998)

Commissioned by:
E.G. Pettit & Co.

Carried out by:
Aquatic Services Unit
UCC

Introduction and Brief

The Aquatic Services Unit, UCC, were commissioned by Mr. Fintan McGivern of E.G. Pettit's & Co. to carry out a Flora & Fauna impact survey of lands surrounding Springfield House near Belview Port, Co. Kilkenny. The aim of the survey is to establish a flora & fauna baseline for the study area and to assess the impact of the construction of a waster-water treatment plant on site and the construction of an access road to the site from the main Waterford to Belview Road. The survey was carried out in June 1998 and comprised plant/vegetation, bird and mammal survey components. The following report outlines the results of the survey and presents recommendations to mitigate the impact of the proposed development.

Section 1 FLORA

General Description of the Site

The survey area occupies the northern tidal bank of the River Suir, shortly down-river of Waterford City. It consists of the ruined Springfield House and gardens at the north-west corner of the site, a large old meadow immediately south of this (which spans the entire W-E width of the site), together with a relatively large area of impounded saltmarsh, which is separated from the estuary by the railway line.

The eastern site boundary consists of a N-S running freshwater stream which discharges into the saltmarsh and which is flanked on both banks by a tall, mature, deciduous tree canopy. The proposed new access road will run parallel to this boundary passing through five fields on its route north from the site of the treatment works toward the port road.

Site 1 Springfield House and Immediate Environs

The former garden area fronting the house is now a damp and heavily cattle-poached pasture, with both annual and perennial weeds co-existing with native marsh plant species. Native species include Marsh Foxtail (*Alopecurcus geniculatus*), Sweet Vernal Grass *(Anthoxanthum odoratum),* Creeping Bent (*Agrostis stolonifera*) and Creeping buttercup *(Ranunculus repens)* etc. These were associated with weed species such as Broad-leaved Dock *(Rumex obtusifolius*), Toad Rush *(Juncus bufonius),* Knotgrass (*Polygonum aviculare* agg.), Pale Persicaria *(Persicaria lapathifolia),* Pineapple Weed *(Matricaria discoidea),* Lesser Swine-Cress *(Coronopus didymus)* and Greater Plantain *(Plantago major*).

Ornamental plantings, which persist within the old garden area of the house, consist mostly of small groupings of specimen trees and shrub species. The trees were: Hybrid Oak *(Quercus petraea x Q. robur*), Lime *(Tilia* genus), Beech *(Fagus sylvatica*), Sycamore *(Acer pseudoplatanus),* Ash *(Fraxinus excelsior),* Sessile Oak *(Quercus petraea)* and some conifers.

Shrubs include: Dwarf Cherry (*Prunus cerasus*), Rhododendron *(Rhododendron ponticum),* Holly (Ilex aquifolium), Bridewort (*Spiraea* genus) and Elm suckers *(Ulmus* genus*)*. The southern house-boundary hedge (which runs the full W-E width of the site) holds a particularly impressive series of mature deciduous trees. Within the area of the house-garden, its composition is mainly Sessile Oak and Ash, the sub-storey consisting of: Blackthorn *(Prunus spinosa),* Hawthorn *(Crataegus monogyna),* Holly, Bramble, *(Rubus fruticosus agg.)* and Field Rose *(Rosa arvensis).* Herbaceous plants include: Herb Bennet (*Geum urbanum*), Bush Vetch (*Vicia sepium*), Wood False-Brome (*Brachypodium sylvaticum*), Common dog Violet (*Viola riviniana*), Enchanter's Nightshade (*Circaea lutetiana*) Cock's-foot (Dactylis glomerata), Wood Dock *(Rumex sanguinea*) and Meadow buttercup *(Ranunculus acris).*

Site 2 (Meadow Area South of Springfield House)

This consists of the massive old damp meadow lying immediately south of the house and abutting onto the saltmarsh, together with the western double-hedgebank boundary to the west.

The meadow supports a native paludal flora, with an abundance of Perennial Rye-Grass *(Lolium perenne),* Rough Meadow-Grass *(Poa trivialis*), Sweet Vernal grass, Yorkshire Fog *(Holcus lanatus),* Cock's foot, Creeping Buttercup, Meadow Buttercup, Soft Rush (*Juncus effusus*), Hard Rush *(Juncus inflexus),* Common Muse-ear Chickweed *(Cerastium fontanum),* etc. The western double hedgebank boundary is bordered on its eastern side by a semi-dry ditch, which holds Remote Sedge *(Carex remota),* Marsh thistle (*Cirsium palustre*), Common Flote-Grass (*Glyceria fluitans*), Brooklime (*Veronica beccabunga*) and Creeping bent, etc.

The tree/shrub canopy is well-developed on both hedgebanks. Mature tree species include: Sessile Oak, Ash Sycamore and Horse Chestnut *(Aesculus hippocastanum*), with shrubs such as Holly, Field Rose, Hairy Dog Rose *(Rosa corymbifera*) and Elm saplings.

Site 3 (Impounded Saltmarsh)

The impounded saltmarsh spans the entire W-E width of the survey area. A freshwater stream discharges into the saltmarsh at its north-eastern end, while tidal inflow/outflow to the River Suir estuary occurs at its south-eastern end, under a small railway viaduct.

The saltmarsh flora is very varied, and contains a number of halophytic taxa which appear to be new to the Kilkenny Flora, namely: Cord grass *(Spartina* genus), Sea Couch *(Elytrigia atherica),* Hybrid Sea Couch *(Elytrigia x oliveri = E. atherica x E. repens*) and Saltmarsh Toad Rush *(Juncus ambiguus).*

Common halophytes here (Latin names in species-list) include: Celery-leaved Buttercup, Spear-leaved Orache, Sea Aster, Sea Rush, Brookweed, False Fox-Sedge, Saltmarsh Sedge, Sea Plantain and Sea Pink, with more localised populations of Tall Fescue, English Scurvy-Grass, Lesser Sea-Spurrey, Sea Mayweed, etc. At the western end of the saltmarsh, Sea Club-rush is subdominant, while Amphibious Bistort occurs in small quantity.

Particularly notable is the abundance of Hybrid Sea Couch on both the tidal banks and islets here.

Saltmarsh Plant List.

(Code: H=halophyte; Hk = hedgebank; * = apparent additions to the Kilkenny Flora.)

Agrostis stolonifera	Creeping Bent
Armeria maritima H	Sea/Pink/Thrift
Arrhenatherum elatius Hk	False Oat-Grass
Atriplex prostrata H	Spear-leaved Orache
Aster tripolium H	Sea Aster
Beta maritima	Sea Beet
Bolboschoenus maritimus H	Sea Club-Rush
Carex extensa H	Saltmarsh Sedge
Carex otrubae H	False Fox-Sedge
Cochlearia anglica H	English Scurvy-Grass
Daucus carota HK	Wild Carrot
**Elytrigia atherica* H	Sea Couch
**Elytrigia x oliveri (=E. atherica x E. repens)*	Hybrid Sea Couch
Festuca arundinacea	Tall Fescue
Festuca rubra	Red Fescue
Glaux maritima H	Sea Milkwort
Holcus lanatus	Yorkshire Fog
**Juncus ambiguus* H	Saltmarsh Toad Rush
Juncus effusus (marginal)	Soft Rush
Juncus gerardii H	Saltmarsh Rush
Juncus inflexus (marginal)	Hard Rush
Lotus corniculatus (marginal)	Common Bird's-foot -trefoil
Lotus pedunculatus (marginal)	Marsh Bird's-foot
Mentha aquatica (marginal)	Water Mint
Plantago maritima H	Sea Plantain
Persicaria amphibia (marginal)	Amphibious Bistort
Populus tremula Hk	Aspen
Puccinellia maritima H	Saltmarsh Grass
Ranunculus acris (marginal)	Meadow Buttercup
Ranunculus repens (marginal)	Creeping Buttercup
Ranunculus sceleratus H	Celery-leaved Buttercup
Samolus valerandi H	Brookweed
Schoenoplectus tabernaemontnai H	Saltmarsh Bulrush
**Spartina genus* H	Cord-Grass
Spergularia marina H	Lesser Sea-Spurrey
Spergularia media H	Greater Sea-Spurrey
Triglochin maritima H	Sea Arrow-Grass
Tripleurospermum maritimum H	Sea Mayweed

Site 4 (Railway Embankment)

The survey area section of embankment lies immediately east of the saltmarsh tidal outlet. Bordering scrub on the northern side of the embankment holds: Common Alder *(Alnus glutinosa),* Rusty Willow *(Salix cinerea* ssp. *oleifolia),* Sycamore, this well-drained site consists of an admixture of meadow plants and halophytes - the latter mainly bordering the River Suir estuary here. Common components of the flora include: Sea Mayweed, Red Fescue, Wild Carrot, Meadow Buttercup, Hybrid Sea Couch, Meadowsweet, Hogweed (*Heracleum sphondylium*), Field Horsetail *(Equisetum arvense*), Bush Vetch, Corn Sow-Thistle *(Sonchus arvensis),* Sea Pink, English Scurvy-Grass, Sea Mayweed, marsh Bird's-foot-trefoil and Hemlock Water-Dropwort. Very locally occurring species included: Sea Couch, Agrimony *(Agrimonia* genus), while the pervasive weed, Winter Heliotrope (*Petasites fragrans*) is now established in abundance at the eastern end of the embankment, and poses an ongoing threat to the native flora here. Most surprisingly, Common Couch was only observed at the eastern site extremity - a species that in such habitats is usually abundant.

Site 5 (Fields 1-5)

Site 5 lies at the eastern extremity of the survey area and consists of a linear series of five fields (N-S orientated) wedged between the road to the north and the saltmarsh to the south. The common eastern boundary to all five fields is the freshwater stream, which discharges into the saltmarsh. This stream in turn is bordered on both banks by mature trees - Ash to the front, Sessile Oak forming a second row behind the Ash. This planting pattern is repeated along the eastern margin of all five fields as, largely, is the shrub component, which consists of Blackthorn, Hawthorn, Rusty Willow, Common Dog Rose, Bramble, Privet (*Ligustrum vulgare*) Elm suckers and young beech trees, with occasional plantings of Dwarf Cherry and Laburnum (*Laburnum* genus) as in Field I (i.e. the most southern field).

Fields 1-3

These are seeded perennial Rye-Grass pastures used by cattle, with severely pruned W-E orientated hedgebanks that support a limited flora, mainly Bramble, Common Doge Rose, Privet, occasional Common Elder (*Sambucus nigra*), Hawthorn and Blackthorn. The herbaceous flora consists of Wood Dock, Herb Bennet, Common Dog Violet, Wood False Brome, Soft Shield-Fern (*Polystichum setiferum*), Germander Speedwell (*Veronica chamaedrys*), Sweet Vernal Grass, False Oat-Grass and Broad-Leaved Dock, etc.

Field 4 (Relict Marshy Meadow)

This species-rich old meadow is separated from Field 3 by a thick earth-and-stone hedgebank together with a deep ditch on its northern side. The hedgebank habitat is calcifuge, as is evidenced from the flora, which is dominated by just a few acid-loving species, such as the sub-shrub Bilberry (*Vaccinium myrtillus*) and the rhizomatous perennial grass Brown Bent *(Agrostis vinealis*) - Which is possibly new to the Kilkenny flora. Other associates include: Broad Buckler - Fern (*Dryopteris dilatata)* and Common *Polypodium* group. The ditch itself holds Water Horsetail (*Equisetum fluviatile*), Water Starwort (*Callitriche stagnalis*) and Common Flote-Grass

(*Glyceria fluitans)*. The field itself is probably a rarity in this area, being an un-reclaimed, damp, circum-neutral meadow. Rush species are subdominant here, particularly Acute-flowered Rush (*Juncus acutiflorus*), Hard Rush, Soft Rush, and the interspecific hybrid between these latter two species (*Juncus* x *diffusus*), which is remarkably frequent here as large, sterile, clonal stands. This hybrid is apparently new to the Kilkenny Flora, may be one of the largest stands in Ireland for this taxon. Other frequent species present here are: Common Spotted Orchid (*Dactylorhiza fuchsii*) and heath Spotted Orchid (*Dactylorhiza maculata*), Silverweed (*Potentilla anserina*), Lady's Smock (*Cardamine pratensis*), etc. Compact Rush (*Juncus conglomeratus*) is also common here.

Field 5 (Relict Marshy Meadow)

The physiognomy and floral composition of Field 5 is identical to Field 4, while a small population of Hybrid Hard Rush (*Juncus x diffusus*) is also present here. The north-east corner of the field gives way to a tiny area of Carr scrubwood, which holds an abundance of remote Sedge (*Carex remota*), Common Alder *(Alnus glutinosa*), some Maple *(Acer campestre)* saplings, Hart's-tongue Fern *(Phyllitis scolopendrium*), Broad Buckler-Fern, and Water Figwort *(Scrophularia auriculata*) on the margin of the scrubwood bordering the meadow. Hybrid Montbretia *(Crocosmia x crocosmiiflora*) is also naturalised here.

The margin of the woodland bordering on the roadway has been recently cleared, and weed introductions are now well established, particularly Winter Heliotrope *(Petasites fragrans*) and American Willowherb (*Epilobium ciliatum*), while the native Great Willowherb (*Epilobium hirsutum*) is common.

BOTANICAL EVALUATION & RECOMMENDATIONS

Evaluation

This relatively small survey area is of interest for the presence within it of two ecologically-contrasting habitat types (viz.: saltmarsh and un-drained old meadows) - habitats which, moreover, are under constant threat from infrastructural developments, and thus are rapidly achieving rarity status in Ireland. The value of both habitats is further enhanced by the presence of some large populations of the nationally-rare Hard Rush Hybrid *(Juncus x diffusus)* in the old meadows, and the presence (in some abundance) of the even rarer Hybrid Sea Couch *(Elytrigia x oliveri)* in the saltmarsh.

The abundance of well-developed, mature, deciduous tree species/hybrids in such a compact site is also somewhat noteworthy given that most tree-stands of this quality are now only to be found in National parks and private demesnes.

Recommendations

Site 1: Specimen trees within the former garden of Springfield House should be retained where possible. This particularly applies to some specimen conifers, as well as mature Ash, Sessile Oak, Hybrid Oak, Horse Chestnut, and a cluster of Lime Trees.

Site 2: Every effort should be made to retain the magnificent stand of timber (mainly Oak and Ash in the W-E orientated hedgebank immediately south of the house. This also provides a useful windbreak.

Site 3: The impounded saltmarsh at the southern boundary of the site is of considerable ecological merit for the following reasons and every effort should therefore be made to insure that it isn't impacted by the development and pipe-laying associated with the development:

(i) The site is remarkably intact (un-degraded) and floristically rich;

(ii) As the Kilkenny 'coastline' is of very limited extent, the present saltmarsh is a valuable ecological asset to that county

(iii) Hybrid Sea Couch *(Elytrigia x oliveri)* occurs here in abundance, a nationally rare grass which is new to the Kilkenny Flora.

(iv) Other halophyte additions to the Kilkenny Flora from this saltmarsh are: Saltmarsh Toad-Rush *(Juncus ambiguus)* and Cord-grass *(Spartina genus)*.

The proposed extensive tree plantings earmarked in the County Development Plan for this saltmarsh should not go ahead. Instead, a much narrower band of trees consistent with visual screening should be placed along the southern end of the field immediately landward of the marsh.

Site 5, Fields 4 & 5: Such un-reclaimed old meadows are now becoming increasingly rare in Ireland, making their conservation particularly important. Moreover, Field 4 holds some large populations (i.e. clonal stands of large size) of the nationally-rare Hybrid Hard Rush *(Juncus x diffusus)* which is new to Kilkenny. While Field 5 also holds a small population of this taxon, in addition to a small area of wet woodland - a further distinctive and increasingly rare habitat-type in the Irish Landscape.

Note: Care should be taken to preserve the existing hydrology of these two marshy meadows during the construction of the new access road to the proposed Sewage Treatment Plant.

Conclusions

Overall this site is contains a range of botanical habitats, is floristically rich and environmentally very sensitive. It is of considerable botanical interest and should not be degraded during or after development of the treatment plant.

Section 2. FAUNA - BIRDS

Background

The present survey covers the site of the proposed treatment plant adjacent to the River Suir at Springfield House, including a proposed access road to be constructed running north from the site to the existing road for Belview Port. Consideration is also given to the proposed route of the outfall pipe from the site to the Suir estuary.

Methods

The site and its environs were visited on the morning of 13 June 1998, and surveyed during the period 0830-1200 hrs BST. Weather conditions were favourable (mainly dry but overcast, following earlier drizzle, and with a light northerly wind). Fields, hedgerows, wooded belts and pasture within the proposed site-boundary were walked, and note was kept of all birds seen or heard. Additional observations were made within and around Springfield House and its outbuildings (immediately outside the proposed site boundary); along the belt of mixed woodland (and fields immediately to its west) running north from the site (parallel to the proposed access road); in the saltmarsh immediately south of the site; and along the proposed outfall pipeline route eastwards from the site to just west of Belview Port.

More intensive surveys were not attempted, as significant improvement in estimates of bird population densities would require counts over several days earlier in the breeding season. The results of the survey described below (with the exception of one bird species, considered in more detail) suggest that such increased precision would not be warranted.

Avian usage of the site, and suitability of habitat

Observations on site visit

A total of 37 bird species was recorded on 13 June (Table 2.1). The highest numbers of species were recorded along the wooded belt parallel to the proposed access route (14 species) and within the site-boundary itself (13 species). Most species recorded were associated with woodland or hedgerow habitat, and the most abundant species overall (based on minimum numbers of apparent pairs) appeared to be Wren, Robin, Blackbird and Song Thrush.

Bird species recorded within the site-boundary (Area A in Table 2.1) were typical of parkland or woodland habitats. A number of additional species (notably nesting Stock Dove, Swallow and Spotted Flycatcher) were associated with the ruins of Springfield House (Area B). The ruins were searched for evidence (prey remains) of roosting or breeding Barn Owls *Tyto alba*, but none was found.

The main woodland belt (Area C) running from south to north from the eastern boundary of the site held several additional species (notably Treecreeper, Chiffchaff and Blackcap). Overall densities of breeding birds were possibly highest here (allowing for the greater difficult of surveying birds there compared with more open habitats). Densities and diversity of birds in the fields and hedgerows (Area D) immediately west of the wooded belt were lower than in the wooded belt or on the site itself. Additional species in this area included Willow Warbler and Reed Bunting in the northernmost, rushy field (including Willow scrub).

The most notable bird species recorded near the site was Little Egret *Egretta garzetta*. This was a single individual feeding in the saltmarsh (Area E) immediately adjacent to (and less than 50 m from) the SW corner of the site-boundary. The bird flew from the marsh and, circling briefly overhead, flew downriver. The saltmarsh held several additional wetland species, and a Water Rail was heard in a narrower marshy channel further east, parallel to the railway line (Area F).

Birds recorded along the proposed pipeline route (Areas F, G, H), east from the site, included a mixture of woodland, scrubland, open country and wetland species. Wetland habitat (marsh and channels/pools) was most extensive along the north side of the railway line, but a number of pools were also present south of the line (near the proposed outfall).

Other relevant data (wetland bird counts)

No detailed observations were made during the present survey of birds along adjacent parts of the River Suir itself, as relatively few wetland birds would be expected during summer. However, some data from previous winters are summarised in Table 2, based on the author's counts for BirdWatch Ireland's Irish Wetland Birds Survey (I-WeBS). This section of the Suir (Belview/Little Island/Faithlegg) includes most of the waterfowl wintering east of Waterford city and west of Cheekpoint.

A total of 17 waterfowl species (excluding gulls) were recorded in the area during four counts over winters 1995/96 to 1997/98. No species was regularly present in nationally important numbers ($\geq$ 1% of the total Irish population: Delany 1997), although Lapwing counts occasionally exceeded the "1% threshold." Nevertheless, the wintering assemblage of waterfowl on this part of the River Suir can be considered of local or regional importance, particularly given its semi-inland position and the number of scarce species regularly present (e.g. Common Sandpiper, Greenshank). Additional waterfowl species recorded in recent winters (but outside of I-WeBS counts) include Little Egret, Red-breasted Merganser *Mergus serrator* and Little Stint *Calidris minuta*.

Where possible, Table 2 gives a breakdown of counts into two sub-sections: King's Channel (Waterford mainland and southern shore of Little Island) and North Channel (Kilkenny shore and northern shore of Little Island). At low tide, most waterfowl along the North Channel feed or rest along the riverine mudflats on the Kilkenny shore, mainly between Springfield House and Waterford Port (i.e. mainly upstream of the proposed outfall). Marshes along the Kilkenny shore (both inside and outside the railway track) were mainly used by dabbling ducks *Anas* spp., Snipe and, on one occasion, Jack Snipe, although coverage was probably incomplete.

Likely Impacts

Immediate site and adjacent buildings

The main impact of the proposed development on birds is likely to be through the loss of some breeding habitat at the immediate site of the waste treatment plant. This would mainly involve the wooded hedgerow (including oak) across the middle of the site. Most of the existing trees along the western, northern and eastern boundaries of the site will either be retained or will be replaced by new planting if removed during construction activities. Few if any birds were breeding on the cattle-grazed pasture at the site.

Based on the relative amounts of habitat to be lost or retained, perhaps a 30% reduction in birds numbers (and the loss of a few species) might be expected on the immediate site. Some additional losses can also be expected to result from disturbance during construction of the treatment plant, but in the longer term there should be some recovery. Birds breeding in and around Springfield House will not be affected directly by the development, although some temporary disturbance may occur. In a wider context, given the availability of other suitable habitat in this part of south Kilkenny, and the species involved, losses are likely to be of little significance.

Adjacent marsh habitat

While the proposed planting of a 30-m wide shelter-belt of trees along the southern boundary of the site would have some beneficial effect (by providing new habitat), possible impacts on birds using the adjacent marsh need to be considered. Such a shelter-belt might encroach on, and reduce the area of, marsh habitat, and might also cause some drying-out of the marsh. If this occurred, loss of habitat for some wetland birds could be expected. This is likely to be particularly important in the breeding season (birds nesting in the marsh or feeding here while breeding elsewhere), as suitable wetland habitat is generally in short supply. Wetland-breeding birds tend to be more sparsely or locally distributed in Ireland than many land-bird species, particularly so in agriculturally developed regions such as the south-east.

By far the most significant wetland bird recorded in the present survey is Little Egret, one of which was feeding in the marsh south of the Springfield House site on 13 June 1998. In recent years, there have been frequent records of Little Egrets from the mudflats and marshes along both shores of this part of the lower River Suir (e.g. Milne & O'Sullivan 1997, personal observations). Until now, however, there had been no summer records here. Little Egret is listed in Annex I of the EU Birds Directive as requiring "special conservation measures concerning their habitat in order to ensure their survival and reproduction in their areas of distribution" (Way *et al.* 1993). This requirement has become particularly relevant since Little Egrets bred for the first time in Ireland in 1997 (12 pairs at a south-coast site: Smiddy & Duffy 1997). Further breeding locations have been discovered this year. Previously, the species bred no closer than the Continent, although breeding also took place in Britain for the first time in 1997.

There is much suitable potential breeding habitat for Egrets along the lower River Suir, and the present sighting strengthens suspicions that the species may now be breeding locally. Typical feeding habitat includes shallow fresh or brackish water and flooded meadows, and on the Continent the diet during the breeding season largely comprises small fish, crustaceans, aquatic insects and amphibians (Cramp & Simmons 1977). Marshes and pools along the lower River Suir clearly provide suitable feeding habitat. *Given the strong likelihood that the species is breeding locally (or will do so in the near future), a precautionary approach to alteration of wetland habitat in this area is warranted.*

With particular reference to the Springfield House site, it is recommended that:

- the proposed shelter-belt of trees along the riverward edge of the site should not encroach on the adjacent marsh, or at a minimum should be as narrow as is consistent with visual shielding of the treatment plant;
- damage to the marshland habitat between the site and the proposed outfall should be kept to a minimum, with habitat restored where possible and drainage or other lowering of water-levels avoided.

Access Road (option 3)

The proposed route is likely to have minimal impact on birds using the adjacent wooded belt and hedgerows. Short sections of hedgerow, part of the northern end of the wooded belt, and an area of rushes and scrub will be removed, but most breeding bird species are likely to be retained in the immediate area. The relatively small volume of traffic involved is likely to have only a minimal impact on breeding birds compared with busier roads in the area.

Proposed route and location of outfall

Habitat alteration along this route is likely to be minimal and temporary, and the most serious potential impact would involve any drainage of marsh or pool habitat. As noted above, drainage should be avoided if at all possible. There will be no direct impact on riverside mudflats used by feeding waterfowl in winter, apart from temporary disturbance during the construction period.

General impact of outfall

No significant negative impact of effluent (e.g. through nutrient enrichment or release of toxins) on wetland birds is expected, given the treatment processes and dilutions involved (and in the context of previous untreated discharges along the Suir). In particular, birds feeding along the river channel or its mudflats are not considered to be at risk, given the species and numbers involved. However:

- adequate procedures should be in place to minimise the likelihood of leakages or other emergency spills impacting marsh/pool habitat.

Mitigation

Planting of shelter-belts is planned for the western, northern and eastern margins of the site (adjacent to existing wooded belts), and the western margin of the proposed access route. These will provide new habitat and reduce visual disturbance to birds using existing habitat.

Possible impacts on water-levels of marshes and pools between the site and the proposed outfall location should be taken into account.

Construction procedures to avoid acute impacts on marshes and pools should be implemented.

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Table 2.1 Bird species at or adjacent to the proposed site of the wastewater treatment plant at Springfield House, Co. Kilkenny. Figures in parentheses are minimum numbers of singing (probably territorial) males, apparent pairs, active nests or family parties.

						pipeline route		
*Location:	A. main site	B. house etc.	C. wooded belt	D. fields to north	E. marsh to south	F. marsh/ scrub N	G wooded belt N	H scrub/ bank S
Little Egret *Egretta garzetta*					1			
Grey Heron *Ardea cinerea*					1			
Mallard *Anas platyrhynchos*					4 (1)	1 (1)		
Water Rail *Rallus aquaticus*						1		
Stock Dove *Columba oenas*		4 (1)						
Woodpigeon *C. palumbus*	6 (3)		25 (4)				2 (2)	
Swift *Apus apus*				1 flying				
Skylark *Alauda arvensis*								1
Sand Martin *Riparia riparia*					1 flying			
Swallow *Hirundo rustica*		6 (2)						
Meadow Pipit *Anthus pratensis*				1 (1)	1 (1)			1 (1)
Pied Wagtail *Motacilla alba*		1						
Wren *Troglodytes troglodytes*	12 (6)		10 (6)	3 (3)		1 (1)	3 (3)	1 (1)
Dunnock *Prunella modularis*	2 (1)	1 (1)	1 (1)	1 (1)			1 (1)	2 (1)
Robin *Erithacus rubecula*	13 (8)		6 (4)	1 (1)			2 (2)	
Blackbird *Turdus merula*	3 (1)	1 (1)	6 (6)	3 (2)			2 (1)	
Song Thrush *T. philomelos*	5 (3)		4 (4)	1 (1)			4 (2)	
Blackcap *Sylvia atricapilla*			2 (2)					
Chiffchaff *Phylloscopus collybita*			5 (4)					
Willow Warbler *P. trochilus*				1 (1)			1 (1)	
Goldcrest *Regulus regulus*	5 (1)		1 (1)					
Spotted Flycatcher *Muscicapa striata*		1 (1)						
Coal Tit *Parus ater*	3 (2)						1 (1)	
Blue Tit *P. caeruleus*	5 (1)		3 (2)				3 (1)	1
Great Tit *P. major*	2 (1)							
Treecreeper *Certhia familiaris*			1					
Magpie *Pica pica*			1	1				
Jackdaw *Corvus monedula*	21	15						
Hooded Crow *C. corone*	5		1					
Starling *Sturnus vulgaris*								
House Sparrow *Passer domesticus*		2 (1)						
Chaffinch *Fringilla coelebs*	6 (3)		2 (1)				1 (1)	1
Greenfinch *Carduelis chloris*						1 (1)		2 (1)
Goldfinch *C. carduelis*		1 (1)						
Linnet *C. cannabina*								2 (1)
Bullfinch *Pyrrhula pyrrhula*								1
Reed Bunting *Emberiza schoeniclus*				1 (1)	1 (1)	1 (1)		1 (1)
Total birds	88 (30)	32 (8)	68 (35)	14 (11)	9 (3)	5 (4)	20 (15)	13 (6)
Number of species	13	9	14	9	6	5	10	10

*Locations:
A = trees, hedgerows, pasture within proposed site-boundary.
B = Springfield House, out-buildings and trees immediately outside north-west boundary of site.
C = main woodland belt extending south-north from south-east corner of site to road near Gorteens (Plate 7).
D = fields (and their boundaries) immediately west of C (and along proposed access route).
E = marsh bordering southern margin of site, north of railway track. (Plates 3 & 4)

F = marsh, pools and scrub (north of railway track) from stream outlet at south-east of site east to proposed outfall location west of Waterford port (Plate 6).
G = main wooded belt (field boundary north of track) from south-east corner of site east to proposed outfall (Plate 6).
H = scrub, trees, pools, riverbank (south of track) from stream outlet east to proposed outfall (Plates 5 & 6).

Table 2.2 Counts of waterfowl (excluding gulls) along the "Belview-Little Island-Faithlegg" section of the lower River Suir, Cos. Waterford/Kilkenny, winters 1995/96-97/98 (Walsh, unpublished). All counts were made at low tide; numbers of Snipe (and possibly duck) may be underestimates, as not all marsh habitat could be surveyed.

	25.11.95	25.12.95	12.1.97			25.1.98		
	total	total	North channel	King's (south) channel	total	North channel	King's (south) channel	total
Cormorant *Phalacrocorax carbo*	4	29	43		43	49		49
Grey Heron *Ardea cinerea*	6	4		13	13		22	22
Wigeon *Anas penelope*	50	15	2		2			0
Teal *A. crecca*	23	3	29		29			0
Mallard *A. platyrhynchos*		0			0	2		2
Shelduck *Tadorna tadorna*		0			0	2		2
Oystercatcher *Haematopus ostralegus*	1	26				4	4	8
Lapwing *Vanellus vanellus*	1100	555	956	1794	2750	640	665	1305
Dunlin *Calidris alpina*	94	52	88	20	108	214	2	216
Jack Snipe *Lymnocryptes minimus*			1+		1+			
Snipe *Gallinago gallinago*	2+	45+	2+	8+	10+		2	2+
Black-tailed Godwit *Limosa limosa*	10	2	6	24	30			0
Curlew *Numenius arquata*	76	43	20	2	22		29	29
Redshank *Tringa totanus*	28	22	12	16	28	17	27	44
Greenshank *T. nebularia*	7	2					3	3
Common Sandpiper *Actitis hypoleucos*	2	1			1		1	1
Turnstone *Arenaria interpres*	0	0	4	4	4			0

Section 3 FAUNA – MAMMALS

Introduction

An assessment of the ecological value to mammals of the proposed development (waste-water treatment plant) site at Springfield House Co. Kilkenny, was undertaken in mid June 1998 and consisted broadly of:

1. An assessment of the existing habitat value to mammals.
2. A field survey of mammal signs.
3. An assessment of the existing level of habitat management and proposed development impact.

Mammal Species (General)

In general, it is considered that with the exception of the woodland on the eastern border of the site, the habitats provided elsewhere on the development site are likely to be utilised by a low to moderate number of mammal species. The field survey recorded the presence of three unprotected species utilising the site namely; brown rat *Rattus norvegicus*, rabbit *Oryctotalagus cuniculus* and fox *Vulpes vulpes*. Otter *Lutra lutra* (protected) was recorded utilising the shoreline/wetland habitat on site. Other small, protected species that may utilise the habitats in part are: woodmouse *Apodemus sylvaticus*, pygmy shrew *Sorex minutus* and hedgehog *Erinaceus europaeus*. The habitat requirements of larger protected mammals such as badgers *Meles meles* and stoats *Mustela erminea* are provided in the woodland habitat on the eastern border of the site. Disused and remaining roofed buildings on site are considered unsuitable for bats.

Importance of Habitats to Mammals

Overview

The natural and semi-natural habitats on site broadly consists of riparian shoreline, wetland, pasture, scrub, hedgerow, old gardens/orchard and woodland. The lower area of the site (primarily pasture) is to be developed and a hedgerow/scrub to be removed. The semi-natural habitats in the immediate vicinity of the derelict house, outbuildings and yards have been significantly degraded and fragmented. Most of the ground in the area has been severely poached by cattle and is quite wet underfoot. The site is subject to human and livestock disturbances. The main woodland on the eastern border of the site is not to be affected by the development excepting the upper section traversed by the proposed access road.

Shoreline / Wetland

The shoreline of the site is relatively typical of estuarine environments. Above the high tide level there is a dense summer growth of herbaceous vegetation with occasional clumps of furze and willow. Recent field signs of otters were recorded at the quay on site and further east along the shore at the confluence of an outlet from the wetland bordering the shore. It is likely that otters utilise the entire shoreline in the area. However, the wetland on site offers additional habitat of the type favoured by the species as temporary rest areas. The habitat features of importance to otters are likely to be water-bodies on site, confluences of saltmarsh outlets with the estuary and relatively good vegetation cover. The habitat does not appear to provide permanent resting sites (underground holts for breeding) to the species, the area being disturbed by the railway line. Other mammals do not generally favour the relatively damp nature of these habitats and these are, therefore, considered of marginal importance to other species.

Pasture fields encompassed by the development

Much of the WWTP development and access road is to be constructed on pasture fields in the vicinity of Springfield House. These are severely poached, grazed and low cut. The lower field is also subject to wind exposure. These areas are considered of little importance to mammals.

Old House ruins, outbuildings, gardens and environs

The old house and outbuildings are of no importance to mammals. Some 30% of the backyard is covered in livestock excreta. Most of the small yards in the vicinity are in similar condition. The area is unsuitable for most mammals excepting rats. The only covered shed does not provide suitable areas for bat roosts.

The area immediately west of the old house/building is an enclosed old orchard. It is overgrown and nettles are common. It is damp in places and grazed in spots. It is subject to a low level of disturbance. In general it can be considered of moderate importance to small mammals.

The area immediately south of the old house is overgrown in part, containing bramble and willow scrub. The ground is rough in places and damp underfoot. The degraded understorey has lessened the importance of the area to mammals. Woodmice are likely to be present on the drier banks on site. With exclusion of cattle, the area is likely to become a mammal refuge of moderate to high importance.

The area immediately east of the old house contains waste ground upon which there has been some spoil/rubble spreading. It contains scattered scrub and nettles and is generally degraded. It is of low importance to mammals.

Hedgerows/Woodland

The hedgerow/tree line running (east-west) through the development site south of the old house is to be removed. It is a relatively scattered line of mature deciduous trees bordering a small drainage ditch; it is relatively narrow with little understorey. The ground along it is severely poached and overall it is of little importance to mammals.

The access road to the development site will traverse a further five hedgerows as it travels north from the site and a band of trees/vegetation will be removed in each of the hedgerows the width of the road itself. Other hedgerows/woodland bordering the site (western border - moderate importance, eastern border -high importance) will not be significantly affected excepting an upper portion of the relatively large eastern woodland, which will be traversed by the proposed access road.

The eastern woodland is a relatively mature mixed deciduous wood with a dense understorey considered of high importance to mammals.

Impact

Shoreline / Wetland

The development will potentially impact on these habitats and otters in two ways. Firstly the proposed tree planting on the wetland will negatively impact on otter utilisation of the habitat. Secondly, depending on the location of the proposed pipeline route from the WWTP, attendant drainage/construction works may negatively impact on the flow regime and amount of the water bodies on and bordering the site. Notwithstanding, the interface between the shoreline and wetland habitats are likely to be significantly disturbed during the construction phase and otters may temporarily abandon the habitat in the short term. Provided, however, there is not a significant impact on freshwater bodies and wetland habitat, otters will again utilise the area.

Pasture fields encompassed by the development

Development impact will be minimal

Old House ruins, outbuildings, gardens and environs

This area is generally of low importance to mammals, with the exception of the disused orchard area and some of the drier banks in the garden and other hedgerows immediately south of the derelict Springfield House, which are of moderate importance to small mammals. Overall, should some or all of this area be impacted by the development the affect on mammals is likely to be moderate to low in general. If the area is retained, and cattle are excluded, some areas of the site may become more important for small mammals.

Hedgerows/Woodland

The removal of the east-west running hedgerow, which contains several large trees, will have little impact on mammals given its low level of importance for the group at present.

Hedgerows traversed by the access road on its route north from the site to the main road, will result in some minor loss of habitat and habitat fragmentation, however, the overall impact can be described as minor.

The construction of the access road through the northern portion of the north-south running woodland (to the east of the access road) will cause significant habitat fragmentation and moderate habitat loss. This, notwithstanding, given the overall amount of wood remaining, the impact on mammals is likely to be moderate rather than severe.

Mitigation Measures

It is recommended that tree screening of the development is not undertaken on the wetland immediately bordering the south and south-east of the site so that habitat utilised by the otter (a protected mammal) is preserved. In this respect also, every care should be taken not to alter the drainage regime of the wetland, which would reduce the available standing and flowing water in the area.

Removal of hedgerows and scrub should be organised in such a fashion as to reduce the actual take to the minimum necessary, which would also be compatible with the development. Furthermore, the construction operation should be managed so that 'co-lateral' damage to adjoining areas (hedgerows and woodland, in particular) e.g. caused by excavators, heavy vehicle movements and temporary earth or rubble stockpiling is kept to an absolute minimum.

Plate 1 View of Springfield from the south showing heavily poached weedy meadow in the foreground and large cypress (*Cupressus* sp.) on the left and large Sycamore and Hybrid Oak on the right.

Plate 2 East-west running tree-lined hedge bank with large mature oak. This hedge bank separates the Springfield House gardens and environs area from a large meadow to the south.

Plate 3 Tidal saltmarsh immediately south of the proposed site showing Celery-leaved Buttercup in the foreground and a wide expanse of Sea Club-Rush in the background. Note railway line to the south.

Plate 4 Eastern section of saltmarsh showing open water, which contained shoals of small fish and crustaceans, and extensive natural vegetation.

Plate 5 View to the east showing the outer, estuary-side embankment, which parallels the railway line to the south of the site.

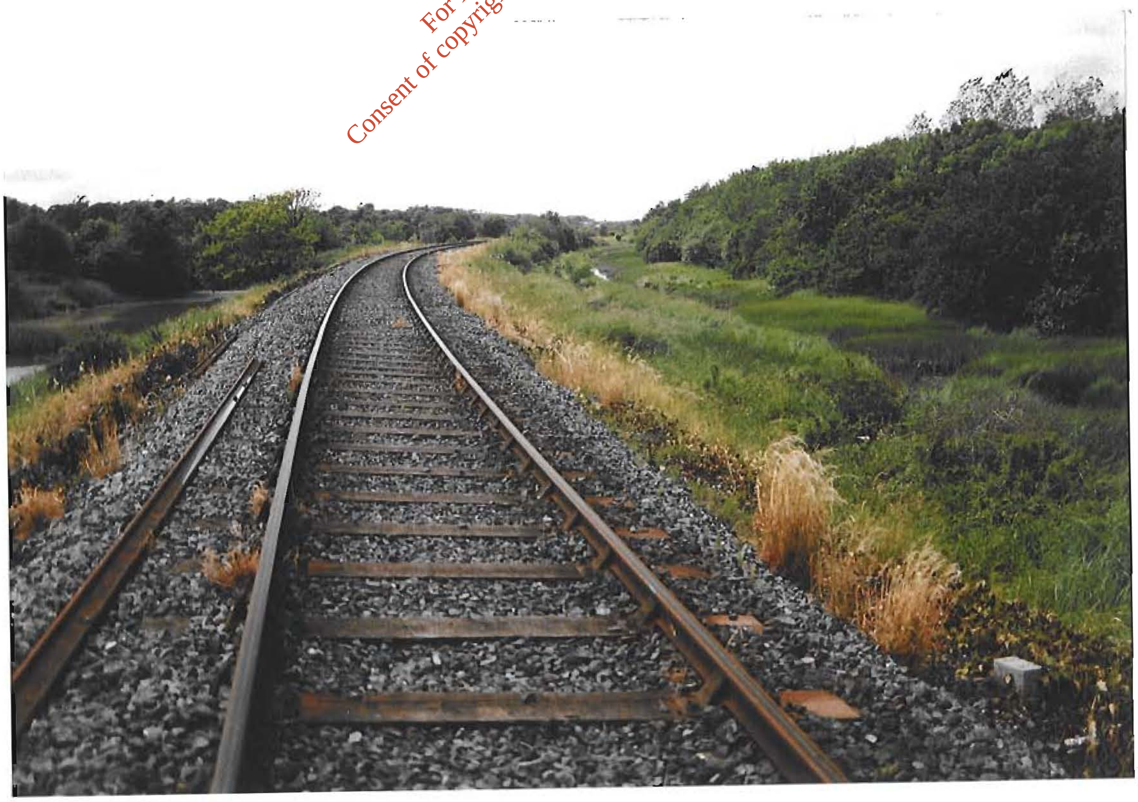

Plate 6 Looking west along the railway line toward the site from the point at which the effluent outfall pipe will discharge to the estuary. Note the linear areas of saltmarsh at both sides of the line.

Plate 7 Dense wooded screen (on the left) which runs north-south form the WWTP site and which will be parallel to and on the eastern side of the proposed access road.

Plate 8 The southern one of two marshy meadows through which the access road will be constructed.