Dublin City Council

Ringsend Wastewater Treatment Works Extension Environmental Impact Statement

Volume 1 Environmental Impact Statement

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Baile Átha Cliath
Dublin City

CDM

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Non-Technical Summary

As part of the Dublin Bay Project, the Ringsend Wastewater Treatment Works (WwTW), outlined in Figure 1, was planned to be constructed in phases. The first phase, commissioned in 2003 provided facilities to cater to a population equivalent (PE) of 1.64 million people. Today, the current average influent loading to the WwTW is approximately 1.8 million PE, which means the Plant, although still performing well, is operating over its design capacity and requires an extension.

Figure 1 Aerial View of Ringsend WwTW

This phase of the Dublin Bay Project will extend the Ringsend WwTW to meet current demand and help to address future development needs within the region, as envisaged in the Greater Dublin Strategic Drainage Study (GDSDS). However, the extension is physically limited to within the boundaries of the existing site and thus the extended capacity will also be limited. To help overcome this limitation, a second Regional plant is being planned by Fingal County Council. The two wastewater treatment plants are inextricably linked under the GDSDS and in the future, some of the loadings received at Ringsend will be diverted to the new Regional plant, thereby helping to extend the life of the Ringsend WwTW well into the future.

This phase of the Dublin Bay Project will provide for a firm capacity of 2.1 million PE on an average daily basis. The term "firm" is used in the context of a scenario in which processing is occurring with the largest single unit out of service. Itis intended to ensure that there is sufficient processing capacity to meet all discharge limits at a 95th percentile compliance frequency. In the case of the Ringsend WwTW, the largest process units affecting capacity are the sequencing batch reactors (SBRs). In order to achieve this firm capacity of 2.1

million PE the design basis for the plant requires that the plant is designed to provide an ultimate design capacity of 2.4 million PE. In summary, this proposed extension allows for the extended works to be robust, reliable and provide adequate capacity even if one of the plant SBRs is temporarily out of service.

Since the Liffey Estuary has been designated as Nutrient Sensitive Waters under the EU Urban Waste Water Treatment Directive (UWWTD), nutrient removal is required to achieve the standard of 10 mg/litre Total Nitrogen and 1 mg/litre Total Phosphorus, in addition to normal secondary treatment standards, for continued discharge at the existing outfall into the Liffey Estuary. The WwTW, as currently configured, has limited ability to remove those nutrients. With open space on site extremely limited and with no ability to expand the WwTW's boundaries, it is most unlikely that compliance with the Directive's Total Nitrogen limit could be accomplished with conventional wastewater treatment processes. Other non-conventional processes which could meet the discharge standard are energy intensive and would impose 45% to 80% additional power consumption upon the proposed scheme. They would also add complexity to the operation and maintenance of the WwTW. In addition, compliance with the Total Phosphorus limit would require large quantities of chemicals to be applied, with resultant increases in sludge production of approximately 3,000 to 14,000 dry tonnes per year (approximately 10% to 30% increase), depending upon the process selected.

Designation of the Liffey Estuary as Nutrient Sensitive Waters has prompted consideration of the option of moving the outfall location to a point outside the Nutrient Sensitive Waters designation, where nutrient release is permitted (Figure 2). Under this scenario, the existing treatment process would be operated in a slightly different mode than they currently are and some facilities would be added to further improve the quality of existing treated water. Energy consumption would decrease from current usage levels. No additional chemicals would be required and sludge production would only increase in general proportion to the increase in influent loadings. This option is considered to be simpler, more reliable, more sustainable, and have a smaller carbon footprint than the non-conventional processes. It is also the least costly option as the operational costs are low, resulting in a lower present worth cost over the design life of the project.

Figure 2 Existing and Proposed Outfall Locations (Points 1 and 2, respectively)

Figure 3 Ringsend WwTW and Tunnel Compound Site Locations (red) and open 0.8 ha space for construction (yellow rectangle)

The proposed project involves the following elements:

- Upgrades on the existing WwTW site;
- Transfer of discharge location to Dublin Bay through the provision of a 9 kilometre long sea outfall ; and
- Road network improvements in immediate vicinity of site (construction phase).

As stated, there will be some onsite upgrades to the WwTW at the current site: the existing treatment process will be operated in slightly different mode and some facilities would be added to further improve the quality of existing treated water within the current site footprint. Additional secondary treatment capacity of 0.4 million PE is proposed to be constructed on a 0.8 hectare open space within the site which was left specifically for future expansion under the original Dublin Bay contract. No element of the proposed extension will be higher than the existing plant structures.

The tunnel inlet shaft will be located on the tunnel site compound, as shown in Figure 3 with the proposed discharge point as shown on Figure 2, Point 2.

It is anticipated that the construction works will commence in 2013 and are expected to last for 3 years, with all works completed by 2016.

The proposed project conforms to the policies and objectives for Dublin City as set out in the Dublin City Development Plan 2011-2017 and the GDSDS. The WwTW extension will contribute to the fulfilment of Dublin City Council's obligations under the Urban Wastewater Treatment (UWWT) Directive and the Water Framework Directive. The proposed project will also result in Ringsend WwTW being compliant with the terms of the Waste Water Discharge Licence (Licence Number D0034-01).

The proposed extension of the Ringsend WwTW is predicted to have no significant negative impacts on the local area and economy. The extension of the treatment plant will provide a significant positive impact on the regional economy during the operational phase of the development, by improving the public utilities infrastructure and generating additional treatment capacity for commercial, industrial and residential customers.

Extensive water quality modelling of the existing discharge situation and the proposed long sea outfall discharge was carried out. The proposed discharge will be located almost 9 kilometres out to sea in a deep underwater area (more than 20 metres depth) with more suitable dispersion characteristics and at a greater distance from amenity and protected areas. There will be a positive benefit to the Liffey and Tolka Estuaries and Dublin Bay due to improved water quality and compliance with the UWWT Regulations, the Environmental Objectives (Surface Waters) Regulations 2009 (SI 272 of 2009) and the Water Framework Directive. There will be no negative impact to the water quality of Dublin Bay at the long sea outfall discharge point. The modelling results have demonstrated that the treated water will disperse to within acceptable concentration limits outside the immediate mixing zone and will not impact negatively upon any designated sites, recreational areas or beaches in Dublin Bay or the eastern coastal area.

There are a number of protected areas within Dublin Bay and the surrounding areas which form part of the Natura 2000 network. These areas required assessment in terms of their conservation objectives and site integrity as part of the ecological assessment. The discharge point will be outside these protected areas and will not impact upon them.

In terms of potential impacts on marine ecology during construction, possible temporary negative impacts on marine mammals could occur. Noise levels from the drilling operation may result in some sensitive species of marine mammals moving away from the immediate area during the drilling of the diffuser shaft. This impact will be short-term and temporary and will not cause any harm to the mammals. No impact is expected on the planktonic community, benthic (seabed) ecology or fisheries during construction.

During the operational phase there will be little or no impact on the water column or benthic production. *E. coli*, while it does act as a food source for microplankton, will not have a negative impact due to the relatively small aerial extent of the bacterial numbers. No significant negative change in intertidal benthic secondary production is predicted. An improvement in benthic sedimentary conditions and an associated increase in macrobenthic diversity may occur inside parts of inner Dublin Bay including the Bull Lagoon. Given the increase in nutrients at the offshore disposal site, phytoplankton within the zone will benefit from this increase and be more productive. As algal blooms are not known to occur at present in the Liffey Estuary, they will not occur in the offshore site. No negative impacts are predicted to occur during the operational phase of this project on marine mammals. Due to extremely small scale of the foot print on the seabed, impact on commercial fisheries is considered to be negligible.

In terms of terrestrial ecology, the only possible impact of the construction phase of the proposed development at Ringsend WwTW would be indirect disturbance from construction workers to Brent Geese and other waterbirds using the compensatory grassland, immediately to the south of the WwTW. To mitigate against such disturbance, solid screening will be erected prior to construction to reduce or eliminate any visual disturbance. Since these waterbirds are habituated to traffic and machinery noise within Dublin Port and on the Tolka Estuary, they should not be disturbed by construction noise on the site of the proposed development.

In terms of the operational impact, in particular, the potential for reduced nutrient discharges to impact waterbird populations was assessed. The present discharge is treated to secondary level so that there is no significant discharge of particulate organic matter, which could affect feeding for gulls in Dublin Bay. Changes in waterbird populations are caused by a large number of variable factors and the interactions between these factors. Whilst it is not possible to demonstrate a simple cause-effect relationship with one of these factors in isolation, previous research studies and surveys have not confirmed any significant relationship between the removalof a wastewater treatment discharge point and /or improved process treatment and the change in waterbird populations in the area. Similarly, there is no proven link between treated water discharge from Ringsend WwTW and waterbird population trends. This is further complicated by other major sources of nutrients entering Dublin Bay, such as from the River Liffey and River Tolka.

In addition, some of the important prey species (such as the lugworm *Arenicola marina* and the Baltic tellin *Macoma balthica*) of the waders that occur in internationally important numbers here, are sensitive to over-enrichment of the sediment; the populations of these species would be expected to benefit from reduction in nutrient discharges to the intertidal areas of Dublin Bay. Improved water quality is also likely to lead to higher diversity of macroinvertebrates in the sediment which should be of benefit to waterbird populations in the long term. Hence, it is concluded that proposed changes in the transfer of treated water from the present outfall at Ringsend to a long-sea outfall will have no significant effect on waterbirds in Dublin Bay and therefore the residual impact will be neutral.

The proposed development, when completed, will form part of a general pattern of utilities and industrial activities associated with the port and, as such, will not give rise to any significant impact on the character and visual environment of the peninsula or the overall bay area. Photomontages were prepared for the EIS and examples of two of these from high amenity areas are presented in Figures 4 and 5 below.

Figure 4 Proposed Extension as seen from Sandymount (red outline represents proposed development which will remain hidden behind the hillock to the left of the chimneys)

Figure 5 Construction Phase as seen from the South Bull Wall (tower cranes to the far left of the chimneys may be visible)

The construction of the tunnel will give rise to some local impacts and pedestrian access will be affected for the duration of its construction, but pedestrian access to the Great South Wall will be maintained throughout construction.

A traffic survey and traffic modelling was carried out to assess potential impacts of the proposed project. It was established that construction on the WwTW site and tunnel site is anticipated to generate a maximum of 38 heavy goods vehicles (HGV) trips per hour. Of these approximately 27 will be generated by the tunnel works. This equates to approximately 1 HGV movement every 2 minutes on the Pigeon House Road where the coastal walking route between Sandymount and the Great South Wall is coincident with the HGV haul route. Annual average daily traffic totals are shown in Figure 6, overleaf. During the construction phase, pedestrian road safety barriers will be erected between the path and roadway where the coastal walking route from Sandymount to the Bull Wall is coincident with the HGV haul route. Following completion of construction and reinstatement there will be no residual impacts on pedestrian activity in the area.

A traffic management plan will be drafted in full consultation with Dublin City Council, An Garda Síochána, the Fire Service and the Ambulance Service. No construction traffic will be permitted during peak traffic periods (7 am to 10 am and 4 pm to 7 pm) and all construction traffic will be required to use the port tunnel to minimise impacts on the city road network. During construction, pedestrian road safety barriers will be erected between the path and roadway where the coastal walking route from Sandymount to the Bull Wall is coincident with the HGV haul route, as previously mentioned. A formal uncontrolled pedestrian crossing will also be provided at this location.

The Ringsend WwTW has had a history of odour problems dating back to before 2005. Dublin City Council (DCC), over the course of three years, implemented a number of permanent odour control improvements that reduced odorous emissions by 75 %. These physical improvements, coupled with an enhanced operations focus that includes a full-time odour control specialist, have reduced the frequency and intensity of off-site odour events. The Ringsend WwTW Extension affords DCC the opportunity to make the further improvements.

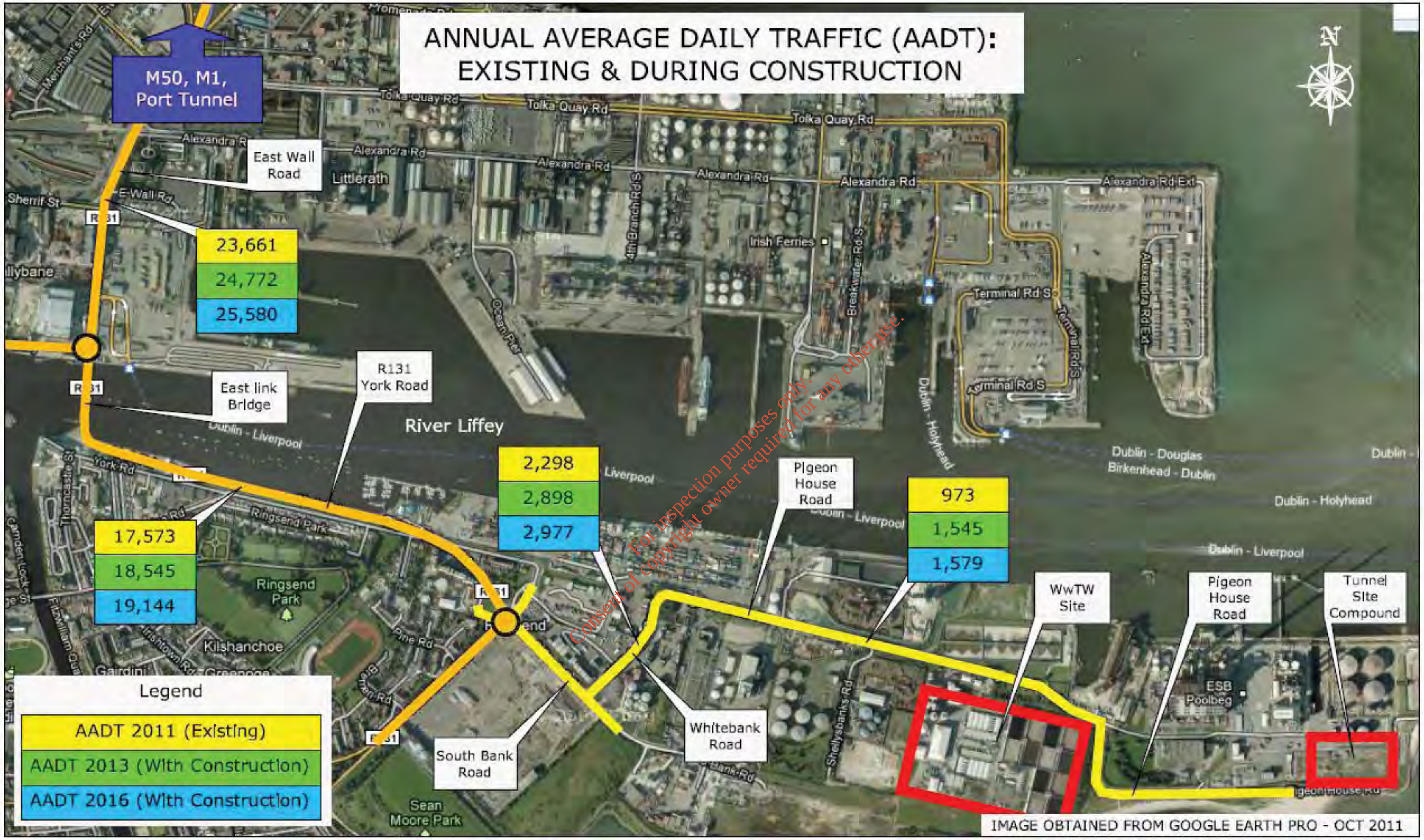


Figure 6 Annual Average Daily Traffic (Existing and During Construction)

Extensive odour modelling of the proposed odour improvements was carried out. The proposed odour control improvements will result in a significant long term beneficial impact on the odour environment. The WwTW will comply with a stringent 10 odour unit (OU) standard at the site boundary. With respect to the frequency of exceedance of odour limits, many EU standards require 98th percentile (175 hr/yr) compliance. While this may seem reasonable for many parameters, it is felt that the potential to exceed the odour standard 175 hours per year is not sufficiently protective. Instead an exceedance frequency of no more than 50 hours per year (99.4th percentile) is proposed. This would result in the WwTW not only achieving, but exceeding the relevant EU standards.

Ambient air quality was also modelled as part of the assessment. There will be negligible impacts on ambient air quality as a result of construction traffic and no measurable increase for the operational phase. Measures to mitigate the emission of dust due to construction activities such as wind breaks and barriers and vehicle speed restrictions will be specified in the construction Environmental Management Plan. Any impacts relating to dust associated with the construction works will be within the immediate vicinity of the construction works and temporary in nature.

Noise surveys and modelling was carried out to assess the potential noise and vibration impacts of the proposed scheme. There is the potential for short term impact during the construction phase. With the appropriate mitigation as specified in this assessment, these impacts are negligible both for humans and marine life in Dublin Bay. The proposed vibration control measures will ensure that no significant impact will arise during the construction period.

The operational phase of the development will be similar to the existing plant; noise levels around the site perimeter will be the same or similar to existing. The new inlet shaft, tunnel and outfall will not cause any increase in airborne noise levels. Underwater noise during the operational phase will be limited to diffusion through the outfall, which is regarded as negligible. The impact of the proposed development during the operational phase is, therefore, categorised as negligible.

Potential archaeology and cultural heritage impacts were assessed utilising sources of information including the Record of Monuments and Places, the National Museum of Ireland Topographical Files, the Dublin City Development Plan 2011-2017, the Inventory of Shipwrecks, documentary and cartographic sources. A site survey of the area of the proposed development was also undertaken and marine geophysical data were assessed at the proposed outfall site.

There will be no direct impact on any of the structures included in the Record of Protected Structures. The height of the proposed secondary treatment extension at the WwTW site will not affect the views to or from the Pigeon House Fort (RPS ref. no. 6794); the Pigeon House Hotel (RPS ref. no. 6795) and the Pigeon House Power Station (RPS ref. no. 6796). As the proposed development is located in close proximity to the Pigeon House Fort, archaeological monitoring will be undertaken during all ground disturbance works by a licensed archaeologist as recommended by the Department of Arts, Heritage and the Gaeltacht. There will be no direct impact on any of the structures included in the Record of Protected Structures.

Marine geophysical data (side scan sonar and magnetometer surveys) were interpreted to assess for underwater archaeological potential. The surveys revealed five anomalies within 200 m of the proposed outfall location, four of which are of low archaeological potential and one unknown (1.4 m long by 1.5 m wide). Following consultation with the Underwater Unit of the Department of Arts, Heritage and the Gaeltacht, it was agreed that an archaeological dive inspection of the diffuser site should be carried out as part of the construction works to clarify the nature of the anomalies.

Site specific mitigation strategies should be agreed with the Dublin City Archaeologist, National Museum of Ireland and the National Monuments Section and/or Underwater Unit of the Department of the Arts, Heritage and the Gaeltacht. It is not envisaged that the operational phase of the scheme will have any impact on archaeological, architectural and cultural heritage.

To assess geological and hydrogeological conditions in Dublin Bay and the sites of the tunnel inlet shaft and outlet diffuser, an extensive programme of site investigation was carried out including 19 boreholes in Dublin Bay, two onshore boreholes, geophysical surveys and laboratory tests. There are two Geological Heritage Areas identified in the GSI mapping in the Dublin Bay Area, namely, North Bull Island and Bottle Quay. Due to their distance from the proposed sites and their qualifying characteristics, no impacts are predicted during the construction phase.

A Waste Management Plan will be prepared by the contractor in accordance with "Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects". Compliance with this plan and the specified mitigation measures for the management of spoil, groundwater and water will ensure that there will be no impact on the soils, geology and hydrogeology during the construction period. There will be no impact on the soils and geology and hydrogeology following the operational stage.

In terms of material assets, there will be no negative impacts associated with the proposed project. Furthermore, the provision of additional wastewater treatment capacity will ensure that development in the WwTW catchment is not constrained by lack of sufficient wastewater treatment capacity. It is considered likely that the proposed project will result in a positive low-moderate impact on the local community during construction by providing employment opportunities in the region.

Glossary and Defined Terms

AA	Appropriate Assessment
ABP	an Bord Pleanála
ADF	Average daily flow, expressed in m^3/s
Administration Building	Building which houses administrative offices and laboratory
Alum	Aluminium sulphate
Ammonia	NH_3.
Anaerobic Digester (-ion)	Degradation of volatile solids under anaerobic conditions.
As-built	Record of facilities (e.g. drawings, equipment) as constructed
BFP	Belt filter press dewatering devices. No longer in use.
Biocake	Dewatered, digested biosolids (not thermally dried)
Biofert	Thermally dried biosolids. May or may not be digested
Biogas	Gas formed through anaerobic sludge digestion. Primarily methane.
Biogas holder	Double membrane biogas holder downstream of anaerobic digesters
Biosolids	Treated sludge ready for beneficial reuse
Bord Gáis	Natural gas supplier to the WwTW
BOD	Five-Day Biochemical Oxygen Demand.
BTF	Biotrickling filter
Cambi	Proprietary name of THP process installed at Ringsend WwTW
cBOD	Carbonaceous BOD
CDM	Camp Dresser & McKee (Ireland) Limited
Centrifuge	Centrifugal dewatering device
CEPT	Chemically enhanced primary treatment
CHP	Combined Heat and Power
cm	centimetre
Class A Biosolids	Biosolids suitable for agricultural reuse
Co-combustion	Combustion of biosolids with other fuels, including solid waste
Co	County
CoCo	County Council.
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
Coliforms	Coliform bacteria
CSO	Combined Sewer Overflow
DB	Design Build.
dBA	A-weighted Sound Pressure level in decibels with a reference level of 20 μPa
DBO	Design, Build and Operate.
DCC	Dublin City Council
DDDA	Dublin Docklands Development Authority
Denitrification	Reduction of oxidised nitrogen species to elemental

	nitrogen (gas)
Dewatering	Increasing solids by mechanical means. Typically from <10 % to >25 %
DIA	Diameter
Discharge Limits	Limits set on WwTW effluent under the EPA Licence
Discharge Licence	EPA Discharge Licence for the WwTW
DIN	Dissolved Inorganic Nitrogen
DECLG	Department of Environment, Community and Local Government
DO	Dissolved Oxygen
Dodder Valley Siphon	Inlet to the WwTW from the Dodder Valley
DOE	Department of the Environment (now DECLG)
Dryer	Thermal dryer.
Dun Laoghaire PS	West Pier Dun Laoghaire Pumping Station
DWF	Dry weather flow, expressed in m^3/s
E. coli	Escherichia coliform
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESB	Electricity Supply Board, provider of electricity to the WwTW
Estuary	Transitional area at the mouth of a river between fresh-water and coastal waters
EU	European Union
Eutrophication	Enrichment of water by nutrients, especially compounds of Nitrogen and/or Phosphorus, causing accelerated growth of algae and higher forms of plant life
FC	Faecal Coliform
FFT	Full flow to (biological) treatment
Flare	Emergency biogas flare
Extension	Official name of the project is Ringsend Wastewater Treatment Works Extension.
FOG	Fats, oils and greases
FOGG	Fats, oils, grease and grit
FOGG Tank	Original name for what is now the grit chamber.
Flow	Wastewater flow measured at various locations
Grit	Dense, generally inert solids removed from the wastewater in the FOGG tanks
GHG	Greenhouse gas(es)
GDSDS	Greater Dublin Strategic Drainage Study
H_2S	Hydrogen sulphide
HF	High Frequency
hr	Preferred dimension for hour
IFAS	Integrated Fixed-Film Activated Sludge
Industrial Waste	Preferred name for "Trade" Wastes
IPS	Intermediate Pumping Station
JBB	J. B. Barry & Partners Ltd.
kg	kilogram
kiosk	prefabricated equipment enclosures
km	kilometre
kW	kilowatt, 1000 watts

kWh	kilowatt-hour
L	litre
LA	Local Authority
Lamella settlers	Primary sedimentation tanks equipped with lamella sludge removal devices
L_{day}	The noise indicator for annoyance during the day period. (07:00 to 19:00)
L_{den}	The 24 hour Leq calculated for an annual period, but with a 5 dB weighting for the evening and a 10 dB weighting for night. Directive 2002/49/EC.
L_{eq}	Shorthand for 'equivalent continuous noise level', which is a parameter that calculates a constant level of noise with the same energy content as the varying acoustic signal being measured. The L_{eq} is an energy mean of the noise level averaged over the measurement period and often regarded as an average level. It is good practice to state the time period over which measurements were taken.
$L_{evening}$	The noise indicator for annoyance during the evening period, (19:00 to 23:00)
LF	Low Frequency
Licence	Generic term for a licence. When referring to Ringsend, the term "Discharge Licence" is used
Liffey Estuary	Current receiving waters. "River Liffey" refers to the river upstream of Islandbridge.
Lime	Calcium hydroxide
Loading(s)	Mass of pollutant(s).
L_n	Typically L_{10} or L_{90}, A noise descriptor based on the % of the measurement period for which a particular value was exceeded. L_{90} is typically reported as the background noise level, whereas L_{10} was used in the past as an indicator for traffic noise. As with L_{eq} it is good practice to state the time period over which measurements were taken.
L_{night}	The night time noise indicator for sleep disturbance during the night. (23:00 to 07:00)
L_{pA}	Sound Pressure (A-weighted) in dB re 20 µPa. L_{pA} (max) refers to a maximum A weighted sound pressure level.
LSO	Long Sea Outfall.
m	metre
MBR	membrane bioreactor
m^3	Preferred dimension for cubic metre
mg	milligram
mg/L	Preferred dimension for milligrams per litre.
mm	millimetre
ml	millilitre
methanol	CH_3OH
methane	CH_4
Mixing Zone	Area where an effluent discharge undergoes initial dilution and is extended to cover the secondary mixing in the receiving water body. An allocated impact zone where water quality criteria can be exceeded
MLPS	Main Lift Pumping Station
MLSS	Mixed liquor suspended solids
MPN	Most Probable Number of bacteria colonies

MPN/100 ml	MPN in a 100 ml sample of water.
MRP	Molybdate Reactive Phosphorus
MW	megawatt, 1,000 kW
MWh	megawatt-hour
Nitrification	Oxidation of nitrogen species to nitrite and nitrate
NPW	Non-potable water
North Dublin WwTW	New WwTW to be sited in Fingal Co
Nutrient Control	Preferred over "Nutrient Removal"
O&M	Operations and Maintenance
OCU	Odour Control Unit
OU	Odour Unit
PE	Population equivalent
Population equivalent	PE, measurement of organic biodegradable load. 1 PE = 60 g BOD / day
Peak flow	Maximum flow received at the WwTW, expressed in m^3/s.
Percent	%
Percentile	%-ile
pH	measure of acidity/basicity.
PHF	Pigeon House Fort
PHH	Pigeon House Hotel
P&ID	Process and Instrumentation Diagram
Pigeon House Road	Road on which the WwTW is sited.
Polymer	Polymeric thickening and dewatering aid
Poolbeg Scheme	Dublin Docklands Development Area Draft planning scheme for Poolbeg Peninsula
Poolbeg Peninsula	Land on which the WwTW is sited
Potable water	Drinking water
Primary Treatment	Treatment of wastewater by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD of the incoming waste water is reduced by at least 20 % before discharge and the total suspended solids of the incoming waste water are reduced by at least 50 % (UWWT Definition)
Primary Discharge	The existing outfall. Designated by EPA as "SW1"
Priority Substances	Priority substances are set out in Annex II of the Directive on Environmental Quality Standards (Directive 2008/105/EC) (EQSD), also known as the Priority Substances Directive.
P_{ref}	Reference sound pressure used to calculate a level in decibels, for air the value is 20μPa and for underwater noise the value is 1μPa.
P_{rms}	Root Mean Square, the RMS value of a fluctuating quantity q is the square root of {q2}, where the angle brackets denot an average (temporal, spatial or both).
PS	Pumping station.
PTS	Permanent Threshold Shift, the component of hearing absolute threshold shift for a given listener is increased through noise exposure that shows no recovery with time after the apparent cause has been removed.
PST(s)	Primary sedimentation tank(s).
psu	Practical Salinity Units

PW	Present worth (same as Net Present Value - NPV)
Ringsend WwTW	Preferred name for the WwTW
s	Preferred dimension for second when combined in a dimension (e.g. m^3/s)
SAC	Special Area of Conservation
SAS	Surplus Activated Sludge
SAS thickeners	Rotary drum thickeners for SAS
SBRs	Sequencing Batch Reactors
Screens	Generally refers to influent screens
Screenings	Materials removed from the wastewater by the screens
Screenings Building	Building that houses the screens
Screw pumps	Archimedes screw pumps downstream of the screens
sec	Preferred dimension for second when standing alone
SEL	Sound Exposure Level, a measure of the sound exposure in decibels. On this scale 0db corresponds to a sready sound pressure whose root mean square frequency-weighted sound pressure equals the reference pressure (1µPa underwater), persisting for a reference time of 1 second. Sound Exposure level can be applied to single events, as well as to noise of a continuing character.
Secondary Treatment	Treatment for the oxidation of BOD.
"Sensitive" (water body)	A designation under the UWWT Directive relating to: natural freshwater lakes, other freshwater bodies, estuaries and coastal waters which are found to be eutrophic or which in the near future may become eutrophic if protective action is not taken surface freshwaters intended for the abstraction of drinking water which could contain more than the concentration of nitrate laid down under the relevant provisions of Council Directive The Liffey Estuary – from Islandbridge weir to Poolbeg Lighthouse, including the River Tolka basin and South Bull Lagoon, was designated sensitive in 2001 (S.I. No 254/2)
Sludge	Solid byproducts of wastewater treatment. Not "biosolids" until fully treated.
SPA	Special Protection Area
SPL	Sound Pressure Level, at a given point is defined as SPL = $10\log_{10}(p_{rms}/p_{ref})^2$
SRT	Solids Retention Time (in activated sludge systems)
SS	Suspended solids
SSE	Sludge Stream Expansion Project
Stormwater Tanks	Basins used to temporarily store and pump back flows in excess of FFT
Storm water Overflow	Overflow pipe from Stormwater Basins. Designated by EPA as "SW2"
Submarine pipeline	Underwater pipeline.
TBM	Tunnel boring machine
tDS	tonnes dry solids. Used in describing sludge processing (eg. tDS/d)
TDS	Total dissolved solids
Tertiary Treatment	Process to control nitrogen or phosphorus.

THP	Thermal Hydrolysis Process
THP Building	Building in which the THP (among other things) is housed
TKN	Total Kjeldahl Nitrogen.
tonne	Preferred for use in expressing mass greater than 1,000 kg
Total N	Total Nitrogen.
Total P	Total Phosphorus.
tpd	tonnes per day
TSS	Total suspended solids
TTS	Temproary Threshold Shift, the component of hearing absolute threshold shift for a given listener is increased through noise exposure that shows a recovery with time after the apparent cause has been removed. Recovery usually occurs within a period ranging from seconds to hours.
Tunnel	The manner in which the effluent outfall is being constructed
µg/L	Preferred dimension for microgram per litre.
UV (irradiation)	Ultra-violet (irradiation)
UWWTD	Urban Wastewater Treatment Directive
Washwater	Final effluent that has been filtered and disinfected for in-plant NPW uses
Wayleave	Easement
Weighbridge	Scale that weighs trucks entering and exiting the WwTW
Works	The WwTW.
WSIP	Water Service Investment Programme
WTE	Waste-to-energy
WwTW	Wastewater Treatment Works
yr	Year
Z- 14	Planning zone created by the DDDA Masterplan affecting the Poolbeg Peninsula
24/7	Operating 24 hours per day on a 7 day week basis
µPa	micro Pascals

Chapter 1 Introduction

1.1 Project Overview

The overriding purpose of this Ringsend Wastewater Treatment Works (WwTW, Works) Extension project is to extend the Works from its present capacity to the maximum achievable within the curtilage of the existing site and to conform to the required discharge standards.

The Preliminary Report for the Ringsend WwTW dated May 1993, recommended that the Works be commissioned in two stages:

- Stage 1 - Immediate design and construction based on the design horizon of 2020; and
- Stage 2 - Subsequent expansion of capacity, as required, on a 0.8 hectare part of the site set aside for this purpose.

Stage 1 of the WwTW was fully commissioned in May 2005. The treatment process consists of secondary treatment with some nutrient removal. Disinfection of the effluent also occurs during the summer months. The treated effluent discharge location is the cooling water channel north of the ESB Ringsend Power Station and from there into the Liffey Estuary.

The WwTW was designed to treat an average influent loading of 1.6 million population equivalent (PE) to secondary treatment standards and is currently overloaded. The average influent loading to the Works is currently approximately 1.8 million PE. The 95th percentile effluent total suspended solids (TSS) standard has not been met for several years and in 2009 the 95th percentile biological oxygen demand (BOD) standard was not met for the first time.

Furthermore, the effluent standards have become more stringent since the original plant was designed and constructed. The Liffey Estuary was designated as Nutrient Sensitive Waters in 2001, and as a consequence the EU Urban Waste Water Treatment (UWWT) Directive requires additional nutrient removal, in addition to normal secondary treatment standards, for continued discharge at the existing outfall to the Liffey Estuary.

The WwTW, as currently configured, has limited nutrient removal capacity. With open space on site extremely limited and with no ability to extend the WwTW's boundaries, it is most unlikely that compliance with the UWWT Total Nitrogen limit at the design horizon loading could be accomplished with conventional wastewater treatment processes. The non-conventional processes (as described in Chapter 3) considered necessary to meet the discharge standard are energy intensive and would add complexity to the operation and maintenance of the WwTW. In addition, compliance with the Total Phosphorus limit would require large quantities of chemicals to be applied with resultant increases in sludge production.

Designation of the Liffey Estuary as Nutrient Sensitive Waters together with the space constraints has, therefore, prompted consideration of the option of moving the outfall location to a point outside the Nutrient Sensitive designation, where additional discharge standards are not applied by any regulatory authorities. Under this proposed scenario, the existing treatment process would be operated in slightly different mode than they are currently operated and some facilities would be added to further improve effluent solids quality. Energy consumption would decrease from current usage levels. No additional chemicals would be required and sludge production would only increase in general proportion to the increase in influent loadings. This option is technically simpler, more reliable, more sustainable, and have a smaller carbon footprint than the non-conventional processes. It is also the low cost option when operating costs are taken into account.

Non-cost factors, including sustainability and environmental factors, strongly favour the Secondary Treatment/Long Sea Outfall alternative. Power consumption, directly attributed to wastewater treatment and indirectly derived from sludge treatment, was calculated to be 45 % to 80 % greater for the nutrient removal alternatives. Chemical consumption, which is zero for the Secondary Treatment/ Long Sea Outfall alternative, ranges from 10,000 m^3/yr to 23,000 m^3/yr for the Nutrient Removal alternatives. Sludge production for Nutrient Removal alternatives is estimated to be approximately 3,000 tonnes per year or 14,000 tonnes per year more than the Secondary Treatment/ Long Sea Outfall alternative, depending upon how phosphorus is removed.

Water quality modelling of a range of outfall locations was carried out (as discussed in Chapter 8). The model was extensively calibrated against available data in the Liffey Estuary including water levels, currents, temperature, salinity and thermal plume extensions.

An examination of the initial modelling results showed that apart from a mixing zone in the immediate vicinity of the outfall location, the receiving waters will meet the Environmental Quality Objectives for coastal water nutrients (specifically Dissolved Inorganic Nitrogen (DIN)). There would also be an improvement in the bathing water quality and in the water quality in the Protected Areas in Dublin Bay.

Thus, the discharge, while not necessitating additional nutrient removal as in the other alternatives, would meet all water quality standards and be more protective of water quality in Natura 2000 sites and bathing waters.

The concept of constructing a marine pipeline was considered, but eliminated due to the large diameter required and in turn, the potentially negative impacts on Natura 2000 sites, marine archaeological sites, operations of the Port of Dublin fishing areas and recreational areas.

To further investigate the proposed outfall option, it was then necessary to undertake a large scale marine site investigation in Dublin Bay and environs. The site investigation comprised approximately a 500 km approx bathymetric survey and 350 km approx geophysical seismic and electrical resistivity survey. Nineteen marine based rotary cored boreholes were drilled into bedrock, up to 103 m below seabed level and in water depths of up to 30 m to determine potential outfall routes. Two additional boreholes were drilled on land at the site of the proposed tunnel inlet shaft. Analyses of these data confirmed that the construction of a Long Sea Outfall tunnel into Dublin Bay is technically feasible.

After an assessment of the design alternatives, the provision of secondary treatment with a long sea outfall discharge proved to be the most beneficial option for the Ringsend WwTW Extension. The discharge location assessed in this document was then selected based on the mapped constraints, environmental impacts, water quality modelling and geotechnical data.

A Design Review Report was prepared in June 2010, which refined the design criteria to increase the WwTW average day treatment to 2.4 million PE with all units in operation and a firm treatment capacity of 2.1 million PE (firm capacity refers to the capacity when the largest process unit is out of service for maintenance or due to equipment failure for example).

The proposed scope of works under this project comprises the following elements:

- Modifications to the existing Ringsend WwTW to improve efficiency and capacity (as described in Section 3.5);
- Install secondary treatment works (on the exisitng WwTW site) capable of treating 400,000 PE to secondary standards and accommodate a peak flow of 2.7 m^3/s; and
- Construct a 9 km long Long Sea Outfall.

It should also be noted that works are currently underway at the existing WwTW as described in Section 5.2 and Chapter 13. These relate to the requirement by the EPA to achieve accelerated compliance with the standard for TSS and the ongoing installation of odour control measures.

The design of the scheme has taken into account that it is anticipated that a regional treatment works will be constructed to the North of Dublin in the next decade, reducing the wastewater load to Ringsend WwTW.

1.2 Statement of Need

The Works is currently overloaded and by 2015, the earliest that the extended Works would be expected to be commissioned, the influent loading is projected to be between 1.90 million PE and 1.95 million PE, or between 116 % and 119 % of original design capacity. Deferring construction of the WwTW extension would only exacerbate the current overloading problem. Effluent quality can be expected to deteriorate further until the upgraded facilities become operational. It is, therefore, recommended that all the wastewater treatment improvements be constructed as part of the Extended Works.

1.3 Requirement for an Environmental Impact Assessment

As detailed in Chapter 6, an EIS for the extension of the Ringsend WwTW is required under the Planning and Development Regulations as the extension of the WwTW is greater than 150,000 PE.

Under the European Communities (Environmental Impact Assessment) Regulations and for the purposes of this project, the "Developer" is Dublin City Council (DCC) and the "Competent Authority" is An Bord Pleanála (ABP).

1.4 Structure of this Report

Chapter 2 describes the Environmental Impact Assessment process. The need for an Environmental Impact Statement (EIS), regulatory framework, scoping and public consultation process are also described in this section. This section also includes the names of the specialists involved in the preparation of the EIS and confirms that no particular difficulties were encountered in the preparation of the EIS.

Chapter 3 describes the existing environment.

Chapter 4 outlines the description of the proposed facility.

Chapter 5 describes the design alternatives considered during the evolution of the project and proposed design solution.

Chapter 6 describes the planning and policy context in which the proposed project is set.

Chapters 7 to 17 describe the impacts of the proposed project, at both construction and operational stages, under a series of categories as follows:

- Chapter 7 Human Beings;
- Chapter 8 Water Quality;
- Chapter 9 Marine Flora and Fauna;
- Chapter 10 Terrestrial Flora and Fauna;
- Chapter 11 Landscape and Visual;
- Chapter 12 Traffic;
- Chapter 13 Air Quality and Odour;
- Chapter 14 Noise and Vibration;
- Chapter 15 Archaeology and Cultural Heritage;
- Chapter 16 Geology and Hydrogeology; and
- Chapter 17 Material Assets

The chapters set out the assessment methodology, a description of the existing environment, the potential impacts of the proposed projects, the specified mitigation measures and residual impacts after the implementation of those mitigation measures.

Chapter 18 builds on the previous chapters and assesses the potential for cumulative impacts.

Chapter 19 summarises the specified mitigation measures described in the preceding chapters.

Chapter 20 summarises the residual impacts described in the preceding chapters.

Chapter 21 lists the references and documents referred to in the EIS.

Chapter 2 The EIA Process

2.1 Introduction

Environmental Impact Assessment (EIA) is the process of examining the environmental effects of a development or scheme at both the construction and operational stages. This process includes the consideration of environmental aspects, identification of impact and mitigation measures at design stage, the preparation of an Environmental Impact Statement (EIS), the evaluation of the EIS by a competent authority and the subsequent decision as to whether or not the development should proceed.

The Planning and Development Regulations 2001-2005 specify the information to be contained in an EIS and include the following:

(a) A description of the proposed development comprising information on the site, design and size of the proposed development;

(b) A description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects;

(c) The data required to identify and assess the main effects which the proposed development is likely to have on the environment; and

(d) An outline of the main alternatives studied by the developer and an indication of the main reasons for his or her choice, taking into account the effects on the environment.

Information is also required on the following matters:

(a) A description of the physical characteristics of the whole proposed development and the land-use requirements during the construction and operational phases;

(b) A description of the main characteristics of the production processes, for instance, nature and quantity of the materials used;

(c) An estimate, by type and quantity, of expected residues and emissions (including water, air and soil pollution, noise, vibration, light, heat and radiation) resulting from the operation of the proposed development;

(d) Aspects of the environment likely to be significantly affected by the proposed development are also to be described, including in particular:

i) human beings, fauna and flora;

ii) soil, water, air, climatic factors and the landscape;

iii) material assets, including the architectural and archaeological heritage, and the cultural heritage;

iv) the inter-relationship between the above factors;

(e) A description is required of the likely significant effects (including direct, indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative) of the proposed development on the environment resulting from:

i) the existence of the proposed development,

ii) the use of natural resources,

iii) the emission of pollutants, the creation of nuisances and the elimination of waste,

iv) and a description of the forecasting methods used to assess the effects on the environment; and

(f) An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.

A summary in non-technical language of this information is also to be included.

This EIS has been prepared with regard to the above requirements on the basis of information available at the time.

2.2 Contributors

This EIS has been produced by CDM (Ireland) Ltd and J B Barry and Partners Ltd together with the following specialist sub-consultants:

- Chapter 9 Marine Flora and Fauna – Aquafact;
- Chapter 10 Terrestrial Flora and Fauna – Natura Environmental Consultants (impact assessment) and Eleanor Mayes, Ecological Consultant (characterisation of exisiting environment);
- Chapter 11 Landscape and Visual – Brady Shipman Martin;
- Chapter 14 Noise and Vibration – Biospheric Engineering; and
- Chapter 15 Archaeology and Cultural Heritage – CRDS.

2.3 Screening

The Environmental Impact Assessment for the extension of the Ringsend Works WwTW was prepared for DCC in accordance with the provisions of the Planning and Development Act, 2000 (as amended), and the Planning and Development Regulations, 2001 (as amended).

Screening is the first task in the environmental assessment process and determines whether an EIS will need to be prepared.

DCC submitted a request to An Bord Pleanála (ABP) for an opinion as to whether an EIS was required and ABP confirmed that an EIS would be required as the development was considered to be Type 22 of Part 1 of Schedule 5 of Planning and Development Regulations 2001 (as amended). SI No. 364 of 2005 amends the Planning and Development Regulations, 2001 to include Type 22 as follows:

"Schedule 5 of the regulations is amended-

(a) by the addition in Part 1 of the following paragraph

22. Any change to or extension of projects listed in this Annex where such a change or extension in itself meets the thresholds, if any, set out in this Annex"

Type 13 of Schedule 5 Part 1 refers to waste water treatment plants exceeding 150,000 population equivalent as follows:

"13. Waste water treatment plants with a capacity exceeding 150,000 population equivalent as defined in Article 2, point (6), of Directive 91/271/EEC."

Having regard to the foregoing, it was confirmed by ABP that an EIS is required for this proposed project.

2.4 Scoping

The EIS scoping study is a key element of the EIA process and signifies commencement of the development of the EIS. The main objective of the environmental scoping study is to identify environmental issues which might arise during the construction and operation of the proposed scheme and are required to be addressed in more detail as part of the EIA. The environmental scoping report also presents the proposed assessment methodologies.

The EIS Scoping Report was completed and issued to the competent authorities and consultees for comment in July 2010. The EIS Scoping Report and summary of comments received are contained in Appendix A. The comments received were then addressed during the environmental assessment process.

It must, however, be emphasised that scoping for an EIS is an on-going process, which continues throughout the EIA process and through the design, construction and monitoring phases. The EIS Scoping Report acts as a common basis for consultation about the scope and methodology of the EIS.

2.5 Data Collection

An extensive data collection exercise was carried out to facilitate the characterisation of potential impacts. This included desktop studies and onsite surveys and investigations. The following surveys were undertaken as part of the EIA, to expand the information relating to the study area. These are detailed in the various relevant sections throughout this EIS, but include:

- Hydrodynamic modeling of the existing and proposed discharge;
- Benthic assessment of the proposed discharge location;
- Habitat surveys of the terrestrial vegetation;
- Bird counts;
- Traffic counts;
- Background noise survey around Poolbeg and noise prediction modelling;
- Marine geological site investigation; and
- Archaeological study of geophysical data at the proposed discharge site.

No particular technical difficulties were encountered during the data collection and preparation of the EIS.

2.6 Non- Statutory Consultation

Consultation was led by issuing and following up with the EIS Scoping Report described in Section 2.4. Public meetings were also held around Dublin in:

- Howth on the 22nd August 2011 in the Deer Park Hotel;
- Clontarf on the 23rd August 2011 in the Clasac Centre;
- Dalkey on the 6th October 2011 in the Heritage Centre;
- Dun Laoghaire on the 7th October 2011 in the Marine Hotel; and
- Ringsend on the 8th October 2011 in Irishtown Stadium, for the Ringsend, Irishtown and Sandymount communities.

Presentations were also made to the:

- Environment & Engineering Strategic Policy Committee, at City Hall on 22nd September; and
- Southeast Area Committee, at City Hall on 14th November.

Table 2.1 details the main comments received in response to the EIS Scoping Report (full responses contained in Appendix A) and comments from the public during the open days. Highlighted in the table, are where these comments have been addressed within the EIS. Further information on consultations specific to specialist topics is given in the relevant chapters.

An advertisement was placed in the Northside People for the week beginning 15th August 2011. Further advertisements were then placed in the Irish Times on Monday 3rd October, the Evening Herald Tuesday 4th October and the Northside and Southside People and News Four (Ringsend) for the week beginning Monday 3rd October.

Leaflets were delivered to 20,300 homes in the area and emails were sent to councillors, deputies and stakeholders including:

- Bath Avenue and District Residents Association;
- Bridge United;
- ESB Sportsco Squash Club;
- George Reynolds House Resident;
- Iris Charles Centre for Older People;
- Merrion Cricket Club;
- Pearse Street Library;
- Poolbeg Yacht Club;
- Power of 1 Lone Parents Group;
- Railway Union Sports Club;
- South East Area Education Committee;
- St Albans Mews Residents Association;
- Ringsend Registered Fishermen & Private Boat Owners Association;
- Poolbeg Quay Residents Association;
- Sandymount & Merrion Residents Association;
- Ringsend Irishtown & Sandymount Environment Group;
- Clontarf Business Forum;
- Donaghmede Residents Estate Association;
- Raheny Tidy Group; and
- The Chairperson of St. Donagh's Residents Association.

A synopsis of the main comments made throughout the public consultation process is set out in Table 2.1.

Table 2.1 Summary of Consultation Responses Received

Topic	Authority	Summary of Comment	Relevant Section in EIS where comment is addressed
Summary of Responses to EIS Scoping Report			
Roads	National Roads Authority	The NRA indicate that it is important that within the context of developing proposals within this area that full consultation with the Authority should take place to ensure that the potential of the Eastern Bypass Scheme is fully integrated into the EIA processes especially in the light of the preparation of alternatives, baseline data, and the implementation of the National Development Plan.	Chapter 12 Traffic
Inland Fisheries	Inland Fisheries Board	Any proposal to move the effluent discharge point to a less ecologically sensitive location away from estuarine protected waters is to be welcomed. IFI highlight the need for careful consideration of potential aquatic ecological impacts of the 'upgraded' effluent load in any alternative location. Potential impacts should be comprehensively assessed and recommendations and mitigationmeasures formulated. All measures necessary should be undertaken to protect surface and groundwater, local aquatic ecological integrity, access for anglers and commercial fishermen both during and after construction. It is essential to consider fisheries impacts of the development at all times.	Chapter 8 Water Quality, Chapter 9 Marine Flora and Fauna and Chapter 17 Material Assets
Planning	Dublin Docklands Authority	Dublin Docklands Authority wish to advise that the site is located within the DDDA's Master Plan area. The Authority plan to prepare a draft planning scheme for the peninsula and formally request on-going liaison in relation to the Wastewater Treatment Works extension.	
Planning	Fingal County Council	Emphasise the importance of the Greater Dublin Strategic Drainage Study, ERBD River Basin Management Plan and Malahide shellfish designated area and pollution reduction measures. Other areas in other jurisdictions may also be relevant.	Chapter 6 Planning and Policy Context and Chapter 8 Water Quality
Protected Area Designations	Fingal County Council	Emphasised that potential impacts in the Fingal Region should be considered.	Chapter 9 Marine Flora and Fauna
Alternatives	Fingal County Council	The use of the most up to date systems to treat the discharge should be discussed as an alternative in the assessment.	Chapter 3 Consideration of Alternatives
Protected Area Designations	Department of Environment Heritage and Local Government	With regard to appropriate assessment we recommend that you consider the potential impact of cleaner water in Dublin Bay on food availability for birds in the SPAs. It is also necessary to consider cumulative impacts with other plans and projects, including existing and proposed discharges, which could result in an in combination impact.	Chapter 8 Water Quality, Chapter 9 Marine Flora and Fauna and Chapter 10 Terrestrial Flora and Fauna

Topic	Authority	Summary of Comment	Relevant Section in EIS where comment is addressed
Marine Mammals	Department of Environment Heritage and Local Government	It must be noted that all cetaceans are listed under Annex IV (including those in Annex II) of Council Directive 92/43/EEC and thereby protected under Article 12 of that Directive. This has been transposed into Irish Law by Regulation 23 of European Communities (Natural Habitats) Regulations (SI 94/1997). Introduction of certain sound sources into the marine environment has the potential to cause injury and possibly mortality in these species.	Chapter 9 Marine Flora and Fauna and Chapter 14 Noise and Vibration
Waste Generation	Department of Environment Heritage and Local Government	Include a description of the facilities to be put in place to cope with waste generated during construction (e.g. material extracted during tunneling) and operation of the proposed facility should be detailed.	Chapter 16 Soils, Geology and Hydrogeology
Construction	Department of Environment Heritage and Local Government	A plan designed to foresee potential events such as equipment malfunction (e.g. tunnel boring machine) or tunnel breakout of drilling muds and resulting in a potential change to the environmental impact of the proposed development. The likelihood of such events occurring should also be evaluated.	Chapter 19 Summary of Mitigation Measures
Water Quality	Geological Survey of Ireland	GSI would be interested in seeing the results of your preliminary hydraulic and water quality modelling.	Chapter 8 Water Quality
Geological Heritage	Geological Survey of Ireland	Emphasised the importance of considering impacts on North Bull Island and Bottle Quay (although due to the location of the site, it is unlikely to be affected by the works.)	Chapter 10 Terrestrial Flora and Fauna, Chapter 16 Soils, Geology and Hydrogeology and Chapter 17 Material Assets
Water Quality	Comments received during Open Days	Comments on the noticeable the improvement in water quality was following commissioning of the existing WwTW facility.	Chapter 8 Water Quality
Air Quality	Comments received during Open Days	Concerns that PM_{10} values are currently being exceeded at Ringsend.	Chapter 13 Air Quality
Amenity	Comments received during Open Days	Concerns about safe pedestrian access along the Pigeon House Road during the construction phase.	Chapter 11 Landscape and Visual and Chapter 12 Traffic
Landuse	Comments received during Open Days	The Waste to Energy Project may not be going ahead and so Dublin City Council should use that site for the WwTW expansion.	Outside the scope of the EIS

Chapter 3 Existing Environment

3.1 Location Overview

Ringsend WwTW is located by the mouth of the River Liffey as it enters Dublin Bay. The Bay is a small, shallow sandy embayment. It is enclosed by two headlands Howth to the north and to Dalkey and Killiney Head to the south. It is approximately 10 kilometres across the mouth of the bay and narrows to the mouth of the River Liffey. The general study area is shown in Figure 3.1.

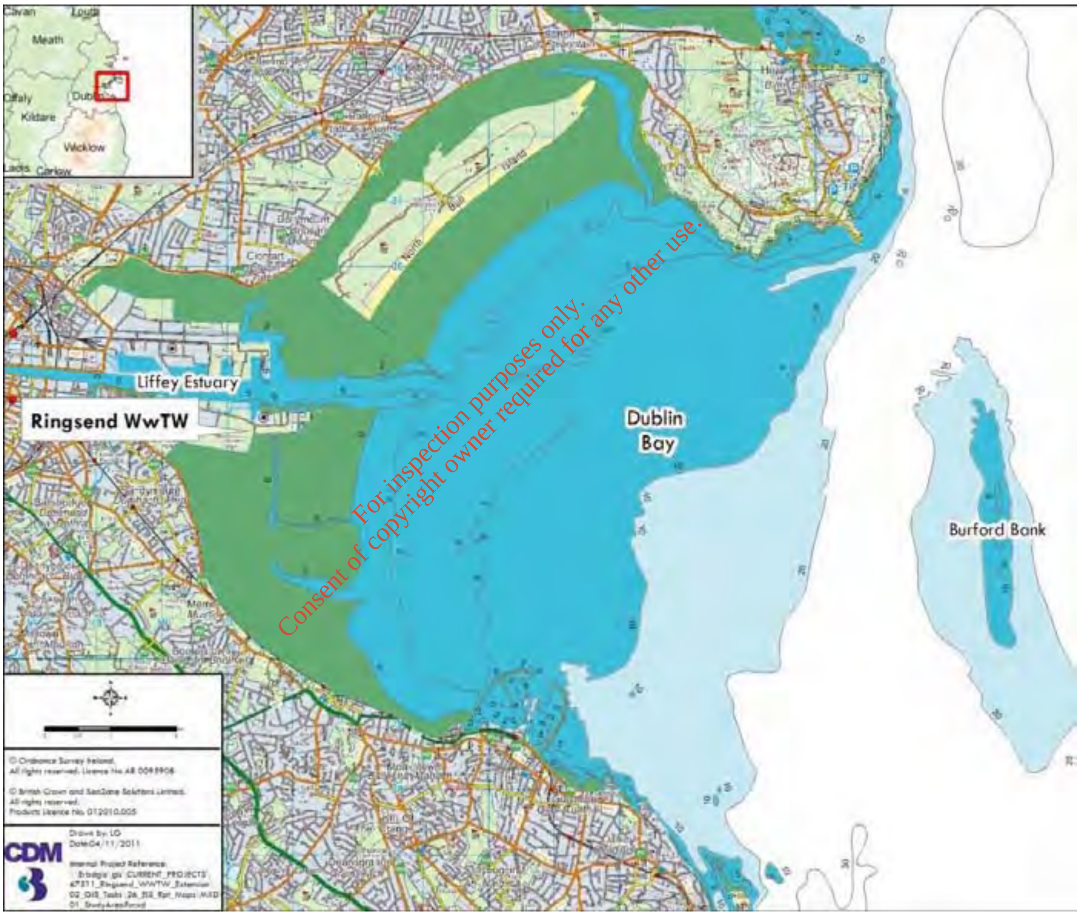


Figure 3.1 Dublin Bay Area

The intertidal zone of the bay occupies the inner third of the bay. The bay slopes gently reaching depths of 20 m at the mouth of the Bay. The water depth decreases towards the harbour with depths of less than 5 m occurring in the inner half of the bay. The Burford Bank sits centrally across the mouth of Dublin Bay and is a linear sand ridge about 5 km in length, which rises to within 5 m of the surface.

The North Bull Island is a prominent physical feature in the bay which developed due to sedimentation accumulation after the construction of the North Bull wall in 1821. To the north of the channel are extensive areas which dry out at low water. These mudflats extend from the mouth of the River Tolka almost to the end of the Bull Wall and north eastwards past the Bull Island Causeway to Sutton Creek, which is a narrow channel between Bull Island and Howth.

Dublin Bay is currently home to a range of activities including fishing, bathing, recreational sports such as water sports and boating. Maritime traffic is busy in Dublin Bay as it is home to Ireland's largest port.

The Liffey enters Dublin Bay between Clontarf and Ringsend in the channel formed by the North Bull Wall and the Great South Wall, see Figure 3.2 and Figure 3.3. The North Bull Wall is a natural bank reinforced by a stone embankment that is only inundated at half tide. It, therefore, holds back the water flowing out of the harbour at and after half ebb. The navigation channel runs close to the Great South Wall and extends from the Port area through the mouth of the harbour. This navigation channel is maintained at a depth of 7 to 8 metres below chart datum by periodic dredging and natural scouring.

The currents in Dublin Port are dominated by the tidal fluctuations and are only to some extent influenced by wind and pressure fields over the east coast of Ireland and Dublin Bay, except during extreme weather conditions. The freshwater inflow influences the currents and a salt water wedge can be observed in the estuary. In the upstream part, around Butt Bridge, the estuary is highly stratified. The stratification decreases downstream. From Ringsend and towards the mouth the estuary can be considered well mixed. Stratification and location of the salt water wedge depends on the tidal conditions and the river discharge. The salinity of the sea water in the outer part of Dublin Bay and along the eastern coast of Ireland shows insignificant annual variation and is around 35 PSU all year round.

Figure 3.2 Liffey Estuary

Figure 3.3 Aerial View of Ringsend WwTW

Dublin Bay contains a number of designated conservation sites including Special Areas of Conservation (SAC) and Special Protection Areas (SPA) as shown in Figure 3.4 and discussed in further detail throughout this document.

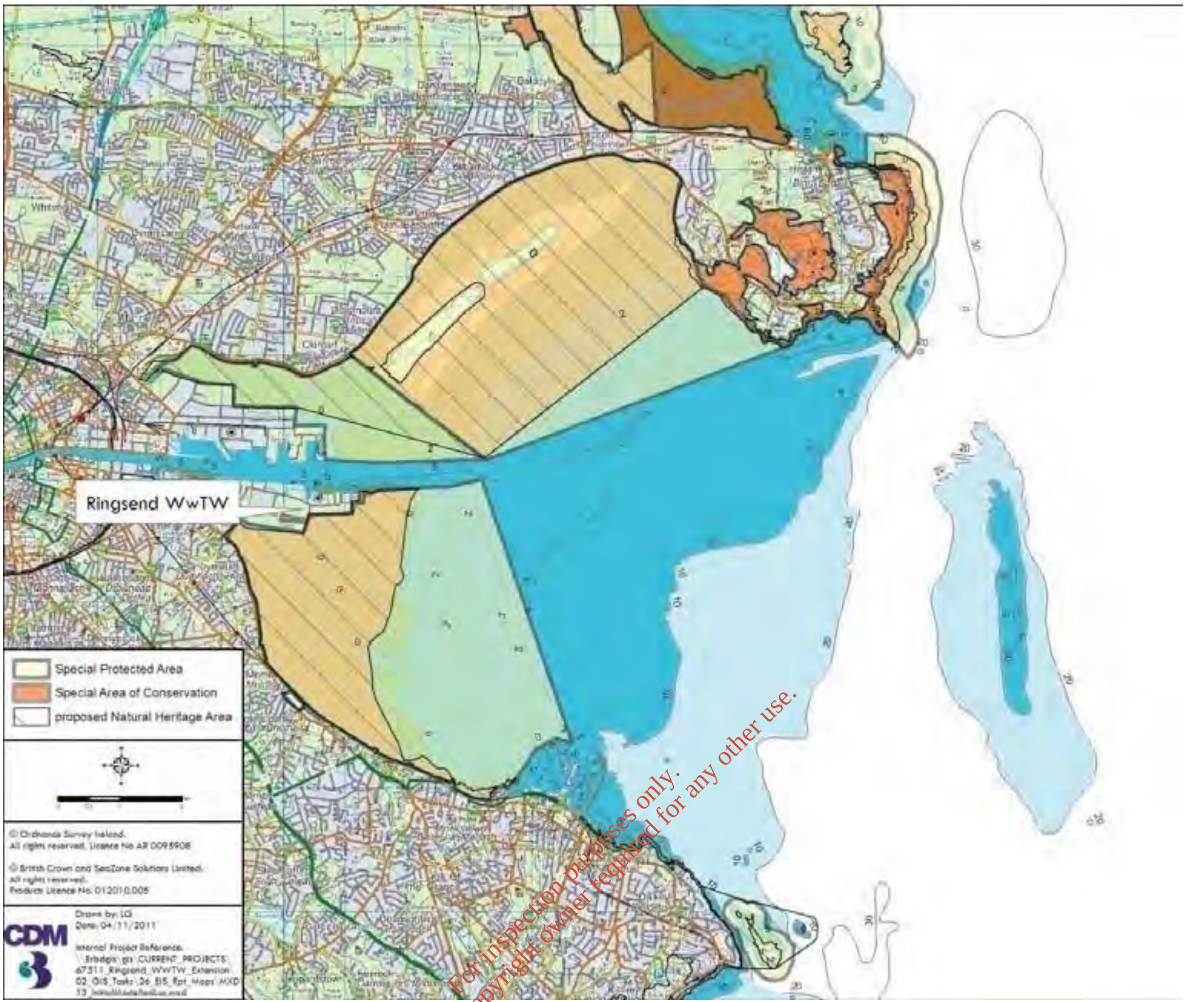


Figure 3.4 Environmental Protected Areas

The Ringsend WwTW Catchment includes Dublin City, Dun Laoghaire and large areas of South County Dublin and Fingal, as shown in Figure 3.5. Flows are received to the WwTW from the following catchment areas:

- Main Lift Pumping Station (MLPS);
- West Pier Dun Laoghaire Pumping station;
- Sutton Pumping Station; and
- Dodder Valley Siphon.

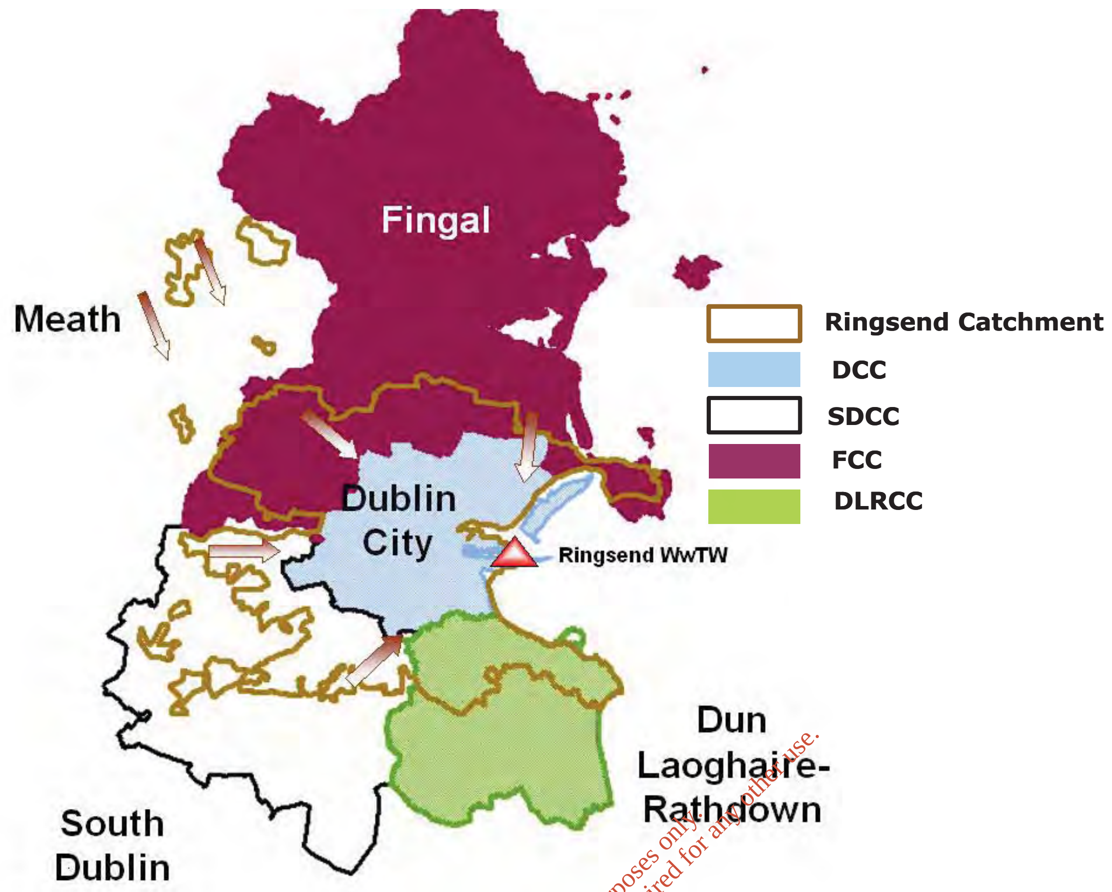


Figure 3.5 Catchments to Ringsend (Source: GDSDS 2008)

3.2 Existing WwTW Design Parameters

The parameters listed in Table 3.1 constitute the Basis of Design for the existing WwTW under the Dublin Bay Project Phase 1 Contract No. 2.

In addition to achieving effluent limits on BOD, COD, TSS and Ammonia Nitrogen, the Works must disinfect during the bathing season to achieve 100,000 Faecal Coliform (FC) bacteria per 100 ml sample (100,000 FC/100 ml) on an 80 percentile basis.

The estimated Year 2020 design BOD loading to the Works, was million PE. The design envisaged expansion by constructing two more sequencing batch reactors (SBRs) on 0.8 hectares of open space within the curtilage of the existing site.

Pollutant loadings to the Works have exceeded the Year 2020 design projections ever since Contract No. 2 entered the operations phase. Notwithstanding the adverse loading conditions, the Works has regularly achieved its effluent limits for BOD, COD, ammonia nitrogen and faecal coliform. There are infrequent exceedances of upper limits, but the Works has met the respective 95th percentile and 80th percentile compliance limits for these parameters. However, effluent total suspended solids (TSS), has achieved compliance with the 95th percentile standard of 35 mg/l only about 80 % of the time The upper level limit of 87.5 mg/l is exceeded on average about once per month.

Table 3.1 Basis of Design for existing WwTW, Contract No. 2

Parameter	Load
Average Daily Flow (ADF)	5.7 m^3/sec
Flow to Full Treatment (FFT)	11.1 m^3/sec
Ultimate Peak Instantaneous Flow	23.5 m^3/sec
Influent BOD load	
Average	98,400 kg/day (200 mg/l)[1]
95th Percentile	157,600 kg/day
Effluent BOD	
95th Percentile	25 mg/l
Not to be Exceeded	50 mg/l
Effluent COD	
95th Percentile	125 mg/l
Not to be Exceeded	250 mg/l
Influent TSS load	
Average	101,100 kg/day (205 mg/l)[1]
95th Percentile	194,300 kg/day
Effluent TSS	
95th Percentile	35 mg/l
Not to be Exceeded	87.5 mg/l
Influent Nitrogen load	
Total N - Average	15,600 kg/day (31.7 mg/l)[1]
Total N – 95th Percentile	21,400 kg/day
Ammonia N – Average	9,500 kg/day (19.3 mg/l)[1]
Ammonia N – 95th Percentile	12,800 kg/day
Effluent Ammonia Nitrogen	
95th Percentile	18.75 mg/l
Not to be Exceeded	47 mg/l
Influent Total Phosphorus	
Average	3,700 kg/day (7.5mg/l)[1]
95th Percentile	5,600 kg/day
Average Daily Flow (ADF)	5.7 m^3/sec

1 As computed from ADF

After Contract No. 2 was signed, the Liffey Estuary was designated as Nutrient Sensitive Waters under (S.I. No. 254 of 2001) Urban Waste Water Treatment (UWWT) Regulations 2001. Consequently, annual mean limits of 10 mg/l total nitrogen (TN) and 1 mg/L total phosphorus applied to discharges into the Estuary. As currently configured, the Works are incapable of meeting the UWWT standards.

Storm tanks receive flows in excess of 11.1 m^3/s and store the wastewater for treatment when influent flows subside. On infrequent occasions the storm tanks overflow to the Liffey Estuary. There is a required limit of 3,000,000 FC/100 ml for the storm water discharge, at a 95 percentile compliance limit.

3.3 Wastewater Discharge Licence

In accordance with the requirements of the Waste Water Discharge (Authorisation) Regulations, 2007 (S.I. No. 684 of 2007), the licensing and certification authorisation process was introduced on a phased basis commencing on 14th December 2007. The regulations focus on discharges from areas served by water services authority sewer networks. The regulations do not cover issues of odours, noise or the management of WwTWs themselves.

A licence was granted by the EPA to Dublin City Council on 27th July 2010 (EPA Licence Register D0034-01) to discharge treated wastewater effluent to the Lower Liffey Estuary.

No specified discharge from the waste water works shall exceed the emission limit values set out in Schedule A: Discharges of the licence.

Table 3.2 Extract from EPA Licence Register D0034-01Primary Waste Water Discharge

SCHEDULE A: Discharges	
A.I Primary Waste Water Discharge	
Primary Discharge Point Code:	SW 1Dublin
Name of Receiving Waters:	Liffey Estuary Lower (IE_EA_090_0300)
Discharge Location:	321073E, 233814N
Monitoring Location:	3203S5E, 233396N (Outlet sampling point)
Parameter	Emission Limit Value
pH	6-9
Toxicity	5 TU
Faecal coliforms	100,000 MPN/ 100ml*
CBOD	25 mg/l
COD	125 mg/l
Suspended Solids	35 mg/l
Total Nitrogen	10 mg/l
Total Phosphorus (as P)	1 mg/l

* *Limit shall apply from 1st May through to 31st August annually*

The licensee (DCC) is required to complete the improvements as set out in *Schedule C: Specified Improvement Programme,* of the licence, by 22/12/2015 in order to ensure compliance with the emission limit values as set out in *Schedule A; Discharges* of the licence.

The EPA require that the licensee apply for a licence review under Regulation (14)(l)(b) of the Waste Water Discharge (Authorisation) Regulations 2007 in relation to any change in the discharge point, and as part of the review seek amendment to emission limit values.

3.4 Process Description

3.4.1 Process Schematic

The Ringsend WwTW was extended to its current configuration under the Dublin Bay Project Contract No. 2, which was procured under a design/build/operate (DBO) scheme. The Works was officially handed over to the operator in May 2005.

Figure 3.6 shows the layout of the existing Ringsend WwTW and Figure 3.7 shows a schematic of the treatment process. The effluent discharge (SW1) is located in a cooling water channel north of the ESB Ringsend Power Station. The storm water overflow pipe (SW2) is located to the north of the storm tanks. Influent and effluent sampling locations as well as outfalls are shown on Figure 5.5.

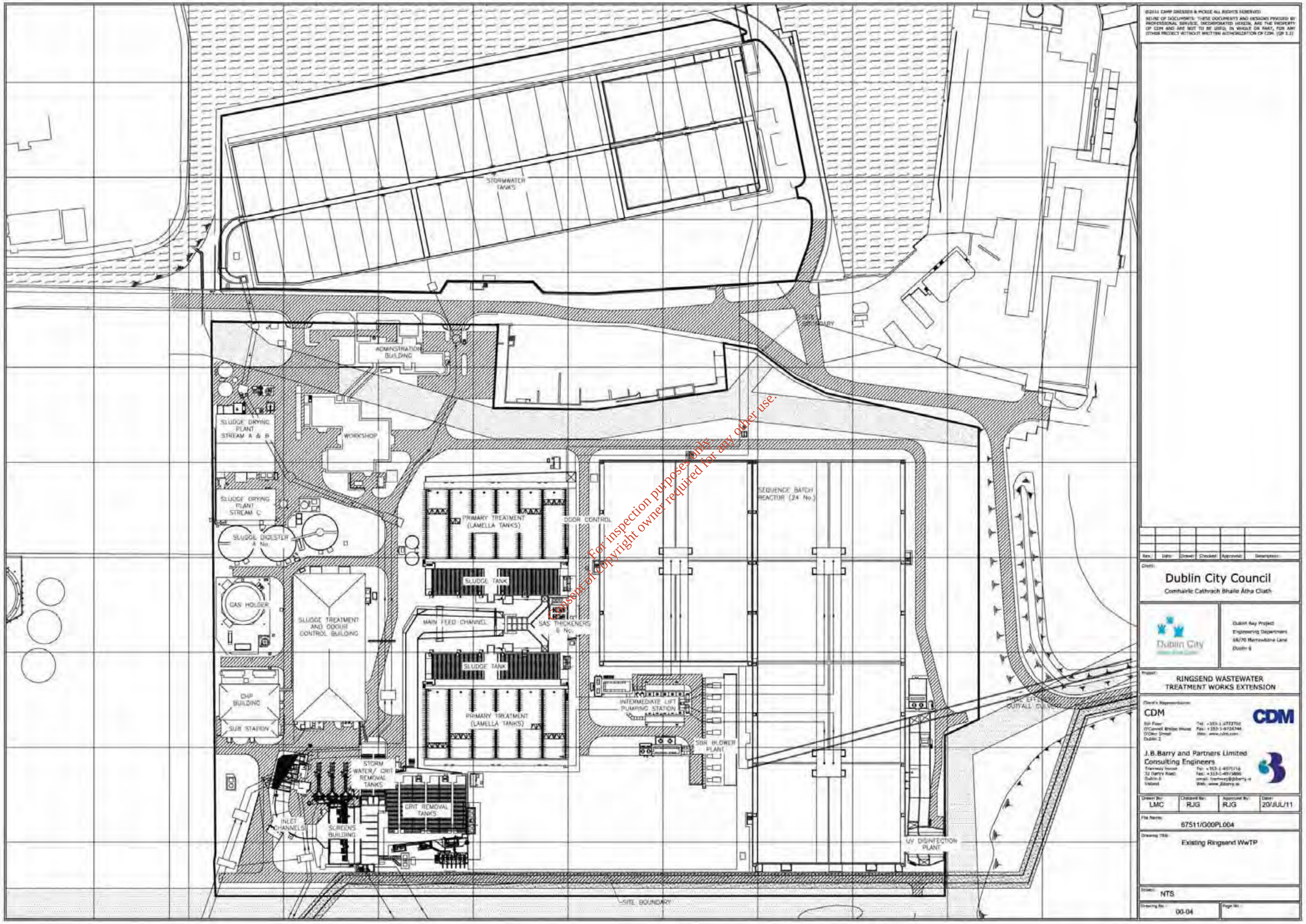


Figure 3.6 Existing Layout of Ringsend WwTW

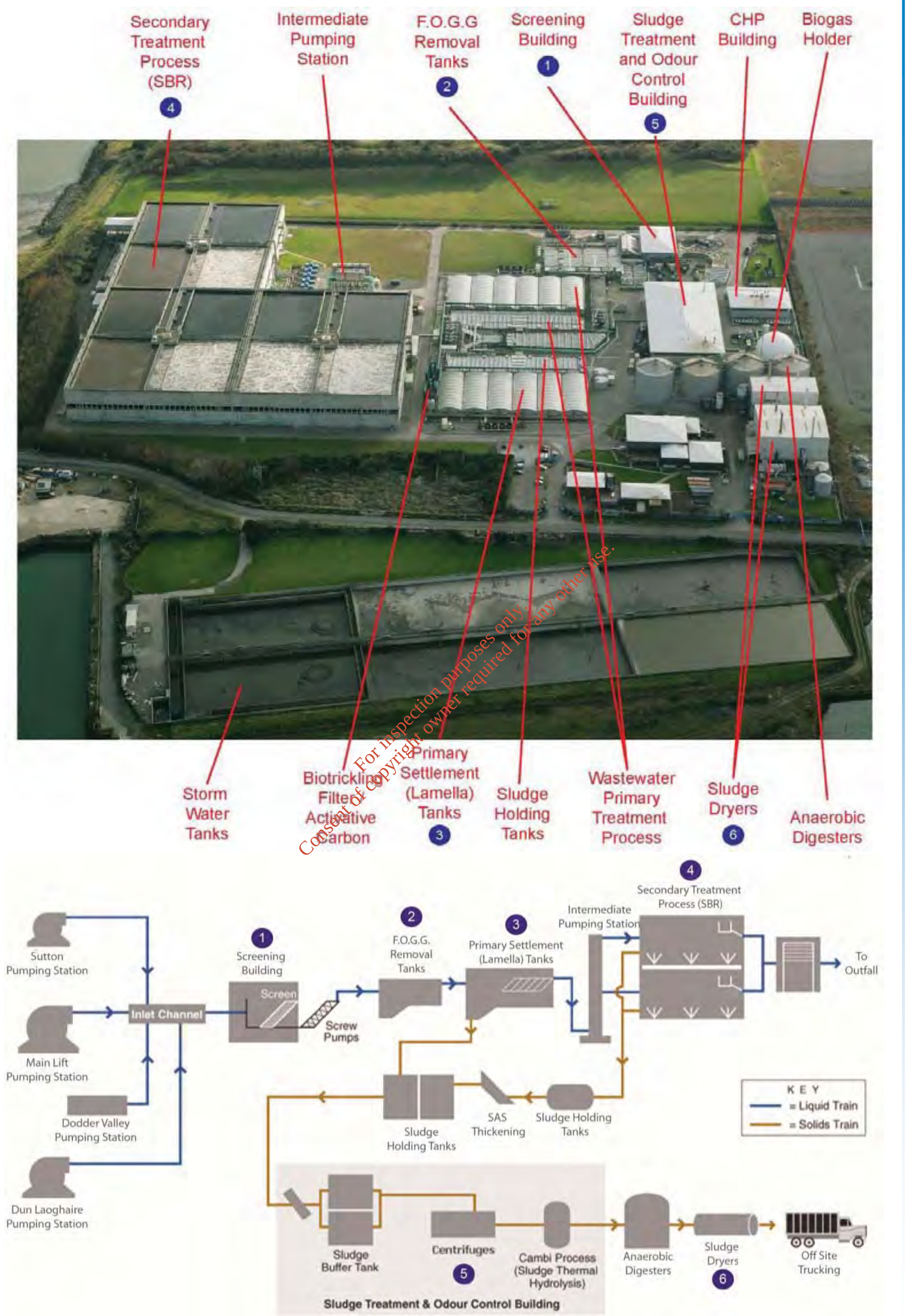


Figure 3.7 Aerial View and Schematic of Ringsend WwTW Process Train

3.4.2 Functional Process Areas

3.4.2.1 Headworks

The headworks facilities collect and consolidate the flow from four main sources: Sutton Pumping Station; West Pier Dun Laoghaire Pumping Station; Main Lift Pumping Station (MLPS); and Dodder Valley Gravity Sewer, as shown previously in Figure 3.7. After consolidation the flow is directed to the screening area (Point 1 in Figure 3.7).

Six mm perforated screens were originally installed at the works and these were subsequently replaced with 6 mm wedge wire bar screens, the replacement was made because the perforated screens would blind with the combination of grease and fibrous material and cause the system to back up, creating occasional overflows. The modifications to install the wedge wire screens in all of the screen bays were completed at the end of 2007 and the improvements have resulted in no bypasses of the screens since that time. The screening facilities are designed to handle a peak wet weather flow of 23 m^3/s.

Screenings are dropped into individual channels for each screen and flushed through the channels loaded directly into compactors. The originally installed macerators were removed in 2007 and replaced by Wash Pactors due to significant problems with blockages and reliability during high flows. The compacted screenings are placed in enclosed skips for disposal.

Screened flows are then pumped by screw pumps into the grit removal tank feed channel.

The FOGG (Fats, Oils, Greases and Grit) tanks (Point 2 in Figure 3.7) when first commissioned did not effectively remove FOG (Fats, Oils and Greases). They are now operated as aerated grit removal tanks and achieve improved grit removal.

The removed grit is then sent to cyclones and classifiers. The dewatered grit is dropped into open skips for disposal.

3.4.2.2 Primary Settling

The primary settling tanks (point 3 in Figure 3.7) have lamella packs to facilitate sludge settling. Lamella packs comprise of inclined plates which cause flocculated material to precipitate from the water that flows over the plates. The tanks can meet the design flow requirements.

A portion of the SAS is returned to the lamella clarifiers for co-thickening.

An upgrade project completed in 2008 improved scum removal, as well as odour capture and control. This system has one collection bridge for each settling tank, discharging scum to a scum trough at the end of each clarifier. The scum is discharged to both sludge holding tanks.

3.4.2.3 Intermediate Pump Station

The intermediate pump station (IPS) is comprised of four high lift and four low lift submersible pumps.

3.4.2.4 Flow Splitting Boxes

The Intermediate pump station lifts the primary effluent into distribution boxes at two levels for splitting in three SBR units on each level. There is an additional chamber in each distribution box to split to a fourth SBR bank on each level.

3.4.2.5 Sequencing Batch Reactors (SBRs)

The SBRs (Point 4 in Figure 3.7) were originally installed with the intent to operate as typical SBRs (i.e., fill, react, settle, decant, in sequence). During the initial operations there was an issue with filamentous growth, which could not be controlled by the operators. This growth resulted in a problem with decanting and sludge being in the decant stream. The operations staff implemented a continuous inflow, constant level (CICL) mode of operation of the SBRs with increased aeration to overcome the filamentous problems. In this mode of operation filling and decanting occur simultaneously.

SBR operations have also changed in terms of the operating level on the top deck SBRs. The original operating level resulted in significant turbulence and unbalanced effluent weir loading due to wave action in the basins caused by strong winds. As a result, the basin operating level has been reduced by approximately one metre. This has reduced the overall active volume of the SBRs by about 10 % and the lesser depth probably contributes to solids carry over, especially during high flow or influent loading conditions. Even with the lowering of the water level, wind on the top deck still causes problems with settling.

The performance of the SBRs in CICL mode has been generally compliant with effluent quality with regard to BOD, but not TSS. There are likely a number of factors that contribute to effluent TSS quality, such as co-thickened primary effluent, high recycle rates from solids processing, and occasionally high sludge volume indices, in addition to the lowered water surface on the upper level.

It has been reported that high air demand of SBRs places significant pressure on SBR blowers and the air diffusion grids in the basins.

3.4.2.6 Ultraviolet (UV) Disinfection

The UV disinfection system is operated during the bathing season and has performed well in terms of bacteriological kill.

3.4.2.7 Storm Tanks

The existing storm flow retention basins comprise a volume of 62,100 m^3 and when full overflow directly to the Liffey Estuary portion of Dublin Bay. The overflow discharge point is separate from the works outfall (SW2 on Figure 5.5). In addition to the overflow from the storm tanks, there is a default overflow from the primary settling tanks that is available should there be a system fault or power failure affecting the IPS or SBRs.

The allowable storm tank overflow is limited to 3,000,000 faecal coliform/100 ml. The overflow is not disinfected.

Storm water collected during storm events must be returned into treatment in shortest possible time to prevent odour release and restore storm water treatment capacity before next storm event starts or contaminated influent requires diversion into storm tanks. In 2009, there were 25 stormwater overflows which equates to 1.1 % of the total flow received at the WwTW. In 2010 there were 24 overflows equating to 0.6 % of the WwTW influent flow.

3.4.2.8 Flow Metering

Influent flow is measured on the flow from the Main Lift Pumping Station, Sutton Pumping Station, Dun Laoghaire pumping station and the Dodder Valley gravity sewer. Flow is measured on each of the main channels from the grit removal tanks into the lamellas. There are also flow meters on the pumped flow pipelines to each SBR at the intermediate pump station.

The final effluent channel also has a flow meter consisting of a level sensor upstream of a flume.

3.4.2.9 Solids Processing

A Sludge Stream Expansion project was completed in 2008, increasing the Works' capacity to thicken SAS and to dewater, hydrolise, and anaerobically digest SAS and primary sludge.

Three rotary drum thickeners were added to the three that had been originally installed, thereby doubling SAS thickening capacity. Almost all of the SAS is now mechanically thickened, but a small amount is returned to the lamella clarifiers for co-thickening.

The sludge holding tanks associated with the primary settling system receive primary sludge and scum from the primary settling tanks.

The SAS holding tanks receive sludge from the SBRs. Thickened SAS from the drum thickeners is held in a partitioned portion of one of the sludge holding tanks.

All of the sludge is screened through sludge screens and discharges to the buffer tanks. The buffer tanks discharge to the centrifuges for dewatering. Centrifuges were installed to reduce reliance on the belt filter presses (BFPs). Two centrifuges, installed in 2007, are located outside adjacent to the sludge treatment building. A third centrifuge was installed inside the sludge treatment building as part of the sludge stream expansion programme. The originally installed BFPs have either been removed or decommissioned and left in place.

The centrifuges dewater the sludge to approximately 20 % dry solids. The un-dewatered sludge is then blended with the dewatered sludge to produce 15 % total solids sludge prior to the sludge thermal hydrolysis process (THP) system. The THP treats the sludge under high temperature and pressure and makes it more amenable to anaerobic digestion.

One additional anaerobic digester was added in the sludge stream expansion programme, bring the total to four and increasing the sludge processing system capacity to 120 tonnes per day.

Biogas generated in the anaerobic digestion process is used to fuel boilers and generate electricity and recover heat through the Combined Heat and Power (CHP) system. On average, the CHP system generates slightly more than 2 MegaWatts (MW) of electricity from biogas. The CHP system also generates electricity from natural gas. A total of 4 MW of capacity is installed.

All biosolids generated have been beneficially reused in agriculture for more than a decade. There are three thermal biosolids dryers that evaporate water from dewatered biosolids, forming pellets of at least 90 percent dry matter. This product, referred to as Biofert, is DCC's preferred biosolids product and is produced to the capacity of the thermal driers. If the capacity of the thermal dryers is exceeded on a given day, excess digested biosolids are centrifugally dewatered to approximately 30 percent dry matter. This product is referred to as Biocake. Both Biofert and Biocake have always met the standards for agricultural re-use.

3.4.2.10 Odour Control

The following capital projects have been undertaken since the 2005 odour survey:

- Increased headworks odour control capacity;
- New channel covers and odour control units (OCUs);
- New IPS covers and OCU;
- New off-gas compressors for THP system;
- New primary clarifier covers and OCUs;
- Upgraded dryer combustion chambers; and
- New biogas scrubbers upstream of the CHP plant.

Operational improvements have been made and a full-time odour control technician was appointed in early 2007. Odour improvements are discussed in further detail in Chapter 13.

3.4.3 Influent Analysis

3.4.3.1 Current Loading

Influent and effluent characteristics were assessed in the *Design Review Report, CDM, JBB, June 2010*. In this section the results of that assessment are summarised. Analytical data was collected from the operator, Celtic Anglian Water (CAW) and two accredited laboratories, their subcontracted independent one City Analysts and DCC's Central Laboratory.

The peak storm flow to Ringsend is 22.6 m^3/s and storm holding tanks cater for flows in excess of full flow to treatment (FFT), which is 11.1 m^3/s. Storm water holding tanks are also provided at Sutton to cater for severe storm conditions. Design flows are shown in Table 3.3.

Table 3.3 Current Ringsend Design (Source: Tender Documents Vol. 2 Employers Requirements 1998)

Design Flow Basis for Ringsend WwTW year 2020 and ultimate Design Year			
Design Parameter	Estimated 2001 Flows (m^3/s)	Design Year 2020 Average Design (m^3/s)	Ultimate Design Year Average Design (m^3/s)
Dry Weather Flow (DWF)	3.8	4.6	5.5
Average Daily Flow	4.8	5.7	6.9
Full Flow to Treatment (FFT)	11.1	11.1	13.8
Peak Flow	22.6	22.6	23.5

Flows are measured by DCC for Sutton, Dodder Valley and the West Pier Dun Laoghaire pumping stations in addition to the recorded flows at Ringsend WwTW.

Average influent flows have increased continuously since 2003 and the 2008 average daily flow (ADF) rate (470,480 m^3/d) is just over 95 % of the design ADF of 492,480 m^3/d (Table 3.4).

Table 3.4 Measured Flows (m^3/d)

Parameter Period	Average (m^3/day)	95 %ile (m^3/day)	Maximum (m^3/day)
Aug '03-Dec '08	401,881	636,338	1,352,012
2003	330,116	480,267	1,017,421
2004	387,343	601,063	1,352,012
2005	393,205	585,354	991,310
2006	381,316	593,488	922,703
2007	407,154	630,737	1,114,190
2008	470,480	794,244	1,102,283
Design	492,480		

3.4.3.2 Background & Design Load

The current plant was designed to treat a population equivalent (PE) of 1.64 million with 2020 design year average BOD and TSS loads of 98.4 t/d and 101.1 t/d, respectively (Table 3.5). Domestic design average pollutant loads were estimated based on per capita contributions of 60 g BOD/c/d and 75g TSS/c/d, 8g AmmN/c/d, 12g TN/c/d and 3 g TP/c/d (ref: Employers Requirements Design-Build Works 1998).

Table 3.5 Current Ringsend Design (Source: Employers Requirements Design-Build Works 1998)

Design Load Basis for Ringsend WwTW year 2020				
	Estimated 2001 Loads		Design Year 2020	
	Average Load	95 %ile	Average Load	95 %ile
Design Parameter	(kg/d)	(kg/d)	(kg/d)	(kg/d)
BOD	88,300	141,400	98,400	157,600
TSS	89,000	171,000	101,100*	194,300
Ammonia (N)	8,100	10,900	9,500	12,800
Total Nitrogen (TN)	13,600	18,600	15,600	21,400
Total Phosphorus (TP)	3,200	4,800	3,700	5,600

**The final design TSS figure included a unit load of 75g/d/d for the dometic contribution only. Figures for Industrial TSS were based on 60 % of 1991 licensed loads*

3.4.3.3 Measured BOD Load

Since the WwTW was commissioned in 2003, the measured annual average BOD loads to the WwTW have been continuously higher than the Contract 2 2020 design figure of 98.4 t/day (Table 3.6). Further, the 95 percentile load was higher than the stipulated 2020 design load for all years except 2007.

The operational data also indicate a high variability in influent BOD load being received at the WwTW. Figure 3.8 shows the trend in BOD loadings to the WwTW in 2007 along with the 2020 design average values. This figure also illustrates the variability of the incoming load.

The 2008 data also showed periods of high load. The period April-May 2008 was a particularly stressed month on the WwTW. Influent BOD loads to the works averaged 188.3 t/d over a 30-day period. This corresponds to an average of 3.14 million PE for the period or 192 % of the design basis, with a peak daily load of 4.83 million PE.

Table 3.6 BOD Load (t/d)

Parameter	Average	95 %ile	Maximum
Period			
Aug'03-Dec '08*	112.5	168.4	361.5
2003*	111.0	157.3	221.8
2004	118.8	162.8	237.6
2005	117.9	162.3	257.6
2006	117.3	195.1	293.3
2007	101.5	140.3	361.5
2008	107.4	181.7	289.8
Design	98.4	157.6	

**Data for 2003 begins 1st August*

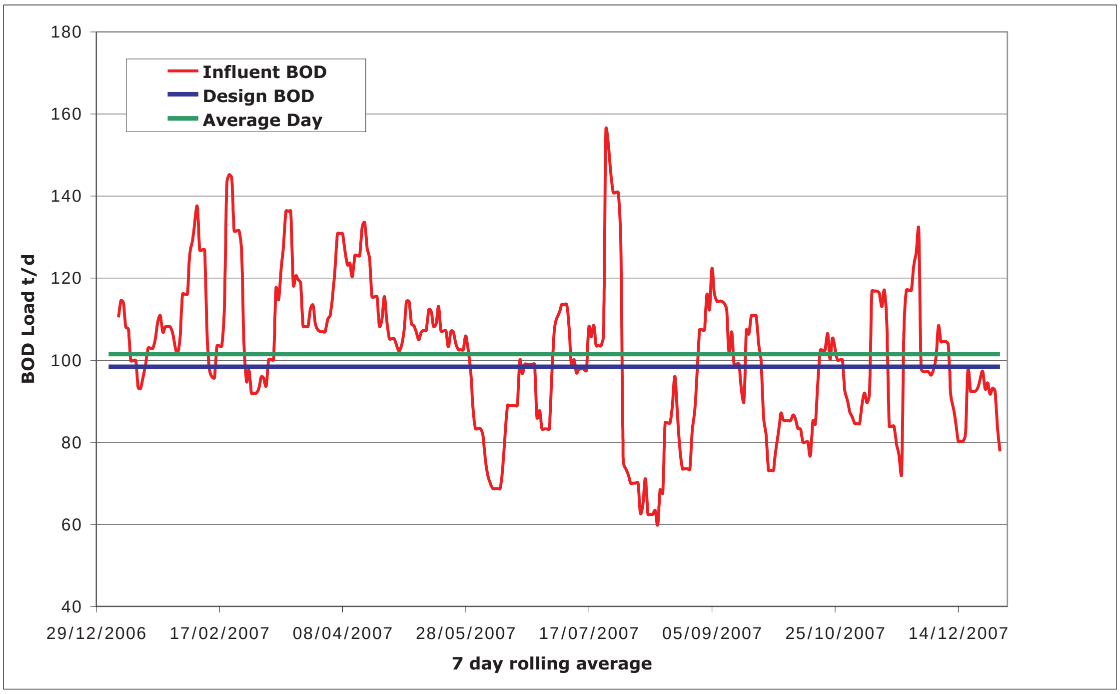


Figure 3.8 Sustained BOD loads received at the WwTW in 2007. BOD(t/d) vs time.

3.4.3.4 Measured TSS Load

Influent TSS loading has increased steadily since 2003 (Table 3.7). The average daily TSS loading in 2008 exceeds the 2020 design year loading and is currently 11 % higher than the design.

Table 3.7 TSS Load (t/d)

Parameter Period	Average	95 %ile	Maximum	Count	Standard Deviation
Aug '03-Dec '08*	99.4	151.2	860.2	1959	45.0
2003	89.8	128.8	211.1	153*	23.7
2004	94.0	135.6	244.4	364	24.3
2005	96.2	142.7	530.7	363	35
2006	96.2	143.3	748.4	365	59.2
2007	102.3	146.7	742.1	352	47.5
2008	112.5	175.5	860.2	364	54.1
Design	**101.1**	**194.3**			

**Data for 2003 begins 1st August*

3.4.3.5 Measured Nutrient Load

The 2008 average total nitrogen (TKN + nitrite + nitrate) loading to the WwTW amounts to approximately 17 t/d. Figure 3.9 illustrates the increasing ammonia and TKN loads to the site from 2003 to 2008. It is noted that from 2005 the TN load has been higher than the 2020 design of 15.6 t/d and since 2006 the ammonia load has exceeded the design figure of 9.5 t/d.

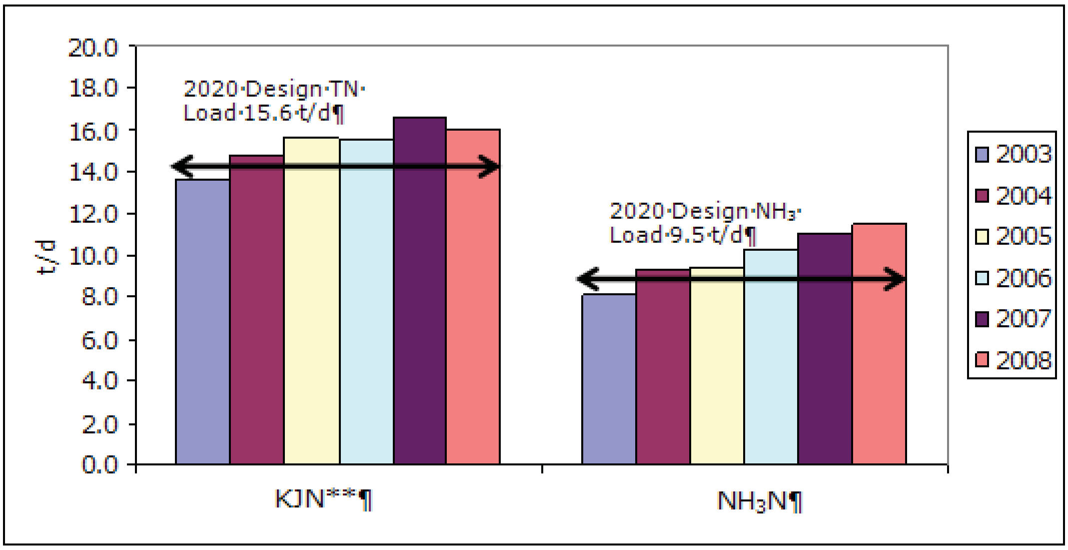


Figure 3.9 Average Nitrogenous Load to the Ringsend WwTW 2003 to 2008

Note: Design load is Total Nitrogen whilst TKN is actually measured in the Influent

The 2020 design phosphorus load for the Ringsend WwTW is 3.7 t/d (5.6 t/d 95 percentile). There is no dedicated phosphorus removal in operation at Ringsend. However, some phosphorus (approximately 35 %) will be removed as a result of sedimentation and biological P uptake and as part of the solids removal process. Table 3.8 shows current influent P concentrations.

Table 3.8 Ringsend WwTW Influent Phosphorus concentrations

	Total P (mg/l)	Reactive P (mg/l)
2005	6.5	3.5
2006	6.4	3.4
2007	5.6	3.5

3.4.4 Effluent Analysis

The works has demonstrated the ability to adequately remove BOD and has often performed exceptionally well under stressed conditions.

Over the period of 1 July 2007 through 31 August 2008, the average effluent BOD concentration was 15 mg/l as compared to the 95 %-ile standard of 25 mg/l. The average BOD removal rate was 93.2 % and 99.2 % of the flow received full secondary treatment. The effluent achieved compliance with the effluent standard of 25 mg/l 90.8 % of the time. While not achieving the required 95 %-ile compliance rate, 69 % (18 of 26) of the exceedances occurred during days on which the influent loadings exceeded the design basis. There were seven days when the effluent exceeded the not-to-exceed limit of 50 mg/l.

TSS removal is not as effective as BOD removal. Over the period of 1 July 2007 through 31 August 2008, the average effluent TSS concentration was 30.1 mg/l as compared to the 95 %-ile standard of 35 mg/l. The average TSS removal rate was 87.8 %. The effluent achieved compliance with the effluent standard of 35 mg/l 81.4 % of the time. There were seventeen days when the effluent exceeded the not-to-exceed limit of 87.5 mg/l. These exceedances correlate better with high influent loading than with high inflow, with fifteen days exceeding the design average influent TSS loading and eight days in which the inflow exceeded the design ADF. There were seven days in which both the design influent flow and TSS loading parameters were exceeded.

During the high load period of April-May 2008, the effluent averaged 35.6 mg/L, with 13 exceedances of the 35 mg/l standard. During the high flow period in August 2008, the effluent averaged 18.6 mg/l and there was only one exceedance of the 95 %-ile standard. The average removal rate was 90.0 %. During the stressed months it again appears that influent loading has a greater influence on effluent quality that influent flow.

In 2007, effluent Total-N and NH_3-N averaged 22.1 mg/l and 4.6 mg/l, respectively. The works is reliably achieving its ammonia limit of 18.75 mg/l as required by the Contract between DCC and CAW. The works is not currently meeting the 10 mg/l Total-N Urban Waste Water Treatment (UWWT) limit for Nutrient Sensitive Waters.

In 2007, the effluent contained an average of 3.6 mg/l TP. The UWWT limit is 1.0 mg/l. There is no requirement in the Contract between DCC and CAW to remove P.

Disinfection is carried out during the bathing season from 1 May through 31 August, annually. During this period, the standard is 100,000 faecal coliforms per 100 ml (FC/100 ml) and 80 % compliance must be achieved over an 8-week rolling average. Both laboratories performing bacteriological analyses for the works (i.e., Central Labs for DCC and City Analysts Ltd. for CAW) had difficulty providing reliable and reproducible faecal coliform results. Discussions centred on the appropriate bacteriological standard took place in 2006 between senior microbiologists from both labs, DCC and CAW. Water-quality studies indicating excellent correlation between *Escherichi coliform (E. coli)* and faecal coliform were cited. It was also noted that in 1986, the U.S. Environmental Protection Agency (USEPA) recommended that *E. coli* be used in place of faecal coliform bacteria in State recreational water-quality standards as an indicator of faecal contamination. As a result of these discussions, DCC and CAW agreed to monitor E.coli instead of faecal coliforms from 1 May 2006 forward. Since that time, the WwTW has always been in compliance with the revised standard.

Chapter 4 The Proposed Scheme

4.1 Proposed Treatment Capacity

The overriding purpose of this project is to extend the capacity of the existing works to the maximum achievable within the existing site and to achieve the required discharge standards. Open space within the site boundaries is extremely limited to one contiguous area of approximately 0.8 hectares and a few much smaller parcels that are not contiguous with the larger parcel. DCC recognised at the outset of the project that the extension would be limited by open space and then further limited by the facility's discharge licence which was received after the project had begun.

Under its Wastewater Discharge Licence, the Ringsend WwTW must comply with effluent BOD and TSS limits at a 95th percentile compliance rate. Even with 100% of treatment capacity available, there will be days on which effluent limits will not be met owing to a number of factors, the variation in loading to the process being the primary one. The Environmental Protection Agency recognises this and allows for 5% non-compliance. This compliance rate leaves little room for error and requires that sufficient processing capacity is always available to meet the demands. Thus, wastewater treatment facilities are designed to have some redundant capacity installed in order to allow for maintenance and repairs while achieving permitted limits. The capacity of a process that can be achieved with the largest processing unit out of service is defined as "firm" capacity.

The sequencing batch reactors (SBRs) represent the limiting process to Ringsend's treatment capacity.

There are a total of 24 sequencing SBRs installed and they are intended to function in six trains of four basins each. When one basin is out of service, all four basins in that train are out of service and the SBR's overall treatment capacity is reduced by 1/6th.

As now proposed each of the six SBR trains, when operated in a BOD removal mode, would have a capacity of 333,000 PE. With one SBR stream out of service, the firm capacity of the proposed works will be 2.067 million PE, (i.e. 5 no. SBR trains at 333,0000 PE plus 400,000 PE expansion) - which is rounded to 2.1 million PE. With all streams in service the capacity would be 2.4 million PE.

The facilities will be designed for the ultimate capacity of 2.4 million PE in order to guarantee that a capacity of 2.1 million PE is always available.

4.2 Projected Loading

Projected loadings to the Ringsend WwTW arise from residential, commercial, institutional and industrial sources. Commercial and institutional loadings have proven difficult to estimate and it has been assumed that these components of the influent loadings will increase in proportion to the residential loadings. The accuracy of industrial loadings is thought to be very good since the users are metered and their effluent quality is monitored.

4.2.1 Residential Load Projection

The baseline for domestic populations is the 2006 Census data. The most recent publication from the Central Statistics Office (CSO) '*Regional Population Projections 2011-2016*' (Dec 2008), indicate some variations in recent population trends and project the population for the Dublin Area using a number of different scenarios. These projections are based on future trends in fertility, mortality, migration (international & internal).

For the Dublin area, the following population projections have been provided in Table 4.1. Targets from the National Spatial Strategy are also included for comparison.

Table 4.1 CSO Population Projections for Dublin (population in thousands) (ref: CSO Regional Population Projections 4th Dec 2008)

Scenario	2006	2011	2016	2021	2026	Annual Average Increase %
M2F1 Recent	1,183	1,279	1,345	1,380	1,365	0.7
M2F1 Traditional	1,183	1,302	1,464	1,563	1,659	1.7
M0F1 Recent	1,183	1,178	1,164	1,132	1,080	-0.5
M0F1 Traditional	1,183	1,199	1,246	1,298	1,343	0.6
NSS Target*	1,183			1,484		

**The National Spatial Strategy: The DECLG is responsible for the implementation of the National Spatial Strategy (NSS) which is aimed at promoting more balanced regional development and harnessing the potential of all regions.*

The economic landscape has altered markedly in recent years and recent publications from the DECLG and the CSO have taken account of this. However the focus in the Regional Planning Guidelines remains on development and balanced growth in gateway cores like Dublin City and as such the projections for the Ringsend WwTW should be consistent with these plans.

Taking populations targets from the 2010 regional planning guidelines for Dublin City, Dun Laoghaire-Rathdown, Fingal and South Dublin the following population projections for the Ringsend Catchment for the year 2025 are made (Table 4.2).

Table 4.2 2025 Projected Residential Population

	2006	2025	Annual Average Increase %
Dublin City	506,211	626,924	1.13
Greater Suburbs	539,558	708,853	1.45*
Others	20,542	27,156	1.48**
Total	1,066,311	1,362,933	

**Average growth rate for Dun Laoghaire-Rathdown, Fingal and South Dublin*
*** Average growth rate for Greater Dublin Area*

4.2.2 Industrial Load Projection

Given the current economic situation both nationally and internationally, it is likely that the industrial load will decrease, in the short term at least. It is also policy within DCC for new and amended trade licence applications to reduce permitted industrial discharges to domestic strength.

Although the current strategy within the Local Authorities is to reduce the licensed industrial PE load to Ringsend, there is currently significantly more PE licensed than is actually used. It is prudent to look at the actual allocation and consider the total loadings if licence holders increased their discharges to that stated in their discharge licences. It is equally prudent to plan for the inclusion of future industrial development in the catchment.

It is proposed that allowance should be made for new controlled industrial development in the Ringsend catchment and that an allocation significantly higher than that currently measured (i.e., 233,853 PE) should be provided. It is proposed to include a figure of 400,000 for industrial PE loads for the year 2025. This allocation is approximately 70 % higher than that currently measured by the four Local Authorities and represents an annual average growth of 3.2 % in this sector.

4.2.3 Total PE Projections

Central Statistics Office (CSO) studies (Dec '08), discussed in Section 4.2.1 have shown a wide variation in regional population growth rates due to recent patterns of internal migration. Based on this and with reference to the projections in the Regional Planning Guidelines for the Greater Dublin Area 2010-2022 (DRA, 2010), high (1.4% per annum) and low (0.7% per annum) growth rates scenarios can be considered for the Ringsend catchment.

In the past four years, the loadings to the WwTW have been stable at approximately 1.8 million PE as shown in Table 5.3. A PE of 1.8 million is adopted as the 2012 baseline.

Table 4.3 Measured Loads to Ringsend WwTW

Year	Load (millions)
2008	1.79 PE
2009	1.74 PE
2010	1.81 PE
2011	1.74 PE

The 2012 baseline PE was projected forward using (i) high and low population growth rates for domestic and non-domestic loads and (ii) an industrial allowance of 400,000 PE.

At the high growth rate, the design capacity of 2.1 million PE would be reached in 2020 and at the lower growth rate it would be reached in 2023.

The Greater Dublin Drainage (GDD) project proposes to divert some of the loadings from the Ringsend catchment to a new Regional WWTP. Whilst the final catchment loadings to be diverted have not yet been finalised, following discussion with Fingal County Council and the GDD team it may be assumed that approximately 600,000 PE would be diverted in two stages. The first diversion of approximately 300,000 PE would take place in 2020 and a second diversion also of 300,000 PE would take place in 2030. According to the GDD team, this latter diversion may be moved forward in time if loadings to the Ringsend WwTW so dictate. These represent very significant reductions in loadings.

Figure 4.1 compares the projected loadings to the proposed Ringsend WwTW capacity.

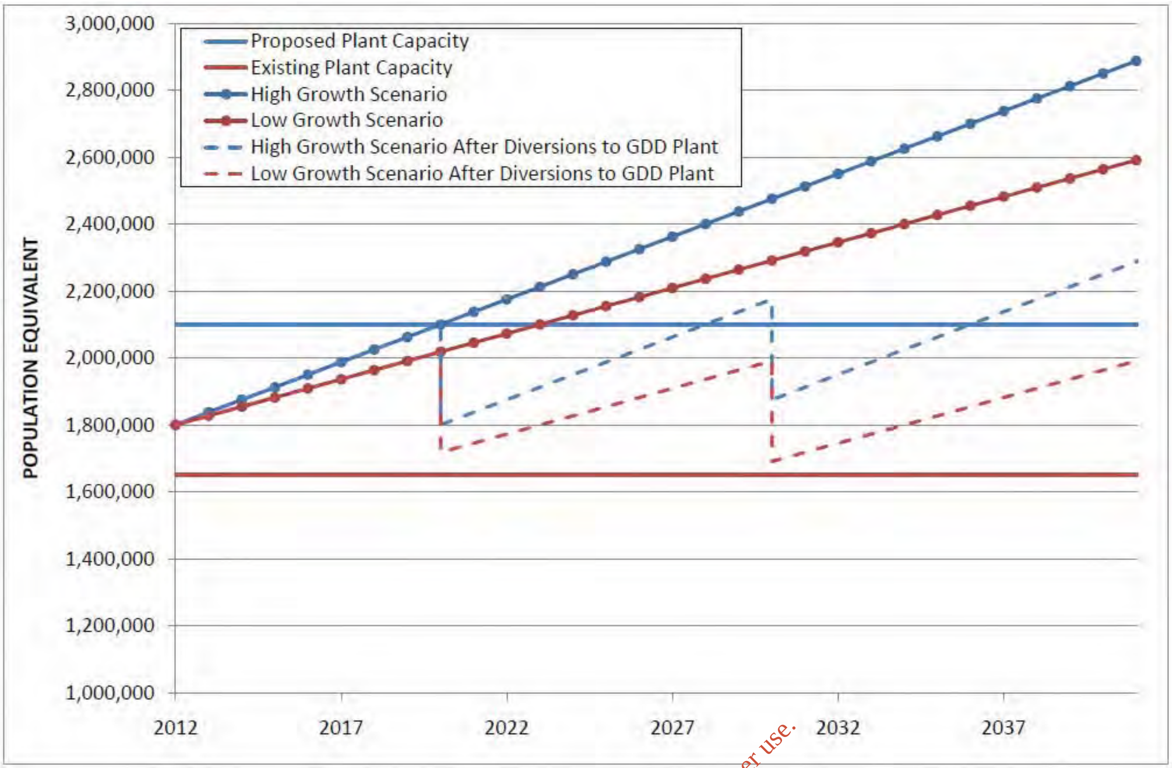


Figure 4.1 Loading Projections for the Ringsend WwTW using high and low growth rate scenarios

Figure 4.1 displays two growth rate scenarios unabated and as a result of the two diversions planned for the proposed North Dublin Regional WwTP.

The first diversion would extend Ringsend's firm capacity to 2028 at the high growth rate or 2034 at the low growth rate. The second diversion would further extend Ringsend's firm capacity to year 2036 or 2045, for high and low growth rates, respectively. The WwTW may become biologically overloaded between 2029 and 2030 if the higher growth rate is realised. If this growth rate and related overloading occurs, DCC would request that Fingal County Council advance the second major diversion. At the lower growth rate, the WwTW would always have sufficient firm capacity through 2045.

The typical planning horizon for wastewater treatment facilities is 20 years. If the Ringsend extension is completed in 2015, as estimated, the planning horizon would reach 2035. The planned diversions are critical to provide the facilities necessary for a 20-year planning horizon.

4.2.4 Proposed Design Load

The original design for the Ringsend WwTW included for an Ultimate Design year flow and load (Table 4.4). The contractor was required to design the preliminary works and the intermediate pumping station for the ultimate flow, but constructed and equipped for the 2020 peak flow. The facility had to be designed to be enlarged to cater for the Ultimate Design Peak Flow of 23.5 m^3/s without detriment to or interference with, the normal operation of the Works. For the Ultimate Design Year, the maximum design full flow to treatment was stated to be 13.8 m^3/s.

Table 4.4 Ultimate Design Load (Source: Employer's Requirements Design Build Tender Documents 1998)

	Ultimate Design Year	
	Average Design	Indicative 95 %ile Load
DWF (m^3/s)	5.5	-
Average Flow (m^3/s)	6.9	-
FFT (m^3/s)	13.8	-
Peak Flow (m^3/s)	23.5	-
BOD (kg/d)	114,300	182,900
TSS (kg/d)	115,400	221,700
Amm.N (kg/d)	10,700	14,500
TN (kg/d)	16,800	23,000
TP (kg/d)	4,100	6,300

Based on the above BOD loads, the Ultimate Design PE was calculated to be 1,905,000 PE with a 95 percentile peak of 3,048,333 PE.

As previously noted, a design basis of 2.4 million PE is required to meet a firm capacity of 2.1 million PE. Table 4.5 tabulates the Design Basis using the following unit loads, 60 g BOD/c/d; 62 g TSS /c/d; 10 g TKN /c/d; 7 g AmmN /c/d; and TP 1.8 g/c/d. A maximum week peaking factor of 1.5 is applied to the average daily loadings. This peaking factor was derived by examining 7-day rolling averages for BOD and TSS over an extended period.

Table 4.5 Proposed Design Basis

	Average Design	Peak Design*
PE	2.4 million	3.6 million
Average Daily Flow (m^3/d)	601,000	-
Average Daily Flow (m^3/s)	6.96	
Dry Weather Flow (m^3/s)	5.57	
Full Flow to Treatment (m^3/s)	13.8	-
Peak Flow (m^3/s)	23.5	-
BOD (kg/d)	144,000	216,000
TSS (kg/d)	148,800	223,200
Ammonia (N) (kg/d)	16,800	25,200
Total Kjedahl Nitrogen (kg/d)	24,000	36,000
Total Phosphorus (kg/d)	4,300	6,500

**Based on the maximum weekly load to the WwTW (or 1.5 times average)*

4.2.5 Conclusions

The Proposed design bases outlined in Table 4.5 are based on a number of assumptions:

- Domestic and non-domestic (excluding industrial) growth rate of 1.4 % consistent with projections in the recent Regional Planning Guidelines for the Greater Dublin Area 2010-2022.;
- Projections were carried out using the 2012 baseline influent WwTW load of 1.8 million PE; and
- An allocation of 400,000 PE for industrial load in the year 2025.

Diversions of some of the loadings within the Ringsend catchment to the proposed North Dublin Regional WwTP are necessary to achieve a 20 year design horizon to year 2035.

Table 4.6 summarises the basis of design for the extension in comparison to that for the current Works.

Treated effluent 95th Percentile Compliance values and Not-to-be-Exceeded values listed in this table are consistent with those in the current EPA Operating Licence. There is no assurance that these values would apply to the Extended Works. Any sea discharge location chosen would fall outside of waters designated as sensitive, and therefore, outside the areas with specified limits placed on forms of phosphorus, nitrogen (including ammonia), or coliform bacteria in the treated effluent.

Table 4.6 Basis of Design

Description	Current	Extended
Average Daily Flow	5.7 m^3/sec	7.0 m^3/sec
Flow to Full Treatment	11.1 m^3/sec	13.8 m^3/sec
Peak Instantaneous Flow	22.6 m^3/sec	23.5 m^3/sec
Influent BOD load		
Average	98,400 kg/day	144,000 kg/day
Max Week		216,000 kg/day
Effluent BOD		
95th Percentile	25 mg/L	25 mg/L
Not to be Exceeded	50 mg/L	50 mg/L
Effluent COD		
95th Percentile	125 mg/L	125 mg/L
Not to be Exceeded	250 mg/L	250 mg/L
Influent TSS load		
Average	101,100 kg/day	148,800 kg/day
Max Week		223,200 kg/day
Effluent TSS		
95th Percentile	35 mg/L	35 mg/L
Not to be Exceeded	87.5 mg/L	87.5 mg/L
Influent Nitrogen load		
Total Kjeldahl N - Average	15,600 kg/day	24,000 kg/day
Total Kjeldahl N - Max Week		36,000 kg/day
Ammonia N - Average	9,500 kg/day	16,800 kg/day
Ammonia N - Max Week		25,200 kg/day
Influent Total Phosphorus		
Average	3,700 kg/day	4,300 kg/day
Max Week		6,500 kg/day
Effluent Bacteria[1]		
80th Percentile	100,000 FC/ml	Not required
Stormwater Bacteria		
95th Percentile	3,000,000 FC/ml	3,000,000 FC/ml
Sludge Loading[2]		
Annual Average	110 tDS/d	151 tDS/d
Maximum Monthly	154 tDS/d	212 tDS/d
Sludge Loading[2]		
Annual Average	3,730 m^3/d	5,100 m^3/d
Maximum Monthly	5,220 m^3/d	7,150 m^3/d

1..During Bathing Water Season only
2 Primary + TSAS.

4.3 Upgrades to the WwTW (2005-2011) and Immediate Improvements

There have been a number of modifications to the Works subsequent to the taking over of Contract No. 2 separate to the WwTW extension. Most of these modifications were related to odour control and solids processing, with little direct impact on wastewater treatment capacity. There is also an ongoing programme of operational improvements referred to here as Immediate Upgrades that addresses effluent TSS deficiencies and complete the odour control programme. These works are currently underway and are not part of this environmental impact assessment. The details of these immediate upgrades are provided for information and completeness. A plan of these operational improvements is shown in Figure 4.4.

4.3.1 TSS Compliance

Prior to the issue of a Wastewater Discharge Licence, the EPA sought accelerated compliance with the EU Standard for effluent TSS. The current recommendation for TSS compliance is to:

- Install covers on the upper level of the Sequencing Batch Reactors (SBRs) to reduce wind effects, thereby improving sedimentation, and
- Install effluent fine screens for a portion of the flow, so that when blended with unscreened flow will achieve a 95 %-ile compliance level of 35 mg/L. The proposed location for effluent fine screens is adjacent to the east side of the SBRs. If this is considered to be infeasible the fine screens could be located at grade to the northeast of the SBRs.

Figure 4.2 shows the installation of floating covers being installed in a large diameter basin. This is one type of cover being considered for the Ringsend SBRs.

Both of these improvements are spatially separated from all other recommended improvements and should present minimal impacts on the Works' operations.

4.3.2 Odour Control

As mentioned above, a programme of odour control improvements has been ongoing since 2005. The elements of this programme of improvements that are currently scheduled for completion are the:

- Capture and treatment of the ventilation air from both dryer buildings;
- Provision of 50 % additional capacity for the main odour control unit;
- Capture and treatment of the ventilation air from the Screenings Building; and
- Enclosure and provision of odour control for the grit storage skips.

Figure 4.2 Example of covers for SBRs (source: Lemna Technologies Inc.)

4.4 Description of the Proposed Project

4.4.1 Introduction

As set out in Chapter 5 the recommended option for the Ringsend WwTW is the provision of secondary treatment with a long sea outfall. This section describes the elements of the proposed WwTW extension project.

Contractors will be appointed to design and build the WwTW extension to achieve the required design standards listed in Table 4.6, within defined design constraints. Therefore, the exact details regarding the design of the development and processes to be used are not available at this stage. Nevertheless an indicative design has been undertaken in order to assess the environmental impacts of the proposed project. Where different treatment processes are possible, the worst case scenario is assessed with respect to the potential impact of the design.

These will be described under the following headings:

- Upgrades on the existing WwTW site;
- Construction of an effluent outfall tunnel extension commencing at the Eastern tip of the Poolbeg Peninsula; and
- Road network improvements in vicinity of site (construction phase).

Figure 4.3 shows the location of the Ringsend WwTW site and the tunnel construction compound.

Figure 4.3 Ringsend WwTW and Tunnel Compound Site Locations

4.4.2 Extension to the Existing WwTW Site

There will be some onsite upgrades to the WwTW at the current site: the existing treatment process will be operated in slightly different mode and some facilities would be added to further improve effluent within the current site footprint. Much of the current unused space is proposed to be utilised for development of the treatment processes and equipment, in accordance with the original plan for the works.

Additional secondary treatment capacity of 0.4 million PE is proposed to be constructed on the 0.8 hectare open space on the site. There are three likely design options for efficient utilisation of the area reserved on the WwTW site for expansion:

- Sequencing batch reactors with effluent filters
- Deep shaft aeration with flotation clarifiers; or
- Conventional activated sludge with final clarifiers.

A fifth anaerobic digester and centrifuge is proposed adjacent to the existing digesters, however, construction will be deferred until such time as solids loading demands them. An aerial view of the digesters can be seen in Figure 3.7. No structure will be higher than the existing SBR tanks and Figure 4.5 shows a rendering of a deep shaft system with accompanying dissolved air flotation clarifiers as it could be configured on the 0.8 hectare site. Further information on the external appearance of the clarifiers or SBR tanks is included in Chapter 11 Landscape and Visual.

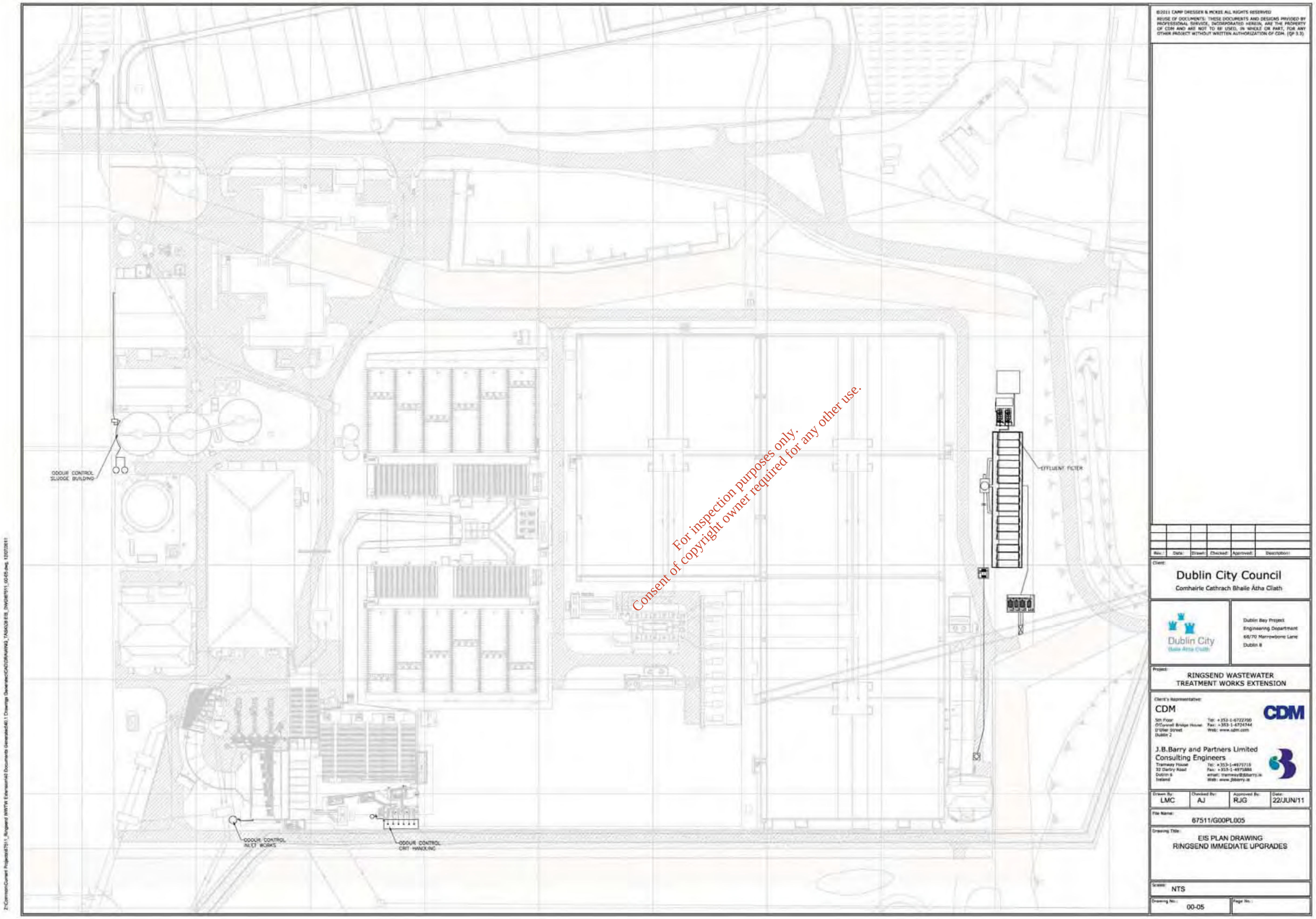


Figure 4.4 Operational Odour Improvements at Ringsend WwTW – Location of Effluent Filters and Odour Control for Sludge Building, Inlet Works and Grit Handling.

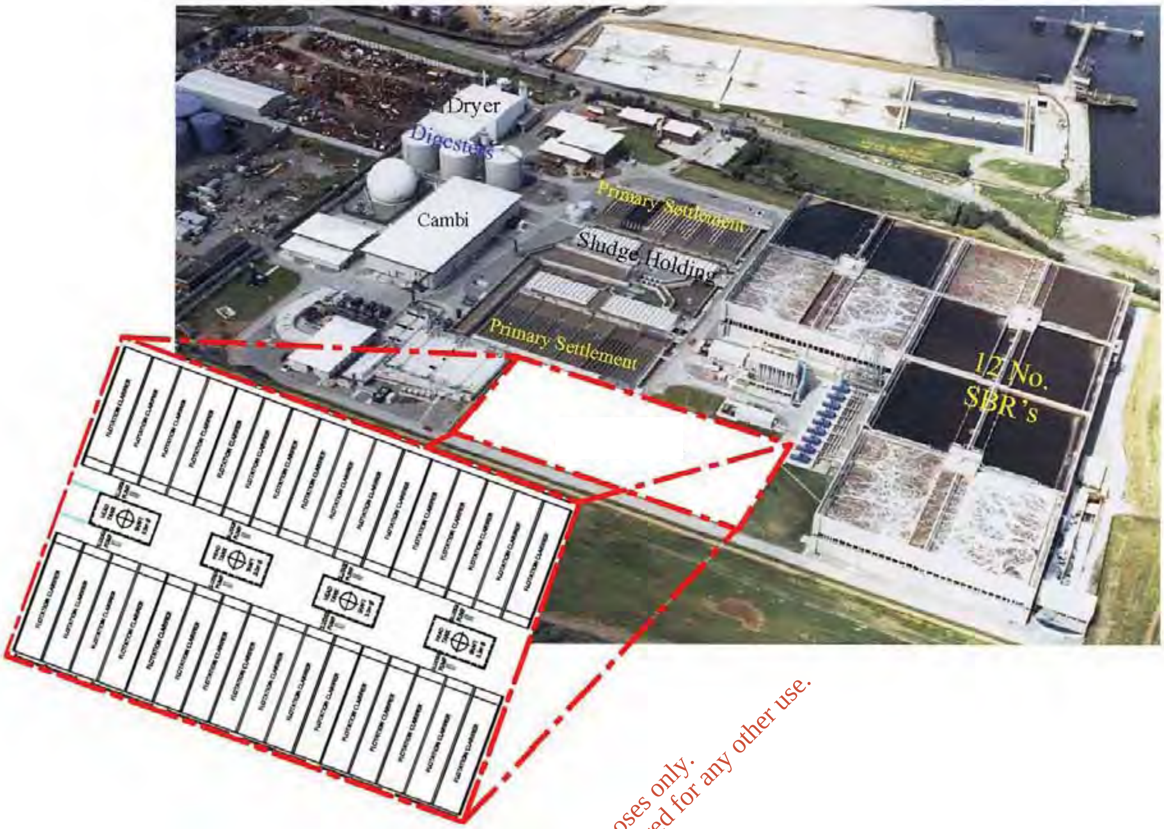


Figure 4.5 Rendering of Deep Shaft System as it could be configured onsite

4.4.3 Effluent Outfall Tunnel Extension

4.4.3.1 Construction Compound

The area selected for the construction compound is shown on Figure 4.6. Figure 4.6 also shows an indicative layout for the construction works operation. The layout will be finalised by the successful contractor. . The available site area for use as a construction compound is approximately 250 m x 90 m in size. The site is bounded on the south and east by an earth berm approximately 2 m high and abuts the ESB site on the other two sides. The existing effluent outfall culvert runs between the berm and the Pigeon House Road to the discharge location in the Liffey Estuary.

The principal construction items to be accommodated on the site will include:

- The tunnel inlet shaft (to remain post construction);
- Mobile crane;
- Materials storage area (e.g. for pipes, segments, rails, oils, lubricants, timber, fuel);
- Spoil handling facility;
- Slurry separation plant and settlement tanks (if a diaphragm wall is constructed);
- Grout batching plant;
- Electricity supply substation;
- Generators;
- Wheel washing facility;
- Offices;
- Stores;
- Workshop;
- Welfare facilities;

- Canteen; and
- Car parking area.

The spoil handling facility should be sufficient to hold a minimum of two days worth of spoil output as it will not be possible to operate the spoil disposal transport operation on a 24/7 basis.

There will be a portion of the construction compound required for a slurry separation plant to separate the spoil from the slurry to enable the reuse of the slurry.

HGV movements during construction will be separated from smaller/ private vehicles where possible and dedicated walkways provided to separate vehicle and pedestrian movements. A one way system for HGV movements will be put in place.

If the tunnel inlet shaft is constructed using diaphragm walls, then lagoons or a series of tanks will be needed for handling displaced bentonite slurry. A series of tanks, typically 18 m diameter, is usual to contain different slurry mixes. These large tanks and construction plant such as the crane will require engineered foundations.

A potable water supply will be required for the site.

Site drainage should preferably be provided for separate surface and foul water. Petrol interceptors will be required in the surface water system for run-off from hard standing areas. Surface water discharge ideally will be to a sewer. Foul sewage will be tankered offsite, discharged to a pumped sewer line or a septic tank.

Fire and emergency points should be located at appropriate points on the site.

Lighting plans will be required for the construction compound.

Figure 4.6 shows the area of earth berm and trees that will be removed during the construction phase to accommodate the works and allow for the two new permanent access points. The existing external site boundary fence line will be retained during construction, except for the inclusion of the two proposed permanent access locations. Secure hoarding or fencing will be required around the site perimeter.

Following construction the construction compound and equipment will be decommissioned. The earth berm and trees will be reinstated. The tunnel inlet shaft will be capped and the site cleared as indicated in Figure 4.7.

4.4.3.2 Site Access

Access to the site is as shown in Figure 4.13 at the southwest and northeast of the site and is discussed further in Section 12.4.2. Reinforcement of the existing effluent outfall culvert may be required at these points in order to carry HGV loads.

A permanent works compound area will be required post construction to provide access to the tunnel inlet shaft as shown in Figure 4.7. This access will be provided by the most easterly of the two proposed access points.

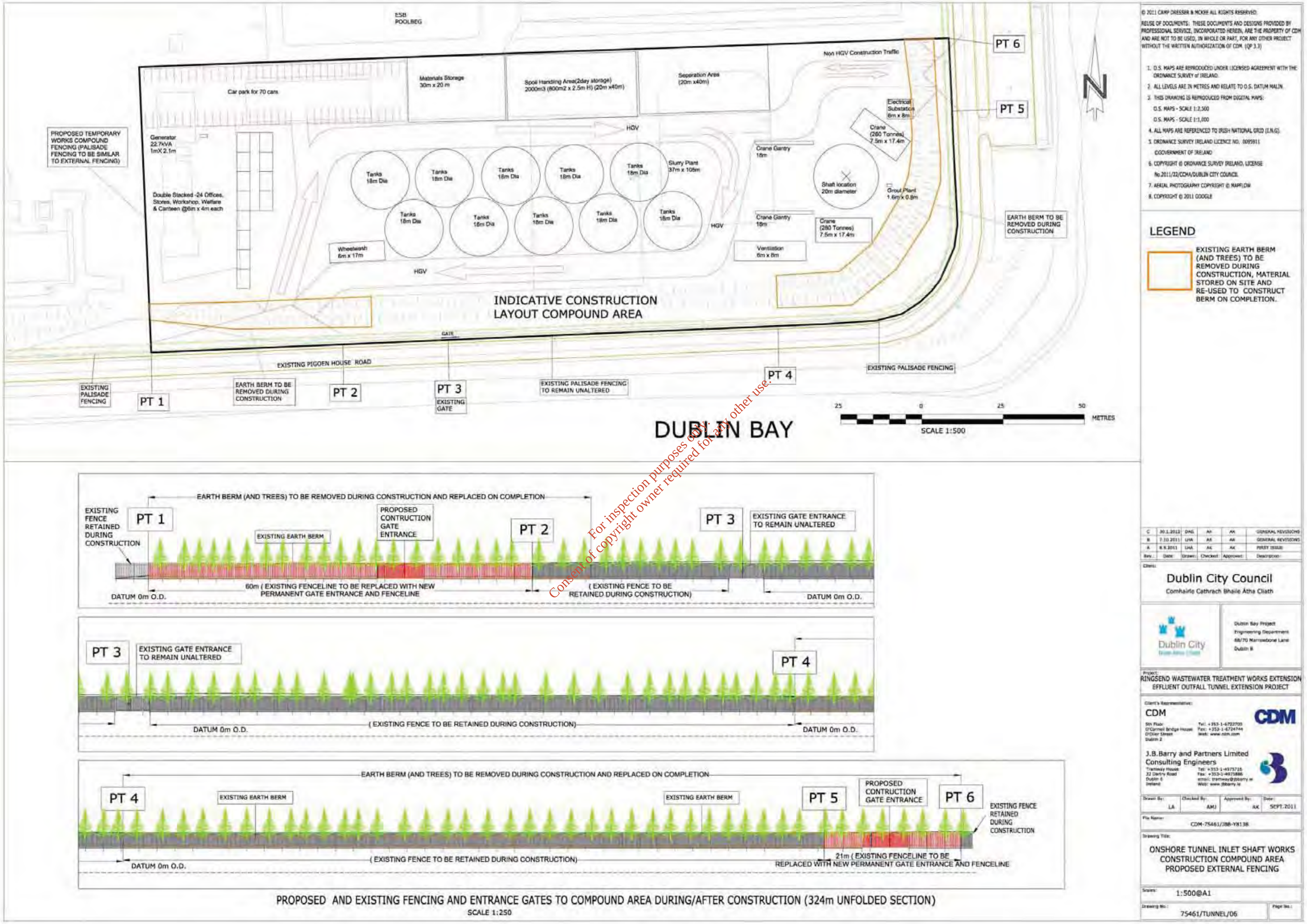


Figure 4.6 Tunnel Inlet Shaft Compound – Indicative Construction Layout

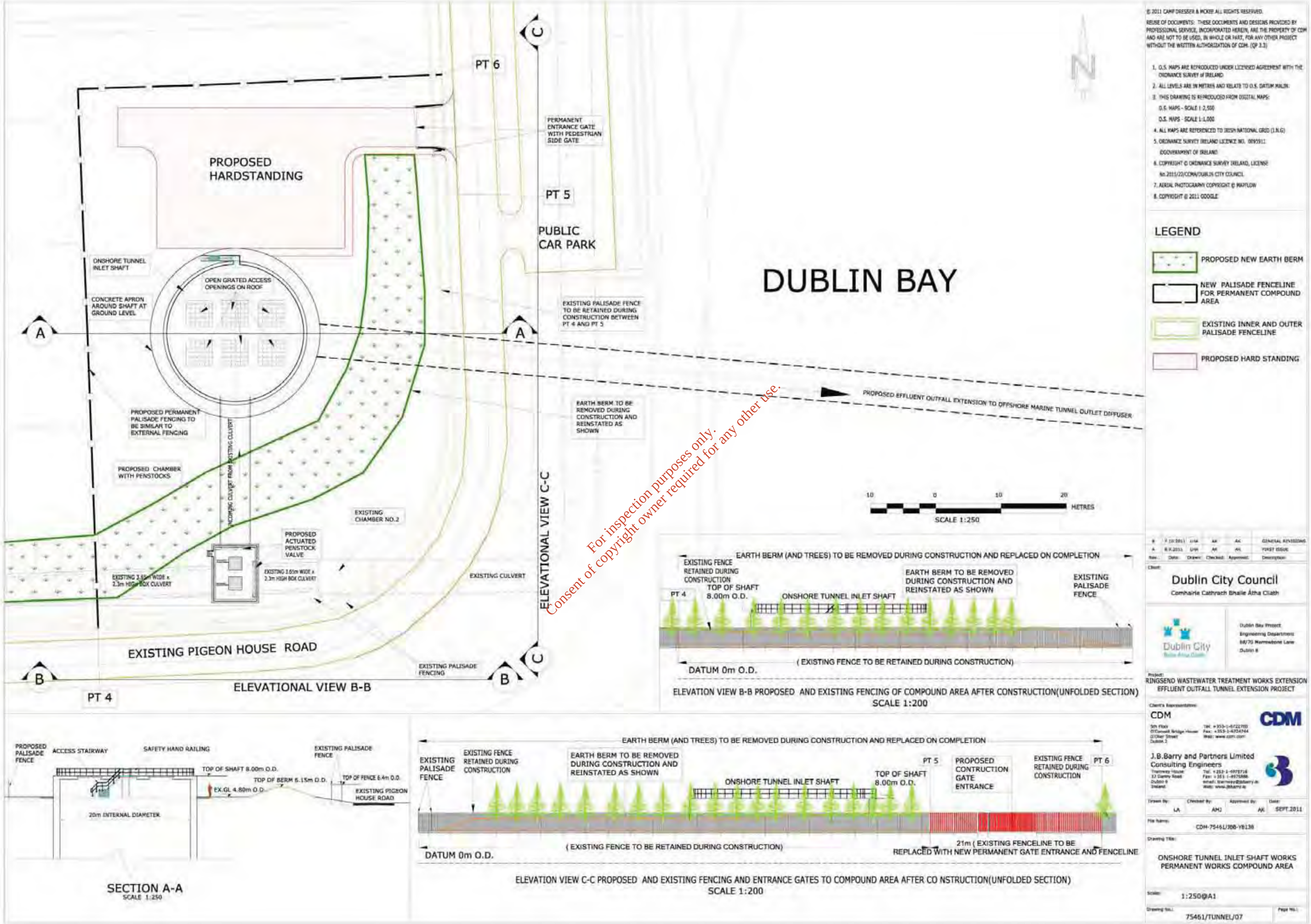


Figure 4.7 Tunnel Inlet Shaft Compound – Indicative Final Layout

4.4.3.3 Onshore Tunnel Inlet Shaft

General

An inlet shaft will be constructed onshore on the Poolbeg Peninsula. The estimated finished internal diameter of the tunnel inlet shaft could be as high as 20 m but may be smaller depending upon the eventual tunnelling construction technique adopted. Therefore the maximum total excavated external diameter is estimated to be 22.5 m or less. Based on a preliminary conceptual design (CDM/JBB, 2011), the tunnel inlet shaft invert is likely to be somewhere between 66 m and 110 m below existing ground level. The final selected depth will depend on a combination of the vertical alignment selected for the tunnel section and geotechnical considerations made by the contractor.

The tunnel excavation operation will commence from the tunnel inlet shaft. The inlet shaft will be used to service the tunnel with equipment and material requirements for the duration of the project. Spoil and slurry waste from tunnel construction will be brought to the surface through the inlet shaft. Therefore the tunnel inlet shaft will be designed for three purposes:

- Temporarily use as launch pit for tunnelling operations and access to tunnel during tunnel construction stage, i.e the onshore shaft construction must guarantee a safe working environment;
- Temporary use as a connection chamber to make final connections to offshore diffuser shaft; and
- Permanent use as conveyance pipe for WwTW final treated effluent.

Onshore Tunnel Inlet Shaft Construction Techniques

The tunnel inlet shaft sinking and lining construction methods will be governed by contractor preference, the depth of the overburden and the requirement to prevent ingress of groundwater. The construction of the inlet shaft and its excavation are strongly interlinked. For the inlet shaft to be sunk in permeable ground conditions, the first things to decide are both how to keep the shaft dewatered and provide ground support during construction. In general a diaphragm wall is used and there are two options:

- Dewatering of the shaft by drawdown of the groundwater table during the construction phase. Use of a retaining wall system as ground support.

- Application of an impermeable vertical and horizontal shaft lining or lowering the permeability of the ground by grouting (Ground freezing could be applied also). Use of a retaining wall system as ground support. Vertical impermeable lining and retaining wall are normally combined.

The tunnel inlet shaft wall structural and shaft lining design will be governed by the contractor's choice of construction technique and preferences - both of which will be heavily influenced by existing geotechnical, geological and hydrogeological conditions at the proposed shaft location. The selection of shaft construction technique, structural design and shaft lining design, should, therefore, be left to the contractor.

Onshore Tunnel Shaft Permanent Compound Area

Figure 4.7 shows an indicative plan and cross section what the completed tunnel inlet shaft will look like during the operational phase, when it will be used as a permanent conveyance pipe for the WwTW final treated effluent.

There will be a new palisade fence line surrounding the tunnel inlet shaft compound area and a permanent access gate at the east of the site. The section of the earth berm that was removed during the construction phase will be reinstated as demonstrated in Figure 4.7.

4.4.3.4 Tunnelled Section

General

The tunnelled section will be approximately 9,000 m long with a finished internal diameter of about 5.0 m. The tunnelled section will run between the base of the tunnel inlet shaft (located onshore) and the base of the tunnel outlet riser diffuser shaft (located 9,000 m offshore) in marine water depths (to seabed) of greater than 25 m below Lowest Astronomical Tide (LAT). The tunnel drive will commence at the tunnel inlet shaft and excavate eastwards towards the diffuser shaft.

Hydraulic Performance Parameters

The basic hydraulic design parameters for the tunnel section are:

- Average daily flow: 7 m^3/s
- Maximum design velocity: 0.7 m/s (preferred)
- Maximum daily flow: 13.8 m^3/s

Conceptual Vertical Alignment Considerations

The marine site investigation results show that tunnelling in deeper bedrock offers the best conditions for tunnelling because the bedrock is mostly stable for the tunnel diameter being considered and of low permeability i.e., it is likely that the major part of the tunnel can be advanced without active face support. The marine site investigation borings show the bedrock to be weathered / fractured over the top 5 – 10 m. So in accordance with tunnel design practice it was recommended that the top of the tunnel should be kept twice the excavated diameter (= 13 m approx) below rockhead in good/fair rock quality conditions and three times the diameter (= 19.5 m approx) in poor conditions such as those encountered onshore where the tunnel inlet shaft is proposed to be located.

The marine site investigation shows that the top of the bedrock is very uneven. The top of the bedrock has been inferred and is shown on Figure 4.10.

A conceptual vertical tunnel alignment based on CDM's preliminary conceptual design work is also shown Figure 4.10. It should be noted that the vertical alignment indicated on Figure 4.10 is purely conceptual in nature and was developed to provide only a proof of concept for the tunnel.The final constructed tunnel vertical alignment will differ from that shown and will be based upon the design proposed by the successful contractor. It is expected that the final tunnel vertical alignment design offered by the successful contractor will be in the bedrock but at elevations deeper than those but with elevations no deeper than 110m below OD Malin.

Tunneling Method

The tunnel will be constructed using a tunnel boring machine (TBM). These machines not only undertake the excavation of the ground, they mostly also provide support to the ground (tunnel face support and all round shield support for operatives) during tunnelling. This support can be just peripheral (like in the case of shield TBMs) or also be applied to the front (Earth pressure TBMs or Slurry Shields for instance). The final tunnel lining will be constructed using precast concrete elements which are assembled and installed directly by the TBM. Tunnel driving control facilities, accommodation, toilets, electric power facilities, emergency facilities, air supply, tunnel segments erector, etc. are all part of the TBM machine and located close to the extraction chamber.

The TBM is designed to suit the lining and so design responsibility rests with the contractor under a Design Build contract. To overcome potential water inflow to the tunnel and/or potential unstable ground conditions (which cannot be excluded) only a shielded TBM should be considered. A shielded TBM with active face support is applied if the tunnel face is not stable and if rock collapse may occur. The shield skin, which covers the entire machine, serves as a temporary support. As final support, usually pre-cast lining segments of reinforced concrete are used. The lining segments are installed under the protection of the rear part of the shield, the so-called tail-skin. A face support using a slurry (slurry TBM) or an earth mud (Earth pressure balanced shield, EPBS), or a combined machine is normally applied. These methods are described below.

- **Slurry TBM** – Slurry shields are TBMs fitted with a full face cutterhead which provides face support by pressurising fluid ("Slurry") inside the cutterhead chamber. The cutterhead acts as the means of excavation, whereas face support is provided by slurry counterpressure, namely a suspension of bentonite or a clay and water mix (slurry).
- **Earth Pressure Balanced Shield TBM (EPBS)** – EPBS are TBMs used for the excavation of soils where face support and counter-effect of ground water pressure is obtained by means of the material excavated by the cutting wheel, which serves as support medium itself. The cutterhead serves as the means of excavation whereas face support is provided by the excavated earth which is kept under pressure inside the excavation chamber by the thrust jacks on the shield.

The slurry is a mixture of water and bentonite, a smectite clay mineral. Some additives improving certain properties of the slurry can also be applied. The main purpose of the slurry is to seal the tunnel contours in highly permeable ground conditions ("filter cake"), support the ground, transport of the cuttings and for cooling of the cutting tools.

Rate of Tunneling Operations

The expected tunnelled section construction progress rates for the proposed 9,000 m long tunnel are as follows:

Hours of TBM operation	24 hours / day, 7 days / week
Long Average tunnel advance rate	16.5 m/day
Tunnelled Section TBM drive duration	18 months

Finished Primary Tunnel Liners

A primary tunnel lining will be applied which will be constructed using precast concrete elements which are assembled and installed directly by the TBM. The maximum finished internal diameter of the tunnelled section will be 5.0 m which would result in a drilled tunnel diameter of 6.5 m, allowing for 0.5 m thick liner rings and 0.5 m for overbreak. The width of the tunnel segments used to complete a tunnel ring will be 1.2 m approx. There are likely to be up to six tunnel segments per tunnel ring. The primary tunnel lining (i.e., the segmental lining) will be designed for the full ground loading and can be designed to be suitable also for the expected tunnel operating conditions.

4.4.3.5 Tunnel Outlet Diffuser Shaft

General

The purposes of the tunnel outlet diffuser shaft will be to:

- Provide a temporary construction shaft area for making the final transition structure connections between the diffuser shaft and the tunnelled section below, i.e., the diffuser shaft construction must guarantee a safe working environment for final connection purposes; and
- Use as the permanent WwTW final treated effluent riser.

The principles of offshore diffuser shaft construction are the same as those for the onshore inlet shaft. However, many restrictions will apply to the marine environment in which the diffuser shaft has to be sunk.

The depth of the diffuser shaft is controlled by the requirements of the vertical tunnel alignment and it would be prudent to keep the shaft as shallow as possible.

The inner shaft diameter has to meet the hydraulic requirements for the diffuser shaft structure. Hydraulic analysis indicates that the diffuser shaft internal diameter will be of the order of 4.0 m or less.

Diffuser Shaft Location

The location of the existing discharge is shown in Figure 4.8. (Detail of the location selection process is included in 5.11.2.) A larger diameter tunnel outlet diffuser shaft will be constructed at the new discharge location in Dublin Bay shown on Figure 4.9 and Figure 4.10. A diffuser head structure will be constructed at this location to enhance dispersion of the final treated effluent discharge. The diffuser head structure will extend to approximately 5 to 7 m above the seabed level.

Seabed level is approximately 26 m below OD Malin at the site of the proposed diffuser shaft. At this location marine sediments extend to approximately 9 m below seabed level. Marine sediments are underlain by glacial till down to bedrock at about 25 m depth below seabed.

Hydraulic Performance Parameters

The hydraulic performance parameters for the diffuser shaft and head will be specified within the tender documents.

Preliminary hydraulic analysis to date indicates that a single diffuser shaft about 4.0 m in diameter will be required with multiple diffuser heads mounted on top. However, the final configuration of the diffuser shaft including the number of diffuser heads will be determined following completion of the water quality dispersion assessment modelling/studies to be undertaken by the successful contractor as part of the detailed design development.

As consistent with the Design Build form of contract, contractors will have the option of submitting an alternative design to the baseline tender reference design. It must be compliant with the principle of environmental impacts being not environmentally worse than the assessed design presented in this EIS. The assessed design, therefore, represents a worst case scenario in terms of diffusion characteristics. An indicative conceptual design of a diffuser is shown in Figure 4.11.

Structural Design

The diffuser shaft will be designed for two conditions based around the GDSDS strategic climate change surge water level of 4.0 m OD Malin:

- Shaft empty/dry – during construction – with external 4.0 m surge water level + wave height; and
- Shaft full of water – operating mode- with external 4.0 m surge water level + wave height.

In compliance with the Design Build form of contract, the diffuser shaft wall structural and shaft lining design will be governed by the contractor's choice of construction technique which will be heavily influenced by existing geotechnical, geological and hydrogeological conditions at the proposed diffuser shaft location. All construction methods will incorporate mitigation measures as specified within this EIS (refer to Chapter 19) which will form part of the Contractor's Environmental Management Plan.

It is likely that the diffuser shaft will be constructed using an outer steel liner used for the seabed drilling operation. Once the diffuser shaft has been drilled an inner liner would then be retrofitted within and subsequently the annulus between both liners infilled with concrete.

The time required to construct the diffuser shaft will be dictated by the chosen construction method, however, at least 6 – 8 months is a realistic time period to construct and fit out the diffuser shaft – after the initial allowance of approximately 6 months for design completion.

Construction Methodology

In compliance with the Design Build form of contract, details of the diffuser shaft sinking and lining construction methods will be governed by contractor preference and the depth of the seabed overburden materials. However, the contractors will be restricted to a large diameter drilling operation using a machine drill (with multiple drill bits/heads mounted within a single machine drill face) within a large thick walled steel liner of extended length. This approach is required because of the marine working environment whereby extended continuous shaft lining will be required.

Construction, drilling and installation operations will likely be undertaken using a fixed position large jackup barge platform with the supporting legs positioned on the seabed for the full duration of the diffuser shaft construction works.

The pre-installed large thick walled steel liners will extend continuously up to the deck level of the large jackup barge platform. Additional steel liners will be welded from topside on the jackup barge platform deck as the diffuser shaft advances downwards.

The principal advantages of such systems are:

- Man-entry requirements are significantly reduced during construction;
- Groundwater lowering is not required;
- The drill cutter heads can work in a submerged environment below the cutter ring; and
- Excavated spoil is removed as a pumped slurry.

The steel shaft liners can be provided in long lengths, floated to site, to minimise jointing/welding and prevent leaks. To keep the shaft dry dewatering by pumping will be required. In the event that the inflow discharge rates are high, then grouting of the bedrock section maybe required.

Disposal of water extracted during the machine drilling operations is discussed in more detail in Chapter 16 Soils, Geology and Hydrogeology. For discharge to the sea, a pre settlement tank or slurry separation unit for fines removal/separation of drilling muds would be required for environmental reasons. Any variation from the baseline tender reference design in this EIS the submission must be based on a proven "not environmentally worse than" (NEWT) concept design.

The selection of slurry additives and cement must be consistent with the requirements of the EIS and good construction management practices including the Construction Industry Research and Information Association (CIRIA) guidance document on the control and management of water pollution from construction sites, Control of Water Pollution from Construction Sites, guidance for consultants and contractors (Masters-Williams et al 2001). For example, in the UK, cement contains chromium and so cannot be used when tunnelling/boring/drilling near aquifers. Use of 'Pulverised Fuel Ash (PFA) in cement can also be restricted if it contains mercury. However it is understood that Irish cement does not contain chromium.

Aquifer friendly material types should be specified. Limitations on the acceptable acrylics/resins permitted will be specified in the tender documents. Oils, grease, lubricants to be used for the diffuser shaft construction plant will be specified as suitable for use in an aquifer zone.

There are two primary methods of forming the diffuser connection/s into the tunnelled section. One method is to pre-drill the diffuser shaft to below proposed tunnelled section invert and then drive through this with the TBM. An alternative (and probably most preferred) is to pre-drill the diffuser shaft to several metres above the underlying tunnelled section and then mine through from below into the underside of the completed diffuser shaft.

In addition to the main large jackup barge platform for main drilling and shaft installation operations a fleet of additional support marine equipment/plant/vessels will be required including:

- Marine supply vessel;
- Barge to transfer spoil generated from drilling of the diffuser shaft;
- Smaller crew transfer vessels; and
- A 2nd servicing smaller jackup to provide general support to the main jackup barge platform and for providing all concreting operations may also be required.

The likely overall sequence of operations for the diffuser shaft construction is:

- Inspect seabed locally;
- Prepare seabed locally (Localised dredging of marine sediments may be required);
- Position and fix the main large jackup barge platform;
- Position and drive outer steel liner into overburden sediments – shaft casing for machine drill;
- Use machine drill with slurry return to main large jackup barge platform;
- Weld additional lengths to outer steel liner casing;
- Progress and complete drilling and remove machine drill;
- Insert inner steel liner;
- Place concrete between inner and outer liner;
- Plug shaft below diffuser shaft liner for eventual removal and breakthrough into the completed tunnel below; and
- Fit out and cap diffuser shaft with a bespoke diffuser head.

Berthing Areas

While the majority of the diffuser shaft construction operation will take place at sea using jackup platform barges and various marine support vessels, there will be a need for the contractor to utilise an existing onshore berthing area. The fully serviced berth area will be leased in the Dublin Bay area and will include the following:

- Area for storage of elements;
- Area for jackup platform barges and other marine support vessels; and
- Area for laydown space, materials handling, etc.

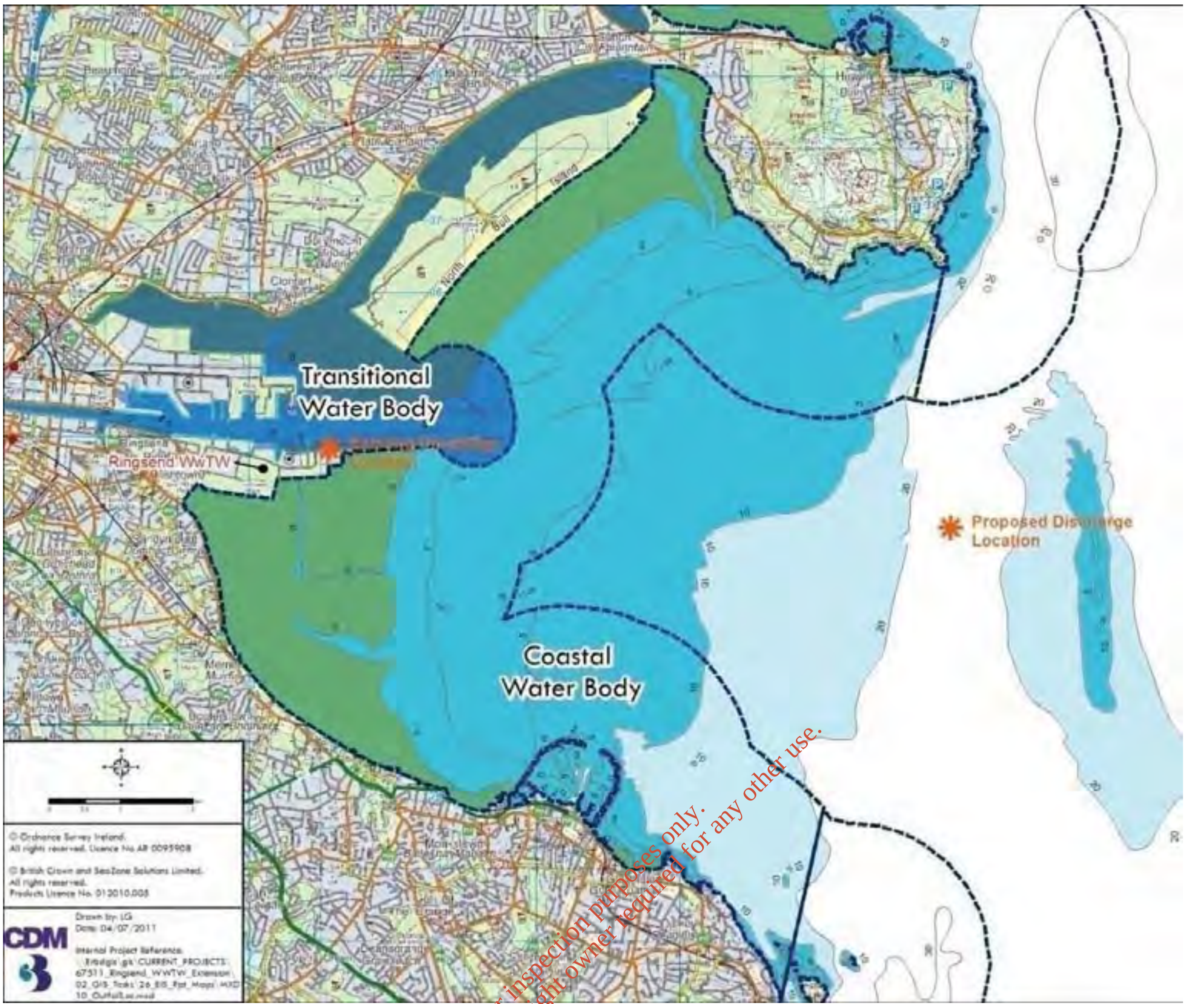


Figure 4.8 Proposed Discharge Location

4.4.3.6 Spoil Disposal

This EIS considers the impact of spoil disposal to land and the impacts associated with spoil transportation over land. DCC are investigating the option of disposal to a suitable site at sea. This option, if considered potentially viable, would require a separate licence application process and full environmental assessment. The disposal to sea option would only be pursued if the impacts of this option are similar or lesser than the disposal to land option. This assessment, therefore, represents a worst case scenario assessment of the spoil disposal options.

Figure 4.9 Existing Outfall Location and Proposed Outfall Location

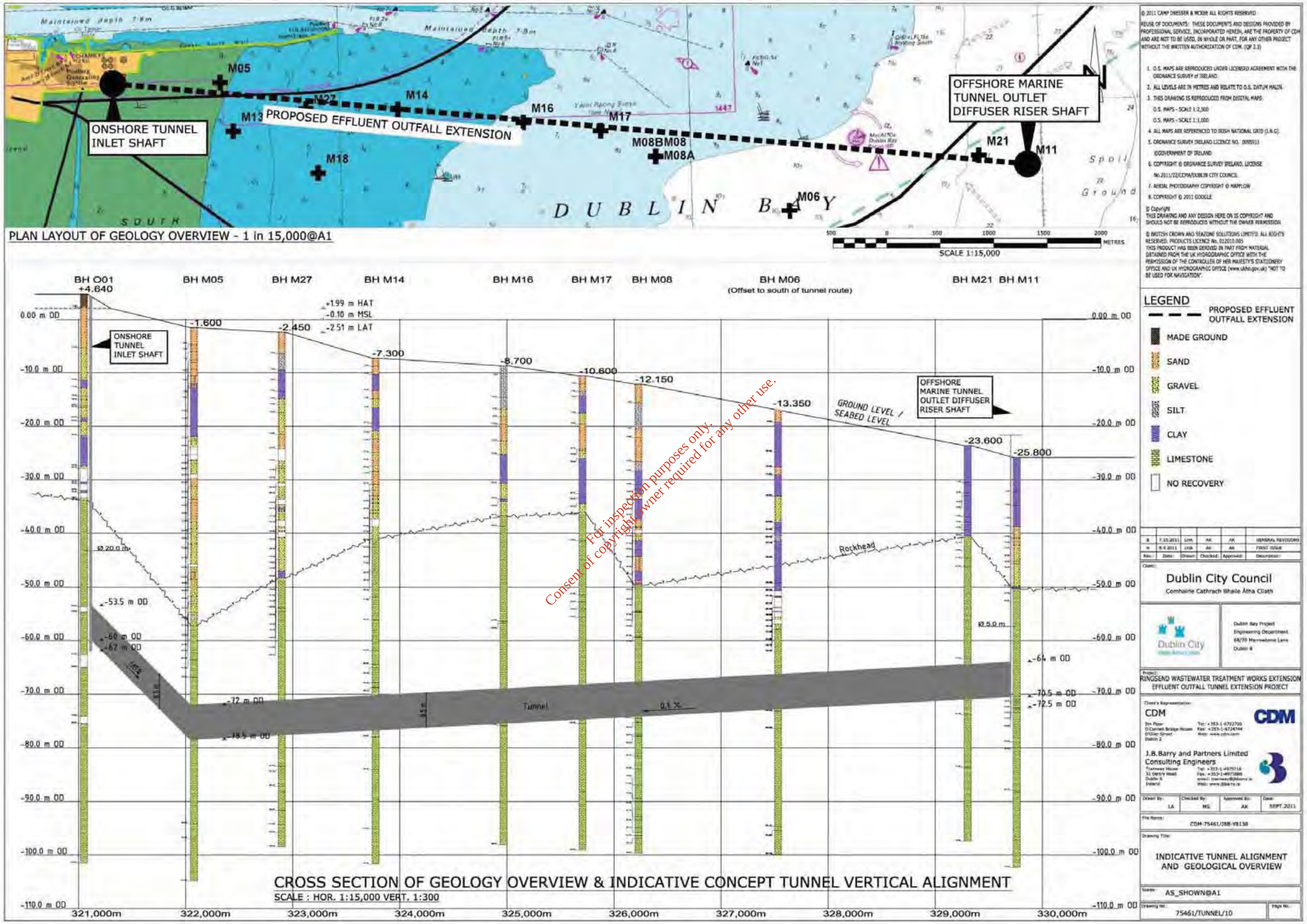


Figure 4.10 Cross Section of Proposed Tunnel Route

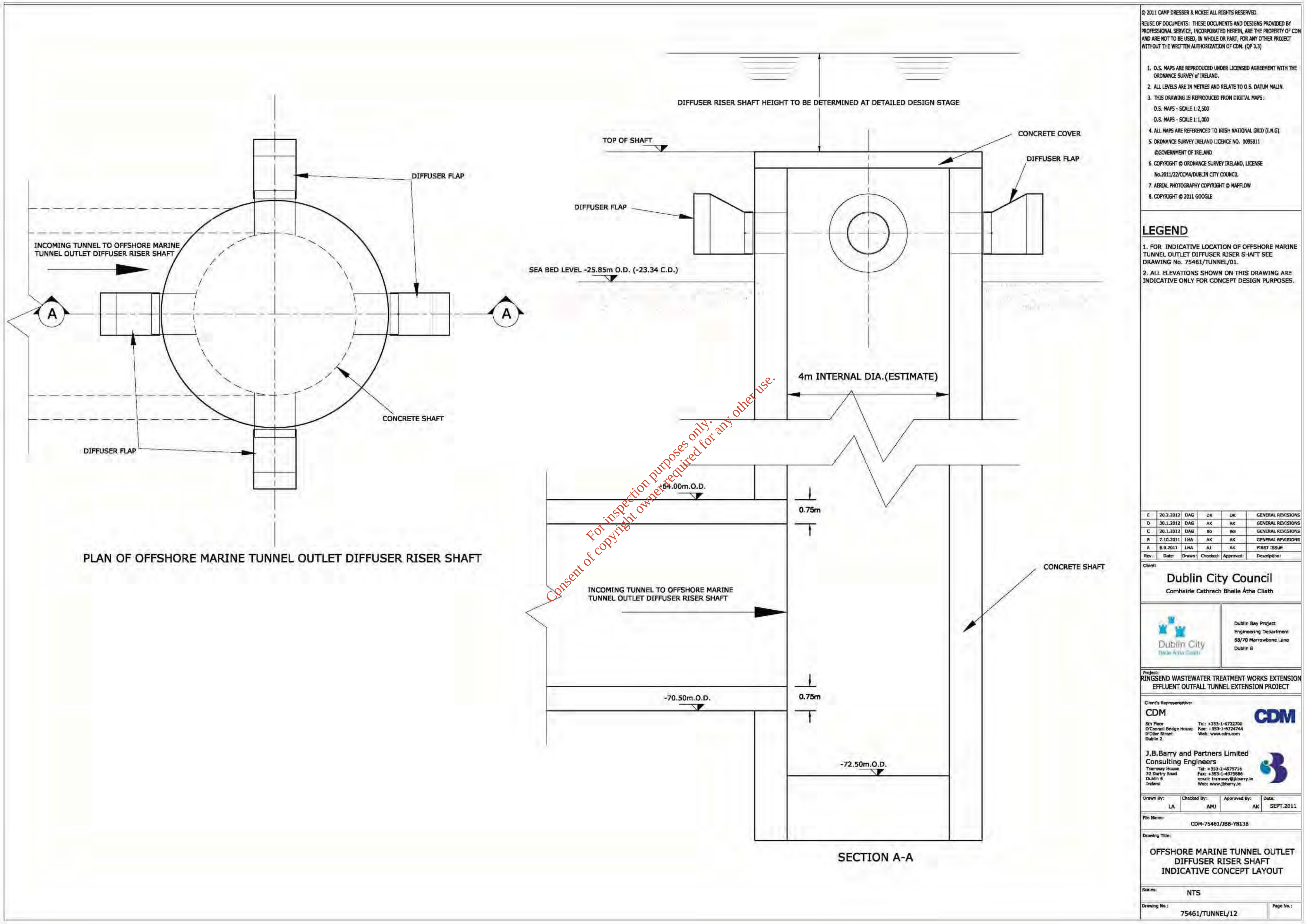


Figure 4.11 Sample drawing of Typical Tunnel Diffuser

4.4.4 Road Network Improvements (Construction Phase)

Road network improvements will be required to the Pigeon House Road. These improvements will involve both road/pathway structural upgrading works, resurfacing, and improved traffic management works.

The Pigeon House Road network improvements and traffic management proposals are detailed on Figure 4.13 and Figure 4.14 respectively. Road strengthening and resurfacing will be carried out between Point A on Figure 4.13 and the entrance to the tunnel inlet shaft site. Completed road alignment and dimensions will be as currently in existence.

In addition to these improvement works a new length of permanent spur road will be constructed between the Pigeon House Road and the SE corner of the Ringsend WwTW. This new road length will allow for the construction on the 0.8 hectare site on the Ringsend WwTW site and for future emergency access to the Ringsend WwTW site post construction.

In the case of HGV traffic all associated access to the construction compound (for constructing the tunnel inlet shaft and tunnelled section) will be via the proposed permanent access to the western end of the compound area.

Pedestrian safety barriers will be used along the footpath on the Pigeon House Road as demonstrated in Figure 4.14.

The proposed alterations to the existing traffic management arrangements are described in more detail in Chapter 12.

4.4.5 Power Supply

To provide power to the tunnel inlet shaft site, electrical cables will be laid in accordance with the standard specification for ESB networks MV/LV Networks Ducting (Minimum Standards) within the ESB wayleave in the compensatory grassland and under Pigeon House Road during the road strengthening and resurfacing works as shown in Figure 4.15.

4.4.6 Car Park and Marshalling Yard for WwTW Improvements (Construction phase)

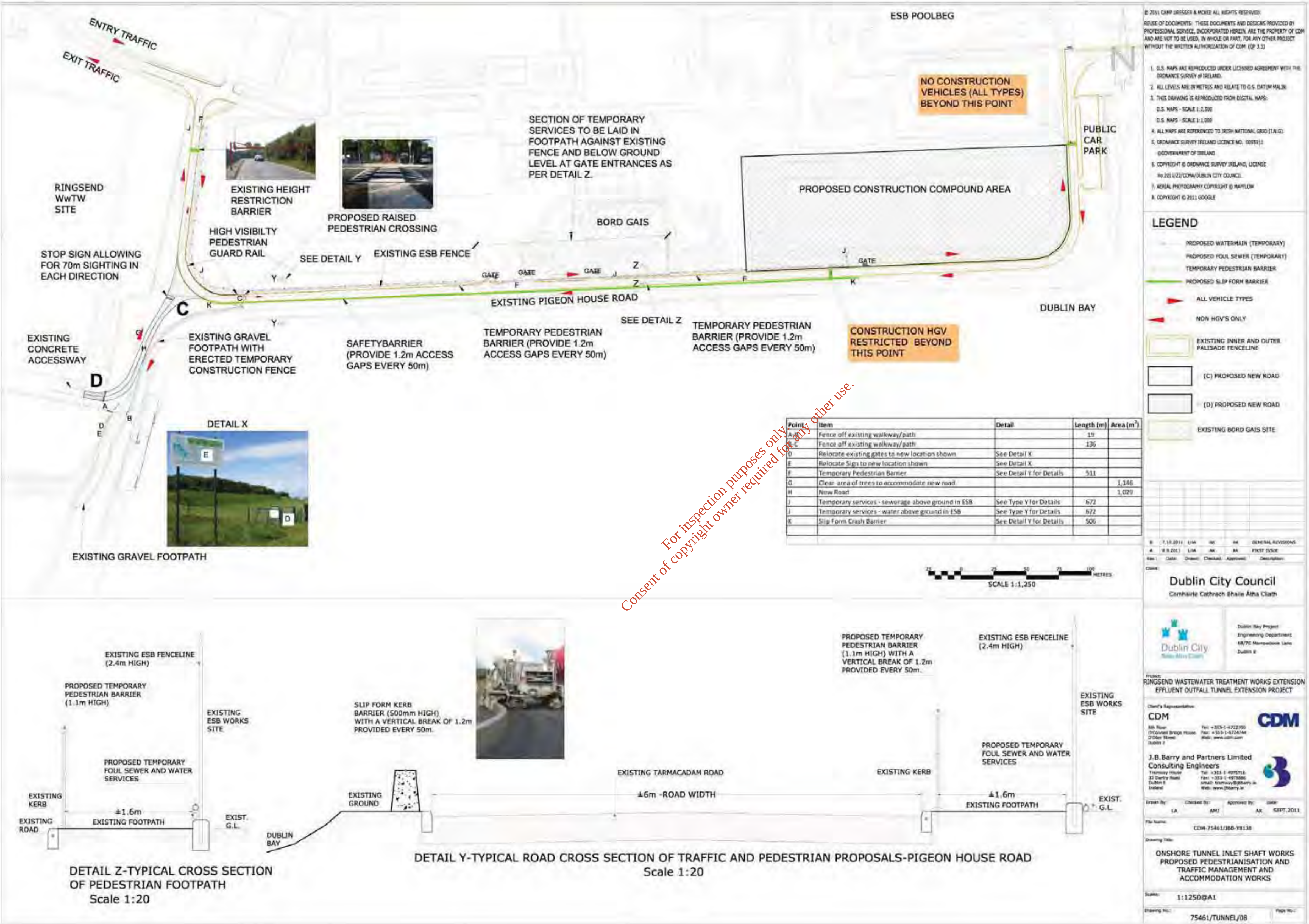
It is likely that additional space will be required above that in the construction compound for car parking and a marshalling yard. A minimum of 1 ha (2.47 acres) will be required. A number of areas have been identified that would be suitable for this purpose, as shown in Figure 4.12; however, the area to be used will be selected by the contractor.

Access to the marshalling yard will be via South Bank Road. Access to the WwTW and construction compound will then be via Shellybanks Road and Pigeon House Road. Traffic flows are discussed in more detail in the Chapter 12 Traffic. This area will be completely reinstated following project completion.

Figure 4.12 Areas available for Marshalling Yard

ROAD AREA	ROAD/LAND OWNERSHIP	WAYLEAVE ACCESS REQUIREMENTS	EXISTING/PROPOSED ROAD AREA
A	DCC	N/A	EXISTING
B	ESB	IN NEGOTIATION	EXISTING
C	ESB	IN NEGOTIATION	PROPOSED
D	DCC	N/A	PROPOSED
E	ESB	IN NEGOTIATION	EXISTING

Figure 4.13 Road Layout



Point	Item	Detail	Length (m)	Area (m²)
A-B	Fence off existing walkway/path		19	
B-C	Fence off existing walkway/path		136	
D	Relocate existing gates to new location shown	See Detail X		
E	Relocate Sign to new location shown	See Detail X		
F	Temporary Pedestrian Barrier	See Detail Y for Details	511	
G	Clear area of trees to accommodate new road			1,146
H	New Road			1,029
J	Temporary services - sewerage above ground in ESB	See Type Y for Details	672	
J	Temporary services - water above ground in ESB	See Type Y for Details	672	
K	Slip Form Crash Barrier	See Detail Y for Details	506	

Figure 4.14 Pedestrian and Traffic Management

Figure 4.15 Indicative Route for Electrical Cabling showing ESB wayleave.

4.5 Overall Programme

An indicative preliminary programme of completion dates is as set out below:

- WwTW Extension Works
  - Design Stage – August 2012
  - Tender Award – May 2013
  - Construction WwTW Extension – July 2015
  - Commissioning WwTW Extension – November 2015
- WwTW Final Treated Effluent Tunnel Extension (Long Sea Outfall)
  - Design Stage – August 2012
  - Tender Award – May 2013
  - On shore Shaft Construction – May 2014
  - Tunnel Shaft Construction – December 2015
  - Diffuser Construction – December 2015

4.6 Procurement Options

There will be two separately procured contracts. The first contract will include all of the works items on the Ringsend WwTW site related to the upgrade and extension of the plant and for gaining access during and after the completed construction works. The second contract will include all works necessary for the construction and operation of the tunnel infrastructure including the necessary access facilities.

The major waste water treatment elements of this project are being progressed under Design Build contract, in accordance with national policy.

The tender contract is expected to be a Design Build contract. While some design decisions can be assumed at this stage and may be prescribed in the tender documents, many design and construction issues will be decided by the contractor and approved by the client's representative. As a result, each assessment chapter takes into account the worst-case scenario option for that particularly element of the assessment.

4.6.1 Existing Wastewater Treatment Works

Placed into formal operation in April 2005, the existing Ringsend Wastewater Treatment Works (Existing Works) is currently operated by the ABA Consortium (ABA) under Contract No. 2, which was tendered in 1998 under a DBO procurement process. There was an extended commissioning period and formal operation began in April 2005.

Odour control improvements were implemented between 2005 and 2008. Improvements were completed in 2010 to the sludge handling system.

4.7 Environmental Management Plan (EMP)

The contractors will prepare an environmental management plan. Environmental management plans capture the critical project specific issues to be managed on the construction sites and provide ways of ensuring that commitments made during the planning phase are incorporated into the design, construction and operational phases of the project. The EMP will, therefore, incorporate the measures set out in the Environmental Statement and will cover all the preventative and management measures to be applied throughout the construction phase to ensure that all environmental effects associated with the proposed development are minimised, mitigated or avoided.

The EMP will serve as a compliance document recording the progress of commitments and their conformity with the requirements set by the relevant authorities and the expectations of the public.

An Environmental Management Plan will include:

- Responsibilities and procedures for implementing required mitigation measures;
- Systems and procedures to review the implementation process; and

Typically the EMP will address topics covered in the Environmental Impact Assessment and include:

- Spill Contingency;
- Audits and review;
- Environmental Liaison and Consultation;
- Spoil Disposal;
- Noise Management;

- Pollution Control;
- Reinstatement Management/Monitoring;
- Waste Management;
- Traffic Management;
- Community Liaison;
- Hazardous Substance management;
- Surface Water Management;
- Environmental Supervision & Training (all personnel);
- Landowner Liaison; and
- Environmental Health and Safety (EHS) performance.

Construction method statements will be developed to manage the construction activities in accordance with the EMP and EIS commitments. The EMP will also establish monitoring protocols for relevant areas such as ecology, archaeology, water, dust, noise and sediment control. The monitoring programmes will be set out within the EMP and will include the timing and frequency of monitoring and policies for evaluating and amending the monitoring programme.

Once detailed design information is available, the EMP will be finalised. Upon the commencement of construction, the EMP will be reviewed according to a regular timeframe and updated, if necessary. These updates will be made in consultation with relevant regulatory authorities. The EMP will provide systems for the effective environmental management of the construction process covering important items such as waste management and pollution control. Environmental auditing will be undertaken to ensure compliance with the EMP.

Chapter 5 Consideration of Alternatives

5.1 Introduction

This section describes alternatives considered during the progression to the proposed design solution. Design alternatives were considered that would meet the effluent legislative requirements and extend the WwTW capacity.

A Preliminary Report for the Ringsend WwTW dated May 1993, included a recommendation that the Works be commissioned in two stages. Stage 1 was to be designed and constructed immediately, on the basis of a design horizon of 2020. A 0.8 hectare area was then set aside within the curtilage of the site for an extension to the WwTW in Stage 2.

A Design Review Report was prepared in June 2010, which refined the design criteria to provide a firm treatment capacity of 2.1 million PE (the lower figure refers to the capacity when the largest process unit is out of service for maintenance or due to equipment failure for example). It also provides details on the alternatives considered as summarised below.

The projected loadings are somewhat higher than those originally planned for Stage 2 and, in addition, the effluent standards have become more stringent. The following sections set out the alternatives assessed in the design process to achieve proposed final design solution.

5.2 Alternatives Overview

This section describes and compares alternatives considered during the design review process. In addition to the Do Nothing scenario, two possible locations for the discharge were considered as follows:

- Discharge to the Nutrient Sensitive Waters of the Liffey Estuary – provision of additional secondary treatment and nutrient removal/disinfection at the existing WwTW and discharge via the existing outfall to the River Liffey; or
- Long sea outfall – provision of additional secondary treatment at the existing WwTW and discharge to Dublin Bay via a long sea outfall; several potential outfall locations were assessed under this scenario.

In 2001, the Liffey Estuary was declared to be a sensitive water body under the Urban Wastewater Treatment (UWWT) Directive (refer to Figure 5.1). This means that additional nutrient removal is required for the discharge of any treated effluent into the River Liffey. The standard specified in the UWWT Directive is a maximum of 10 mg/L Total Nitrogen and 1 mg/L Total Phosphorus. Discharges to the Liffey Estuary would also require seasonal UV treatment to remove bacteria and to protect bathing waters and the coastline.

Figure 5.1 Extent of Nutrient Sensitive Waters Designation

A long sea outfall that discharged secondary treated effluent outside the Nutrient Sensitive Waters would be compliant with the UWWT Directive and water quality standards. The incorporation of additional nutrient removal and disinfection would be unnecessary.

Further details of the dilution and dispersion modelling undertaken for the potential outfall locations are described in Chapter 8 of this EIS.

Associated with the two main design alternatives are a number of different treatment processes which were reviewed to determine if they, either alone or in combination, met the project criteria including the technical, legislative and environmental considerations. Cost and operational factors were also considered. The Design Review Report, which provides more technical detail on the alternatives considered, is provided in Volume 2, Appendix B.

5.3 Do Nothing Scenario

The existing Ringsend WwTW was designed to treat 1.64 million PE to secondary treatment standards, specifically: 25 mg/l BOD; 125 mg/l COD; 35 mg/l TSS; and 18.75 mg/l Ammonia Nitrogen. It also includes for seasonal disinfection. The average influent loading to the Works is currently approximately 1.8 million PE. As a result of this overloading the 95th percentile effluent TSS standard has not been met for several years and in 2009 the 95th percentile BOD standard was not met for the first time.

As the Liffey Estuary has now been designated a nutrient sensitive water body, nutrient removal to achieve 10 mg/l Total Nitrogen and 1 mg/l Total Phosphorus for continued discharge into the Liffey Estuary is now required.

The Works, as currently configured, cannot treat the current loading to the required standards and has limited ability to remove nutrients. The Do Nothing scenario is therefore not a sustainable option given (i) the current over loading (ii) the project increase in loading and (iii) the implementation of more stringent nutrient removal standards. In addition, DCC would not be able to meet its statutory obligations if the Do Nothing scenario was adopted.

5.4 Treatment Options

5.4.1 Commonalities to All Alternatives

Irrespective of whether the discharge location is to the Liffey Estuary or Dublin Bay, a number of improvements to the existing WwTW will be required. These include:

- Adding a sixth influent screw pump to pass 13.8 m3/s forward;
- Adding one low level and one high level pump to increase intermediate pumping station (IPS) capacity to 13.8 m3/s;
- Extend lamella packs in all lamella settlers to improve solids removal efficiency at higher flows. Lamella settlers are primary sedimentation tanks equipped with sludge removal devices. The lamella settlers currently treat flows up to 11.1 m^3/s and were designed for a peak flow of 13.8 m^3/s providing the lamella packs are extended. : and
- Improvements to the SBRs will be made including installation of covers above the upper level SBRs to eliminate wave formation in high wind conditions and restore original volumetric capacity.

5.4.2 Treatment Options

The following is a brief description of the treatment options considered and these, either alone or in combination, were investigated to determine if they met the design criteria.

IFAS – Integrated fixed-film activated sludge process involves increasing the capacity of the activated-sludge system by adding material (ropes, sponges, plastic) on which organisms grow as a film to the aeration tanks. With the added material, the concentration of biomass can be increased by about one-third compared with suspended-growth systems, resulting in decreased volume and surface area. The Ringsend facility is much larger than any existing facility with IFAS, and IFAS has not yet been attempted with SBRs. Two suppliers did not recommend the application of IFAS at Ringsend. The option was therefore not considered further as it was deemed technically unsuitable for the project requirements.

Biological Filters – Biological filters are able to contain concentrations of biomass four or five times those of activated-sludge processes, thus decreasing the volume of tankage and resultant land area required as compared to conventional suspended-growth processes. However, this process could not provide the requisite treatment capacity without also requiring Chemically Enhanced Primary Treatment (CEPT). This option was not considered further for this project due to the capacity limitations, higher capital costs and greater operational complexity.

Decrease Loads to Secondary Treatment by improving the efficiency of primary treatment and treating sidestreams. This would provide additional capacity at the existing SBRs.

- **CEPT** – Chemically Enhanced Primary Treatment. The efficiency of primary treatment can be improved by adding chemicals ahead of the primary settling tanks. Suitable chemicals include aluminium salts such as alum and polyaluminum chloride. CEPT removes more BOD and suspended solids than conventional primary treatment, CEPT also decreases required downstream facilities and decreases production of surplus activated sludge. Denitrification filters would be provided (see below).
- **Sidestream treatment** – the purpose of sidestream treatment is to directly remove nitrogen from solids processing return streams. Three options were considered:

  1) conventional nitrification/denitrification, which consists of the oxidation of ammonia nitrogen to nitrite and then to nitrate;

  2) SHARON (Single High-Activity Ammonia Removal over Nitrite) Process which requires the addition of methanol; and

  3) ANAMMOX/DEMON (Anaerobic Ammonium Oxidation / De-Ammoniafication) Processes which require no biodegradable carbon.

Conventional activated sludge – Conventional activated sludge consists of aeration tanks and separate secondary clarifiers. At Ringsend, conventional activated sludge processes could be implemented in two ways. One way would be to add secondary clarifiers and to convert the SBRs to aeration tanks. The other way would be as stand-alone activated sludge plant with new aeration tanks and secondary clarifiers. Conventional activated sludge wsas dropped from further consideration due to capacity limitations.

Membrane Bioreactors – A membrane biological reactor (MBR) consists of a biological reactor with suspended biomass and solids separation by micro or ultra filtration membranes with nominal pore sizes ranging from 0.1 to 0.4 microns. The MBR process utilises activated sludge technology, but replaces conventional final settlement with a membrane that effectively filters the final effluent. It is noted that MBR are particularly expensive and were discounted on the basis of economics.

Deep-Shaft Process – The deep-shaft process is an activated-sludge process that uses an in-ground vertical shaft to provide biological treatment. The shaft can be up to 100 metres deep and 5 metres in diameter. Since the aeration tank is deep, its surface area is small as compared to conventional aeration basins. The bioreactor consists of two tubes, one inside the other. Flow goes down the inner tube, and then up the space between the two tubes. As the depth of the aeration tank (shaft) becomes greater oxygen transfer rates increase. At the great depths, solubility of nitrogen is very high, and flotation-type clarifiers are used rather than conventional clarifiers. Deep-shaft aeration has been applied only in special cases and due to the limited availability of area, Ringsend could constitute a "special case."

Phosphorus Removal – The concentration of phosphorus in the effluent from the SBRs averages about 5 mg/L. To meet the effluent requirement of 1 mg/L when the discharge is to the Liffey Estuary, chemical dosing with about 20 m^3/day of alum solution would be required. This could be added at either the primary tanks or, more likely, in the SBRs. This treatment is only required for a discharge to the Liffey Estuary.

Compact System to Treat Storm Flows (Ballasted Flocculation) – This process uses a coagulant (usually ferric chloride, but sometimes alum) and "microsand" (grain size from 0.075 mm to 0.3 mm in diameter) which is added to screened, degritted wastewater. The mixture is flocculated and then settled in plate settlers. The sludge is passed through a cyclone, where the microsand is recovered.

This could be considered as a pre-treatment process to free up space for more space intensive processes. With ballasted flocculation, the use of some of the storm tanks could be eliminated, thus making a large area available for other uses. The storm tanks are located across Pigeon House Road from the main plant. It is noted that operating costs for ballasted flocculation are very high because of the chemical dosage required.

Denitrification filters – The sequencing batch reactors (SBRs) operated in the nitrification mode could be followed by denitrification filters. Methanol, or another readily biodegradable carbon source, would be added upstream of the denitrification filters. In addition to denitrifying, the filters would capture effluent solids and return them to the primary clarifiers during the backwash cycle. The addition of a small amount of metal salts can precipitate phosphorus, which is then trapped in the media along with total suspended solids (TSS).

5.5 Assessment of Feasible Design Alternatives

Figure 5.2 displays the additional capacity required to meet the ultimate design capacity of 2.4 million PE (2.1 million PE firm capacity). See Section 4.1 for a discussion of firm capacity.

Based on the additional required capacity, a number of potential design solutions were brought forward for further assessment. The IFAS and Biological Filter options were eliminated from further consideration as they were found to be technically infeasible. The membrane bioreactor options were also discounted on the basis of excessive cost. A summary of the assessment of potential technical options is set out graphically in Figure 5.3.

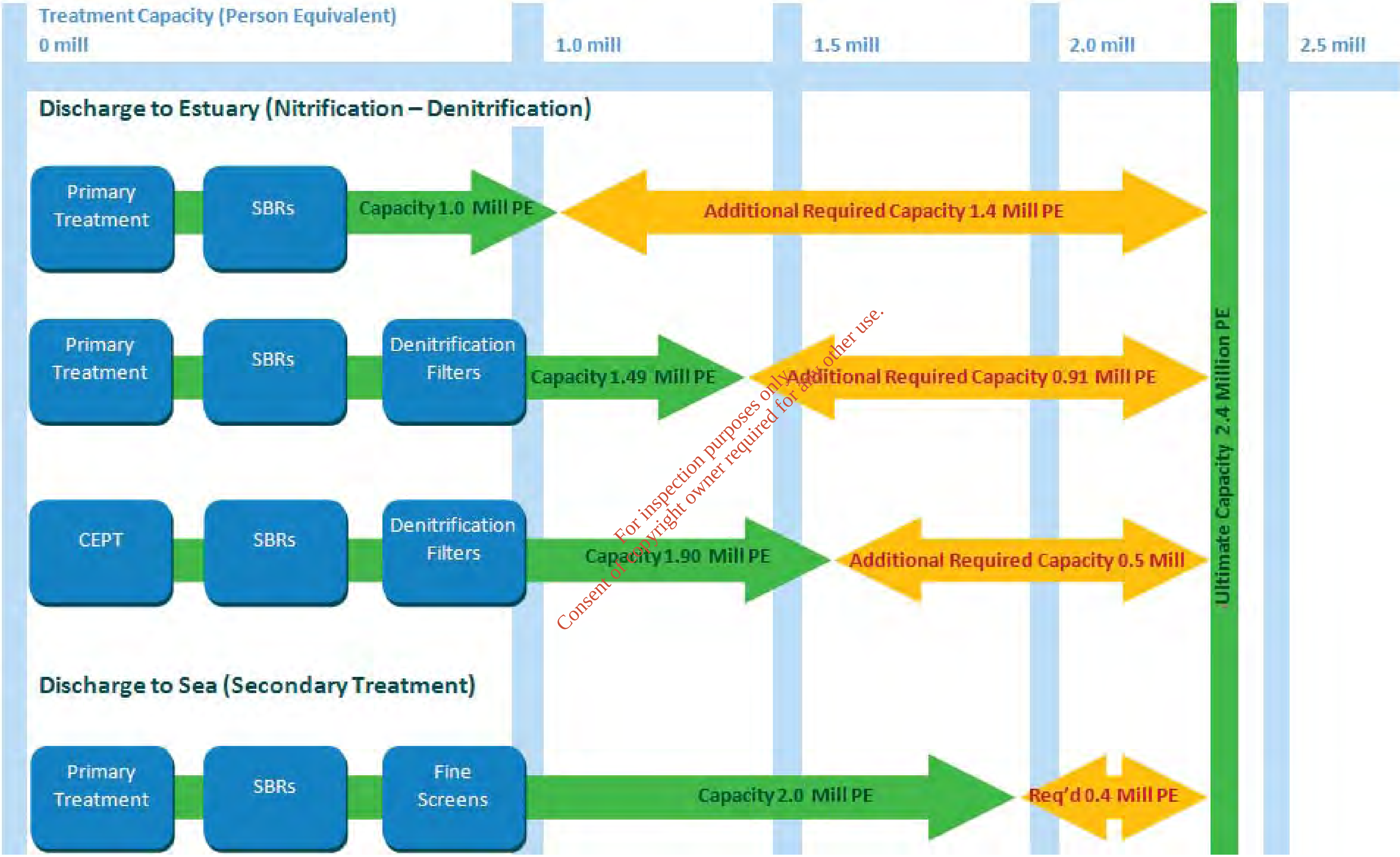


Figure 5.2 Additional Treatment Capacity Required

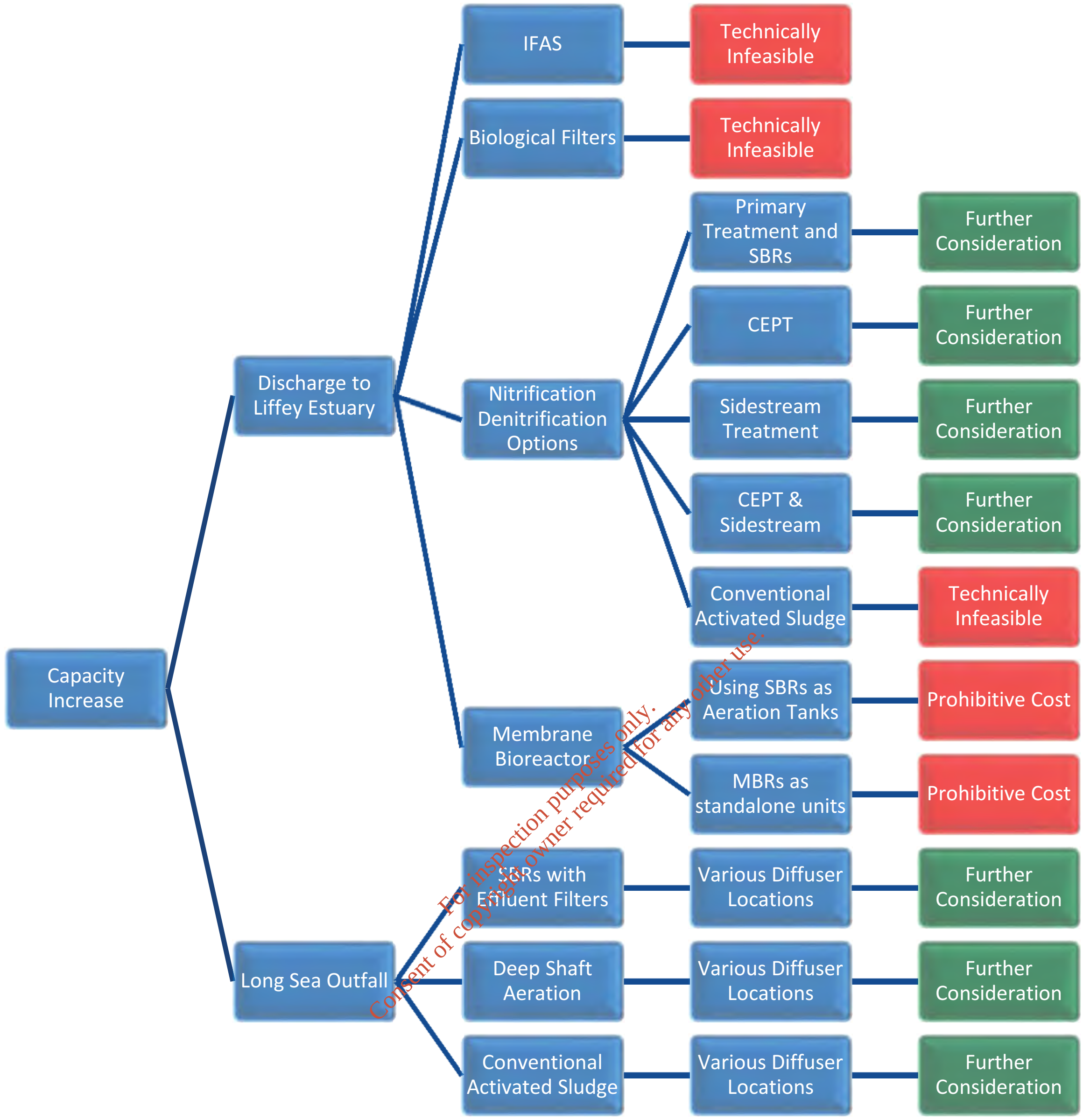


Figure 5.3 Summary of potential design solutions

5.6 Liffey Estuary Outfall Discharge Alternatives

Four technically viable alternatives were identified that are compatible with a discharge to the Liffey Estuary. These are:

- Deep shaft aeration operated in a nitrification/denitrifcation mode (NDN) with current Primary Treatment and SBRs;
- Deep shaft NDN with CEPT;
- Deep shaft NDN with sidestream treatment; and
- Deep shaft NDN with CEPT and Sidestream Treatment.

5.6.1 Deep Shaft NDN with Current Primary Treatment and SBRs

Under this alternative the existing SBRs would be operated to achieve full nitrification for an influent loading of 1.49 million PE. Denitrification filters would be provided. Alum would be added to the denitrification filters for phosphorus control.

To achieve the required treatment capacity at the extended plant, deep shaft aeration systems would be required constructed in the 0.8 hectare open space on the WwTW site and in the triangular open space to the southeast of the storm tanks.

Surplus Activated Sludge (SAS) production rates would be very similar to current rates and would increase in general proportion to loading increases. The net increase in sludge production, from the denitrification filters and the alum sludge from phosphorus control, would be 17 tDs/d in addition to the sludge production associated with biological nitrification.

Seasonal UV disinfection would be continued to ensure the required bacteriological levels at the bathing beaches in the inner bay.

5.6.2 Deep Shaft NDN with CEPT

Under this alternative the primary tanks would be dosed with alum to enhance TSS removal as well as to control phosphorus. The SBRs would be operated to achieve full nitrification for an influent loading of 1.90 million PE. Denitrification filters would be provided.

To achieve the required secondary treatment capacity at the extended plant, deep shaft NDN systems would be constructed in the 0.8 hectare open space on the WwTW site.

The net increase in sludge production, from the denitrification filters and the alum sludge from phosphorus control, would be 45 tDs/d in addition to the sludge production associated with biological nitrification.

Seasonal UV disinfection would be continued to ensure the required bacteriological levels at the bathing beaches in the inner bay.

5.6.3 Deep Shaft NDN with Sidestream Treatment

Under this alternative the SBRs would be operated to achieve full nitrification for an influent loading of 1.49 million PE. Denitrification filters would be provided. Sidestream treatment (either SHARON or ANAMMOX) would be provided to reduce the nitrogen load returning to the SBRs. While this does not increase the SBRs' capacity to remove BOD, it would reduce power consumption within the SBRs and also reduce the mass of nitrate to be denitrified in the denitrification filters. Alum would be added to the denitrification filters for phosphorus control.

To achieve the required secondary treatment the deep shaft NDN systems would be constructed in the 0.8 hectare open space on the WwTW site and in the triangular open space to the southeast of the storm tanks.

SAS production rates would be very similar to current rates and would increase in general proportion to loading increases. The net increase in sludge production, from the denitrification filters and the alum sludge from phosphorus control, would be 14 tDs/d in addition to sludge production associated with biological nitrification.

Seasonal UV disinfection would be continued to ensure the required bacteriological levels at the bathing beaches in the inner bay.

5.6.4 Deep Shaft NDN with CEPT and Sidestream Treatment

Under this alternative the primary tanks would be dosed with alum to enhance TSS removal as well as to control phosphorus. Sidestream treatment would remove a portion of the nitrogen from recycle streams. The SBRs would be operated to achieve full nitrification for an influent loading of 1.90 million PE. Denitrification filters would be provided.

To achieve the required secondary treatment, deep shaft NDN systems would be constructed in the 0.8 hectare open space on the WwTW site.

The net increase in sludge production, from the denitrification filters and the alum sludge from phosphorus control, would be 41 tDs/d in addition to sludge production associated with biological nitrification.

Seasonal UV disinfection would be continued to ensure the required bacteriological levels at the bathing beaches in the inner bay.

5.7 Long Sea Outfall Discharge Alternatives

A variety of long sea outfall locations were considered. The concept of constructing a pipeline was considered, but eliminated in favour of a tunnel due to potentially negative impacts to operations of the Port of Dublin, Natura 2000 areas, marine archaeological sites, fishing and recreational areas.

Three dimensional hydraulic modelling was carried out to establish the dilution and dispersion characteristics of each location. This is described in further detail in Section 8.2 of this EIS. A discharge to a long sea outfall will require secondary treatment as in the other options, but not additional removal or disinfection, to achieve compatibility with water quality standards.

Three viable types of design alternatives are identified that are compatible with a long sea outfall discharge to Dublin Bay. These are:

- Conventional activated sludge with final clarifiers.
- Deep shaft aeration with flotation clarifiers; or
- Sequencing batch reactors (SBRs) with effluent filters.

5.7.1 Conventional activated sludge with final clarifiers

Under this alternative, the existing SBRs would be operated in carbonaceous (or BOD removal) mode to treat an average influent loading of 2.0 million PE. This is done by increasing the rate of biological loading in order to intentionally avoid nitrification.

To achieve the required treatment capacity at the extended plant, conventional secondary treatment processes (i.e., aeration basins and clarifiers) would be required and given the restricted space, a two-storey arrangement is anticipated. This arrangement would provide at least eight activated sludge basins (six SBRs plus at least two new activated sludge basins), permitting process redundancy that is lacking. The conventional secondary treatment processes would be constructed in the 0.8 hectare open space on the WwTW site.

5.7.2 Deep shaft aeration with flotation clarifiers

Under this alternative, the existing SBRs would be operated in BOD removal mode to treat an average influent loading of 2.0 million PE.

To achieve the required treatment capacity at the extended plant, deep shaft aeration systems would be required which would be operated to avoid nitrification i.e., in a conventional BOD removal mode. The deep shaft aeration system would be constructed in the 0.8 hectare open space on the WwTW site.

5.7.3 Sequencing batch reactors (SBRs) with effluent filters

Under this alternative, additional secondary capacity would be added in the form of SBRs together with effluent fine screens.

5.8 Consideration of Assessment Factors

5.8.1 Consideration of Cost Factors

The alternatives were evaluated on the basis of Total Present Worth over a 20-year planning period. Total Present Worth Cost brings all the cost elements to bear and is considered to be a more objective basis for decision making than any of the component costs.

The components of Total Present Worth are the Capital Cost, the Present Worth of Annual Operating Costs, and the Residual Asset Value at the end of the planning period. Capital Costs include 35% contingencies. Annual Operating Costs are those accrued annually to operate the facility, such as electricity, natural gas, chemicals and salaries of operations and maintenance staff. Twenty years of annual costs are brought to a single Present Worth cost by applying a series present worth factor. Residual Asset Value is remaining value of the facilities at the end of the planning period and is shown as a credit. Structures are expected to have a life of 40 years and will have 50% of their life remaining at the end of the planning period. The expected life of a rock tunnel is at least 100 years, so 80% of the tunnel's life will remain at the end of 20 years.

Table 5.1 presents the capital, annual, and present worth costs of the alternatives presented in this chapter.

Table 5.1 Cost Comparison of Wastewater Treatment Alternatives

	Discharge to Liffey Estuary (Nutrient Removal Alternatives)				Long Sea Outfall
	Current Primary	With CEPT	With Sidestream	With Both	Secondary Treatment with 9 km Outfall
Total Capital	€131,000,000	€138,000,000	€128,000,000	€133,000,000	€222,000,000
Annual Operating	€8,600,000	€10,900,000	€8,100,000	€10,200,000	€3,000,000
PW Annual	€105,000,000	€133,000,000	€99,000,000	€125,000,000	€37,000,000
Residual Asset Value	€(8,200,000)	€(6,500,000)	€(8,300,000)	€(6,500,000)	€(48,000,000)
Total Present Worth	€228,000,000	€265,000,000	€219,000,000	€252,000,000	€211,000,000
Ratio to lowest	108%	123%	104%	119%	100%

The Long Sea Outfall/Secondary Treatment alternative has a cost advantage over the Discharge to the Liffey Estuary/Nutrient Removal alternatives.

5.8.2 Consideration of Reliablility

The Secondary Treatment/Long Sea Outfall alternatives would continue to use the SBRs for biological treatment, as would all other alternatives, but would be operated at a shorter solids retention time

(SRT) that would prevent nitrification. Operation in a carbonaceous mode is more stable than in a nitrification mode, especially at lower temperatures. In early 2010, record low wastewater temperatures were experienced, resulting in a significant degradation of effluent BOD and ammonia concentrations. BOD compliance was rapidly restored as temperatures normalised. Nitrification took much longer to re-establish.

The Secondary Treatment/Long Sea Outfall alternatives would supplement SBR capacity with traditional secondary treatment. It is envisioned that these facilities would be comprised of aeration basins and clarifiers or deep shaft aeration systems. Additional SBRs could conceivably be added, but only if the problems attendant to excessive effluent TSS are adequately dealt with.

All alternatives compatible with discharge to the Liffey Estuary would require the addition of denitrification filters downstream of the SBRs. While denitrification filters are considered to be a reliable, any additional unit processes arranged in series reduce overall system reliability.

Deep shaft NDN has not been practiced at a scale comparable to that at Ringsend and, hence, there is some risk in scaling up the design. In addition, the double-decked flotation clarifier arrangement as proposed would be unique. The design criteria used by the vendor are not as conservative as those CDM would normally recommend. There is, therefore, some risk that the facilities may not achieve the design horizon loadings.

The Secondary Treatment/Long Sea Outfall alternatives should be more stable than processes that remove nutrients. In addition, the selection of an outfall provides a reliable discharge solution for decades to come.

The Secondary Treatment/Long Sea Outfall alternatives have a reliability advantage over those providing Nutrient Removal.

5.8.3 Consideration of Ease of Operation

This criterion considers the relative ease of operation for each of the alternatives. A lesser number of unit processes are desirable. Also, the degree of operability is generally considered to be inversely related to complexity.

Deep Shaft NDN with Conventional Primary Treatment would add two unit processes i.e., denitrification filters and deep shaft aeration. The deep shaft aeration system includes a number of unusual facilities, such as flotation clarifiers, that would add to system complexity. In addition, deep shaft aeration facilities would be sited at two locations, on the existing site and adjacent to the storm tanks, making operational logistics more difficult.

Deep Shaft NDN with CEPT would add three unit processes i.e., CEPT, denitrification filters, and deep shaft aeration. Treatment of the much increased sludge production would place further demands on operations staff.

Deep Shaft NDN with Sidestream Treatment would add three unit processes: SHARON or ANAMMOX, denitrification filters, and deep shaft aeration. The deep shaft systems would be sited at two locations.

Deep Shaft NDN with CEPT and Sidestream Treatment would add four unit processes: SHARON or ANAMMOX, CEPT, denitrification filters, and deep shaft aeration. Treatment of the much increased sludge production would place additional demands on operations staff.

Secondary Treatment with a Long Sea Outfall would add two new unit processes: effluent fine screens and conventional secondary treatment. Fine screens are very simple devices. Conventional activated sludge or deep shaft aeration would be simpler to operate than deep shaft NDN, since it would not be required to nitrify and denitrify and would require no chemical addition.

Operations of a secondary system would be somewhat less complex than any system that requires Nutrient Removal. In terms of complexity and additional equipment to maintain the Nutrient Removal alternative with Conventional Primary treatment would be most comparable. The other Nutrient Removal processes get more difficult to operate as unit processes are added (i.e., CEPT, Sidestream Treatment, Both)

The Secondary Treatment/Long Sea Outfall alternatives provide an advantage in terms of ease of operations over those providing Nutrient Removal.

5.8.4 Consideration of Maintenance

This criterion considers the relative ease of maintenance for each of the alternatives. A lesser number of unit processes is desirable, because there would be a lesser number of subsystems and different equipment items to understand, maintain, and support. The existing spare parts storage area is limited and would need to be extended to support any significant increase in equipment items. Maintenance requirements will generally increase as control systems become more complex due to the number of field instruments that must be calibrated and maintained. It is often difficult to train and retain electricians and instrumentation and control systems specialists at wastewater treatment works because they are in high demand elsewhere.

Denitrification requires chemical storage and feed systems, which are considered to be easy to maintain. Backwash pumps and controls are fairly simple and require only routine maintenance. However, there will be a large number of equipment items due to the numbers of individual filters to be added.

CEPT requires chemical storage and feed systems, neither of which should present maintenance difficulties.

Sidestream treatment systems would be proprietary designs and their control systems may not be totally compatible with other control systems at the WwTW and require a high level of process control. The SHARON process requires the addition of a soluble carbon source, such a methanol, and the ANAMMOX process uses ammonia.

Deep Shaft NDN systems would be proprietary designs and their control systems may not be totally compatible with other control systems at the Works. These systems would add several types of pumps, as well as blowers, compressors and flotation clarifiers. Polymers may be used to assist in TSS capture, but maintenance of polymer systems is routine at Ringsend.

Secondary Treatment with a Long Sea Outfall would add effluent fine screens and an additional secondary treatment. The fine screens are automatically backwashed but will require occasional removal of biological deposits with sodium hypochlorite. Secondary treatment would likely introduce different aeration equipment as well as new clarifier equipment, adding to storage demands.

Operations of a secondary system would be somewhat less maintenance intensive than any system that requires Nutrient Removal. In terms of complexity and additional equipment to maintain, the Nutrient Removal alternative with Conventional Primary treatment would be most comparable. The other Nutrient Removal processes get more difficult to maintain as unit processes are added (i.e., CEPT, Sidestream Treatment, Both)

The Secondary Treatment/Long Sea Outfall alternatives provide an advantage in terms of maintenance over those providing Nutrient Removal.

5.8.5 Consideration of Sludge Production

The alternatives including CEPT will generate approximately 12,800 to 14,200 tonnes per year more sludge than the Secondary Treatment/Long Sea Outfall alternatives. Those that do not include CEPT will generate approximately 2,900 to 4,000 tonnes per year more sludge from phosphorus removal.

The Secondary Treatment/Long Sea Outfall alternative has a distinct advantage in minimising sludge production over those providing nutrient removal.

5.8.6 Consideration of Power Consumption

Direct power consumption for each of the alternatives is what is required for treating the wastewater to the appropriate discharge standards. The categories are summarised as follows:

- Aeration and pumping for SBRs;
- Aeration and pumping for new secondary treatment facilities;
- Aeration, pumping and solids separation for deep shaft systems;
- Drive power and pumping for effluent fine screens;
- UV disinfection; and
- Denitrification system pumping.

The total indirect power consumption to digest and dry sludge is estimated to be 2.05 MWh/tonne dry solids. This rate is applied to the additional solids produced from chemical addition and/or improved TSS removal. It is noted that unit power consumption may actually be higher because much of the sludge generated from chemical addition will be inorganic and destruction rates in the digesters might not continue to be as high as currently achieved.

Table 5.2 summarises energy consumption from each of the alternatives and compares each of the alternatives to the secondary treatment alternative, which consumes the least amount of electricity.

Generation of electricity produces greenhouse gases, the rates of which vary according to the source of the electric power from renewable sources on the low end of the scale to coal and peat at the upper end. While the rates vary according to the sources, total emissions will be linear with consumption for the same mix of sources.

Table 5.2 Electrical Power and Chemical Consumption of Wastewater Treatment Alternatives

	Nutrient Removal				Secondary Treatment
	Current Primary	With CEPT	With Sidestream[1]	with both[1]	with Outfall
Power Consumption (MWh/yr)					
Direct Power Consumption	44,000	38,400	44,400	38,400	27,200
Indirect Power Consumption	31,400	52,400	29,200	49,400	23,200
Total	75,400	90,800	73,200	87,800	50,400
Ratio to Secondary Treatment with Outfall	150 %	180 %	145 %	174 %	100 %

1. Assumes ANAMMOX process

The Secondary Treatment/Long Sea Outfall alternative would be operated to avoid nitrification and reduce the associated power for oxidation of nitrogen species. Effluent would not be disinfected and would flow by gravity through the outfall. No chemicals would be applied and, therefore, no chemical sludge would be produced. Direct power consumption for the SBRs plus indirect power consumption for sludge treatment is estimated to be approximately 50,400 MWh/yr in the design year.

In addition to higher power demand for nitrification, all Nutrient Removal alternatives require chemical addition for phosphorus control, creating additional chemical sludge quantities that add substantial indirect power demands. The least energy intensive Nutrient Removal alternatives would consume 45 % more power than Secondary Treatment/Long Sea Outfall alternatives, and the most intensive would consume 80 % more power.

The Secondary Treatment/Long Sea Outfall alternatives have a distinct energy advantage over those providing Nutrient Removal.

5.8.7 Consideration of Chemical Consumption

Table 5.3 presents a summary of the chemicals that would be used for each of the alternatives. The secondary treatment options compatible with an ocean discharge would require no additional chemicals for wastewater treatment. The options compatible with discharge into the Liffey Estuary would consume between 10,400 m^3/yr and 22,500 m^3/yr of alum, methanol, and polymer. These chemicals produce secondary greenhouse gas emissions from their production and transport. The additional sludge they produce would further add to greenhouse emissions from sludge processing, transport, and disposal.

The secondary treatment alternative would require no chemicals other than those currently used for solids processing.

Nutrient removal alternatives would require between 10,000 m^3/yr and 20,000 m^3/yr of alum, methanol or other soluble carbon source, polymer, sodium hypochlorite, and citric acid. Deliveries are estimated at two to four tankers per day.

The secondary treatment alterative has a distinct advantage in chemical consumption over those providing nutrient removal.

Table 5.3 Chemical Consumption of Wastewater Treatment Alternatives

	Nutrient Removal				Secondary Treatment with Outfall
	Current Primary	With CEPT	With Sidestream[1]	with both[1]	
Alum (m^3/yr)	8,000	16,800	8,000	16,800	-
Methanol (m^3/yr)	3,800	5,600	2,200	3,400	-
Polymer[2] (m^3/yr)	200	100	200	100	
Total	12,000	22,500	10,400	20,300	-

1. *Assumes ANAMMOX process*
2. *Assumes 25 % active liquid polymer*

5.8.8 Consideration of Water Quality

All alternatives discharging to the Liffey Estuary, while compliant with UWWT Directive standards, will add pollutant loading to the estuary and the inner bay, which contain Special Protected Areas (SPAs), Special Areas of Conservation (SACs) and Bathing Waters. The long sea outfall alternative would improve water quality in the estuary and the bay. A preliminary assessment of water quality was carried out in *"Preliminary Assessment of Long Sea Outfall Locations"*, CDM, Jan 2010 and subsequent reports and a summary of these assessment reports is contained in Chapter 8 Water Quality of this document.

Preliminary assessment of the long sea outfall options demonstrated that secondary treated discharges would not have a significant impact on Coastal or Transitional water bodies. Appropriate Assessments of the outfall discharges concluded that there would be changes in water quality in the immediate vicinities of the discharge point, but that no significant impacts were predicted for any Natura 2000 site. Further, by moving the discharge terminus offshore, water quality within the estuary and the inner bay, where Natura 2000 sites and bathing waters are located, will improve.

5.8.9 Consideration of Greenhouse Gases

Power consumption has a direct relationship with greenhouse gas production. However, the ratio of carbon emissions to energy consumption at the Ringsend WwTW is complex because it varies greatly with the source of energy used in power production (by the utility), the degree to which the CHPs are operated with natural gas, the ratio of sludge dried (with natural gas) or dewatered as Biocake, and the degree to which energy is recovered from sludge processing. A greenhouse gas emission rate was estimated and the CO_2 equivalent related to energy consumption calculated. Chemical production and transportation generate greenhouse gases as does sludge treatment, transportation to the distribution centre, and incorporation into the soil, and the CO_2 equivalent is set out in Table 5.4, below.

Since the Secondary Treatment/Long Sea Outfall alternative has a distinct advantage in power consumption, chemical consumption and sludge production, it follows that it has a distinct advantage in greenhouse gas emissions. The Secondary Treatment/Long Sea Outfall alternative has slightly less than two thirds of the greenhouse gas emissions of the other alternatives and a minimum of 10,000 tonnes CO_2 less than the alternatives per year. This equates to the electricity use of over 1,200 homes per year.

Table 5.4 Greenhouse Gas Emission Generation

	Nutrient Removal				Secondary Treatment with Outfall
	Current Primary	with CEPT	with Sidestream	with Both	
Direct Power Purchased					
MWh/yr	44,000	38,400	44,400	38,400	27,200
GHG Factor (tonnes CO_2/MWh)	0.550	0.550	0.550	0.550	0.550
GHG (tonnes CO_2/yr)	24,200	21,120	24,420	21,120	14,960
Sludge Hauling (tonnes/yr)	15,317	25,561	14,243	24,097	11,317
GHG Factor (tonne CO_2/tonne sludge)	0.0093	0.0093	0.0093	0.0093	0.0093
GHG (tonnes CO_2/yr)	142	238	132	224	105
Sludge Drying					
MWh/tonne input	2.05	2.05	2.05	2.05	2.05
MWh/yr input	31,400	52,400	29,200	49,400	23,200
GHG Factor (tonnes CO_2/MWh)	0.205	0.205	0.205	0.205	0.205
GHG (tonnes CO_2/yr)	6,437	10,742	5,986	10,127	4,756
Total GHG (tonnes CO_2/yr)	30,779	32,100	30,538	31,471	19,821

5.9 Summary of Assessment of Alternatives

The primary objective of the project is to extend the Works from its present capacity to the maximum achievable within the curtilage of the existing site and to achieve the required discharge standards. This was further defined in the Design Review Report which refined the design criteria to increase the

WwTW average day treatment to 2.4 million PE with all units in operation and a firm treatment capacity of 2.1 million PE at all times (the lower figure refers to the capacity when the largest process unit is out of service). Additional objectives are to provide facilities that are robust, reliable and provide redundancy. A summary of the assessment of the alternatives is graphically presented in Figure 5.4.

Secondary Treatment with a Long Sea Outfall discharge is the lower-cost alternative. The cost variance depends on outfall length, but in all cases the Total Present Worth is lower than the least cost Nutrient Removal alternative. It also consumes less energy and chemicals and produces less sludge and greenhouse gases. It is simpler to operate and maintain. It is the low-risk alternative. The discharge would meet water quality standards and be protective of existing Natura 2000 sites and bathing waters.

The provision of secondary treatment with a Long Sea Outfall discharge is therefore recommended as the most beneficial option for the Ringsend WwTW Extension.

5.10 Design Build Procurement

In accordance with current Government policy, it is likely that the project will be procured as a Design/Build (DB) contract. In this case the waste water treatment process proposed by the tendering contractors will be required to comply fully with the Performance Requirements set out in the Contract Documentation including such Development Consent Approval as may be granted by An Bord Pleanála.

Three viable secondary treatment processes (conventional, deep shaft aeration or additional SBRs) would result in compliance with the process requirements and could, therefore, be selected at detailed design stage. Some flexibility will be provided in the contract documents in relation to the treatment type and plant layout provided that the process chosen meets the performance requirements and other design criteria and complies with the Statutory Approval.

The consideration and assessment of likely significant effects/impacts and the measures envisaged to avoid, reduce and where possible remedy significant adverse effects/impacts (mitigation measures) are based on the preliminary design of the scheme as detailed in this Environmental Impact Statement.

The preliminary design and the environmental mitigation measures will be further progressed and refined during the detailed design and procurement of the scheme, including the mitigation measures contained in such Approval as may be granted.

The detailed design and procurement will provide for development of the preliminary design in a manner such that there is no material change in terms of significant adverse effect on the environment. Opportunities may be identified to further reduce the significance of adverse effect/impact and, in some cases, improve the residual effect/impact.

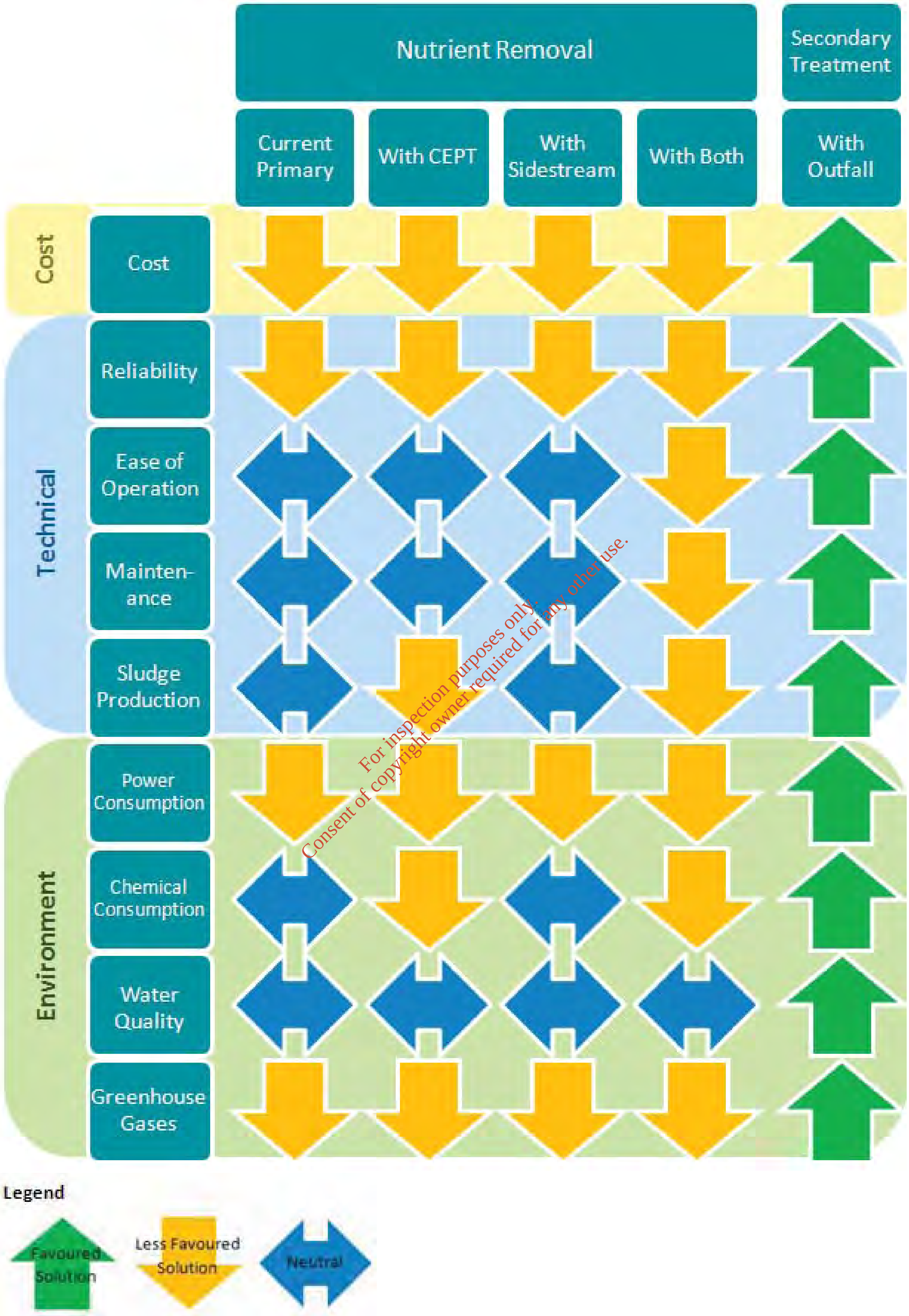


Figure 5.4 Simplified Summary Matrix of Assessment of Feasible Alternatives

5.11 Discharge Location Alternatives

5.11.1 Modelling of Existing Discharge

In early 2009, Dublin City Council (DCC) engaged CDM to undertake a study into the impact of existing Ringsend WwTW and storm water overflow on the receiving waters of the Liffey and Tolka estuaries and Dublin Bay. CDM subcontracted DHI (Danish Hydraulic Institute) to provide mathematical hydraulic and water quality modelling of the receiving waters using a MIKE3 model previously established for the Waste to Energy Plant at Poolbeg Study and subsequently adapted for a pre-feasibility study for a potential system of flood defence barrages in Dublin Bay.

The study provided details of modelling and discussion of the impact of the discharge and comparison with relevant water quality standards (discharge points are shown in Figure 5.5.) Results of the study were contained in *"Modelling the Impact of Ringsend Wastewater Treatment Works and Storm Overflow Discharge in the Liffey and Tolka Estuaries and Dublin Bay",* April 2009.

Figure 5.5 Ringsend Wastewater Treatment Works and Storm Overflow Discharge.

5.11.2 Identification of Long Sea Outfall Locations

A number of studies were then undertaken in order to identify appropriate long sea outfall locations, as outlined below and further discussed in Section 8.2.1 Evolution of the Project Water Quality Modelling.

5.11.2.1 Preliminary Modelling

Five potential outfall locations were initially modelled and the results are included in the report entitled "Modelling the Impact of Ringsend Discharges in the Liffey and Tolka Estuaries and Possible Long Sea Outfall Discharges in Dublin Bay" October 2009. The study also provided information on the existing discharge and storm water outfall. Figure 5.6 displays on a bathymetric map of the bay, the location of the five locations that were initially modelled.

On the basis of preferential dispersion characteristics, the environmental impacts of two of the five potential outfall locations (as shown in green on Figure 5.7) were then examined in further detail in "Preliminary Assessment of Long Sea Outfall Locations", CDM/JBB, January 2010 and was provided to the EPA under separate cover. This report considered the two outfall locations in terms of the Environmental Objectives (Surface Water) Regulations 2009, the Bathing Water Regulations 1992 and

2008, the Dublin Bay Water Quality Management Plan priority objectives. It also involved a preliminary ecological assessment as described below.

Habitats Directive Article 6 Screening

The preliminary Appropriate Assessment screening of the two modelled outfall locations was carried out to establish whether there would be any significant negative impacts on Natura 2000 protected areas associated with these options. Natura Environmental Consultants were commissioned to undertake a Screening Assessment for each of the two options.

The assessments concluded that although the discharge from the proposed long sea outfalls will result in a change in water quality in the vicinity of the outfall, no significant negative impacts were predicted for any existing or proposed Natura 2000 sites (or for the proposed SAC in the Kish Banks).

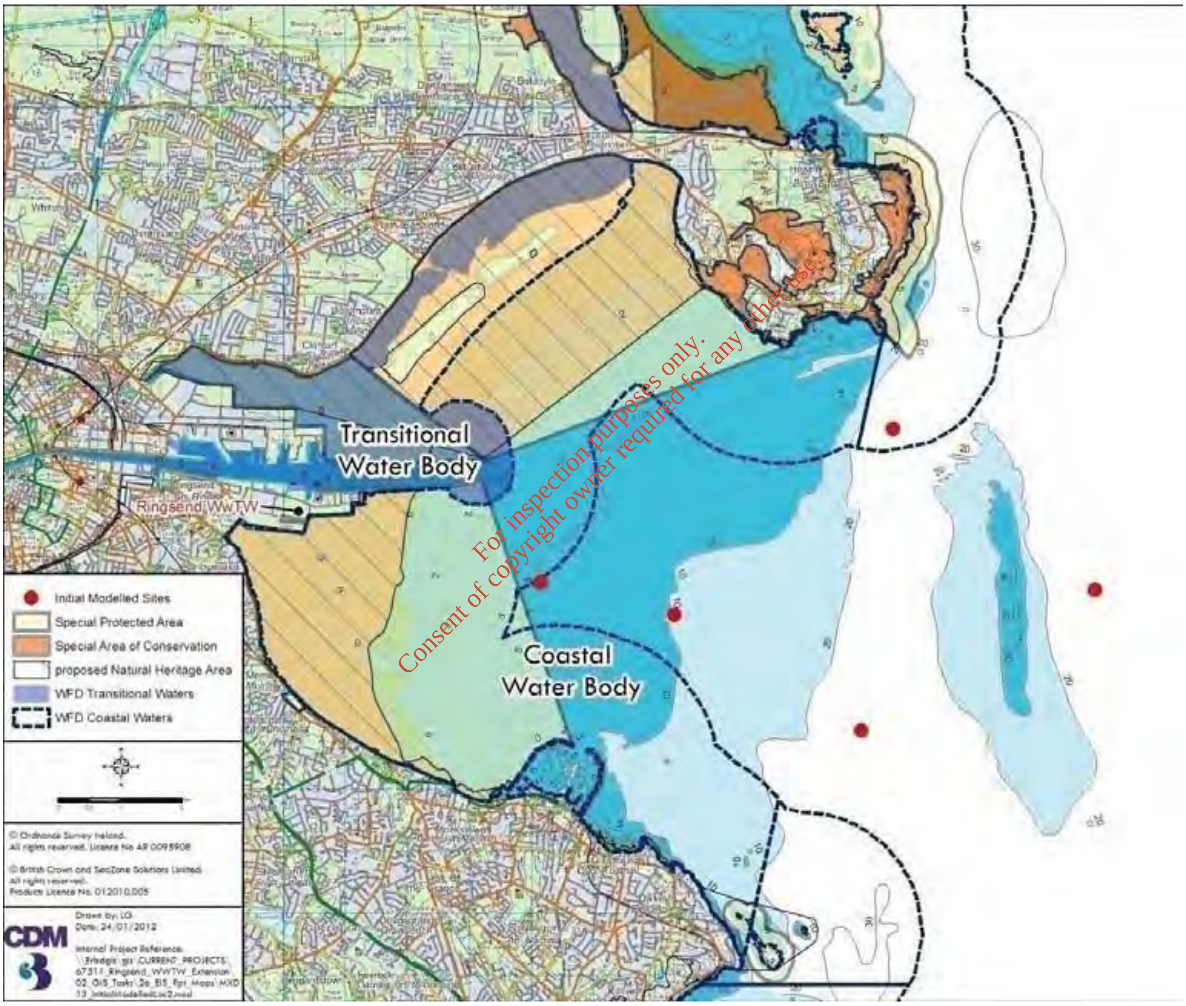


Figure 5.6 Initial Long sea Outfall Modelling Locations

5.11.2.2 Constraints Mapping

To further investigate potential long sea outfall discharge locations in Dublin Bay, a desk top study was undertaken to identify and map all known existing constraints on potential discharge locations. The potential constraints in Dublin Bay were broadly split into six categories, as outlined below :

- A: Operational – Dublin Port Company and Dún Laoghaire Harbour operations;

- B: Environmental – Natura 2000 sites, National Heritage areas (NHAs), WFD water body classificaions and nutrient sensitive waters;
- C: Structures and Obstructions – Pipelines and cables and recorded shipwrecks;
- D: Amenity – Bathing waters, sailing and boating and water sports;
- E: Fisheries – Areas where different fishing methods are carried out; and
- F: Geological – bathmetry and bedrock geology (prior to Marine Site Investigtion).

All the known potential constraints were compiled onto one map of Dublin Bay as shown in Figure 5.7. Keeping the results of the preliminary modelling in mind and areas with the least constraints were highlighted for further water quality modelling. A full discussion of the constraints is contained in a report entitled *"Constraint Mapping of Dublin Bay"* (CDM, 2010a) and is reproduced in Appendix B.

5.11.2.3 Further Modelling

Following the results of the preliminary modelling of potential outfall locations, the hydraulic model was further developed and then used to predict effluent dispersion, plume trajectories and compliance with EU Water Quality standards in Dublin Bay for a further four locations. The model is further described in Chapter 8 Water Quality.

These four potential outfall locations were selected for further modelling based on the preliminary modelling and the constraints identification exercise, as displayed in Figure 5.7. These are referred to as Locations B1 to B4 and are displayed in Figure 5.8 in relation to the environmental protected areas and the WFD water bodies.

CDM

Scale 1:55,000 at A3

Figure 5.7 Constraints Key Map – Overview of Potential Constraints

CDM BARRY & PARTNERS

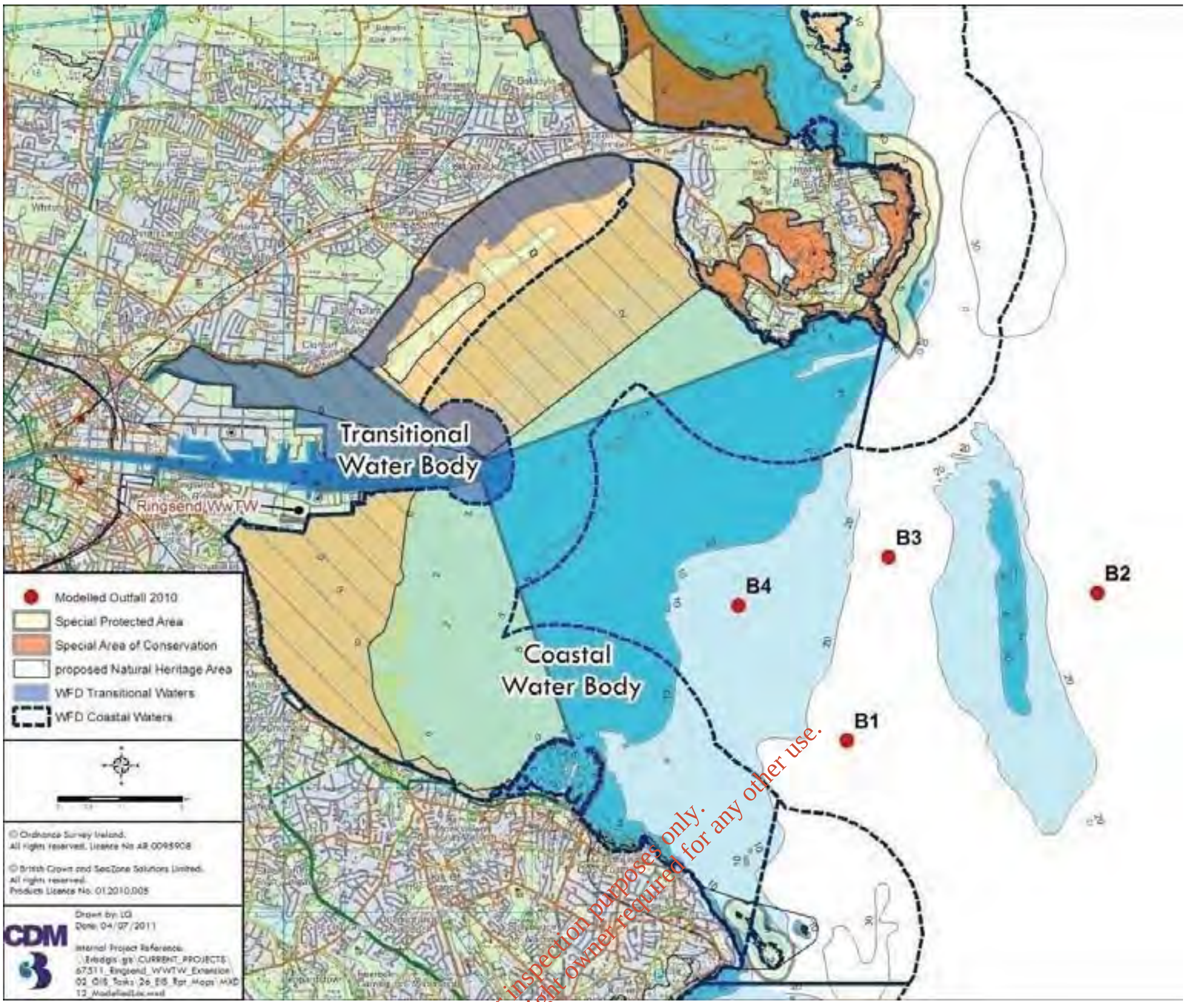


Figure 5.8 Modelled outfall locations and protected areas in Dublin Bay

The results are discussed in the following section and a full discussion of the dispersion characteristics is available under separate cover in *"Ringsend Long Sea Outfalls Modelling Results"* CDM and DHI, January 2011 and also in Appendix G.

5.11.3 Selection Proposed Outfall Location

The results of the further modelling showed that Locations B1, B2 and B3 had preferential dispersion characteristics, with protected areas and amenity areas unaffected by the dispersion plume. Location B4 was eliminated from further consideration due to the unfavourable dispersion characteristics at that location. The modelled outfall locations were also assessed based on technical, environmental and cost factors. The results of the assessment are summarised in Figure 5.9.

Cost of the long sea outfall is proportional to the length of tunnel, therefore, Location B2 was eliminated as it was the least preferred option offering no perceived advantages in terms of dispersion characteristics or water quality for the additional cost.

Locations B1 and B3 offered similar characteristics with respect to dispersion characteristics and absence of impact on protected areas and amenity areas. Both locations were shown to be least affected by the restrictions identified in the constraints maps in Appendix B.2. However, it was decided to proceed with Location B3 due to its more central location with respect to Dublin Bay.

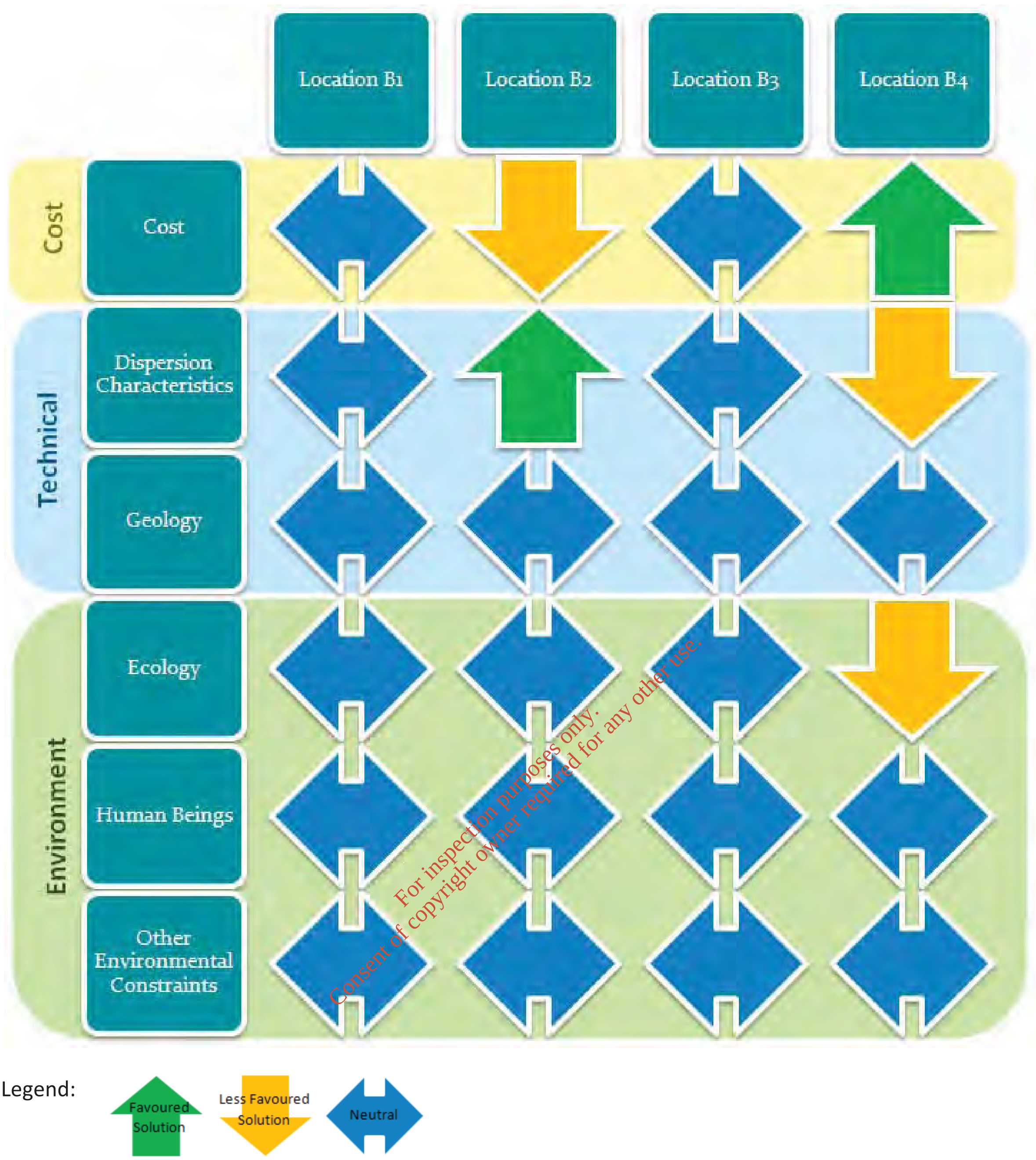


Figure 5.9 Summary of Assessment of Potential Outfall Locations

Following the results of the modelling it was decided to proceed with Location B3 as the location to be included in the design solution and to undergo full Environmental Impact Assessment. (The water quality modelling is discussed in more detail in Chapter 8.)

Chapter 6 Planning and Policy Context

The legislation and planning context relevant to the extension of the Ringsend WwTW were reviewed with respect to their environmental and development policies. This EIS sets out to address these policies. The following is a list of the main legislation that applies to the proposed scheme:

- European Communities (Environmental Impact Assessment) Regulations (Amendment) (SI 659 of 2006);
- The Planning and Development Acts 2000 to 2006;
- Planning and Development Regulations, 2001 (as amended) (SI 600 of 2001);
- Planning and Development (Strategic Infrastructure) Act 2006 (Commencement) Order (SI 525 of 2006, SI 553 of 2006, SI 684 of 2006);
- European Communities (Water Policy) Regulations (S.I. No. 722 of 2003);
- European Communities Environmental Objectives (Surface Waters) Regulations 2009 (SI 272 of 2009;
- The Urban Waste Water Treatment (Amendment) Regulations 2010 (SI 48 of 2010);
- The Waste Water Discharge (Authorisation) Regulations, 2007 (SI 684 of 2007); and
- European Communities (Waste Water Treatment) (Prevention of Odours and Noise) Regulations 2005 (S.I. No. 787 of 2005).

The Environmental Impact Statement (EIS) has been prepared in accordance with the European Communities (Environmental Impact Assessment) Regulations as amended and the Planning and Development Regulations as amended. The relevant sections are described in more detail below.

European Communities (Water Policy) Regulations

The EU introduced the Water Framework Directive (WFD) in 2000. The Water Framework Directive was transposed into Irish legislation by the European Communities (Water Policy) Regulations 2003. The WFD Regulation is aimed at improving water quality in rivers, lakes, groundwater, and coastal waters. The WFD Regulation requires an integrated approach to managing water quality; with the aim of maintaining and improving water quality. The legislation provides for the protection of the quality status of all waters through the establishment of river basin districts where a set of environmental objectives must be met by defined timelines. Specifically the WFD aims to:

- protect/enhance all waters (surface, ground and coastal waters).
- achieve "good status" for all waters by December 2015.
- manage water bodies based on river basins (or catchments).
- streamline legislation.

European Communities Environmental Objectives (Surface Waters) Regulations

The Environmental Objectives (Surface Water) Regulations came into effect on 30th July 2009 and have significant implications across a range of existing legislation. They address the requirements of the Water Framework, Dangerous Substances and Priority

Substances Directives. The Regulations also repeal the Phosphorus and Dangerous Substances Regulations. The Regulations apply to all surface waters and provide for:

- The establishment of legally binding quality objectives for all surface waters and environmental quality standards for pollutants.
- The examination and where appropriate, review of existing discharge authorisations by Public Authorities to ensure that the emission limits laid down in authorisations support compliance with the new water quality objectives/standards.
- The classification of surface water bodies by the EPA for the purposes of the Water Framework Directive.
- The establishment of inventories of priority substances by the EPA.
- The drawing up of pollution reduction plans by coordinating local authorities (in consultation with the EPA) to reduce pollution by priority substances and to cease and/or phase out discharges, emissions or losses of priority hazardous substances.

The Urban Waste Water Treatment (Amendment) Regulations 2010

The Urban Waste Water Treatment (Amendment) Regulations were introduced in 2010. The Regulations amend the Urban Waste Water Treatment Regulations 2001 by designating ten additional areas as sensitive (including the River Liffey) and also incorporates some minor technical amendments. The WwTW will be designed to comply with the Urban Waste Water Treatment (Amendment) Regulations which specifies the type of treatment standards required for the receiving waters (i.e., the discharge location for the treated effluent from the WwTW). This sets limits for BOD, TSS, Nitrogen, Phosphorous and so forth. Cognisance is also taken of the beneficial use of the receiving waters i.e., whether it is a designated bathing area, blue flag beach, location of fishing and shellfishing areas. Water Quality standards are discussed in more detail in Chapter 8.

European Communities (Waste Water Treatment) (Prevention of Odours and Noise) Regulations 2005

The European Communities (Waste Water Treatment) (Prevention of Odours and Noise) Regulations 2005 requires that there is no odour or noise nuisance arising from the operation of the WwTW. Odour and noise models have been developed that demonstrate the existing and proposed odour and noise limits. These are discussed in more detail in Chapter 13 and Chapter 14

6.1 Environmental Impact Assessment

The Environmental Impact Statement for the extension of the Ringsend Works WwTW has been prepared in accordance with the provisions of the Planning and Development Acts, 2000 to 2011, and the Planning and Development Regulations.

This Environmental Impact Statement has been prepared having regard to the Guidelines on the Information to be contained in Environmental Impact Statements 2002 (Environmental Protection Agency) and the Advice Notes on Current Practice in the preparation of Environmental Impact Statements 2003 (Environmental Protection Agency).

The proposed development is to increase the capacity of the Ringsend Wastewater Treatment Works to the maximum available within the curtilage of the site while also satisfying the discharge standards. from 1.64 million Population Equivalent (PE) to a treatment capacity of 2.4 million PE with a firm treatment capacity of 2.1 million PE. DCC submitted a request to An Bord Pleanála for an opinion as to whether an EIS was required. An Bord Pleanála confirmed that an EIS would be required as the development was considered to be Type 22 of Part 1 of Schedule 5 of Planning and

Development Regulations 2001 (as amended). S.I. No. 364 of 2005 amends the Planning and Development Regulations, 2001 to include Type 22 as follows:

> *"Schedule 5 of the regulations is amended-*
>
> *a) by the addition in Part 1 of the following paragraph*
>
> *22. Any change to or extension of projects listed in this Annex where such a change or extension in itself meets the thresholds, if any, set out in this Annex"*
>
> Type 13 of Schedule 5 Part 1 refers to waste water treatment plants exceeding 150,000 population equivalent as follows:
>
> *13. Waste water treatment plants with a capacity exceeding 150,000 population equivalent as defined in Article 2, point (6), of Directive 91/271/EEC .*

Having regard to the foregoing, it was confirmed that an EIA is required for this project.

The EU Directive on Environmental Impact Assessment (85/337/EEC) and the European Communities (Environmental Impact Assessment) Regulations, 1989(as amended) refer to the duties of the "Developer" and the "Competent Authority". For the purposes of this project, the "Developer" is DCC and the "Competent Authority" is An Bord Pleanála (the Board).

6.2 Planning Legislation

6.2.1 Strategic Infrastructure

The proposed development falls within the definition of 'strategic infrastructure development' as defined in the Planning and Development (Strategic Infrastructure) Act, 2006 which amends the Planning and Development Acts, 2000-2002. Part 3, 6 (c) of the Planning and Development (Strategic Infrastructure) Act, 2006 amends Section 2(1) of the Principal Act (Planning and Development Act, 2000, as amended by Planning and Development Act, 2002) by inserting the definitions for 'strategic infrastructure development'. There are eight definitions of strategic infrastructure developments as follows:

> *(a) any proposed development in respect of which a notice has been served under section 37[1]B(4)(a),*
>
> *(b) any proposed development by a local authority referred to in section 175[2](1) or 226[3](6),*
>
> *(c) any proposed development referred to in section 181[4]A(1),*
>
> *(d) any proposed development referred to in section 182[5]A(1),*
>
> *(e) any proposed strategic gas infrastructure development referred to in section 182C(1),*
>
> *(f) any scheme or proposed road development referred to in section 215,*

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[1] Control of Development, Appeal to Board
[2] EIA of certain development carried out by or on behalf of Local Authorities
[3] Obligation to obtain permission in respect of development on foreshore
[4] Development by State Authorities
[5] Cables, wires and pipelines

(g) any proposed railway works referred to in section 37(3) of the Transport (Railway Infrastructure) Act 2001 (as amended by the Planning and Development (Strategic Infrastructure) Act 2006), or

(h) any compulsory acquisition of land referred to in section 214, 215A or 215B, being an acquisition related to development specified in any of the preceding paragraphs of this definition;

Criterion (b) above applies to this project. Sections 175(1) refers to 'EIA of certain developments carried out by or on behalf of Local Authorities' and includes Waste Water Treatment Plants with a capacity or extension capacity greater than the specified threshold. This is discussed in Section 6.2 above (with reference to the Planning and Development Regulations).

Sections 226(6) refers to 'Local Authority development on the foreshore'. Where a local authority proposes to carry out development (non-roads) within its own functional area that is subject to EIA and the development proposed is wholly or partly on the foreshore, an application for approval under section 226 of the Planning and Development Acts must be made.

Where both of the above criteria apply, the Principal Act only requires the application to be made under Section 226. Consequently planning approval will be sought from the Board under Part XV (Development on the Foreshore) of the Planning and Development Acts 2000-2011 and shall be referred to the Strategic Infrastructure Division.

6.2.2 Planning and Development Regulations

This EIS was prepared in accordance with the requirements of the Planning & Development Regulations. Part 11, Chapter 3 of the Regulations lists the prescribed authorities that should be consulted in relation to the EIS. These authorities depend on the type of development proposed and include An Taisce, Regional Fisheries Board, DECLG, EPA and so forth.

There are number of Seveso sites in the vicinity of the proposed extension. The proposed Dublin Waste to Energy facility which is located on the adjoining site has been identified as a Seveso site in the DCC Development Plan (2011 – 2017). Article 12 of the Seveso 2 Directive (96/82/EC) provides that appropriate consultation procedures must be put in place so as to ensure that before decisions are taken, technical advice is available to Planning Authorities in respect of relevant establishments. The Health & Safety Authority provides such advice where appropriate in respect of planning applications within a certain distance of the perimeter of these sites. The Health and Safety Authority is also a statutory consultee under Part 10, Chapter 4 of the Planning and Development Regulations.

6.2.3 Foreshore Licence

A Foreshore Licence will be required for the element of the project that is to be undertaken in the foreshore and an application for a licence will be made to the Coastal Zone Management Division of the Department of Environment, Community and Local Government (DECLG). Normally an EIS would be required to accompany the Licence application under the Foreshore Acts 1933 - 2009. However, as the application for planning approval will be accompanied by an EIS under Part XV of the Planning and Development Acts, the Coastal Zone Management Division of the DECLG will be a Statutory Consultee and consequently it is not necessary to accompany the Foreshore Licence application form with an EIS.

6.2.4 The Waste Water Discharge (Authorisation) Regulations

A system for the licensing or certification of waste water discharges (WWD) from areas served by local authority sewer networks was brought into effect by the Minster for the Environment, Heritage and Local Government on 27th September 2007. The licensing and certification authorisation process was introduced on a phased basis in accordance with the requirements of the Waste Water Discharge (Authorisation) Regulations, 2007. The existing WwTW currently has a discharge licence and a new discharge licence will need to be obtained for the proposed scheme.

6.3 Planning Policy

The proposed development is reviewed in the context of current planning policy, including:

- National Development Plan 2007-2013;
- National Spatial Strategy 2002-2020;
- Dublin City Development Plan 2011-2117;
- Dublin Docklands Development Authority Masterplan 2008;
- Greater Dublin Regional Drainage Study;
- Dublin Bay Water Quality Management Plan;
- Village Design Statement, Sandymount, 2011;

The relevant policies in relation to the proposed extension are listed below.

6.3.1 National Development Plan and National Spatial Strategy

The National Development Plan (NDP) and the National Spatial Strategy (NSS) sets out the roadmap to Ireland's future taking into account population growth and changes to the economy and society. The NDP integrates strategic development frameworks for regional development, for rural communities, for all-island co-operation, and for protection of the environment with common economic and social goals.

The NDP and NSS therefore set out the general and strategic aims for the country as a whole. Individual Development Plans, Local Area Plans or Masterplans for cities, towns and areas are then developed which encompass and implement the aims of the NDP and NSS. In the case of Ringsend this is the Dublin City Development Plan.

The NDP identifies five main cities, Dublin, Cork, Limerick, Galway and Waterford, as 'Gateways', or engines of regional and national growth. The NDP set the NSS the task of further developing the Government's approach to achieving more balanced regional development, including the identification of a limited number of additional gateways.

Section 3.2 of the NSS states "*Dublin as the capital city plays a vital national role. But it needs effective strategic planning and better management of the strong development pressures within it to secure and consolidate that role for the future.*"

Section 3.3.1B of the NSS states "*With further improvements to its amenities and quality of life attractions, Dublin can maintain and improve its European and world competitiveness in attracting investment and encouraging people to live in the city area itself.*

The continuing health of the Dublin is critically dependent on

- *creating an efficient and high quality system of public transport connections within the Dublin area to improve access to employment, education, services and amenities*
- *good international access particularly through Dublin Airport and Dublin Port*
- *good transport and telecommunications connections with other national gateways*
- *efficient and cost effective water services and waste management infrastructure*

- *concentrating employment intensive activities close to public transport corridors and road transport intensive activities close to the strategic road network*
- *continuing investment in and development of Dublin's ability to innovate in education, research and development through its third level educational institutions and effective linkages with industry*
- *maintaining the distinction between the city and town components within the Greater Dublin Area as envisaged by the Strategic Planning Guidelines for the area, which focus on the metropolitan area, the hinterland and a number of other strategically placed towns as primary or secondary development centres within the hinterland*
- *protecting Dublin's outstanding natural setting – Dublin Bay, the Dublin and Wicklow Mountains, surrounding rural hinterlands, river valleys like the Boyne and Liffey, and physical amenities such as parks*
- *investing in the quality of life attractions of the city and its surrounding centres, particularly in terms of education at primary and secondary level, healthcare, childcare, cultural and entertainment facilities*
- *eliminating areas of social deprivation and ensuring integrated development of areas in the future."*

6.3.2 Dublin City Development Plan 2011 - 2017

The Dublin City Development Plan sets out policies and objectives for Dublin city. The plan guides how and where development will take place in the city over the 6 years. The plan was adopted by Dublin City Council at a special adjourned meeting on 24th November 2010 and came into effect on 22nd December 2010

The proposed development conforms with the Dublin City Development Plan 2011 -2017. The relevant policies and objectives are quoted below.

"It is the policy of Dublin City Council:

- ***SI43*** *To ensure the upgrading of wastewater infrastructure and to facilitate the provision and safeguarding of infrastructure corridors required to facilitate sustainable development in the city and region*
- ***SI44*** *To support the development of the Greater Dublin Regional Wastewater Treatment Plant, Marine Outfall and Orbital Sewer to be located in the northern part of the Greater Dublin Area to serve the Dublin Region as part of the Greater Dublin Strategic Drainage Strategy.*
- ***SI45*** *To provide additional and improved wastewater treatment capacity by the upgrading of the Ringsend Waste Water Treatment Plant.*
- ***SI46*** *In co-operation with the other local authorities to implement the recommendations, as appropriate, of the Greater Dublin Strategic Drainage Strategy, subject to funding being available*
- ***GC24*** *To seek the continued improvement of water quality, bathing facilities and other recreational opportunities in the coastal, estuarine and surface waters in the city and to protect the ecology and wildlife of Dublin Bay."*

"It is an objective of Dublin City Council:

- ***SIO75** In cooperation with other Local Authorities in the Region to implement appropriate Development Management policies to prevent overloading of the wastewater infrastructure and the consequent risk of pollution of natural waterbodies"*

6.3.3 Dublin Docklands Development Authority Masterplan 2008

The Dublin Docklands Development Authority Masterplan 2008 is incorporated into the Dublin City Development Plan. Under the Masterplan, the Poolbeg peninsula and the site of the proposed development fall within the SRDA 6 (Strategic Development and Regeneration Area) as set out in the Dublin Docklands Development Authority (DDDA) Masterplan 2008. Future development in Poolbeg will be informed by the following development principles.

- To ensure that new development facilitates the implementation of a global landscape plan for the Poolbeg Peninsula developed in the context of the unique landscape qualities of the peninsula, river and bay area.
- To ensure that significant dimensions of the landscape framework are implemented as part of any future development in utilities.
- To support a "differentiated character" approach within an overall landscape framework that will allow for the consolidation of specific activities.
- To promote an urban scale and form of development with mixed use and defined areas of "predominant character".
- To allow for utilities operation and expansion within an overall environmental improvement strategy and landscape plan.
- To promote and protect the ecology of the area, while providing for recreational open space with public access within a consolidation framework for public utilities, including the re-use of historic structures.
- To improve accessibility through the development of a movement framework with a strong emphasis on public transport, pedestrian/cycle networks and incorporating innovative approaches geared to developing sustainable modes of commuter movement and car parking.
- To initiate a phased development of both commercial development and public realm – landscape/road infrastructure to ensure that key elements of the landscape framework are of the highest quality design and are implemented early in the overall phasing plan to set future precedent for area character.
- To ensure phased implementation of major redevelopment sites can be linked to the implementation of significant public realm packages of the landscape framework plan identified outside of the commercial sites in question.
- To ensure that all development is compatible with the nature conservation designations of the south bay including the Habitats Directive.

- To ensure that the unique landscape qualities of the Poolbeg Peninsula, rivers and bay area are recognised in any development proposals for the Poolbeg area and that the existing open character and nature of the views from Irishtown Nature Park are retained as far as practicable.

6.3.4 Greater Dublin Strategic Drainage Study

The existing wastewater treatment works in the study area were assessed in relation to their currently planned expansion, the ultimate design load and receiving water and existing site constraints. The wastewater treatment works were summarised as:

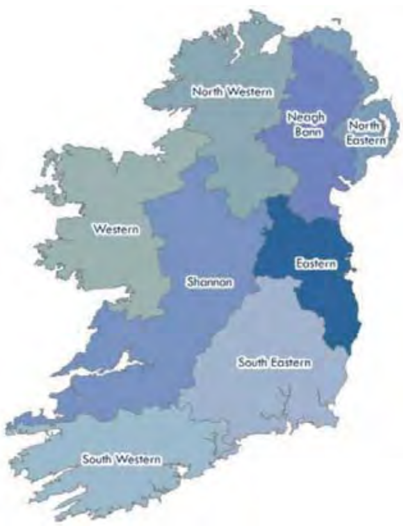
"Ringsend – The existing plant is at capacity and needs immediate expansion for short term needs to meet the requirements of the Nitrogen Discharge Standards for Dublin Bay as set out in the Urban Wastewater Treatment Regulations."

The study has defined the issues facing the Region's drainage and taken a strategic approach to address them, being:

- *"To relieve overloading at Ringsend WwTW, while catering for committed development to 2011 of zoned lands and resolving pollution and flooding risks within the existing networks."*
- *"To provide for necessary ongoing development in the Greater Dublin Region, while ensuring that existing networks, Ringsend and other local WwTWs can accommodate the needs of the existing catchments to 2031."*

6.4 Eastern River Basin District River Basin Management Plan

The island of Ireland has been divided into eight river basin districts (refer to map) to help manage implementation of the WFD and a River Basin Management Plan has been developed for each river basin district.



The Eastern River Basin District - River Basin Management Plan 2009-2015 (ERBD Plan) describes the actions that are proposed to ensure the necessary protection of our waters over the coming years. It sets out how the aims and objectives of improving and protecting water quality and ecology in the waters of each river basin district could be achieved, by means of a Programme of Measures.

Under the ERBD Plan, the Liffey Estuary has been designated moderate status with the objective to achieve good status by 2027. The extension to the Ringsend WwTW and need to achieve this good status water has been identified as an objective under the Plan. This is discussed in further detail in Section 8.1.1.1.

6.5 Dublin Bay Water Quality Management Plan

A list of priority objectives were drafted as part of the Dublin Bay Water Quality Management Plan. It should be noted that these objectives were drafted prior to the commissioning of the existing treatment plant. The 16 priority objectives are a very general statement of environment policy in relation to water quality in the Bay and were drafted in 1991 when untreated sewage was being discharged. The objectives are discussed in more detail in Chapter 8 Section 8.8.6.

6.6 Flood Risk Assessment

A Flood Risk Assessment was undertaken for the Ringsend WwTW Extension site (Ringsend WwTW Extension Flood Risk Assessment, CDM & JBB, 2012).

There are no records of groundwater or surface water flooding at the WwTW site or tunnel inlet shaft site, but Pigeon House Road flooded during the February 2002 event as a result of wave action. The biggest flood risk is therefore from tidal/coastal flooding.

Pigeon House Road is in Flood Zone A - High risk and is categorised as 'less vulnerable development' or 'water compatible development'. As this is an existing road, mitigation measures were proposed for consideration over the long term. The WwTW extension site is classified as being 'highly vulnerable development (including essential infrastructure)' and is located within Flood Zone C – Low Risk. The tunnel inlet shaft is classified as being a 'water compatible development' and is located within Flood Zone B – Moderate Risk. The assessment demonstrated that the proposed project is an appropriate development for the location.

As the proposed works are located on brownfield sites, the proposed project will not result in any additional surface water runoff and will have an imperceptible impact on the existing flood regime of the area.

6.7 Sandymount Village Design Statement, September 2011

Sandymount VDS is the second 'Pilot' VDS project to be carried out under the Heritage Council's new community-led Village Design Programme II. It was supported and lead by local community groups, residents, Dublin City Council and the Heritage Council. The following two objectives from the VDS are noted.

7.2 The Strand & Promenade

Objective: To retain the Strand and sea wall as a primary visual and recreational amenity for residents and visitors in recognition of its contribution to Sandymount's cultural and natural heritage.....*The wide expanse of sand that is exposed at low tide is not just a major asset to Sandymount but is also the reason why the Village has developed in the manner in which it has done.*

7.5 Green Infrastructure

Objectives: To retain and enhance opportunities for biodiversity and habitat creation within the village. To respect the contribution of existing ornamental planting to Village character. To monitor the effect of development on wildlife / habitats.....*Sandymount is fortunate in having the beach as a natural resource. The Strand is one of Ireland's prime Special Protection Areas (SPAs) for winter wading birds. This is enhanced by the wildlife corridor associated with the River Dodder, the proximity of the*

Irishtown Nature Park, several green open spaces and the fact that a large proportion of the village is cultivated as private gardens.

6.8 Conclusions

The proposed extension to the treatment plant will be accommodated within the curtilage of the existing WwTW. The initial review concludes that the proposed extension of Ringsend Wastewater Treatment Plant is in agreement with planning policy. The construction of the long sea outfall discharging into Dublin Bay is outside the existing curtilage. The outfall will be constructed by tunnelling and will not involve any disturbance to the seabed other than in the immediate area of the outfall terminus.

Planning approval will be sought from the Board under Part XV (Development on the Foreshore) of the Planning and Development Acts 2000-2011 and shall be referred to the Strategic Infrastructure Division. A number of separate licences and consents will also be required including a Foreshore Licence.

Chapter 7 Human Beings

7.1 Introduction

This chapter assesses the potential impact of the proposed Ringsend WwTW Extension on human beings in the context of the Socio Economic environment. Human Beings in this chapter are taken to refer to the local residential population, the people who work in the area and the people who visit the area. The impacts on the quality of life of the human beings due to the construction and operation of the proposed Ringsend WwTW extension are assessed. This section deals with demography, employment, and community aspects. Other impacts on human beings are covered within other environmental element assessments, namely:

- Chapter 8 Water Quality;
- Chapter 11 Landscape and Visual;
- Chapter 12 Traffic;
- Chapter 13 Air Quality and Odour;
- Chapter 14 Noise and Vibration; and
- Chapter 17 Material Assets

7.2 Methodology

7.2.1 Data Sources

A desk based study was undertaken to collate information on population, demography and employment within the vicinity of the proposed development. The assessment of impact on human beings was based on data sourced from the following:

- Census Data from the Central Statistics Office;
- Dublin City Development Plan 2011 -2017;
- Dublin Docklands Development Authority Masterplan 2008; and
- Economic and Social Research Institute's Quarterly Commentaries; and
- Sandymount Village Design Statement, 2011.

The Dublin Docklands Authority Draft Planning Scheme for Poolbeg Peninsula has now been rescinded and procurement for consultants to produce a revised scheme has commenced.

7.2.2 Study Area

For the purposes of this chapter, the local community area is taken to be the local electoral divisions of Pembroke East A, B and C (Refer to Figure 7.1 for details). These contain the areas of Ringsend, Irishtown and Sandymount. However, it should be noted that for assessment of impacts on human beings that are dealt with elsewhere (air, noise, odour, traffic, etc) larger study areas have been used as deemed appropriate.

Figure 7.1 Electoral Divisions

7.2.3 Impact Assessment Criteria

The source and type of impacts is set out in Sections 7.4 and 7.5. The mitigation measures that are defined for any potentially significant impacts are set out in 7.7. Any likely residual impacts are evaluated in terms of magnitude and significance in Section 7.8.

7.2.3.1 Magnitude

The magnitude of an impact is assessed in consideration of its intensity, and its extent in space and time. Impacts can be described as low medium or high.

7.2.3.2 Duration

Short-term Impact	-	Impact lasting one to seven years.
Medium-term Impact	-	Impact lasting seven to fifteen years.
Long-term Impact	-	Impact lasting fifteen to sixty years.
Permanent Impact	-	Impact lasting over sixty years.
Temporary Impact	-	Impact lasting for one year or less.

7.2.3.3 Significance

The significance of all impacts is assessed in consideration of the magnitude of the impact and the importance / sensitivity of the affected area. Impact significance is described as being *Not significant*, of *Low* significance, of *Medium* significance, or of *High* significance.

7.3 Existing Environment

7.3.1 Land Use

The land which constitutes the Poolbeg peninsula has been reclaimed commencing in the 17th and 18th centuries and continued through the 19th and 20th centuries. The bulk of reclamation took place in the mid 20th century. Details on the history of the area can be found in Chapter 15 Archaeology and Cultural Heritage. The peninsula is dominated by industrial installations such as the ESB power generating station, the wastewater treatment works, and various port/dockland related activities. Planning permission has been granted for a waste to energy facility on the site adjoining the waste water treatment works. The peninsula is zoned (the Dublin City Development Plan 2011 – 2017) "to provide for the protection and creation of industrial uses and facilitate opportunities for employment creation".

There are a number of amenity and recreation areas on the peninsula (as shown on Figure 7.2):

- Irishtown Nature Reserve;
- Irishtown Stadium;
- Sean Moore Park;
- Poolbeg Marina;
- Sandymount Strand; and
- South Bull Wall.

There are no residential dwellings within 900 metres of the Ringsend Wastewater Treatment Works. The nearest dwellings are 11 cottages (Coast Guard Cottages) located on the northern end of Séan Moore Road.

The surrounding communities of Ringsend, Sandymount and Irishtown are located in the South Inner City on the southern side of the River Liffey. These are established residential communities with limited potential for further development.

Figure 7.2 Poolbeg Peninsula – Location Map

7.3.2 Demography of the Local Area

The 2006 census data was consulted to provide demographical data for the local area. (The demography / population equivalent (PE) of the area served by the WwTW is described in Section 4.1.) There has been an overall increase in the population of the surrounding communities between 2002 and 2006. However, this has been confined to Pembroke East A. The populations of Pembroke East B and C actually dropped over this period.

Details of the population trend between 2002 and 2006 is shown Table 7.1. The overall population of Dublin City South increased by 3 % in the same period.

Table 7.1 Population Trends (Source CSO)

Electoral Division	2002	2006	2011*	Change in Population 2006-2011	
	Persons	Persons		Actual	Percentage
Pembroke East A	4,304	4,754	4,916	162	3.4
Pembroke East B	3,595	3,435	3,606	126	3.6
Pembroke East C	3,900	3,723	3,936	175	4.7
Total	11,799	11,912	12,458	463	3.9

** Figures are provisional from 2010 Census data*

The breakdown of the socio economic groups within each of the electoral divisions for 2006 is tabulated in Table 7.2. The socio economic distribution of Pembroke East B and C are very similar with a much higher proportion of employers and professionals than Pembroke East A.

Table 7.2 Persons aged 15 years and over Socio Economic Group, 2006 (CSO Census 2006)

	A	B	C	D	E	F	G	H	I	J	Z	
	Employers and managers	Higher professional	Lower professional	Non-manual	Manual skilled	Semi-skilled	Unskilled	Own account workers	Farmers	Agricultural workers	All others gainfully occupied and unknown	Total
Pembroke East A	622	340	361	983	520	517	477	200	0	2	713	4,735
Pembroke East B	874	623	462	478	117	113	71	117	1	2	383	3,241
Pembroke East C	1,066	810	498	497	60	46	17	121	3	0	415	3,533
Total	2562	1773	1321	1958	697	676	565	438	4	4	1511	11509
Pembroke East A	13.14 %	7.18 %	7.62 %	20.76 %	10.98 %	10.92 %	10.07 %	4.22 %	0.00 %	0.04 %	15.06 %	
Pembroke East B	26.97 %	19.22 %	14.25 %	14.75 %	3.61 %	3.49 %	2.19 %	3.61 %	0.03 %	0.06 %	11.82 %	
Pembroke East C	30.17 %	22.93 %	14.10 %	14.07 %	1.70 %	1.30 %	0.48 %	3.42 %	0.08 %	0.00 %	11.75 %	
Total	22.26 %	15.41 %	11.48 %	17.01 %	6.06 %	5.87 %	4.91 %	3.81 %	0.03 %	0.03 %	13.13 %	

The economic status breakdown (2002 and 2006) of the nearest electoral divisions are shown in Table 7.3 and Table 7.4. The highest unemployment is in Pembroke East A. Unemployment decreased between 2002 and 2006 censuses.

Table 7.3 Persons aged 15 years and over by principal economic status and sex, 2002 (CSO Census 2002)

	At work	Looking for first regular job	Unemployed having lost or given up previous job	Student	Looking after home / family	Retired	Unable to work due to permanent sickness or disability	Other	Total
Pembroke East A	1,998	22	256	331	368	420	235	25	3,655
Pembroke East B	1,865	13	67	309	306	463	44	27	3,094
Pembroke East C	1,961	16	57	405	310	514	47	46	3,356

Table 7.4 Persons aged 15 years and over by principal economic status and sex, 2006 (CSO Census 2006)

	At work	Looking for first regular job	Unemployed having lost or given up previous job	Student	Looking after home / family	Retired	Unable to work due to permanent sickness or disability	Other	Total
Pembroke East A	2,527	34	216	298	318	431	227	11	4,062
Pembroke East B	1,786	14	54	280	228	507	41	11	2,921
Pembroke East C	1,963	8	46	355	244	562	22	16	3,216

7.3.3 Employment

There has been a considerable rise in unemployment since the 2006 census. Current detailed employment data is not available on an electoral division level. However the national trends in unemployment are shown in Table 7.5 and it can be seen that the percentage unemployed in the country was reasonably steady from 2005 to 2007. Since 2007 the number of unemployed has more than tripled. It is reasonable to assume that the neighbouring communities would have experienced significant increases in unemployment.

Table 7.5 National Unemployment Trends ('000) (CSO)

Economic Sector	Apr - Jun 2005	Apr - Jun 2006	Apr - Jun 2007	Apr - Jun 2008	Apr - Jun 2009	Apr - Jun 2010	Apr - Jun 2011
Total in Employment	1,944.60	2,034.9	2,113.9	2,112.8	1,938.5	1,859.1	1,821.3
Total Unemployed	95.8	97.9	103.1	126.7	264.6	293.6	304.5
Total Labour Force	2,040.4	2,132.8	2,217.0	2,239.6	2,203.1	2,152.7	2,125.9
Not in Labour Force	1,247.5	1,243.3	1,245.6	1,275.3	1,320.8	1,359.7	1,376.9
Population 15 Years & Over	3,287.9	3,376.1	3,462.5	3,514.9	3,523.8	3,512.4	3,502.7
% Unemployed	4.70 %	4.59 %	4.65 %	5.66 %	12.01 %	13.64 %	14.32%

The major industrial activities in the Poolbeg Peninsula generally relate to the Port activities (including transport, shipping, cargo, storage), the ESB power generating station, the existing WwTW and medium industrial units such as for steelmaking, builders suppliers, quarry supplies and so forth.

7.3.4 Tourism

As noted earlier, there are a number of recreational areas/activities in this immediate locality. These include the Irishtown Nature Reserve, Sandymount Strand and sporting facilities such as the Irishtown stadium. The Aviva stadium is approximately 1.5 km away. Dublin city centre, and its tourism and recreational facilities, is approximately 2 km away.

Dublin Bay and the Irish Sea are used for various water based recreational activities such as sailing, fishing, diving and swimming.

7.3.5 Non Statutory Consultation

As described in Chapter 2, a number of non statutory consultation days were held in locations around Dublin Bay in November 2011 (Howth, Clontarf, Ringsend, Dun Laoghaire and Dalkey). The principal concerns, which have all been addressed in later sections of this EIS, include:

- Traffic loadings and particularly in relation to HGV movements;
- Pedestrian safety and the maintenance of the walking route along Pidgon House Road;
- Water Quality in Dublin Bay – the need to improve the treated effluent WQ standards; generally the idea of moving the discharge location from the Liffey Estuary to the Irish Sea was welcomed; and
- Maintenance of the Irishtown Nature Reserve to ensure that there is no interference to the birds during construction or operation.

7.4 Impact of the Proposed Project - Construction

During the construction phase it is anticipated that up to 100 construction workers will be employed during the peak construction period for the tunnel and WwTW onsite upgrades. It is anticipated that a proportion of this will comprise local labour, this is a positive medium-term low-moderate impact for the local economy of the area.

It is likely that the proposed development will increase the population of the area in the short-term during the construction phase, as it is probable that there will be an influx of construction workers. Construction workers will positively impact on businesses in surrounding settlements that will provide workers with services creating employment opportunities in the local service industry. This will be a positive medium-term low-moderate impact on the local economy addressing the need for employment opportunities in the region in light of recent increases in unemployment rates.

Construction activities have the potential to cause a nuisance to the local environment and result in disruption. However, these impacts, outlined below, will be short-term in nature and will cease upon completion of construction.

The construction of the inlet shaft and tunnel will give rise to some local landscape and visual impacts to construction plant and activities on site including; site compounds, temporary fencing, material storage, plant and machinery and vegetation stripping and pedestrian access will be affected for the duration of its construction. The construction of the outlet diffuser shaft will involve barges and other machinery at the diffuser location and barges and boats to transfer materials, equipment and people. However, these impacts will be short-term and will be restricted to the construction period. Construction phase landscape and visual impacts are discussed in detail in Chapter 11 Landscape and Visual.

Increased traffic and heavy goods vehicle movements during the construction phase will have a negative short-term impact on the local community, primarily due to potential traffic disruption on local roads and barriers to be installed to protect pedestrian routes. Traffic impacts are discussed in detail in Chapter 12 Traffic.

The main health and safety impact identified relates to the construction workers and strict legislation is in place to protect workers and visitors to construction sites. The main health and safety impact for the public relates to additional vehicular traffic on the roadways, the prevention of access by the public to the construction sites (including the outfall diffuser) and the safety of ships/boats during the construction of the tunnel and the outfall diffuser.

Normal working hours during the construction period for the WwTW are expected to be Monday to Friday 07:00 to 18:00 and Saturday 07:00 to 12:00. During certain stages of the construction phase it is expected that some work will have to be carried out outside of normal working hours, however this will be kept to a minimum. However, the tunnel and tunnel shaft is expected to be constructed on a continuous basis (24 hours per day/7 days per week). Construction phase noise and dust impacts are discussed in Chapter 13 Air Quality and Odour and Chapter 14 Noise and Vibration, respectively.

7.5 Impact of the Proposed Project - Operation

The proposed expansion of the Ringsend wastewater treatment works is predicted to have no significant negative impacts on the local area and economy. The expansion of the treatment plant will provide a significant positive impact on the regional economy during the operational phase of the development, by improving the public utilities infrastructure and generating extra treatment capacity. This will allow additional planning applications to be approved.

As described in Section 4.3.2, ongoing odour prevention measures are being implemented at the WwTW and stringent limits will also be applied for the extension to the plant. These are described in more detail in Chapter 13 Air Quality and Odour. There should therefore be no odour impact as a result of the works.

The outfall diffuser shaft will be located outside of the main shipping lanes and in approximately 20m depth of water. In accordance with the requirements of Dublin Port Authority, whilst this location will be marked on maps, a buoy or other marker will not be provided in-situ as these would only encourage visits by boats or divers.

7.6 Do-Nothing Impact

In the absence of the proposed project demographic issues and employment numbers would be expected to remain unchanged.

With no increase in capacity for wastewater treatment, restrictions could be placed on residential, commercial and industrial development in the city.

Failure to comply with the Urban Wastewater Treatment Directive (UWWTD) could also result in fines being levied against Ireland by the EU for breaching the requirements for discharge into a designated Sensitive Water. Fines would likely be in the form of an initial lump sum with further fines on an additive daily basis until compliance is achieved.

Continuing to discharge effluent in breach of the UWWTD would be in breach of the Water Framework Directive and render the Eastern River Basin District unable to comply with the obligations as set out in the Eastern River Basin District River Basin Management Plan 2009 – 2015 and subsequent plans.

7.7 Mitigation Measures

7.7.1 Construction Mitigation

There are no specific mitigation measures proposed in relation to socio-economic impacts during construction. Specific mitigation measures in relation to other impacts on Human Beings such as noise, air quality, landscape and visual, traffic and material assets are dealt with in their respective chapters.

Safe working practices, in accordance with the legislation, will be in place during the construction period to protect the workers and visitors to the construction sites. The construction sites will be suitably fenced and access to the sites shall be limited to authorised personnel. Dublin Port Authority to be informed of the precise location and coordinates of the tunnel and specifically the outfall diffuser. Measures to protect the public from construction traffic are described in Chapter 12 Traffic.

7.7.2 Operational Mitigation

There are no specific mitigation measures proposed in relation to socio-economic impacts during the operational phase. Specific mitigation measures in relation to other impacts on Human Beings such as noise, air quality, landscape and visual, traffic and material assets are dealt with in their respective chapters.

7.8 Residual Impacts

There are no negative residual impacts predicted.

No significant negative impacts on the socioeconomic environment are predicted.

7.9 Difficulties encountered in compiling required information

No significant difficulties were encountered in compiling the required information.

Chapter 8 Water Quality

8.1 Introduction

This chapter of the Environmental Impact Statement provides an assessment of the impact of the proposed effluent outfall extension of the Ringsend WwTW on water quality for the receiving environment in Dublin Bay. Mitigation measures where required, are put forward to reduce the impact of the proposed scheme.

8.1.1 Water Quality Legislative Requirements

This section sets out the framework that defines the water quality requirements pertaining to this proposed project and covers:

- Water Framework Directive;
- Environmental Objectives (Surface Waters) Regulations 2009;
- Bathing Waters Regulations;
- Urban Wastewater Treatment Regulations;
- Marine Framework Regulations; and
- Dublin Bay Water Quality Management Plan.

8.1.1.1 Water Framework Directive

The Water Framework Directive (WFD) (2000/60/EC) is an umbrella directive that will gradually encompass all water related laws. The Directive commits member states to preventing deterioration and achieving at least good status in all of our rivers, lakes, estuaries, coastal and groundwaters by the year 2015; extensions are applied to certain water bodies to 2021 or 2027 where justified in line with the reasons specified in the legislation.

The Water Framework Directive was transposed into Irish law by Irish Statutory Instruments including, inter alia, EC Water Policy Regulations (SI No. 722 of 2003) and EC Water Policy Regulations (Amendment) (SI No. 413 of 2005). The WFD takes a holistic approach to water resources management, the key objective of the WFD is to protect and improve the quality of waters, specifically:

- Rivers;
- Lakes;
- Transitional (estuarine) and coastal waters; and
- Groundwaters.

The WFD specifies the factors which must be used in determining the ecological status or ecological potential and the surface water chemical status of a surface water body. The Environmental Protection Agency (EPA) has developed classification systems and Environmental Quality Standards (EQS) for the purpose of assessing the status of surface waters. Classification schemes provide a way of comparing waters and looking at changes in status over time. This enables improvements to be planned and the environmental benefits of these actions to be demonstrated. The Eastern River Basin District (ERBD) River Basin Management Plan 2011 – 2015 covers the implementation of the WFD for the east coast of Ireland and covers the study area for the proposed project.

Under the WFD:

- "Transitional Waters" are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows; and
- "Coastal Waters" are defined as waters out to a distance of one nautical mile beyond the baseline from which territorial waters are measured.

As the proposed outfall location is located outside of the transitional and coastal waters, the WFD standards do not cover these waters, and sothese standards do not cover waters outside this limit, the change in water quality is assessed in the context of the standards contained in the Environmental Objectives Regulations 2009 Environmental Objectives (Surface Waters) Regulations for the purposes of this EIS.

Figure 8.1 shows the water body boundaries under the Water Framework Directive and the proposed outfall location.

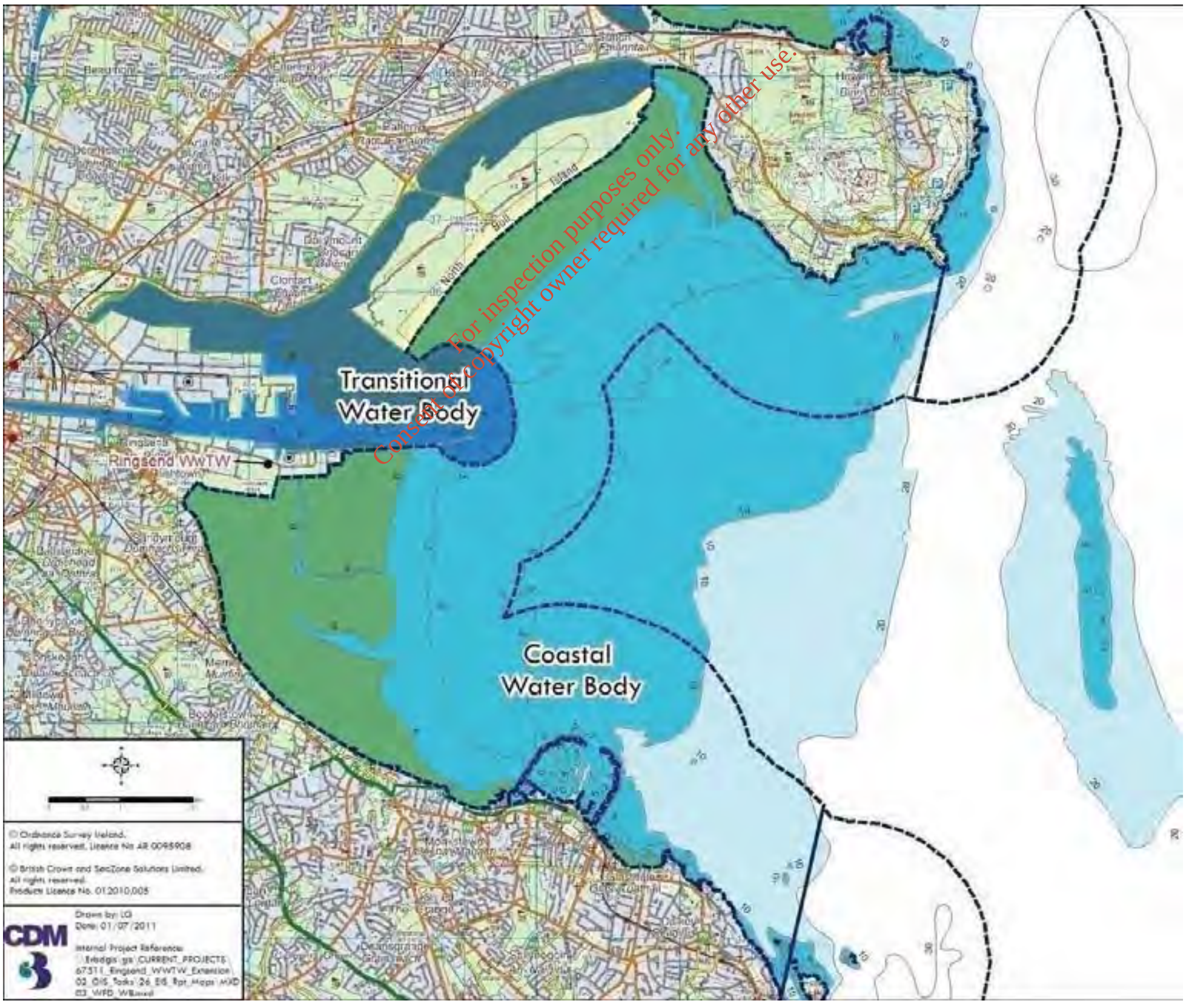


Figure 8.1 Water Framework Directive Water Bodies in Dublin Bay

The Water Framework Directive sets out measures that must be implemented to avoid deterioration of water quality and achieve good status by the specified year. The River Basin Management Plan

2009 – 2015 includes Basic Measures and Supplementary Measures. Basic Measures include 11 key Basic Directives:

- The Bathing Water Directive (2006/7/EC) (76/160/EEC repealed);
- The Birds Directive (79/409/EEC);
- The Drinking Water Directive (98/83/EC) (80/778/EEC repealed 25/12/2003);
- The Major Accidents (Seveso) Directive (96/82/EC) extended by Directive 2003/105/EC;
- The Environmental Impact Assessment Directive (85/337/EEC) as amended by Directive 97/11/EC;
- The Sewage Sludge Directive (86/278/EEC);
- The Urban Wastewater Treatment Directive (91/271/EEC);
- The Plant Protection Products Directive (91/414/EEC);
- The Nitrates Directive (91/676/EEC);
- The Habitats Directive (92/43/EEC); and
- The Integrated Pollution Prevention Control Directive (96/61/EC)

8.1.1.2 Environmental Objectives (Surface Waters) Regulations 2009

The European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009) regulations came into effect in July 2009 apply to all surface waters and are made to give effect to the measures needed to achieve the environmental objectives established for bodies of surface water by the WFD. Wastewater Discharge Authorisations must set standards (emission limits) that will ensure that the receiving waters will comply with the standards laid out in the regulations.

The water quality standards proposed for the general physico-chemical conditions supporting the biological elements in transitional and coastal waters are listed in Table 8.1.

Table 8.1 Relevant Environmental Quality Objectives from S.I. No. 272 of 2009

	Transitional	Coastal
Temperature		
	Not greater than a 1.5°C rise in ambient temperature outside the mixing zone	
Biochemical (BOD) (mg O_2/l)		
		≤4.0 (95 %ile)
Dissolved Oxygen lower limit		
0 psu	95 %ile > 70 % saturation	
35 psu	95 %ile > 80 % saturation	95 %ile > 80 % saturation
Dissolved Oxygen upper limit		
0 psu	95 %ile < 130 % saturation	
35 psu	95 %ile < 120 % saturation	95 %ile < 120 % saturation
Dissolved Inorganic Nitrogen (mg N/l)		
0 psu		Good status ≤2.6
34.5 psu		Good status ≤0.25
34.5 psu		High status ≤0.17
Molybdate Reactive Phosphorus (MRP) (mg P/l)		
0-17 psu	≤0.060 (median)	
35psu	≤0.040 (median)	

The practical salinity unit (psu) defines salinity in terms of a conductivity ratio of a sample to that of a solution of 32.43456g of KCl at 15°C in 1kg solution. A sample of seawater at 15°C with conductivity equal to this KCl solution has a salinity of exactly 35 psu.

The principal quality standard of concern in relation to wastewater discharges to Coastal Waters are nutrients in the form of Dissolved Inorganic Nitrogen (DIN). DIN is considered to be the limiting nutrient in coastal waters and a breach of the environmental quality standard may lead to eutrophic conditions (algal blooms, etc) and consequently the only nutrient standards in place for coastal waters are for DIN.

8.1.1.3 Bathing Water Regulations

The legislation governing the quality of bathing waters for the 2009 season is set out in the Quality of Bathing Waters Regulations (S.I. 155 of 1992) and amendments, which transposed the EU Directive (76/160/EEC) concerning the quality of bathing water, see Table 8.2. The purpose of the legislation is to ensure that the quality of bathing water is maintained and, where necessary, improved so that it complies with specified standards designed to protect public health and the environment.

A new Directive on bathing water (Directive 2006/7/EC) came into force on 24 March 2006 and will repeal the existing 1976 Quality of Bathing Waters Directive with effect from 31 December 2014. This new Directive aims to provide greater benefits in relation to improve health protection for bathers and a more pro-active approach to beach management including public involvement. The new Bathing Water Quality Regulations 2008 (SI No. 79 of 2008) transposed the 2006 Directive into Irish Law on 24 March 2008 (Table 8.3). It establishes a new classification system for bathing water quality based on four classifications poor, sufficient, good and excellent, and generally requires that a classification of sufficient be achieved by 2015 for all bathing waters.

Table 8.2 Quality of Bathing Waters National Limit Values and EU Guide and Mandatory Values

Parameters	EC Directive concerning the quality of bathing waters 76/160/EEC		National Limit Values (SI 155 of 1992)
	G (Guide)	M (Mandatory)	
Total Coliforms (Number/100ml)	≤ 500 [Note 1]	≤ 10,000 [Note 2]	≤ 5,000 [Note 1] ≤ 10,000 [Note 2]
Faecal Coliforms (Number/100ml)	≤ 100 [Note 1]	≤ 2,000 [Note 2]	≤ 1,000 [Note 1] ≤ 2,000 [Note 2]

Note 1: by 80 % or more of samples
Note 2: by 95 % or more of samples

Table 8.3 Quality of Bathing Waters Regulations, 2008 (S.I. No. 79 of 2008)

Parameters	Excellent Quality	Good Quality	Sufficient Quality [Note 3]
Escherichia coli (cfu/100ml)	250 [Note 1]	500 [Note 1]	500 [Note 2]
Intestinal enterococci (cfu/100ml)	100 [Note 1]	200 [Note 1]	185 [Note 2]

Note 1: by 95 % or more of samples
Note 2: by 90 % or more of samples
Note 3: Poor Quality for microbiological enumerations are worse than the "sufficient quality" values.

Transitional measures are in place until the new Bathing Water Quality Regulations 2008 are fully implemented. As part of these transitional measures, the 1992 Quality of Bathing Waters Regulations governed the quality of bathing waters for the 2010 season. The 'good' classification is related to compliance with guide and mandatory values, the 'sufficient' classification is related to compliance with the mandatory values only, whereas the 'poor' classification is noncompliance with mandatory values. Bathing waters are not classified as 'excellent', as the 1992 Regulations do not have bathing water standards that equate to an excellent classification (EPA, 2011). (The terms 'good' and 'poor' are also used for classification under the WFD, but are not equivalent and are calculated differently. WFD classification is discussed in more detail in Section 8.3.3.2.)

The new Directive on bathing water (Directive 2006/7/EC) establishes tighter microbiological standards for two new parameters Intestinal enterococci and *Escherichia coli*. From the 2011 bathing season onwards, these two robust microbiological parameters will be monitored and used to classify bathing waters (EPA, 2011). Note *Escherichia coli* is considered to be equivalent to the parameter Faecal coliforms and the parameter Intestinal enterococci is considered to be equivalent to the parameter Faecal streptococci.

Designated bathing waters in Dublin Bay are discussed in Section 8.3.3.3.

Blue Flag Status

The Blue Flag Scheme is a voluntary scheme to identify high-quality bathing water areas, administered in Ireland by An Taisce and at European level by the Foundation for Environmental Education in Europe (FEEE). To receive a blue flag, a bathing site, in addition to maintaining a high standard of water quality, must meet specified objectives with regard to the provision of safety services and facilities, environmental management of the beach area and environmental education.

The more stringent Blue Flag standards are shown in Table 8.4.

Table 8.4 Blue Flag Programme for Beaches for 2011 – Water Quality Standards

Parameters	Limit Values
Escherichia coli (Faecal Colibacteria) (cfu/100ml)	250 Note 1
Intestinal Enterococci (streptococci) (cfu/100ml)	100 Note 1

Note 1: by 95 % or more of samples

8.1.1.4 Urban Wastewater Treatment Regulations

The Urban Wastewater Treatment Directive (91/271/EEC), the Urban Waste Water Treatment (UWWT) Regulations, 2001 (S.I. 254 of 2001) which incorporate and update the Environmental Protection Agency Act, 1992 (Urban Waste Water Treatment) Regulations, 1994 as amended in 1999, place a responsibility on local authorities to provide treatment of urban waste water, to monitor discharges from agglomerations and to transmit the results of such monitoring to the EPA.

The ten water bodies which were originally designated as Nutrient Sensitive Waters by the Minister for the Environment and Local Government are listed in Part 1 of the Third Schedule of the 1994 Regulations and a further 30 were designated in the 2001 Regulations (Part 2 of the Third Schedule). On 15th of July 2004, Part 2 of the Third Schedule to the Regulations was amended, designating two additional areas (in Cork Harbour). Member states are required by the Directive to ensure that the identification of sensitive areas is reviewed at intervals of not more than four years.

Certain measures, such as treating wastewater to remove nitrogen and phosphorus nutrients, must be implemented in these areas so as to protect them from the adverse effects of waste water discharges and eutrophication.

Member states submit reports during the implementation process and must publish status reports every two years thereafter. The EC regularly compiles a synthesis report on the implementation status of the directive in all member states. Legal action may be taken if member states do not comply with the directive.

The Liffey Estuary from Islandbridge weir to Poolbeg Lighthouse, including the River Tolka basin and South Bull Lagoon, as shown in Figure 8.2, has been designated a nutrient sensitive area.

Figure 8.2 Extent of Nutrient Sensitive Area Designation

Nutrient reduction is required for all discharges from agglomerations with a population equivalent of more than 10,000.

Where discharges to sensitive water bodies occur, the UWWT Regulations specify emission limit values for total phosphorus and/or total nitrogen in addition to values for BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand) and TSS (Total Suspended Solids), which apply to discharges generally. The 2004 Urban Waste Water (Amendment) Regulations also includes a technical clarification on the reporting of total phosphorus as mg/l P and total nitrogen as mg/l N.

Requirements for discharges from urban waste water treatment plants to sensitive areas are listed below in Table 8.5. One or both parameters may be applied depending on the local situation. The values for concentration or for the percentage shall apply.

Table 8.5 Requirements for Discharges to Sensitive Areas

Parameters	Concentration	Minimum percentage of reduction (1)	Reference method of measurement
Total phosphorus	2 mg/l P (10,000 - 100,000 p.e.) 1 mg/l P (more than 100,000 p.e.)	80	Molecular absorption spectrophotometry
Total nitrogen [2]	15 mg/l N (10,000 - 100,000 p.e.)[3] 10 mg/l N (more than 100,000 p.e.)[3]	70 - 80	Molecular absorption spectrophotometry

(1) Reduction in relation to the load of the influent.
(2) Total nitrogen means: the sum of total Kjeldahl-nitrogen (organic N + NH3), nitrate (NO3) - nitrogen and nitrite (NO2) - nitrogen.
(3) These values for concentration are annual means as referred to in paragraph 4 (c) of the Fifth Schedule. However, the requirements for nitrogen may be checked using daily averages when it is proved, in accordance with paragraph 1 of that Schedule, that the same level of protection is obtained. In this case, the daily average must not exceed 20 mg/l of total nitrogen for all the samples when the temperature from the effluent in the biological reactor is superior or equal to 12°C. The conditions concerning temperature could be replaced by a limitation on the time of operation to take account of regional climatic conditions.

8.1.1.5 Marine Strategy Framework Regulations

The Marine Strategy Framework Directive (MSFD) (2008/56/EC) was formally adopted by the European Union in June 2008. It establishes a legal framework for the development of marine strategies designed to achieve good environmental status in the marine environment by the year 2020. 'Good environmental status' means the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations.

The directive was transposed into Irish law on 31st May 2011 with the European Communities (Marine Strategy Framework) Regulations 2011 (SI No. 249 of 2011). The regulations require:

- An initial assessment of the status of Ireland's marine waters, a determination of good environmental status and the establishment of a series of environmental targets and associated indicators in 2012;
- The establishment and implementation of monitoring programmes for ongoing assessment and regular updates of targets in 2014;
- The development of a programme of measures designed to achieve or maintain good environmental status in 2015; and
- The entry into operation of that programme of measures by 2016.

Member States must then determine the good environmental status of the waters on the basis of criteria such as biodiversity, the presence of non-indigenous species, stock health, the food chain, eutrophication, changes in hydrographic conditions and concentrations of contaminants, the amount of litter and noise pollution.

At present there are no standards for the discharge of treated effluent to the open sea apart from the emission standards contained in the UWWT regulations. However the assessment of the impacts of the discharge from the proposed extension will assess the water quality in the sea as if it were classified as coastal water under the Water Framework Directive. It is not expected that good environmental status requirements will be more stringent for marine waters than for coastal water bodies within 1 km of the shore.

8.1.1.6 Dublin Bay Water Quality Management Plan

A number of priority objectives were set out in the Dublin Bay Water Quality Management Plan for certain areas of the bay as shown in Figure 8.3. These objectives (as set out in Table 8.6) were drafted in 1991 and a considerable amount of work and improvement has been undertaken since then. The Ringsend Wastewater Treatment Works has undergone a major upgrade in 2003 which introduced secondary treatment (prior to this there was only primary treatment). The dumping of sludge at sea also ceased.

In addition, there has been a considerable amount of environmental legislation passed in the interim (Water Framework Directive, European Environmental Objectives (Surface Water) Regulations Objectives, the Habitats Directive) which are all contributing to the protection of the waters of Dublin Bay. The Eastern River Basin District Management Plan has been completed and includes Coastal areas of the Bay.

Since the objectives were drafted it is acknowledged that there has been a considerable improvement in the water quality of the waters of Dublin Bay. The EPA have reported an overall improvement in Dublin Bay Water Quality since the commissioning of the upgrade in 2003. (EPA, 2005)

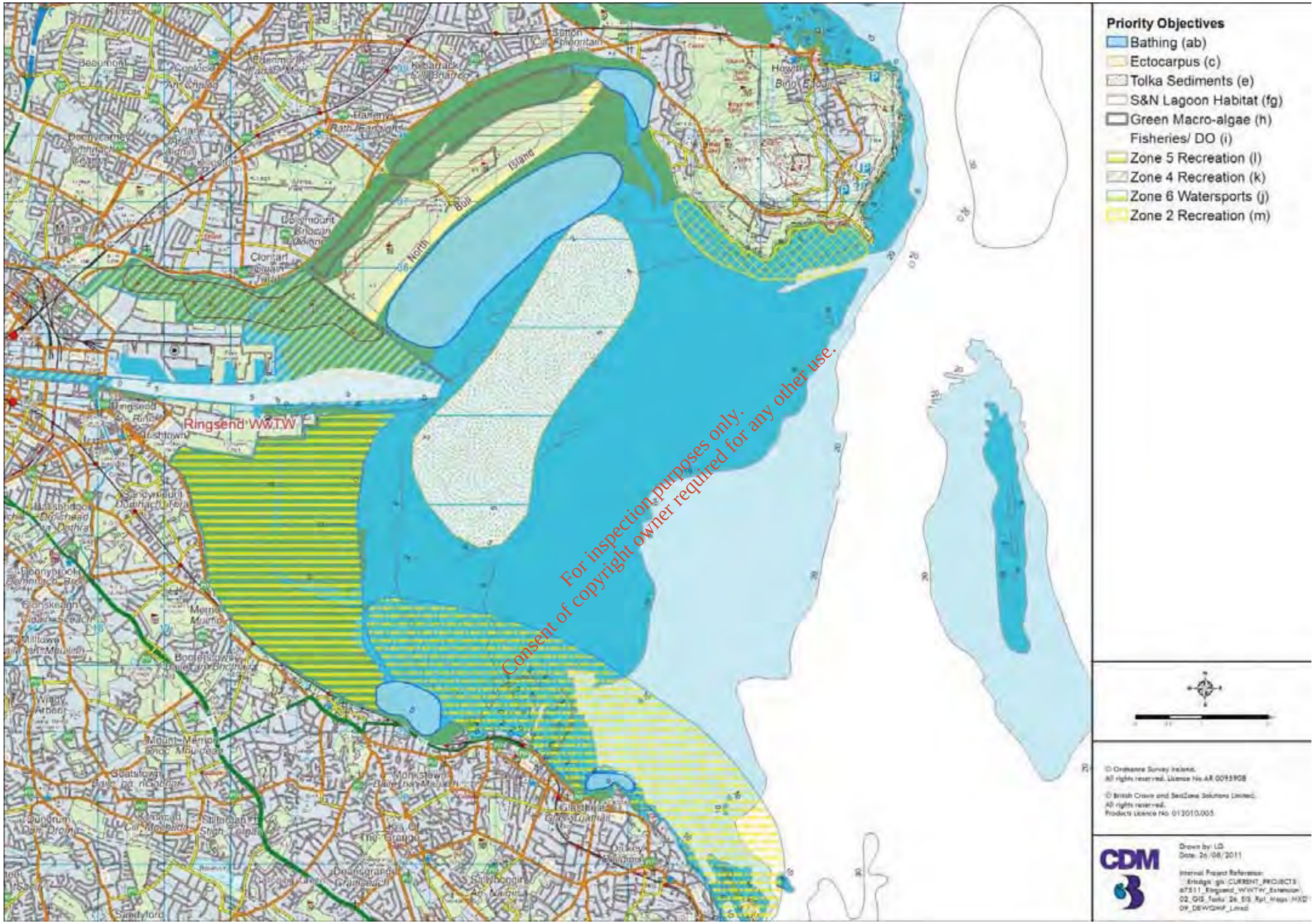


Figure 8.3 Priority Areas as set out in the Dublin Bay Water Quality Management Plan

Table 8.6 Dublin Bay Water Quality Management Plan Priority Objectives

Priority Objective	Focus	Objective
A	Zone 3 Bathing	Ensuring that the quality of bathing waters in the area between Red Rock and the Bull Wall including Dollymount Strand (recreational Zone 3) conforms to the requirements of the Bathing Water Regulations with particular emphasis on microbiological parameters.
B	Zone 6 Bathing	Ensuring that the quality of bathing waters in the area between Seapoint and Sorrento Point (recreational Zone 6) conforms to the requirements of the Bathing Water Regulations with particular emphasis on microbiological parameters.
C	Ectocarpus	The reduction of deposits of algae, in particular Ectocarpus, on recreational beaches (Dollymount, Shellybanks), to the extent that these deposits are indirectly attributable to waste inputs to the Plan area; in particular to reduce the supply of particulate organic matter to the areas colonised by the tubeworm Lanice thereby aiming at reducing the availability of anchorages and mineralised nutrients for the development of Ectocarpus.
D	Sewage Solids	Improving the aesthetic quality of the beaches and shoreline waters of the Plan area by measures such as the interception of plastics and other solids of sewage origin.
E	Tolka Sediments	Improving the environmental quality of the Tolka Estuary, particularly in relation to the chemical and bacteriological of the intertidal elements.
F	South Lagoon Ecosystem	Ensuring a stable biological habitat is maintained in the south lagoon of the Bull Island; and that its wildlife conservation is protected.
G	North Lagoon Ecosystem	Ensuring a stable biological habitat is maintained in the north lagoon of the Bull Island; and that its wildlife conservation is protected.
H	Green Macro-Algae	Ensuring that effluents and related inputs do not give rise to excessive growths of green macro-algae in the Bull Island Lagoons or the Tolka Estuary; the aim is to achieve a reduction in the anthropogenic contribution to these growths by reducing the particulate content of sewage effluent as a source of nutrient to the sediments and thence to the algae.
I	Fisheries / BOD / DO	Ensuring that excessive dissolved oxygen deficits do not occur in the waters of the Liffey Estuary, and that the dissolved oxygen standards are met; thereby protecting migratory fish.
J	Zone 6 Watersports	Protecting the microbiological quality of the waters of zone 6 for water sports such as wind surfing.
K	Zone 4 Recreational	Protecting the environmental quality of Zone 4 (Bull Wall to Great South Wall and Matt Talbot bridge) particularly for non water- contact recreation.
L	Zone 5 Recreation	Protecting the recreational uses of Zone 5 (Great South Wall to Blackrock)
M	Zone 2 Recreation	Protecting the recreational uses of Zone 2 (Baily to Red Rock)
	Other Ecosystems / Wildlife; Protection of Wildlife and their Habitats, not encompassed by the Foregoing	Protection of wildlife and their habitats not encompassed by the foregoing
	Other Fisheries	Protection of other existing fisheries in the Plan area.
	External Areas	Protection of areas outside the Plan boundaries from environmental degradation from any action taken under the provisions of this plan.

8.2 Methodology

CDM subcontracted DHI to develop and calibrate a mathematical hydraulic and water quality model of the receiving waters using a MIKE3 model that they had previously established for DCC for the Waste to Energy (WtE) study and further developed for a pre-feasibility study for a potential system of flood defence barrages in Dublin Bay.

The hydraulic model was further developed and then used in this study to predict effluent dispersion, plume trajectories and compliance with EU Water Quality standards in Dublin Bay.

8.2.1 Evolution of the Project Water Quality Modelling

The model used for the EIS has been progressively developed and improved as described in the following sections (8.2.1.1 to 8.2.1.4).

8.2.1.1 Modelling of Ringsend WwTW and Storm Overflows

In early 2009, Dublin City Council (DCC) engaged CDM (Ireland) Ltd (CDM) to undertake a study into the impact of existing Ringsend Wastewater Treatment Works (WwTW) and storm water overflow on the receiving waters of the Liffey and Tolka estuaries and Dublin Bay. CDM subcontracted DHI (Danish Hydraulic Institute) to provide mathematical hydraulic and water quality modelling of the receiving waters using a MIKE3 model previously established for the Waste to Energy Plant at Poolbeg Study and subsequently adapted for a pre-feasibility study for a potential system of barrages in Dublin Bay.

The modelling was carried out using a three dimensional (3D) hydrodynamic model which had been established for the Dublin Waste to Energy study (WtE) and the pre-feasibility study for a potential system of barrages in Dublin Bay.The geographical coverage of the model includes the Liffey estuary (upper and lower), Tolka estuary and the Dublin Bay area in order to ensure a correct prediction of the circulation of the area. The boundary of the model is shown in Figure 8.4 with applied bathymetry from C-Map™.

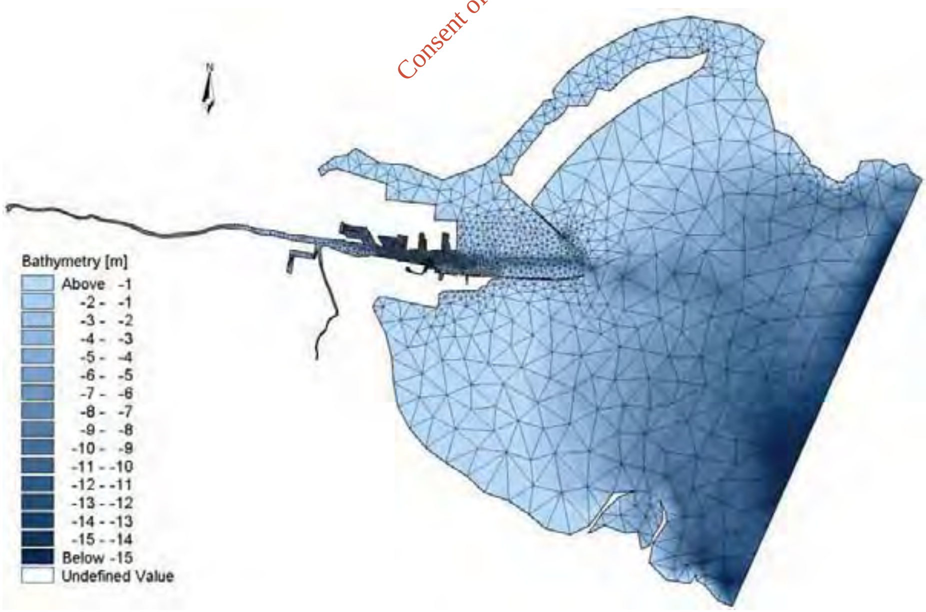


Figure 8.4 Boundary and bathymetric data of the Dublin WTE study thermal model. (Late 2009/2010)

The MIKE 3 model is 3D, based on an unstructured flexible mesh and uses a finite volume solution technique. The meshes are based on linear triangular elements as shown in Figure 8.5. The flow in the Liffey and Tolka estuaries varies both vertically and horizontally and, therefore, a 3D model capable of calculating the buoyancy effects due to salinity stratification was required.

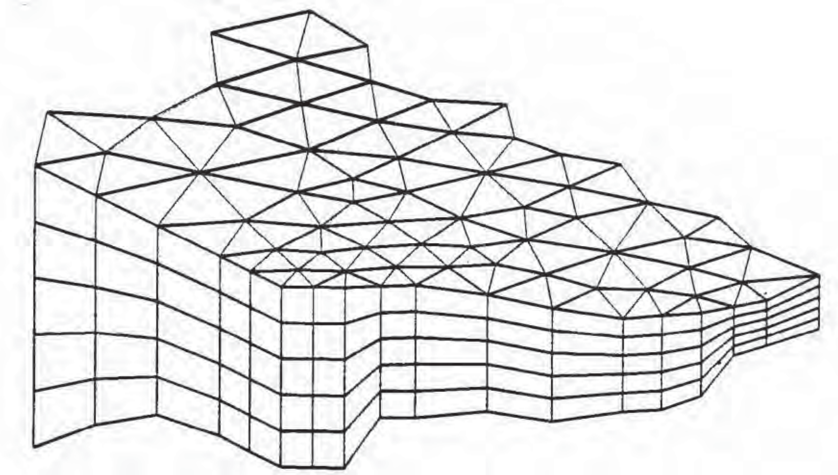


Figure 8.5 Example of three-dimensional triangular grid using the FM solution technique

The computational model mesh was initially generated on the basis of a combination of bathymetric data available with C-Map™ and bathymetric survey data collected during the WtE facility at Ringsend, Dublin. The original version of the model had a high resolution in the lower part of the Liffey and was set up for two simulation periods for dry and wet weather conditions. Driving forces of the model are water levels, wind, air, salinity and water temperature. Water temperature and salinity were applied to the model boundaries based on information on temperature and salinity profiles collected during the initial phase of the WtE study.

Results of the study were contained in *"Modelling the Impact of Ringsend Wastewater Treatment Works and Storm Overflow Discharge in the Liffey and Tolka Estuaries and Dublin Bay"*, CDM/DHI April 2009.

8.2.1.2 Preliminary Modelling of Potential Long Sea Outfall Locations

To further support the characterisation of the discharge characteristics and the development of a design solution, a further modelling investigation was carried out "*Modelling the Impact of Ringsend Discharges in the Liffey and Tolka Estuaries and Possible Long Sea Outfall Discharges in Dublin Bay*" October 2009. The purpose of the modelling was twofold. Firstly, to fulfil requirements for additional information in relation to the existing discharge:

- To assess the impact of the existing primary discharge (SW1) (as shown in Figure 5.5);
- To provide details of modelling and discussion of the impact of the discharge and comparison with relevant water quality standards, discussion of any limitations of the model and inclusion of relevant drawings; and
- To assess the impact of discharges from the Storm Water Outfall (SW2) (as shown in Figure 5.5).

The second objective was to enable a preliminary assessment of the impact from potential long sea outfall locations on the water quality of Dublin Bay and protected areas. Five potential outfall locations were chosen for this preliminary evaluation (see Figure 5.6).

The model previously used was extended as shown in Figure 8.6. The model is based on DHI's MIKE 3 flexible mesh (FM). It is applicable for analysing free-surface flow hydrodynamics and dispersion in coastal areas and seas. The geographical coverage of the mesh includes the Liffey Estuary (upper and lower), Tolka estuary, the Dublin Bay area and part of the Irish Sea as shown in Figure 8.7.

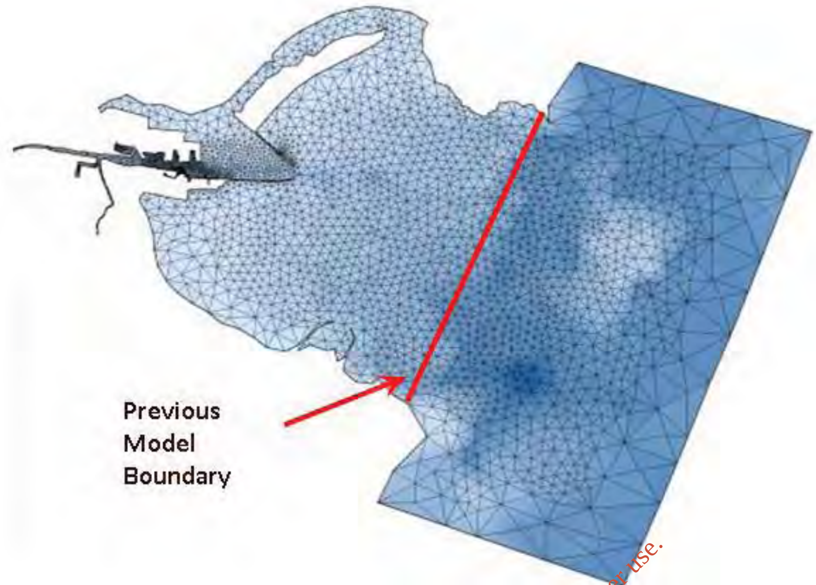


Figure 8.6 Boundary and bathymetric data of the long sea outfalls model. (Late 2010)

The model was thoroughly calibrated against available data in the Liffey Estuary including water levels, currents, temperature, salinity and thermal plume extensions as described in the Marine Survey Report (DHI, July 2010) in Appendix G2. The circulation in the bay was validated against measured circulation patterns in the tidal cycle. The original model was extensively calibrated to simulate the conditions in the inner part of Dublin Bay and the Lower Liffey and Dublin Port.

The boundary conditions for the model were obtained from a larger model of the seas around Ireland as shown in Figure 8.7. In order to check the accuracy of the boundary conditions from the larger scale model they were compared with measured current time series from the spring of 2010.

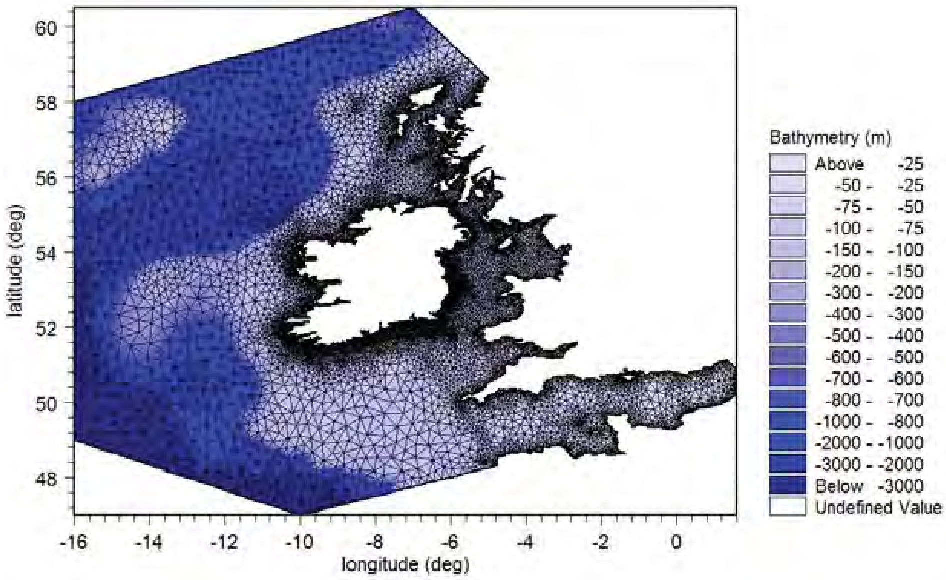


Figure 8.7 Bathymetry and computational mesh for the model around Ireland

8.2.1.3 Further Water Quality Modelling for Site Selection of Long Sea Outfall

Following the results of the initial modelling of potential outfall locations, the hydraulic model was further developed as described below and then used to predict effluent dispersion, plume trajectories and compliance with EU Water Quality standards in Dublin Bay. A field data collection campaign was undertaken to provide field data for calibration and verification of the model to ensure there would be full confidence in the predictions as described in Appendix G2 Marine Survey Report (DHI, July 2010).

Bathymetry

High resolution bathymetric data from the Infomar project funded by the Marine Institute of Ireland was merged into the xyz data that defines the depth to the seabed in the model domain (Figure 8.8).

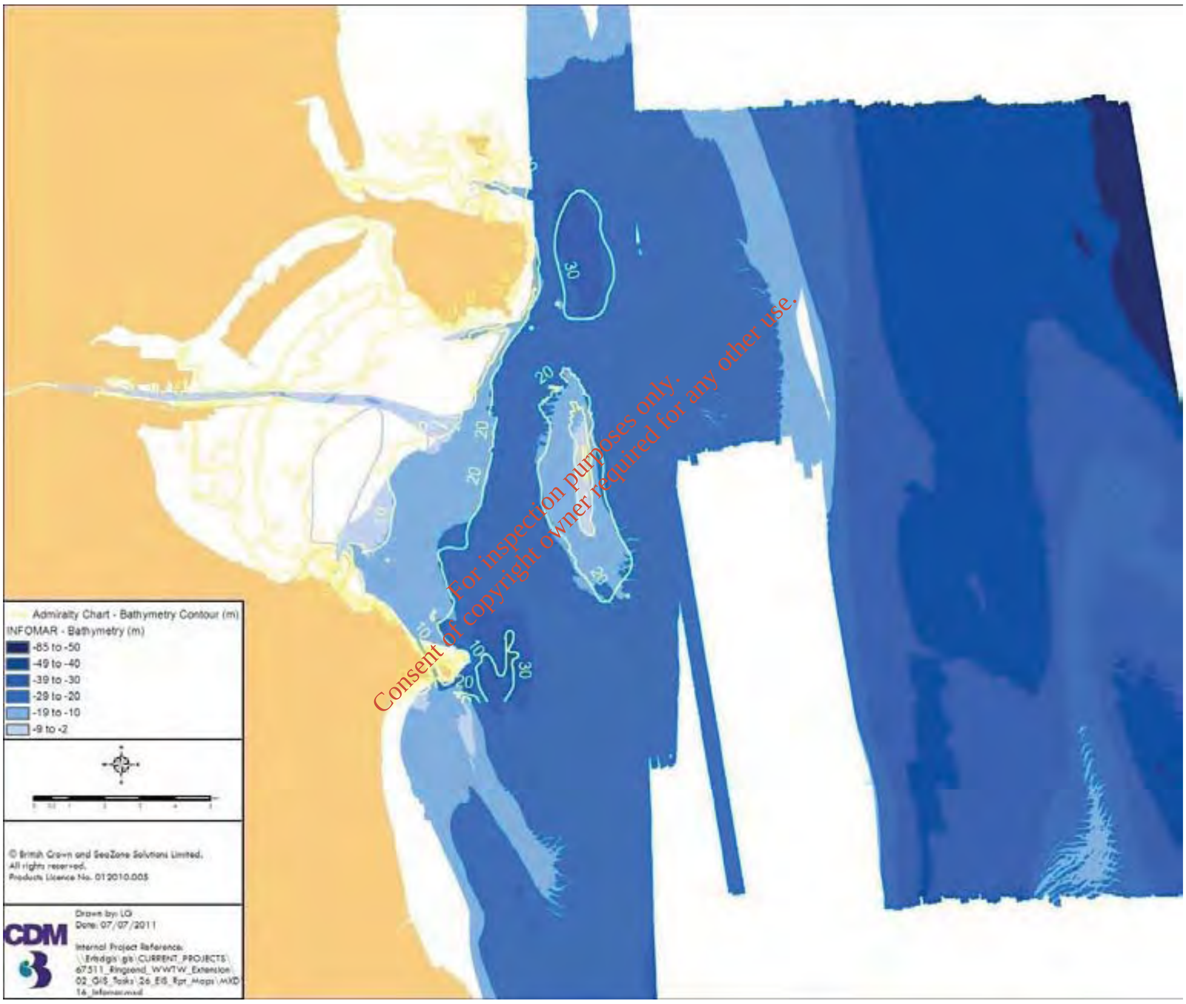


Figure 8.8 Coverage of the Infomar data set in the area of Dublin Bay

Model Extent

The model domain was extended to cover a wider area of the Irish Sea as shown in Figure 8.9. The model extent is significantly greater than previously to ensure that it is sufficient to contain the maximum excursion of the effluent and to avoid any disturbance at the boundaries to influence the area of interests.

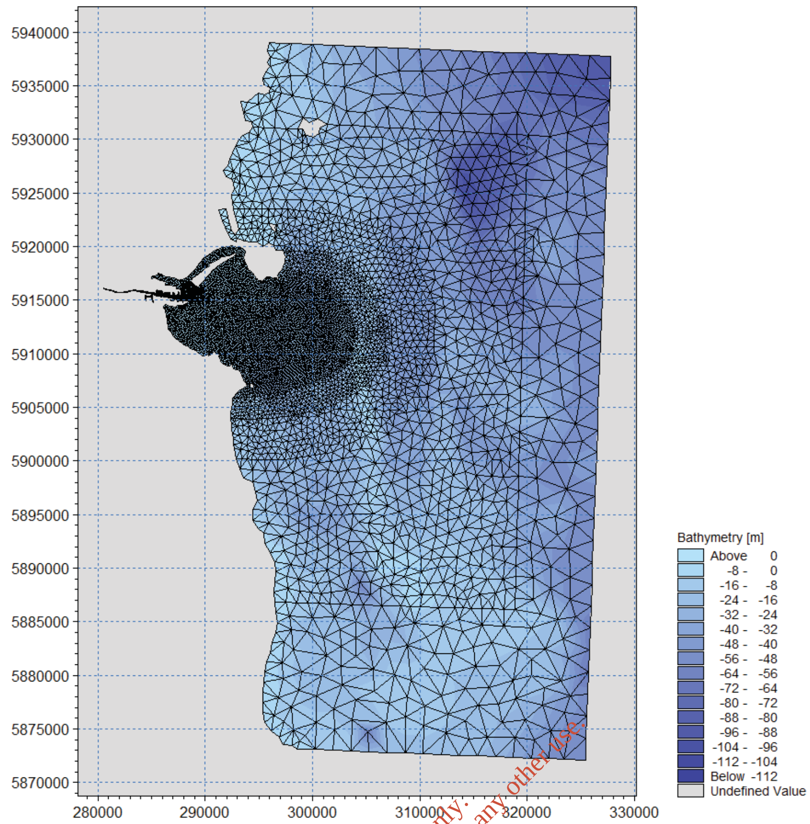


Figure 8.9 Applied mesh of the extended model

At this stage four potential outfall locations were selected for further modelling based on the preliminary modelling results and the constraints identification exercise. These are referred to as Locations B1 to B4 and are displayed in Figure 5.8. The model is detailed in "*Ringsend Long Sea Outfalls Modelling Results* " (CDM/DHI, 2011) and reproduced in Appendix G.

The modelled outfall locations were also assessed based on technical, environmental and cost factors and Location B3 was selected during this process (refer to Section 5.11.3 Selection Proposed Outfall Location for details).

8.2.1.4 Water Quality Modelling for Inclusion in EIS

Model inputs were reviewed prior to the final water quality modelling for EIS water quality assessment.

Two scenarios were modelled:

- Existing Conditions - Ringsend WwTW average flow current conditions (5.14 m^3/s) and typical measured background concentration in the bay and rivers. The outfall location was modelled at its existing location.
- Proposed Outfall - Ringsend WwTW average flow future conditions (6.9 m^3/s) and typical measured background concentration in the bay and rivers. The outfall location was modelled at its proposed location B3.

A 15-day period was chosen to encapsulate a full spring/ neap tide tidal cycle to encompass water circulation patterns and the variation of current velocities in the bay. The results were assessed for tidal variation and maximum concentration, (see Section 8.3.4 and Section 8.5.1 for model plots):

- Tidal Variation Plots – Both spring and neap tide plots at differing tidal states were generated for each of the outfall locations for each parameter. Neap tide results are shown here as these display poorer pollutant dispersion than during higher tidal ranges and so represent "worst case" conditions.

- Maximum Concentration Plots for the period simulated; defined as the maximum concentration simulated in each element of the modelling mesh during entire 15 day simulation. These plots are therefore not a representation of any single time but an amalgamation of worst conditions during the entire simulation.

8.2.2 Long sea Outfall Model Calibration

In order to check the accuracy of the extended boundary conditions derived from the Irish Sea model, as shown in Figure 8.7, the simulated data was compared with current time series measured in spring 2010.

With the purpose of providing data for calibration and verification of a numerical model, DHI has conducted two current measurement campaigns in Dublin Bay, Ireland. The first campaign was performed from 6 April to 11 April 2010 and the second between 11 May to 14 May 2010. The first campaign comprised vessel-based mapping of spatial current distribution in Dublin Bay, deployment of two bottom-mounted Acoustic Doppler Current Profilers (ADCPs), a temperature/conductivity string as well as float trackings. The second campaign also comprised mapping of spatial current distribution as well as float trackings. Additionally, the deployed instruments were all recovered. The hydrographical data was used to develop and calibrate a three-dimensional hydrodynamic model based on the thermal model set up for the WtE study. The locations of the ADCPs are displayed in Figure 8.10 and detailed in Ringsend Wastewater Treatment Plan Long Sea Outfall Dublin Bay Marine Survey Report, DHI, 2010 in Appendix G.2.

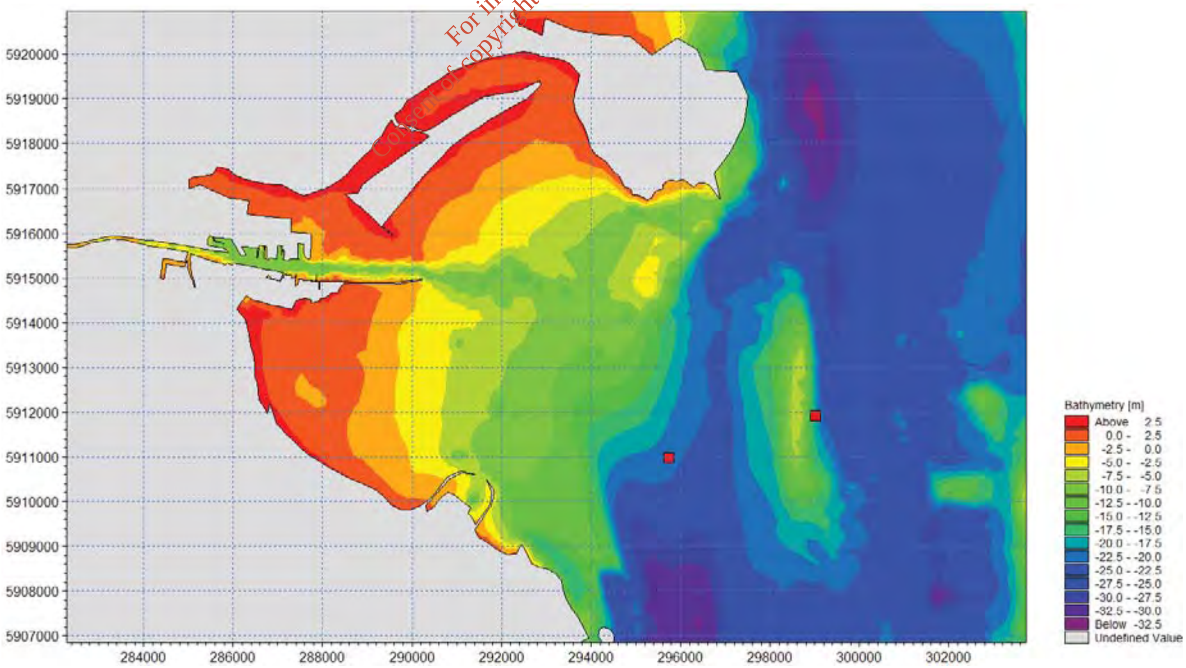


Figure 8.10 Position of the two fixed stations for ADCP current measurements survey in April and May 2010

The calibration process also required freshwater inflows for the March-April 2010 period during the ACDP survey in the Bay. These were derived from the following:

- Hydrometric station 09037 at Botanic Gardens was used to estimate the flows on the Tolka;
- Hydrometric station 09010 at Waldrons Bridge and 09011 on the River Slang as well as some gauge area transposition were used to calculate the flows on the River Dodder;
- Hydrometric station 09035 on the River Camac was used to calculate the River Camac; and
- No suitable hydrometric stations exist on the downstream reaches of the River Liffey; therefore, data from a previous Water Framework Directive study were used to calculate these flows. A Mike Basin model had been established and used to simulate flows in the Liffey model for five years between 2000 and 2005. Since no flow data exist for 2010 on the River Liffey, the lowest average March-April for the five year period was selected to represent the relative dry March-April in 2010.

Table 8.7 shows the summary of the freshwater flows on the four rivers used for the initial calibration of the 3D model. The location of these rivers are shown in Figure 8.13.

Table 8.7 Average Flows for the Four Major Rivers for Model Calibration, m^3/s

River	Year	March	April	March-April Average
Liffey	2004	8.99	13.40	11.2
Tolka	2010	1.69	1.66	1.67
Dodder	2010	1.69	1.84	1.76
Camac	2010	0.567	0.575	0.57

8.2.2.1 Calibration Results

The prime calibration data comprised of the two ADCP current meters located in the outer bay for a period of one month. The more easterly position was located on the seaward edge of Burford Bank in an area where the water depth changes rapidly, while the westerly position is inshore of the bank in an area with less steep seabed gradients.

A diagram of the correlation between the model predictions and measured currents for the western measurement position was very good and is shown in Figure 8.11. The model reproduces tidal current speeds, directions, phasing and water levels accurately.

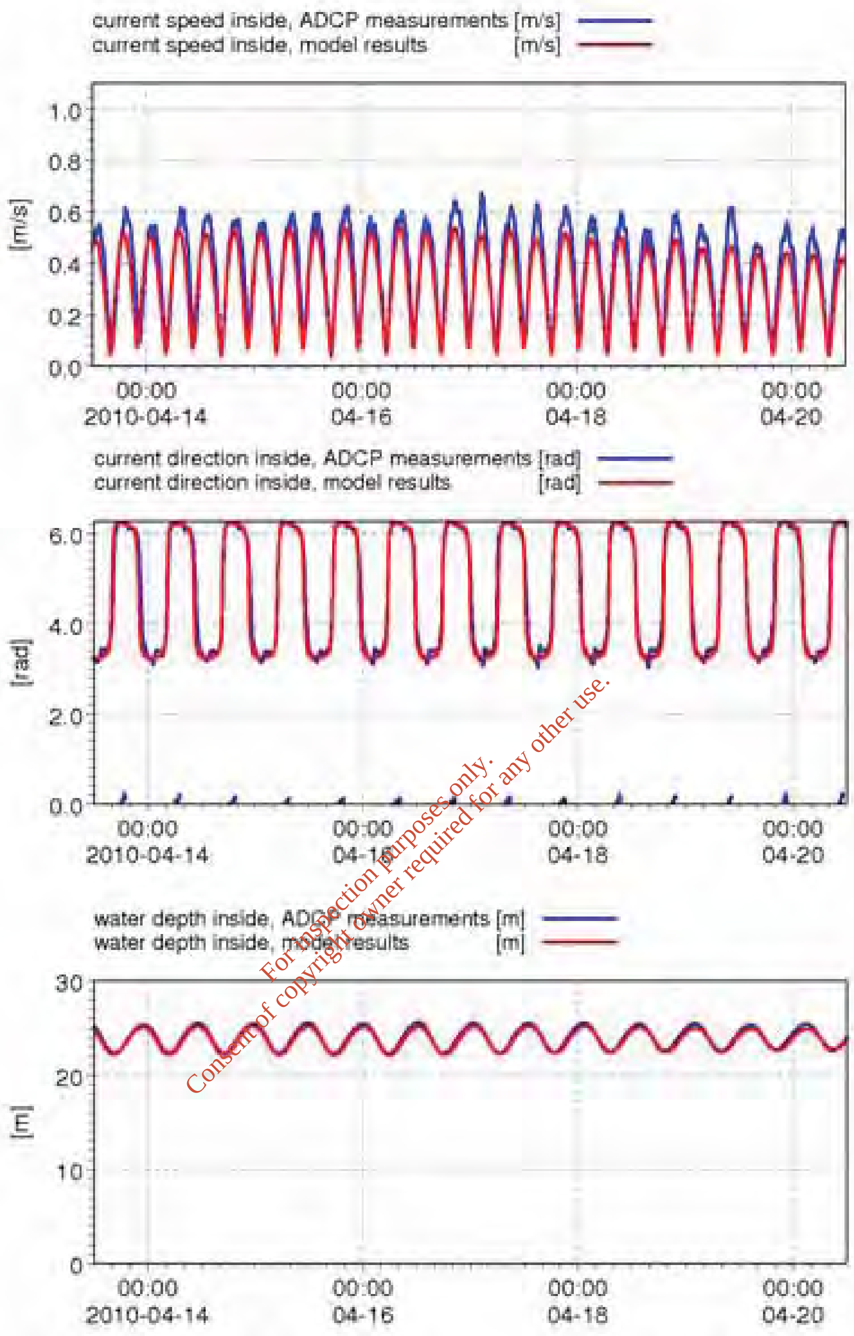


Figure 8.11 Comparison of model results and measurements, western position

8.2.3 Long Sea Outfall Model Data Inputs

The data inputs to the model for the existing and proposed discharge are described in the following sections. This includes a description of the loading from Ringsend WwTW, background loads from the rivers discharging to Dublin Bay and the input from the outer bay itself.

8.2.3.1 Hydraulic Flows at Ringsend

For the purpose of the long sea outfall modelling two flow conditions were selected (Table 8.8):

- For the existing discharge (Run 1) the average daily flow of 5.14 m^3/s was selected; and

- For the proposed discharge (Run 2) the average daily flow for the ultimate design horizon of 6.9 m^3/s was selected.

Table 8.8 Measured Flows and Current Ringsend Design

Design Parameter	Measured Flows[1]	Design Year 2020 Average Design[2]	Ultimate Design Year Average Design[2]
	(m^3/s)	(m^3/s)	(m^3/s)
Average Daily Flow	5.14	5.7	6.9

1 Source is average flow from Total Influent Data 07-09
2 Source is Tender Documents Vol. 2 Employers Requirements 1998

8.2.3.2 Pollutant Loads at Ringsend

The average concentrations of Dissolved Inorganic Nitrogen, Molybdate Reactive Phosphorus, BOD and *E. coli* for the current discharge and the proposed future discharge are shown in Table 8.9. These pollutant concentrations were derived from measured effluent concentrations and design values. Average concentrations were chosen for modelling as transient peaks that last hours to days are not representative of a continuous discharge.

Table 8.9 Present and Future Average Pollutant Concentrations in Ringsend WwTW Effluent

Parameter	Present (Run 1)[1]	Future (Run 2)[2]
Dissolved Inorganic Nitrogen (DIN)	19.4 mg/l	18.75 mg/l
Molybdate Reactive Phosphorus (MRP)	3.6 mg/l	3.6 mg/l
Biological Oxygen Demand (BOD)	20.1 mg/l	25 mg/l
E. coli[3]	130,000 MPN/100ml	130,000 MPN/100ml

1 Source is annual average taken from Ringsend Effluent Data, where DIN is between Sept 07-April 08, MRP is between 2005-Aug 2008, BOD is between Jan 05-May 08, E. coli is prior to UV disinfection during the bathing season (01/05-31/08) between 2005-2008.
2 Source is for DIN and BOD is Design Contract 2 and MRP and E. coli are annual average taken from Ringsend Effluent Data, see note 1
3 E. Coli is accepted as a surrogate for Faecal Coliform

8.2.3.3 Background Concentration Monitored in Dublin Bay

DCC contracted CDM to carry out a sampling programme from December 2008 to November 2009 to collect data in Dublin Bay. The average values for MRP, DIN and BOD in the outer bay were used as background concentrations representative of the input to Dublin Bay from the Irish Sea, these are presented in Table 8.10. The samples were collected from a depth approximately 1m above the seabed. The monitoring site used was located 5km ESE of Poolbeg Lighthouse as shown in Figure 8.12.

Table 8.10 Background Concentrations in Dublin Bay (December 2008-November 2009)

Substance	Bay
Dissolved Inorganic Nitrogen (DIN)	0.019 mg/l
Molybdate Reactive Phosphorus (MRP)	0.016 mg/l
Biological Oxygen Demand (BOD)	2 mg/l
E. coli	No data

Figure 8.12 Dublin Bay Water Quality Monitoring Points (2008-2009)

8.2.3.4 River Loads Discharging into Dublin Bay

Water quality data for the four main rivers discharging to Dublin Bay; Liffey, Tolka, Dodder and Camac were sourced from DCC Central Laboratory for the years 2007 to 2009. The monitoring points selected on the Liffey were above or at the tidal limit, thus eliminating any influence from the existing Ringsend WwTW discharge, as shown in Figure 8.13.

Figure 8.13 Dublin Rivers with the selected monitoring locations

Concentrations for DIN, MRP, BOD and *E. coli* were averaged for the period 2007 to 2009 for each of the four rivers as shown in Table 8.11. Note that some parameters were reported as method detection limits (e.g. <2 mg/l). These could not be used as they do not provide a quantitative value and consequently the derived mean values are higher than in reality as the low concentration events are discounted.

Table 8.11 DCC River Water Quality Monitoring

Parameter	Liffey	Tolka	Dodder	Cammock
Sampling Station	(40063) Liffey City Islandbridge Weir	(45082) Tolka River Annesley Bridge	(41074) Dodder River Ballsbridge	(41383) Camac to Liffey
Dissolved Inorganic Nitrogen (DIN) (mg/l)	2.45	2.05	1.46	2.14
Molybdate Reactive Phosphorus (MRP) (mg/l)	0.05	0.07	0.03	0.07
Biological Oxygen Demand (BOD) (mg/l)	3.17	2.89	2.33	4.21
E. coli (MPN/100ml)	2,124	4,698	2,042	10,865

River Liffey

There is no hydrometric station in the vicinity of the water quality monitoring point at Islandbridge. Flow was derived from three upstream gauges and gauge area transposition for the ungauged part of the catchment. The gauge at Leixlip PS (09022) measures flow from 848 km^2 of the Liffey catchment.

A second hydrometric station (09001) on the Ryewater measures flow from 210 km^2 and a third on the Griffeen (09002) measures 35 km^2 of the catchment.

The remaining ungauged catchment area was calculated as being 57 km^2. The gauge for the Ryewater was used to calculate flows in the ungauged catchment area. The Griffeen has a similar area to the ungauged catchment, however, the Griffeen hydrometric record was not as good as the Ryewaters. The average flow from the three gauged catchments and ungauged catchment was calculated for use in the outfall model (see Table 8.12).

River Tolka

A suitable hydrometric gauge (09037) was found on the river in the vicinity of the water quality monitoring point at Annesley Bridge. The average flow from 1999 to 2010 was calculated for use in the outfall model (see Table 8.12).

River Dodder

There is no hydrometric station in the vicinity of the water quality monitoring point at Ballsbridge. Flow was derived from two upstream gauges and gauge area transposition for the ungauged part of the catchment. The gauge at Waldron's Bridge (09010) measures flow from 94 km^2 of the Dodder catchment. A second hydrometric station (09011) on the River Slang at Frankfort (09011) measures flow from 5 $km^2$of the catchment.

The remaining ungauged catchment area was calculated as being 8 km^2. Gauge 09011 was used to calculate flows in the ungauged catchment area, as it has similar area and catchment characteristics. The average flow average from 2007 to 2010 for stations 09010, 09011 and gauge transposition was calculated for use in the outfall model (see Table 8.12).

River Camac

No suitable hydrometric station was available in the vicinity of the water quality monitoring point at Emmet Rd. Therefore, one upstream gauge and gauge transposition were used to calculate flow at this point. Hydrometric gauge (09035) measures flow from 37 km^2 of the catchment.

The remaining ungauged catchment area was calculated as being 14 km^2. The hydrometric gauge 09035 was used to calculate flows in the ungauged catchment area, as it has similar catchment characteristics. The average flow from 2007 to 2010 for station 09035 and gauge transposition was calculated for use in the model (see Table 8.12).

Table 8.12 Summary of flows in Dublin Rivers for Input to Model

River	Flow (m^3/s)	Comments	Data years
Liffey	15.9	Average from stations No. 09022 (Leixlip PS), 09001 (Ryewater), 09002 (Griffeen) and an gauge transposition.	1950 to 2006, 1956 to 2009, 1977 to 2010
Tolka	1.8	Average from station No. 09037	1999 to 2010
Dodder	2.5	Average from station No. 09010, 09011 and gauge transposition	2007 to 2010
Camac	0.9	Average from station No. 09035 and gauge transposition	2007 to 2010

All sources are added to the model at the surface. In reality some of the sources are placed at the seabed, however they are all buoyant relative to their receiving waters and, therefore, the plume will rise to the surface, most probably within the same calculation cell in which the discharge was released.

8.2.3.5 Water Quality Standards

The results were analysed against surface water environmental quality standards and bathing water standards. The standards are discussed in detail in Section 8.1.1 and standards are listed in Table 8.1 to Table 8.4.

It should be noted that the proposed location of the discharge point is outside the areas delineated for consideration under the WFD. It is located some distance out into the Irish Sea; which is 4 km outside of the delineated transitional waters and greater than 1.5 km from the currently delineated coastal waters.

The standards used to assess the impact of the existing and proposed outfalls are listed in Table 8.13. In all plots the outer contour value equates to the Environmental Quality Standard or the Bathing Water requirements. However, it is important to note that the model's maximum concentration plots are the maxima for the entire simulation and not an instant in time, whereas the environmental quality objective for DIN and MRP are a median value.

Table 8.13 Water quality standards selected for outer contour on model plots

Parameter	WFD Water Body Type	Status Objective	Value	Salinity	Standard Type	Legislation Source
Dissolved Inorganic Nitrogen (DIN) (mg/l)	Coastal	Good Status	≤0.25	35 psu	Median	European Communities Environmental Objectives (Surface Waters) Regulations 2009 (SI No. 272 of 2009)
Molybdate Reactive Phosphorus (MRP) (mg/l)	Transitional	Not specified	≤0.04	35 psu	Median	
Biological Oxygen Demand (BOD) (mg/l)	Coastal	Not specified	≤4	n/a	95 %	
E. coli (MPN/100ml)	Transitional and Coastal	Good/ Sufficient Quality	500	n/a	95 % 90 %	Bathing Water Quality Regulations 2008 (SI No. 79 of 2008)

Note that in the European Communities Environmental Objectives (Surface Waters) Regulations 2009 (SI No. 272 of 2009) there is no standard for DIN and BOD in transitional waters and no standard for MRP in coastal waters. For this reason transitional and coastal water bodies were not distinguished between on the model plots when comparing the modelled results to the standards.

The principal quality standard of concern in relation to wastewater discharges to coastal waters are nutrients in the form of Dissolved Inorganic Nitrogen (DIN). DIN is considered to be the limiting nutrient in coastal waters and a breach of the environmental quality standard may lead to eutrophic conditions (algal blooms, etc).

8.2.4 Long Sea Outfall Model Decay Coefficients

In order to simulate the behaviour of the nutrients and bacteria a decay rate was introduced for each parameter. The objective was to approximate the complex interactions that each pollutant is subject to once introduced into the receiving waters. The values were based on DHI experience in similar projects throughout the world.

The introduction of a constant empirical decay coefficient is sufficient for an impact analysis of the behaviour of the pollutants. However, there are some limitations to this approach; for example, *E.coli* concentration is strongly influenced by the sun's radiation and pH of the receiving water. The daily variation of the sun's radiation and water transparency play an important rule on the decay of the bacteria. The accumulation of E.coli on bottom sediment can also affect its concentration in the water column.

8.3 Existing Environment

8.3.1 Hydrography

Ringsend WwTW is located by the mouth of the River Liffey as it enters Dublin Bay. The Liffey enters Dublin Bay between Clontarf and Ringsend in the channel formed by the North Bull Wall and the Great South Wall. The North Bull Wall is a natural bank reinforced by a stone embankment that is only inundated at half tide. It, therefore, holds back the water flowing out of the harbour at and after half ebb. The navigation channel runs close to the Great South Wall and extends from the Port area through the mouth of the harbour. This navigation channel is maintained at a depth of 7 to 8 metres below chart datum by dredging and natural scouring.

Dublin Bay is a small, shallow sandy embayment. It is enclosed by two headlands: Howth to the north and Dalkey to the south. It is approximately 10 kilometres across the mouth of the bay and narrows to the mouth of the River Liffey. The intertidal zone of the bay occupies the inner third of the bay. The bay slopes gently reaching depths of 20 m at the mouth of the Bay. The water depth decreases towards the harbour with depths of less than 5 m occurring in the inner half of the bay.

The Burford Bank sits centrally across the mouth of Dublin Bay, approximately 10 km east of Poolbeg. Oriented north-south, the Burford Bank is a linear sand ridge about 5 km long and 1.5 km wide, and the seabed rises to within 5 m of the water surface. Bathymetric comparisons suggest that the Burford Bank and smaller similar offshore banks are quasi-stable over time, probably maintaining their position due to the interaction between wave and current regimes (Wheeler et al., 2000).

The North Bull Island is a prominent physical feature in the bay which developed due to sedimentation accumulation after the construction of the North Bull wall in 1821. To the north of the channel are extensive areas which dry out at low water. These mudflats extend from the mouth of the River Tolka almost to the end of the Bull Wall and north eastwards past the Bull Island Causeway to Sutton Creek, which is a narrow channel between Bull Island and Howth.

The sediment in Dublin Bay is predominantly sand and silt. The distribution of sediment types are largely a function of the currents. Where the currents are strongest, coarse sandy gravel sediments are predominant, such as the area to the north west of Burford Bank. Where the currents are weak, mud accumulates.

With the purpose of providing data for calibration and verification of a numerical model, DHI has conducted two current measurement campaigns in Dublin Bay, Ireland. The first campaign was performed from 6 April to 11 April 2010 and the second between 11 May to 14 May 2010. The first campaign comprised vessel-based mapping of spatial current distribution in Dublin Bay, deployment of two bottom-mounted Acoustic Doppler Current Profilers (ADCPs), a temperature/conductivity string as well as float trackings. The second campaign also comprised mapping of spatial current distribution as well as float trackings. Additionally, the deployed instruments were all recovered. The hydrographical data was used to develop and calibrate a three-dimensional hydrodynamic and transport numerical model which forms part of the subsequent thermal impact and re-circulation study. Refer to 8.2.2 Model Calibration for further details of the results and the locations of the ADCPs are displayed in Figure 8.10.

The wave climate in Dublin Bay is affected by both wind waves and swells. Figure 8.14 gives an example of presentation of wave data (wave rose) from station 2.The rose shows the distribution of wave height on direction intervals. The prevailing wave direction is north east, that is the largest waves are arriving from north east.

Figure 8.15 gives an example of presentation of current data (current rose) from station 1. The rose shows the distribution of current velocity on direction intervals. The prevailing current direction is north, that is the strongest current is running in a northerly direction.

Tides are generated by the gravitational effects of the moon and sun and as their relative positions change the tide is propagated around the world's oceans as a long period wave, the amplitude of which is determined by the alignment of the moon and sun. In the open oceans the height of the tidal wave is relatively small, but as it approaches land the shallow water and funnelling effects of some land masses causes the wave to be amplified. The tidal wave enters the Irish Sea from both the north and south and meets close to the Isle of Man; at this point (known as the amphidromic point) there is no tidal variation at all. The tidal currents in the Irish Sea offshore of Dublin Bay are north/south caused by the tidal wave propagating northwards during the flood tide and southward during the ebbing tide, but within the Bay, more complex flow patterns develop during the various states of the tide. The tides at Dublin Port are semi-diurnal; that is they exhibit two high tides and two low tides each day. The range of mean spring and neap tides (low water to high water) is 3.4 m and 1.9 m respectively (UKHO 2008). The time of high and low water varies from place to place as the wave moves along the coast; for the purposes of this document, times relate to high water at Dublin Port.

At high tide the flow offshore has a strong southward component and results in an anticlockwise circulation in the bay with currents greater than 0.5m/s in the outer part of the bay and virtually zero in the western part of the bay. South of Howth Head the current flow towards the west but are more southerly further south and inshore.

One hour after high tide the circular pattern persists, but off Howth Head the flow reverses to a north easterly direction. By 2 hours after high tide the ebb becomes stronger and water flows out of the bay towards the south east and north east; however there remains a low velocity westward component in the centre of the bay.

By 4 hours after high water flow is consistently eastwards as the tide ebbs. At low tide at Dublin Port the flood wave in the Irish Sea is strongly developed with a northerly flow which sets up a clockwise circulation in the bay with north westerly currents in the south of the bay and north easterly to the south of Howth Head. This pattern persists throughout the flooding tide with a well developed clockwise circulation.

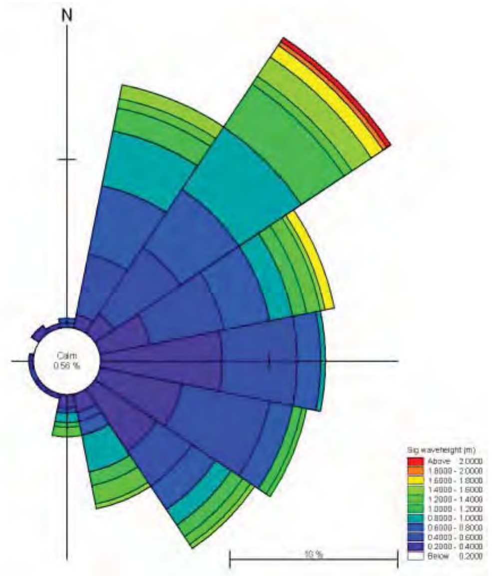


Figure 8.14 Example of presentation of wave data (wave rose) from station 2.

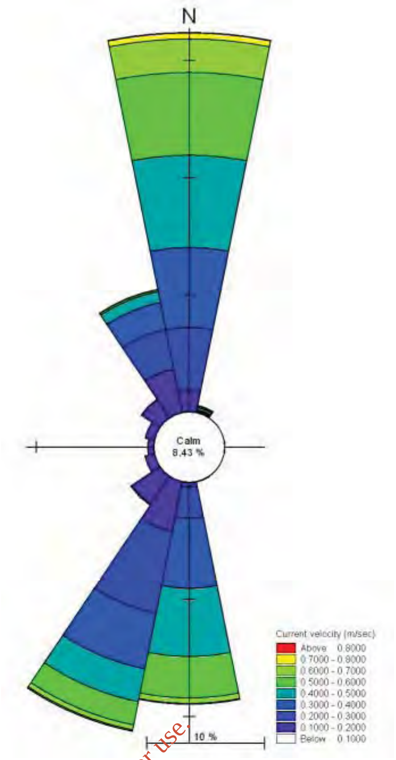


Figure 8.15 Example of presentation of current data (current rose) from station 1.

8.3.1.1 River Catchments

Ringsend WwTW is located in the Hydrometric Area No. 09 (Liffey). There are four principal rivers that discharge to Dublin Bay the above mentioned Liffey, the Dodder, the Tolka and the Camac. The Dodder discharges to the Liffey. The Poddle River as well as the Royal Canal and the Grand Canal also discharge to the Liffey. In addition several small streams flow from the surrounding areas into the bay.

The River Liffey has a catchment size of approximately 1,300 km^2. It rises in the Liffey Head Bog between Kippure and Tonduff in the Wicklow mountains and the upper part of the catchment is fairly steep and is characterised by pastural lands. The lower catchment is relatively flat and characterised by urban landuse. The discharge in the River Liffey is regulated by dams. There are dams for three ESB hydroelectric power stations along the river, at Poulaphouca, Golden Falls and Leixlip. Major reservoir facilities also exist at Poulaphouca one which is used for water supply.

The Liffey Estuary is highly salinity-stratified. Average surface water salinity upstream of Ringsend is variable and salinities at depth are significantly higher and less variable. From Ringsend towards the mouth of the estuary the salinities are close to those of the Irish Sea and the estuary is considered well mixed. Dublin Bay itself is well mixed throughout the year because of strong tidal mixing and a shallow water column, it is around 35 PSU. (O'Higgins and Wilson, 2005).

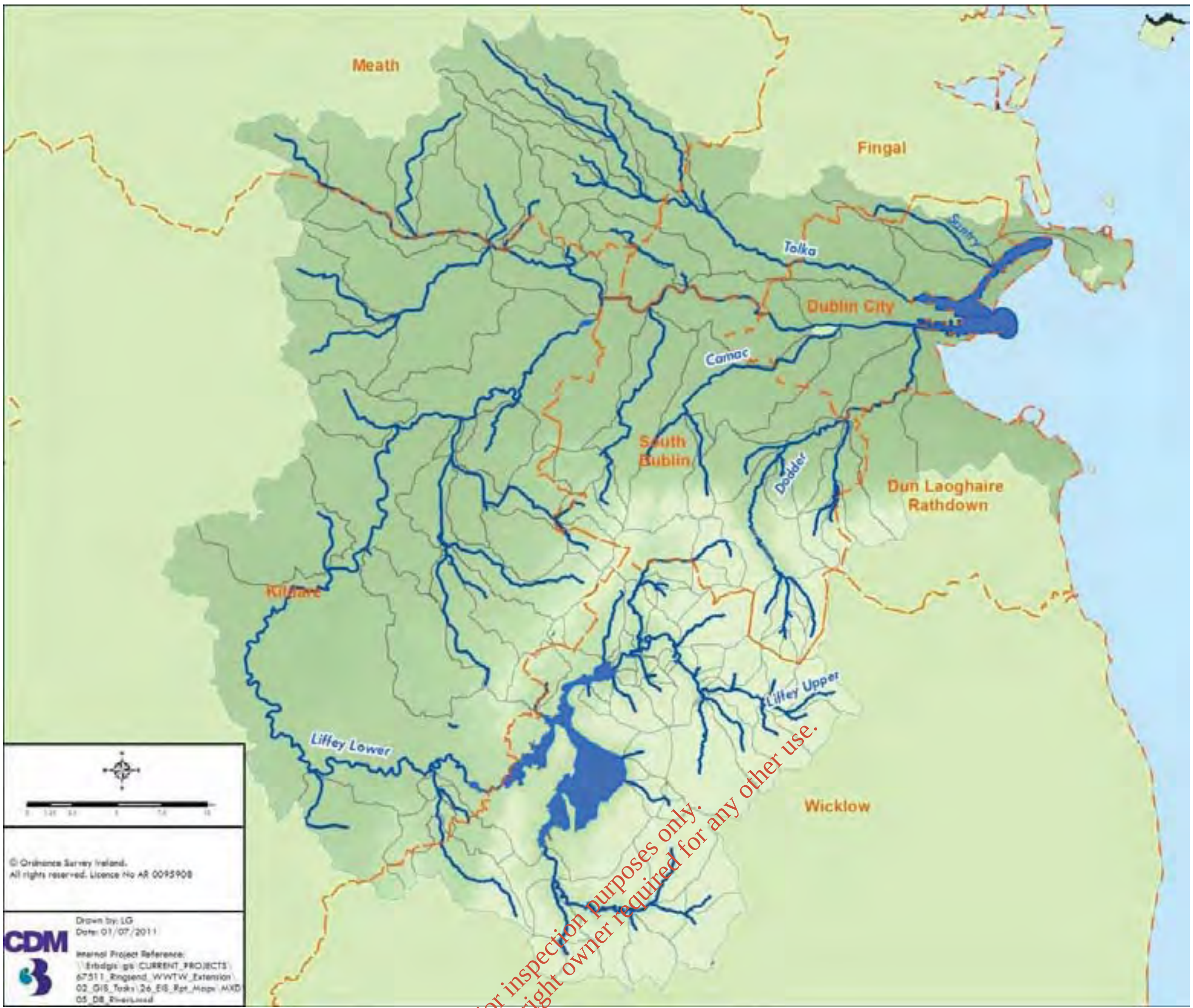


Figure 8.16 River Catchments Discharging to Dublin Bay

The River Tolka is the second largest of the four rivers it flows through Meath and Dublin City. The Dodder and the Camac are the smallest of the four rivers in terms of catchment size and discharges into the Liffey.

Water is abstracted from the Liffey Estuary by the ESB Power Generation Station for use as cooling waters. The ESB Cooling Waters mix with the WwTW discharge before final discharge to the estuary. There are currently a Combined Cycle Gas Turbine (CCGT) power generation plant at Poolbeg. The CCGT is run continuously whilst the Thermal Plant that was previously used during periods of peak demand closed during 2010.

The effluents include condenser cooling water, discharge from the water treatment neutralisation tanks, boiler blowdown water and screen wash water. The IPPC Licences for these plants contain limits for the quality of the effluents in terms of physical and chemical properties.

8.3.2 Construction Compounds

As can be seen in Figure 8.17, there are no watercourses within the general construction area on the Ringsend WwTW.

As can be seen in Figure 8.18, there are no watercourses within the general construction area of the tunnel inlet shaft. The site is, however, in close proximity to the waters of the Liffey Estuary to the south and east.

Figure 8.17 Construction Area within Curtilage of WwTW

Figure 8.18 Area for Construction of Tunnel Inlet Shaft

8.3.3 Water Quality

8.3.3.1 Water Quality

The water quality of Dublin Bay and the main rivers that discharge to it are discussed in this section, under the following headings:

- Water Framework Directive Status Classification;
- Bathing Waters;
- Trophic Status; and
- Actual Water Quality Data.

The Greater Dublin Strategic Drainage Study (GDSDS) identified over 250 intermittent discharges of combined sewage outflow (CSO) in the Greater Dublin area, of which; 152 (60 %) discharged to the Liffey / Grand Canal / Dodder / Tolka systems which converge in Dublin Harbour and 205 (80 %) discharged into Dublin Bay, either directly or via rivers and streams (Dublin Drainage Consultancy, 2005).

Significant levels of persistent contaminants, such as heavy metals, are largely confined to the upper parts of the Liffey and Tolka estuaries and, to a lesser extent, that of the Dodder. Pollution in the Tolka basin was first noted in Victorian times, with heavy metal pollution generally attributed to domestic and agricultural sources rather than from specialised industries (Wilson, 1980). Jones & Jordan (1977 as cited in Wilson, 2003) reported a gradient of metal contamination from the entry of the Camac to the harbour mouth. Subsequent surveys (Wilson et al, 1986; Brennan, 1988; Britton, 2001) have shown an overall decline in metal levels with the closure of certain industries and the upgrading of the Victorian sewage system (Wilson, 2003).

8.3.3.2 Water Framework Directive Classification

The EPA have completed a WFD classification of transitional and coastal waters. Dublin Bay and its estuaries have been found to be of moderate status.

The status of a water body is determined by combining assessment results for biological, chemical and physicochemical quality elements. The ecological status of natural surface waters falls into one of five classes: high, good, moderate, poor or bad. There are two classes for the chemical status of surface waters: good or fail. The quality element most severely affected by human activity determines the overall ecological status; this is called the ' one out - all out principle'. Figure 8.19 shows how the various monitored elements combine to give the status classification.

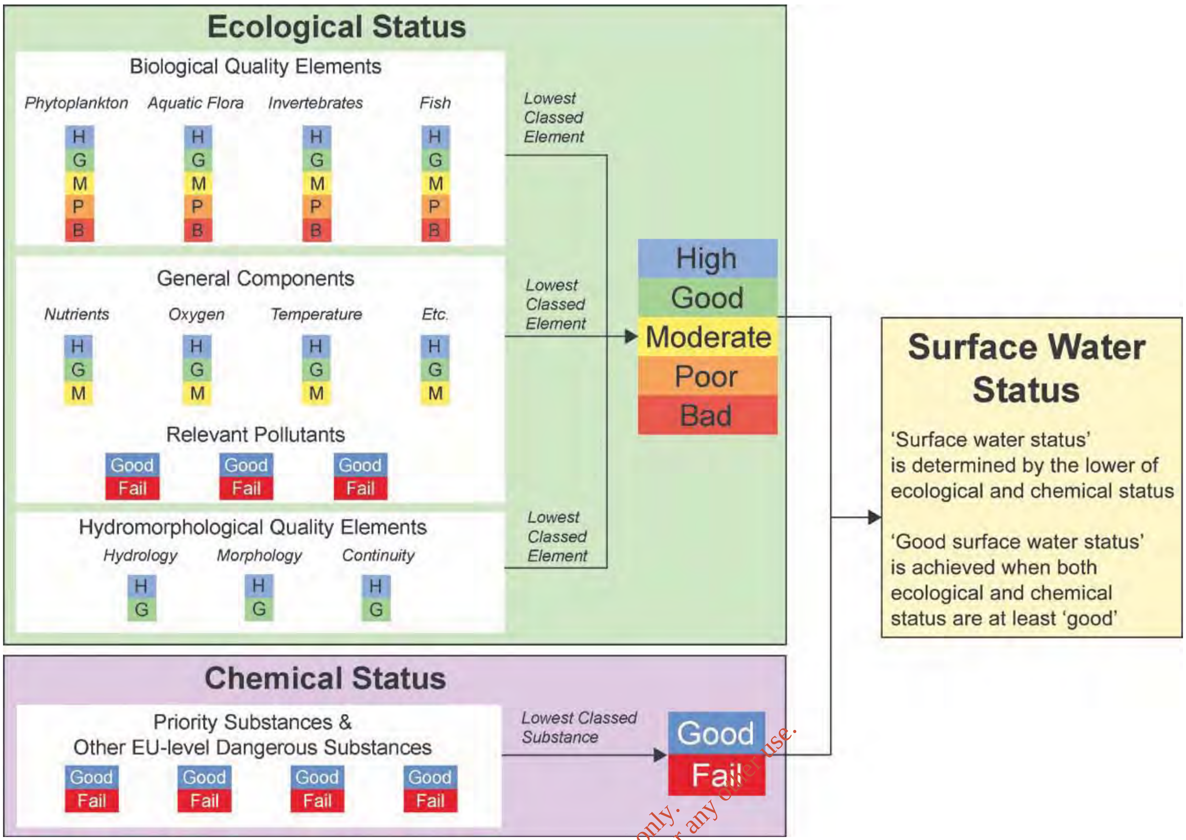


Figure 8.19 Elements of WFD Status Classification

The elements causing transitional and coastal bodies in Dublin to fail to achieve at least good status are shown set out in the ERBD River Basin Management Plan 2009 – 2015 and summarised in Table 8.14 and Table 8.15, below.

Table 8.14 Elements causing transitional water bodies to fail to achieve at least good status

Name	Ecology		Chemical		Protected area		Interim Overall Status Classification
	Status	Reason	Status	Reason	Status	Reason	
Liffey Estuary Lower	Good	Molybdate Reactive Phosphorus (MRP)	Fail	Priority substances	Less than good	Failing to meet sensitive water (UWWTD) objectives	Moderate
North Bull Island							Unknown
Tolka Estuary	Moderate	Molybdate Reactive Phosphorus, Opportunistic Macroalgae, Fish	No Data	No Data	Less than good	Unfavourable Conservation Status	Moderate

Table 8.15 Elements causing coastal water bodies to fail to achieve at least good status

Name	Ecology		Chemical		Protected area		Interim Overall Status Classification
	Status	Reason	Status	Reason	Status	Reason	
Dublin Bay	Moderate	Dissolved Inorganic Nitrogen (DIN)	Fail	Priority substances	Less than good	Unfavourable Conservation Status	Moderate

The River Basin Management Plan 2009-2015 sets out the measures to be implemented in each water body to prevent deterioration and improve the water quality across the river basin district. The target dates for achieving good status for the relevant water bodies are set out in Table 8.16. Under the WFD water bodies are to achieve good status in 2015, with extensions possible until 2021 and 2027; in the case of these water bodies the target date was extended to 2027 due to the location at the bottom of the catchment.

Table 8.16 Target Year to Attain Good Status under the WFD

Name	Year to Attain Good Status
Liffey Estuary Lower	2027
North Bull Island	2027
Tolka Estuary	2027
Dublin Bay	2027

8.3.3.3 Bathing waters

Under the Quality of Bathing Waters Regulations, 1992, four stretches of beach have been designated as bathing water protected areas within Dublin Bay:

- Dollymount Strand;
- Sandymount Strand;
- Merrion Strand; and
- Seapoint.

They are all located in the coastal waters and the locations are shown in Figure 8.20 reflecting the EPA's monitoring point for each site and compliance status. The nearest bathing water beaches to Ringsend WwTW are Dollymount Strand to the north and Sandymount Strand to the south.

Bathing waters can be classified as 'excellent', 'good', 'sufficient' and 'poor' under the Bathing Water Regulations, as described in Section 8.1.1.3. Dollymount Strand had good water quality status during the period 2003 to 2010 except in 2006 when the bathing area had sufficient water quality status. Sandymount Strand had good water quality status in 2009 and 2010 and during the period 2006 to 2007. The bathing area had sufficient water quality status in 2008 and during the period 2003 to 2005. Merrion Strand had good water quality status in 2003, 2006, 2009 and 2010 sufficient water quality status in 2004, 2007 and 2008 and had poor water quality status in 2005. Seapoint achieved good water quality status in 2010 and the previous seven years.

Blue Flag beaches are selected through strict criteria dealing with water quality, environmental education and information, environmental management, and safety and other services. In Dublin Bay the only flag awarded Blue Flag status in 2009/2010 was Dollymount Strand. However Dollymount Strand did not retain its Blue Flag Status for 2011 due to water quality.

Figure 8.20 Bathing Water protected areas Bathing Water Quality Results for 2010

8.3.3.4 Trophic Status

The status of estuarine and coastal water bodies is assessed by the EPA using the Trophic Status Assessment Scheme (TSAS) as set out in Water Quality in Ireland 2007-2009, EPA, 2010. This assessment is required for the UWWT Regulations and Nitrate Regulations. The scheme compares the compliance of individual parameters against a set of criteria indicative of trophic state. These criteria fall into three categories nutrient enrichment, accelerated plant growth and disturbance to the level of dissolved oxygen normally present.

Based on criteria levels of nutrient enrichment (DIN and MRP), chlorophyll levels and percentage saturation of DO, the trophic status of the water can be classified into eutrophic, potentially eutrophic, intermediate and unpolluted based on the following:

- Eutrophic water bodies are those in which criteria in each of the categories are breached;
- Potentially Eutrophic water bodies are those in which criteria in two of the categories are breached and the third falls within 15 per cent of the relevant threshold value;
- Intermediate status water bodies are those which breach one or two of the criteria;
- Unpolluted water bodies are those which do not breach any of the criteria in any category.

The Environmental Protection Agency (EPA) report "Water Quality in Ireland 1998-2000" identified eutrophic conditions in the Liffey Estuary. Under the UWWT Regulations 2001 the Liffey Estuary was designated as 'nitrate sensitive'.

During the 1999-2006 period, the trophic status of the Liffey Estuary improved from eutrophic to intermediate. The outcome of the most recent TSAS of estuarine and coastal waters for the period 2007-2009 showed that the Liffey Estuary Lower and Dublin Bay were unpolluted. The Liffey Estuary Upper was classified as Intermediate which means that one or two of the criteria were breached. The observed improvement in water quality in the Liffey Estuary is a result of the installation of significantly upgraded treatment facilities at the Ringsend WwTW.

The outcome of the most recent TSAS of estuarine and coastal waters for the period 2007-2009 showed that the Tolka Estuary is Potentially Eutrophic which means that two of the categories were breached and the third falls within 15 per cent of the relevant threshold value.

8.3.3.5 Water Quality Data

Water quality monitoring data for Dublin Bay and the Liffey and Tolka Estuaries, for the years 2008 to 2009, were provided by Dublin City Council. The data were recorded from sites within the vicinity of the study area with both surface and at depth samples. The data are summarised as mean values presented in Figure 8.17 and the locations shown on Figure 8.21.

In the Lower Liffey Estuary levels of ammonia and MRP peak in surface waters near the existing outfall. After the outfall the nutrient levels decrease indicating that the outfall is a significant contributor of nutrients in the Liffey Estuary. The median Molybdate Reactive Phosphate (MRP) levels are almost four times higher than EQS "higher salinity" median levels in the surface waters at the outfall.

In the Tolka Estuary there are high MRP levels. The median values are higher than environmental quality standard (EQS) "higher salinity" in surface waters and at depth at two of the sampling locations close to the mouth of the estuary.

While phosphorus can limit plant growth in freshwater and estuarine systems, nitrogen is considered to be the limiting nutrient in open coastal waters and is not significantly influenced by freshwater run-off. In order for a water to meet the "good status" category it is the median value that applies for DIN. The Environmental Objectives Regulations 2009 has inadvertently omitted the reference to median concentration (EPA, Pers. Comm.). At all of the sampling locations within Dublin Bay the median value of DIN was found to be below the median value of 0.25 mg/l N for saline waters (34.5 psu).

BOD concentrations were generally low, as indicated by average values of 2.0 mg/l O_2 in both the Liffey Tolka estuaries and Dublin Bay. This value is also the limit of detection for the method used, at least 90 % of the reported measurements were less than 2.0 mg/l O_2, indicating that the actual average value for the Liffey and Tolka estuaries and Dublin Bay is much lower than the limit of detection.

Results for Dissolved Oxygen (DO) all fall within an acceptable range, as defined by lower and upper limits required for DO saturation in transitional and coastal water bodies.

Table 8.17 Average (or Median) Water Quality Results 2008-2009 (Dublin City Council)

Sampling Location	Surface / Depth	Salinity (PSU)	Temp. (°C)	BOD (mg/l)	DO (% sat)	Ammonia (mg/l N)	DIN* (mg/l N)	MRP* (mg/l P)	Chlorophyll a (mg/m^3)
Liffey Estuary									
Upper, Liffey at Islandbridge	S	0.2	11.4	2.1	99.6	0.085	1.953	0.044	1.2
Upper, Liffey at Heuston Bridge	S	0.5	11.5	2.0	99.3	0.074	1.89	0.045	1.1
Upper, Liffey at Matt Talbot Bridge	S	4.3	10.9	2.1	97.2	0.081	1.656	0.050	0.9
	D	28.8	11.0	2.3	86.1	0.126	0.3	0.047	2.0
Lower, Dodder Grand Canal Basin	S	4.7	10.7	2.1	98.9	0.053	1.117	0.034	1.1
	D	27.3	10.1	2.0	94.6	0.086	0.292	0.038	0.9
Lower, East Link Toll Bridge	S	9.9	10.8	2.0	96.8	0.079	1.185	0.043	0.7
	D	31.8	11.0	2.0	92.3	0.087	0.212	0.035	1.1
Lower, RO RO Ramp No. 5 (Old TW Outfall)	S	21.2	11.4	2.2	100.1	0.105	0.68	0.039	0.9
	D	32.2	11.0	2.0	98.4	0.053	0.141	0.028	1.0
Lower, Ringsend Cascade	S	26.4	12.7	2.2	100.6	0.434	1	0.155	1.1
	D	31.6	11.2	2.0	97.5	0.093	0.184	0.034	1.2
Lower, Poolbeg Lighthouse	S	29.9	11.4	2.0	100.7	0.153	0.291	0.055	1.3
	D	32.4	11.0	2.0	101.2	0.052	0.082	0.020	1.1
Tolka Estuary									
Tolka at Drumcondra Bridge	S	0.3	11.3	2.3	104.4	0.063	1.54	0.077	1.95
Tolka Estuary at Annesley Bridge Road	S	0.5	11.7	2.4	111.5	0.045	1.49	0.067	2.10
Tolka Estuary at East Point Business Park Bridge	S	7.5	11.7	2.1	102.0	0.107	1.14	0.076	0.90
Tolka Estuary, Castle Ave.	S	24.9	11.2	2.0	96.1	0.156	0.55	0.070	1.31
	D	29.7	11.4	2.0	98.0	0.117	0.26	0.042	1.51
Tolka Estuary, Clontarf Boat Club	S	27.5	11.2	2.0	99.1	0.129	0.37	0.060	1.13
	D	31.9	11.1	2.0	100.0	0.057	0.15	0.031	1.11
Tolka Estuary, S. Lagoon at Bull Wall Wooden Bridge	S	27.7	11.3	2.0	100.1	0.143	0.28	0.068	0.95
	D	28.7	11.4	2.0	100.1	0.111	0.28	0.053	1.01
Dublin Bay									
1km NE Poolbeg Lighthouse	S	33.4	10.8	2.0	100.5	0.017	0.0845	0.0155	1.1
	D	33.3	10.9	2.0	101.3	0.021	0.035	0.017	1.0
South Bull Buoy, 1km SE Poolbeg Lighthouse	S	32.4	11.0	2.0	101.3	0.034	0.122	0.02	1.0
	D	33.3	10.7	2.0	100.9	0.018	0.061	0.016	1.0
2.5km SSE Poolbeg Lighthouse	S	32.8	10.8	2.0	101.7	0.023	0.063	0.017	1.0
	D	33.4	10.7	2.0	100.1	0.020	0.057	0.016	1.2
No. 4 Buoy, 2.5km E of S Poolbeg Lighthouse	S	33.0	10.7	2.0	101.7	0.022	0.065	0.017	0.9
	D	33.4	10.7	2.0	100.6	0.017	0.06	0.017	1.0
2.5km ENE Poolbeg Lighthouse	S	32.7	10.9	2.0	101.9	0.027	0.1185	0.027	1.0
	D	33.2	10.7	2.0	101.3	0.019	0.065	0.019	0.9
Dún Laoghaire, 5km E of S Poolbeg Lighthouse	S	33.1	10.7	2.0	101.6	0.021	0.075	0.016	0.8
	D	33.4	10.7	2.0	100.2	0.016	0.067	0.014	1.0
Drumleck Point, 5km ESE Poolbeg Lighthouse	S	33.3	10.8	2.0	101.7	0.016	0.04	0.013	0.9
	D	33.2	10.8	2.0	100.4	0.018	0.053	0.016	1.0
Drumleck Point, 5km ENE Poolbeg Lighthouse	S	33.0	10.9	2.0	101.8	0.022	0.072	0.023	1.2
	D	32.0	10.8	2.0	102.3	0.032	0.098	0.027	1.0

** Median values*

Figure 8.21 DCC Water Quality Monitoring Locations in Dublin Bay and the Liffey and Tolka Estuaries

8.3.4 Modelling Results for Existing Situation

The plots of the summary results for both the neap tide mid flood and low water stages and maximum concentration simulations are presented in this section. Ringsend WwTW average flow current conditions and typical measured background concentration in the bay and rivers were used as model inputs. The outfall location was modelled at its existing location (SW1)

The modelling results of each dissolved inorganic nitrogen (DIN), molybdate reactive phosphorous (MRP), biochemical oxygen demand (BOD) and *Escherichia coli (E. coli)* are presented for each scenario. The water quality standards used to assess the impact of the existing outfall are outlined in Section 8.2.3.5.

8.3.4.1 Dissolved Inorganic Nitrogen (DIN)

The modelled tidal plots for neap tide mid flood and low water for the parameter DIN for the existing discharge are presented in Figure 8.22 and Figure 8.23. The maximum values for each grid cell during the entire simulation are shown in Figure 8.24. The graphic therefore shows the highest concentration at any time in each grid cell and represents a worst case scenario at each point and not a representation of one particular time.

To achieve good status a coastal water body must achieve a median value of less than 0.25 mgN/l at 34.5 psu. It should be stressed that in order for a water to meet the "good status" category it is the median value that applies. In the figures below, the blue highlighted area corresponds to where a DIN concentration of between of 0.25 mg/l DIN to 0.35 mg/l was modelled.

They show that in the existing situation the DIN plume extends from the existing Ringsend outfall into the Tolka estuary and along Dollymount Strand. The results also show that in the existing situation the DIN plume extends to the Bull lagoons and all along Dollymount Strand.

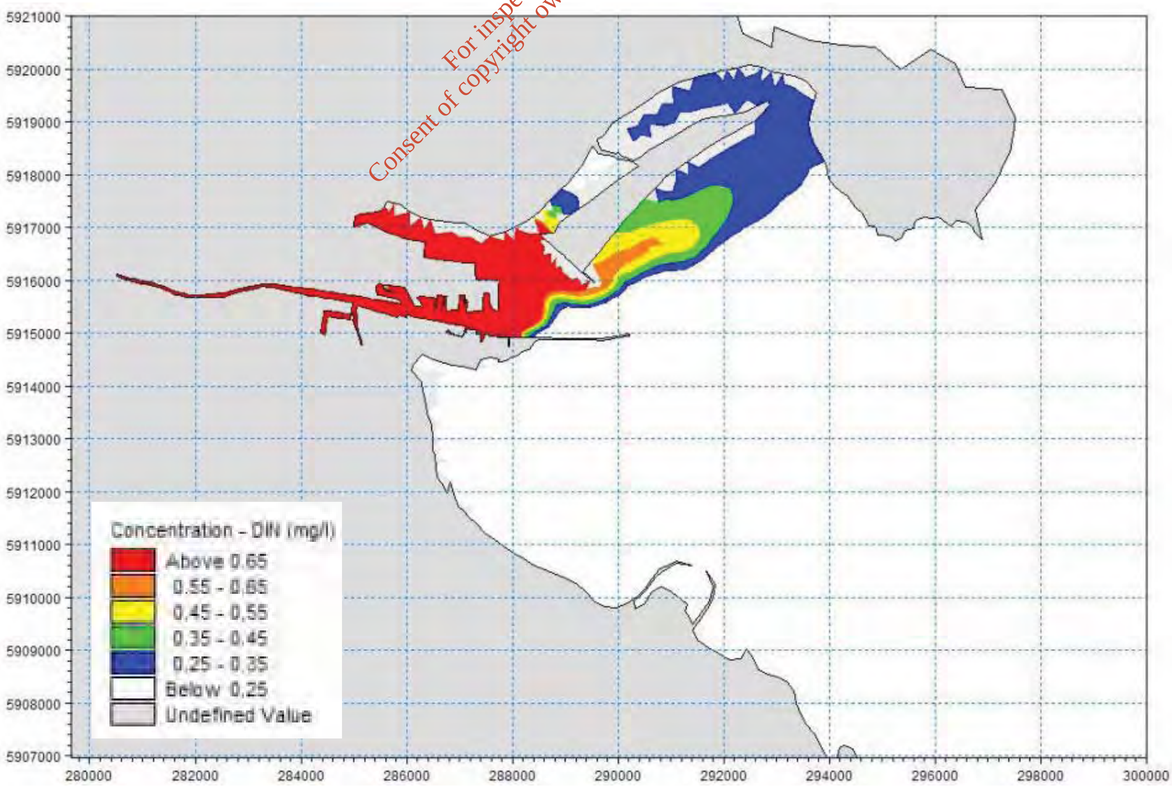


Figure 8.22 Existing outfall, DIN, Mid Flood Neap

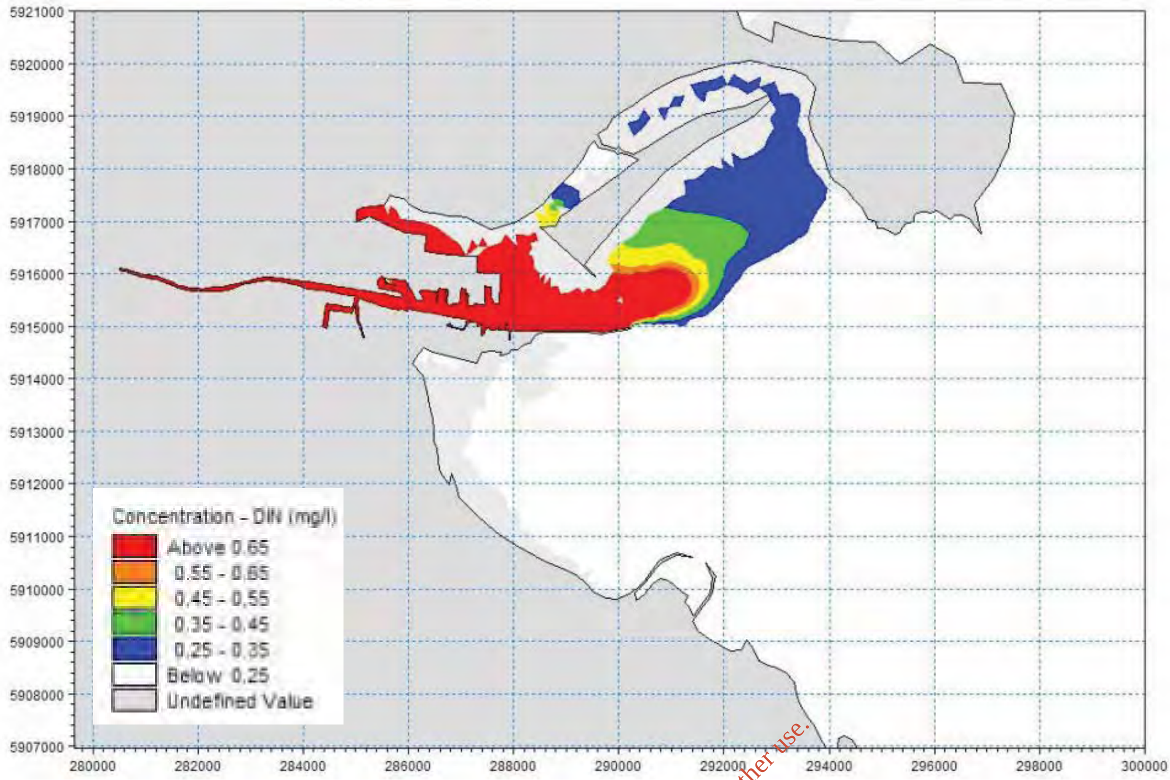


Figure 8.23 Existing Outfall, DIN, Low Water Neap

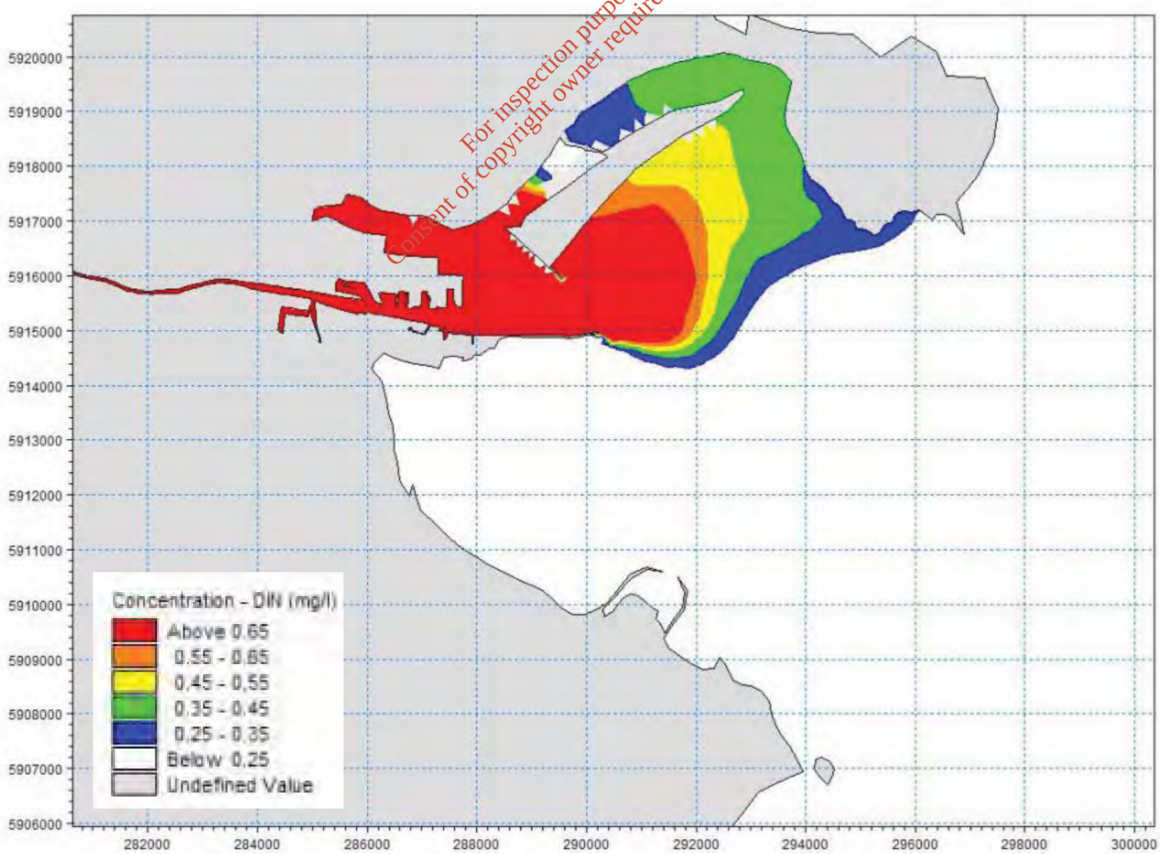


Figure 8.24 Existing outfall, DIN, Maximum Concentration

8.3.4.2 Molybdate Reactive Phosphorus (MRP)

The tidal plots for neap tide mid flood and low water for MRP are presented in Figure 8.25 and Figure 8.26. The maximum values for each grid cell during the entire simulation are shown in Figure 8.27. The graphic therefore shows the highest concentration at any time in each grid cell and represents a worst case scenario at each point and not a representation of one particular time.

Under the Environmental Objectives Regulations 2009 MRP limits are set out for transitional water bodies only. At 35 psu (corresponding to seawater) the median should not exceed 0.04 mg P/l. The blue area in the figures below corresponds to 0.04 to 0.05 mg P/l.

The results show that in the existing situation the MRP plume extends from the existing Ringsend outfall into the Tolka estuary and potentially extend to the Bull lagoons and all along Dollymount Strand to Howth Head.

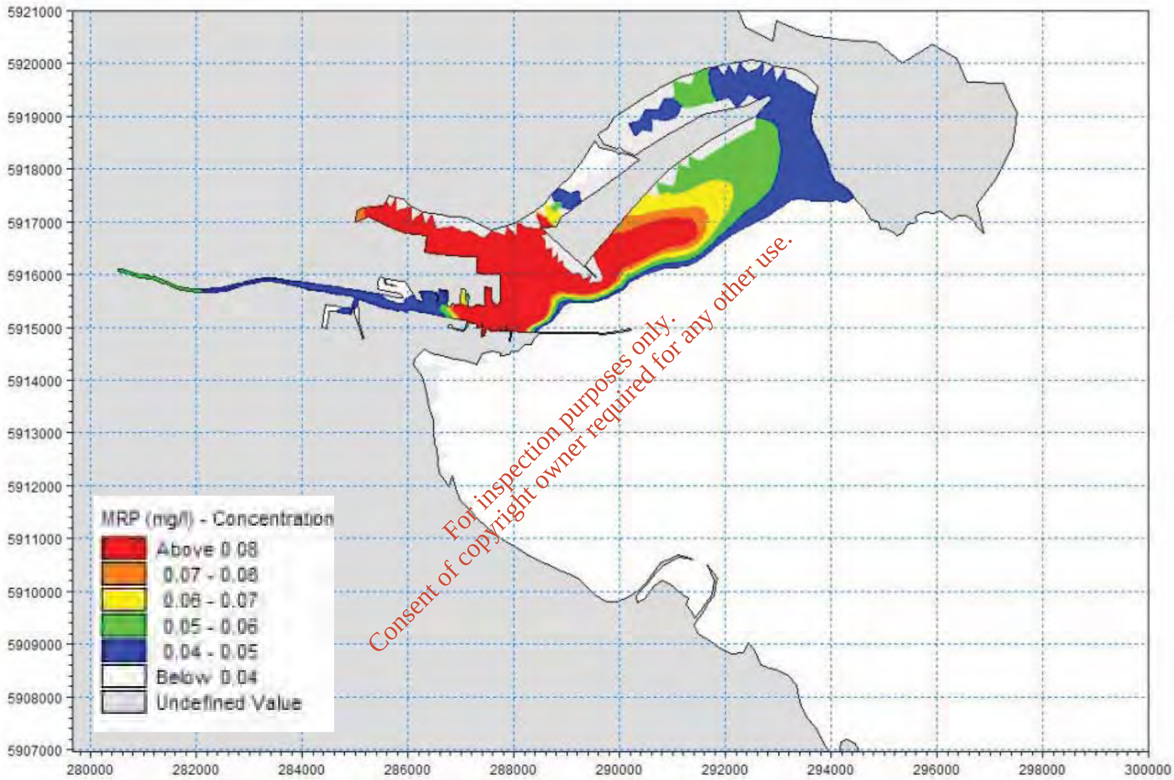


Figure 8.25 Existing outfall, MRP, Mid Flood Neap

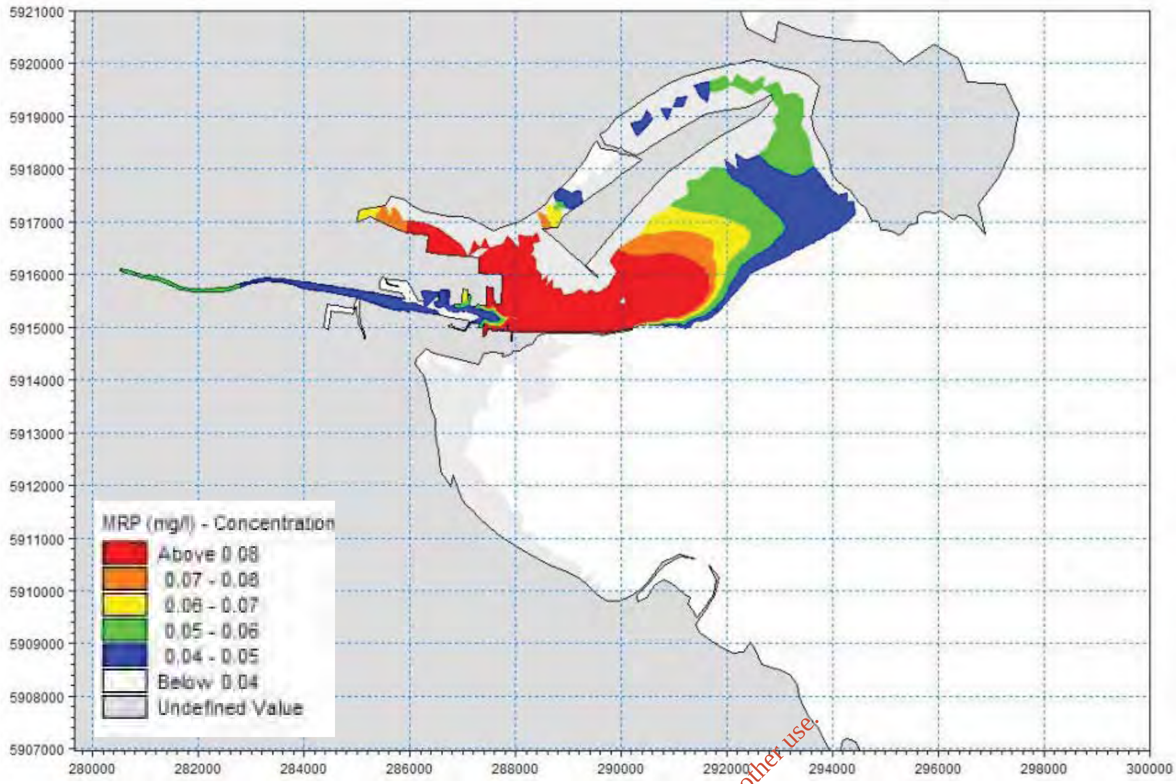


Figure 8.26 Existing outfall, MRP, Low Water Neap

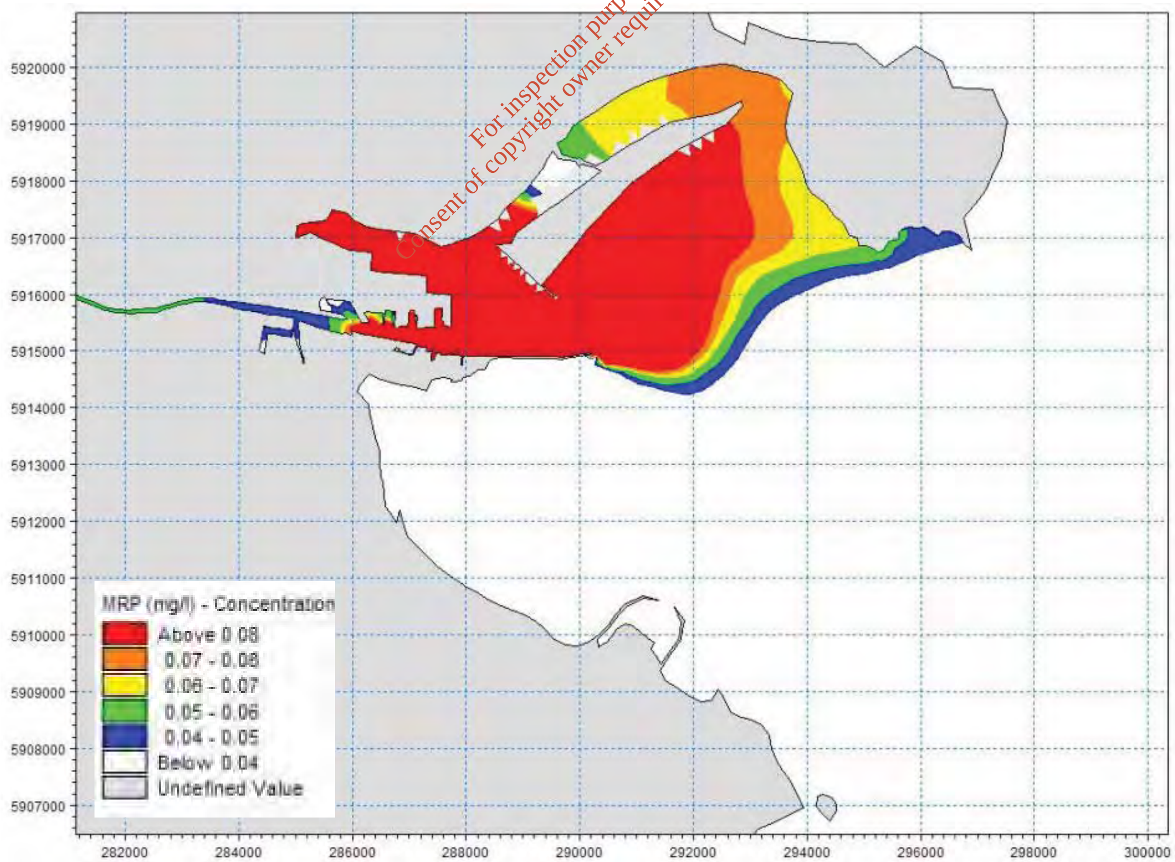


Figure 8.27 Existing outfall, MRP, Maximum Concentration

8.3.4.3 Biochemical Oxygen Demand (BOD)

The tidal plots for neap tide mid flood and low water for BOD are presented in Figure 8.28 and Figure 8.29. The plots show that in the existing situation there is a small BOD plume at the existing Ringsend outfall.

The Environmental Objectives Regulations 2009 set out of a BOD limit of 4 mg/l (95 %ile) for coastal waters. The blue area in the figures below correspond to an average of 4 mg/l BOD.

The maximum values for each grid cell during the entire simulation are shown in Figure 8.30. The results show that in the existing situation the influence of the plume on BOD concentrations is localised and extends just along the South Bull Wall. The plume does not reach into the coastal waters to where the Environmental Quality Objectives apply.

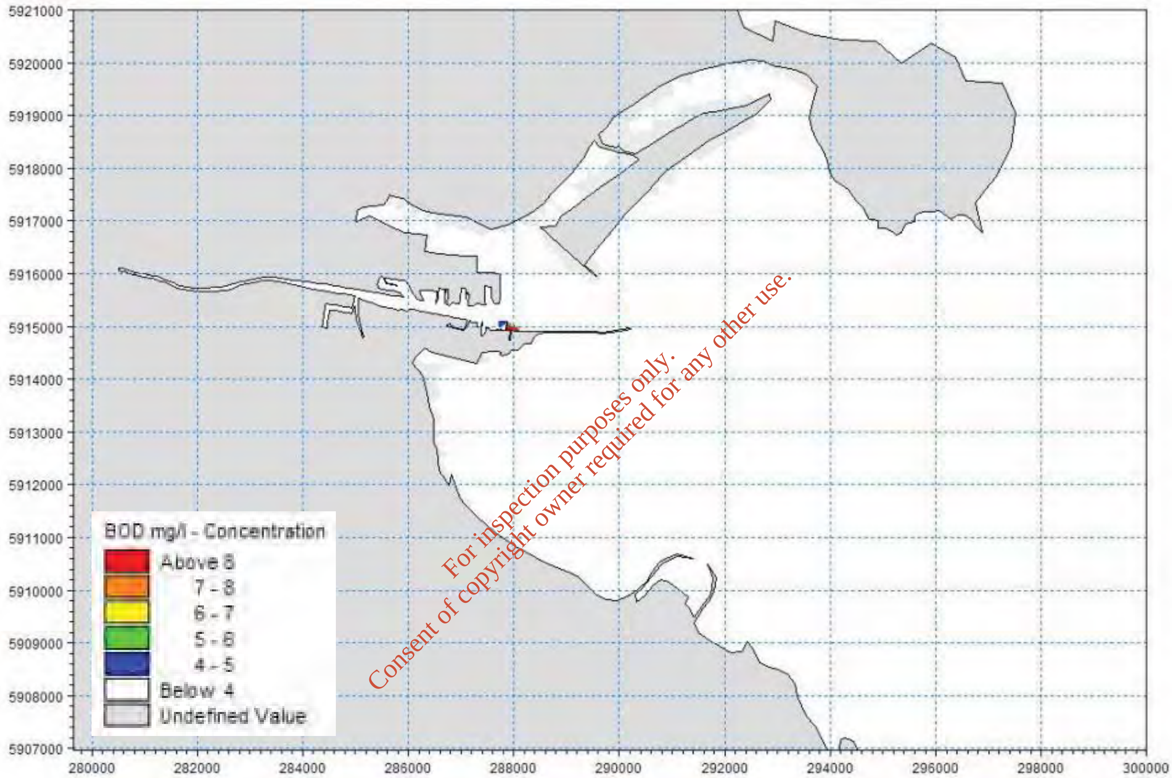


Figure 8.28 Existing outfall, BOD, Mid Flood Neap

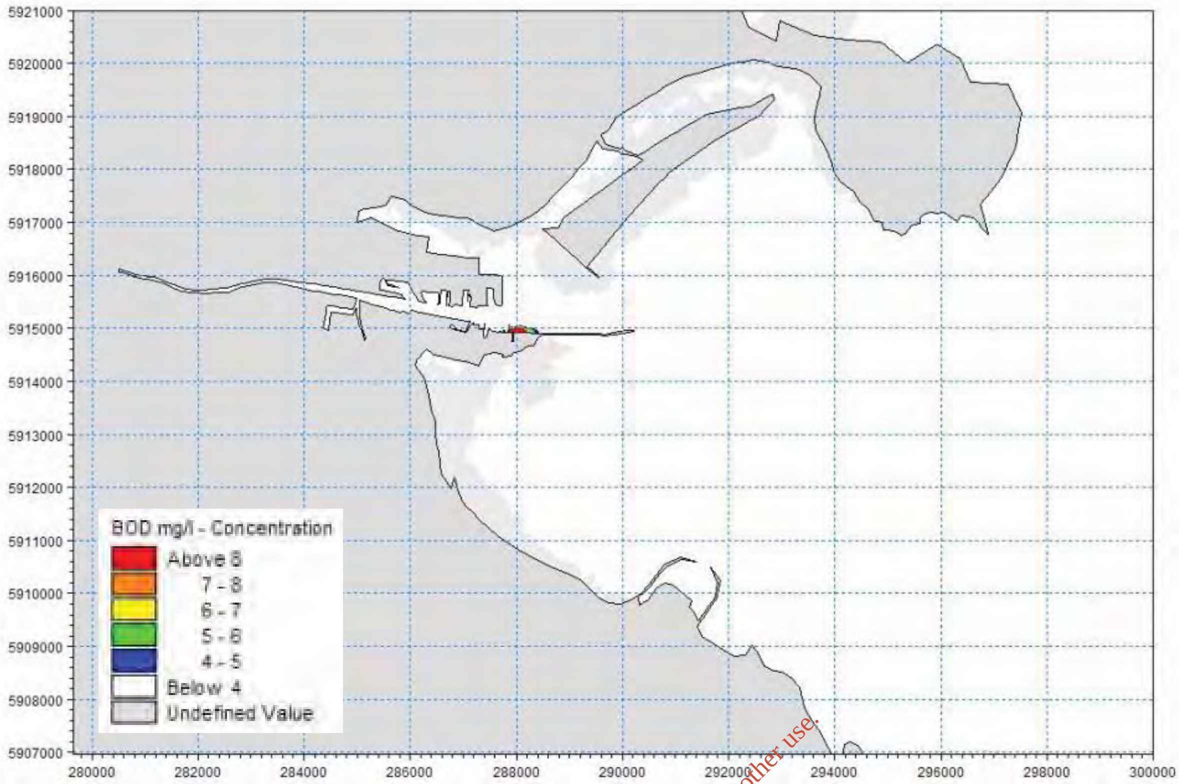


Figure 8.29 Existing outfall, BOD, Low Water Neap

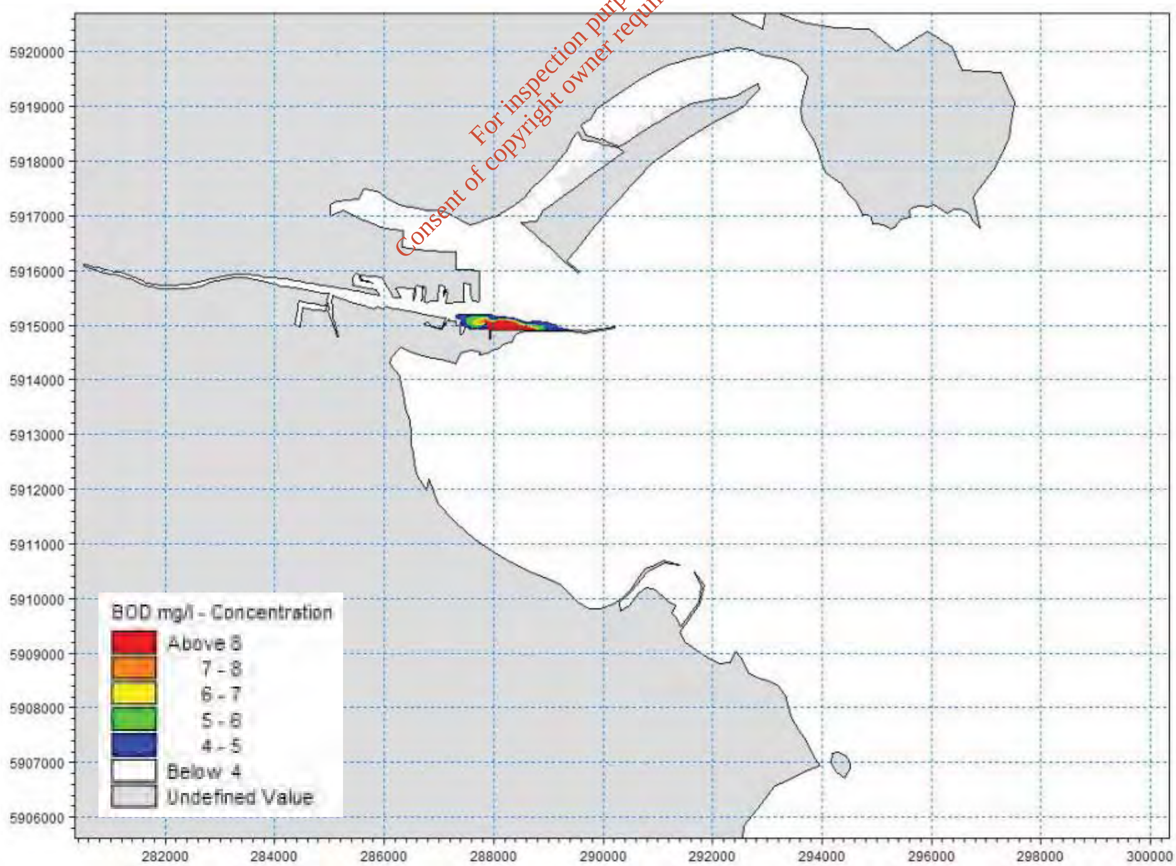


Figure 8.30 Existing outfall, BOD, Maximum Concentration

8.3.4.4 Escherichia coli (*E. coli*)

The tidal plots for neap tide mid flood and low water for *E. coli* are presented in Figure 8.31 and Figure 8.32. The plots show that in the existing situation the *E. coli* plume extends from the existing Ringsend outfall towards the north.

E.coli is of significance as limits exist for designated bathing waters as set out in Table 8.2 to Table 8.4. Under the Quality of Bathing Waters regulations, 2008 (SI 79 of 2008) for coastal and transitional waters the E.Coli concentration must be 500 cfu/100ml or less to achieve good quality, or 250 cfu/100ml or less to achieve excellent quality.

The maximum values for each grid cell during the entire simulation are shown in Figure 8.33. The plots show that in the existing situation the *E. coli* plume is predominantly localised to the Liffey Estuary, but may areas outside the estuary in the inner bay.

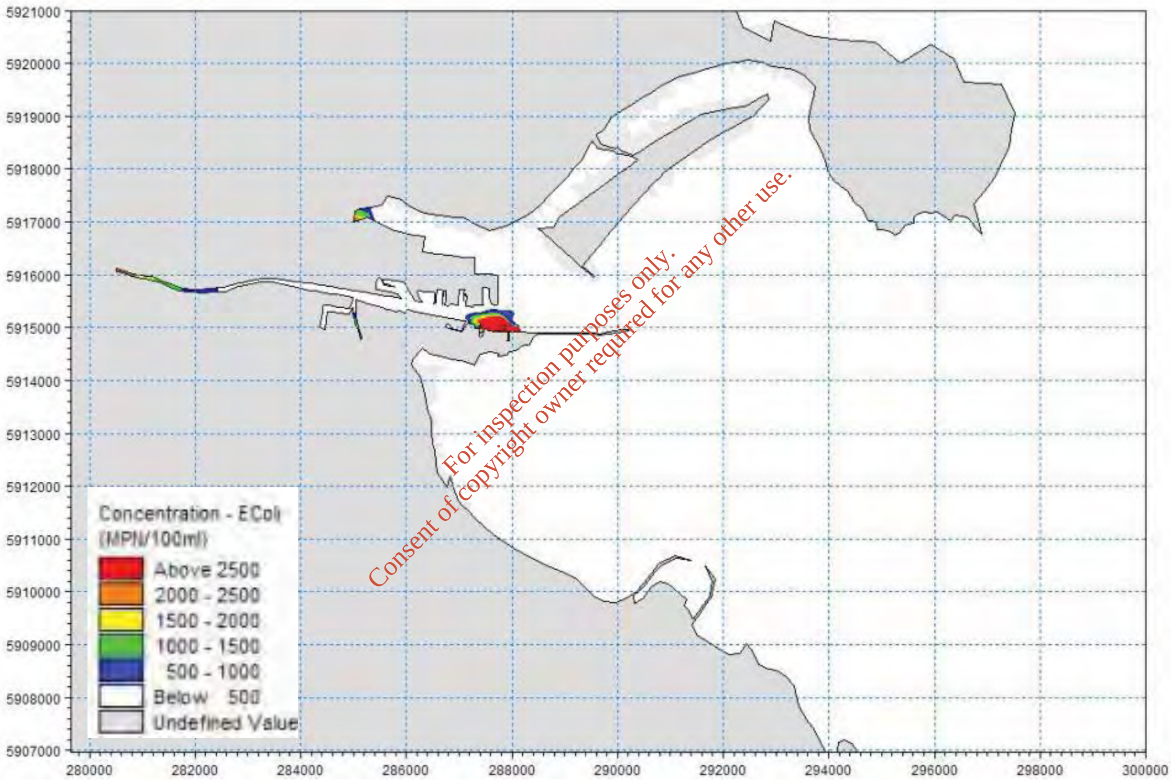


Figure 8.31 Existing outfall, *E. coli*, Mid Flood Neap

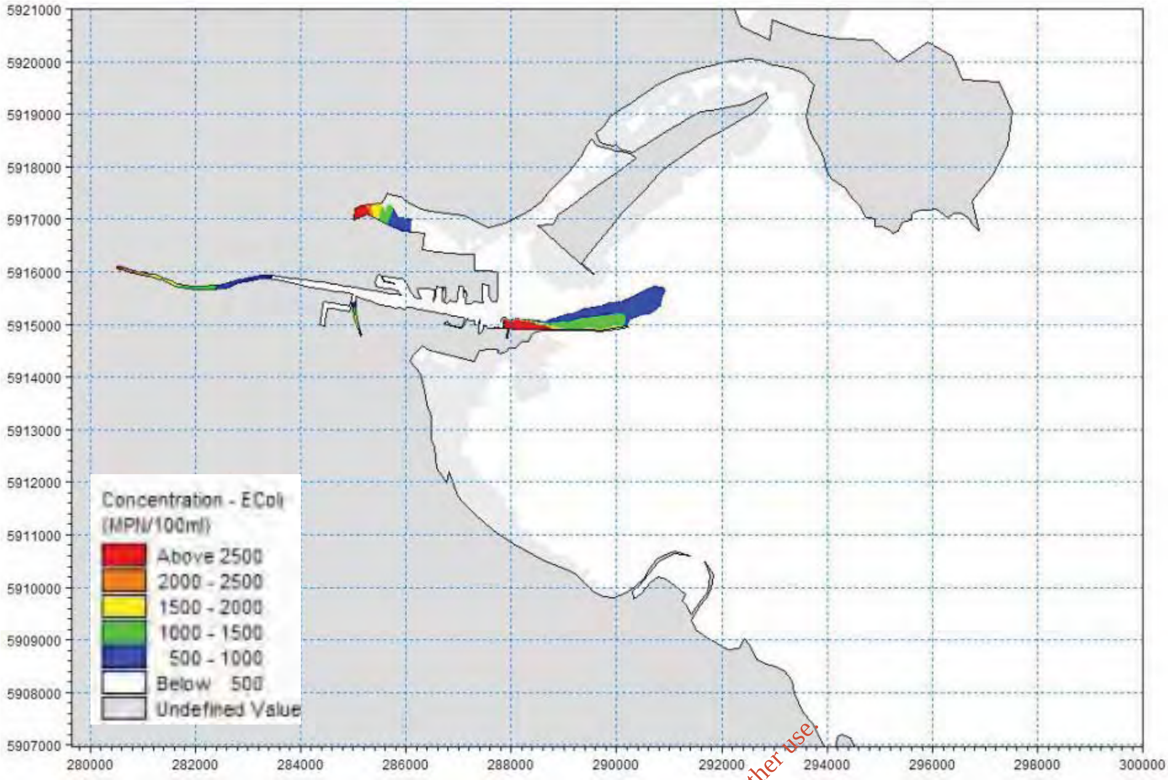


Figure 8.32 Existing outfall, *E. coli*, Low Water Neap

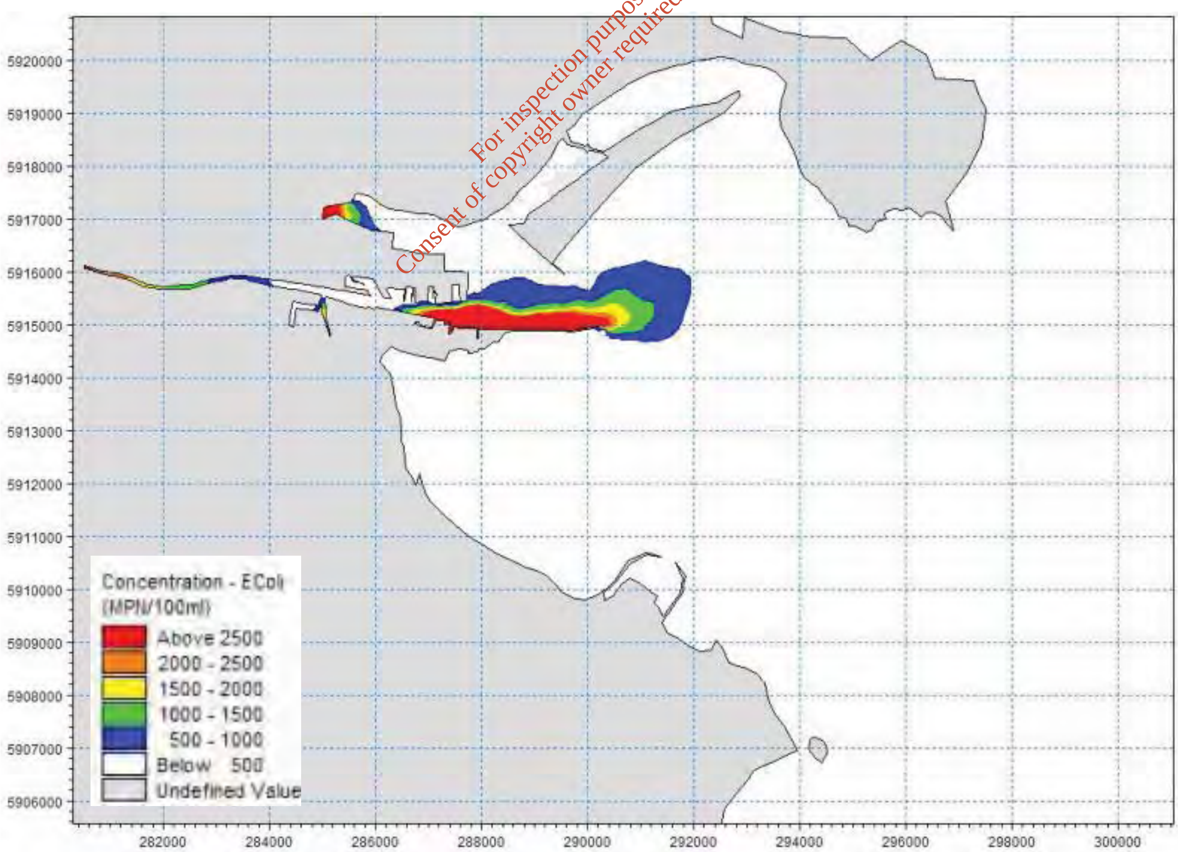


Figure 8.33 Existing outfall, Maximum Concentration, *E. coli*

8.3.4.5 Modelling of Existing Situation - Conclusions

Figure 8.22 to Figure 8.33 show the impact of the existing WwTW discharge on the Liffey Estuary and Dublin Bay. The discharge is seen to impact significantly on the Liffey Estuary and the North Inner Bay. Plots at the same stages in the tidal cycle are included for the proposed discharge in Section 8.5.1 to enable a direct comparison of the proposed impact against the current situation.

8.4 Impact of the Proposed Project – Construction

8.4.1 Construction Compounds

8.4.1.1 Surface Water Runoff

During the construction phase, various activities have the potential to result in increased surface water runoff which could potentially impact local drainage patterns and may result in very localised flooding. These include:

- The installation of surface water drainage discharge points to watercourses and surface water or foul drains;
- The installation of hard standing for temporary construction compounds and access roads; and
- The construction of surface and elevated structures on existing greenfield sites.

There is the potential for contaminated surface water runoff to arise during the construction phase without the correct mitigation measures. If discharged to surface water courses this could negatively impact on surface water quality. Potentially contaminated runoff may arise in parking and turning areas, fuel off-load and distribution areas, materials storage areas, skip and waste compactor areas. Surface run-off from the proposed development would be exposed to oils in the paved areas of the development. The pollutants in the surface water could then be discharged into the Liffey. This would result in a slight-moderate negative impact on water quality. Compliance with the surface water runoff mitigation measures as set out in Section 8.7 will result in **no impact** on water quality.

8.4.1.2 Accidental Spillage of Pollutants or Chemicals

During the construction phase, accidental spillage of pollutants and chemicals used could contaminate the area immediately surrounding the construction compound. Potential contamination of sediments and marine organisms from the accidental release of organic polymers or heavy metals associated with cementing and/or grouting materials may occur. These materials may be toxic to marine organisms in sufficient quantities and in the event of an accidental release, it could potentially contaminate the seabed sediments adjacent to construction, inhibiting recolonisation of the area after construction. This would result in a negative impact on water quality. Compliance with the appropriate mitigation measures are set out in Section 8.7 will result in **no impact** on water quality.

8.4.2 Tunnelling

8.4.2.1 Tunnel Arisings

Excavated cuttings will be crushed within the TBM and depending on the type of TBM may be mixed with the drilling fluid (for example bentonite slurry or water). The drilling fluid containing this material is pumped back to the slurry separation plant located at the tunnelling compound using a dedicated transport system through the advancing tunnel bore. Excavated materials from tunnelling (tunnel arisings) will be separated from the drilling fluid/bentonite slurry mixture and stock-piled temporarily on the site in an area reserved for this purpose (tunnel arisings storage area). Depending on the geology of the section tunnelled, tunnel arisings will comprise varying amounts of crushed rock, sands and gravels. Tunnel arisings will be stored in bunded areas to prevent siltation of water courses resulting in **no impact** on water quality.

This material will be sorted by the separation plant into various fractions which may be recombined after the separation process depending on the re-use potential of the material. Compliance with good practice will result in **no impact** on water quality.

Due to the nature of the segment lined tunnelling process and materials used during tunnelling there is no ingress of tunnelling slurries or compounds through the bedrock into the environment outside the tunnel resulting in **no impact** on water quality in the Bay.

8.4.2.2 Drilling Fluid

As set out above, drilling fluids such as bentonite mixed with water or suitable alternative drilling fluids, such as water mixed with polymer additives, may be used. The use and consumption of drilling fluid in the tunnelling process will be monitored throughout the works by material balance calculations and pressure control. In the unlikely event of loss of drilling fluid, the volume imbalance or the reduction in pressure would alert the operator and mitigation measures would quickly be put in place to control any localised breakout resulting in **no significant negative impact.**

Should bentonite slurry be used, it will be managed at a bentonite handling unit, which will be located within the construction compound. This facility will circulate and recycle the drilling fluid/bentonite slurry throughout the tunnelling process via dedicated hoses to and from the TBM and includes areas for settlement and filtration. The separation plant will include a number of stages of treatment using plant such as shakers and cyclones, and will be designed to efficiently recover bentonite slurry for reuse in the tunnelling process, preventing any pollution of surface water courses or detrimentally affecting water quality.

Drilling fluid removed from the system each day as slurry will be passed through a centrifuge and filter press. Following the recycling of the bentonite, the remaining liquid will be treated at the tunnelling compound water treatment system and will be disposed of at an authorised facility resulting in **no impact** on water quality.

8.4.2.3 Surface Intervention

Due to the size and nature of the TBM and tunnelling operations, there will be no surface intervention and all issues of repair and maintenance are carried out from within the tunnel meaning that there will be **no significant impact** on water quality..

8.4.3 Diffuser Shaft

8.4.3.1 Accidental Spillage of Pollutants or Chemicals

Accidental spillage of pollutants, chemicals or fuel would have the potential for localised pollution of the Bay. Potential contamination of sediments and marine organisms from the accidental release of organic polymers or heavy metals associated with cementing and/or grouting materials from the foundations may occur. These materials are toxic to marine organisms in sufficient quantities and in the event of an accidental release, it could potentially contaminate the seabed sediments adjacent to the development, inhibiting recolonisation of the area after construction. This would result in a moderate negative impact on water quality. Appropriate mitigation measures are set out in Section 8.7. Compliance with these mitigation measures should result in **no impact** on water quality.

8.4.3.2 Drilling of Shaft

Construction commencement works for the diffuser shaft may result in a short term increase in the turbidity of the water column due to the disturbance of the sediment; this period will be in the order of two days. Impacts of increased turbidity are likely to be minimal in an overall context as they will be of a short term nature and likely to be rapidly dispersed by the currents in the area. **No significant impacts** on water quality are therefore predicted.

8.5 Impact of the Proposed Project - Operation

8.5.1 Model Results for Proposed Discharge

Following the completion of the proposed project, the only impact on water quality will be the change in the discharge location and characteristics.

The plots of the summary results of the modelling for the proposed discharge for both the neap tide mid flood and low water stages and maximum concentration simulations are presented in this section. Both neap and spring tides were modelled, although neap tides only are presented as these display poorer pollutant dispersion than during higher tidal ranges and so represent "worst case conditions". Surface concentrations are shown as the treated effluent is bouyant and rises to the surface. The modelling results of each dissolved inorganic nitrogen (DIN), molybdate reactive phosphorous (MRP), biochemical oxygen demand (BOD) and *Escherichia coli (E. coli)* are presented for each scenario. The water quality standards used to assess the impact of the proposed outfall are outlined in Section 8.2.3.5.

8.5.1.1 Dissolved Inorganic Nitrogen (DIN)

The tidal plots for neap tide mid flood and low water DIN for the proposed outfall discharge are presented in Figure 8.34 and Figure 8.36. The impact of the discharge is seen to be reduced in the Liffey and Tolka Estuaries. Figure 8.35 and Figure 8.37 show the modelled concentrations superimposed on the modelled concentrations for the existing discharge. The reduction in area prone to elevated DIN levels as a result of the proposed discharge from Ringsend WwTW is seen to be significantly smaller.

The maximum values for each grid cell during the entire simulation are shown in each Figure 8.38. The graphic therefore shows the highest concentration at any time in each grid cell and represents a worst case scenario at each point and not a representation of one particular time. Figure 8.39 shows the modelled concentrations superimposed on the modelled concentrations for the existing discharge. The impact of the WwTW discharge can be seen to be significantly reduced, particularly with respect to the waters surrounding Bull Island.

To achieve good status a coastal water body must achieve a median value of less than 0.25 mg N/l at 34.5 psu. It should be stressed that in order for a water to meet the "good status" category it is the median value that applies. The Environmental Objectives Regulations 2009 has inadvertently omitted the reference to median concentration (informed by EPA). In the figures below, the blue highlighted area corresponds to where an average DIN concentration of between of 0.25 mg/l DIN to 0.35 mg/l was modelled.

Figure 8.34 and Figure 8.36 show the average DIN values for low and mid flood neap tides; elevated DIN levels in the bay can be seen to be limited to a finite mixing area around the discharge point. Figure 8.39 shows the maximum extent of a potential elevated concentration. It should be stressed that this figure does not represent an average concentration but signifies the maximum concentration in that modelled grid over the modelled period. It is, therefore, not representative of the mixing zone associated with the discharge point.

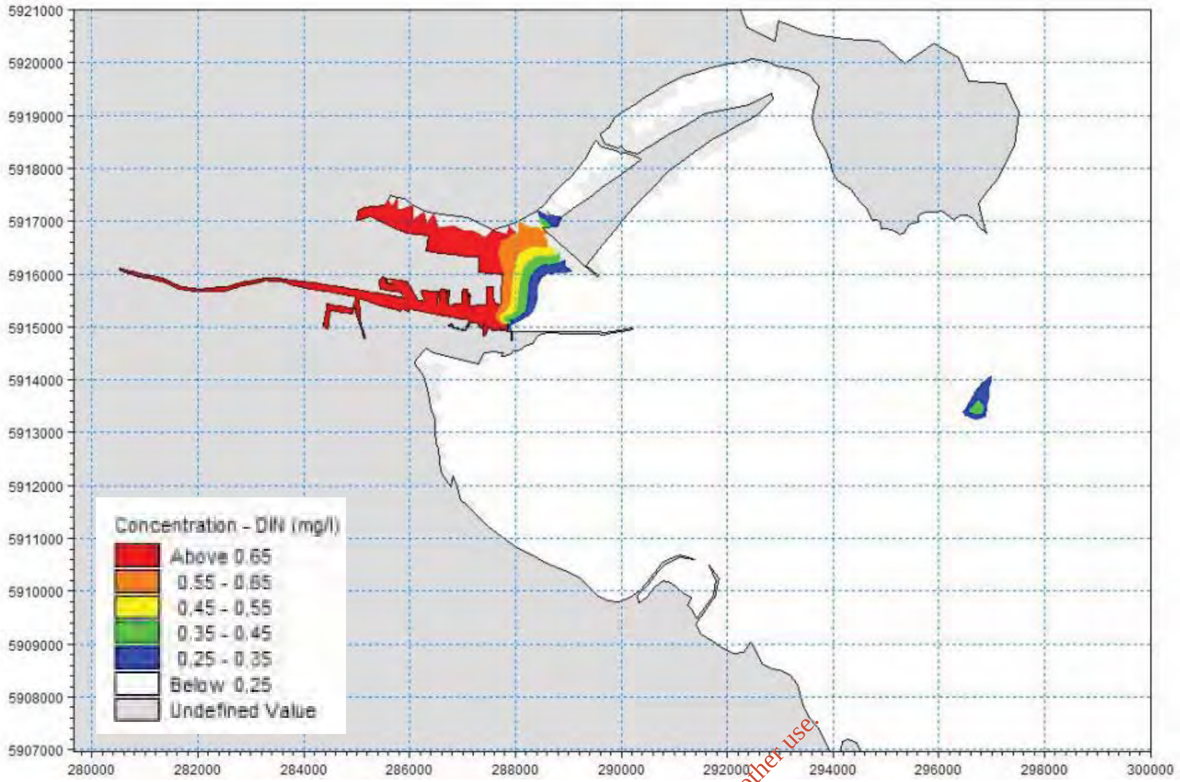


Figure 8.34 Proposed outfall, DIN, Mid Flood Neap

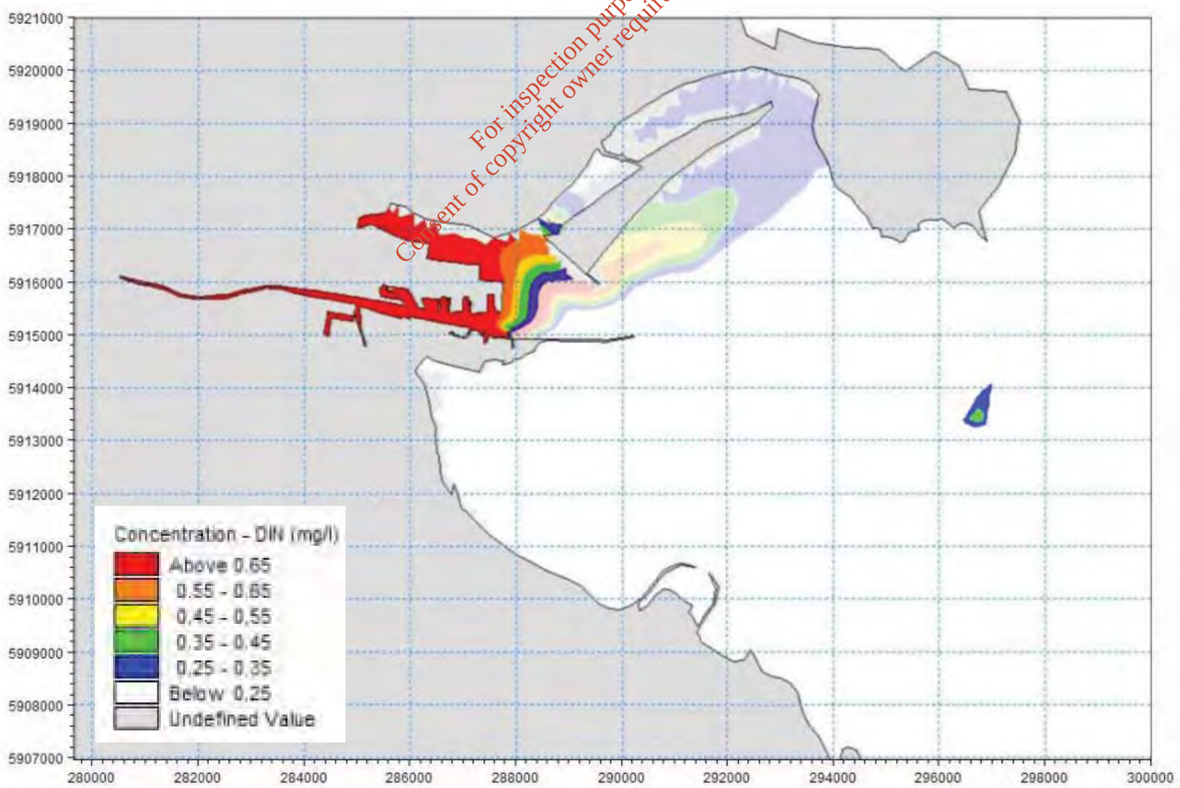


Figure 8.35 Proposed outfall, DIN, Mid Flood Neap superimposed on Existing Discharge

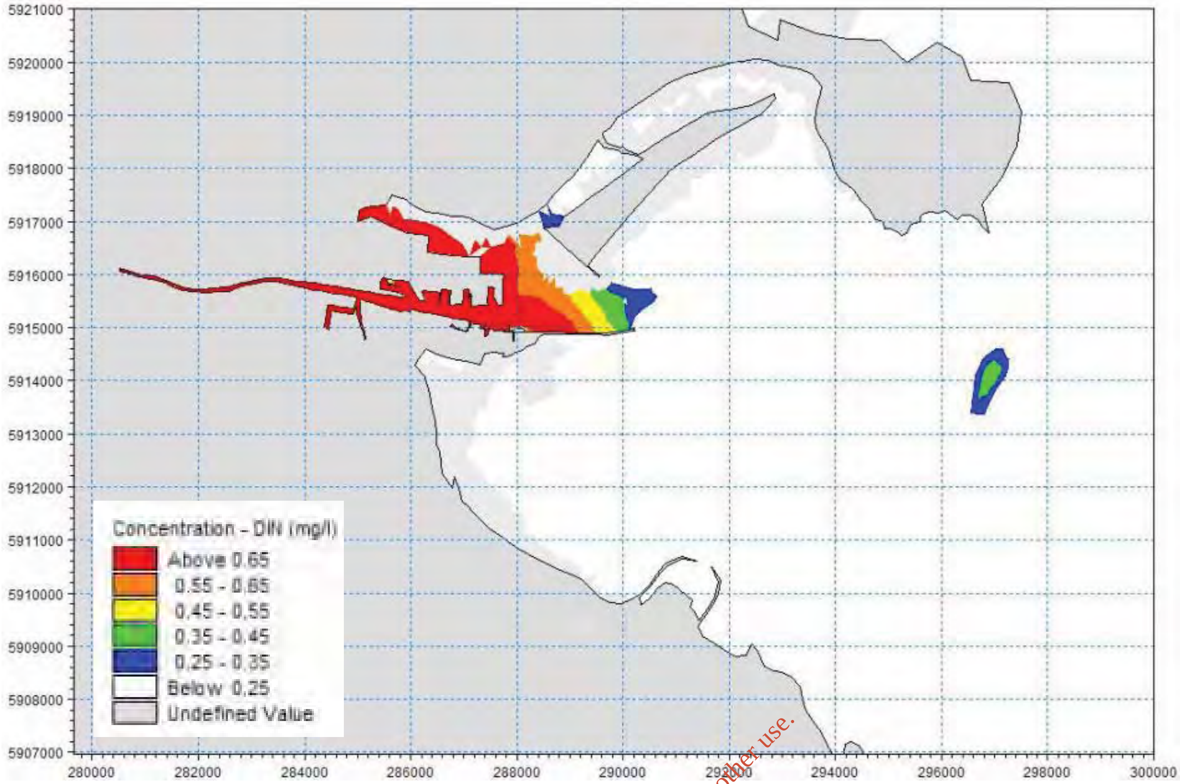


Figure 8.36 Proposed outfall, DIN, Low Water Neap

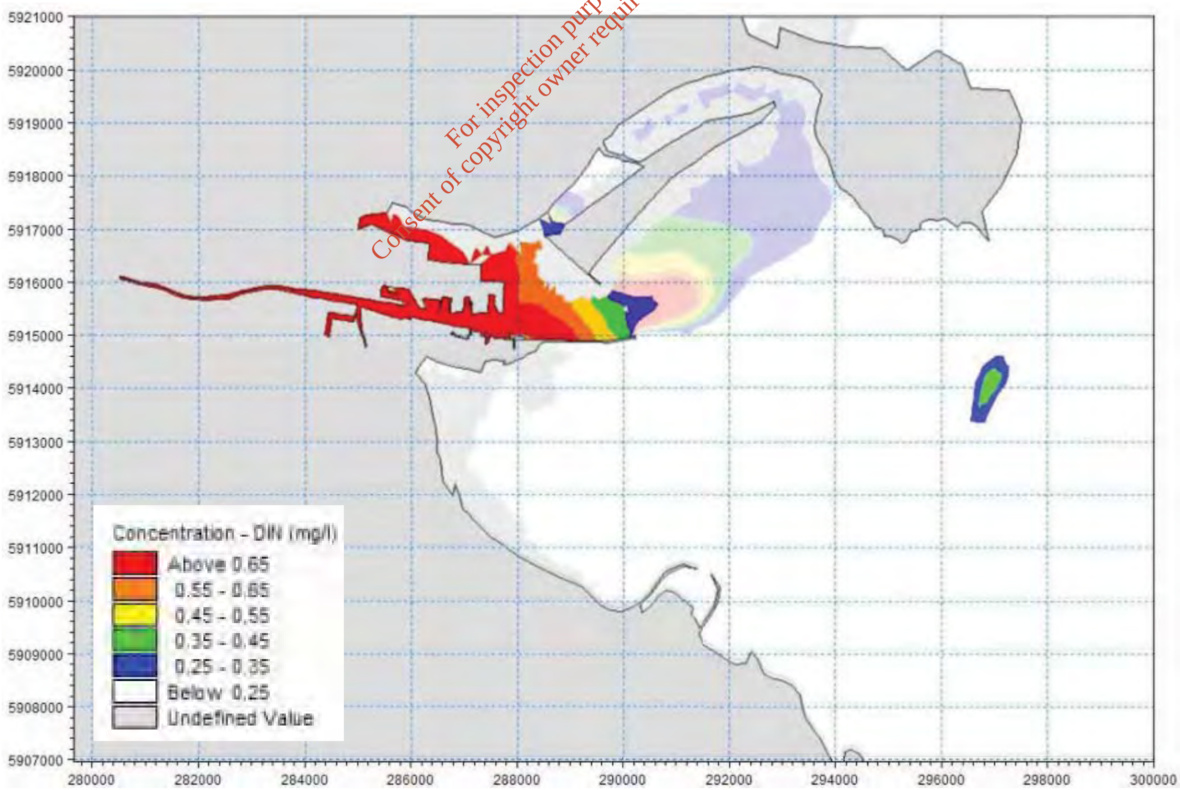


Figure 8.37 Proposed outfall, DIN, Low Water Neap superimposed on Existing Discharge

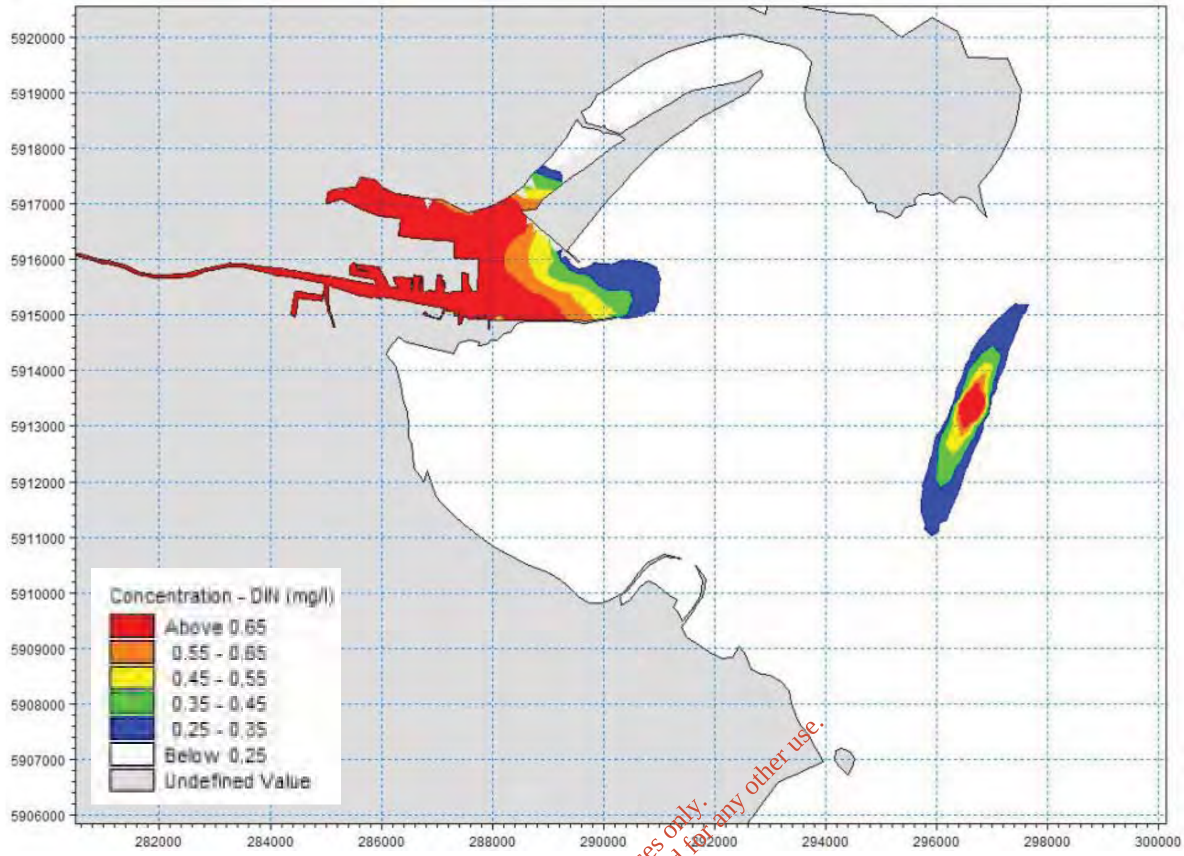


Figure 8.38 Proposed outfall, DIN, Maximum Concentration

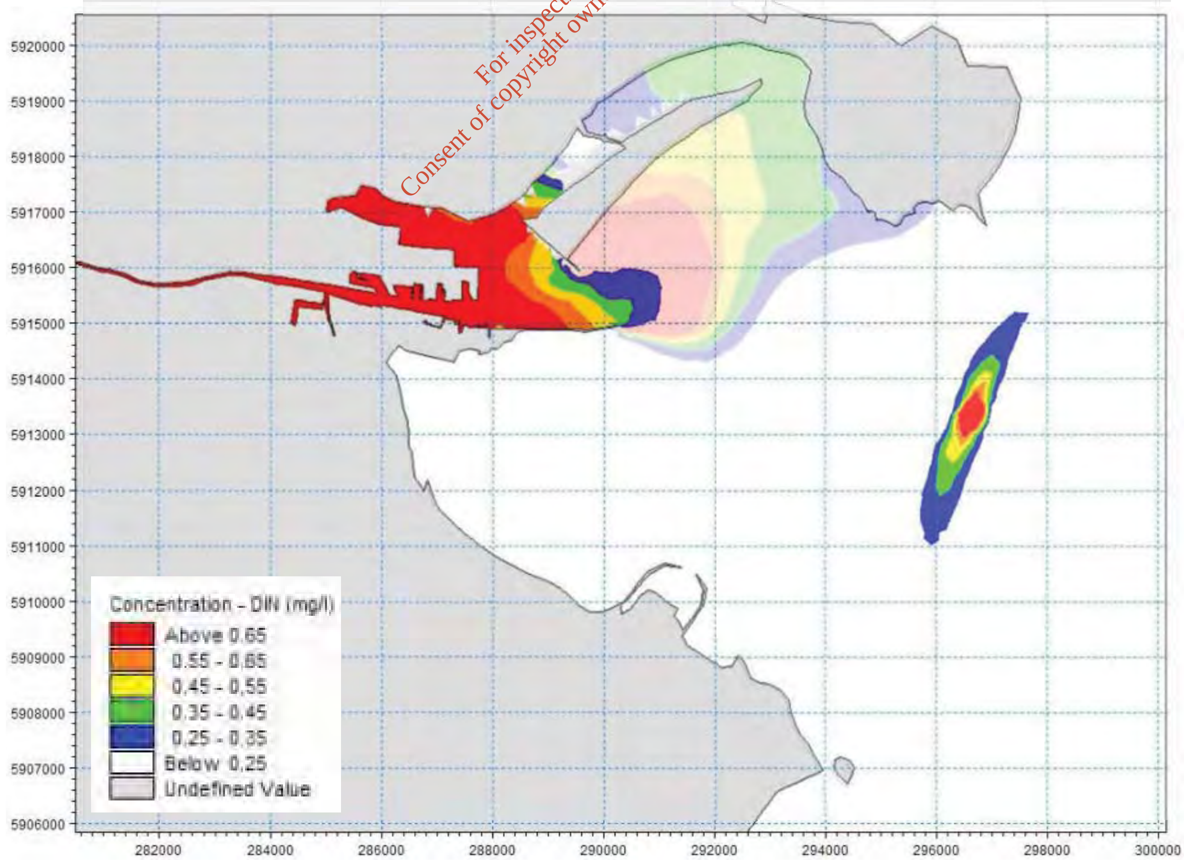


Figure 8.39 Proposed outfall, DIN, Maximum Concentration superimposed on Existing Discharge

To further investigate the DIN concentrations in the bay the average DIN concentrations at a selected number of points was calculated. These points are shown in Figure 8.40 and were selected to represent the range of ecologically significant areas in the area.

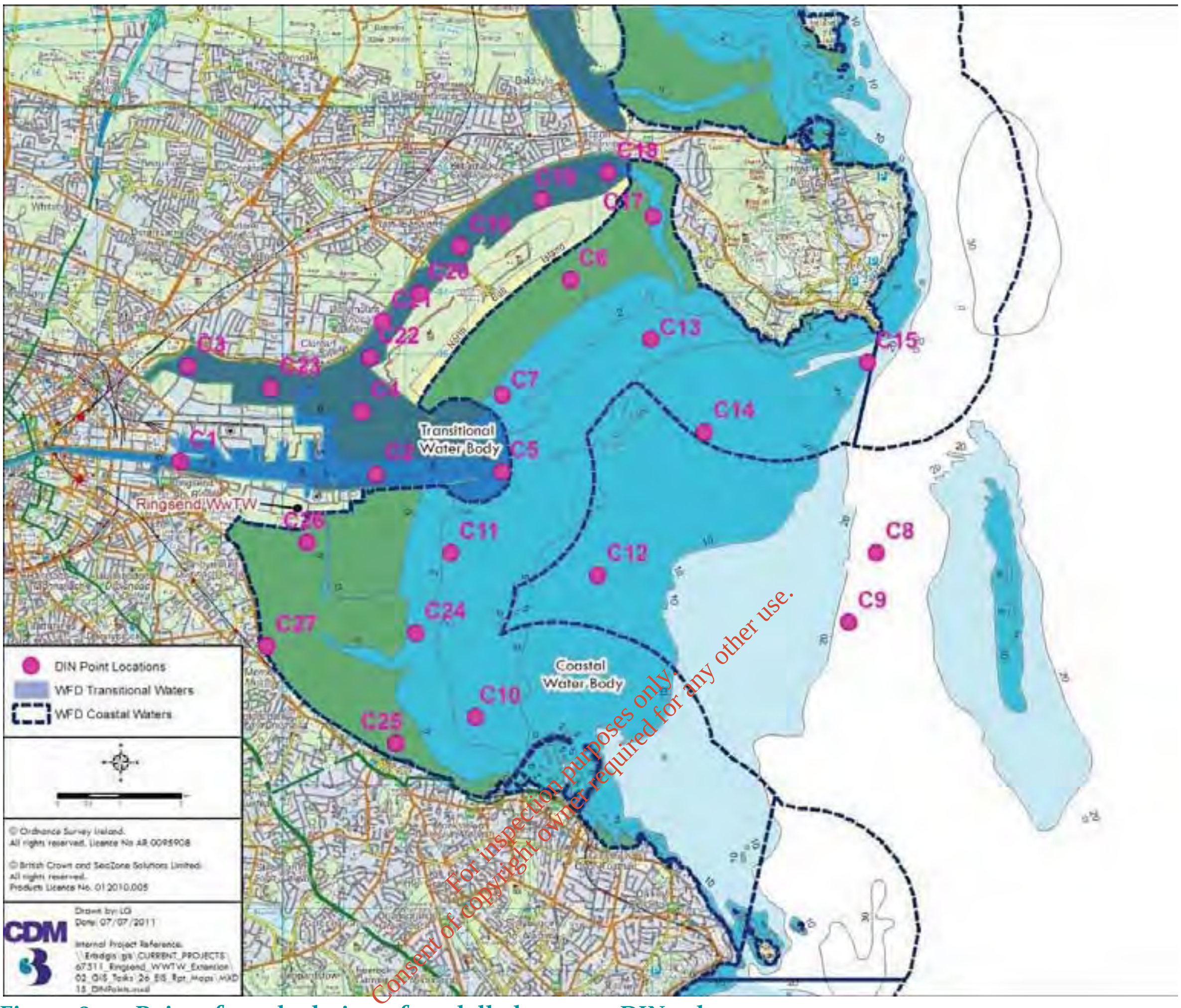


Figure 8.40 Points for calculation of modelled average DIN values

As can be seen from Table 8.18, the proposed project improves the water quality at all points that were rated as good or less than good under the Environmental Objectives Regulations 2009, to high status. Potential impacts with respect to ecology are discussed in Chapter 9 and Chapter 10.

Table 8.18 Modelled Average DIN Values

			Current Situation			Proposed Discharge		
Point No.	Description	WFD Water body	Average DIN mg/l	Percent of time under water	Environmental Quality Objective Status	Average DIN mg/l	Percent of time under water	Environmental Quality Objective Status
C01	Upstream Liffey	Transitional	1.75	100 %	N/A	1.75	100 %	N/A
C02	Downstream Liffey	Transitional	1.03	100 %	N/A	0.32	100 %	N/A
C05	Mouth of Liffey Estuary	Transitional	0.23	100 %	N/A	0.08	100 %	N/A
C03	Tolka Estuary 1	Transitional	1.52	100 %	N/A	1.22	100 %	N/A
C04	Tolka Estuary 2	Transitional	1.01	79 %	N/A	0.32	79 %	N/A
C23	Tolka Estuary 3	Transitional	1.25	58 %	N/A	0.59	58 %	N/A
C20	South Bull Lagoon 1	Transitional	0.10	100 %	N/A	0.06	100 %	N/A
C21	South Bull Lagoon 2	Transitional	0.25	100 %	N/A	0.13	100 %	N/A
C22	South Bull Lagoon 3	Transitional	0.45	100 %	N/A	0.22	100 %	N/A
C16	North Bull Lagoon 1	Transitional	0.24	39 %	N/A	0.08	39 %	N/A
C18	North Bull Lagoon 2	Transitional	0.29	63 %	N/A	0.08	63 %	N/A
C19	North Bull Lagoon 3	Transitional	0.26	100 %	N/A	0.08	100 %	N/A
C17	Sutton	Coastal	0.28	98 %	Good	0.08	98 %	High
C06	North Dublin Bay 1	Coastal	0.38	80 %	< Good	0.10	80 %	High
C07	North Dublin Bay 2	Coastal	0.37	100 %	< Good	0.10	100 %	High
C13	North Dublin Bay 3	Coastal	0.22	100 %	Good	0.08	100 %	High
C14	North Dublin Bay 4	Coastal	0.05	100 %	High	0.06	100 %	High
C15	North Dublin Bay 5	Coastal	0.07	100 %	High	0.07	100 %	High
C08	Diffuser site (150m)	n/a	0.05	100 %	N/A	0.29	100 %	N/A
C09	South Dublin Bay 1 (1200m)	n/a	0.05	100 %	N/A	0.12	100 %	N/A
C10	South Dublin Bay 2	Coastal	0.04	100 %	High	0.05	100 %	High
C11	South Dublin Bay 3	Coastal	0.04	100 %	High	0.05	100 %	High
C12	South Dublin Bay 4	n/a	0.04	100 %	N/A	0.06	100 %	N/A
C24	South Dublin Bay 5	Coastal	0.04	100 %	High	0.05	100 %	High
C25	South Dublin Bay 6 - feeding area	Coastal	0.04	51 %	High	0.05	51 %	High
C26	South Dublin Bay 7 - feeding area	Coastal	0.04	38 %	High	0.04	38 %	High
C27	South Dublin Bay 8 - feeding area	Coastal	0.03	36 %	High	0.04	36 %	High

8.5.1.2 Molybdate Reactive Phosphorus (MRP)

The tidal plots for neap tide mid flood and low water for MRP are presented in Figure 8.41 and Figure 8.43. In the proposed modelled scenario, the plume is removed from the estuary but there are still inputs from the rivers. The proposed situation shows a small near-field plume at the proposed long-sea outfall.

The maximum values for each grid cell during the entire simulation are shown in Figure 8.45. The plume that previously extended to the Bull lagoons and all along Dollymount Strand to Howth Head largely disappears from the Tolka and Liffey Estuary but there are still elevated MRP levels in the rivers due to upstream riverine inputs.

The modelled maximum shows the maximum extent of any modelled elevated concentration. As a result of the tidal flow the discharge disperses on a north south axis. At any single phase in the tidal cycle the discharge will tend to disperse from the outfall towards the north or from the outfall towards the south. While the maximum concentration plot appears to show an extended mixing zone, this combines the plume direction for all phases of the tide and as such does not represent a single point in time. However, the plume does not negatively impact on any protected areas such as bathing beaches. A significant change is seen in the Liffey and Tolka estuarine areas and the Bull Island lagoons as the WwTW impact is no longer evident

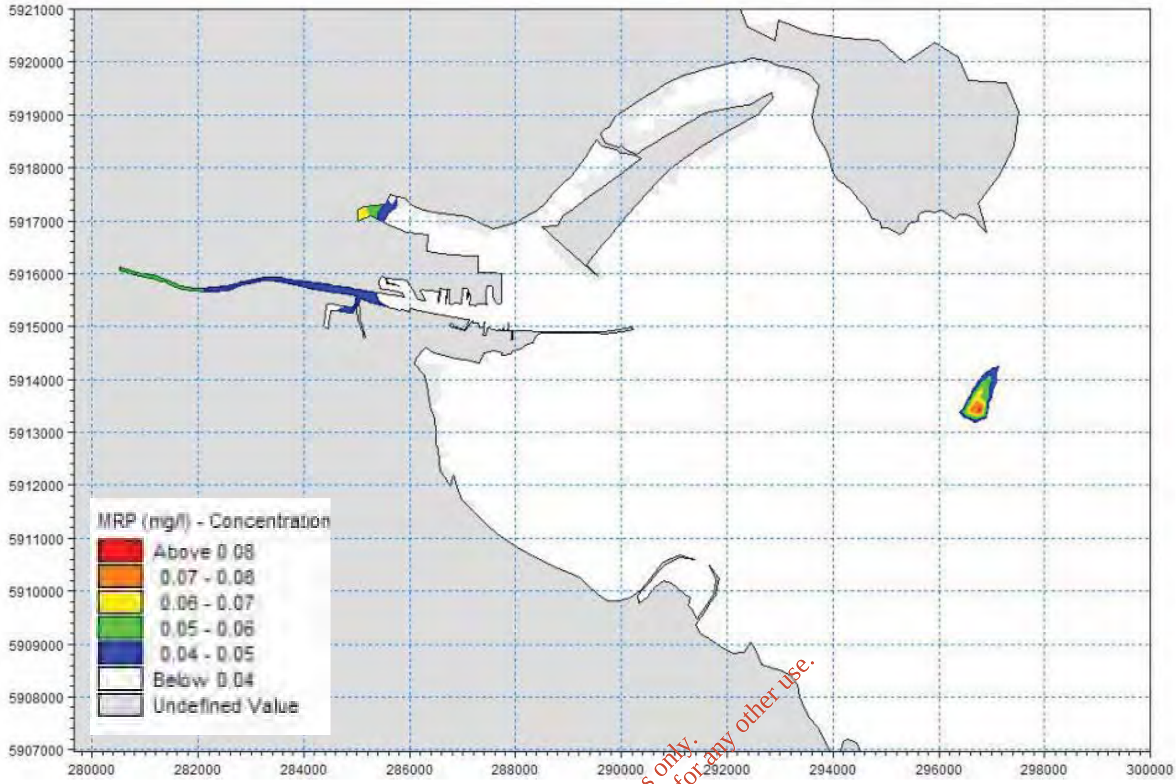


Figure 8.41 Proposed outfall, MRP, Mid Flood Neap

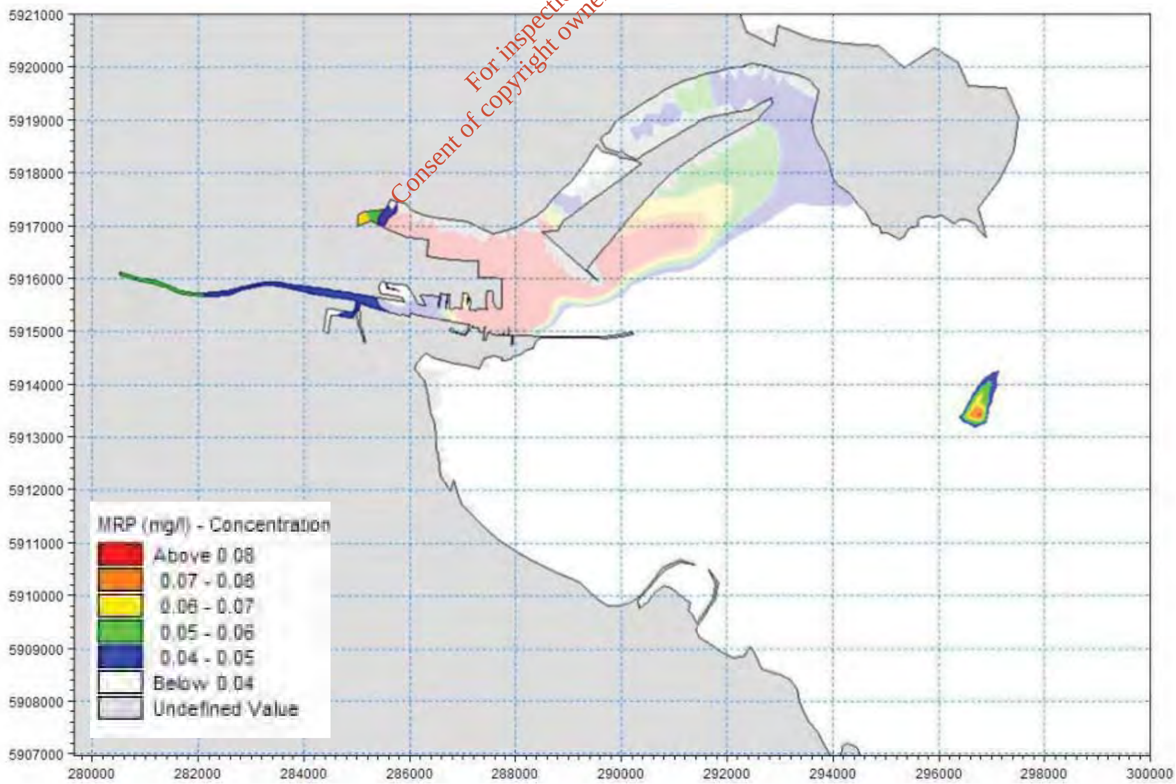


Figure 8.42 Proposed outfall, MRP, Mid Flood Neap superimposed on Existing Discharge

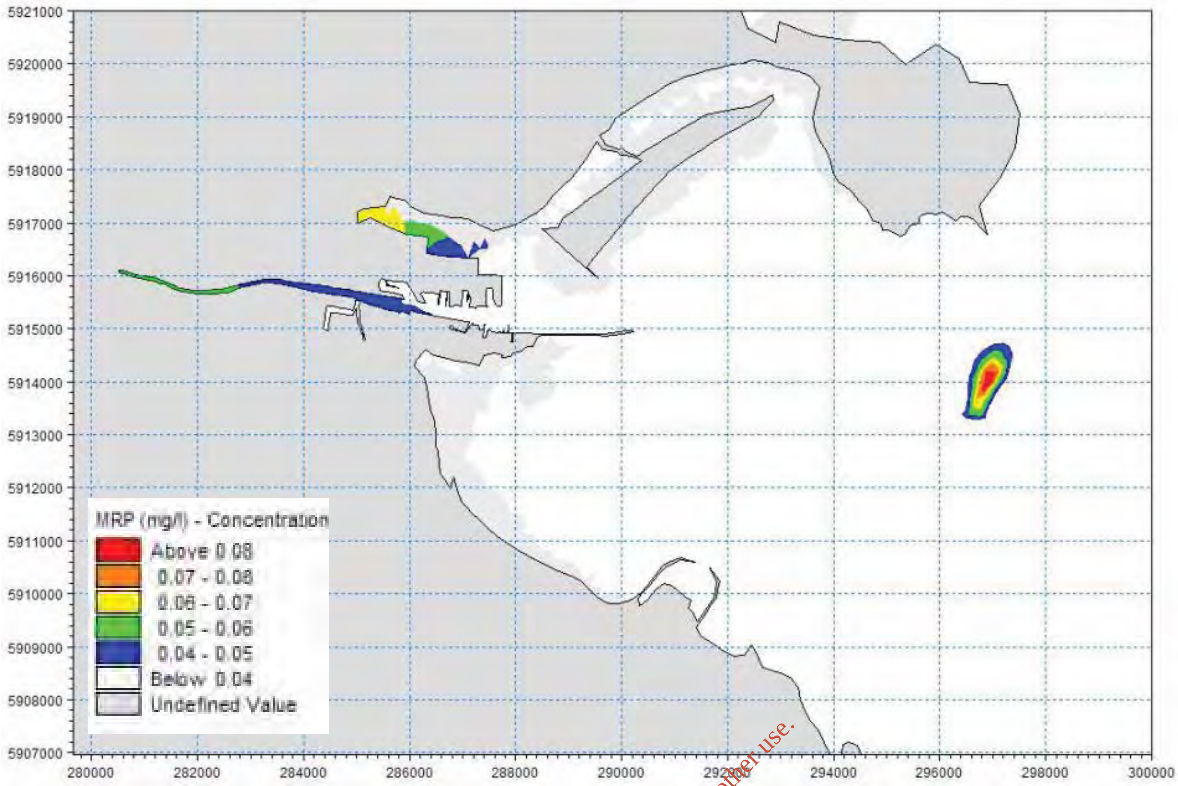


Figure 8.43 Proposed outfall, MRP, Low Water Neap

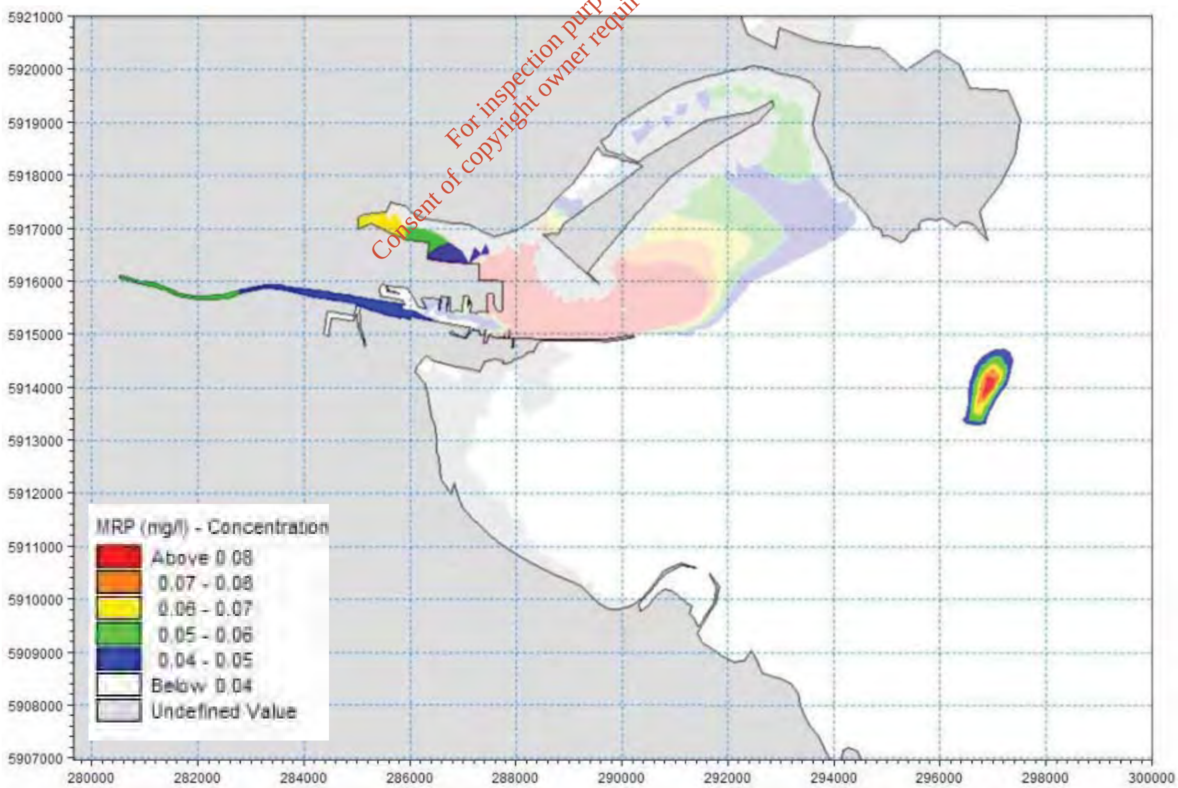


Figure 8.44 Proposed outfall, MRP, Low Water Neap superimposed on Existing Discharge

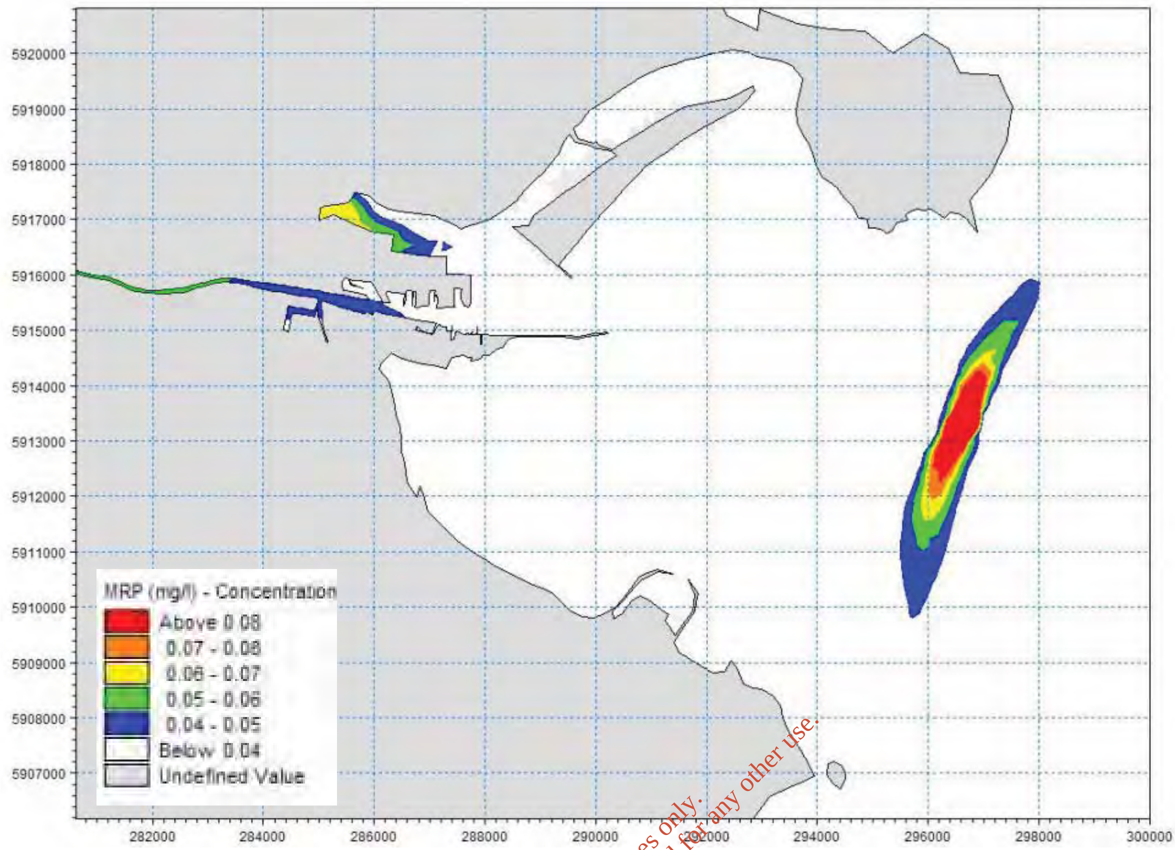


Figure 8.45 Proposed outfall, MRP, Maximum Concentration

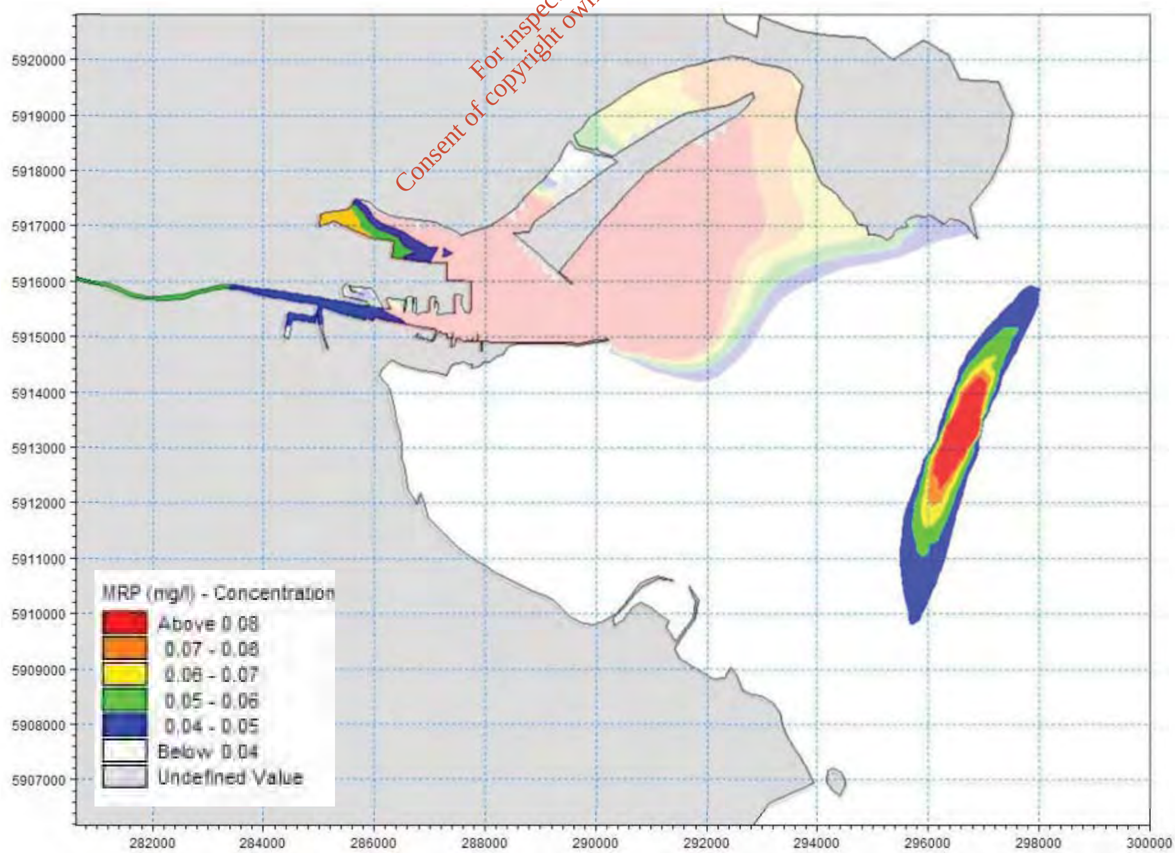


Figure 8.46 Proposed outfall, MRP, Maximum Concentration superimposed on Existing Discharge

8.5.1.3 Biochemical Oxygen Demand (BOD)

The modelled BOD concentrations for neap tide low water and neap tide mid flood are presented in Figure 8.47 and Figure 8.49. The small BOD plume at the existing Ringsend outfall previously evident in the plots for the existing situation is no longer visible.

The maximum values for each grid cell during the entire simulation are shown in Figure 8.51. The plot of the existing situation, which can be seen in Figure 8.52, shows that in the existing situation the BOD plume is small and just extends along the south Bull Wall. In the plot showing the proposed situation, there is no BOD plume.

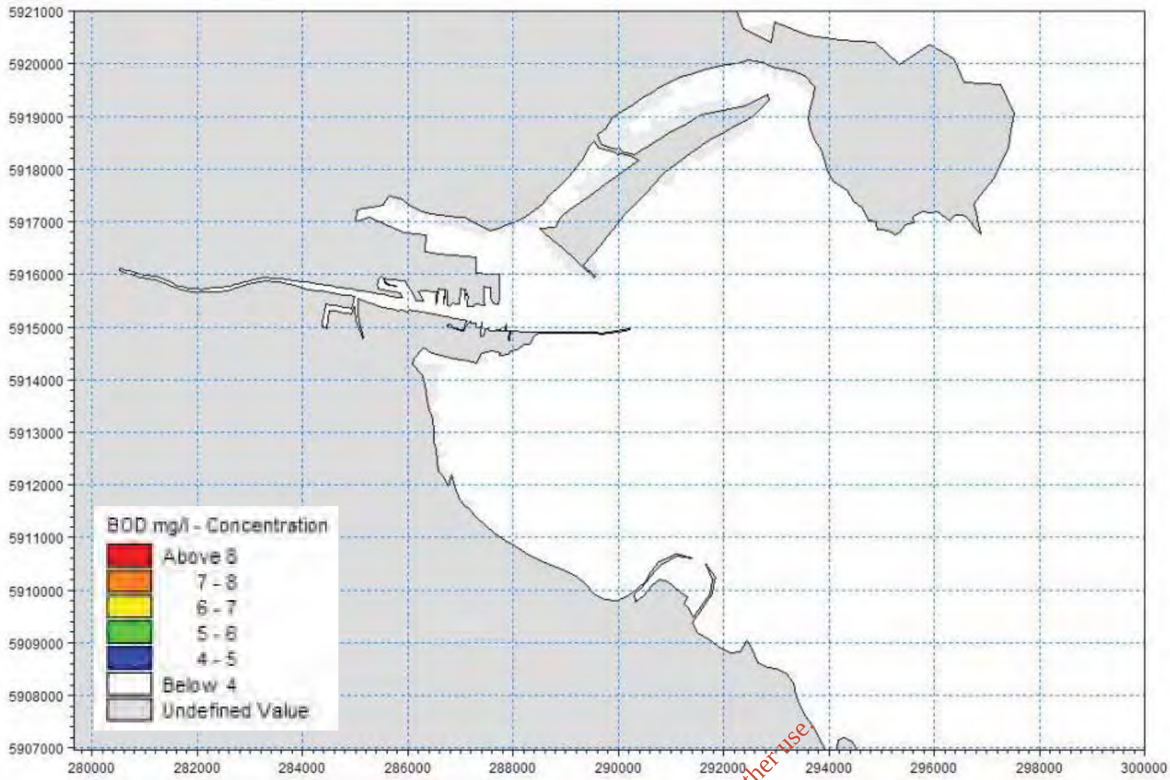


Figure 8.47 Proposed outfall, BOD, Mid Flood Neap

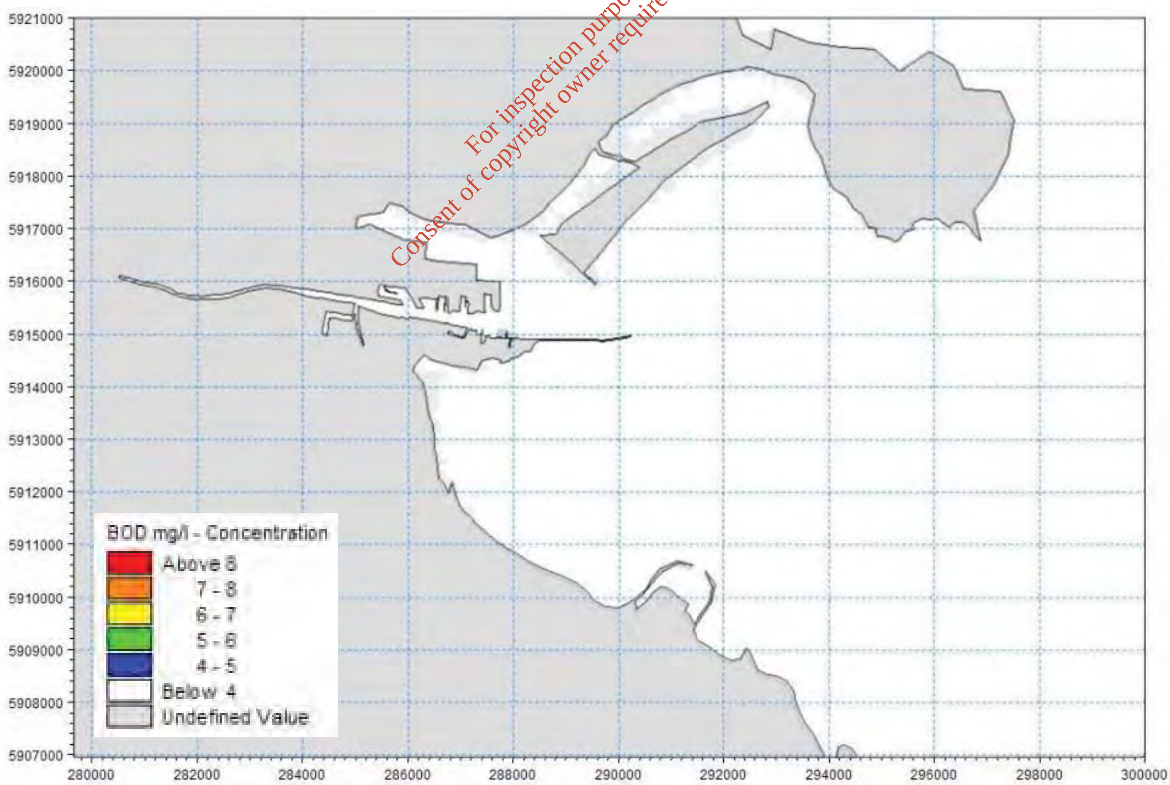


Figure 8.48 Proposed outfall, BOD, Mid Flood Neap superimposed on Existing Discharge

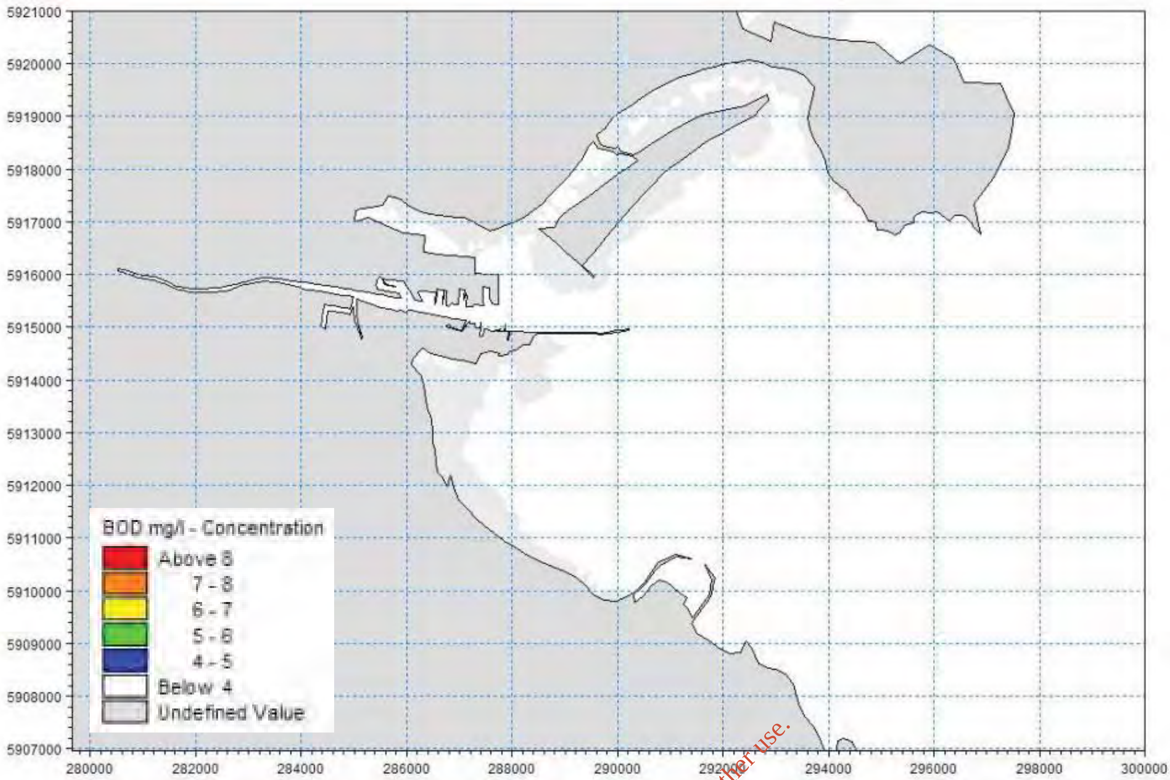


Figure 8.49 Proposed outfall, BOD, Low Water Neap

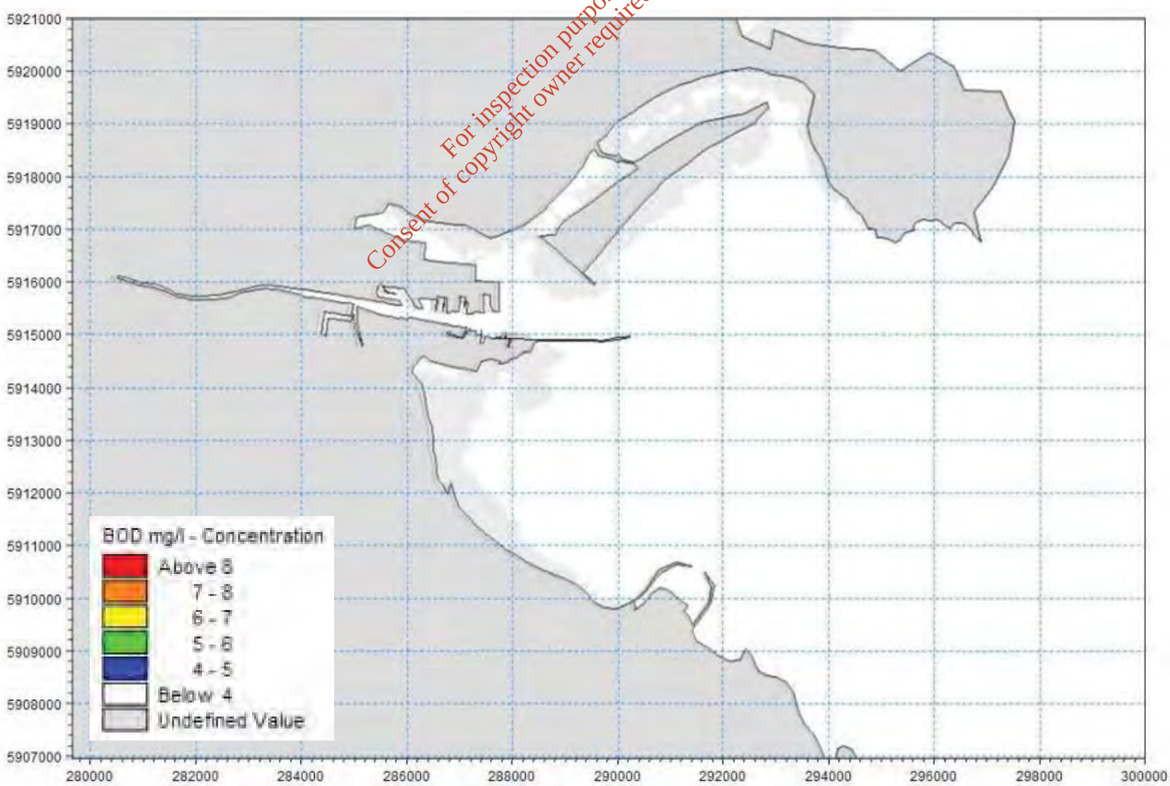


Figure 8.50 Proposed outfall, BOD, Low Water Neap superimposed on Existing Discharge

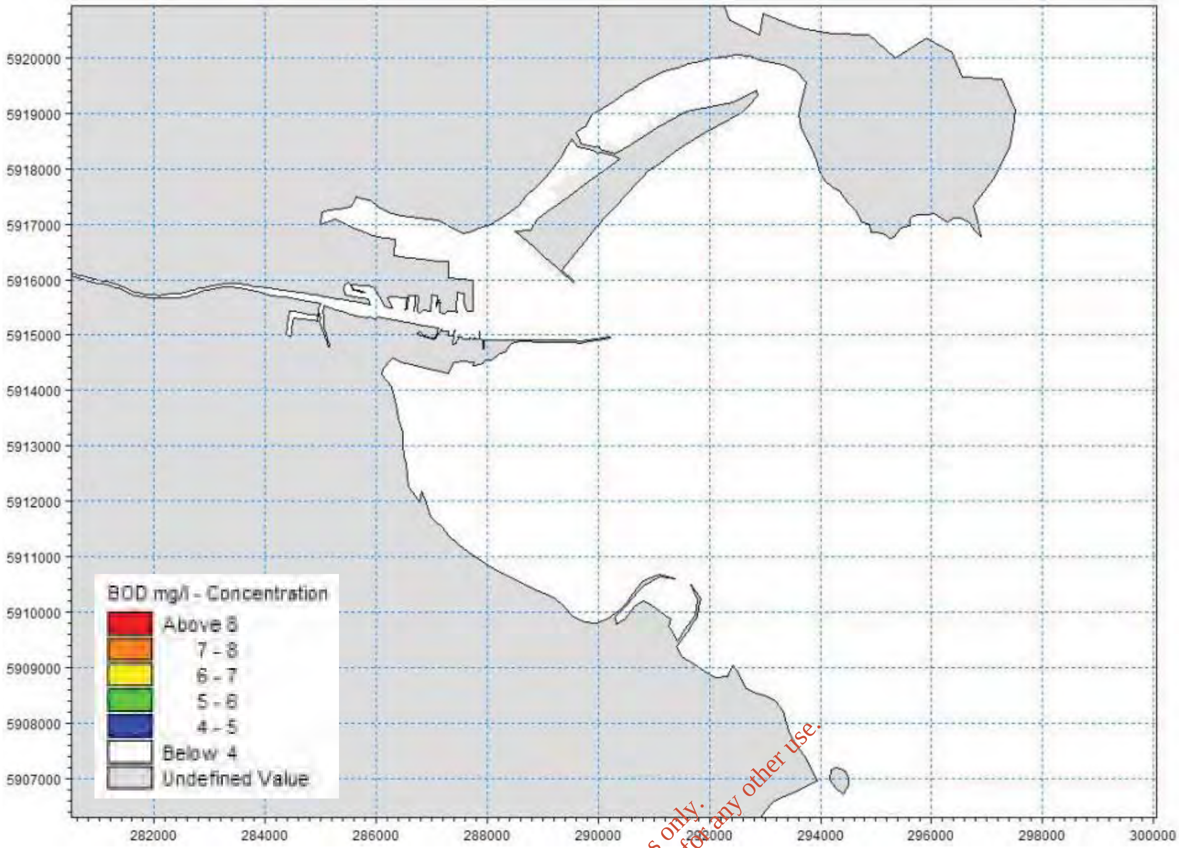


Figure 8.51 Proposed outfall, BOD, Maximum Concentration

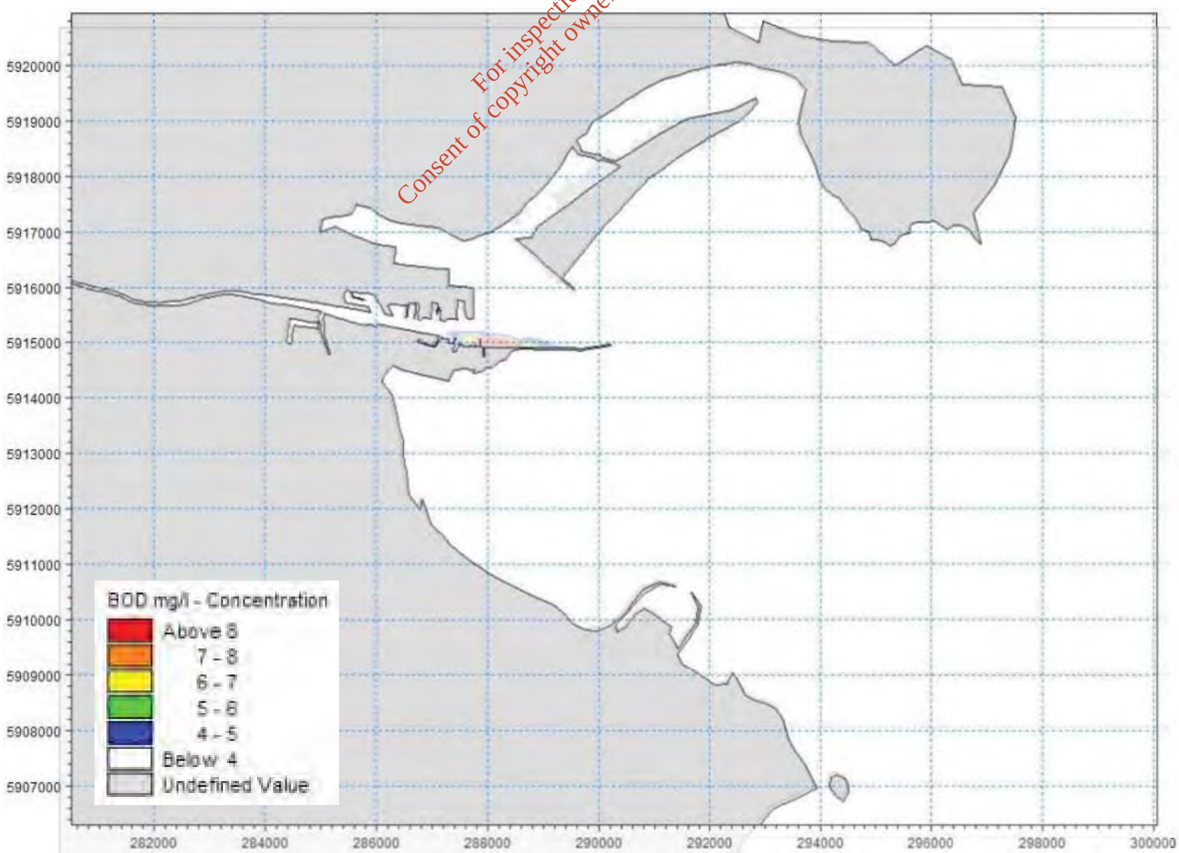


Figure 8.52 Proposed outfall, BOD, Maximum Concentration superimposed on Existing Discharge

8.5.1.4 Escherichia coli (*E. coli*)

The tidal plots for neap tide mid flood and low water for *E. coli* are presented in Figure 8.53 and Figure 8.55. The modelled concentrations from the proposed discharge are shown superimposed on the existing discharge in Figure 8.54 and Figure 8.56. The plots show that in the existing situation the *E. coli* plume extends from the existing Ringsend outfall towards the north. The low water neap tide plot shows that in the existing situation the *E.coli* plume extends along the Great South Wall to the inner Bay. In the proposed situation the plume is removed from the estuary and there is a small near-field plume at the proposed outfall.

The maximum values for each grid cell during the entire simulation of the proposed discharge are shown in Figure 8.57 and superimposed on the existing situation in Figure 8.39. The plots show that in the existing situation the *E. coli* plume extends from the Liffey Estuary into the inner Bay. In the proposed situation the plot it can be seen that the *E. coli* plume disappears from the estuary. The proposed situation also shows that an extended area may experience an increase in *E.coli* concentrations although at a distance removed from bathing beaches and recreational areas where there is no negative impact. Again is should be emphasised that this does not represent concentrations at one time, but is instead an amalgamation of the highest concentration in each modelled grid square over the entire simulation period.

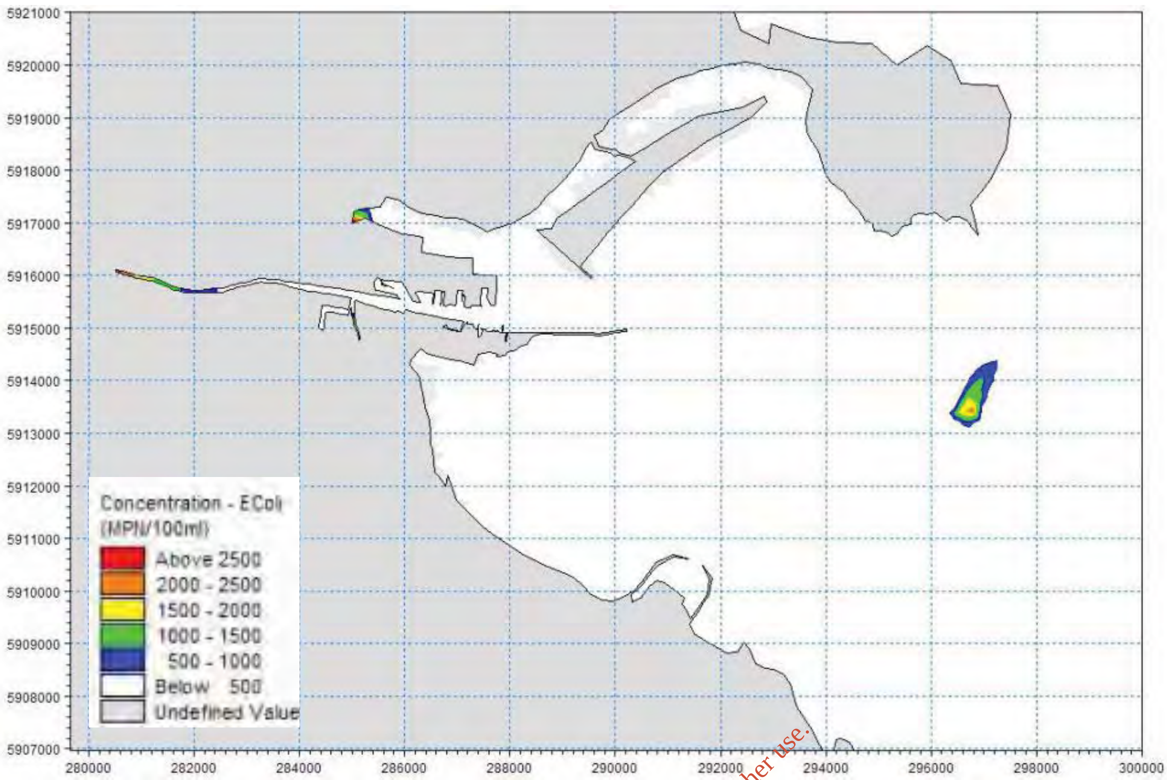


Figure 8.53 Proposed outfall, *E. coli*, Mid Flood Neap

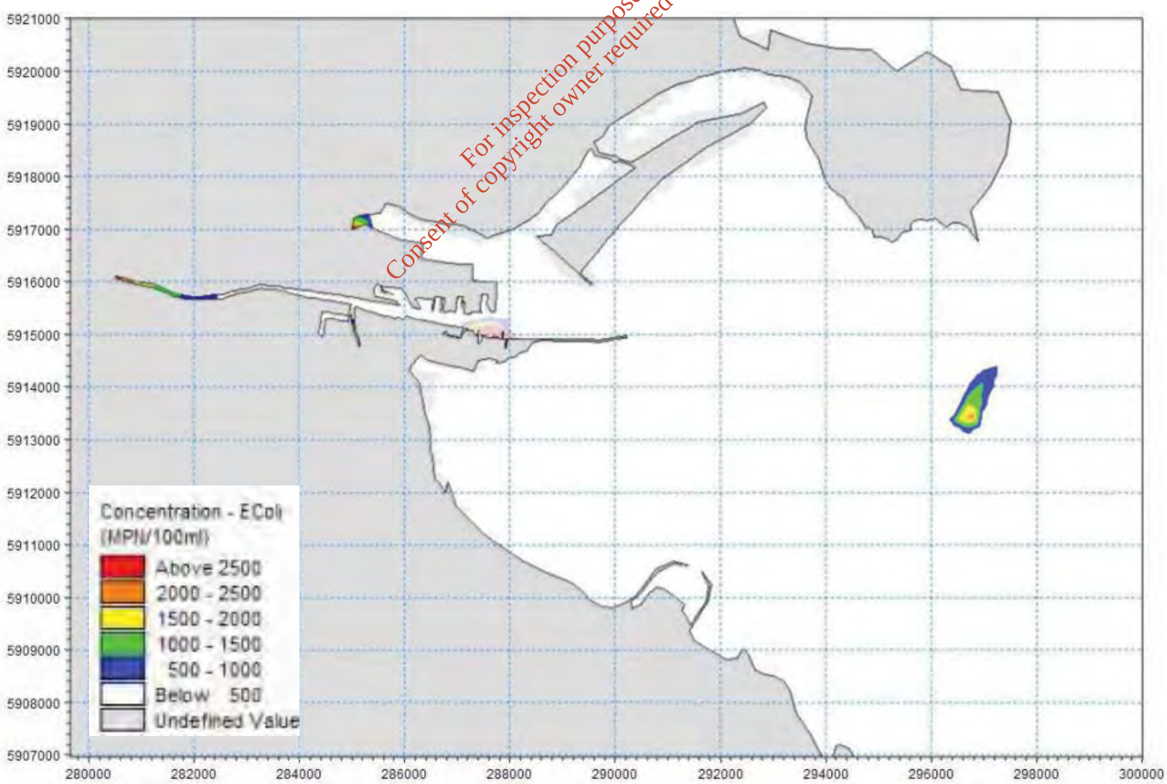


Figure 8.54 Proposed outfall, *E. coli*, Mid Flood Neap superimposed on Existing Discharge

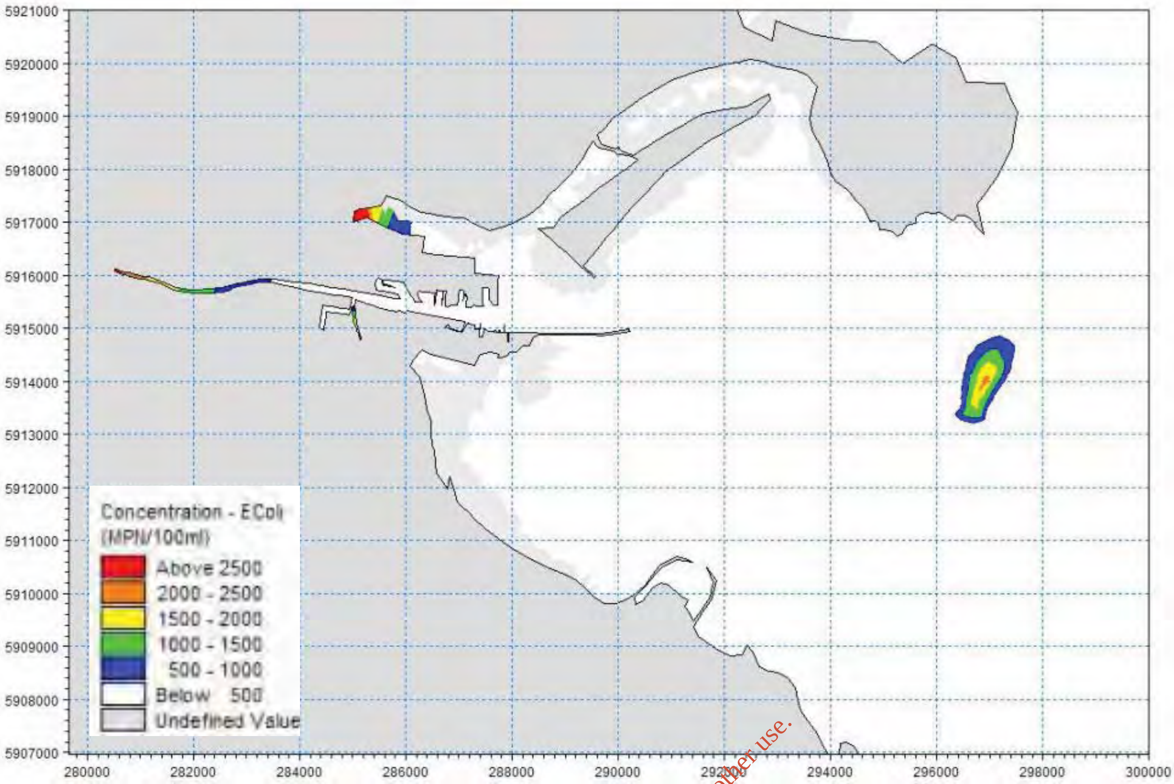


Figure 8.55 Proposed outfall, *E. coli*, Low Water Neap

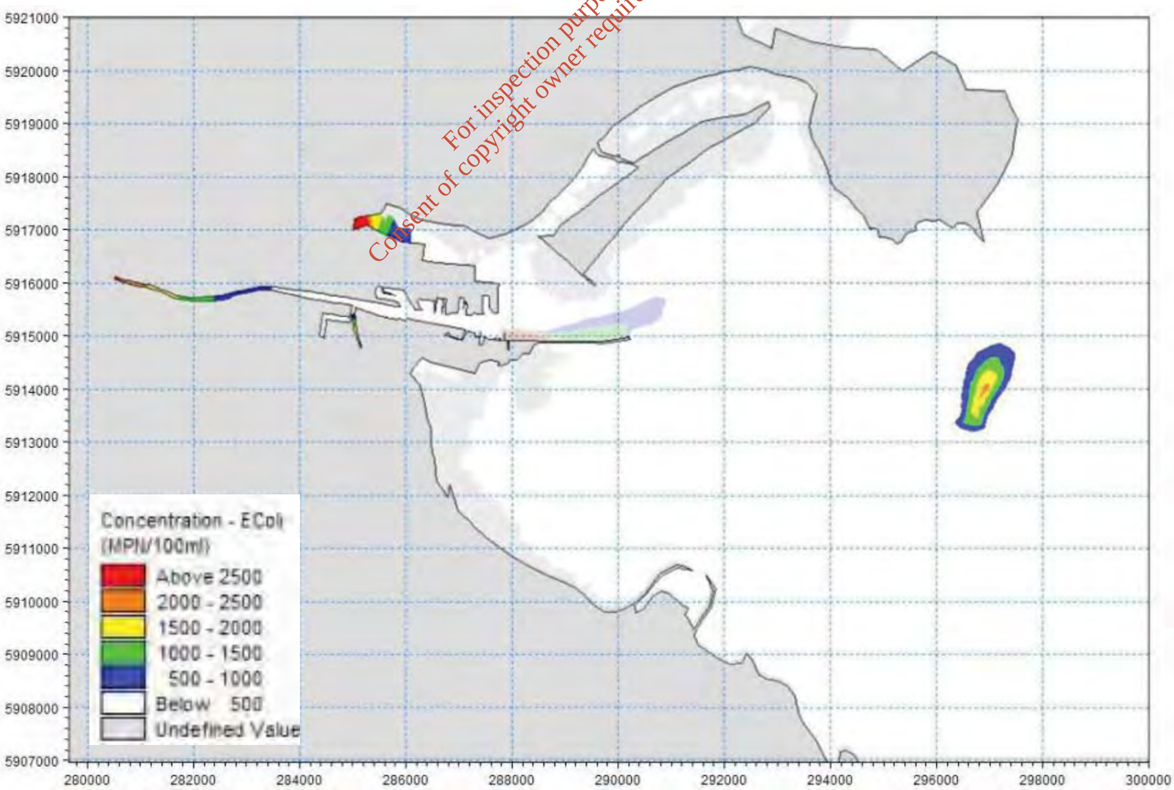


Figure 8.56 Proposed outfall, *E. coli*, Low Water Neap superimposed on Existing Discharge

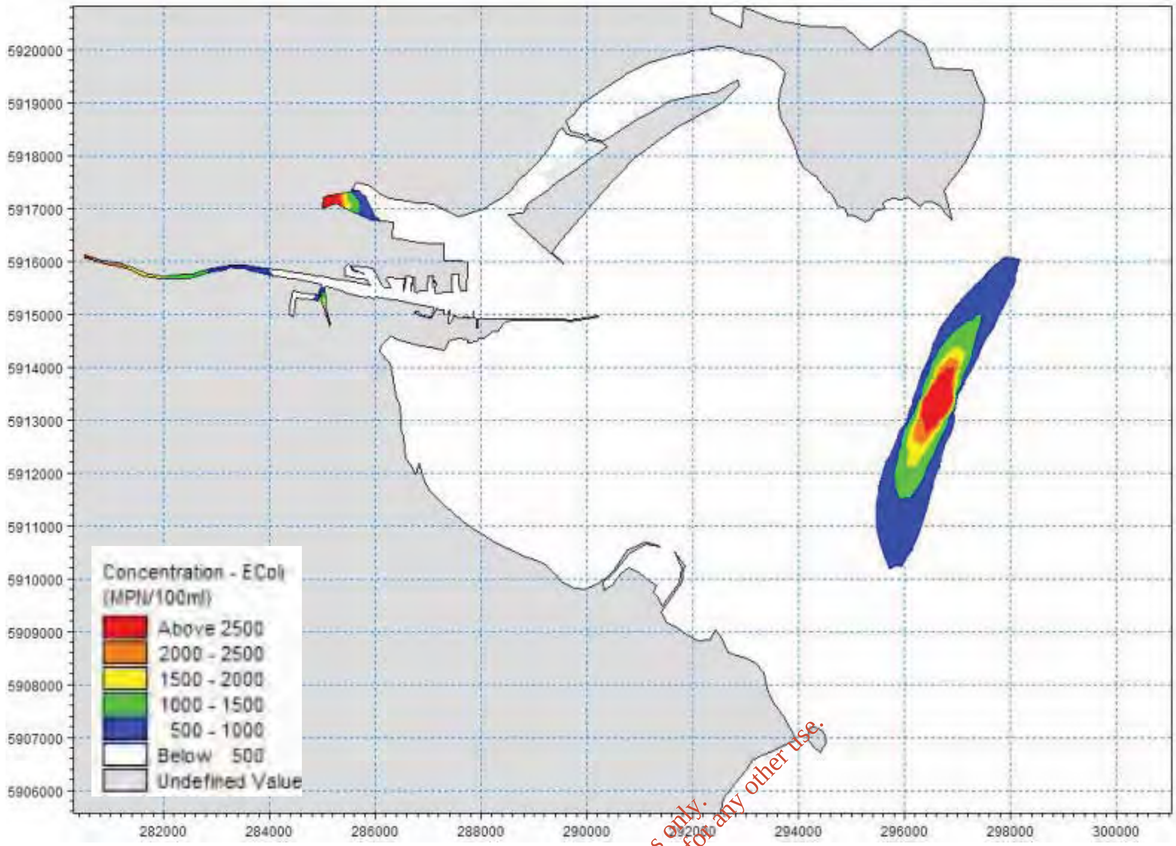


Figure 8.57 Proposed outfall, Maximum Concentration, *E. Coli*

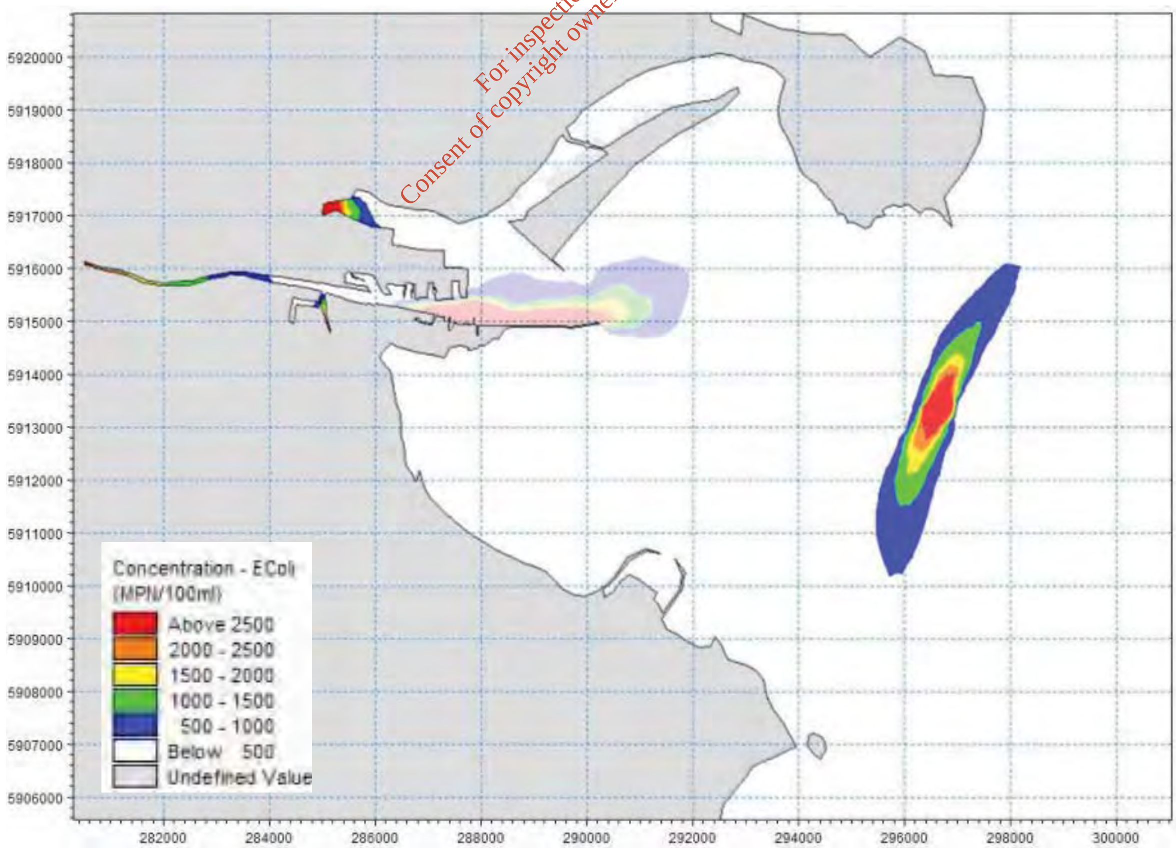


Figure 8.58 Proposed outfall, Maximum Concentration, *E. coli* superimposed on Existing Discharge

8.6 Do Nothing Impact

Long term effects of climate change may influence the degree of environmental impact caused by changes in water quality and intermittent discharges. The forecast for Ireland is drier summers, wetter winters and warmer average temperature throughout the year. High rainfall may result in overflows operating more frequently and with greater spilled volumes and decreased water quality. The effects of low summer flows in water courses would compound this problem. Without an improvement in plant capacity and an increase in storm overflows, water quality in the Liffey Estuary would deteriorate.

There will be an increase in the Full Flow to Treatment of 2.7 m3/s with the extended works, and the proposed diversions to the Regional WwTP will free up further processing capacity such that the Ringsend WwTW will not reach its firm capacity until at least 2035. Until such time as the influent flows reach the extended design capacity there will be fewer overflows from the Ringsend WwTW into the Liffey Estuary.

In the absence of the proposed project, the WwTW would continue to discharge into the designated sensitive area of the estuary. The plant would continue to cause breaches of the Environmental Environmental Objectives Regulations 2009 and would be in breach of the UWWT 2001 as amended. Failure to upgrade the WwTW would also be a breach of the Water Framework Directive as compliance with the Urban Wastewater Treatment Directive is a basic measure as set out in the ERBD River Basin Management Plan. This would result in fines being levied against Ireland by the European Court of Justice for breaches of environmental legislation.

8.7 Mitigation Measures

8.7.1 Land-based Activities

An Environmental Management Plan will be established prior to commencement of works on-site. In particular, a Fuel/Chemical Handling and Storage Management Plan will be implemented at the outset of the construction phase to minimise the potential risk of adverse impact on the environment. This management plan shall incorporate the practices outlined in Control of Water Pollution from Construction Sites (CIRIA, 2001) and Environmental Handbook for Building and Civil Engineering Projects (CIRIA, 2000).

The employment of good construction management practices will serve to minimise the risk of pollution of soil, storm water run-off or groundwater. Measures set out in the Construction Industry Research and Information Association CIRIA guidance note on the control and management of water pollution from construction sites, Control of Water Pollution from Construction Sites, guidance for consultants and contractors (CIRIA, 2001) will be adhered to. The guide is written for project promoters, design engineers and site and construction managers. It addresses the main causes of pollution of soil, groundwater and surface waters from construction sites and describes the protection measures required to prevent pollution of groundwater and surface waters and the emergency response procedures to be put in place so that any pollution, which occurs, can be remedied. The guide addresses developments on green field and potentially contaminated, brown field sites.

The guidelines provided by the ERFB (2006) on the protection of fisheries habitats during construction projects will be adhered to, particularly for any activities in the vicinity of watercourses such as at the berthing area, in order to ensure that the impact on the water environment during the construction phase of the proposed scheme is minimised.

To minimise the risk of surface water runoff contamination, the construction compound design will incorporate a surface water drainage system which would collect rainfall run-off, and any other surface displaced liquids. The design of the drainage system should be in accordance with good construction practice, as described below.

Any discharges arising from the construction phase of the proposed scheme entering the foul/storm sewer network will be in accordance with the requirements of a discharge licence if required) granted by Dublin City Council. Similarly, any water discharge to surface water bodies will be treated in accordance with the requirements of a discharge licence (if required) granted by Dublin City Council.

All discharge points will be fitted with oil separators which will comply with current European Standard EN858. The oil separators will have silt chambers for the removal of silts and other settleable solids. Each separator will be fitted with an automatic alarm system which will relay information to a control unit to indicate the condition of the separator. The alarm probes will be set to coincide with the maximum oil storage volume for each separator. All full retention separators will be fitted with automatic closure devices which will be set to operate when the separated light liquid storage capacity reaches a volume equal to ten times the nominal size of the separator. By-pass separators will not be fitted with automatic closure devices.

Treatment of water produced during the construction phase will involve silt removal using a silt trap and hydrocarbon removal using a hydrocarbon interceptor or slurry separation plant for tunnel spoil. The slurry separation equipment will be located in a designated bunded area with separation from water gullies or drains.

Re-fuelling of construction equipment and the addition of hydraulic oil or lubricants to vehicles/ equipment will take place in designated bunded areas within the construction compounds, away from surface water gullies or drains. The vehicles and equipment will not be left unattended during refuelling. Spill kits and hydrocarbon adsorbent packs will be stored in this area and operators will be fully trained in the use of this equipment. As a precaution, a spill kit will also be stored in the cab of appropriate vehicles in case of localised hydrocarbon loss of containment incidents, such as a machine 'blowing' a hydraulic hose.

Any hazardous waste residuals or potentially contaminated sludge from spill clean-up will be stored within appropriate metal or plastic containers in temporary bunded storage areas in the construction compounds prior to removal by an appropriate Local Authority or EPA approved waste management contractor for off-site treatment/recycling/disposal.

To prevent the chemical contamination which could occur from accidental spillages, such as oil and other chemicals through poor operational management, the non-removal of spillages, poor storage, handling and transfer of oil and chemicals suitable precautions should be taken and best practice for the storage, handling and disposal of such material followed. To prevent chemical pollution, all fuels or chemicals kept on the construction site will be stored in bunded containers. All refuelling and maintenance will be carried out in ramped containment areas away from sensitive environments (i.e., up-gradient of protected habitats or adjacent watercourses).

Washing of trucks in the vicinity of the watercourses will be prohibited. All contractors will be required to make provision for removal of any concrete truck washwaters, no such washwaters will be permitted to be discharged to surface waters under any circumstances.

Regular monitoring of water will be conducted during the construction phase prior to discharge to ensure all relevant water quality parameters are within criteria specified by the relevant Local Authority

Foul water (i.e., sanitary waste and sewerage) should be collected by a separate system and gravitated to a pumping station which would pump this waste water to the mains sewer.

8.7.2 Marine Based Activities

All on board waste discharge, from pipeline survey and maintenance vessels and marine rigs, will follow the guidelines from Annex V of the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978 (MARPOL) for domestic waste discharges to the environment. Solid and Chemical Waste will be treated onboard and recycling will take place wherever practicable. No waste is to be disposed of at sea. Bilge water will be treated in accordance with MARPOL standards. All waste discharge will be monitored & recorded as per vessel procedures.

Any hazardous wastes will be in sealed, labelled drums and stored in lockable chemical cabinets. A record will be kept on the type and quantities of waste arising on each vessel.

Ballast tanks will be separated from any hydrocarbon storage areas on board the vessels and no potentially contaminated drain systems will be routed to the ballast tanks. De-ballasting shall be undertaken offshore in accordance with International Marine Organisation (IMO) guidelines and away from sensitive environmental areas to prevent introducing marine organisms from outside the project location.

Project vessels and rigs will be equipped with oil-water separation systems in accordance with MARPOL requirements.

Any spills on deck will be contained and controlled using absorbing materials. This will be collected in dedicated drums to avoid contamination of deck run-off water.

Vessels or rigs without a sewage treatment system will have a suitable holding tank, waste water will then be brought back to shore for treatment by a licensed contractor.

All chemicals used onboard the project vessels or rigs will be handled in compliance with the relevant Safety Instructions, including Control of Substances Hazardous to Health (COSHH) Handling of Hazardous Materials

For each chemical, a Material Safety Data Sheet will be available, as well as an assessment of the hazards associated with the chemical (to personnel, for storage, for emergency response). These will be available at the various places where the chemical is used, and centralised with the Safety Officer on board.

Chemicals will be stored in compliance with the handling instruction, including separation of incompatible chemicals, provision of adequate fire fighting, spill containment and other safety facilities. The only bulk storage on board vessels will be the fuel; all other chemicals will be stored in drums or smaller containers and will be suitably bunded to contain any leaks or spills.

The construction management of the project will take account of the recommendations of this document to minimise as far as possible the risk of soil, groundwater and surface water contamination.

8.8 Residual Impacts

8.8.1 Compliance with Discharge Licence

The proposed project will result in Ringsend WwTW being compliant with the terms of the Waste Water Discharge Licence (Licence Number D0034-01).

8.8.2 Environmental Objectives (Surface Waters) Regulations 2009

The modelling summarised thus far in this chapter demonstrates that the receiving water (apart from the mixing zone) will meet good status criteria and meet the environmental quality objectives for coastal water nutrients levels. The proposed project will result in a significant long term positive impact for the water quality in the inner bay and estuary.

The only area which may not comply with the requirement to have a median concentration of less than 0.25 mg/l N is the mixing zone at the outfall. Exceedances of the environmental quality objectives within a mixing zone are permitted under the Environmental Objectives Regulations 2009. It should also be noted that the mixing zone where the exceedance may occur is not a defined water body under the WFD and associated legislation and as such is not subject to the standards set out therein. However, we have reviewed the water quality results against those for coastal and transitional waters defined under the WFD, as no standards exist beyong this defined zone.

8.8.3 Water Framework Directive

The proposed project will contribute towards the achievement of the goals of the WFD of reaching good status in all water bodies. The proposed moving of the outfall from a nutrient sensitive area to the outer bay fulfils several of the objectives for the coastal and transitional water bodies as set out in the ERBD River Basin Management Plan 2009 – 2015. The fact that the outfall is located a considerable distance from water bodies defined as part of the Water Framework Directive will ensure that the discharge from the proposed outfalls will not be a contributory factor to any failure to comply with the regulations at any point within those specified water bodies (coastal and transitional). It should also be noted that the mixing zone where the exceedance may occur is not defined as a specific water body under the framework directive.

Any potential failures to comply in such areas will result from other factors such as the existing background nutrient loads from the Liffey and Tolka. The transfer of the discharge from the Liffey Estuary to a long sea outfall can only result in a considerable improvement in the water quality in the estuaries, the bay, as demonstrated by teh water quality modelling undertaken for this EIS, and at various sensitive receptors located along the coastline.

In the areas where the nutrient concentrations are predicted to meet the "good status" criteria it is reasonable to conclude that eutrophic conditions will not occur as a result of the discharge and that chlorophyll and other ecological indicators will remain unaffected.

8.8.4 Urban Wastewater Treatment Regulations

The proposed project will fulfil the requirements of the UWWT Regulations, 2001 which incorporate and update the Environmental Protection Agency Act, 1992 UWWT Regulations, 1994 as amended in 1999, with respect to the required level of treatment for a discharge to a nutrient sensitive area. The proposed project will comply with these requirements by ensuring that WwTW does not discharge into waters that are designated as nutrient sensitive.

8.8.5 Bathing Waters Regulations

The proposed discharge location will not negatively influence any designated bathing waters and will significantly reduce the impact of the current discharge plume which, at some phases of the tidal cycle reaches Dollymount Strand.

8.8.6 Dublin Bay Water Quality Management Plan

8.8.6.1 Priority Objective a) Zone 3 Bathing and b) Zone 6 Bathing

Zone 3 Bathing; Priority Objective: ensuring that the quality of bathing waters in the area between Red Rock and the Bull Wall including Dollymount Strand (recreational Zone 3) conforms to the requirements of the Bathing Water Regulations with particular emphasis on microbiological parameters.

Zone 6 Bathing; Priority Objective: ensuring that the quality of bathing waters in the area between Seapoint and Sorrento Point (recreational Zone 6) conforms to the requirements of the Bathing Water Regulations with particular emphasis on microbiological parameters.

As discussed previously discharges from the assessed long sea outfall locations will not result in a deterioration in Bathing Water Quality.

8.8.6.2 Priority Objective c) Ectocarpus

Priority Objective: the reduction of deposits of algae, in particular Ectocarpus, on recreational beaches (Dollymount, Shellybanks), to the extent that these deposits are indirectly attributable to waste inputs to the Plan area; in particular to reduce the supply of particulate organic matter to the areas colonised by the tubeworm Lanice thereby reducing the availability of anchorages and mineralised nutrients for the development of Ectocarpus.

A study was carried out into Ectocarpus growth in the bay. Dublin Bay displays algal blooms in the intertidal area of the North and South Bull Lagoons and in the shallow subtidal zones (where Ectocarpus seems to be the dominant species (Brennan et al. 1994). A model proposed by Jeffrey et al. (1995) suggested that the nitrogen source facilitating this growth was in the form of particulate N, which settled out of suspension and was then rapidly remineralised by the sediments and the fauna for uptake by the algae. Prior to plant improvements, the WwTW was the predominant source of particulate N (in readily processable form).

However, both the River Liffey and the River Tolka, and the tidal currents from the Irish Sea also bring in substantial quantities of N (Wilson 2004) . Stable Isotope Analysis (SIA) was used to measure the isotopic signatures of C and N, specifically 13C and 15N, and the signature in turn linked to the contributing sources (e.g. food types) and used to discriminate among sewage particulate organic matter (POM), marine POM and river POM.

Results indicate that Ectocarpus growth is not dependent on nutrients from Ringsend WwTW but also utilises nutrients from marine and estuarial sources. A change in the location of the discharge may, therefore, have a beneficial impact and, at worst, would not be expected to negatively impact this priority objective relating to Ectocarpus growth, which is a natural process in the Bay.

8.8.6.3 Priority Objective d) Sewage Solids

Priority Objective: Improving the aesthetic quality of the beaches and shoreline waters of the Plan area by measures such as the interception of plastics and other solids of sewage origin.

The discharge will be screened to intercept plastics and other solids of sewage origin. Any potential long sea outfall discharge will support this priority objective.

8.8.6.4 Priority Objective e) Tolka Sediments

Priority Objective: improving the environmental quality of the Tolka Estuary, particularly in relation to the chemical and bacteriological of the intertidal elements.

The removal of the discharge from the Liffey Estuary to a location nine kilometres out into Dublin Bay ensure that the source of potential impact will be further from the receptor of concern. As a consequence the risk of the chemical and bacteriological quality being adversely affected due to the deposition of suspended solids discharged from the Ringsend WwTW will be significantly reduced.

8.8.6.5 Priority Objective f) South Lagoon Ecosystem

Priority Objective: ensuring a stable biological habitat is maintained in the south lagoon of the Bull Island; and that its wildlife conservation is protected.

The discharge from the proposed long sea outfall will have no significant impacts due to the distance of the discharge from the designated Natura 2000 sites in Dublin Bay. This is considered in more detail in Chapters 8 and 9, Marine and Terrestrial Ecology.

8.8.6.6 Priority Objective g) North Lagoon Ecosystem

Priority Objective: ensuring a stable biological habitat is maintained in the north lagoon of the Bull Island; and that its wildlife conservation is protected.

The discharge from the proposed long sea outfall will have no significant impacts due to the distance of the discharge from the designated Natura 2000 sites in Dublin Bay. This is considered in more detail in Chapter 9 and Chapter 10, Marine and Terrestrial Ecology.

8.8.6.7 Priority Objective h) Green Macro-Algae

Priority Objective: ensuring that effluents and related inputs do not give rise to excessive growths of green macro-algae in the Bull Island Lagoons or the Tolka Estuary; the aim is to achieve a reduction in the anthropogenic contribution to these growths by reducing the particulate content of sewage effluent as a source of nutrient to the sediments and then to the algae.

Dublin Bay displays several features of eutrophication including algal blooms in the intertidal area of the North and South Bull Lagoons (mostly Enteromorpha spp.) and in the shallow subtidal areas.

Prior to plant improvements, the WwTW was the predominant source of particulate N (in readily processable form) in Dubllin Bay. However, both the River Liffey and the River Tolka, and the tidal currents from the Irish Sea also bring in substantial quantities of N (Wilson 2004). Stable Isotope Analysis (SIA) was used to measure the isotopic signatures of C and N, specifically 13C and 15N, and the signature in turn linked to the contributing sources (e.g. food types) and used to discriminate among sewage POM, marine POM and river POM.

As referenced in 8.8.6.2, results indicate that for algae such as Ectocarpus, growth is not only dependent on nutrients from Ringsend WwTW but also nutrients from marine and estuarine sources. A change in the location of the discharge may, therefore, have a beneficial impact and, at worst, would not be expected to negatively impact this priority objective relating to the growth of green micro-algae which is a natural process in the Bay.

8.8.6.8 Priority Objective i) Fisheries / BOD / DO

Priority Objective: ensuring that excessive dissolved oxygen deficits do not occur in the waters of the Liffey Estuary, and that the dissolved oxygen standards are met; thereby protecting migratory fish.

The transfer of the discharge into the outer bay will result in an improvement in the water quality in the Liffey Estuary which will benefit migratory fish. This is discussed in more detail in Chapter 9, Marine Ecology.

8.8.6.9 Priority Objectives j, k, l and m:

Priority Objective j: protecting the microbiological quality of the waters of zone 6 for water sports such as wind surfing.

Priority Objective k: protecting the environmental quality of Zone 4 (Bull Wall to Great South Wall and Matt Talbot bridge) particularly for non water- contact recreation.

Priority Objective l: protecting the recreational uses of Zone 5 (Great South Wall to Blackrock)

Priority Objective m: protecting the recreational uses of Zone 2 (Baily to Red Rock)

Of the 16 objectives listed in the Dublin Bay Water Quality Management Plan (1992) Objectives (j) to (m) are directed at protecting recreation and water sports areas within the Bay and the areas cover the virtually the entire coastline in the Bay area.

In the absence of any standards specifically for recreational or water sports areas it is considered appropriate to assess the consequences of the proposed long sea outfalls in terms of the contribution that they will make to the overall faecal coliform counts in these amenity areas.

The proposal for the long sea outfall will result in a cessation of discharges of treated effluent from the Ringsend WwTW into the Liffey Estuary. The discharge of the treated effluent will be transferred to a point just outside Dublin Bay. It is clear that this must result in an improvement in the bacteriological quality of the Inner Bay. However, it must be noted that there will still be considerable faecal coliform loads entering the Bay from the Liffey and Tolka and other smaller sources. The modelled plots for the maximum concentrations of faecal coliforms associated with the long sea outfalls clearly show that apart from a finite mixing area the receiving Coastal Waters in the vicinity of the outfalls will conform to the Bathing Regulations (1992 and 2008). There will be no negative impact on the bacteriological quality of the amenity areas defined in the Priority Objectives.

8.8.6.10 Other Ecosystems / Wildlife; Protection of Wildlife and their Habitats, not encompassed by the Foregoing

Priority Objective: protection of wildlife and their habitats not encompassed by the foregoing

There will be no negative impact on the ecology of the bay; this is discussed in more detail in Chapter 9 and Chapter 10, marine and terrestrial ecology.

8.8.6.11 Other Fisheries

Priority Objective: Protection of other existing fisheries in the Plan area.

As shown by the modelling, there will be a change in nutrient levels in the immediate vicinity of the outfall, however tthere will be no impact on fisheries in the Plan area.

8.8.6.12 External Areas

Priority Objective: Protection of areas outside the Plan boundaries from environmental degradation from any action taken under the provisions of this plan.

The area in the vicinity of the outfall (the mixing zone) is outside of the plan boundaries and here there will be elevated nutrient and faecal coliforms. The treated wastewater will meet the standards specified in the UWWT regulations as the receiving water is not designated as a nutrient sensitive area.

It is proposed to tunnel the outfall from the treatment plant and consequently there will be no disturbance of the seabed apart from the point at which the tunnel will emerge (i.e., the discharge location).

Apart from the area in the vicinity of the outfall discharge point no significant impacts are predicted.

8.8.7 Conclusions

The proposed project will results in significant residual positive benefits to the Liffey and Tolka Estuaries and the inner Dublin Bay. Predicted improvements in water quality are shown graphically in Section 8.5.1.

In terms of statutory obligations, the proposed scheme will enable compliance with the UWWT Regulations discharge standards and will also be compliant with the environmental quality objectives for transitional and coastal waters set in the Environmental Objectives (Surface Water) Regulations 2009.

The proposed project will result in improved water quality at designated bathing areas and also in recreational areas in the Bay. This is discussed in more detail in Chapter 17.

8.9 Difficulties encountered in compiling required information

No significant difficulties were encountered in compiling the required information.