WATER QUALITY RISK ASSESSMENT

DPC Maintenance Dredging 2020-2021
Water Quality Risk Assessment

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1 INTRODUCTION

Dublin Port Company (DPC) is submitting a Dumping at Sea licence application to the EPA for the next phase of Maintenance Dredging at Dublin Port. This dredging will be carried out over 2020 and 2021. The maintenance dredging footprint will take place within the Inner Liffey Channel and the Approach Channel within Dublin Bay over seabed that has already been impacted by dredging. The impacted areas will include zones that have been subject capital dredging to –10m CD under the Alexandra Basin Redevelopment (ABR) Project, and also in zones where capital dredging are planned but have not yet occurred. The maintenance dredging will only extend to the existing dredged depths.

This report assesses the potential impact of the proposed 2020-2021 maintenance dredging campaigns on water quality within the receiving environment. Existing water quality in the vicinity of the proposed maintenance dredging campaigns is established based on available water quality information. The likely significant effects of the dredging campaigns on water quality are determined and measures to reduce, avoid and prevent these likely significant effects are proposed, where they are necessary.

2 WATER QUALITY

2.1 Assessment Methodology

Baseline water quality within the receiving environment has been established through the review of national monitoring data used to establish water quality status in the context of the EU Water Framework Directive (WFD) and supporting environmental standards. Recent high frequency monitoring data, collected during DPC's ABR Project, has also been considered.

An assessment has then been made of the 2020-2021 Maintenance Dredging operations and associated disposal at sea activities to determine the likelihood for significant impacts on water quality using criteria for rating significance and magnitude set out in the National Roads Authority (NRA) publication “Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes” (NRA, 2008). The significance of impact on surface water quality likely to occur during the maintenance dredging campaigns are determined using a predominantly qualitative methodology supported, where appropriate, by quantitate assessment. The assessment is a consideration of a combination of receptor sensitivity (Table 2-1) and the potential magnitude of the impact on the water environment (Table 2-2), in order to determine significance (Table 2-3).

Table 2-1 Criteria for Rating Receptor Sensitivity (NRA, 2008)

Value (Sensitivity)	Typical Descriptors
Extremely High	***Attribute has a high quality or value on an international scale.*** Examples: River, Wetland or surface water body ecosystem protected by EU legislation. I.e. designated under the Habitats, Birds, Shellfish, Bathing Water or Freshwater Fish, Drinking Water or Nitrate Directives.
Very High	***Attribute has a high quality or value on a regional or national scale.*** Examples: River, Wetland or surface water body ecosystem protected by national legislation (NHA status), Regional important potable water source supplying >2500 homes, nationally important amenity site for wide range of leisure activities, Quality Class A (Biotic Index Q4, Q5), Flood plain protecting more than 50 residential or commercial properties from flooding.
High	***Attribute has a high quality or value on a local scale.*** Examples: Salmon fishery, locally important potable water source supplying >1000 homes, Quality Class B (Biotic Index Q3-4), Flood plain protecting 5 to 50 residential or commercial properties from flooding, Locally important amenity site for wide range of leisure activities.
Medium	***Attribute has a medium quality or value on a local scale.*** Examples: Coarse fishery, Local potable water source supplying >50 homes, Quality Class C (Biotic Index Q3, Q2-3), Flood plain protecting between 1 and 5 residential or commercial properties from flooding.
Low	***Attribute has a low quality or value on a local scale.*** Examples: Locally important amenity site for small range of leisure activities, Local potable water source supplying <50 homes, Quality Class D (Biotic Index Q2, Q1), Flood plain protecting 1 residential or commercial property from flooding. Amenity site used by small numbers of local people.

Table 2-2 Criteria for Rating the Magnitude of Impact (NRA, 2008)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Loss or extensive change to a water body or water dependent habitat.
		Increase in predicted peak flood level >100mm.
		Extensive loss of fishery
		Extensive reduction in amenity value
		Potential high risk of pollution to water body from routine run-off
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Increase in predicted peak flood level >50mm
		Partial loss of fishery
		Potential medium risk of pollution to water body from routine run-off
		Partial reduction in amenity value
Minor Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Increase in predicted peak flood level >10mm
		Minor loss of fishery
		Potential low risk of pollution to water body from routine run-off
		Slight reduction in amenity value
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Negligible change in predicted peak flood level Negligible loss of amenity value Negligible loss of fishery

The approach to assessing the significance of impacts comprises assigning each impact to one of the four categories of magnitude as outlined in Table 2-1 and enables different characteristics to be assessed based upon the same scale.

Table 2-3 Criteria for Rating the Significance of Environmental Impacts (NRA 2008)

Importance of Attribute	Magnitude of Impact			
	Negligible	Minor	Moderate	Large
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound
High	Imperceptible	Moderate / Slight	Significant / Moderate	Severe / Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

The significance determination and assessment of the potential likely environmental effects of each component of the proposed maintenance dredging campaigns has been made based on the matrix presented in Table 2-3 and defined in Table 2-4.

Table 2-4 Defining Impact Significance (NRA, 2008)

Impact Level	Attribute Importance				
	Extremely High	**Very High**	**High**	**Medium**	**Low**
Profound	Any permanent impact on attribute	Permanent impact on significant proportion of attribute			
Significant	Temporary impact on significant proportion of attribute	Permanent impact on small proportion of attribute	Permanent impact on significant proportion of attribute		
Moderate	Temporary impact on small proportion of attribute	Temporary impact on significant proportion of attribute	Permanent impact on small proportion of attribute	Permanent impact on significant proportion of attribute	
Slight		Temporary impact on small proportion of attribute	Temporary impact on significant proportion of attribute	Permanent impact on small proportion of attribute	Permanent impact on significant proportion of attribute
Imperceptible			Temporary impact on small proportion of attribute	Temporary impact on significant proportion of attribute	Permanent impact on small proportion of attribute

To conclude the assessment, mitigation measures are proposed to reduce, avoid and prevent these likely significant effects, where appropriate. This enables a “with mitigation” assessment to be made of any residual impact as a result of the proposed maintenance dredging and/or in combination with other projects in the vicinity of Dublin Port.

2.2 Receiving Water Environment

A desk-based assessment of surface water quality in the vicinity of the proposed maintenance dredging campaigns was conducted. The sources of the water quality information are summarised include:

- Water Framework Directive water body status information arising from the Water Framework Directive monitoring programme. Water Quality in Ireland Report 2010-2015 (2017) supported by water quality information available on the EPAs online Water Framework Directive Application (www.catchments.ie);
- Protected areas datasets including:
  - bathing water quality information outlined in the EPA’s most recent bathing water quality report, Bathing Water Quality in Ireland, A Report for the Year 2017 (EPA, 2018);
  - information on Nutrient Sensitive Areas as outlined in the EPA’s most recent Urban Waste Water Treatment Report (2017); and
  - the existing Register of Protected Areas (under Article 6 of the Water Framework Directive) for water dependent habitats and species in the SAC and SPA networks held by the EPA.
- Department of Environment, Community and Local Government - Marine Strategy Framework Programme of Measures Summary Report (2016);
- Water Quality in Ireland – An Indicators Report (2018);
- Marine Institute water quality monitoring data for Liffey Estuary Lower and Dublin Bay 2015 – 2018;
- Site specific water quality monitoring data was made available by Dublin Port Company’s Monitoring Programme (ongoing for the ABR Project), these data are reported in DPC’s annual environmental returns/baseline state of the environment reporting.

2.2.1 Surface Water Bodies

For the purposes of monitoring and assessing the quality of surface waters, all rivers, lakes, coastal interbasins, estuaries, and coastal waters (within 1 nautical mile of the shoreline) have been divided into management units called “water bodies”. The condition of each water body must be reported to the European Commission in the form of ecological status and chemical status. Ground water bodies are similarly delineated with status identified.

Surface water bodies are grouped into sub-catchments for the purposes of water management, of which there are 583 nationally, which are further grouped into catchment management units of which there are 46 based on the hydrometric areas used by public authorities. As illustrated in Figure 2-1, the 2020 maintenance dredge loading activity will take place within the Liffey Estuary and Dublin Bay. The propoed maintenance dredging campaigns are located within two surface water bodies: ‘Liffey Estuary Lower’ transitional water body (EA_090_0300) and ‘Dublin Bay’ coastal water body (EA_090_0000). The ‘Liffey Estuary Upper’ (EA_090_0400) and the 'Tolka Estuary' (EA_090_0200) transitional water bodies are situated upstream of the proposed maintenance dredging campaigns.

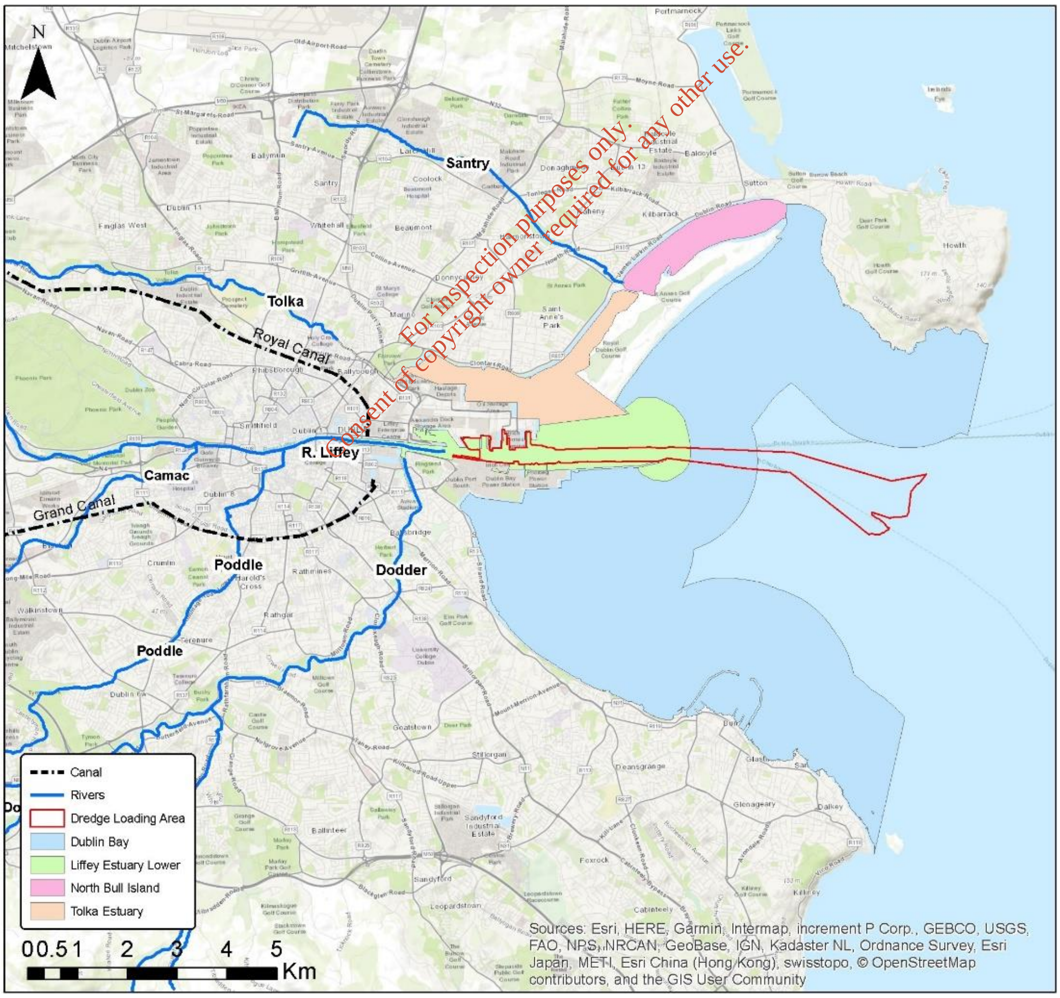

Figure 2-1 Site Location in the Context of the Wider Surface Water Environment

The proposed maintenance dredging campaigns lie within the ‘Dublin Urban’ groundwater body (EA-G-008). This water body has achieved and maintained ‘good’ status since the 2007-2012 WFD Monitoring Cycle as reported in 2017. All these waterbodies are grouped into the 'Liffey and Dublin Bay Catchment' (HA09) of the Irish River Basin District.

Due to the nature of the proposed maintenance dredging campaigns, there are no likely significant water quality effects on groundwater expected and these have therefore not been assessed further in this report.

2.2.2 Water Framework Directive Water Body Status

Directive 2000/60/EC establishing a framework for community action in the field of water policy (the Water Framework Directive), and transposing regulations, establishes a legal framework for the protection, improvement and sustainable management of rivers, lakes, transitional waters (estuaries), coastal waters (to a distance of one nautical mile) and groundwater.

The fundamental objectives of the WFD are to maintain "high status" of surface waters where it exists, prevent deterioration in the existing status of waters, and achieve at least "good status" in relation to all waters by the end of the current river basin management cycle (2021) unless subject to extended deadlines. A water body must achieve both good 'ecological status' and good 'chemical status' before it can be considered to be at good overall status. An assessment of the risks to the achievement of these objectives for water bodies has been undertaken by the EPA through the extensive characterisation of water bodies and the key pressures acting upon them. This will allow the development of a programme of measures to allow the achievement of the WFD objectives.

The Programme of Measures (POMs) outlines the steps that will be taken to meet WFD objectives as applicable to each water body. This Programme is contained within an overarching River Basin Management Plan (RBMP). These measures will require implementation at strategic level but also at regional and local level through the establishment of Regional Integrated Catchment Management Programme. Whilst none of the water bodies within the project area have been included amongst those 190 prioritised areas for action in the current River Basin Management Plan for Ireland 2018 - 2021 (DHPLG, 2018), it is noted that measures required to ensure compliance with existing legislation will be implemented during this river basin management cycle.

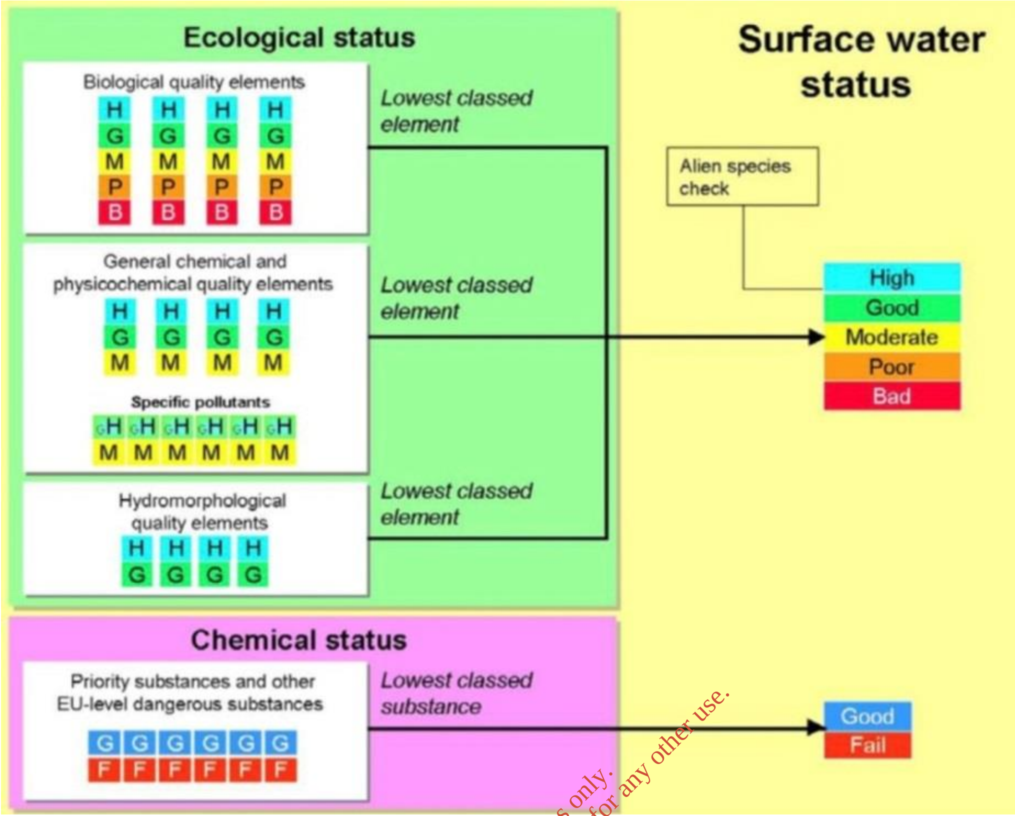

Figure 2-2 Elements of the Water Framework Directive Status

Environmental Quality Standards (EQSs) for classifying surface water status are established in the European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (SI No. 272 of 2009), as amended. These regulations set standards for biological quality elements, physico-chemical conditions supporting biological elements (including general conditions and specific pollutants), priority substances and priority hazardous substances.

As shown in Figure 2-2 the 'ecological status' of a water body is established according to compliance with the EQSs for biological quality elements, physico-chemical conditions supporting biological elements and relevant pollutants and hydromorphological quality element. The 'chemical status' of a water body is established according to compliance with the EQSs for priority substances and priority hazardous substances.

In addition to achieving good ecological and chemical status, a water body must achieve compliance with standards and objectives specified for protected areas, which include areas designated by the Bathing Water Directive; the Urban Waste Water Treatment Directive; the Shellfish Waters Directive; the Habitats Directive and the Birds Directive. Waters bodies that are compliant with WFD standards, but that contain protected areas that are non-compliant with protected area standards are downgraded to 'less than good' status.

Based on monitoring information and data from 2010 to 2015, the current WFD status classification of transitional and coastal water bodies potentially affected by the proposed maintenance dredging campaigns is illustrated in Figure 2-3.

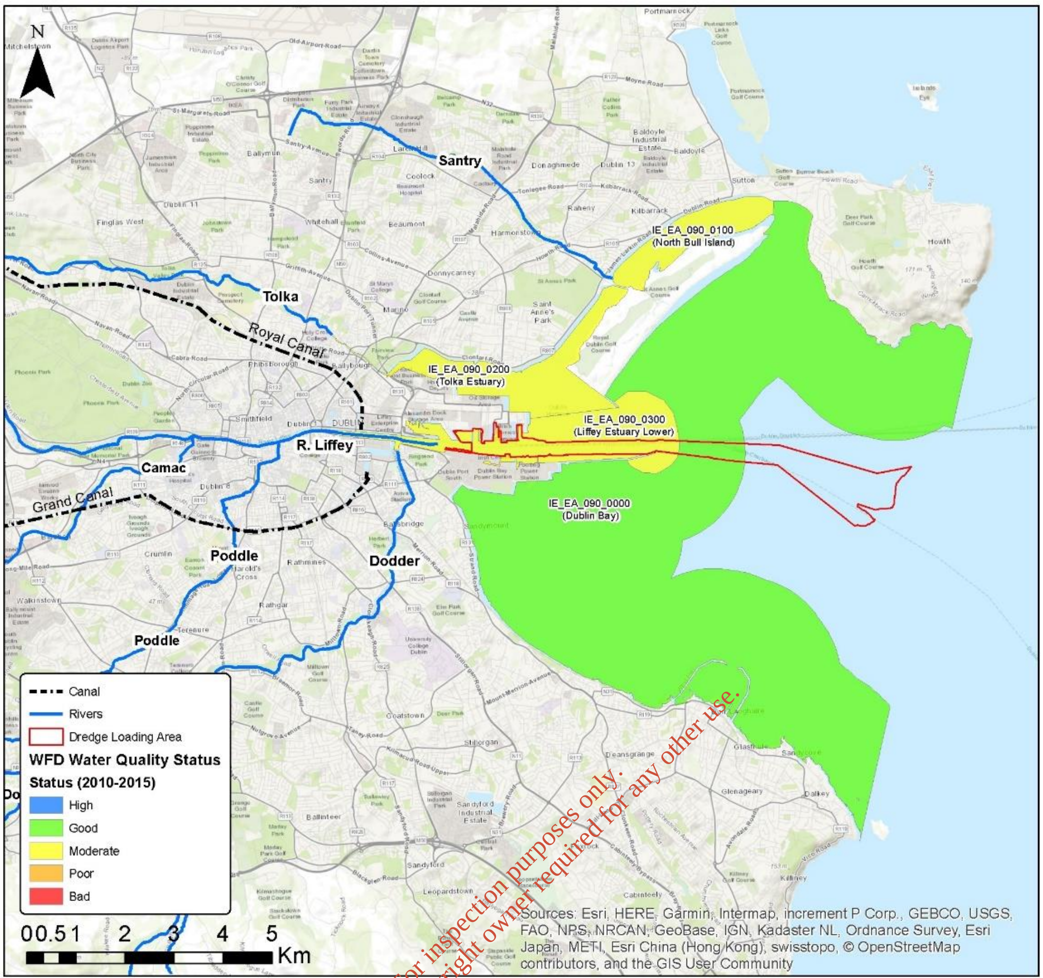

Figure 2-3 Water Framework Directive Water Body Status – Reported 2017

The WFD status classification between 2007 and 2015 is shown in Table 2-5 for each of these water bodies. In summary the Liffey Estuary Lower and Tolka Estuary transitional water bodies have most recently been reported as “moderate” in 2015, with the Liffey Estuary Lower reported as good in 2010-2012. The Dublin Bay coastal water body was reported as “moderate” in the 2007-2009 WFD monitoring cycle and in 2010-2012 it was reported as “good” and has since maintained that status, as reported in 2017. The Liffey Estuary Upper was reported as “poor” in the 2007-2009 WFD monitoring cycle. In the 2010-2012 monitoring cycle it was reported as “moderate” and has since maintained that status, as reported in 2017.

Table 2-5 WFD Status (2007-2015)

WFD Status 2007-2015	Liffey Estuary Lower WFD Status	Liffey Estuary Upper WFD Status	Tolka Estuary WFD Status	Dublin Bay WFD
	EA_090_0300	EA_090_0400	EA_090_0200	EA_090_0000
Overall WFD Water Quality Status (2007-2009)	Moderate	Poor	Moderate	Moderate
Overall WFD Water Quality Status (2010-2012 - Interim)	Good	Moderate	Moderate	Good
Overall WFD Water Quality Status (2010-2015)	Moderate	Moderate	Moderate	Good

A further breakdown of the ecological and chemical elements for the 2010-2015 WFD cycles is shown in Table 2-6. The Liffey Estuary Lower water body is currently at "moderate" Ecological Status but was at "good" status in the previous monitoring cycle. This resulted from a reduction in Biological Status from "good" to "moderate" due to a reduction in Fish Status from "good" to "moderate". Oxygenation conditions have also reduced from "high" in the 2007-2009 monitoring interval to "good" in the current 2010-2015 interval.

The Dublin Bay coastal water body has improved from "moderate" in the 2007-2009 monitoring cycle to "good" Ecological Status in the latest monitoring intervals. This resulted from an increase in Biological Status from "moderate" to "good" due to improving Invertebrate Status, notwithstanding the deterioration in Supporting Chemistry Conditions, including Oxygenation Conditions, from "high" to "good" status.

The Tolka Estuary has retained 'moderate' Ecological Status throughout all monitoring intervals although Fish Status has improved to "good" status in the last two monitoring intervals and Oxygenation Conditions have reduced to "moderate" status' from previous "good" status.

The Liffey Estuary Upper has improved Ecological Status from "poor" in the 2007-2009 monitoring cycle to "moderate" in the most recent monitoring period. The improvement reflects a change in Fish Status from "poor" to "moderate".

This assessment of likely significant effects on water quality has been undertaken having regard to the necessity to comply with the WFD and in doing so ensuring that the proposed maintenance dredging campaigns do not prevent the achievement of the WFD objectives for these water bodies in subsequent RBMP cycles.

Table 2-6 WFD Status Breakdown (2010-2015)

WFD Status 2010-2015			*Liffey Estuary Lower*	Liffey Estuary Upper	*Tolka Estuary*	*Dublin Bay*
			EA_090_0300	EA_090_0400	*EA_090_0200*	*EA_090_0000*
Ecological Status	*Biological Status*	*Phytoplankton Status*	*Good*	*Good*	*High*	*High*
		Other Aquatic Floras Status	*Not Available*	*Not Available*	*Moderate*	*Good*
		Invertebrate Status	*High*	*Not Available*	*Moderate*	*Good*
		Fish Status	*Moderate*	*Moderate*	*Good*	*Not Available*
	Supporting Chemistry Conditions	*Oxygenation Conditions*	*Good*	*Moderate*	*Moderate*	*Good*
		Nutrients Condition	*Good*	*Moderate*	*Moderate*	*High*
		Relevant Pollutants	*Pass*	*Not Available*	*Not Available*	*Pass*
	Hydromorphological Quality Element	*Hydrology, Morphology, Continuity*	*Poor*	*Bad*	*Poor*	*Good*
	Ecological Status (2010 – 2015)		**Moderate**	**Moderate**	**Moderate**	**Good**
Chemical Status	*Priority substances and other EU-level dangerous substances*		*Good*	*Not Available*	*Not Available*	*Good*
	Chemical Status (2010 – 2015)		**Good**	***Not Available***	***Not Available***	**Good**
Overall WFD Quality Status 2010 - 2015			**Moderate**	***Moderate***	***Moderate***	**Good**

2.2.3 Protected Areas

A significant proportion of the area of Dublin Bay and adjacent coastline is protected under existing EU legislation requiring special protection due to the sensitivity to pollution or particular environmental importance. All of the areas requiring special protection in the Irish River Basin District have been identified by the EPA, mapped and listed in a national register of protected areas (required under Article 6 of the WFD Directive). The register of protected areas includes:

- areas designated for the abstraction of water for human consumption (Drinking Water Protected Areas);
- areas designated for the protection of economically significant aquatic species, i.e. Freshwater Fish and Shellfish;
- bodies of water designated as recreational waters, including areas designated as bathing waters;
- nutrient-sensitive areas, including areas identified as Nitrate Vulnerable Zones under the Nitrates Directive or areas designated as sensitive under Urban Waste Water Treatment Directive; as well as
- areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection including relevant Natura 2000 sites (Special Protection Areas (SPAs); and candidate Special Areas of Conservation (cSACs)).

These protected areas have their own monitoring and assessment requirements to determine their condition. They are often assessed for additional pollutants or requirements relevant to their designation. Protected areas within the Dublin Port and Dublin Bay area include areas of Bathing Water, Nutrient Sensitive Waters and Natura 2000 sites.

2.2.3.1 Bathing Waters

The Bathing Water Directive (2006/7/EC) came into force in March 2006, and was transposed into Irish law by the Bathing Water Quality Regulations, 2008, as amended. The previous 1976 Directive was repealed with effect from 31 December 2014. Since 2014, the annual water quality classification (rating) of a beach or lake has been based on water quality results covering a four-year period rather than a single previous season's data. Water quality at beaches and lakes is classified as Excellent; Good, Sufficient or Poor (Table 2-7). This approach is common across all EU Member States and there is a requirement to ensure that bathing waters are of 'Sufficient' standard or better. Any 'Poor' bathing water requires a programme of adequate management measures to be implemented. A minimum of 16 samples are required for formal annual assessment.

Table 2-7 Annual Assessment Criteria for Bathing Waters

Parameter	Excellent	Good	Sufficient
E. coli (Freshwater)	500*	1000*	900**
E. coli (Coastal)	250*	500*	500**
Intestinal enterococci (freshwater)	200*	400*	330**
Intestinal enterococci (Coastal)	100*	200*	185**

*based on 95-percentile value **based on 90-percentile value

The bathing areas in the immediate vicinity of the loading area are Dollymount Strand, Sandymount Strand, Merrion Strand and Seapoint. Most recently, Dollymount Strand has been classified as Good; Sandymount and Merrion Strands have been classified as Poor; and Seapoint has been classified as Excellent (Figure 2-4). Sandymount Strand has deteriorated from Sufficient in the 2016 to Poor in the most recent 2017 monitoring period. The remaining sites showed no change over this interval.

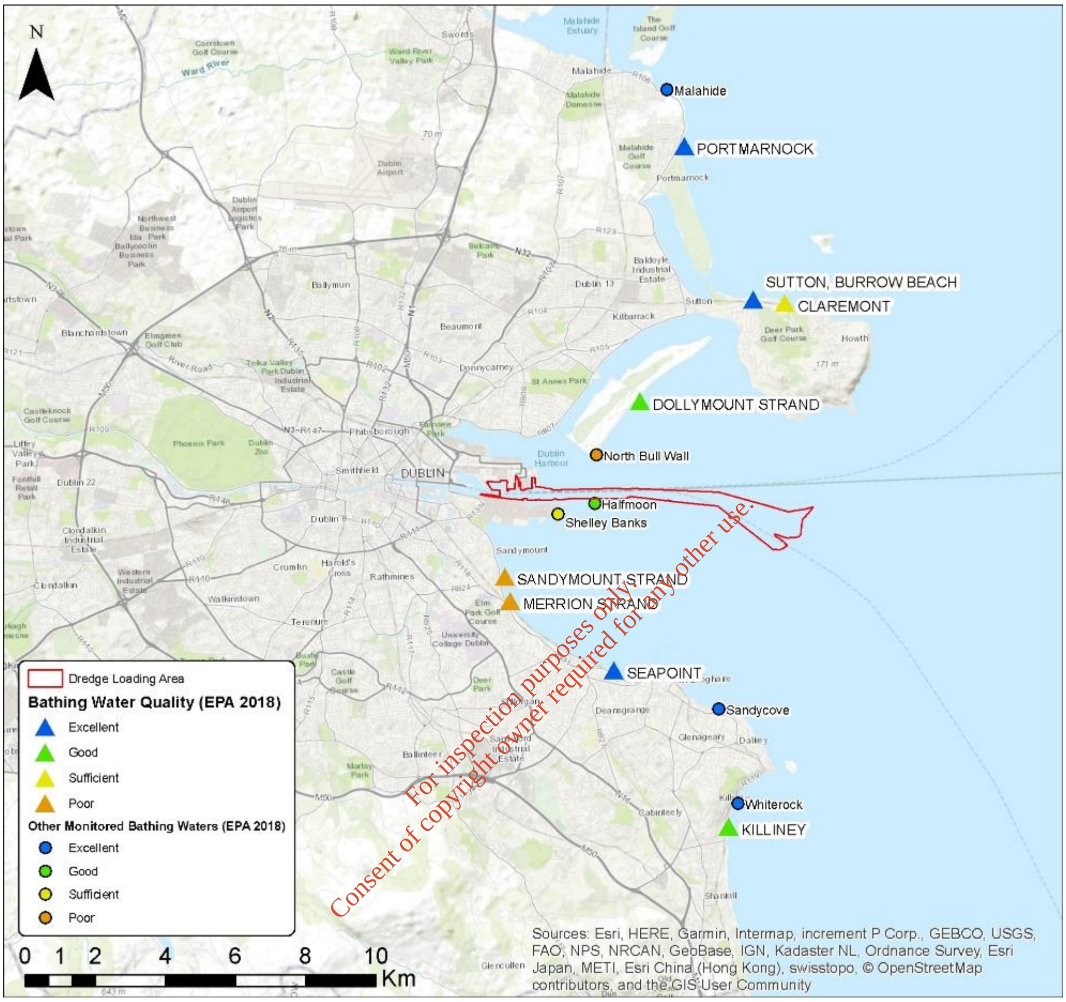

Figure 2-4 Bathing Water Quality in the Dublin Area 2017 (EPA, 2018)

Both Merrion and Sandymount Strands are considered vulnerable to pollution. The likely pollution sources are identified as arising from surface water inflows, drainage misconnections from domestic properties and fouling by large numbers of birds that roost on the extensive areas of exposed sand at these sites. Seabird droppings have as much as 10 million *E.coli* bacteria per gram so it is possible that they may be contributing to a decline in quality, particularly as microbiological standards have become stricter and bird numbers appear to be increasing.

In addition to the waters which Ireland has formally identified to the EU as bathing waters there are many locations around the country which are monitored by local authorities because swimming or recreational activities are known to take place there. Water quality results for other monitored waters for the period 2014-2017 shows the quality likely to be achieved at these waters.

Of the other monitored waters in the Dublin Bay area, the North Bull Wall Causeway on the River Liffey, is indicated as likely to be of Poor quality. The Half Moon bathing area is indicated as Good; Shelley Banks as Sufficient; White Rock and Sandycove as Excellent (Figure 2-4).

	Dollymount	Sandymount	Merrion	North Bull	Half Moon	Shelley Banks	Seapoint	Sandycove	Forty Foot	Shelley Banks
08/08/18-08/08/18										
30/07/2018										
25/07/2018										
24/07/2018										
23/07/2018										
16/07/18 - 17/08/18										
12/07/18 - 15/07/2018										
11/07/2018										
10/07/2018										
01/07/2018										
26/06/18-28/06/18										
25/06/2018										
24/06/2018										
17/06/2018										
13/06/2018										
12/06/2018										
11/06/2018										
08/06/2018										
05/06/2018										
28/05/2018										
23/05/2018										

Table 2-8 Status of Individual Samples during the 2018 Monitoring Season

Notwithstanding bathing restrictions at Merrion and Sandymount due to previous poor-quality bathing water, the results for all sites monitored during 2018 have been substantially excellent for individual samples during the 2018 monitoring season Table 2-8).

2.2.3.2 Nutrient Sensitive Waters

The Urban Waste Water Treatment Regulations 2001, as amended (which transpose the Urban Wastewater Treatment Directive (91/271/EEC) into Irish law and update the Environmental Protection Agency Act, 1992 (Urban Waste Water Treatment) Regulations 1994, as amended) list nutrient sensitive waters in the Third Schedule.

The Liffey Estuary from Islandbridge weir to Poolbeg Lighthouse, including the River Tolka basin and South Bull Lagoon has been designated as a nutrient sensitive area (Figure 2-5). Ringsend WWTP currently discharges in the Lower Liffey Estuary.

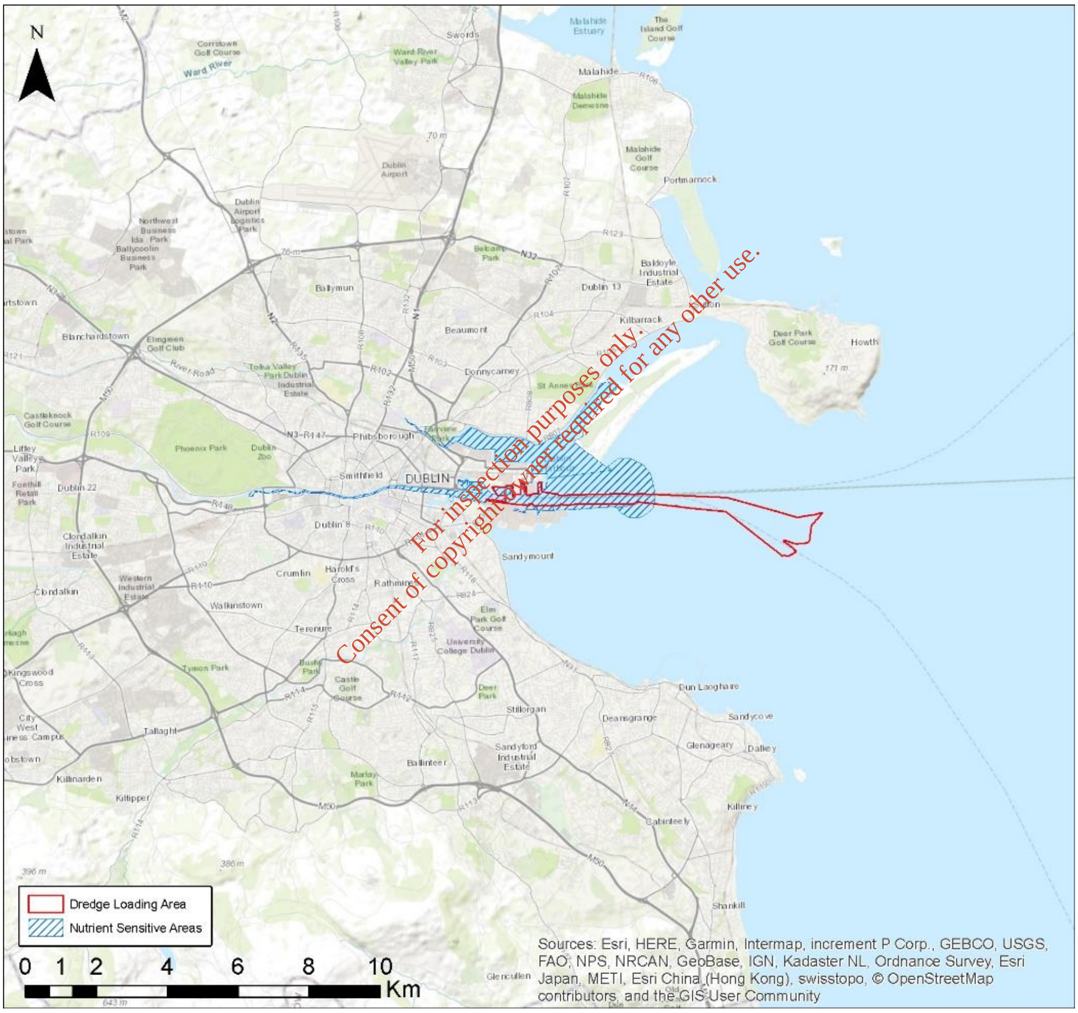

Figure 2-5 Nutrient Sensitive Areas

2.2.3.3 Natura 2000 Protected Areas

Natura 2000 is a European network of important ecological sites. The EU Habitats Directive (92/43/EEC) places an obligation on Member States of the EU to establish the Natura 2000 network. The network is made up of Special Protection Areas (SPAs), established under the EU Birds Directive (79/409/EEC), and cSACs, established under the Habitats Directive itself.

As illustrated in Figure 2-6 the proposed maintenance dredging loading activities within Dublin Harbour do not lie within any Natura 2000 site (i.e. SPA or cSAC). The outermost section of the navigation channel within Dublin Bay does however lie within the Rockabill to Dalkey SAC (Figure 2-7). The licensed dumping area also lies within the Rockabill to Dalkey SAC which is designated for the marine Annex I qualifying interest reefs and the Annex II species *Phocoena phocoena* (harbour porpoise). The potential of likely significant effects from the proposed maintenance dredging campaigns has been assessed in the Natura Impact Statement accompanying this Dumping at Sea Licence Application.

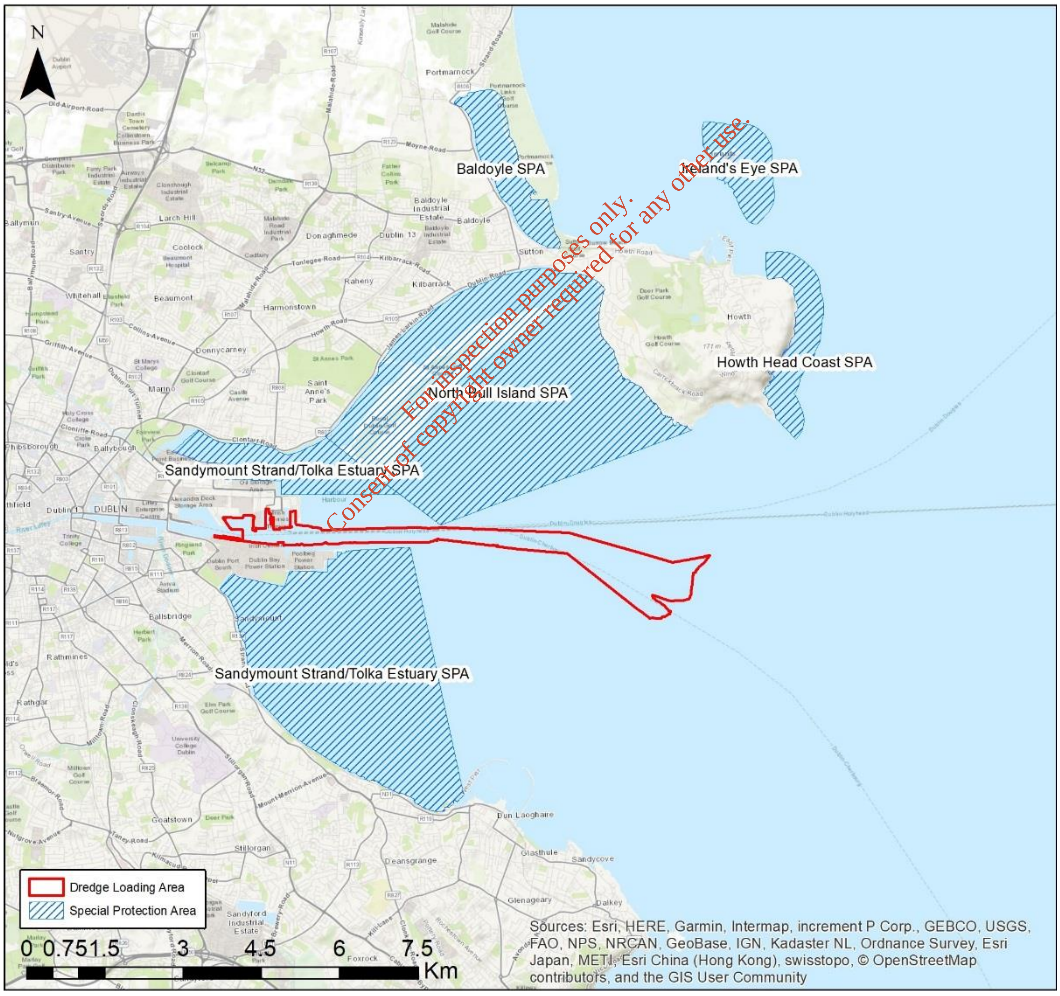

Figure 2-6 Natura 2000 Designated Sites (Special Protection Areas)

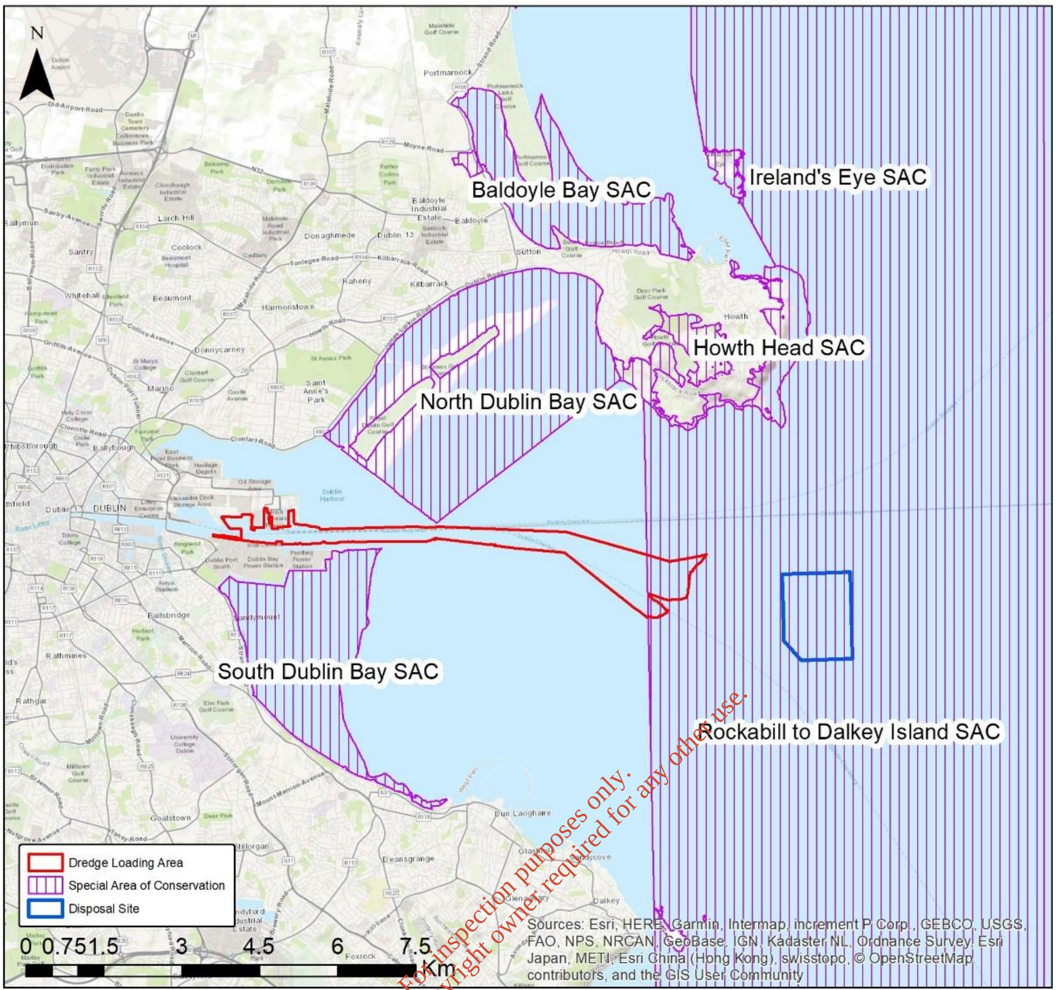

Figure 2-7 Natura 2000 Designated Sites (Special Areas of Conservation)

For the reasons set out in the Appropriate Assessment Screening Report and Natura Impact Statement, the proposed maintenance dredging will not have any adverse effects on the qualifying interests of any European site. The purpose of the water quality assessment is to demonstrate that the maintenance dredging operations will not cause significant effects on the bathing waters, nutrient sensitive waters and, where necessary, water quality modelling and evaluation against relevant standards, has been undertaken.

2.2.4 Marine Strategy Framework Directive Environmental Status

The Marine Strategy Framework Directive (MSFD) (2008/56/EC) was formally adopted by the European Union in June 2008 and is transposed into Irish law by the European Communities (Marine Strategy Framework) Regulations 2011, as amended. The overarching aim of the Directive is to protect Europe's marine waters by applying an ecosystem-based approach to the management of human activities while enabling the sustainable use of the marine environment for present and future generations. The Directive establishes a legal framework for the development of marine strategies designed to achieve Good Environmental Status (GES) in the marine environment by the year 2020. The marine strategy involves defining GES, setting environmental targets and indicators, implementing monitoring programmes for ongoing assessment, and developing and implementing programmes of measures to achieve or maintain GES.

GES is defined as '*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 assessment of GES is undertaken by reference to qualitative descriptors which define overarching objectives in respect of key socio-economic or ecological aspects of the marine environment. These specifically require the consideration of the following:

- biodiversity;
- non-indigenous species;
- exploited fish and shellfish;
- food webs;
- human-induced eutrophication;
- sea-floor integrity;
- alteration of hydrographical conditions;
- contaminants in water and seafood;
- marine litter; and
- the introduction of energy including underwater noise.

To date, an Initial Assessment (constituting a comprehensive review of the physical, chemical and biological characteristics of the marine area, as well as the human pressures acting upon it) has been undertaken (DEHLG 2013)). A comprehensive set of environmental targets and associated indicators is under development. These will be used to demonstrate that GES has been achieved or is being maintained in accordance with the objectives of the MSFD. A monitoring programme will be established by the Department of Housing, Planning and Local Government and the Marine Institute to identify measures which will need to be taken in order to achieve or maintain GES in marine waters. To date, the extent of achievement of GES has not been established for individual water bodies, therefore this water quality assessment relies on the WFD water quality assessment to ensure that the proposed development will not cause conflict with the MSFD.

2.2.5 EPA Water Quality in 2016: An Indicators Report

In 2018 the EPA published the Water Quality in Ireland, An indicators Report. The intention of the report is to keep decision makers and the public informed by providing timely, scientifically sound information on water quality using a series of water quality indicators. Of the sixteen indicators three relate to Transitional and Coastal Waters;

- Indicator 9 – Trophic Status of Transitional and Coastal Waters,
- Indicator 10 – Nitrogen in Transitional and Coastal Waters,
- Indicator 11 – Phosphorus in Transitional and Coastal Waters.

2.2.5.1 Indicator 9 – Trophic Status of Transitional and Coastal Waters

The assessment of trophic status is used to identify waters that may be sensitive to nutrient enrichment and the occurrence of eutrophication. Trophic status is a measure of the amount of biomass in a water body at a certain time. Too much nutrient leads to too much biomass, which can severely impact the normal functioning of saline ecosystems and can cause changes to the biological communities and undesirable disturbance to the overall ecology. Eutrophication in estuaries and coastal waters can be caused by nitrogen and/or phosphorus. Phosphorus is generally considered the primary limiting nutrient in river-dominated estuaries while nitrogen is considered the primary limiting nutrient in coastal ecosystems.

The trophic status of transitional and coastal water bodies is assessed using the EPA's Trophic Status Assessment Scheme (TSAS) and is required for the EU Urban Waste Water Treatment Directive (91/271/EEC) and the EU Nitrates Directive (91/676/EEC). The scheme compares the compliance of individual parameters against a set of criteria indicative of trophic state (Table 2-9) and classifies water bodies as follows:

- ***Eutrophic*** water bodies are those in which criteria in each of the categories are breached, i.e. where elevated nutrient concentrations, accelerated growth of plants and undesirable water quality disturbance occur simultaneously;
- ***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 Water Quality in 2016 Indicator Report has indicated that the Liffey Estuary lower and the Liffey Estuary Upper water bodies have been designated as being Intermediate, the Tolka Estuary has been designated as Eutrophic and Dublin Bay is Unpolluted.

Table 2-9 Parameters and criteria used in the Trophic Status Assessment Scheme (TSAS) for Irish Marine Water Bodies (EPC, 2010)

Category	TSAS criteria	Value from 3-year period	Threshold	Score
A: Nutrient enrichment	Nitrogen	DIN (Winter or Summer)	Salinity Corrected Threshold Value (see Appendix)	Pass/Fail
	Phosphorus	MRP (Winter or Summer)		Pass/Fail
B: Accelerated Growth	Chlorophyll	Median (Summer)		Pass/Fail
		90%ile (Summer)		Pass/Fail
	Macroalgae	WFD EQR[1] (Summer)		Pass/Fail
C: Undesirable Disturbance	Dissolved Oxygen	5%ile (Summer)		Pass/Fail
		95%ile (Summer)		Pass/Fail

[1] Ecological Quality Ratio for Good Status, derived from WFD compliant assessment method.

2.2.5.2 Indicator 10 – Nitrogen in Transitional and Coastal Waters

Nitrogen is generally considered the primary limiting nutrient in coastal ecosystems, meaning that the concentration of this nutrient can limit the growth of algae and aquatic plants. Increases in nitrogen can lead to elevated growth of phytoplankton and/or macroalgae. Levels of Dissolved Inorganic Nitrogen (DIN) are monitored in winter, when levels are expected to be at their seasonal maximum due to the absence of any significant plant or algal growth.

The EPA have defined salinity-dependent thresholds for DIN in transitional and coastal waters, and there is an environmental quality standard for coastal waters. These assessment thresholds range from ≤2.6 mg N/l at a salinity of 0 to ≤0.25 mg N/l at a salinity of 34.5, and are used to assess water quality of transitional and coastal waters around Ireland. Dissolved inorganic nitrogen concentrations above the assessment threshold indicate the presence of elevated nitrogen levels from anthropogenic sources. The indicator uses the median winter DIN concentration for the period 2014–2016 to assess number of exceedances against the assessment threshold.

The EPA 2016 Indicators Report has reviewed trends in some coastal and transitional water bodies. Liffey Estuary Lower, Tolka Estuary and Dublin Bay have been included in this analysis, but Liffey Estuary Upper has not. Indicator 10 reports that the Medium DIN Concentration trend between 2007 and 2016 has remained stable for all three water bodies. It also reports at that the Liffey Estuary Lower and Tolka Estuary have experienced between 1% to 50% exceedances of Winter DIN and Dublin Bay has not experienced exceedance of Winter DIN.

2.2.5.3 Indicator 11 – Phosphorus in Transitional and Coastal Waters

Phosphorus is important in transitional systems because it is limiting in lower salinity waters. Salinity-dependent thresholds have been defined for phosphorus in transitional and coastal waters and there is an environmental quality standard for transitional waters (S.I. 272, 2009). The assessment threshold is 0.060 mg P/l for fresh to intermediate salinity waters and ranges from 0.059–0.040 mg P/l for intermediate to full salinity waters. Phosphorus concentrations above these thresholds can indicate excess phosphorus being transported to surface waters due to anthropogenic activity. Levels of Molybdate Reactive Phosphorus (MRP) are monitored in winter, when levels are expected to be at their seasonal maximum due to the absence of any significant plant or algal growth. Winter (January–March) phosphorus exceedances give an indication of available nutrients without the influence of biological activity, which mainly occurs during the summer growth period.

Indicator 11 reported that the Median MRP concentration trend between 2007 and 2016 has remained stable for Liffey Lower Estuary and the Tolka Estuary while the concentration of Dublin Bay has decreased significantly. It also reports that the Liffey Estuary Lower and Tolka Estuary have not experienced exceedances of Winter MRP and Dublin Bay has also not experienced exceedance of Winter MRP.

In this water quality assessment consideration has been given to potential effects of the proposed maintenance dredging campaigns on these nutrient related environmental indicators.

2.2.6 Marine Institute Monitoring

The Marine Institute (MI) monitors water quality at two locations in Dublin Bay and one location in the Liffey Estuary Lower (Figure 2-8). Available physico-chemical monitoring data from January 2015 to March 2018 have been collated and are summarised in Figure 2-9.

The mean turbidity measured by MI at Dublin Bay stations 1 and 2 is 8 NTU. This is in agreement with measurements made at the coastal monitoring buoys in the ABR Project where mean turbidity at four sites and at three depths was measured at 8 to 14 NTU. The mean turbidity measured in the Liffey Estuary Lower (based on data from September and November 2018 only) is 21 NTU. This compares with mean turbidity of 2.4 to 7.4 measured at four sites in the Liffey Estuary during the ABR Project. The slightly higher turbidity measured by MI may relate to the time of year when measurements were made at this site (September and November). It also reflects the greater variance in turbidity in the dynamic Port area.

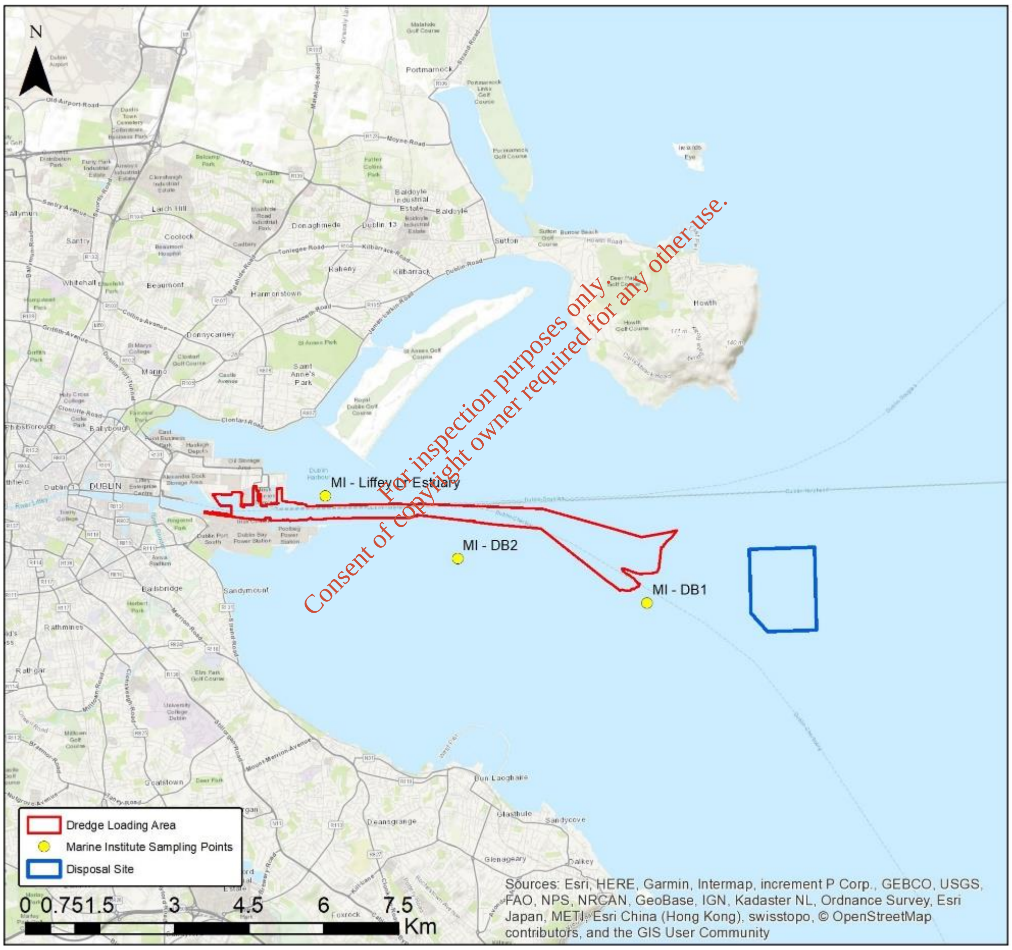

Figure 2-8 Marine Institute Monitoring Locations relative to the Loading Area and the Licenced Disposal Site

Dissolved oxygen levels are 8.9 mg/l at both Dublin Bay sites and slightly lower in the Liffey Estuary at 8.3 mg/l. This compares with average dissolved oxygen levels of 8.5 to 9.0 mg/l measured in the Liffey Estuary by the ABR Project and confirms that DO is typically around saturation levels.

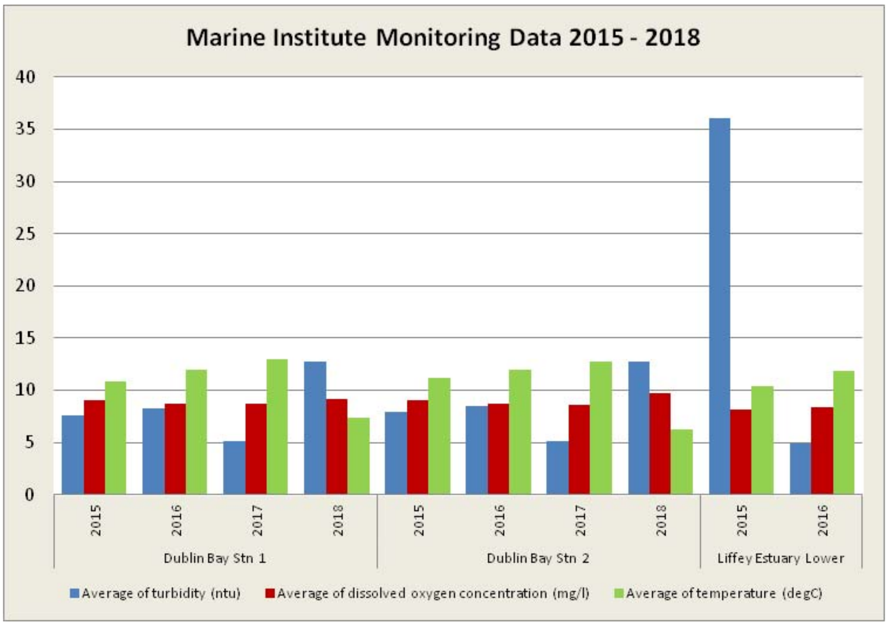

Figure 2-9 Marine Institute Summary Water Quality Data 2015 – 2018

This Marine Institute monitoring data provides a baseline of existing turbidity levels and variations giving context for the assessment of the proposed maintenance dredging campaigns.

2.2.7 Dublin Port Company Monitoring Programme (ABR Project)

2.2.7.1 Within Dublin Port

Dublin Port Company is carrying out extensive monitoring of water quality in Dublin Port and Dublin Bay as part of its Alexandra Basin Redevelopment (ABR) Project.

Monitoring stations have been established in the Port to provide detailed information on relevant water quality parameters. The locations of these stations have been agreed with the Planning Authority. They measure real time water quality and continuously relay the data to a shore-based location. Trigger levels that initiate investigations have been set for key water quality indicators to allow a quick response and remedial actions, including the temporary cessation of the works where appropriate.

Monitoring stations have also been established in Dublin Bay at the licensed dredge dumping site as required by Dumping at Sea Permit S00024-01 to provide for the protection of the marine environment by way of monitoring of the impacts associated with the loading and dumping at sea activity during dredging operations. Continuous real-time turbidity monitoring is carried out at four stations and at three depths along with tidal current and wave climate at one station.

Monitoring Stations

Four water quality monitoring stations have been established at locations within the Liffey Estuary (Figure 2-10). The sites chosen represent ambient surface water quality in the Liffey Estuary Lower and in the Tolka Estuary water bodies. Monitoring at the Tolka Estuary station commenced on the 23rd June 2017 while the other three sites were in operation throughout 2017. The monitoring station at the Tolka Estuary is mounted on an OSIL

Micro Field buoy. At the East Link, Poolbeg Sludge Jetty and North Bank Light stations the monitoring apparatus has been secured to permanent in-river structures.

Four parameters are measured at each of the water quality stations. Measurements are made every 15 minutes using a Hydrolab Multiparameter HL4 Sonde with integrated sensors. A secure stilling tube maintains the sonde at a fixed point below the surface and a watertight compartment on the structure houses a data-logger and communications hardware. The parameters measured are turbidity, temperature, dissolved oxygen and salinity. In addition, water level is measured at the Poolbeg Sludge Jetty station. Data are relayed from the monitoring stations via a 3G connection and web-based telemetry software (ADCON addVANTAGE pRO 6.6) is used to visualize and distribute the information.

The information from the network of monitoring stations is supplemented by data collected by boat surveys in the estuary and Dublin Bay. Water samples are taken at fixed locations and along set paths that are strategically located to measure any impacts on water quality in the area, including behaviour and dispersal of turbidity plumes.

Figure 2-10 Water Quality Monitoring Stations in the Dublin Port Area

Turbidity and Total Suspended Solids

Turbidity is monitored as a proxy for total suspended solids (TSS) in water due to the ease and frequency with which it can be measured. Turbidity is a measure of the cloudiness or haziness of water caused by material suspended in the water such as soil particles, sediment, or small floating algae. Particles are often small and can remain in suspension in the water for lengthy periods. Turbidity can be caused by natural events such as flooding, algal growth, water currents, wind and wave action as well as human activities.

Turbidity is measured in NTU (Nephelometric Turbidity Units), which is basically a measure of the amount of light scattered by particles in suspension. It is readily measured on site and can be used to give a rapid estimate of the total amount of suspended solids in the water. Measuring the total suspended solids concentration requires taking water samples for filtration, weighing and drying in the laboratory.

The relationship between turbidity and suspended solids in water is site-specific. It is influenced by the type of sediment in suspension, its colour, shape and reflectivity. Therefore, a sediment sample from the Liffey at East Link Bridge was taken and used to establish a relationship between turbidity and suspended solids for the Port area. The sediment consisted of sandy silt and suspensions were prepared from this sample to provide turbidity in the range 0 to 150 NTU. Turbidity (NTU) and TSS (mg/l) were measured for 75 suspensions to allow development of a calibration curve (Figure 2-11).

This relationship can be used to estimate total suspended solids from turbidity readings at the monitoring stations in the Port area. Based on this relationship a factor of 2.5 is used to convert NTU to TSS mg/l.

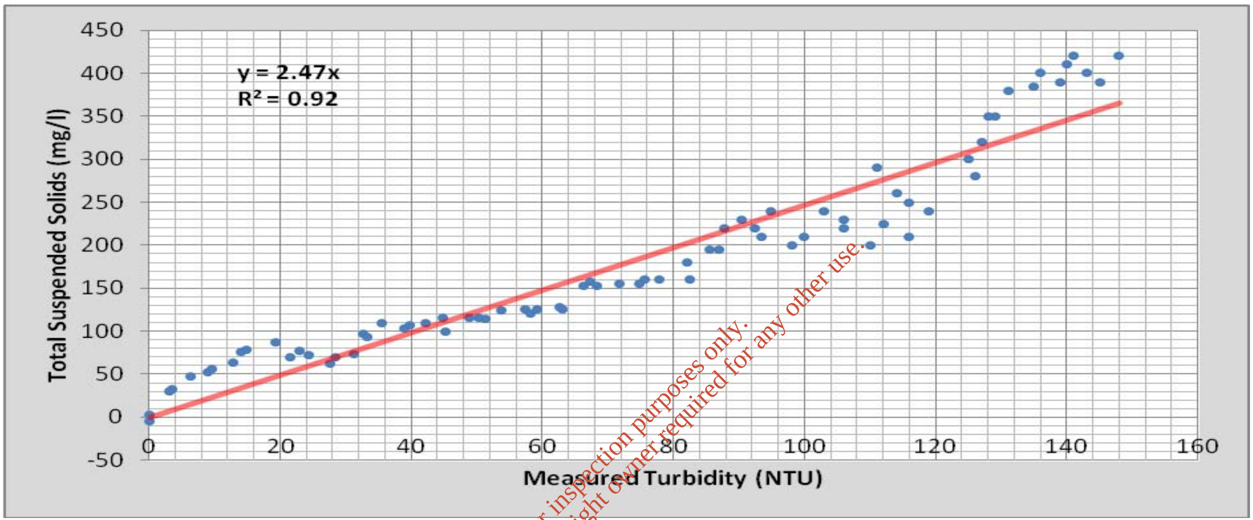

Figure 2-11 Relationship Established between Turbidity and Total Suspended Solids (Inner Liffey Channel)

Dissolved Oxygen (DO), Temperature and Salinity

The amount of oxygen dissolved in the water is reported as milligrams per litre (mg/l). Aquatic animals breathe using the oxygen dissolved in the water. The level is therefore critically important, particularly for fish. Salmon and trout begin to be affected by low oxygen levels at about 6 mg/l (around 50% saturation), and at dissolved oxygen levels below 1.7 mg/l death of some adult fish is likely.

Temperature is one of a number of factors that can affect oxygen levels in water. When freshwater is saturated with oxygen it can hold about 12.7 mg/l of oxygen at a temperature of 5°C; this reduces to 9.1 mg/l at 20°C. High temperatures also promote more rapid microbiological breakdown of organic wastes and this can also use up oxygen in the water.

Other factors, including salinity and atmospheric pressure, can also affect dissolved oxygen levels. For example, seawater holds about 20% less oxygen than freshwater when saturated, and algae produce oxygen during the daylight hours when they are photosynthesising but use it up during darkness when respiring. These factors produce daily and tidal rhythms of higher and lower dissolved oxygen levels.

Salinity is measured in PSU (practical salinity units). Full seawater has a salinity of about 35 PSU, while freshwater has a value close to zero. As well as influencing the type of animals and plants that occur in the water, salinity affects many aspects of the water's chemistry and physical properties (including the amount of oxygen dissolved in the water as demonstrated above).

Summary statistics for each full data set are set out in Table 2-10 to Table 2-13. Although maximum and minimum values are given for each parameter these obviously reflect extreme outlier values that are highly unlikely to be representative of general ambient water quality. The percentile values listed give a more robust indication of the true dispersal of the measurements, and clearly most of the measurements (90% of them) lie between the 5 percentile and 95 percentile values listed.

The graphs in Figure 2-12 to Figure 2-15 show the 24-hour average values for turbidity, salinity, dissolved oxygen and temperature at each of the monitoring stations. Various dredging campaigns between 2017 and 2018 are also shown. Some data gaps occur due to several causes e.g. fouling of instruments, apparatus failure or damage.

Table 2-10 Summary Statistics for Dissolved Oxygen, Salinity, Temperature and Turbidity at Eastlink Monitoring Station

	DO (mg/l)	Salinity (PSU)	Temperature (°C)	Turbidity (NTU)
Mean	7.9	32.6	11.6	2.4
Max	11.0	34.8	18.6	9.0
Min	5.6	25.0	3.9	0.0
5%-ile	6.1	29.3	6.4	0.0
95 %-ile	9.7	33.8	17.0	7.1
n	17533	17533	17533	17533

Table 2-11 Summary Statistics for Dissolved Oxygen, Salinity, Temperature and Turbidity at Poolbeg Monitoring Station

	DO (mg/l)	Salinity (PSU)	Temperature (°C)	Turbidity (NTU)
Mean	8.4	32.0	11.9	7.4
Max	12.5	35.3	19.0	190.3
Min	5.9	22.7	6.3	0.0
5%-ile	6.8	26.7	6.9	0.0
95 %ile	9.6	34.4	17.2	34.3
n	17533	17533	17533	17533

Table 2-12 Summary Statistics for Dissolved Oxygen, Salinity, Temperature and Turbidity at Northbank Monitoring Station

	DO (mg/l)	Salinity (PSU)	Temperature (°C)	Turbidity (NTU)
Mean	8.3	33.2	11.6	2.6
Max	10.7	34.8	18.6	39.5
Min	5.4	27.7	4.1	0.0
5%-ile	6.0	31.6	6.5	0.0
95 %ile	9.9	34.3	16.9	8.6
n	17533	17533	17533	17533

Table 2-13 Summary Statistics for Dissolved Oxygen, Salinity, Temperature and Turbidity, at Tolka Monitoring Station

	DO (mg/l)	Salinity (PSU)	Temperature (°C)	Turbidity (NTU)
Mean	8.9	31.8	12.1	3.3
Max	12.8	35.3	19.0	52.5
Min	5.5	23.3	4.1	0.0
5%-ile	7.9	27.0	6.3	0.0
95 %ile	10.3	34.2	17.3	12.6
n	13357	13357	13357	13357

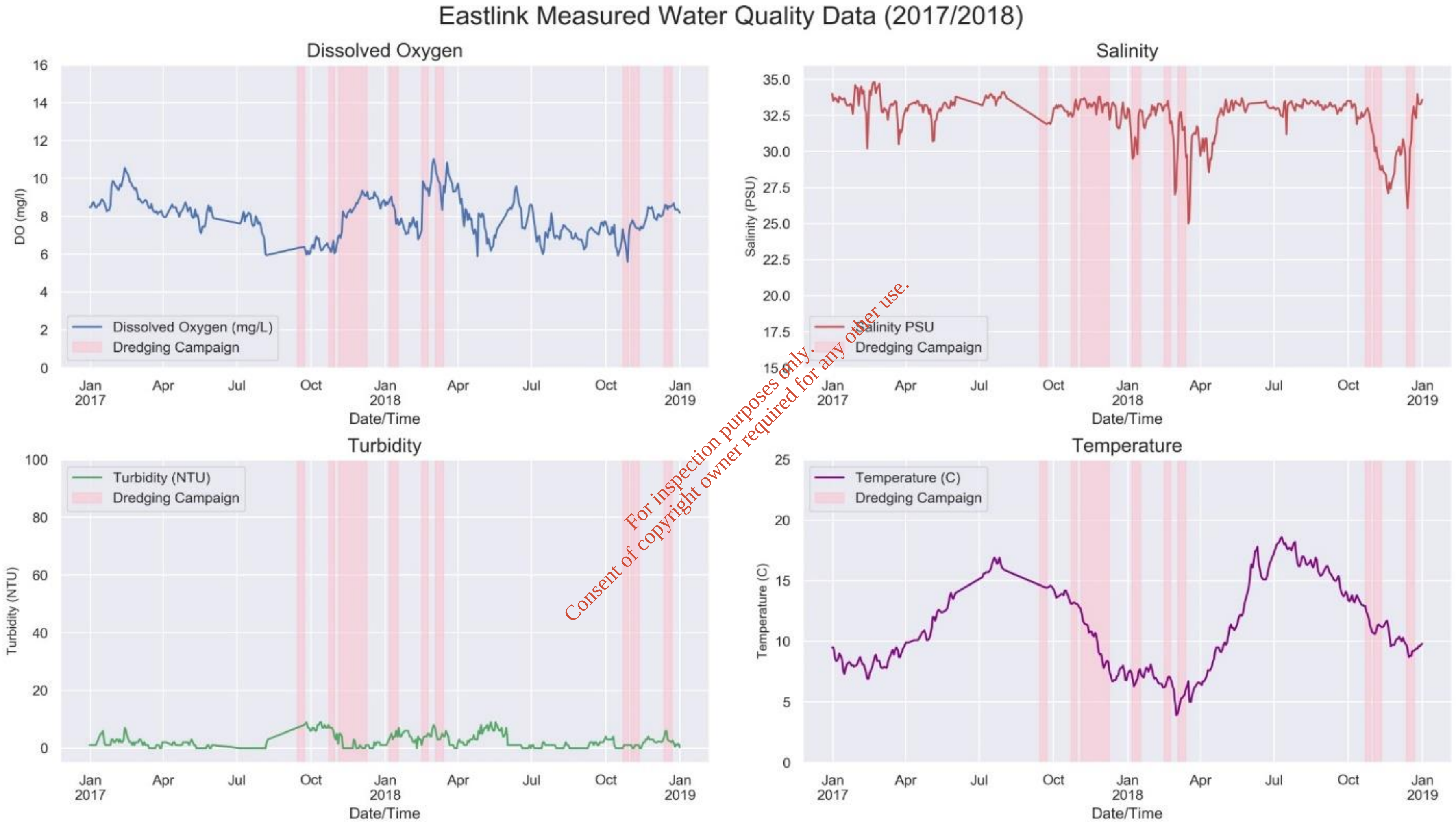

Figure 2-12 Plots of 24-Hour Averages for Water Quality measurements made at Eastlink Monitoring Station (2017-2018) -Dredging Periods shown by Pink Bars.

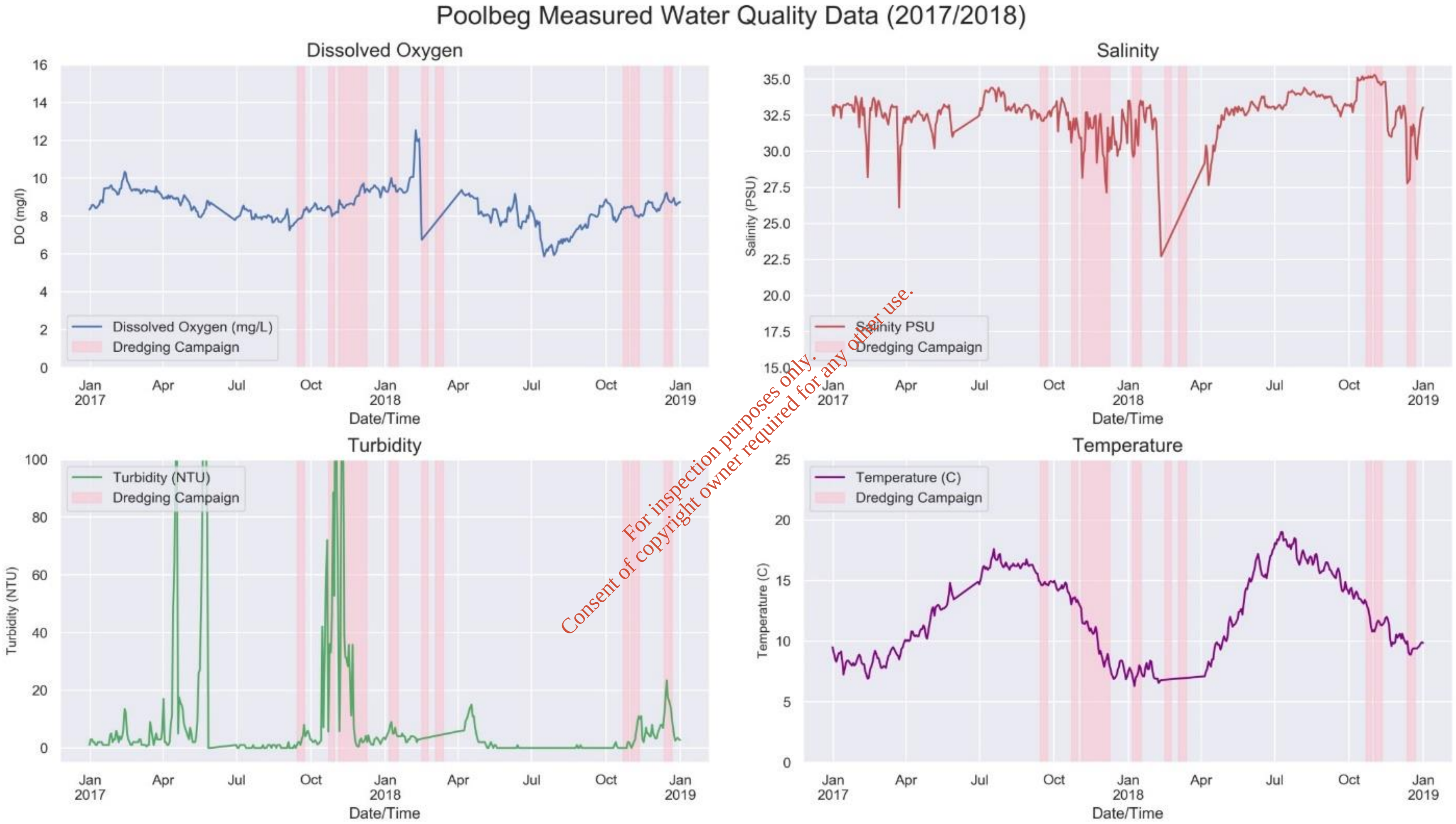

Figure 2-13 Plots of 24-Hour Averages for Water Quality measurements made at Poolbeg Monitoring Station (2017-2018) -Dredging Periods shown by Pink Bars.

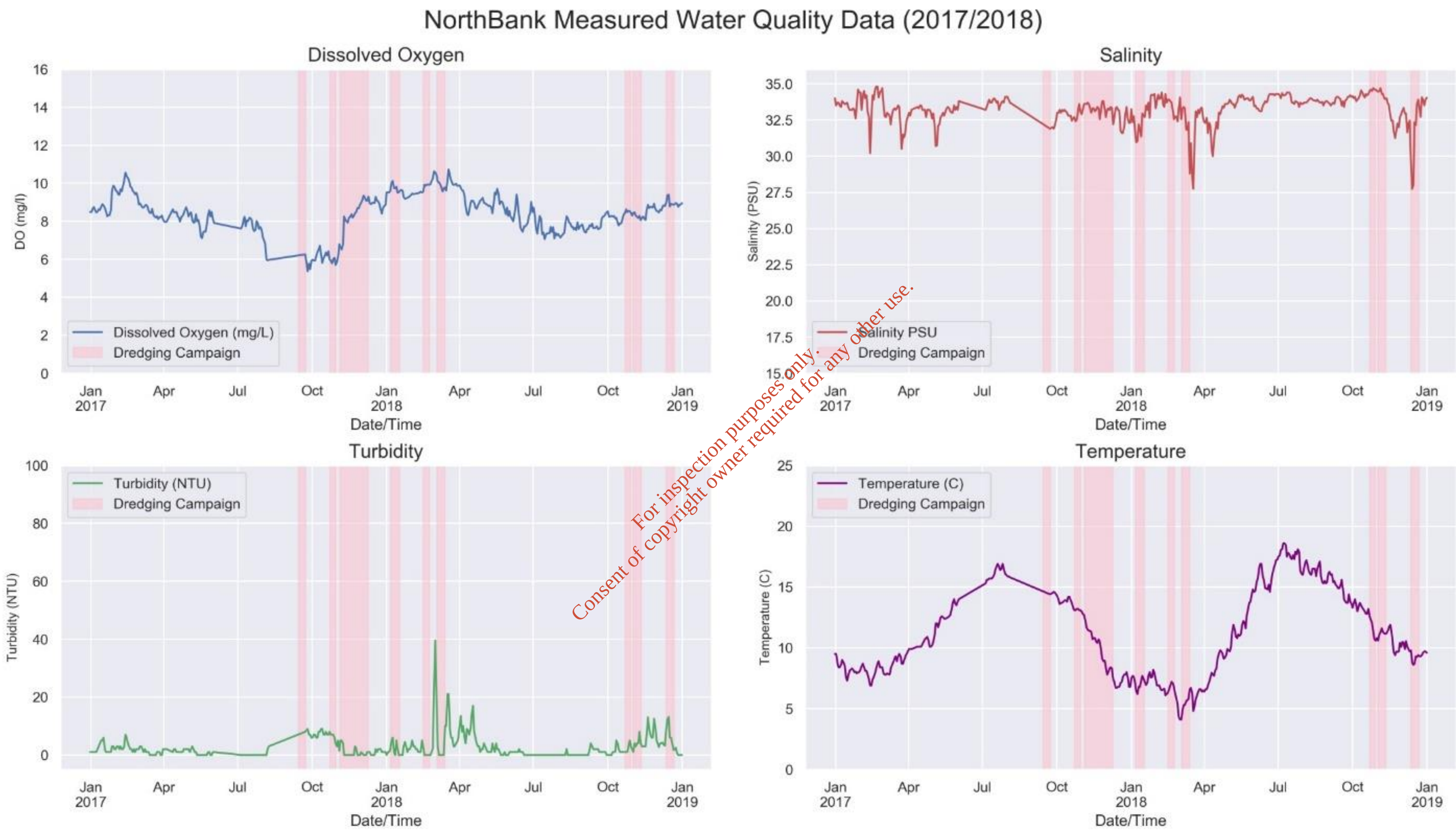

Figure 2-14 Plots of 24-Hour Averages for Water Quality measurements made at Northbank Monitoring Station (2017-2018) -Dredging Periods shown by Pink Bars.

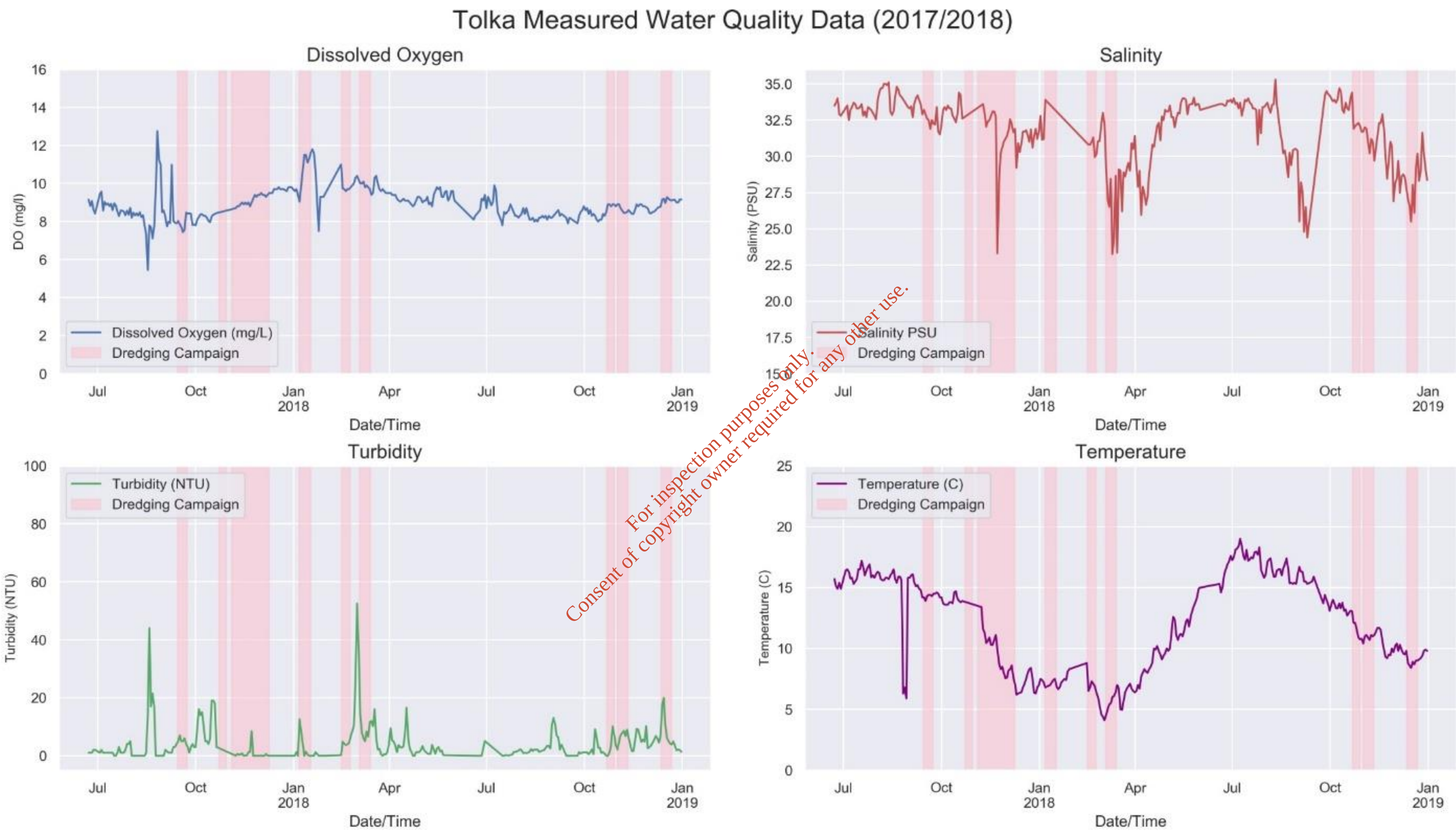

Figure 2-15 Plots of 24-Hour Averages for Water Quality measurements made at Tolka Monitoring Station (2017-2018) -Dredging Periods shown by Pink Bars.

In general, salinity remains relatively high at all sites, between 22 and 35 PSU. However, on some occasions significant freshwater influences are obvious, such as at East Link during major storm events when riverine freshwater inputs increase.

Temperature shows the expected seasonal trend. Temperature peaks at about 19°C during July and August (2018) at East Link, North Bank Light and Tolka Estuary. The temperature at the Poolbeg site is slightly higher compared to the other three sites, the higher temperatures here probably reflecting the influence of the nearby cooling water stream.

The two water quality parameters of greatest significance are turbidity and dissolved oxygen. Figure 2-11–Figure 2-15 shows that at its extremes, turbidity is very variable, particularly at Poolbeg where very high spikes of turbidity are sometimes measured. However, 95% of turbidity measurements are less than 35 NTU at Poolbeg, and less than 15 NTU at East Link, North Bank and Tolka Estuary. Many of the higher turbidity readings recorded are transient and local and do not represent events of any environmental significance or diagnostic value in assessing potential impacts.

Some periods of higher turbidity are discernible particularly at Poolbeg (Figure 2-13). Turbidity is volatile at Poolbeg Jetty. This appears to be mainly due to site characteristics and tidal effects particularly during low spring tides. Turbidity at all sites may be elevated during storm conditions. The October 2017 event results from the impact of storm Ophelia followed quickly by storm Brian. Maximum wave heights of 4.8m and 3.8m respectively were recorded in Dublin Bay during these storms. The impact of storm Ophelia on turbidity is illustrated in Figure 2-16 The February/March 2018 event was caused by storm Emma when a maximum wave height of 7.8m was recorded in Dublin Bay.

Investigations during elevated turbidity events have confirmed that ABR Project activities are not the cause of these events. Comparisons of mean turbidity during periods of 'dredging' and 'no dredging' activity showed that here is little difference between absolute values and no apparent pattern i.e. no consistent increase in mean turbidity during dredging episodes as reflected in the plots presented in Figures 2-11 to 2-14 above. In fact, mean turbidity is higher just as frequently during periods when no dredging was occurring. Measured turbidity results demonstrate that dredging campaigns in 2017/2018 did not cause any discernible increase in turbidity within the inner Liffey channel.

Finally, dissolved oxygen levels generally range between 5 and 12.8 mg/l. The mean dissolved oxygen values clearly indicate that oxygen levels are consistently close to saturation levels and no extended periods of oxygen sag or impacts of any dredging activities are obvious

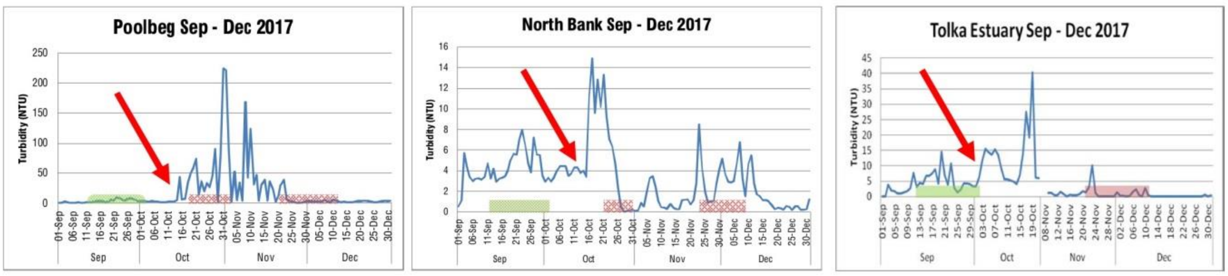

Figure 2-16 Mean daily turbidity September to December 2017 (periods of dredging are indicated by horizontal bars – green for maintenance dredge and red for dredge campaigns (onset of storm Ophelia is shown by the red arrows))

2.2.7.2 Within Dublin Bay

Turbidity is measured in the outer bay area using four Coast Eye Monitoring Buoys as part of the ABR Project monitoring programme. The buoys are shown in Figure 2-17 on the deck of the Commissioners of Irish Light vessel the ILV Granuaile at the time they were launched. Three of the buoys are positioned at the licensed dumping site near the Burford Bank (to the north, in the middle, and to the south). A fourth buoy is located about 2.5km to the northeast of Dalkey. This fourth buoy gives an indication of the background conditions in Dublin Bay away from any spoil dumping and dredging activities. All the buoys are moored in about 20m water depth. Their locations are shown in Figure 2-18.

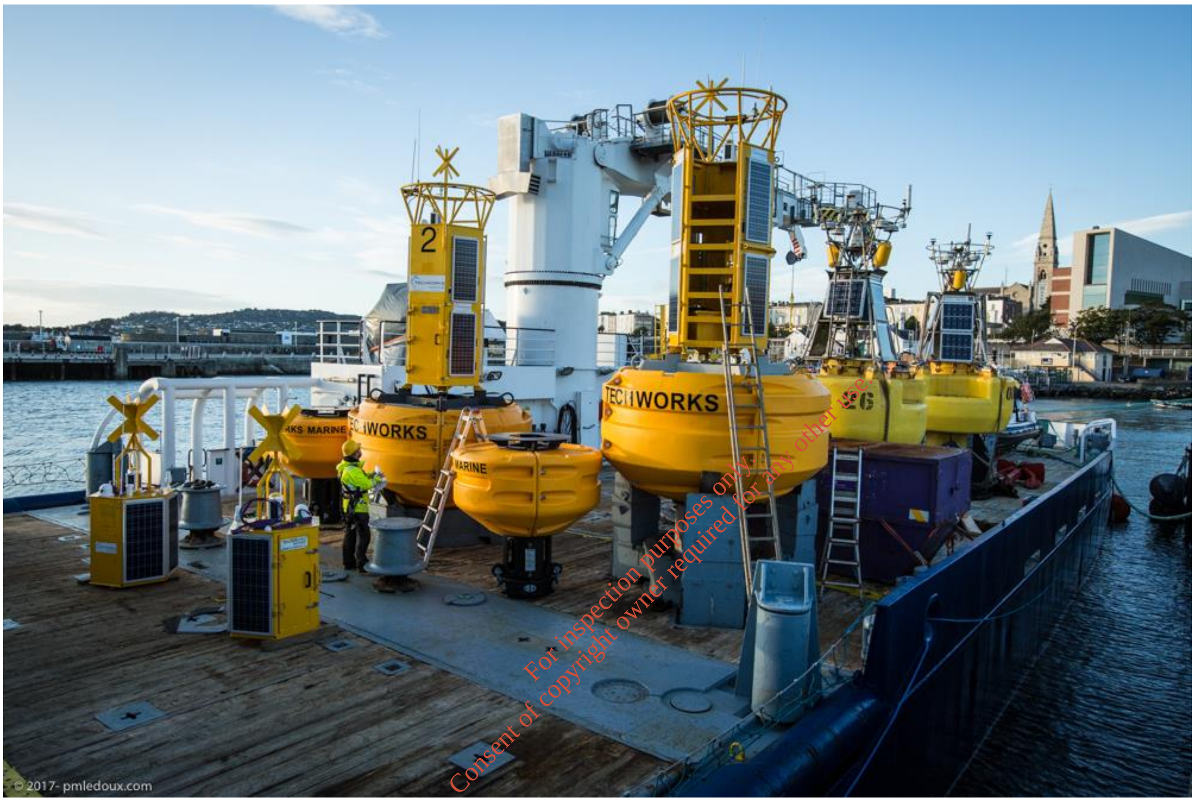

Figure 2-17 Coasteye Monitoring Buoys On Board the ILV Granuaile for Deployment in Dublin Bay

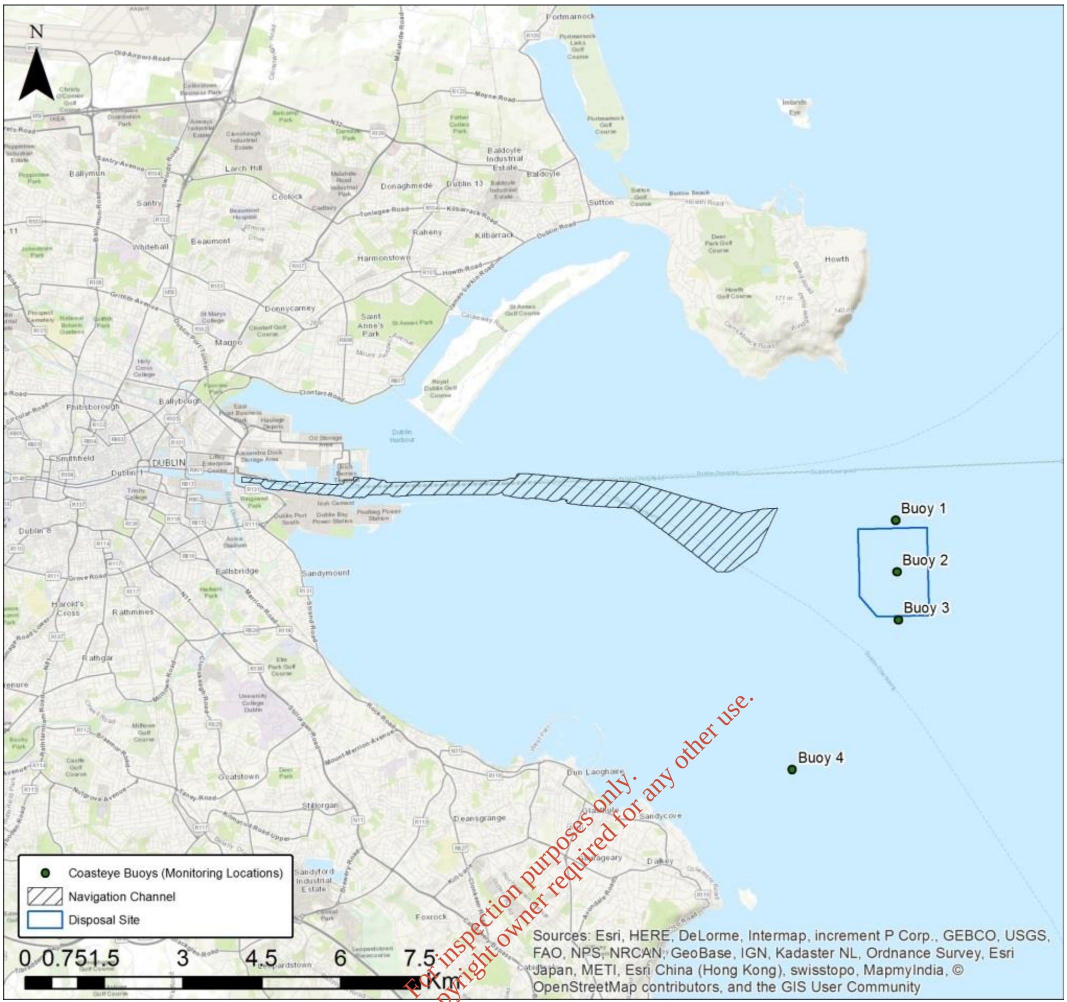

Figure 2-18 Locations of the Coasteye Monitoring Buoys at the Disposal Site

Turbidity and Total Suspended Solids in the Bay

As described earlier the relationship between turbidity and suspended solids in water is site specific. Therefore, sediment from outside the breakwaters was sampled and used to establish a relationship between turbidity and suspended solids for the outer Bay area. The sediment consisted of fine sand and suspensions were prepared from this sample to provide turbidity in the range 0 to 150 NTU. Turbidity (NTU) and TSS (mg/l) were measured for 75 suspensions to allow development of the blue calibration curve in Figure 2-19. The previous calibration curve for fine river sediments is also shown for comparison (red curve).

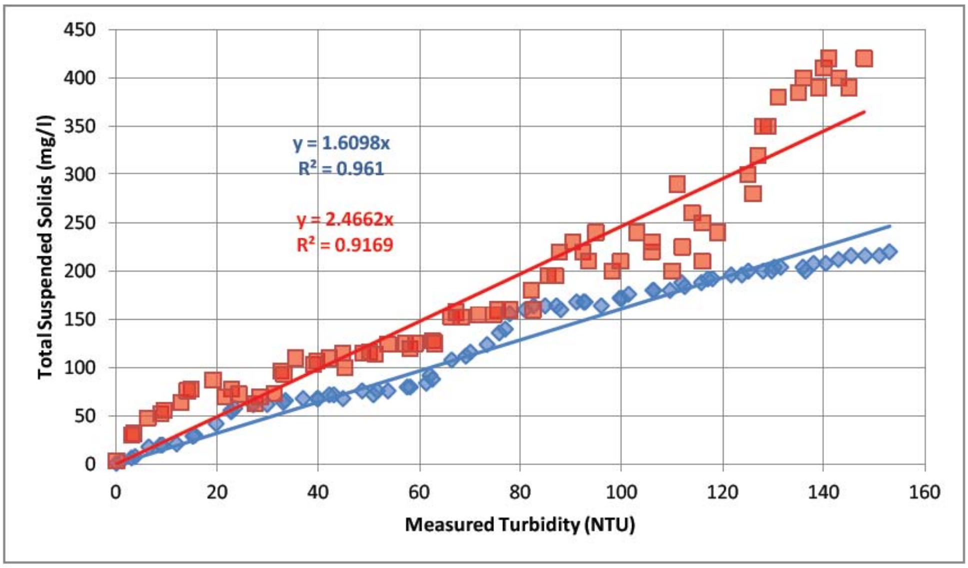

Figure 2-19 TSS versus Turbidity for suspensions of river bed silt sediment (red) and approach channel fine sand sediment (blue). Equations & r^2 values in corresponding colours for each series

Total suspended solids (TSS) (mg/l) is estimated at 1.61 times the turbidity (NTU) for the approach channel sediments (fine sand). The correlation coefficients squared show very good relationships in both calibration series ($r^2 > 0.90$). These relationships are site/sediment-specific but allow an estimate of TSS based on recorded turbidity. They indicate that turbidity increases more rapidly with increasing amounts finer sediments (silt) in suspension than with coarser sediments (fine sand).

Each of the monitoring buoys is equipped with three turbidity sensors: one near the water surface; one in mid water; and one nearer the bottom. Measurements at the buoys are made every fifteen minutes and are relayed to a shore-based computer for analysis and reporting. This gives a 3-dimensional record of water clarity and allows detection of any plume of sediment spreading from the dump site when dredge spoil is released. Data recording at each buoy began in September 2017.

Figure 2-20 to Figure 2-23 shows turbidity from September 2017 until December 2018 for all three depths at each of the four monitoring buoys. The pink vertical bars indicate periods when dredging took place and the grey lines highlights some of the storms that passed through Ireland during 2017 and 2018.

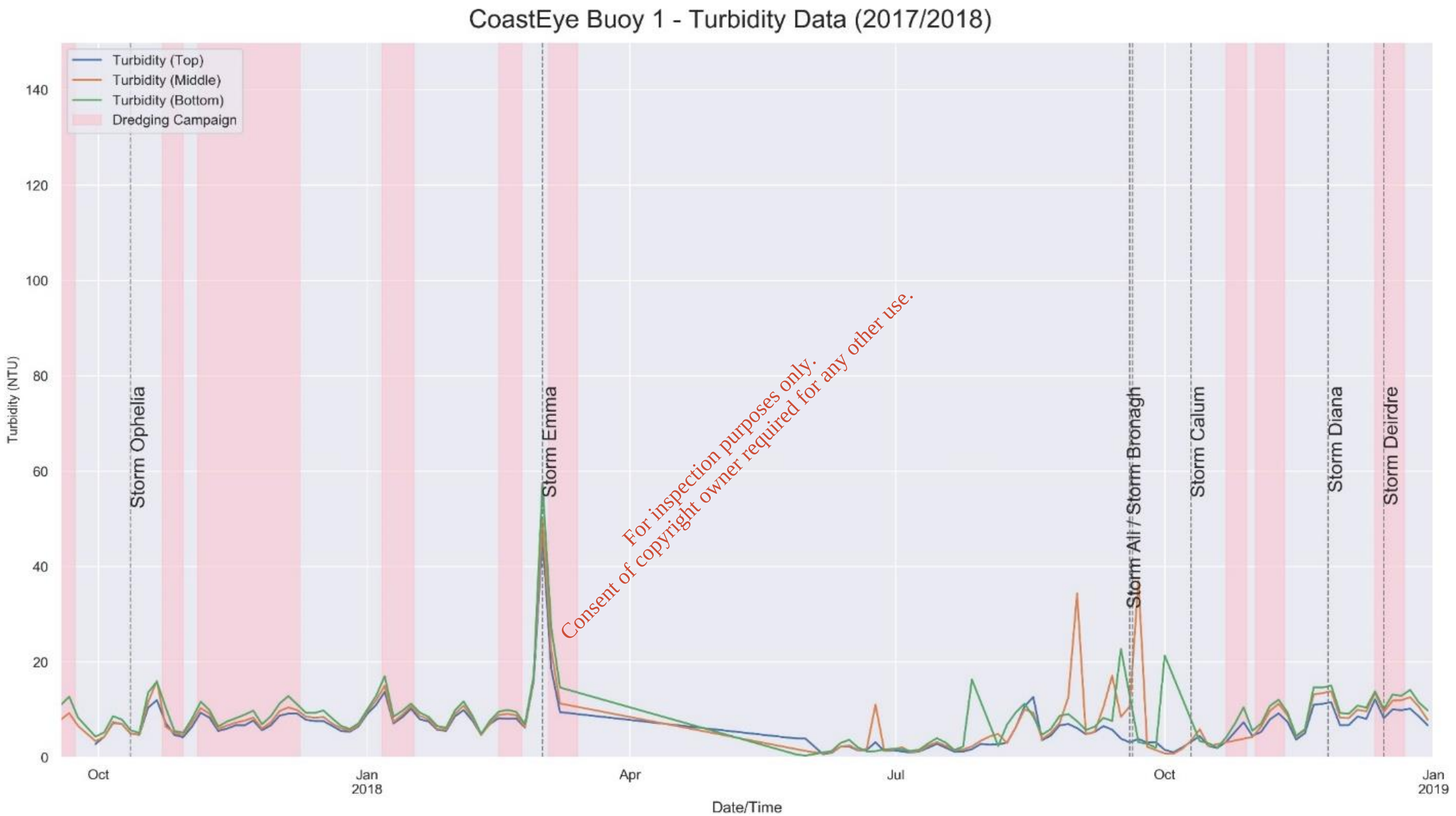

Figure 2-20 Plots of 24-Hour Averages for Turbidity measurements made at Coasteye Buoy 1 Monitoring Station (2017-2018) -Dredging Periods shown by Pink Bars.

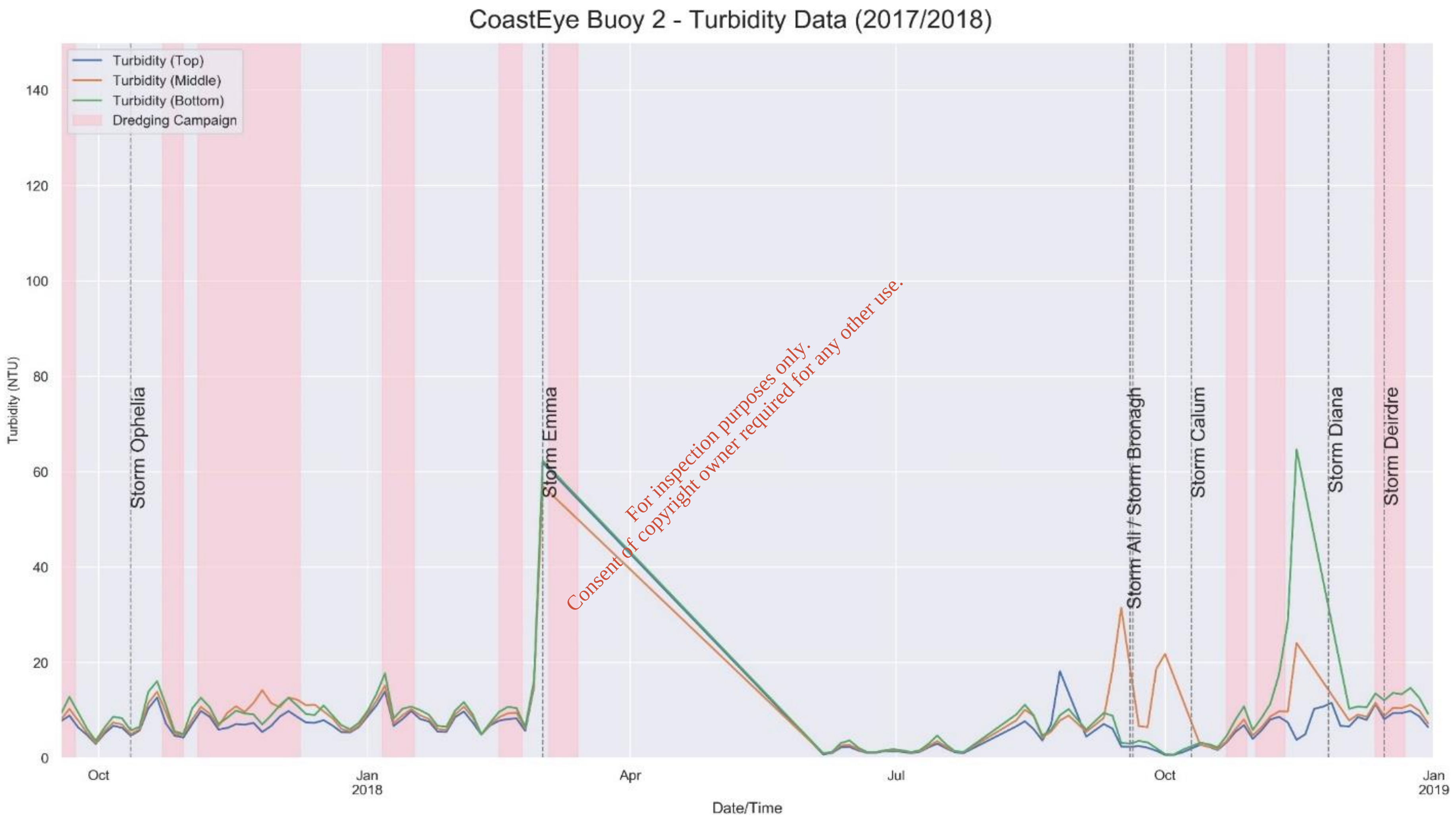

Figure 2-21 Plots of 24-Hour Averages for Turbidity measurements made at Coasteye Buoy 2 Monitoring Station (2017-2018) -Dredging Periods shown by Pink Bars.

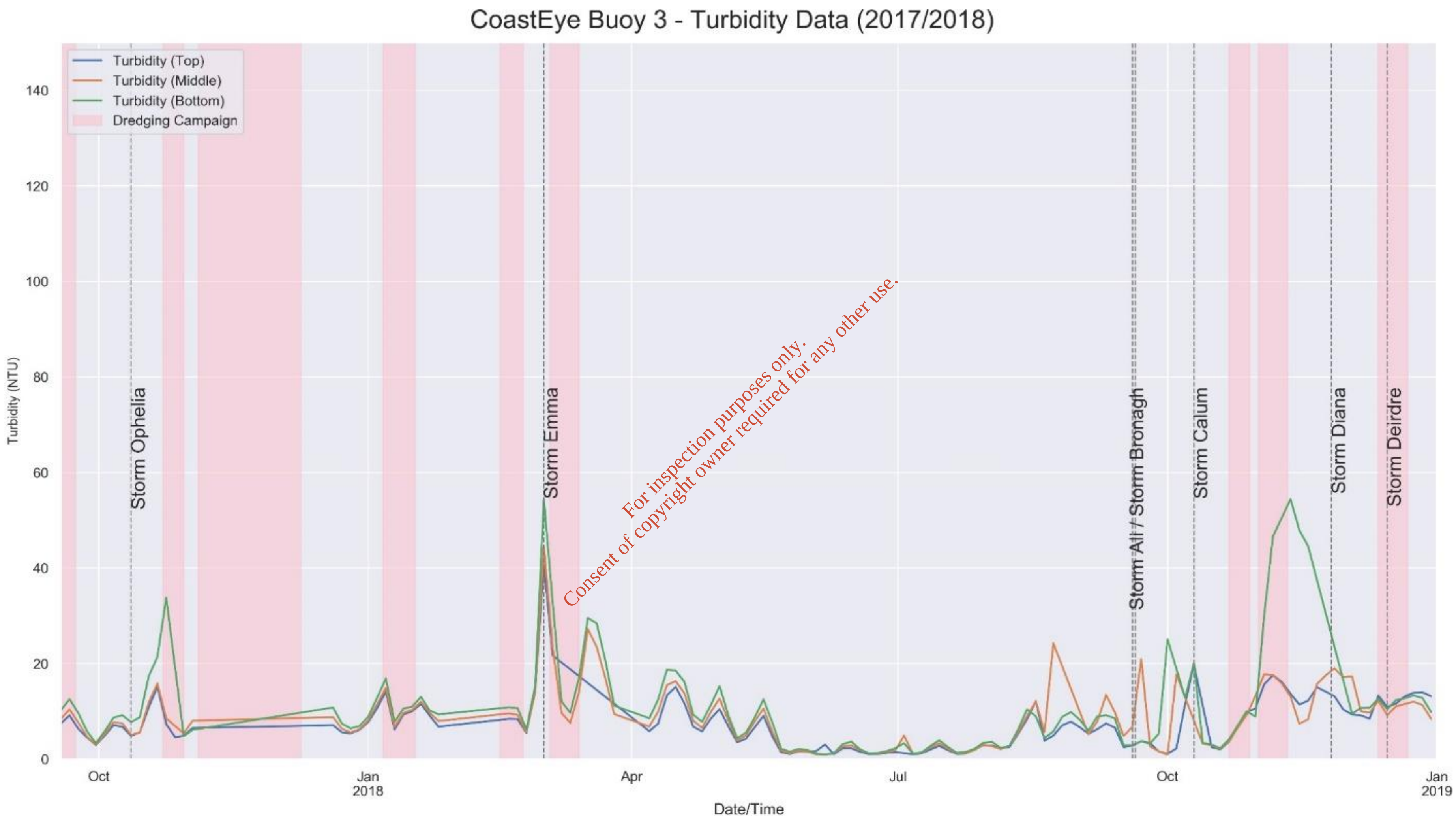

Figure 2-22 Plots of 24-Hour Averages for Turbidity measurements made at Coasteye Buoy 3 Monitoring Station (2017-2018) -Dredging Periods shown by Pink Bars.

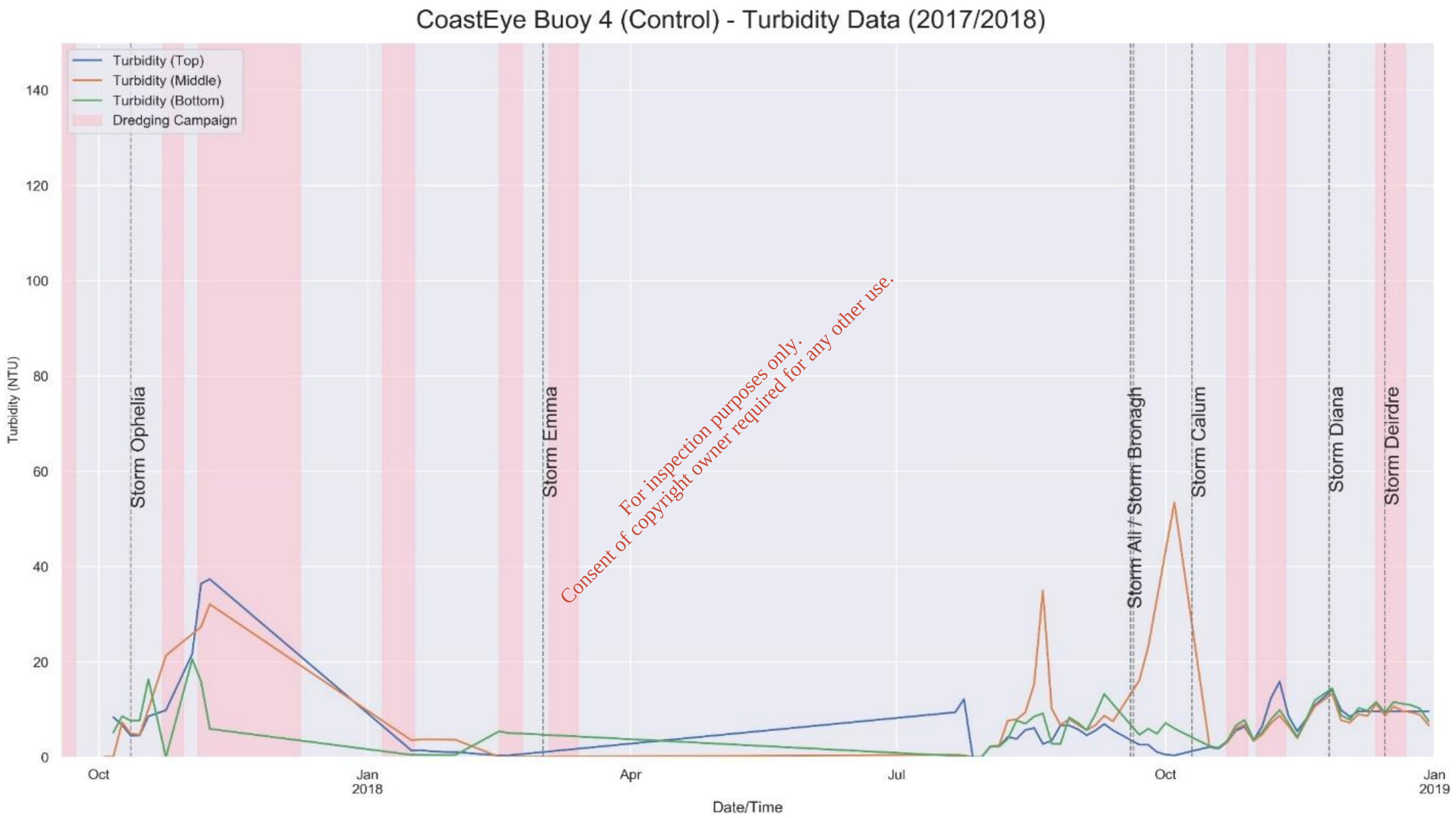

Figure 2-23 Plots of 24-Hour Averages for Turbidity measurements made at Coasteye Buoy 4 Monitoring Station (2017-2018) -Dredging Periods shown by Pink Bars.

Table 2-14 Summary Statistics for CoastBuoy 1 between Sept 2017 to Dec 2018

	Turbidity (NTU) - Top	Turbidity (NTU) - Middle	Turbidity (NTU) - Bottom
Mean	6.5	7.5	8.4
Max	46.5	50.2	57.5
Min	0.7	0.7	0.3
5%-ile	1.4	1.4	1.4
95 %-ile	11.2	14.2	15.0
n	43777	44929	44929

Table 2-15 Summary Statistics for CoastBuoy 2 between Sept 2017 to Dec 2018

	Turbidity (NTU) - Top	Turbidity (NTU) - Middle	Turbidity (NTU) - Bottom
Mean	11.4	12.8	14.1
Max	61.9	57.0	64.7
Min	0.6	0.9	0.7
5%-ile	1.2	1.5	1.4
95 %-ile	47.6	43.9	51.3
n	44929	44929	44929

Table 2-16 Summary Statistics for CoastBuoy 3 between Sept 2017 to Dec 2018

	Turbidity (NTU) - Top	Turbidity (NTU) - Middle	Turbidity (NTU) - Bottom
Mean	7.7	8.8	11.2
Max	40.7	44.6	54.5
Min	1.0	0.9	0.9
5%-ile	1.3	1.3	1.6
95 %-ile	16.4	18.1	33.8
n	44929	44929	44929

Table 2-17 Summary Statistics for CoastBuoy 4 between Sept 2017 to Dec 2018

	Turbidity (NTU) - Top	Turbidity (NTU) - Middle	Turbidity (NTU) - Bottom
Mean	7.9	8.2	4.8
Max	37.4	53.5	20.6
Min	0.0	0.0	0.0
5%-ile	0.6	0.1	0.5
95 %-ile	28.1	29.4	11.7
n	43201	43489	43201

It is apparent that mean daily turbidity is low at all sites, mean turbidity at the top and middle buoy is typically between 6 and 14 NTU. The average turbidity increases slightly with depth at all monitoring sites within the disposal site. As noted above the maximum turbidity values are heavily influenced by short transient episodes often during stormy weather that are of no environmental significance and are of limited diagnostic value in assessing water quality. By comparison the 95 percentile values show that turbidity is rarely above 50 NTU at any of the sites. Using the relationship established above between turbidity and total suspended solids from the Bay area, this is equivalent to a TSS of less than 100mg/l.

There is no obvious relationship between turbidity in Dublin Bay and dredging periods. A statistical analysis of the turbidity monitoring results is presented in the Dumping at Sea Permit S0024-01 Annual Environmental Report 2017. The results show no marked difference between turbidity at the dump site (Buoys 1, 2 and 3) and the control site (Buoy 4). The highest turbidity reading was in fact recorded at the control site. The results show that the dominant influence on turbidity levels is in fact the natural spring–neap–spring tidal cycles with the highest turbidity levels recorded close to the seabed.

In conclusion, the measured turbidity results demonstrate that both the dredging campaigns during 2017 and 2018 did not cause any discernible increase in turbidity above background levels. These site-specific detailed monitoring data have provided further understanding of existing turbidity levels and variations to provide added context for the assessment of potential significant effects of the proposed maintenance dredging campaigns.

2.2.8 Summary of Existing Water Quality

A review of available national monitoring information for the water bodies in the immediate vicinity of the proposed development site, in combination with real time monitoring data from the Port and Dublin Bay area and supported by computational water quality assessment has concluded:

- Overall WFD Water Quality between 2010-2015 for the Liffey Estuary Lower, Liffey Estuary Upper, Tolka Estuary and Dublin Bay is Moderate, Moderate, Moderate and Good respectively and the 'Dublin Urban' groundwater body (EA-G-008) has achieved and maintained 'good' status since the 2007-2012 WFD Monitoring Cycle as reported in 2017.
- Within the immediate vicinity of the loading activity , there are a number of protected areas under Article 6 of the WFD Directive including areas of Bathing and Recreational Water, Nutrient Sensitive Areas and Water Dependant Natura 2000 sites;
  - The bathing areas in the immediate vicinity of the loading area have been classified as Dollymount Strand - Good; Sandymount and Merrion Strands - Poor; Seapoint – Excellent in the 2017 Monitoring period. Sandymount and Merrion bathing waters are considered vulnerable to pollution due largely to surface water inflows, and faecal pollution by birds. Bathing water monitoring in the 2018 season has indicated excellent quality in most sampling instances to date.
  - The Liffey Estuary from Islandbridge weir to Poolbeg Lighthouse, including the River Tolka basin and South Bull Lagoon has been designated as a nutrient sensitive area.
  - The licensed dumping area is within the Rockabill to Dalkey SAC which is designated for Annex I qualifying interest Reef and Annex II species *Phocoea phocoena* (harbour porpoise.
- To date, the extent of achievement of GES under the MSFD has not been established for individual water bodies, consequently no further conclusions can be drawn currently in relation to the MSFD and the WFD water quality assessment is relied on until specific standards are identified.
- The EPA Water Quality in 2016: An indicators Report has stated that the Trophic status for the Liffey Estuary Lower, Tolka Estuary and Dublin Bay is Intermediate, Eutrophic and Unpolluted respectively;

It was also stated that levels of Winter Dissolved Inorganic Nitrogen (DIN) concentration trends have remained stable between 2007 and 2016. In addition, Winter Molybdate Reactive Phosphorus (MRP) concentration trends have remained stable for the Liffey Estuary Lower between 2007 and 2016 and the Tolka Estuary while the concentration of Dublin Bay has shown a significant decrease over this period.

- Marine Institute monitoring provides turbidity, temperature and dissolved oxygen datasets for the estuary and Dublin Bay which are comparable with the ABR Project monitoring datasets.
- DPC is carrying out extensive monitoring of water quality in Dublin Port and Dublin Bay as part of its ABR Project. Monitoring stations have been established in the Dublin Port and Bay areas to provide detailed information on relevant water quality parameters. Monitoring carried out by the Marine Institute has confirmed the turbidity and dissolved oxygen levels recorded during the ABR Project monitoring programme.
  - High frequency water quality monitoring as part of the ABR Project at various locations in the port has shown that average daily turbidity remains generally low and less than 10 NTU (equivalent to about 25mg/l Total Suspended Solids) but may be elevated during storms. The mean dissolved oxygen monitoring data also shows that oxygen levels are consistently close to saturation levels.
  - High frequency measurements of turbidity in Dublin Bay gives a 3-dimensional record of water clarity and shows that mean daily turbidity is low at all sites, typically around 10 NTU (equivalent to about 16mg/l Total Suspended Solids), and increases slightly with depth. There is no obvious relationship between turbidity and dredging periods.
  - Water quality has been satisfactory during the monitoring programme 2017 to date and has not been impacted by loading or dumping during dredging operations. Measured turbidity results demonstrate that the dredging campaigns during 2017 and 2018 did not cause any discernible increase in turbidity above background levels.
- As discussed in detail in Section 3, water quality model simulations, undertaken to assess the likely water quality impact of dredging and disposal operations on general water quality and for protected areas, have concluded that there will be no significant elevation in suspended solids **outside the immediate zone of the operations**. To further support these predictions, it is noted that ongoing Water Quality monitoring undertaken during the ABR Project Capital dredging works and routine maintenance dredging works have demonstrated that these disposal operations did not cause any discernible increase in turbidity above background levels. In addition, the potential impact on the dispersion of the plume (or associated nutrient concentrations or other water quality indicators) in the vicinity of the Ringsend WWTW Outfall was also examined with no change predicted in the water quality of these receiving waters.

2.3 Likelihood of Impacts

The likelihood of environmental impacts arising due to the maintenance dredging loading and disposal at sea activities is assessed in relation to the dredging and disposal operations. The potential impacts on water quality have been identified for assessment.

The significance of any environmental effect is rated based on the magnitude of the impact and the importance of the attribute as detailed in Section 2.1. Based on the criteria detailed in NRA Guidelines the Dublin Bay coastal water body, the Liffey Estuary Lower and Tolka Estuary water bodies are considered to be of "extremely high" importance due to its designation under the Urban Waste Water Treatment Directive

(91/271/EEC) and proximity to the South Dublin Bay and Tolka Estuary SPA designated under EU Birds Directive (79/409/EEC). The Liffey Estuary Upper is considered to be of "very high" importance due to its quality and value on a regional scale.

The proposed maintenance dredging campaigns at Dublin Port has the potential to directly impact upon the ‘Liffey Estuary Lower’ transitional water body (EA_090_0300) and ‘Dublin Bay’ coastal water body (EA_090_0000) given the location of the proposed maintenance dredging campaigns. The potential to indirectly impact upon the adjacent 'Tolka Estuary' (EA_090_0200) ‘and Liffey Estuary Upper’ river water body (EA_090_0400), transitional water bodies has also been considered.

2.3.1 Potential Impacts

For the purposes of this assessment the main impacts to water quality is mobilised suspended sediment caused by; maintenance dredging operations within the loading area and the disposal of spoil at the offshore disposal site. Increases in suspended sediments and turbidity levels from dredging and disposal operations may under certain conditions have adverse effects on water quality, water dependant habitats and aquatic ecology through; physical disturbance and also through reduced light penetration into the water column leading to the potential reduction in photosynthesis activity and a decrease in dissolved oxygen (DO) levels. Such impacts can be can prevent the achievement of WFD objectives and could result in the deterioration of status in extreme circumstances

For maintenance dredging and disposal operations, the extent of these environmental affects is near-field and temporary generally only lasting as long as dredging operations are taking place.

2.4 Description of Likely Significant Impacts

2.4.1 Maintenance Dredging & Disposal Operations

Dredging operations will cause temporary suspension and release of sediments at the loading sites. Spoil disposal operations will also give rise to temporary sediment plumes at the licensed dumping site at the approaches to Dublin Bay. Dredging loading operations have been designed to minimise the disturbance and escape of material at the seabed and during removal through the water column. Proposed individual loading operations are of relatively short duration and intermittent in nature. It is envisaged that disposal operations occur at the licensed dumping site which is naturally dispersive for fine sediments. Nevertheless, significant amounts of dredge material will be removed and deposited at the dumping site over a relatively extended period.

The magnitude of the potential impact from suspended sediment due to dredging and disposal is considered to have a *minor adverse* risk to water quality. The localised significance of the environmental effect is therefore *significant adverse* in the absence of mitigation based on the extremely high sensitivity of the receiving environment.

2.5 Mitigation Measures

In absence of mitigation, the maintenance dredging and disposal works have the potential to have *Significant Adverse* impacts on the aquatic environment.

With these considerations in mind, detailed mitigation has been incorporated into the design of the proposed maintenance dredging campaigns to minimise its potential impact on the water environment. This section details the mitigation measure that will be employed on site during the maintenance dredging campaign.

2.5.1 Suspended Sediment and Sedimentation

Suspended sediment, including cobbles, gravels, sands, silts and mud is the single main pollutant to the aquatic environment generated by the proposed maintenance dredging campaigns. In this instance, the primary source of suspended sediments will arises during the loading and dumping operations. The adoption of appropriate sediment controls during maintenance dredging is essential to prevent increased suspended sediment concentrations.

Dredging and Disposal

DPC completed its first winter capital dredging season (October 2017 – March 2018) as part of the ABR Project. This dredging campaign was fully compliant with the requirements of all the development consents, as confirmed by high resolution environmental monitoring results reported in the Annual Environmental Report submitted to the Office of Environmental Enforcement (OEE) in March 2018. The monitoring included year-round real-time measurement of water quality parameters in the Liffey Channel and in Dublin Bay at eight monitoring stations and at various water depths. This was supplemented by sediment plume and hydrographic monitoring that validated Plume Dispersal Modelling.

A Dredging Management Plan was developed for the ABR Project and is set out in *Alexandra Basin Redevelopment Project Construction Environmental Management Plan (CEMP) Rev. F August 2018*. The mitigation proposed for dredging operations in the 2020-2021 Maintenance Dredging Campaign has been informed by the ABR Project monitoring and experience working in the same locations. The following key relevant mitigation measures will apply to each dredging campaign:

- The maintenance dredging activity will be carried out during the months (April – September) to avoid overlap with the ABR Project capital dredging works.
- No over-spilling from the dredger will be permitted while the dredging activity is being carried out within the inner Liffey Channel.
- The dredger's hopper will be filled to a maximum of 4,100 cubic metres (including entrained water) to control the volume of sediment released at the dumping site.
- Full time monitoring of Marine Mammals within 500m of loading and dumping operations will be undertaken in accordance with the measures contained in the Guidance to Manage the Risk to Marine Mammals from Man-Made Sound Sources in Irish Waters (NPWS 2014).
- A documented Accident Prevention Procedure will be put in place prior to commencement
- A documented Emergency Response Procedure will be put in place prior to commencement

- A full record of loading and dumping tracks and record of the material being dumped will be maintained for each trip.
- Dumping will be carried out through the vessel's hull.
- The dredger will work on one half of the channel at a time within the inner Liffey channel to prevent the formation of a silt curtain across the River Liffey.

In circumstances where the above mitigation measures are employed during the proposed maintenance dredging and disposal operations, the potential impact to receiving water environment will be negligible thus reducing the significance of environmental effect to *Imperceptible.*

2.6 Residual Impacts

Thus, in circumstances where the appropriate mitigation measures are fully implemented during the proposed maintenance dredging campaigns as outlined above, the impact of on the water quality in the area will be imperceptible.

Accordingly, the 2020-2021 maintenance dredging campaign will not have a significant effect on the water quality of the receiving waters. It can therefore be concluded that the proposed maintenance dredging campaigns are compliant with the requirements and environmental objectives of the EU Water Framework Directive and the other relevant water quality objectives for these water bodies.

2.7 Potential Cumulative Impacts

Potential cumulative impacts may arise from the 2020-2021 maintenance dredging when combined with other existing and/or approved projects. In accordance with the European Commission (2017) and EPA Draft Guidelines (2017), existing and/or approved projects with the potential for cumulative impacts have been identified. Cumulative impact assessments have been undertaken in this section for relevant pressures that could potentially give rise to cumulative impact. Each development with the potential to impact on the water environment has been considered through a review of the environmental supporting information (where available) for the existing or approved developments.

2.7.1 Dublin Port Company ABR Project

The *Alexandra Basin Redevelopment (ABR) Project* is the first major infrastructure project to be brought forward for planning and other consents from Dublin Port Company's (DPC) Masterplan 2012 to 2040. The Masterplan recognised the need to provide capacity in the Port to cater for 60m (million) gross tonnes of cargo by 2040 and was approved by the Board of DPC in February 2012. An Bord Pleanála granted permission for the ABR Project on 8th July 2015 (29N.PA0034).

The ABR Project comprises a number of engineering works set out in DPC's Masterplan document, mainly:

- Works at Alexandra Basin West including construction of new quays and jetties, remediation of contamination on the bed of the basin, capital dredging to deepen the basin and to achieve the specified depths of -10m Chart Datum (CD) at the new berths.

- Infilling of the Basin at Berths 52 & 53 and construction of a new river berth with a double tiered Ro-Ro ramp.
- Deepening of the fairway and approach to Dublin Port to increase the ruling depth from -7.8m CD to -10.0m CD.

In terms of impact assessment, both the ABR Project are part of Dublin Port Company's Masterplan and have been planned and designed as part of a structured and integrated development programme that considers environmental impact and cumulative effects. The most relevant element of the ABR Project in considering potential cumulative impacts on water quality is the capital dredging elements. Dredging undertaken as part of the ABR Project will occur in the same water body (Liffey Estuary Lower) and spoil dumping will use the same licensed dumping site at the approaches to Dublin Bay. DPC will implement mitigation through avoidance of overlap of dredging activity with the ABR project. This temporal separation will mitigate cumulative effects on water quality. The extensive mitigation measures described above will be implemented during the dredging maintenance dredging campaigns.

On the basis of scheduling the maintenance dredging campaigns to avoid overlap and comprehensive mitigation measures applied it can be concluded that there will be no cumulative effects on water quality.

2.7.2 Irish Water – Ringsend Wastewater Treatment Plan (WwTP) Upgrade Project

Irish Water has submitted a planning application for strategic infrastructure development to An Bord Pleanála (Ref. PL29S.301798) seeking permission to further progress the upgrade of the Ringsend Wastewater Treatment Plant (WwTP). The need for additional wastewater treatment capacity has previously been identified to meet increased commercial, domestic and industrial demand together with a requirement to meet higher environmental standards in the Lower Liffey Estuary which is designated as a "sensitive" water body requiring higher treatment standards. As a result, Irish Water propose to expand the existing wastewater treatment plant to 2.4 million PE capacity and to upgrade the Ringsend WwTP using enhanced Nereda© treatment technology to allow for improved environmental outcomes.

Estimates of the potential reduction of pollutants due to the upgrade are provided in the *Ringsend Wastewater Treatment Plant Upgrade Project EIAR* (June 2018). These are reproduced here in Table 2-18. It has been estimated in process proving trials that the proposed upgrade and enhanced treatment process will result in a substantial reduction in BOD, sediment and nutrient loads with significant positive environmental benefits.

The Ringsend Wastewater Treatment Plant Upgrade EIAR (June 2018) finds that there is potential for a temporary negative but not significant effect in the Tolka Estuary during the upgrade due to a number of secondary treatment tanks being temporarily out of operation. However, it concludes that the benefit of the permanent positive impact after the completion of construction outweighs the insignificant, temporary negative impact observed during the construction phase. Therefore, given the positive impact of the WwTP upgrade on receiving water quality it is unlikely that there will be any cumulative adverse effects when considered in combination with the 2020-2021 maintenance dredging campaigns.

Table 2-18: Final Effluent Discharge – Load Reduction Summary			
Parameter	***Current Average***	***Future Average***	***% Reduction***
BOD (Biochemical Oxygen Demand)	8,739 kg/day	7,206 kg/day	17.5%
Suspended Solids	16,205 kg/day	10,508 kg/day	35.2%
Ammonia	4,370 kg/day	600 kg/day	86.3%
DIN (Dissolved Inorganic Nitrogen)	5,939 kg/day	4,804 kg/day	19.1%
MRP (Molybdate Reactive Phosphate)	1,056 kg/day	420 kg/day	60.2%

Measures intended to avoid or reduce these potentially significant effects on the European sites were proposed as part of the Stage Two Appropriate Assessment, and there will be no adverse effect on the integrity of any European site as a result.

The Ringsend WwTP project is sufficient spatially separated from proposed maintenance dredging project to prevent any significant in-combination visual or noise disturbance on SPA feature species at construction stage. With the measures proposed to avoid or reduce the likely significant pollution effects predicted for the WwTP Project, there will be no adverse effects upon the integrity of any European site. When both projects are considered together, there will be no additional in combination effects.

2.7.3 Howth Yacht Club Project

Howth Yacht Club are holders of a Dumping at Sea Permit (Ref. No. S0010-01) granted in August 2011 for capital works at the inner marina basin at Howth Harbour to extend the existing marina to provide additional berths. Loading and dumping activities must be completed within one year of the date of commencement of activities. Dumping of the uncontaminated dredged material is to be at the licensed dumping site at Burford Bank in Dublin Bay.

The Burford Bank dumping site is an established spoil ground which has been used previously by Howth Yacht Club for the disposal of dredged material and is also currently permitted for use by Dublin Port Company (Dumping at Sea Permit S0024-01). Under permit S0010-01, Howth Yacht Club are permitted to load and dump a maximum of 120,000 tonnes of dredged material over a one year period. In its application for a Dumping at Sea Permit Howth Yacht Club estimated a maximum daily quantity for dumping of 1,200 tonnes and 800 tonnes in each load. It also suggested a spring or winter commencement and campaign duration of six months.

The annual load is equivalent to approximately 6% of the annual permitted quantity of material that may be dumped at this site by Dublin Port Company under Dumping at Sea Permit S0024-01. While dumping by Dublin Port Company is restricted to the winter months (October to March), no such restriction applies to Howth Yacht Club activities. Given the possibility of a spring commencement to dredging in Howth it is possible, therefore, that there could be temporal separation of some if not all dredging activities under these two permits.

Only Howth Yacht Club and Dublin Port Company currently hold Dumping at Sea Permits for use of the Dublin Bay dumping site and the Howth permit has been in place since 2011 without commencement. The dumping site has been used by a number of users over many years without significant environmental effect. A *Marine Benthic Survey of the Dredge Spoil Disposal Area at the Burford Bank (June 2016),* ABR Dublin

Port Company concluded that the biological communities identified from the dumpsite and the adjacent areas were similar to those recorded by Walker and Rees (1980), who had identified communities present in Dublin Bay dominated by similar fauna over 20 years earlier. This indicates the stable nature of the benthos (which water quality elements support) within Dublin Bay and around the area of the dumpsite. Results from the above survey generally concur with the findings of previous surveys of the area and indicate stable benthic communities at high biological status in the area of the dumpsite.

Therefore, it is unlikely that any significant cumulative effects will occur due to the Howth Yacht Club proposed project.

2.8 Conclusions

Baseline water quality within the receiving environment was established through review of national monitoring data used to establish water quality status in the context of the EU Water Framework Directive (WFD) and supporting environmental standards. Recent high-frequency monitoring data collected during Dublin Port Company's ABR Project was also reviewed.

Using baseline water quality data and site specific water quality model simulation outputs, an assessment of the 2020-2021 Maintenance Dredging loading and dumping activities was conducted to determine the likelihood of significant impacts on water quality using the criteria for rating significance and magnitude as set out in the National Roads Authority (NRA) publication "*Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*" (NRA, 2008) and appropriate mitigation measures to reduce impacts were proposed, where necessary.

In circumstances where the appropriate mitigations measures are fully implemented during the proposed maintenance dredging campaigns, the impact to the water quality in the area will be imperceptible. The loading and dumping activities is therefore not expected to have a significant effect on the water quality of the receiving waters.

It can therefore be concluded that the proposed maintenance dredging campaigns are compliant with the requirements and environmental objectives of the EU Water Framework Directive and the other relevant water quality objectives for these water bodies.