DHI WATER & ENVIRONMENT

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Dublin Waste to Energy Project

EPA Oral Hearing
Combined Brief of Evidence - Water

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Dublin Waste to Energy Ltd

Brief of Evidence
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1 INTRODUCTION

DHI was commissioned by DONG Energy (formerly Elsam) and later Dublin Waste to Energy Limited to investigate the dispersion of cooling water discharged from the WtE facility into the River Liffey and to evaluate the impact on the ecosystem of the receiving waters of the possible use of biocide additives in the discharged cooling water.

A 3D hydrodynamic model that simulates the water levels, currents, salinity and temperature of the lower River Liffey, Dublin Port and a part of Dublin Bay was established.

The model reproduced the existing situation for different tidal and river run-off situations by comparison with measurements of water levels, temperature, salinity and currents.

The model was applied to assess the effect of the discharge and intake of cooling water for the WtE facility on the temperature conditions in the marine environment. .

The model also simulated the addition of biocide to the discharged cooling water, the dispersion of the biocides and the decay in nature in order to assess the impact on the marine ecosystem.

Extensive evidence on these issues was presented by us in a joint presentation at the An Bord Pleanála oral hearing in April 2007, in which we elaborated upon Chapter 12 of the EIS and addressed the matters raised in submissions by the public on these topics. I prepared the evidence on the hydrodynamic modelling. My colleague Dr Dorte Rasmussen prepared the evidence on the choice and potential impact of biocide use in the cooling water system. In this joint presentation we intend to address the issues raised in objections to the EPA Proposed Decision in relation to the dispersion of cooling water and the addition of biocides.

2 QUALIFICATIONS AND EXPERIENCE

Mr Hans Jacob Vested

I hold a Master of Science degree in Civil Engineering from the Technical University of Denmark, 1983 majoring in Hydraulics, Soil Mechanics and Structural Engineering. I am a member of the Danish Society of Professional Engineers and the Danish section of the "Conseil National des Ingénieurs et des Scientifiques de France" (CNISF).

I have been active in the field of hydraulics and coastal engineering for 23 years of which 21 years have been with DHI. Since 1988 I have been involved in the development of numerical simulation tools at DHI and was instrumental in the early development of the DHI model for 3-dimensional flow MIKE 3. I have through my career gained extensive experience in estuarine problems and the development and application of numerical hydrodynamic and transport models. This involves special knowledge of hydrodynamics, advection-dispersion, cooling water and thermal plumes, cohesive sediments and storm surge modelling. I have also acted as reviewer for several international journals, the EU Commission, the Norwegian Scientific Council and the Dutch Science Foundation. I am a member of PIANC Working Group 43 on minimisation of siltation problems in harbours.

I am technically responsible for cooling water and thermal plume studies at DHI. Presently I am Head of Projects in the Coastal and Estuarine Department at DHI.

Recent cooling water, thermal plume, estuary and coastal flooding project experience:

- Recirculation Study and Bathymetric Survey Works for 240MW Net Coal-Fired Electric Generating Plant, Quintero Bay, Chile (2006-2007)
- Venice Storm Surge Model System (2006-2007)
- Hydraulic studies for location of cooling water intake and outfall. Q-Chem II Mesaieed Port, Qatar (2006)
- Ras Laffan Thermal Plume Study (2005)
- Development of storm surge model based on MIKE 21 FM, for the Irish coast (2004)
- Hydraulic Studies for Zawiya Combined Power Plant (2004-2005)
- Simulation of salinity and temperature in the Venice Lagoon. (2002-2004)
- Hydraulic Studies for Benghazi Power Plant (2003-2004)
- Loire Estuary, restoration and decision support (1995-2003)
- Thermal Pollution and Environmental Impact Odense Fjord, Denmark (1998-2000)

Dr Dorte Rasmussen

I hold a Ph.D and a Master of Chemical Engineering from the Technical University of Denmark, 1983, with key qualifications in: Risk Analyses and Hazard Assessments; Computer Modelling of the Fate of Pollutants in the Environment; Modelling of the physical-chemical properties of pure chemicals and mixtures; and database development. I have more than 18 years of experience in project management, research and consultancy assignments for private companies and environmental authorities.

Recent environmental risk assessment and fate modelling of chemicals in coastal areas:

- Assessment of pollutants discharged into the Caspian Sea from an offshore energy production platform (2006)
- Assessment of the consequences of depositing harbour sludge from Rømø Harbour in the Wadden See (2005)
- Modelling the concentrations of chemicals in the Lillebælt (Denmark) area from multiple discharges from waste water treatment plants - using ECO lab (2004)
- Risk assessment of leachate from a land-fill with harbour sludge Port of Esbjerg, Denmark (2004)
- Assessment of the consequences of depositing harbour sludge in a confined land fill at Wadden Sea (2004)
- Environmental hazard and risk assessment of PAHs in produced water from oil rigs. Client: Danish Environmental Protection Agency (2002)
- Assessment of the fate of Orimulsion 400 in the water column and the tainting in fish in The North Sea. (2001)
- Assessment of environmental risks associated with enlargement of Copenhagen Harbour by reclamation infill of polluted soil (2000)

3 THERMAL PLUME IMPACT

3.1 Thermal Plume Modelling

The estimated impact of the thermal plumes was determined through the application of the thermal plume model known as MIKE 3.

MIKE 3 is a hydrodynamic and thermodynamic model developed by DHI that has been applied to more than 30 cooling water studies alone at DHI since 2000. The model is part of the DHI MIKE software system and is used under more than 150 licences (see www.dhigroup.com/software). The DHI MIKE software is considered an industry standard that has been scientifically documented and approved in peer reviewed articles. It is recognised by organisations such as Federal Emergency Management Agency (FEMA) in the US.

3.2 Application to River Liffey

A MIKE 3 model was set up and calibrated for the particular conditions of the River Liffey, Dublin Harbour and Dublin Bay. The model simulates the water levels, currents, salinity and temperature distribution depending on the tidal elevations in Dublin Bay, freshwater run-off from the River Liffey, River Tolka and the Dodder, meterological conditions (wind, air pressure, heat exchange with atmosphere) as well as discharge of heat from Poolbeg, Synergen and North Wall and the water from Ringsend Waste Water Treatment Plant.

The model was calibrated by comparison with field data and information including tidal elevations, current measurements, salinity and temperature measurements. The following information and data were specifically collected and applied for the set-up and calibration of the model:

- Temperature measurements at outfall in June 2004 (prepared for Elsam Engineering by Svend Ole Hansen ApS, Revision 1 March 2005).
- Bathymetric survey of River Liffey near outfall in March 2006 (prepared by DHI).
- Measurements of temperature, salinity, water levels and current measurements in River Liffey in May 2006 (prepared by RPS).
- River run-off data for River Liffey, River Tolka and Dodder (Source - the Irish Environmental Protection Agency).
- Current and Tides Study Dublin Bay (Source - Irish Hydrodata Limited, Rathmacullig West, Ballygarvan, Co. Cork December 1989).

- Open boundary conditions of tidal variation from a larger model of the entire Irish Sea (supplied by RPS).

- Irish Coast Pilot. Offshore and coastal waters round Ireland including routes to the Irish Sea from Atlantic Ocean Landfalls (Thirteenth Edition, The Hydrographer of the Navy, 1994).

- Impact of the River Liffey discharge in nutrient and chlorophyll concentrations in the Liffey estuary and Dublin Bay (Irish Sea). T.G. O'Higgins and G.G. Wilson. Estuarine Coastal and Shelf Science 64 (2005) pp. 323-334

The application of a such a hydrodynamic numerical simulation model of water flow and heat exchange is a recognised and recommended standard method of assessing the impact on the marine environment of thermal plumes from discharge of cooling water (see for example pages 30, 277, 282 and 287 in the Reference Document on the Application of Best Available Techniques to Industrial Cooling Systems December 2001 (BREF-document), Ref. /1/).

3.3 Cumulative Impact

In order to calculate the cumulative impact of thermal plumes, the modelling took into account all discharges of waste heat to the River Liffey from the Poolbeg peninsula, see Figure 3.1.

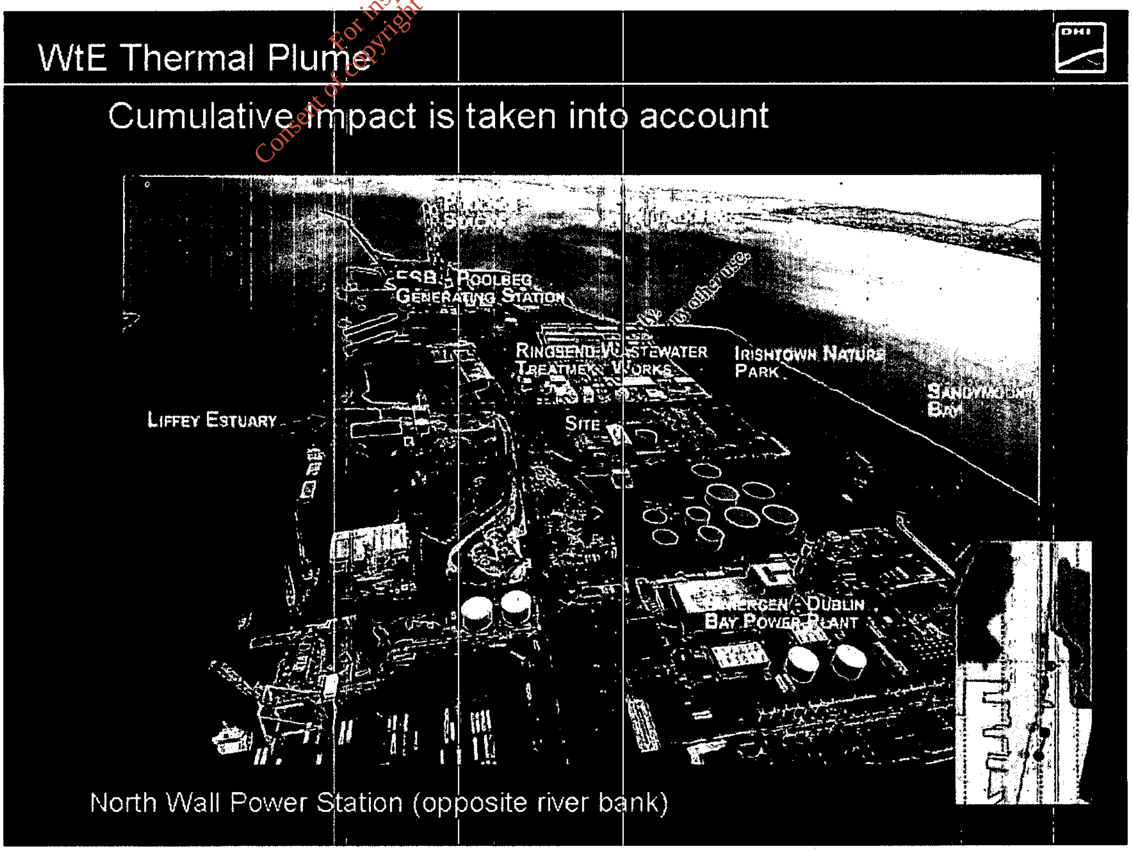

Figure 3.1 Location of all intakes and outfalls included in the modelling

The cumulative impact was determined on the basis of all existing power plants operating at full licensed values. The values adopted in the simulations are given in the tables below. Table 1 identifies the three power plants with thermal discharge to the River Liffey and Table 2 identifies the WtE operating characteristics.

Table 1 – Thermal Discharges to River Liffey

Plant	Discharge (m^3/s)	ΔT (deg C)	Outlet	Intake	MW
Synergen	8.4	9.5	Surface	Middepth	334
Poolbeg	23.8*	11.5	Surface	Surface	1146
North Wall	5.1	12.5	Surface	Middepth	267
Dublin WTE	3.9	9.0	Surface	Middepth	147

** maximum pump capacity*

3.4 WtE Facility Operations

The outfall temperature of the WtE cooling water is equal to the temperature of the water at the point of intake plus the temperature increase in the condenser that is required to cool the steam turbine generator. This is shown schematically in Figure 3.2. The outfall temperature will therefore vary in line with variations in the temperature of the River Liffey. The connection between the intake and outfall temperature is important for calculating the cumulative impact of all the thermal discharges in the River Liffey. The temperature rise of cooling water for the WtE facility relative to the intake temperature will be 9 degrees C for 98% of hourly values over a year (operating at maximum limits).

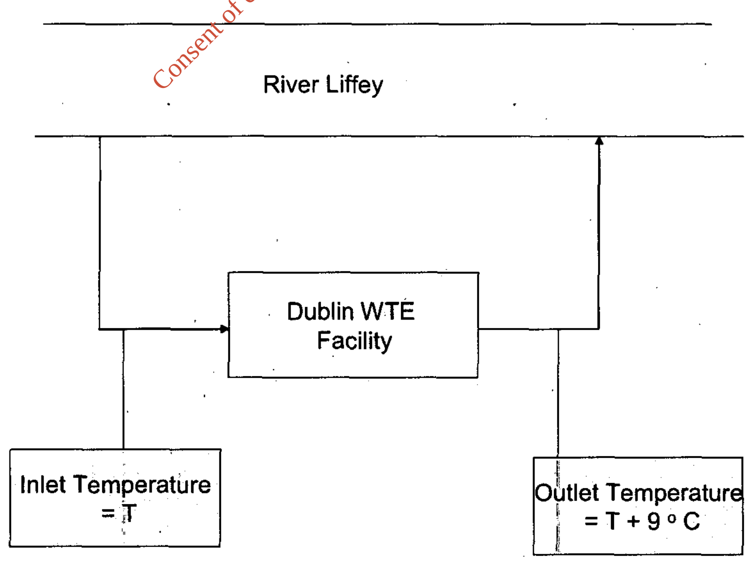

Figure 3.2 The outfall temperature of the cooling water from the WtE is equal to the intake water temperature plus the increase in temperature over the condenser. The maximum water temperature discharged to the River Liffey will be 9 ° C above the inlet temperature.

3.5 WtE Thermal Discharge

The impact of thermal discharge from the WtE facility is assessed in two steps. Firstly, the baseline situation is simulated with all the existing power plants in operation (Synergen, Poolbeg and North Wall). Secondly, the WtE facility is included and the simulation is repeated. The two simulated temperature results are then subtracted and the excess temperature arising from the inclusion of the WtE facility is determined. In this manner the cumulative effects of all power plants are included in the assessment as well as their possible interaction, i.e. the possibility that the intake temperatures may be higher than in a river where no heated discharges take place and recirculation of intake and outfall water may occur has been taken into account in the modelling.

Figure 3.3 shows the simulated rising tide surface layer thermal plumes from North Wall, Synergen, WtE and Poolbeg power plant. The interaction between the Poolbeg power plant and the WtE / Synergen plumes is observed.

The Liffey Estuary is not salmonid freshwater for the purposes of the European Communities (Quality of Salmonid Waters) Regulations 1988 (the "Salmonid Regulations"), however the impacts of the WtE thermal plume were measured against the standards set out in the Regulations at the request of the Department of Communications, Marine and Natural Resources. The temperature requisites for the purposes of the Salmonid Regulations are as follows:

"Temperature measured downstream of a point of thermal discharge (at the edge of the mixing zone as determined by the local authority) must not-

a) Exceed the unaffected temperature by more than 1.5° C;

b) Exceed

(i) 21.5° C ; or

(ii) 10° C, during the period from 1 November to 30 April where species which need cold water for reproduction are present.

A thermal discharge must not cause sudden variations in temperature. (Temperature limits to be conformed with for 98% of the time)."

No mixing zone has been defined for the Liffey Estuary as it is not designated salmonid water.

Figure 3.4 shows that the combined area of impact of thermal plumes from the Dublin WtE and Synergen is estimated to be approximately 25% of the cross section of the River Liffey for the 1.5° C requirement, 25 % of the cross section for the 21.5° C requirement, and 33% for the 10° C requirement. The facility will be operated on a steady basis all year around. Thus sudden variations in temperature conditions due to the operation of the plant will not occur.

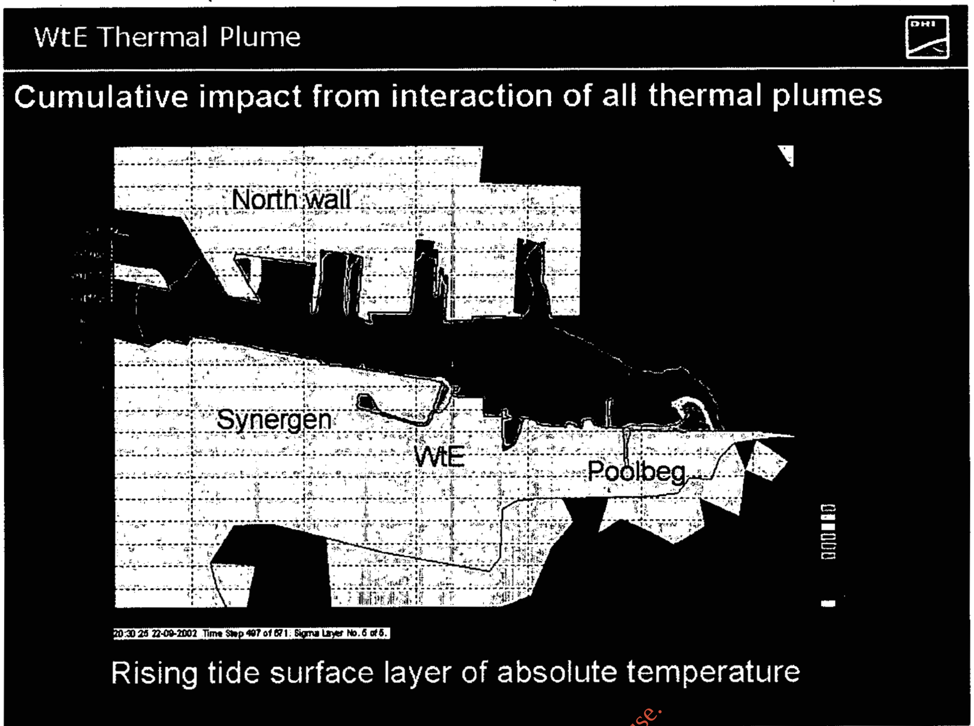

Figure 3.3 The absolute surface temperature at rising tide. The thermal plume from Poolbeg reaches the WtE/Synergen thermal plume.

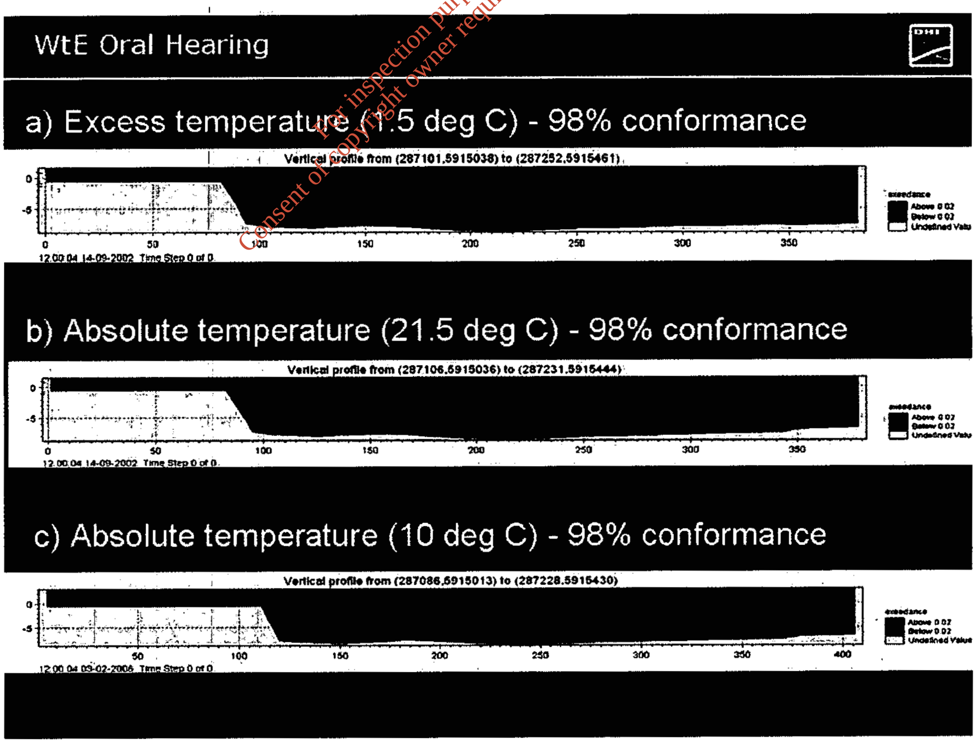

Figure 3.4 Cross section of the Liffey at the WtE/Synergen outfall. The blue colour indicates the area where the temperature is less than excess temperature 1.5° C, 21.5° C in summer and 10° C in winter, for 98% of the time.

3.6 Impact on Synergen

The proposed location of the WtE cooling water intake is at the outlet of the existing open channel that conveys cooling water from the Synergen power plant as well as from the planned WtE facility. The potential impact of the WtE cooling water intake location on absolute cooling water discharge has been taken into consideration.

The simulations based on the MIKE3 model indicate the possible increase in temperature of the intake water for the Synergen facility as a result of cooling water discharged from the WtE facility. The excess temperature is calculated as the difference between the absolute temperatures in the Synergen intake with and without the WtE in operation. The simulation without the WtE (the baseline situation) includes Synergen, Poolbeg and North Wall in operation.

The Synergen intake is located at -3.57m OD Poolbeg. This corresponds to -6.3m below Mean Sea Level (MSL). The water depth at the outfall is approximately 10 metres and the intake is thus approximately 3.7m above seabed. The model applies 5 layers over the vertical. The thickness of the layers varies with the tide and the intake is in between layer 3 and 4. The point of the intake is accordingly put in layer 3, i.e. at mid-depth in order not underestimate the impact on Synergen.

The location of the thermal plume depends on the tide. Figure 4.1 shows the inland movement of the thermal plume at rising tide at the surface as well at mid-depth.

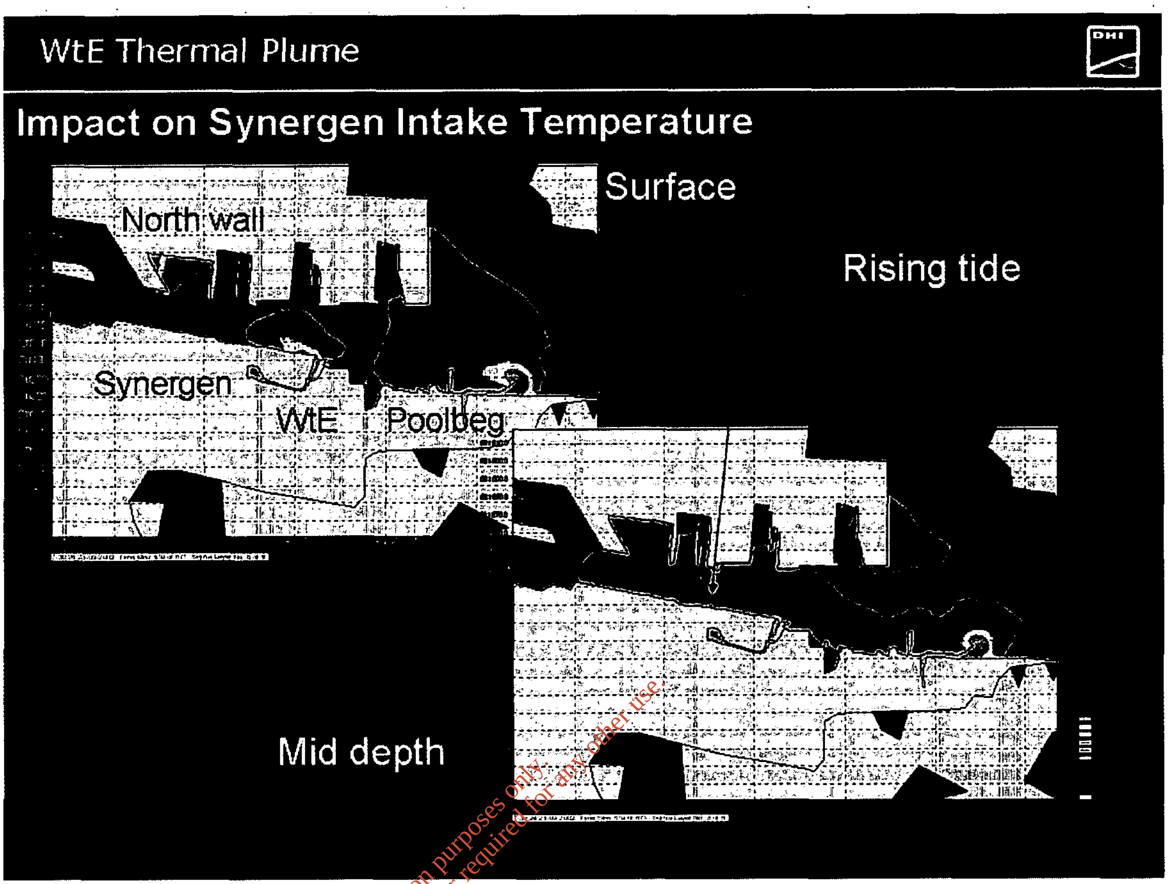

Figure 3.5 Simulation of absolute temperatures of thermal plume at rising tide for surface and mid-depth. Operation at full licensed values, includes WtE facility, summer situation.

Depending on the water movements in the River Liffey the WtE facility induces an excess or additional temperature increase at the Synergen intake that varies with the tide as shown in Figure 4.2 and 4.3 for the winter and summer situation, respectively. The increase in excess temperature occurs at rising tide when the thermal plume moves inland. This effect is most pronounced at spring tide and less at neap tide.

For the winter situation the maximum increase in excess temperature is 0.50 ° C and the average increase is 0.15° C. For the summer situation the maximum increase in excess temperature is 0.76° C while the average increase is 0.20° C.

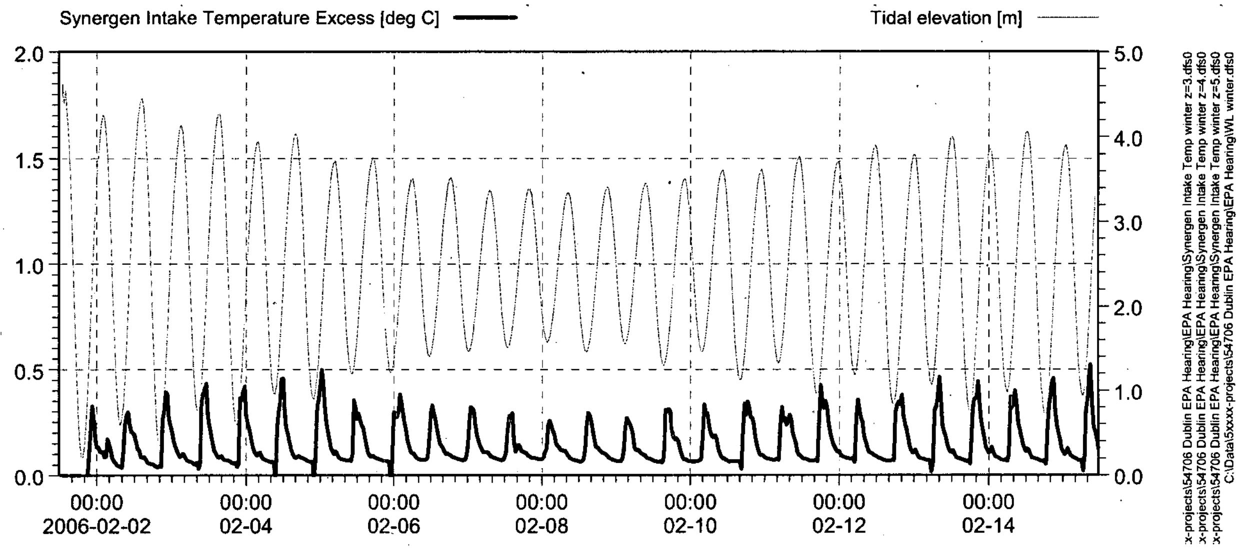

Figure 3.6 Excess temperature in Synergen intake. Full licensed thermal discharges. Winter situation.

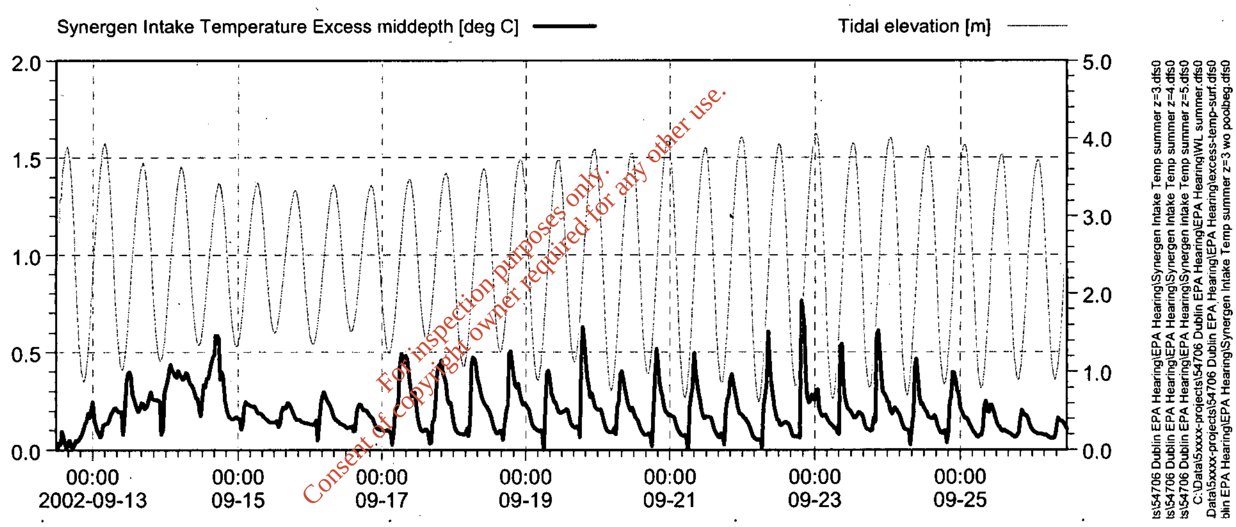

Figure 3.7 Excess temperature in Synergen intake. Full licensed thermal discharges. Summer situation.

The effect of elevated temperature in the WtE intake was taken into consideration in the assessment of both excess and absolute temperatures for the purposes of the Salmonid Regulation (see above and brief prepared for the An Bord Pleanála hearing Ref. /2/).

The elevated temperature of the WtE intake is shown in Figure 4.4. The figure shows that there is an increase in excess temperature up to about 1.0° C as well as significant sudden reductions of about 1 to 1.5° C. This is explained by the redistribution of the flow around the outfall. The increase in surface outflow is compensated by an increased flow of colder bottom water that reduces the intake temperature.

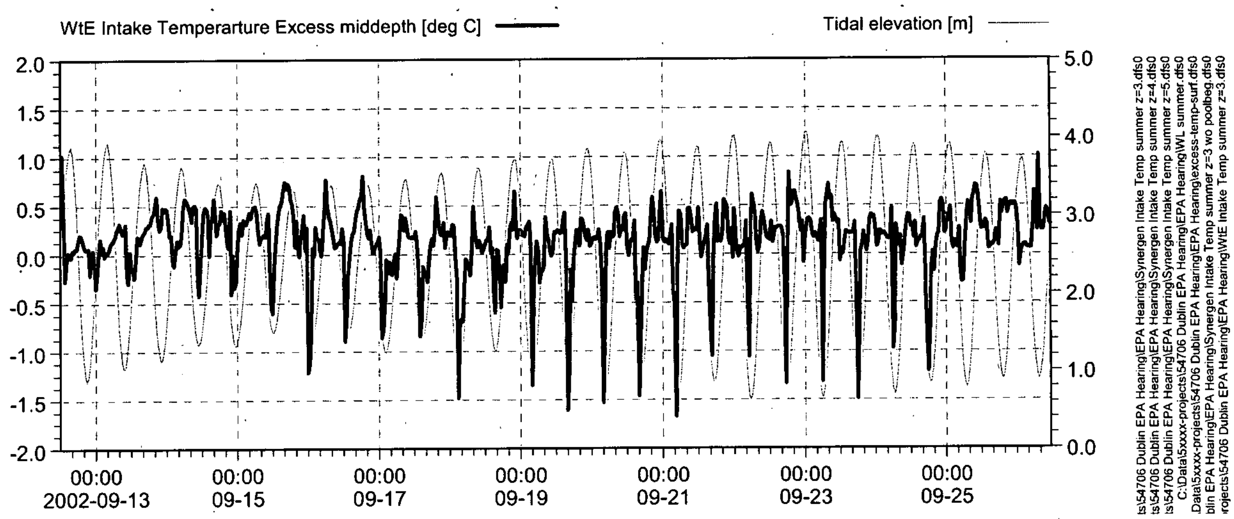

Figure 3.8 Elevated temperature in WtE intake. Full licensed thermal discharges. Summer situation.

4 BIOCIDE IMPACT

4.1 The potential impact of biocide use on water quality has been addressed using internationally accepted methodologies and a conservative approach. The conservative risk assessment showed that even when using a continuous high dosage of 1 mg/L, an environmental impact outside the outfall of the facility is not expected, thus an impact on the water quality is not expected.

It should be noted that Schedule B.2 (Emissions to Water) of the EPA Proposed Decision stipulates a Hypochlorite/Chlorine emission limit value of 0.2mg/l (24hr average), 0.5mg/l (maximum instantaneous) which further highlights the conservative approach of the completed risk assessment.

Based on recorded emission amounts of chlorine and water, it can be calculated that in 2005 Synergen operated with an average emission concentration of 0.1 mg/L chlorine in its discharged cooling water.[1]

The dosing of the biocide should be kept at a minimum. A sufficient biocidal treatment is monitored by measuring the total residual chlorine (TRC) in the discharged cooling water at the outlet. The total residual chlorine should be kept at a certain minimum level.

The effect of cumulative biocidal discharges has been considered. The risk assessment and modelling of the use of biocide took into account the cumulative effects of contributions from other plants in the area using the same biocide. The background concentration of the degradation products of hypochlorite/chlorine due to usage at Synergen power plant, Poolbeg power plant and North Wall generating station was estimated and was found to be at least one order of magnitude lower than the concentration level at which no effects on the species in the water are expected.

Reference

Ref. /1/ European Commission. Integrated Pollution Prevention and Control (IPPC). Reference Document on the Application of Best Available Techniques to Industrial Cooling Systems (BREF) December 2001.

Ref. /2/ ABP hearing

[1] Dublin Bay Power Plant. EPA Annual Environmental Report. IPCL no. 486. Reporting period: 1 January to 31 December 2005.